



SCHOOL OF ECONOMICS AND MANAGEMENT

Department of Business Administration

FekH99

Entrepreneurship and Business Management

Spring 2026

Innovation clusters in a digital world

How do the companies in innovation clusters practice collaboration in the context of digitalization, and how does this affect the advantages of geographic proximity?

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Sammanfattning

Examensarbetets titel: Innovationskluster i en digital värld: *Hur arbetar företag i innovationskluster med samarbete i en digitaliserad kontext, och hur påverkas fördelarna av geografisk närhet?*

Seminariedatum: 2026-06-04

Kurs: FEKH99, Examensarbete inom entreprenörskap och innovation på kandidatnivå 15 hp.

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Fem nyckelord: Innovationskluster, Samarbete, Digitalisering, Geografisk närhet, Kunskapsöverföring

Syfte: Att förstå hur företag i innovationskluster arbetar med samarbete i en digitaliserad miljö, och hur detta förändrar fördelarna av geografisk närhet.

Metod: Studien använder en kvalitativ forskningsmetod där semistrukturerade intervjuer genomfördes, och tematisk analys användes för att identifiera mönster i det empiriska materialet.

Teoretiskt perspektiv: Studien bygger på teorier inom innovationskluster, kunskapsöverföring, samarbete och digitalisering.

Resultat: Företag använder en hybrid kombination av digitalt och fysiskt samarbete, där geografisk närhet fortfarande är viktig trots digitalisering.

Slutsats: Digitalisering har omformat snarare än ersatt den geografiska närhetens roll, eftersom fysisk interaktion och medlemskap i innovationskluster fortfarande är betydelsefulla.

Abstract

Title: Innovation clusters in a digital world: *How do the companies in innovation clusters practice collaboration in the context of digitalization, and how does this affect the advantages of geographic proximity?*

Seminar date: 2026-06-04

Course: FekH99, Bachelor Degree Project in Entrepreneurship and Innovation

Management, Business Administration, Undergraduate level, 15 University credits.

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Key words: Innovation cluster, geographic proximity, Collaboration, Digitalization, Knowledge transfer

Purpose: To understand how companies in innovation clusters practice collaboration in the context of digitalization, and how this affects the advantages of geographic proximity?

Methodology: The study uses a qualitative approach in which semi-structured interviews were conducted, and thematic analysis was applied to identify patterns in the empirical material.

Theoretical perspective: The study is based on theories related to innovation clusters, knowledge transfer, collaboration, and digitalization.

Result: Companies use a hybrid combination of digital and physical collaboration, where geographic proximity remains important despite digitalization.

Conclusion: Digitalization has reshaped rather than replaced the role of geographic proximity, as physical interaction and cluster membership continue to remain important.

Acknowledgment

A huge thank you to all the individuals who agreed to participate in the interviews and thereby made this thesis possible. We would also like to thank our supervisor, Joakim Winborg, for guiding us throughout the writing process and continuously challenging us to develop a well structured and thoughtfully argued thesis. Additionally, we would like to thank all the professors and course directors throughout our bachelor's degree who have prepared us for the challenge of successfully writing our final thesis.

Lastly, we would like to thank our families for their support throughout the years leading up to this moment. Without you, completing our bachelor's degree and taking the next step toward an exciting future would have been significantly more difficult.

Place: Lund

Date: May 29th 2026

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1. Introduction

1.1 Background

Localized industries or commonly referred to as clusters, is not a new phenomenon. Marshall (2013) described the localization of industries as a result of natural causes, such as the condition and access to specific resources. Clusters became highly sought by experts within the specific field due to the constant job market within the area. By being closely connected to each other it enhances the cluster members productivity, flexibility and efficiency (Porter, 1998).

In modern context, the importance of clusters is reflected in countries such as Sweden, which is recognized as a global leader in innovation (Patent och registreringsverket, 2025). In 2025, the country ranked second out of 139 economies in the Global Innovation Index and has consistently been placed among the top three for six consecutive years. This high ranking reflects Sweden's strong performance in generating innovation outputs, demonstrating its ability to effectively translate investments in research and development into tangible results.

One of Sweden's key strengths lies in its well-developed system of innovation clusters (Patent och registreringsverket, 2025). For instance, Sweden has strong innovation clusters in Stockholm, particularly within digital communication and technology, and in Gothenburg, within transportation and engineering, with both cities ranked among the world's top 100 leading innovation hubs. The longstanding success in innovation is due to the close collaboration between the universities, government, industry, and innovation clusters play a central role in facilitating such interactions.

The establishment of new innovation clusters is supported by the Swedish government by investing in new projects such as a project with the innovation authority Vinnova (Regeringskansliet, 2023). They have been directed to establish new innovation clusters supporting the whole country's development within innovation and technology. In addition, one of Vinnova's goals is that before 2035 there should be up to five world leading excellence clusters focusing on research and innovation in Sweden (Vinnova, 2025). The aim is to be competitive in areas such as artificial intelligence, biotech and energy technology. Research, thereby, consistently demonstrates that innovation clusters in Sweden are not declining, but rather continuing to grow.

1.2 Problematization

Recent developments in digitalization have, however, introduced new ways for companies to interact, collaborate, and exchange knowledge across geographic boundaries. As one of the most significant transformations in contemporary society, digitalization has reshaped how companies operate and engage with one another (Hagberg et al. 2016). Through the use of digital tools, companies can collaborate across distances without being physically co-located (Verhoef et al. 2021). Consequently, knowledge can increasingly be shared and accessed regardless of spatial proximity.

This highlights a fundamental paradox, while digitalization enables collaboration across geographic distances (Verhoef et al. 2021), innovation clusters continue to expand (Vinnova, 2025). This development raises critical questions regarding how companies practice collaboration in increasingly digitalized environments, whether different forms of collaboration facilitate different types of knowledge transfer, and to what extent digitalization alters the advantages traditionally associated with geographic proximity. Despite these developments, existing research such as Porter (1998), Marion and Fixson (2020) and Heidenreich and Mattes (2025), have not fully addressed how digitalization affects how collaboration is practiced within innovation clusters and its implications for geographic proximity.

Porter (1998) only examines clusters in general, rather than innovation clusters specifically and their advantages, highlighting the importance of proximity for interaction and knowledge transfer. The study was also conducted prior to recent developments of digitalization. More recent research has begun to address digitalization in relation to innovation, but often without connecting it directly to the role of geographic proximity within innovation clusters. Marion and Fixson (2020) show how digitalization has fundamentally changed the nature of innovation, and further highlight that the use of digital tools is associated with collaboration, knowledge creation and knowledge sharing. However, their focus is primarily on digital innovation processes rather than on how these developments affect the continued relevance of geographic proximity in innovation cluster settings.

In addition, Heidenreich and Mattes (2025) discuss the development and advantages of innovation clusters due to geographic proximity. They also highlight that innovation clusters

may struggle to adapt to new challenges, such as digitalization, due to lock-in effects. However, this issue is not further explored in their study.

In conclusion, existing research has largely examined the phenomena of innovation clusters, collaboration, digitalization and geographic proximity separately, resulting in a gap regarding how they intersect within innovation clusters in a modern context. As a result, there is a need to re-examine the role of geographic proximity in light of the context of digitalization and forms of collaboration.

1.3 Purpose and research question

The purpose of this study is to develop a deeper understanding of how companies in innovation clusters practice collaboration in the context of digitalization, and how this affects the advantages of geographic proximity. By examining how collaborative processes are affected by digitalization the study aims to assess whether and how the perceived advantages of geographic proximity persist or are transformed. The study will therefore investigate:

How do the companies in innovation clusters practice collaboration in the context of digitalization, and how does this affect the advantages of geographic proximity?

1.4 Structure

In the following chapters, the study begins by reviewing existing research within the chosen field, focusing on geographic proximity, innovation clusters, knowledge transfer, collaboration, open innovation, followed by digitalization and its effects on the previously named factors. The methodological approach is then presented, after which the empirical data collected for the study is introduced. This is followed by an analysis of the study's findings, which are subsequently discussed in relation to the existing literature. The study concludes with a discussion covering its contributions, limitations and suggestions for future research.

2. Theory

2.1 Geographic proximity

2.1.1 Innovation cluster

As innovation clusters serve as the context of the study and form the foundation for the advantages associated with geographic proximity, defining the concept is necessary. An innovation cluster refers to a concentration of interconnected companies and institutions in a particular field, with the purpose to collaborate, interact and even compete across boundaries to drive innovation further (Remotti, 2021). This definition is further reinforced by Porter (1998), who emphasizes that clusters consist of networks of interconnected companies, each representing different but complementary components within a specific field. Numerous clusters can also include the government or other institutions, for example universities, that can provide specialized knowledge and support. Innovation clusters share the same structural characteristics as traditional clusters as described by Porter (1998), differing solely in their emphasis on innovation. Nevertheless, they operate in a similar manner.

The geographic proximity of the companies facilitates repeated interaction which in turn leads to better coordination and trust between the companies (Porter, 1998). This behavior results in the companies within the clusters being able to work flexibly, effectively and efficiently. According to Heidenrich and Mattes (2025) the geographic proximity of companies also reduces transaction costs by lowering transportation and communication expenses. Thereby, companies located within clusters, tend to experience higher levels of productivity (Porter, 1998). This is due to better access to employees and suppliers, access to specialized information and complementaries. As the cluster signifies opportunity it attracts potential employees which lowers the transaction costs regarding recruiting. Close proximity to suppliers further reduces those costs and delays. In addition, specialization drives regional concentration as companies are attracted to specialized labour and suppliers which further develop the innovation clusters (Heidenrich & Mattes, 2025).

