Managing unbounded digital transformation: exploring the role of tensions in a digital transformation initiative in the forestry industry

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Abstract

Purpose – Prior research has highlighted the pervasive importance of digital technologies in business and societal settings, but their enabling role in digital transformation, and effective forms of organization to address tensions that arise during attempts to promote it, have been insufficiently explored. Therefore, the purpose of this paper is to investigate how and why tensions affect clusters established to foster digital transformation.

Design/methodology/approach – Empirical data were acquired through a qualitative exploratory holistic single case study, focused on the Swedish Cluster of Forest Technology. This included interviews with informants, selected by homogeneous purposive sampling, and event observation to investigate the personal perspectives of representatives of every company engaged in the cluster, followed by a thematic analysis of their comments.

Findings – The case study revealed three major tensions, between knowledge flow, collaboration and competition, but also others that were interrelated with those major tensions, related to matters such as trust and protection of intellectual property, power equality and hierarchy, and networks that must be managed in digital transformation efforts.

Originality/value – The paper extends understanding of the tensions that arise, and their management, in digital transformation processes.

Keywords Digital transformation, Digital innovation, Digital technologies, Cluster, Competition, Collaboration, Knowledge flow, Leadership, Tensions

Paper type Research paper

1. Introduction

Rapid advances in digital technologies, such as artificial intelligence (AI), cloud computing and the Internet of Things (IoT), are fundamentally changing the nature of contemporary organizations. The speed and scale of today's technological change are radically transforming workplaces or even displacing workers altogether (Acemoglu and Autor, 2011; Brynjolfsson and McAfee, 2014). The impact of this digital transformation on organizations and their environments remains contested, with some predicting substantial job losses through automation (Iansiti and Lakhani, 2020), while others paint a more optimistic picture, predicting that as many new jobs will be created by new technologies as they displace (Arntz *et al.*, 2017). Regardless of which view is more accurate, organizations clearly need to integrate new digital technologies and engage in digital transformation to remain competitive (Fitzgerald *et al.*, 2014), as the effects of digital transformation are already

being felt across a broad range of job roles (Singh and Hess, 2017) and industries (Scott and Orlikowski, 2021).

In recent years, various scholars have shown that pervasive digitalization has fundamentally transformed business logic (Hinings *et al.*, 2018) and ecosystems (Riasanow *et al.*, 2021), organizational dynamics (e.g. Gregory *et al.*, 2015), social structures (Yoo *et al.*, 2010a; Bonina *et al.*, 2021), the economy (Scholz *et al.*, 2018) and societal contexts as a whole (Nylén and Holmström, 2011; Ciriello *et al.*, 2018). Digital technologies have democratized the digital innovation process (Yoo *et al.*, 2012), and dramatically changed the structure of products and services while generating new value-creation pathways (Nambisan *et al.*, 2017, 2019). Thus, they have fundamentally changed organization-, product- and service-related aspects of innovation in increasingly diverse domains and industries (Yoo *et al.*, 2010a; Yoo *et al.*, 2012; Porter and Heppelmann, 2014; Lyytinen *et al.*, 2016; Nylén and Holmström, 2019). Hence, digital technologies play crucial roles in facilitating openness and enabling new organizational opportunities (Yoo *et al.*, 2012; Nambisan *et al.*, 2019; Elia *et al.*, 2020). In tandem, by seizing advantages from external sources of transforming innovation, technologies and knowledge, organizations may optimize domestic growth, gain momentum and even competitive advantage (Yang *et al.*, 2018).

Cited observations of these recent phenomena have clearly highlighted the unboundedness of digital transformation, i.e. its capacity to extend far beyond prior organizational boundaries and trigger the formation of new organizational constellations (Holmström, 2022). However, there are still urgent need for a better understanding of the triggers, nature and impacts of digital transformation for both theoretical and practical reasons, partly because a sharp increase in recent studies suggests that digital transformation is affecting increasingly diverse industries and occupations. Fortunately, there is a long trajectory of rigorous research across multiple disciplines that can be applied to grasp some, but not all, aspects of these emerging trends. Notably, while the impact of technology in various workplaces has been studied for several decades (Orlikowski, 1992; Acemoglu and Autor, 2011), there is less understanding of optimal strategies for organizations to manage digital transformation processes. Moreover, there is a need for further empirical research on how digital transformation unfolds (Wu *et al.*, 2021) as emerging digital technologies are driving increasingly rapid transformation processes (Verhoef *et al.*, 2021).