Relationships between different actors within the innovation cluster also enables companies to better understand industry developments and emerging technologies as a result of site visits and face-to-face contact, thereby driving the direction and pace of innovation further (Porter, 1998). Since all the needed resources are near, the cluster members can adapt and

develop their products or services faster, giving them a competitive advantage to outside competitors. This also gives the companies a better chance to experiment and innovate since the suppliers and machinery are geographically close. Moreover, individuals operating within a cluster are often better positioned to identify market gaps due to their in depth knowledge of multiple parts of the industry (Porter, 1998). This can stimulate innovation and entrepreneurial activity by facilitating a higher incentive to create a new business. However, the advantages of how an innovation cluster operates are closely linked to the interactions between members, highlighting the importance of geographic proximity for facilitating knowledge transfer and collaboration.

2.1.2 Geographic proximity's effect on knowledge transfer

One of the key elements of innovation clusters is the geographic concentration of the involved companies (Porter, 1998). Geographic proximity can be defined as the physical distance between the involved parties (Ben Letaifa & Rebeau, 2013). As mentioned previously, this proximity allows knowledge to be easily accessed when other experts within the sector are close by (Porter, 1998). Howells highlights two main types of knowledge, codified and tacit knowledge (2002). Codified knowledge refers to information that can be formalized and transmitted. The individual is not required to have prior understanding in order to interpret this information. Tacit knowledge, in contrast, requires direct experience and sometimes even picked up without being directly aware of it. This information can not be directly communicated in any formalized way. Regarding geographic proximity, tacit knowledge can be transferred between individuals and companies in a simplified manner when the parties are near each other (Howells, 2002).

To explain why location affects knowledge, Howells (2002) highlights that knowledge is inherently shaped by spatial factors. Knowledge originates from individuals, whose cognitive, social, cultural and economic conditions are influenced by their surroundings. Furthermore, knowledge develops through interaction, which is dependent on distance, as closer proximity increases the likelihood of interaction. In addition, learning processes are embedded in specific social and geographic contexts, where individuals acquire knowledge through shared environments and interactions.

These interactions can be seen as externally acquired information and an important aspect is picking up new information through learning (Howells, 2002). Individuals in close proximity learn new information unintentionally in shared spaces between different people with ranging knowledge. Lastly, all this information absorbed by an individual is then interpreted. This interpretation can differ vastly based on the tacit knowledge the person has previously acquired which in turn is shaped by location and shared experiences. The information that is spread in this situation is called knowledge spillover, and can be defined as sharing of knowledge about people, companies, organizations and how the local area works (Fioravanti et al. 2021). The more similar situations and experiences the companies within geographic proximity share, the more their absorptive capacity increases when knowledge is spread. Because of this, clusters often achieve high local knowledge.

According to Fioravanti et al. (2021), the knowledge transfer process within clusters can be understood through three main mechanisms: collaboration, relationships with support institutions and labour mobility. Collaboration involves the exchange of information, techniques and complementary capabilities between cluster members, where informal relationships and companies' motivation to engage in knowledge-sharing activities play a crucial role. Relationships with support institutions, such as universities, provide access to specialized expertise, research and skilled labour, thereby facilitating knowledge transfer. Finally, labour mobility and geographic proximity further enhance knowledge transfer, as clusters enable companies to access a concentrated pool of skilled workers, allowing knowledge to spread through the movement of individuals between organizations (Fioravanti et al. 2021).

2.2 Collaboration

2.2.1 Collaboration and knowledge transfer

As collaboration is one of the relevant concepts of the study, its definition is required. The term collaboration refers to “the shared commitment of resources to the mutually agreed aims of a number of partners” (Dodgson, 2014, p. 462) and can be seen as the driving force to interactions. Similarly Sweet (2023) defined collaboration as involving participants working

together on a shared project. The actions that occur during the collaborations are known as knowledge transfers and refers to how knowledge and experience from one part of an organisation are communicated and applied in another (Argote & Ingram, 2000). The transfer of knowledge becomes visible through the behavior of the receiving unit. In practice, these transfers are often measured by examining changes in knowledge or changes in performance on the receiving end (Argote & Ingram, 2000).

2.2.2 Open innovation

The collaborative logic of open innovation is particularly relevant in innovation clusters, where geographic proximity, a high concentration of members, and continuous knowledge flows create favorable conditions for open innovation (McPhilips, 2020). Therefore, the concept of open innovation is used to understand how companies practice collaboration and must therefore be addressed.

According to Chesbrough (2006), open innovation can be defined as an approach where companies intentionally use both internal and external knowledge, as well as internal and external paths to market, to advance their innovation. Companies should no longer solely rely on internal resources to innovate, instead innovation increasingly depends on collaboration with external actors. Therefore, the company can and should collaborate with other external ideas to stay ahead of the competition.

There are different types of open innovation processes, inside-out, outside-in and coupled. Inside-out refers to the idea of organisations transferring their knowledge and technology with other organisations (McPhilips, 2020). The concept can also be referred to as technology exploitation (van de Vrande, 2009) and to share knowledge the company can use out-licensing agreements or create strategic alliances (Lichtenthaler, 2008). The company can for instance out-license intellectual property or technology to other companies, forming alliances and becoming the supplier (Chesbrough & Bogers, 2014).

The second type, outside-in approach can be referred to as technology acquisition (van de Vrande, 2009). Technology acquisition refers to organisations inquiring knowledge from others into their own business (McPhilips, 2020). It also involves opening up the company's innovation process to external contributions (Chesbrough & Bogers, 2014). To gain outside knowledge and inputs, the companies can use in-licensing and also strategic alliances. These

strategic alliances or collaborations can be with both suppliers and customers (Chesbrough & Bogers, 2014).

The third type of open innovation is the coupled type (Chesbrough & Bogers, 2014). This type combines the two previous approaches into one which means combining inflows and outflows of knowledge transfer to improve and commercialize the innovation. For it to be a coupled type of innovation there needs to be two or more members that intentionally share knowledge with each other across their boundaries. Strategic alliances, joint ventures and networks are all necessary mechanisms for this approach to function.

2.3 Digitalization

2.3.1. Digitalization

Digitalization is a central concept in this study. However, given its broad nature and the varying definitions found in previous research, it is important to clarify how the concept is understood in this study.

As summarized by Reis et al. (2020), previous definitions of digitalization range from narrow technical understandings to broader organizational and societal understandings. In its narrower sense, digitalization is understood as the transformation of analogue data into digital form (Maxwell & McCain, 1997). Broader definitions, however, extend beyond data conversion. Machekhina (2017) contributes to this broader understanding by relating digitalization to the transformation of different types of information into digital language. Building on this wider perspective, Reis et al. (2020) emphasize that digitalization also involves broader social, economic, and organizational change. Reis et al. (2020) therefore highlight a middle-ground understanding of digitalization, in which the concept includes both the transformation of analogue data into digital language and the wider effects this transformation may have on business relationships, value creation, and society as a whole. This definition is reinforced by Eling and Lehmann (2018), who state that the integration of the digital and analogue world has transformed industries. This is also the definition used in this study by examining how it affects how companies collaborate and the advantages of geographic proximity.

2.3.2. Digital tools and technologies

To examine the effects of digitalization, digital technologies are understood, as described by Ancillai et al. (2023), as digital tools and systems that affect companies' activities and processes and may reshape how companies create, deliver, and capture value. Examples include Industry 4.0, the Internet of Things, cloud computing, big data, and blockchain. Accordingly, digital technologies are not only technical tools, but technologies that may influence how companies operate and generate value. This definition is further reinforced by Boccardo et al. (2023) who emphasizes that digital technologies has reshaped business processes and practices.

2.3.3. Digital transformation

At the company level, these broader changes are often discussed through the concept of digital transformation. Verhoef et al. (2021) define digital transformation on the basis of several earlier definitions cited in the article. The definition describes digital transformation as “a change in how a firm employs digital technologies, to develop a new digital business model that helps to create and appropriate more value for the firm” (Verhoef et al. 2021, p. 889). Verhoef et al. (2021) further emphasize that digital transformation should be viewed as a multidisciplinary phenomenon, involving changes in several areas of the company, including marketing, strategy, supply chains, organization, and information technology. This makes digital transformation relevant for understanding not only internal organizational change, but also changes in how companies interact with external actors. Since Verhoef et al. (2021) base their definition on several earlier contributions to the field, their definition provides a suitable foundation for how digital transformation is understood in this study.

2.3.4. Effects of digitalization

Innovation has undergone a rapid transformation over the past 15 years, as digitalization has fundamentally changed the nature of innovation as well as how it is carried out and managed (Marion & Fixson, 2020). Marion and Fixson (2020) further argue that, in the context of innovation, the use of digital tools is associated with the degree of collaboration, which is closely related to knowledge creation and sharing. They also suggest that digital work processes may alter the relationship between collaborators.

Furthermore, digital tools have changed the landscape by increasing the speed and performance of the design process, through earlier use (Marion & Fixson, 2020). The tool's increased capabilities and user-friendliness also change how knowledge is created in the development process (Marion & Fixson, 2020). Combined with low cost, this ease of use has significantly reduced the barriers to accessing design tools and made them more widely available. As these tools have developed, research shows that they can increase collaboration and generate more concepts (Marion & Fixson, 2020). However, Marion and Fixson (2020) also note that the introduction of new tools may create resistance, as employees can become less willing to learn and adopt them. Thus, although digital tools may become a competitive advantage by making processes faster and less resource-intensive when managed effectively (Marion & Fixson, 2020), their benefits should not be assumed to materialize automatically. In line with this, Ancillai et al. (2023) highlight that, despite significant investments in digital technologies and digital transformation, companies often struggle to fully realize their potential.

These developments can also be seen in the growing importance of business model innovation and new forms of inter-organizational cooperation. Rachinger et al. (2019) argue that increased digitalization has affected companies' activities and business models by making new forms of collaboration, product and service offerings, and relationships with customers and employees possible. They further suggest that digitalization puts pressure on companies to reassess their current strategies and systematically explore new business opportunities at an early stage. Rachinger et al. (2019) highlight that digitalization, as a form of technological evolution, can affect any kind of organization. This became particularly visible during the 2010s, when developments in mobile technologies, social media, and analytics sped up the digital transformation of business models.