In addition, the organizational and technological change processes generally entail numerous tensions derived from competing demands (Gregory *et al.*, 2015; Svahn *et al.*, 2017), including tensions between exploration and exploitation (Westergren and Holmström, 2012; Wimelius *et al.*, 2021), stability and evolvability (Tilson *et al.*, 2010; Wareham *et al.*, 2014), control and flexibility (Svahn *et al.*, 2017), speed and stability (Haffke *et al.*, 2017) and between collaboration and competition (Selander *et al.*, 2010; Tidström, 2014). The associated organizational paradoxes may be important drivers, or obstacles, of digital transformation initiatives (Smith *et al.*, 2017). As digital technologies play major roles in organizations' digitization of their operations, overall strategic trajectories, as well as connections within and among them, they inevitably influence such tensions (Selander *et al.*, 2010). Digital technologies may potentially ease, exacerbate or otherwise alter these tensions. However, the roles of tensions in digital transformation have received limited research attention (Danneels and Viaene, 2022). Therefore, the nature, emergence and interactive effects of such tensions with digital technologies on digital transformation processes require further elucidation.

In efforts to contribute to such elucidation, we posed the following research question: *How and why do paradoxical tensions affect the trajectory of digital transformation initiatives?* To address this question, we reviewed previous studies on digital transformation and consolidated them into three specific research streams. We then applied this framing in an exploratory case study of the Swedish Cluster of Forest Technology, which was established

in northern Sweden to foster innovation among the cluster members. Our objectives were to identify tensions that have arisen within the cluster and explore both the cluster's and its members' responses to the tensions at critical junctures. More broadly, our study is intended to contribute to the emerging scholarly debate regarding digital transformation and its management, by unpacking and deepening understanding of how tensions may affect the course and outcomes of digital transformation initiatives. Digital transformation is a complex phenomenon (Hess *et al.*, 2016). Therefore, it is important to understand how tensions are enacted or influenced by digital technologies for both researchers who explore processes and outcomes and practitioners who seek to manage digital transformation processes.

The remainder of the paper is structured as follows. In Section 2, we outline the current theoretical understanding of the general nature and scope of digital transformation positing the role of underlying tensions in digital transformation initiatives. In Section 3, we discuss previous understandings of tensions that arise when organizations digitally transform, which guide our empirical analysis. In Section 4, we present the research methodology we applied, describe the Swedish forestry sector, and present the case study. Section 5 is dedicated to our empirical findings. In Section 6, we discuss our empirical findings in relation to previous findings, summarize our main contributions to digital transformation management and provide recommendations for the cluster and future research.

2. Digital transformation: state-of-the art
Digital transformation is a multidimensional (see e.g. Hausberg *et al.*, 2019; Verhoef *et al.*, 2021; Porfírio *et al.*, 2021) and complex process (Hess *et al.*, 2016; Porfírio *et al.*, 2021). Recent literature reveals distinct differences between digital transformation and both digital disruption (e.g. Skog *et al.*, 2018) and IT-enabled transformation (Vial, 2019; Wessel *et al.*, 2021). A number of scholars have also clarified the distinction between digitization and digitalization (Tilson *et al.*, 2010; Yoo *et al.*, 2010a; Gong and Ribiere, 2021) and explained the conceptual links between digitalization, digital innovation and digital transformation (Osmundsen *et al.*, 2018; Holmström, 2022).

However, examining the entire body of literature on digital transformation to identify pertinent studies for addressing our research question would have been problematic due to the diverse and disperse nature of the concept and sheer volume of literature. Moreover, from an academic perspective, digital transformation *per se* is a rather fragmented field due to diverse foci of investigation, such as the digital transformation of societies, industries, economies and specific companies. Thus, we set specific boundaries in efforts to maximize the likelihood of retrieving a manageable set of the most informative studies for our purpose. To elucidate the premises of digital transformation initiatives, we first describe the literature review methodology, and then summarize the retrieved digital transformation literature to provide a theoretical overview.