Beyond changes in internal processes and business models, digitalization may also reshape companies' external collaboration patterns as it is a broader change that has made adaptation a strategic necessity for organizations (Nieto et al. 2023). Nieto et al. (2023) further highlights that firm-level digitalization broadens the range of partners involved in a firm's innovation network, as digitalization supports the search, handling, and sharing of information with technological partners. As a result, companies are increasingly likely to seek knowledge from external sources, especially since most companies can no longer organize their innovation activities entirely in-house.

This broader expansion of collaboration with external partners is also reflected in how digitalization has transformed innovation networks (Lyytinen et al. 2016). Through digitalization, these networks are no longer constrained in the same way, which makes it easier to connect actors across greater distances. In turn, innovation networks can become more geographically distributed and involve more diverse forms of knowledge. At the same time, Lyytinen et al. (2016) point out that these developments also create challenges in terms of how knowledge is developed, absorbed, and combined, as digitalization shifts control and increases the need for coordination across geographic locations and over time.

Overall, the literature suggests that digitalization may reduce some of the limitations traditionally associated with geographic distance, while at the same time increasing the need for coordination and knowledge integration across locations. This is particularly relevant for this study, as it suggests that digitalization may reshape the advantages of geographic proximity for companies in innovation clusters.

2.4 Conceptual framework

Altogether these theoretical concepts create the conceptual framework to be used in this study. Innovation clusters provide the foundation of the framework, as they describe the context in which companies operate and the advantages associated with cluster location. Their importance comes from the way they facilitate collaboration which results in enhanced productivity, stimulating innovation and supporting the emergence of new companies (Porter, 1998). Within this context, companies are part of a local network that contributes to repeated interactions and exchanges of knowledge.

To understand how the companies operate within this context, the concept of open innovation is applied. Open innovation is used to understand how collaboration and knowledge transfers actually occur, and explains different methods of transferring this knowledge both internally and externally to other companies. In this framework, open innovation is not treated as a separate phenomenon, but as the mechanism through which companies within clusters engage in collaboration and facilitate knowledge transfer.

Building on this, collaboration becomes a central element of the framework. Collaboration in innovation clusters involves not only joint activities and interactions between companies, but also the exchange and development of knowledge, making knowledge transfer an integral component of collaborative processes. Thereafter, the concept of digitalization serves to analyze how collaboration and knowledge transfer are affected within a modern digitalized context, and how it influences the advantages associated with geographic proximity.

Based on the conceptual framework, several theoretical assumptions can be drawn. Firstly, the collaboration practices among companies within innovation clusters are expected to consist of both physical and digital collaboration, as digitalization enables networks across geographic boundaries, requiring companies to adapt to this transformation since digital tools can create a competitive advantage (Lyytinen et al. 2016; Nieto et al. 2023; Marion & Fixson, 2020). Secondly, the ability to use digital tools simplifies the transfer of codified knowledge as it can be easily formalized and thereby transferred through digital channels, making it less dependent on geographic proximity (Howells, 2002). In contrast, tacit knowledge is context-specific, experience-based, and shaped by social and spatial conditions, making it more dependent on physical proximity.

In conclusion, digital tools are expected to reduce the importance of geographic proximity for some forms of knowledge transfer and collaboration. On the other hand, companies may still struggle to fully realize the benefits of digital technologies and therefore not utilizing its full potential (Ancillai et al. 2023). This further implies that the value of clusters is likely to remain important not only for collaboration and tacit knowledge exchange, but also for other location-specific advantages, such as access to specialized labour and suppliers, lower transaction costs and knowledge spillovers (Heidenrich & Mattes, 2025; Fioravanti et al. 2021; Porter, 1998), which digitalization cannot fully replace.

3. Method

3.1 Research approach and design

A research design is defined as the framework for the collection and analysis of data (Bryman et al. 2024). This study uses a qualitative research approach, which focuses on the words of the study subjects rather than numerical data and statistical analysis. The researcher using a qualitative approach views the world and its surroundings as constantly changing. A key characteristic of a qualitative study is that the researcher aims to interact with the subjects and understand the information gathered from their perspective.

In order to examine the research question, it is important to obtain in-depth and realistic information due to the question being aimed at understanding companies choices and experiences rather than a causal relationship. This is made possible through the use of a qualitative approach (Bryman et al. 2024).

Regarding the research method, the study can be classified as abductive, which refers to a combination of the classic inductive and deductive methods (Bryman et al. 2024). The abductive method means that the researcher discovers a question or phenomenon that is not completely explained and aims to study and solve this gap. When applying this method, dialectical shuffling occurs, which means the researcher moves back and forth between theory and empirical data to discover new original insights.

3.1.1 Research method

The research method refers to the technique used to collect the data and can include activities such as structured interviews (Bryman et al. 2024). In line with the qualitative method, several steps were taken to collect the empirical data needed for the study. The research process began with a review of business administration literature in order to identify what has previously been researched and what remains unexplored. The research question was developed through an iterative process alongside the literature review.

Following this, the research design for the study was developed, including the selection of the research object (Bryman et al. 2024). Subsequently, relevant empirical data was collected through semi-structured interviews. Qualitative interviews were chosen because the research

question required in-depth insights into the participants' perspectives on the research topic. Interviews were therefore considered an appropriate method for generating detailed empirical material (Bryman et al. 2024). Semi-structured interviews were selected in particular because they allowed for both structure and flexibility (Bryman et al. 2024). The structure was ensured through a prepared interview guide, with questions asked to all interviewees and formulated in the same way. At the same time, the flexible format enabled the researchers to ask follow-up questions based on responses considered significant for the study (Bryman et al. 2024). This made it possible to capture what the interviewees considered important in greater depth by allowing them to elaborate on issues relevant to the thesis topic. The interviews were conducted primarily in person, but some interviews had to be through a video call on Teams due to logistical reasons. Video calls through Teams were used to ensure a similar experience to physical interviews as possible (Bryman et al. 2024).

The interviews were thereafter conducted in Swedish as this is the participants native language, with one exception as the interviewee was not Swedish but comfortable speaking English. Although the interviews required translation for the presentation of the results, conducting them in Swedish was deemed beneficial, as it enabled participants to communicate more naturally and provide richer, more nuanced responses, which is especially important as the study aims to analyse participants' experiences. To ensure credible translations and accurate participant understanding, all relevant English concepts were carefully translated into Swedish. This was possible due to all concepts having Swedish equivalents.

3.1.2 Research challenges

During the process, there were several potential challenges to navigate. Firstly, when conducting qualitative research the risk of lacking transparency exists (Bryman et al. 2024). To navigate this, a clear interview guide was made as well as a well structured explanation of exactly how the research was to be conducted. Together with this, the choice of interviewees was explained and credible which increases the transparency of the study.

Furthermore, a potential limitation of the qualitative method is that individuals may have limited insight into their own social interactions and behaviors. Since the research is based on conversations with the interviewees, some actions, routines, or perceptions may be

subconscious and therefore difficult for respondents to fully recognize or articulate (Bryman et al. 2024). As the study relies heavily on the interviewees' own experiences and interpretations, careful consideration was given to the phrasing of the interview questions. In addition, several topics and behaviors were approached from multiple angles throughout the interviews in order to capture broader and more nuanced perspectives from the respondents.

Another challenge that was also mentioned as a risk by Bryman et al. (2024) was the fact that qualitative studies can easily become too subjective, meaning that the choice of information to be used in the study might be affected based on what is seen as personally important or interesting. Simultaneously, this subjectivity also results in difficulties regarding replication of the study. According to Bryman et al. (2024) qualitative studies are often less structured and subjective which results in challenging replication.

To reduce the risk of subjectivity the study creates a transparent result by transcribing the interviews verbatim. Transcribing the interviews reduced the risk of forgetting useful information as well as enabled the possibility to go through the answers after the fact and carry out a thorough review (Heritage, 1984). Transcribing can also enable other researchers to get an exact understanding of what was asked and answered, reducing the limitation of replication. In order to transcribe correctly, each interview was recorded. This method simplified a thorough and correct transcription enhancing the study's objectivity (Bryman et al. 2024).

3.2 Literature selection

An important step in this study is the identification and review of relevant literature in order to develop a comprehensive literature review and theoretical framework (Bryman & Bell, 2024). This process involves critically assessing sources and thereafter collecting what has been previously researched. The literature review thus serves as a foundation by outlining what has already been explored in the field, while also highlighting potential research gaps (Bryman et al. 2024).

To gather material for the theoretical framework, academic articles from high-quality journals were used as the primary sources. These journals are classified as level 1 or 2 according to

the Norwegian Register for Scientific Journals, Series and Publishers. The academic articles used are peer reviewed, meaning they are evaluated by independent experts in the field prior to publication (Bryman et al. 2024). This process ensures a high level of academic reliability and thereby contributes to the quality of the literature used in this study. However, as Bryman et al. (2024) note, relying solely on journal rankings or impact factors does not guarantee the quality of individual articles. Therefore, the selected articles were also assessed based on their relevance and influence within the research field by for instance examining citations.

In addition to academic articles, a limited number of book chapters were included. These were sourced from Cambridge University Press, Oxford University Press and Springer, which are academic publishers who publish peer-reviewed research through their own platforms (Bryman et al. 2024). Including book chapters alongside journal articles broadens the literature base and reduces the risk of overlooking relevant and influential contributions.

To identify relevant literature, searches were conducted using online databases and digital library resources. To ensure credibility, platforms such as Scopus, Consensus and Lund University's library tools were accessed through the university's databases. These resources enabled the identification of peer-reviewed journal articles by applying appropriate filters and selection criteria.

The search process was guided by key terms such as “innovation clusters”, “digitalization”, and “geographic proximity”. These keywords were used both individually and in combination, along with relevant synonyms, to ensure a comprehensive search and to minimize the risk of overlooking relevant studies.

The reviewed literature subsequently revealed indications of incompleteness, often referred to as a research gap (Bryman et al. 2024). This identified gap served as the foundation for the formulation of the research question (Bryman et al. 2024). The research question were reformulated iteratively during the collecting of literature and learning more about the subject.

3.3 Selection of interviewees

In order to examine the question of this study, several interviews with individuals working in companies located in innovation clusters were carried out. In line with the research question, the aim of the interviews is to understand how they collaborate in the context of digitalization and if it has somehow lessened or changed the benefits of geographic proximity.

To answer the research question, the selection process involved multiple levels, including the selection of the type of cluster, industry sector, company, and interviewee based on specific criteria (Bryman et al. 2024). More specifically, the sampling strategy can be described as purposive sampling, as participants were selected according to predefined criteria considered relevant for addressing the research question.

Innovation clusters were chosen as the empirical context due to the limited research examining their role in relation to digitalization. Within this context, the life science sector was selected as the specific focus of the study. The life science industry is particularly relevant, as Sweden is recognized as one of the leading countries globally within the sector (Business Sweden, n.d.). Furthermore, approximately 99% of life science innovations involve digital components, making the sector especially suitable for this study, as it increases the likelihood that companies are influenced by digitalization and its effects.

The two specific innovation clusters were chosen in order to get perspectives from different cities while still focusing on one specific sector. Interviewing companies within the same sector reduces unnecessary variation, since they operate under similar context and conditions, which facilitates the identification of patterns (Alvehus, 2023) and enables a more in-depth study of the group (Saunders et al. 2009). Furthermore, it reduces the risk that the findings are shaped by sector-specific conditions rather than the phenomenon under investigation.

The companies included in the study are micro and small companies, all with fewer than 50 employees. The selection of these companies is motivated by their resource constraints, which increase their reliance on collaboration with external partners to access knowledge and support innovation processes (Audretsch et al. 2023). This makes them particularly suitable for this study, as it enables the exploration of how collaboration and knowledge exchange are shaped within the context of innovation clusters. Additionally, their structural limitations are significant to the study. According to OECD (2021), smaller company size often acts as a

barrier to the adoption of digital transformation, resulting in these companies being behind. As this study focuses on how digitalization affects companies in innovation clusters, this factor makes them especially interesting and relevant.

Finally, the interviewees selected were from companies physically located in the innovation cluster, meaning that they have both office spaces and their registered business address within the cluster. This was considered appropriate as the study aims to examine dynamics within the innovation cluster, making actors embedded in the innovation cluster particularly relevant sources of data. Additional criteria was that all participants held senior managerial positions or strategically relevant roles, such as CEO, CTO and Innovation Specialist which provided them with direct insight into strategic decision-making and innovation processes as well as the company's spatial positioning. To ensure the collection of rich and relevant empirical data, the interviewees were also selected based on their knowledge of organizational collaboration and digitalization related processes. This purposive sample strategy enabled the study to capture both geographic and collaborative dimensions central to the research objective.

3.4 Data collection

The information collected through the semi-structured interviews was based on two main themes: (1) Collaboration practices in the context of digitalization and (2) The advantages of locating within an innovation cluster. These themes were chosen in order to sufficiently address the research question, while also reflecting the theoretical framework on which the study is based. The theme (1) Collaboration practices in the context of digitalization, was chosen in order to understand how the collaboration practices were affected by digitalization as well as what type of knowledge is shared between them. The theme (2) The advantages of locating within an innovation cluster, was selected to get a comprehensive understanding of why the companies want to be located in the innovation cluster and its perceived benefits. Focusing on these two themes simplified the interpretation of the collected data, as the responses could be analyzed within clearly defined conceptual areas. At the same time, structuring the semi-structured interviews around these themes ensured that the questions remained relevant and aligned with the purpose of the study.

Regarding interviews the study conducted eight interviews spanning around one hour each in order to gather a sufficient amount of data and insights. The number of interviews was considered appropriate as theoretical saturation was reached, with clear patterns emerging in the interviewees' responses, indicating that additional interviews were no longer expected to contribute significant new insights or themes to the study (Alvehus, 2023).

The specific individuals selected for the study were contacted by email and invited to participate in an interview. As part of this initial contact, they were given a description of the purpose of the study and the reasons for conducting it, so that they could make an informed decision about whether to participate (Bryman et al. 2024). After agreeing to take part, they received additional information regarding the interview procedure and the measures taken to ensure confidentiality. Before each interview, the participants were informed about their rights in accordance with GDPR, and they gave their informed consent through a written form.

3.5 Method for data analysis

One of the most common methods for data analysis of qualitative material is thematic analysis (Bryman et al. 2024). This involves analysing the data to try and identify themes. The themes identified will largely be regarding the repetition of concepts, which according to Bryman et al. (2024) is one of the most common ways to identify a pattern of the data. The patterns identified will be closely related to the research question to ensure its relevance.

According to Braun and Clarke (2006), thematic analysis involves six phases, which guided this study. The first phase consists of familiarization with the data by transcribing, reading and re-reading the content. This is followed by the identification and coding of relevant and interesting features in the data, which was done systematically for all interviews. By analyzing each interview separately and thereafter pinpointed recurring aspects, codes were identified. These codes were then organized into broader themes that are supported by the empirical material. Subsequently, the themes are reviewed and clearly defined before being assigned appropriate names. The identified themes are then to be analyzed and interpreted in relation to the existing literature in order to address the research question. All data and phases

were carefully examined by all authors to minimize subjectivity and ensure the same conclusions were drawn.

This method is highly suitable for the study as by organizing the empirical material into themes, the method enables a structured in-depth interpretation of how digitalization influences collaboration and the advantages of geographic proximity for companies in innovation clusters. Furthermore, the flexibility of thematic analysis allows the findings to be interpreted in relation to the study's theoretical framework, which aligns with the abductive research approach (Bryman et al. 2024).

3.6 Use of generative AI

Generative AI tools were used as supportive tools during parts of the study's writing process. The specific uses of these tools, as well as the tools applied, are presented below. The authors remained responsible for all final formulations, analyses, and conclusions.

Tools used: ChatGPT (OpenAI), Scopus AI, Consensus and Sunet Scribe

Extent and purpose of use:

- **Idea generation:** ChatGPT was used to support the development of interview questions through alternative formulations by brainstorming.
- **Language improvement:** ChatGPT was used to refine grammar and improve the structure of text written by the authors.
- **Feedback and revision support:** ChatGPT was used to receive feedback on drafts in order to enhance coherence.
- **Finding academic literature:** Consensus and Scopus AI was used to identify relevant academic literature, which were subsequently evaluated and selected by the authors.
- **Transcription:** Sunet Scribe was used in order to transcribe the recorded interviews which were then thoroughly examined by the authors to ensure its accuracy.

For a complete list of the prompts used, see appendix.

4. Empirical data

4.1 Company A

4.1.1 Background information

Company A originally emerged from a research project conducted by a Swedish research institute and is primarily financed and owned by several large multinational companies. The business idea focuses on the development of sustainable material solutions.

4.1.2 Collaboration practices in the context of digitalization

Collaboration is a central aspect of the company's operations. The owners, together with external companies specializing in different stages of the production process, are highly involved in the company's activities, and frequent communication occurs between the actors. However, these collaborations are primarily conducted with external partners rather than with companies located within the innovation cluster itself.

Instead, collaboration within the innovation cluster is mainly characterized by practical day to day interactions, such as borrowing equipment and sharing resources. However, Company A emphasized that physical proximity alone does not automatically generate collaboration. According to the interviewee, meaningful interaction requires a sense of community fostered through networking events and social activities organized by the cluster management.

Digital tools were described as highly important for the company's operations, particularly video meeting platforms used to communicate with external partners and other parts of the company. Most daily meetings and collaborations are conducted digitally, making digital communication essential for both internal and external collaboration. The interviewee also emphasized the importance of clear agendas for effective digital meetings.

At the same time, the implementation of new digital tools was also described as a potential challenge. The interviewee explained that complex digital systems often result in low levels of usage and may instead create frustration among employees, urging them to be simple and accessible.

Although digital meetings were generally considered effective, physical meetings were still viewed as highly valuable, particularly during initial interactions. Face to face meetings were described as important for creating better understanding and increasing trust between the parties involved. As the interviewee explained, “if you are going to start working with someone, it is quite nice to meet in person first” (Company A, interview 4 May 2026; original quote: “ska man börja jobba med någon så är det ju ganska trevligt att träffas.”; translated by the authors).

4.1.3 The advantages of locating within the innovation cluster

According to Company A, the advantages of locating in an innovation cluster was the geographic proximity to several strategically important partner companies situated near the cluster. These companies constitute key collaborators for Company A, making close physical distance advantageous for maintaining efficient communication and facilitating collaboration. As a result, the innovation cluster was perceived as a suitable location for establishing the company’s research office.

Another important factor influencing the location decision was the sense of community within the cluster environment. As a relatively small company, Company A emphasized the importance of employee wellbeing and social surroundings, viewing the innovation cluster as a positive contribution to both internal culture and the day to day work experience. According to the interviewee, the environment “creates new ideas, new inspiration, and different perspectives that you might not as easily gain elsewhere.” (Company A, interview 4 May 2026; original quote: “skapar det ju nya tankar, nya inspiration och vinklingar lite grann som man kanske inte får lika lätt på köpet på ett annat ställe”; translated by the authors).

Finally, Company A emphasized the importance of activities organized by the cluster management, including community breakfasts and investor events. According to the interviewee, these types of networking opportunities and social initiatives would likely not have been available if the company had been located independently outside the innovation cluster.

4.2 Company B

4.2.1 Background information

The company operates within the medical technology sector and develops healthcare-related technologies used in medical treatment. The company has been part of the innovation cluster since its early stages.