2.1 Reviewing related research
Following Webster and Watson (2002), our review of the digital transformation literature was concept-centric. In addition, following Durach *et al.* (2017), we recognized a need to expand the search beyond publications' titles and abstracts to find relevant articles and thus scanned titles, abstracts, keywords and introductions. Initially, we attempted to identify most of the relevant articles by screening entries in the Google Scholar, Web of Science (WoS) and Scopus databases, using combinations of the search terms: "digital technologies," "transform," "IT," "IS," "organizational change" and "digital transformation." Due to the breadth of research on the concept of digital transformation and related phenomena, we set several boundary conditions designed to maximize the salience of retrieved studies. Webster and Watson (2002)

suggest that substantial, relevant contributions are most likely to be found in the leading journals in the pertinent field. Thus, we centered our research on leading peer-reviewed journals in the IS and management realms. After further examination of the 'hits' and their relevance, we were left with 125 articles in peer-reviewed journals that treated digital transformation as a core subject, are in English and are available, thereby meeting key criteria (Fisch and Block, 2018). We subsequently reduced the number of articles to 35 that seemed to capture the most common patterns and definitions, for close scrutiny.

We found significant variation in the digital transformation concept (see also Warner and Wäger, 2019; Scott and Orlikowski, 2021) and in what it encompasses (Wessel *et al.*, 2021), depending on both the focal area and specific scholar(s). The complexity surrounding digital transformation (Matt *et al.*, 2015) reflects the lack of a fully-fledged and generally accepted definition (Hausberg *et al.*, 2019; Hanelt *et al.*, 2021; Gong and Ribiere, 2021), and the inconsistent use of the term by leaders within and across industries to describe different organizing and strategizing initiatives (Warner and Wäger, 2019). Therefore, we first examined the most strongly highlighted assumptions and concepts used to characterize the nature of digital transformation, and then classified them into three streams (Table 1). The following section presents the three streams we identified, which we designate *the boundless transformational dynamics*, *digital transformation of strategies and organizational logics* and *structural reconfiguration and societal changes* streams. The streams are interdependent and highlight important aspects of digital transformation as both a process and an outcome triggered by the unbounded nature of digital technologies.

Boundless Transformation Capabilities: "Everything flows … in a fluid and dynamic digital world" as described and discussed by Mousavi *et al.* (2021). This fluidity, enabled and triggered by the unbounded nature of digital technologies (Yoo *et al.*, 2010a, 2010b; Nambisan *et al.*, 2017), results in amorphous organizational and industrial boundaries

Research stream	Description of digital transformation	Relevant articles
1. Boundless Transformational Dynamics	Due to their boundless nature, digital technologies transform and accelerate innovation processes by enabling myriads of collective interactions between multiple actors (networks) and promoting knowledge-sharing and openness	Yoo *et al.* (2010a), El Sawy *et al.* (2010), Yoo *et al.* (2010b), Dougherty and Dunne (2012), Loebbecke and Picot (2015), Lyytinen *et al.* (2016), Schlagwein *et al.* (2017), Hinings *et al.* (2018), Nambisan *et al.* (2019), Tan *et al.* (2020), Marion and Fixson (2021), Bailey *et al.* (2022)
2. Digital Transformation of Strategies and Organizational Logics	The boundless nature of digital technologies has transformative effects on strategizing and organizing logics (including culture, leadership, strategy, capabilities, business models, etc.) that can pave the path for value generation or generate tensions	Bharadwaj *et al.* (2013), Fitzgerald *et al.* (2014), Kane *et al.* (2015), Nambisan *et al.* (2017), Matt *et al.* (2015), Hess *et al.* (2016), Warner and Wäger (2019), Eden *et al.* (2019), Li (2020), Sebastian *et al.* (2020), Wimelius *et al.* (2021), Porfírio *et al.* (2021)
3. Structural reconfiguration and societal changes	The profound changes driven by digital technologies result in transformations of organizational identity, cultures and objectives, penetrating both societies and industries	Besson and Rowe (2012), Li *et al.* (2018), Vial (2019), Chanias *et al.* (2019), Verhoef *et al.* (2021), Baiyere *et al.* (2020), Lanamäki *et al.* (2020), Wessel *et al.* (2021), Scott and Orlikowski (2021), Hanelt *et al.* (2021), Nadkarni and Prügl (2021)

Table 1.
The three identified streams of digital transformation research

(Hanelt *et al.*, 2021). The complexity and adaptability of digital technologies (Yoo *et al.*, 2012), along with their multi-layered transformational capabilities (Nambisan *et al.*, 2017), change "the uncertainty inherent in innovation" (Nambisan *et al.*, 2019, p. 1) and facilitate both collaboration and knowledge sharing (Bailey *et al.*, 2022). The new forms of organizing erode not only organizational boundaries but also intellectual property and national boundaries (Ibid).