4.2.2 Collaboration practices in the context of digitalization

Company B engages in collaborations both within and beyond the innovation cluster. The company's main business activities and customer relationships are primarily located in the United States, meaning that many customer-driven and business-related collaborations occur outside the cluster. At the same time, the innovation cluster remains important for other forms of collaboration.

Within the innovation cluster, collaboration was described as being facilitated by physical proximity. Company B collaborates with other listed companies in the innovation cluster and has also contributed to initiatives supporting networking and investment opportunities for smaller companies. The interviewee further noted that companies can share resources and competencies, while also noted that collaboration may also be limited by competition, confidentiality, or conflicts of interest.

The interviewee did not present physical and digital collaboration as opposites, but rather explained that the format depends on the situation. Digital video meetings were described as necessary for many international collaborations, especially since customers and partners are located in different parts of the world. However, for especially important or valuable meetings, particularly with major long-term customers, the company may still choose to travel for physical meetings. Face-to-face interaction was considered more effective for building trust. According to the interviewee, physical meetings make it easier to interpret body language, capture nuances, and develop the social dimension of a business relationship. Although digital meetings have improved, especially as people have become more used to video communication, they were still not considered able to fully replace physical interaction.

At the same time, the interviewee described Company B as still being in a learning phase regarding some aspects of digital development, while emphasizing that companies need to continue adapting in order to remain competitive. Overall, digitalization was viewed as highly valuable for enabling international collaboration and maintaining contact across countries, but not as a replacement for physical proximity.

4.2.3 The advantages of locating within the innovation cluster

Beyond collaboration practices in the context of digitalization, the interviewee also described several advantages of being physically located within the innovation cluster. Company B's relocation to the innovation cluster was facilitated by the opportunity to establish itself there at an early stage and adapt its premises and laboratories to its operational needs.

A central benefit of being located in the innovation cluster was the proximity to other life science companies. The interviewee explained that the innovation cluster enables companies to participate in shared activities, seminars, and discussions, while also creating opportunities to interact with companies facing similar industry-related challenges. This was considered valuable not only in relation to research and medical technology, but also regarding regulatory requirements, investor relations, and business development.

Finally, the interviewee described the innovation cluster as an increasingly important platform for the life science sector more broadly. Since many companies are located in the same environment, the innovation cluster can create a stronger collective voice in discussions with policymakers, research institutes, larger companies, and other external actors. While Company B did not move to the innovation cluster primarily because of image, the interviewee acknowledged that it has become more well-known over time and that the company benefits from being part of that development.

4.3 Company C

4.3.1 Background information

Company C operates in the life sciences sector and focuses on new therapeutic solutions. Its activities cover the full development chain, including preclinical and clinical research, with

some projects currently being tested in clinical trials. The company has been located in the innovation cluster for several years.

4.3.2 Collaboration practices in the context of digitalization

Company C's largest collaborations are primarily external and international, although the innovation cluster remains an important local collaboration environment. The interviewee explained that proximity lowers the threshold for initiating conversations, sharing ideas, and identifying potential collaborations. This may involve informal knowledge exchange as well as practical arrangements, such as sharing personnel between companies. The interviewee also noted that many issues can be discussed openly before reaching the point where confidentiality agreements or more formal arrangements become necessary.

Digital tools play a central role in Company C's work, particularly because parts of the organization and project teams are located abroad. Much of the morning workday is spent in digital meetings with colleagues in China, while later parts of the day often involve more local or physical meetings. Shared digital platforms are also used to coordinate documents and work across organizational boundaries. The interviewee linked the normalization of these digital practices strongly to the Covid-19 pandemic, which was described as accelerating the acceptance and use of remote collaboration tools.

Despite this extensive use of digital collaboration, the interviewee did not present physical and digital interaction as fundamentally different in terms of decision-making. Important discussions and decisions can take place in both formats. However, physical meetings were still considered valuable for adding a social dimension to collaboration and for building trust and genuine human contact between organizations.

The interviewee described the combination of physical proximity within the innovation cluster and digital connections to international partners as providing "the best of both worlds" (Company C, interview, 5 May 2026; original quote: "det bästa av två världar"; translated by the authors). Digital tools enable global collaboration, while the innovation cluster offers local access to people, informal encounters, and opportunities to build relationships face to face. The interviewee did not perceive digitalization as reducing the value of physical innovation clusters since the innovation cluster still has several advantages.

4.3.3 The advantages of locating within the innovation cluster

Company C's choice of location was influenced by several factors. Since the premises within the innovation cluster were still being developed at the time of relocation, the company was able to influence the design of its laboratories and workspaces to better suit its operational needs. The interviewee also emphasized the importance of accessibility for both employees and patients participating in clinical studies.

The interviewee also described the benefits of being situated in an environment where informal encounters can occur naturally. Everyday interactions during lunch breaks, coffee meetings, or other shared activities were presented as important for creating new contacts and following up on earlier conversations. The cluster's shared spaces were seen as particularly valuable in this regard, as they provide neutral and low-threshold environments where companies can meet without the formality of entering one another's premises.

Another advantage of the innovation cluster was access to shared resources and nearby expertise. The interviewee explained that Company C can use specialized laboratory capacity located in the same building instead of maintaining all equipment internally. The innovation cluster was also presented as valuable for recruitment, since it creates a larger life science context in which both employees and accompanying family members may find relevant career opportunities.

Finally, the interviewee highlighted the cluster's visibility and reputation. Although image was not the sole reason for locating there, the innovation cluster was described as a recognizable context that can support external communication and increase visibility.

4.4 Company D

4.4.1 Background information

Company D operates a specialized healthcare clinic providing cardiological examinations and treatments. The company has been operating since 2024, when it established its clinic within the innovation cluster.

4.4.2 Collaboration practices in the context of digitalization

When discussing collaboration, the interviewee from Company D emphasized that companies within the innovation cluster are often highly motivated to develop new relationships due to the opportunities associated with the location. As a result, spontaneous interactions occur frequently, contributing to an open and collaborative environment. Since many companies operate in related fields, the interviewee also highlighted the potential for future collaborations if relevant opportunities emerge. However, the company's current professional collaborations primarily involve external partners rather than companies located within the innovation cluster itself.

When discussing digitalization, the interviewee explained that digital tools such as Teams are frequently used for meetings and daily communication. Although digital tools can technically replace most physical meetings, the outcomes are not always considered equivalent. Physical meetings were described as important for building trust, since there is “greater trust and you dare to be more open when sitting face to face with each other,” after which communication can more easily be maintained digitally (Company D, interview 6 May 2026, original quote; ”man har större tilltro och man vågar vara mer öppen när man sitter mitt emot varandra”; translated by authors).

When discussing digitalization, the interviewee explained that digital tools such as Teams are frequently used for meetings and daily communication. Although digital tools can technically replace most physical meetings, the outcomes are not always considered equivalent. Physical meetings were described as important for building trust and enabling more open conversations, after which communication can more easily be maintained digitally.

Company D has also invested in new digital systems for administrative support. However, the company has in some cases returned to physical solutions within patient care due to usability challenges among patients and low utilization levels.

Lastly, the interviewee explained that, in their experience, digitalization has increased rather than reduced the importance of physical localization. According to the interviewee, initiating relationships through physical interaction and subsequently maintaining them through digital communication creates synergies that strengthen both collaborations and the company as a whole.

4.4.3 The advantages of locating within an innovation cluster

In addition to these collaboration practices, the interviewee also highlighted several advantages associated with being located within the innovation cluster. When searching for a location to establish its clinic, Company D considered the innovation cluster to be an attractive option for several reasons. Firstly, the long term vision and planned development of the innovation cluster aligned well with the company's own strategy and ambitions. According to the interviewee, the company expected the image and reputation associated with the innovation cluster to positively influence perceptions of the clinic by contributing to a trustworthy and professional profile.

Secondly, the opportunity to participate in the planning and design of the clinic's layout was viewed as an important advantage when selecting the location. This allowed the company to adapt the physical environment to its operational needs rather than having to adjust its operations to an already existing facility.

Finally, the interviewee highlighted the value of spontaneous interactions and relationship building within the cluster environment. This was described not only as the opportunity to meet new people, but also as being part of an environment that positively influences the day to day work experience, employee wellbeing, and the overall working environment through social interaction and external inspiration. As the interviewee stated, "When you see and hear about others working with similar things you become impacted" (Company D, interview, 6 May 2026; original quote: "När man ser och hör andra som jobbar med liknande saker blir man påverkad av det."; translated by the authors).

4.5 Company E

4.5.1 Background information

Company E represents a small company within the life science sector. The company operates in the field of cancer diagnostics and develops medical technologies used for diagnostic purposes.

4.5.2 Collaboration practices in the context of digitalization

Company E described collaboration as taking place with a range of external actors both within and outside the innovation cluster. A significant share of production is outsourced to external actors due to their greater production capacity and specialized expertise, while the company also utilizes support functions available within the cluster. However, Company E does not engage in closer innovation-related collaboration with other companies, although the interviewee acknowledged that such collaboration may enhance innovation for others.

Company E also made a clear distinction between physical and digital collaboration. Complex discussions, planning, and decision-making are typically conducted face-to-face, whereas routine meetings and coordination are handled digitally. Despite the widespread use of digital tools, the company emphasized the continued importance of physical interaction for building strong relationships and a sense of community, as expressed by the interviewee: “You do not become a team on Teams” (Company E, interview, 4 May 2026; original quote: “Man blir inte team på Teams”; translated by the authors).

Company E further stressed the importance of establishing relationships face-to-face before relying on digital communication. Physical meetings, such as informal social interactions, were described as more effective for building trust compared to virtual interactions, which require more deliberate effort. Physical interactions and informal networking are also easier due to the close proximity. At the same time, Company E actively uses digital tools such as SharePoint and Teams to facilitate collaboration. However, the interviewee emphasized that these tools must remain manageable and not overly complex, as excessive or complicated systems may hinder rather than support collaboration.

Finally, although Company E relies extensively on digital collaboration, the interviewee does not expect digitalization to reduce the importance of physical innovation clusters. This is because physical locations provide a shared context for interaction and relationship-building that cannot be fully replicated digitally. According to the interviewee, this is particularly important for smaller companies in development stages, which depend on close, in-person collaboration, as digital collaboration alone may make coordination more difficult and limit progress.

4.5.3 The advantages of locating within an innovation cluster

Despite the extensive use of digital collaboration, Company E continued to perceive several advantages associated with being physically located within the innovation cluster. An advantage that was highlighted particularly was the access to skilled and specialized personnel, which facilitates recruitment and provides a large pool of qualified employees. Proximity to other companies also enables more flexible staffing arrangements, where employees can divide their time between companies, allowing smaller companies to access expertise they might otherwise not afford. In addition, Company E highlighted the convenience of shared services within the cluster, reducing the need to manage everyday operational tasks such as maintenance and office services.

The presence of support functions within the cluster, including IT companies, intellectual property specialists, and legal services, was also identified as an important factor, as it facilitates access to external expertise. In addition, the possibility of sharing resources such as laboratory facilities further motivated Company E's decision to locate within the cluster.

Finally, Company E emphasized the importance of identity and image. Being part of the innovation cluster was described as influencing how the company is perceived both internally and externally. As the interviewee expressed, "Here, you feel medtech" (Company E, interview, 4 May 2026; original quote: "Här känner man sig medtech"; translated by the authors). The interviewee also noted that some companies maintain a presence within the innovation cluster despite not operating on-site, primarily because of the value associated with being affiliated with the environment.

4.6 Company F

4.6.1 Background information

Company F operates in the field of pharmaceutical development within oncology, with a particular focus on diagnostics and treatments. The original idea emerged from a university researcher and subsequently formed the foundation of the company.

4.6.2 Collaboration practices in the context of digitalization

Company F operates with a lean organizational structure, employing no permanent staff and instead contracting personnel as needed. According to the interviewee, this structure reflects the company's need for highly specialized expertise, particularly in research contexts where different models must be applied across stages. As a result, the company collaborates extensively with external partners, most of whom are located outside the innovation cluster. Company F also out-licensed one of their previous projects to an external company. At the same time, Company F relies on the informal networks within the cluster to identify and access qualified personnel.

Regarding its collaboration practices, Company F adopted new ways of working following the COVID-19 pandemic, including the increased use of digital tools such as Teams. The interviewee described a clear distinction between digital and physical collaboration depending on the nature of the activity. Digital meetings are primarily used for routine tasks, such as reporting and administrative coordination. In contrast, physical meetings are preferred when the objective is to build long-term relationships or establish trust, as they allow for better interpretation of reactions and body language. Similarly, meetings involving more complex or strategic discussions, such as those with the board, are typically conducted in person to assist participation and engagement.

Although Company F makes extensive use of digital collaboration, the interviewee emphasized that physical interaction remains essential. Being part of an innovation cluster and engaging in face-to-face collaboration are still considered important for employee well-being, as well as for maintaining efficiency and productivity.

4.6.3 The advantages of locating within the innovation cluster

Given its reliance on specialized expertise, one of the main reasons for Company F's location within the innovation cluster is the opportunity to access a localized pool of skilled labor and established networks. The informal networks within the innovation cluster also facilitate faster problem-solving and knowledge transfer, thereby enabling the company to operate more efficiently. In addition, the innovation cluster serves as a meeting point, where Company F also makes use of shared resources such as laboratory facilities. The interviewee further emphasized the importance of having a physical location and work environment

where employees can meet and interact, noting that social interaction remains necessary for well-being even if much of the day-to-day work is conducted remotely.

Furthermore, one of the most prominent advantages highlighted was the reputational value associated with the cluster, as expressed by the interviewee: “after all, it is simply a good address” (Company F, interview, 5 May 2026; original quote: “Det är trots allt en bra adress helt enkelt”; translated by the authors). Company F emphasizes the importance of the image that being part of the innovation cluster conveys. The interviewee further explained that affiliation with a recognized innovation cluster contributes to the company’s credibility, both nationally and internationally, by signaling legitimacy through its association with other companies in the same environment.

4.7 Company G

4.7.1 Background information

The company has been based in the innovation cluster since 2017 but initially emerged out of a well known Swedish University where the technology began to develop. The tool has created a new and updated way to manipulate cells.

4.7.2 Collaboration practices in the context of digitalization

Company G primarily collaborates with companies located outside the cluster, as its customer base is globally distributed. However, the interviewee also described several forms of day to day collaboration occurring within the innovation cluster itself. Being located close to other small companies and startups creates opportunities for spontaneous interaction, practical support, and resource sharing between companies.

The cluster environment also facilitates networking through organized events and formal networks. In particular, the interviewee highlighted the CEO network established within the innovation cluster, where executives from different companies meet several times per year to discuss common challenges, exchange experiences, and support one another in various business situations.

In terms of digitalization, digital communication tools such as Teams have become an important part of the company's daily operations since the Covid 19 pandemic. The interviewee explained that employees rapidly had to adapt by learning how to guide customers through the installation and use of the company's products via video meetings. At the same time, physical interaction continues to be viewed as highly valuable, particularly when establishing new relationships and building trust. As the interviewee explained, "You need to meet in person before you can build trust, but you don't have to meet more than once" (Company G, interview, 5 May 2026). Regarding the importance of places such as innovation clusters, the interviewee further explained that digital evolution does not lessen the benefits of physical localization, since many situations cannot be fully replaced by digital tools.

4.7.3 The advantages of locating within the innovation cluster

According to the interviewee, these forms of physical interaction and networking also reflected several of the broader advantages associated with being located within the innovation cluster. Initially, Company G relocated to the innovation cluster due to limited space at its previous location. The relocation also provided the company with access to laboratory facilities and the necessary infrastructure, allowing it to avoid investing in and constructing its own labs, as the interviewee explained: "we rent space in there as a lab so that we don't have to build one ourselves." (Company G, interview, 5 May 2026). At the same time, the interviewee explained that the location allows them to be near one of the biggest concentrations of researchers working in their field.

In addition, the company considers the cluster environment to be an attractive workplace due to both the available resources and the overall working environment. The innovation cluster offers access to specialized support services, including legal and human resource consultants, who can assist companies when needed. According to the interviewee, these resources represent a valuable advantage of being located within the cluster.

Finally, access to restaurants, social areas, and meeting facilities was also highlighted as a benefit associated with the cluster location, contributing to both convenience and the overall positive work environment.

4.8 Company H

4.8.1 Background information

Company H develops medical technology within neurological healthcare, with a focus on improving treatment methods for neurological conditions. The company's research and development activities are based within the innovation cluster.

4.8.2 Collaboration practices in the context of digitalization

Company H described its innovation process as primarily internally driven, with external collaboration occurring selectively in situations where additional expertise is needed. Company H made a clear distinction between digital and physical collaboration. Video meetings were described as useful for information sharing, follow-ups, and meetings with external experts, as they provide access to specialized knowledge without the time and cost associated with travel. Digital tools were considered particularly efficient for routine interactions, especially when the purpose is clearly defined and the meeting is kept structured, such as reporting meetings, supplier updates, and shorter follow-ups.

However, the interviewee explained that Company H does not actively work with introducing new digital tools at an organizational level. Instead, knowledge about such tools tends to emerge through individual interest and informal learning. Physical meetings were described as more important for building trust, creative problem-solving, practical development work, and informal exchanges that arise through proximity. Creative sessions were considered difficult to conduct digitally, as they often require whiteboards, sketches, physical objects, and direct interaction. Spontaneous conversations during lunches, coffee breaks, or cluster events were also seen as valuable for advice, knowledge sharing, and new contacts. Digital meetings were therefore regarded as useful for structured communication and access to expertise, but not as a replacement for the physical innovation cluster.

4.8.3 The advantages of locating within the innovation cluster

The interviewee emphasized several advantages associated with physical localization within the innovation cluster. One of the main advantages highlighted by Company H was the opportunity to be located close to companies operating within the same industry and at a

similar stage of development. The innovation cluster was described as an environment where companies could exchange experiences and learn from one another.

The interviewee also emphasized the importance of specialized support functions within the cluster. For a small medical technology company, areas such as quality management, regulatory documentation, clinical study design, and business development require specific expertise. Rather than developing all of these competencies internally, Company H can access external specialists and incubator support when needed, which was described as particularly valuable during the development phase.

In addition, the innovation cluster was described as an important arena for networking. Recurring breakfasts, lunches, presentations, and informal meetings make it easier to identify potential collaborations, reconnect with previous contacts, and discover companies working with related technologies or challenges.

The interviewee also highlighted access to shared resources and services as a practical advantage, since developing such infrastructure internally would be too costly for a small company. Finally, the innovation cluster was described as a meeting place where companies can encounter investors, policymakers, and other relevant industry actors.

5. Analysis

5.1 Collaboration in the context of digitalization

A recurring pattern throughout the interviews was that companies rarely practice collaboration solely internally. Instead, the companies relied heavily on external expertise, resources, and guidance originating both from actors within the innovation cluster and from partners outside the cluster. This strong reliance on external collaboration can be connected to Chesbrough's (2006) concept of open innovation.

The findings revealed a distinction between the types of collaboration taking place within the innovation cluster and those occurring with external actors. Collaborations within the innovation cluster were mainly characterized by practical and day-to-day interactions. According to Companies A, D, and G, these collaborations included sharing staff, borrowing equipment, exchanging experiences, and utilizing support functions within the cluster. Such practices align with the outside-in approach to open innovation (McPhilips, 2020), where companies integrate external knowledge and competencies into their own operations. Notably, only Company F used an inside-out approach, specifically out-licensing agreement to bring their innovation to market (Lichtenthaler, 2008).

The findings also reflected the coupled approach to open innovation (Chesbrough & Bogers, 2014), as Companies A, D, E, F, and G explained that networking events and social initiatives within the cluster, such as breakfast meetings and executive networks, functioned as forums for continuous knowledge exchange and relationship-building among cluster members. The geographic proximity within the cluster thereby facilitated learning processes and knowledge spillovers between companies (Howells, 2002; Fioravanti et al. 2021), where both inflows and outflows of knowledge contributed to organizational learning and development (Chesbrough & Bogers, 2014).

One of the clearest patterns in the findings is that all companies rely mostly on external partners outside the innovation cluster for collaboration. Several companies described how digital technologies enabled frequent interaction with actors both nationally and internationally. For example, Company C reported daily digital meetings with colleagues in China, while Company B maintained meetings with actors in the United States. This supports Marion and Fixson's (2020) argument that digital tools reduce barriers and support greater

collaboration across geographic distances. The findings also align with Lyytinen et al. (2016), Nieto et al. (2023), and Verhoef et al. (2021), who argue that digitalization enables more geographically distributed innovation networks and reshapes how companies organize external relationships.

The findings further indicate that collaboration takes place through a hybrid form of interaction (Lyytinen et al. 2016; Nieto et al. 2023; Marion & Fixson, 2020), where both digital and physical interactions are important depending on the situation. Digital meetings were mainly described as effective for routine interactions and structured discussions with clear agendas. Company H explained that digital meetings increase efficiency when interactions are formalized and goal-oriented. Several interviewees also emphasized that digital meetings reduce the need for travel and make collaboration faster and less costly, which is consistent with Marion and Fixson's (2020) argument regarding the efficiency advantages of digital tools.

The knowledge transfer occurring in these digital settings can largely be understood as codified knowledge transfer, as the interactions are typically structured and formalized (Howells, 2002). In contrast, physical interaction was often described as more valuable in informal and exploratory situations. Company C emphasized the importance of physical interaction for creating social connection, while Company H highlighted its role in creative collaborations. Physical meetings were also repeatedly described as important for establishing trust and facilitating continued digital collaboration. This suggests that physical interaction is particularly important for tacit knowledge transfer, where knowledge is exchanged through direct social interaction and shared environments (Howells, 2002).

At the same time, the findings indicate that the effects of digitalization should not be assumed to emerge automatically. Company A noted that complex digital systems may create frustration and remain unused, while Company D described moving away from certain digital solutions due to usability challenges. Company B referred to being in a learning phase regarding some digital tools, and Company H explained that the implementation of new tools often depends on individual interest rather than systematic strategies. This aligns with Marion and Fixson's (2020) argument that the benefits of digital technologies may create resistance and do not emerge automatically. It also supports Ancillai et al.'s (2023) observation that

companies often struggle to fully realize the potential of digital technologies despite significant investments.

Viewed together, the findings suggest that digitalization has expanded the possibilities for how the companies practice collaboration in innovation clusters. While digital tools enable geographically distributed and efficient collaboration, physical proximity continues to hold significant value in collaborations involving trust, social interaction, relationship building, and tacit knowledge exchange.

5.2 The advantages of geographic proximity in the context of digitalization

Building upon the findings regarding collaboration practices, several recurring patterns emerged throughout the empirical material concerning the advantages companies associated with geographic proximity within the innovation cluster. One theme that consistently was emphasized across the interviews was the value of geographic proximity to partners, collaborators, and researchers operating within related fields. This aligns with Remotti's (2021) description of innovation clusters as concentrations of interconnected actors within a specific domain. However, while Remotti (2021) defines the structural composition of innovation clusters, the empirical findings provide further insight into the practical advantages of such proximity.

Another recurring advantage identified across the interviews was access to shared resources and support functions. While Porter (1998) emphasizes access to specialized resources and complementary assets as key cluster benefits, the findings suggest a more active form of resource sharing within innovation clusters. With the exception of Company D, all companies described borrowing equipment, utilizing shared laboratory facilities, and relying on common support services such as legal expertise, consultants, and specialized infrastructure. This suggests that geographic proximity not only increases access to resources but also facilitates their practical use across organizational boundaries.

Porter (1998) further argues that geographic proximity enables repeated interaction, coordination, and enhanced information flows between companies. The empirical findings support this argument while also illustrating how these interactions materialize in practice.

Company A, C, D, F, G, and H highlighted the importance of informal networking through shared spaces, networking events, lunches, and spontaneous conversations. Among these companies, Company A, D, E, F, and G emphasized that such interactions were valuable not only for knowledge exchange and inspiration, but also for relationship-building and employee well-being. Rather than occurring solely through formal collaborations, knowledge exchange frequently developed through everyday encounters and informal social interaction. This supports Fioravanti et al.'s (2021) argument that collaboration functions as an important mechanism for knowledge transfer.

Access to skilled labour also emerged as a recurring theme throughout the empirical material. Consistent with previous research (Porter, 1998; Heidenreich & Mattes, 2025), Company E, C, and F emphasized the ease of recruitment and the possibility of accessing highly specialized competence through the innovation cluster. In addition, Company B, C, E, and F described arrangements where personnel could work across company boundaries or divide their time between organizations. This suggests that geographic proximity may facilitate more flexible forms of competence sharing within the innovation cluster, aligning with Fioravanti (2021) and the idea that labour mobility facilitates knowledge transfer.

Finally, the findings highlight that the advantages of being located within an innovation cluster extend beyond the productivity-oriented advantages emphasized by Porter (1998). Almost all companies described the innovation cluster as an attractive and inspiring environment that positively influenced employee well-being, workplace satisfaction, and the overall work atmosphere. Shared spaces and everyday interactions were viewed as contributing to a socially supportive setting that enhanced the daily work experience.

In addition, several companies, including Company B, C, D, E, and F, emphasized the symbolic value associated with cluster membership. For instance, Company F described how affiliation with the innovation cluster contributed to perceptions of credibility, visibility, and professionalism. As explained by Company E, some companies maintained a physical presence within the innovation cluster despite conducting much of their work remotely, suggesting that the value of cluster membership extends beyond direct operational benefits. Together, the findings indicate that innovation clusters provide not only productivity and innovation-related advantages, but also social and reputational value. This extends Porter's (1998) framework by highlighting how geographic proximity may contribute to identity

formation, legitimacy, employee well-being, and informal interaction in addition to productivity and innovation outcomes.

When discussing whether digitalization had affected the advantages associated with geographic proximity, all companies emphasized that digital tools had not replaced the value of physical interaction or the benefits connected to being located within an innovation cluster. Instead, digitalization was described as complementing existing innovation cluster advantages rather than replacing them. The findings nevertheless suggest that digitalization influences different cluster advantages in different ways. Several companies described how digital communication tools made it easier to maintain collaboration with actors located outside the innovation cluster, thereby reducing the importance of geographic proximity for certain structured and operational forms of interaction. This supports previous research arguing that digitalization enables innovation networks to become more geographically distributed (Lyytinen et al. 2016) and broadens the range of actors involved in company innovation networks (Nieto et al. 2023).

At the same time, many of the advantages associated with geographic proximity remained difficult to replicate digitally. Shared resources and laboratory facilities still depended on physically shared environments, while informal networking, spontaneous conversations, and social interaction continued to play an important role in relationship-building, inspiration, and employee well-being. In addition, the symbolic value associated with cluster membership, such as legitimacy, credibility, and visibility, appeared largely unaffected by digitalization, as some companies maintained a physical presence within the innovation cluster despite conducting substantial parts of their work remotely.

Consequently, the findings suggest that digitalization reshapes rather than reduces the advantages of geographic proximity within innovation clusters. While digital technologies reduce the dependence on physical proximity for certain operational and communication-related activities, the social, symbolic, and informal advantages associated with physically shared environments continue to hold significant value.

6. Conclusion and discussion

6.1 Conclusion

This study set out to answer how companies in innovation clusters practice collaboration in the context of digitalization, and how this affects the advantages of geographic proximity. It examined the paradox that digitalization enables collaboration across distances, while innovation clusters remain relevant.

The findings show that companies practice collaboration through a hybrid combination of digital and physical interaction, where the choice of format depends on the purpose, content, and relational character of the collaboration. Digital collaboration was primarily used for structured and planned interactions, such as routine meetings, coordination, information exchange, and communication with actors outside the cluster, thereby facilitating the transfer of codified knowledge. This made collaboration across geographic distances more efficient and reduced the need for physical co-presence, particularly when the knowledge exchanged was codified, clearly articulated, and connected to specific tasks or agendas.

However, the findings also show that digital collaboration does not replace the value of physical interaction. Face-to-face interaction remained important for informal networking, trust-building, spontaneous encounters, and the transfer of tacit knowledge. These forms of collaboration were often less structured and more dependent on social interaction, shared experiences, and the ability to interpret nuances that are difficult to capture digitally.

The findings also suggest that the potential of digitalization was not always fully realized. Due to limitations related to usability, adoption, and the integration of digital tools into everyday work, digital tools were mainly perceived as complementing rather than replacing physical interaction.

The findings further indicate that companies did not primarily depend on the innovation cluster for all formal collaborations, as many important collaborations took place with external actors beyond the cluster. Instead, the value of being located in the cluster was mainly connected to the broader environment and conditions that the innovation cluster provides. Companies benefited from access to shared resources, personnel, equipment, experiences, support functions, and informal networks within the cluster environment. This

reflects an outside-in approach, as companies gained value by accessing external knowledge and resources within the cluster, while elements of a coupled approach were also visible through recurring social interactions and informal knowledge exchange. Thus, the advantages of geographic proximity were not only connected to direct formal collaboration between companies, but also to the resources, relationships, and social environment made possible by physical proximity.

Overall, the findings indicate that digitalization changes the role of geographic proximity by reducing its importance for structured and operational collaboration, while preserving its value for aspects that are difficult to reproduce digitally. These include trust-building, tacit knowledge exchange, informal conversations, shared social experiences, access to resources and expertise, support functions, informal networks, credibility, and professional image. Taken together, the findings suggest that digitalization does not remove the advantages of geographic proximity, but reshapes them.

6.2 Discussion

The findings of this study contribute to research on innovation clusters, digital collaboration and geographic proximity by addressing the paradox outlined in the problematization. Previous research suggests that digitalization enables companies to collaborate across geographic distances without being physically co-located (Verhoef et al. 2021), while innovation clusters continue to expand and remain relevant environments for companies (Vinnova, 2025). Rather than treating these developments as contradictory, this study shows that digitalization and geographic proximity coexist and fulfil different functions. The companies in this study used digital tools to support efficient collaboration across distance, particularly in structured and planned interactions, while still perceiving the innovation cluster as valuable for informal interaction, trust-building, social belonging and credibility. This contributes to existing research by showing that digitalization does not eliminate the advantages of geographic proximity, but reshapes how and when these advantages matter.

In relation to traditional cluster research, the findings support Porter's (1998) argument that geographic proximity remains important for companies located in clusters, despite the nearly three decades of digital transformation that have followed since his work was published.

However, the study also extends this perspective by showing that the value of proximity in a digitalized context is not limited to productivity, flexibility, efficiency and access to resources. Instead, the findings indicate that proximity also creates social and symbolic advantages, including informal encounters, trust-building, belonging and image of legitimacy. This suggests that the advantages of innovation clusters may be more multidimensional than traditional cluster theory implies. The study therefore contributes to cluster research by showing that geographic proximity remains relevant not because all collaboration requires physical closeness, but because certain relational and informal dimensions of collaboration are difficult to replace digitally.

The findings also contribute to research on digitalization and collaboration. Hagberg et al. (2016) describe digitalization as reshaping how companies operate and engage with one another, while Verhoef et al. (2021) emphasize that digital technologies enable interaction across geographic boundaries. By connecting this discussion to Howells' (2002) distinction between codified and tacit knowledge, this study contributes by showing that the effects of digitalization depend on the type of collaboration and knowledge being exchanged. Digital collaboration was mainly used for formal meetings, routine coordination, information exchange and collaboration with actors outside the cluster. These interactions were often structured, planned and connected to more codified forms of knowledge, which can be more easily articulated, formalized and transferred through digital communication. In contrast, physical interaction remained important for informal networking, spontaneous encounters, trust-building and the transfer of tacit knowledge, which is more dependent on social interaction, shared experience and contextual understanding. The study therefore contributes to existing research by specifying why some forms of collaboration are more easily digitalized, while others continue to depend on geographic proximity.

Furthermore, the study contributes to research on the limitations of digitalization within innovation clusters. Although digital tools make distance-based collaboration possible, the findings indicate that this potential is not always fully realized. Several companies described challenges related to usability, limited adoption of digital tools and insufficient effort to further develop digital ways of working. This aligns with Ancillai et al.'s (2023) argument that companies may struggle to fully utilize the potential of digital technologies. It also relates to Heidenreich and Mattes' (2025) discussion of how innovation clusters may face challenges in adapting to digitalization due to lock-in effects. However, since lock-in effects

were not examined in detail in this study, the findings should not be understood as direct evidence of lock-in, but rather as indicating that digitalization's impact depends on how companies adopt, integrate and use digital technologies in practice.

These methodological limitations highlight the importance of evaluating the trustworthiness of the study. The study's trustworthiness was assessed through the four criteria proposed by Lincoln and Guba (1985): dependability, confirmability, credibility and transferability. Dependability was strengthened by the recurring patterns identified across the interviews, as several companies described similar experiences regarding geographic proximity, collaboration and digitalization. However, as the study is qualitative and based on respondents' experiences, identical results may not necessarily emerge in another context or with different interviewees.

Confirmability was strengthened through the use of a structured interview guide, where all interviewees were asked the same core questions, as well as through a consistent approach to transcription and analysis. Interpretations were also supported by empirical examples and interview statements to increase transparency. Credibility was strengthened by interviewing respondents with direct insight into the relevant concepts and decision-making processes within their companies, and by the fact that recurring themes emerged across independent interviews. However, since all interviewees were located within innovation clusters, they may have emphasized the positive aspects of cluster membership. On the other hand, this provided the study with experience-based insights from companies directly operating within such environments, which was essential for the purpose of the study.

Finally, transferability may be limited, as the study focused exclusively on companies within the life science sector. Companies in other industries may experience collaboration, digitalization and geographic proximity differently. Although, the relatively homogeneous sample strengthens the possibility for theoretical generalization by reducing unnecessary variation and external influencing factors (Alvehus, 2023). Consequently, the findings can be considered transferable to companies in similar industries and innovation cluster contexts.

6.3 Future research

The discoveries in this study open up several possibilities for future research regarding geographic proximity, collaboration and the effect of digitalization. Since this study mainly focused on companies operating within life science, future studies could examine whether these discoveries differ depending on the type of industry located within the innovation cluster.

Another interesting direction for future research would be to examine more mature companies who have been located within the innovation cluster for a longer period of time. Even though some of the investigated companies have been located in the innovation cluster for a longer period, several of them have only recently established themselves in the specific location. This could affect how far the companies have gotten in their process of building relationships and collaborations within the clusters. Future research could therefore explore how these factors differ within more established companies within clusters.

Finally, an additional perspective would be what long-term effects the Covid 19 pandemic has had on the implementation of digital tools within companies. A common response regarding implementation of digital tools was that the pandemic forced and normalized the process of frequent digital collaborations. Therefore, future studies could compare collaboration patterns before and after the pandemic in order to understand whether digitalization fundamentally transformed collaboration practices or primarily reinforced already existing trends.

6.4 Practical implications

The findings of this study provide several practical implications for both companies operating and managing an innovation cluster or companies who are considering establishment within one. One important implication from the study concerns the role of image and reputation in the companies' decision to locate within an innovation cluster. Several companies described the location to play an important role in their branding, credibility and recognizability within the life science sector. This suggests that an important part of creating new innovation

clusters or developing existing ones is to create and maintain an attractive location and operation that creates legitimacy for companies who choose to locate there.

An additional implication of this study concerns the importance of community, belonging, and active participation within innovation clusters. Several companies emphasized that shared spaces, networking opportunities, and recurring social events were important factors both when selecting the location and in creating a positive day-to-day working environment within the cluster. The findings further suggest that companies engaging more actively in cluster activities, remaining open to knowledge exchange, and participating in social and professional interactions generally appear to benefit more from the opportunities associated with geographic proximity. Consequently, it becomes important not only for companies to actively participate in the cluster environment, but also for cluster management to continuously facilitate and evaluate social and networking activities in order to maintain satisfaction and encourage interaction among member companies.

Lastly, an additional contribution relates to trust and relationship building within collaborations between companies. The findings indicate that physical interaction remains highly important, especially during early stages of collaboration, as a method of building trust and stronger personal relationships. At the same time, once the relationship is established physically, digital tools appear to be effective for maintaining collaboration over time. This suggests that companies may benefit from implementing hybrid collaboration structure.

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Appendix

Interview guide:

1. Can you briefly describe your role and your organization?
2. How long have you been based in the cluster? And have you been based somewhere else before that?
 - What would you say is the main difference between being located in a cluster and being located elsewhere?
3. Why did your organization choose to locate in the cluster?
4. What role, if any, does location play in your day-to-day work?
5. What advantages, if any, do you associate with being located close to other companies in the cluster?
6. What challenges, if any, do you associate with being located close to other companies in the cluster?
7. Can you describe how new ideas or innovations typically emerge in your organization?
 - What role do external actors play in this process?
8. In what ways does your organization collaborate with other companies?
 - How frequently do these collaborations take place?
 - How often do you collaborate physically versus digitally?
 - What digital tools do you use when collaborating digitally?
9. Who do you typically collaborate with? For example, companies within the cluster, outside companies, or other types of actors?
 - *Only within the cluster:* Do you feel that the cluster provides everything you need in terms of collaboration, knowledge, and resources? Or are there situations where you feel something is missing?
10. Does the way you collaborate differ depending on whether it takes place digitally or physically? Can you give examples?
 - Is one preferred over the other? Why?
11. Are there any collaborative activities that you think require face-to-face contact? If so, can you give examples?
12. How is knowledge and ideas shared between your organization and other companies?

13. Do you experience differences in trust when collaborating physically within the cluster versus digital collaborations?
14. What factors influence your decision to remain located in the cluster, given that digital collaboration makes it possible to work with actors globally?
15. Do you think digitalization will reduce the importance of physical clusters in the future? Why or why not?
16. Do you feel that your organization makes full use of digital tools in collaboration? Why or why not?
17. Is there anything else you think is important regarding collaboration, digitalization, or location that we haven't discussed?

Prompts AI

Idea generation: ChatGPT was used to support the development of additional interview questions and alternative formulations through brainstorming.

- Can you give me examples of how I can formulate this sentence more academically?
- How can I make this interview question as clear and understandable as possible?
- How can I formulate this interview question more open and unbiased?

Language improvement: ChatGPT was used to refine grammar and improve the structure of text written by the authors.

- Can you help me improve the flow in this sentence?
- Give me examples of synonyms for this word
- Correct the grammar in this section
- Improve the grammar of this section

Feedback and revision support: ChatGPT was used to receive feedback on drafts in order to enhance coherence.

- Can you improve the existing transition between these two parts?
- Is the following paragraph clear or does it need to be refined in some way?
- Can you help me shorten this paragraph?
- Can you give me feedback on this section regarding the language and flow?

Finding academic literature: Consensus and Scopus AI was used to identify relevant academic literature, which were subsequently evaluated and selected by the authors.

- Can you help me find peer reviewed articles about geographic proximity?
- Can you help me find peer-reviewed articles about knowledge transfer, specifically tacit and codified knowledge transfer?
- Can you help me find research about collaboration and knowledge transfer?
- Can you help me find peer-reviewed articles with definitions of digitalization?
- Can you help me find literature regarding the definition of innovation cluster?