These paradigmatic changes and the associated tensions that emerge throughout the process are the focal concerns of this stream. Concurrently, the essentially unbounded, weakly pre-defined and highly distributed nature of digital innovation transforms entire innovation and business ecosystems (Nambisan *et al.*, 2017; Tan *et al.*, 2020; Hanelt *et al.*, 2021), thereby strongly promoting interconnectedness (El Sawy *et al.*, 2010) and facilitating openness (Yoo *et al.*, 2012; Schlagwein *et al.*, 2017; Nambisan *et al.*, 2019). Digital technology engenders openness by facilitating participation among actors, inputs, process and outcomes that promote innovation (e.g. Nambisan *et al.*, 2019), thereby eroding traditional work structures and fostering the emergence of new opportunities beyond the horizon of opportunity of any single company (see e.g. Loebbecke and Picot, 2015).

Specifically, the openness of digital innovation transforms business models (Li, 2020; Loebbecke and Picot, 2015) and enables the creation and development of new products and/or services instigated by novel actors or actors' constellations (Yoo *et al.*, 2010b; Nambisan *et al.*, 2017; Hinings *et al.*, 2018). Concomitantly, the less-predefined agency engenders new ways of sharing, managing and absorbing knowledge (Marion and Fixson, 2021). Hence, digital innovation typically transforms and spans organizational boundaries by creating knowledge that could not emerge otherwise (Dougherty and Dunne, 2012). The success of these open organizational forms is associated not only with knowledge-sharing practices but also with transparency, digital artefacts and connectivity, as Lyytinen *et al.* (2016) emphasize.

Digital Transformation of Strategies and Organizational Logics: This stream maps the pervasive and dynamic role of digital technologies in transforming organizing and strategizing logics, the "organizational antecedents" as categorized by Hanelt *et al.* (2021), while changing "how, when, and where work gets done, as well as by whom and for whom" (Bailey *et al.*, 2022, p. 2). Studies in this stream highlight digital transformation's role in streamlining or realigning operational backbones and enhancement of customers' experiences to generate value (Fitzgerald *et al.*, 2014; Sebastian *et al.*, 2020). For instance, Eden *et al.* (2019) describe the gradual interlinking of the workforce and transformation activities as essential for large-scale digital transformation. A mindset incorporating an innovation culture and openness has also recognized the importance of embracing digital transformation initiatives and encouraging associated activities (Gurbaxani and Dunkle, 2019). In addition, appropriate strategic actions (Hess *et al.*, 2016; Porfírio *et al.*, 2021), a strategic vision from leadership (Fitzgerald *et al.*, 2014) and both coordination and implementation of a digital transformation strategy (Bharadwaj *et al.*, 2013; Matt *et al.*, 2015; Sebastian *et al.*, 2020) are required for balancing and orchestrating exploration and exploitation activities (Hess *et al.*, 2016). Similarly, Besson and Rowe (2012) argue that transformation is primarily a managerial issue, while Kane *et al.* (2015) and Warner and Wäger (2019) recognize the importance of strategy in conjunction with technology as key drivers of digital transformation. Hence, managerial cognition (Li *et al.*, 2018) prompts digital transformation initiatives, and management of the associated challenges is essential for a successful outcome. In the same vein, Fitzgerald *et al.* (2014) and Warner and Wäger (2019) note that firms have to cope with significant challenges even when senior leadership embraces digital technologies to enable digital transformation. Moreover, managers may face decision-making challenges between explorative activities for achieving long-term sustainability and exploitative activities for short-term performance (Smith, 2014), and

sustaining a balance between the exploitation of existing abilities and building new capabilities may generate tensions (Svahn *et al.*, 2017).

Structural Reconfiguration and Societal Changes: The key differentiator of digital transformation from previous IT-enabled transformations is the rapid pace of technological change (Nadkarni and Prügl, 2021) engendered by digital technologies. This stream, which dominates the current literature, focuses on the associated radical changes in structural micro-foundations engendered by digital transformation and their societal impact (see also Vial, 2019).

The fundamental shifts include reconfigurations of cultures (Gurbaxani and Dunkle, 2019), values (Hinings *et al.*, 2018), mindsets (Baiyere *et al.*, 2020) and the status quo (Porfírio *et al.*, 2021). Hence, digital transformation extends beyond organizational functional thinking and studies in this stream holistically consider the "comprehensiveness of the actions" (Singh and Hess, 2017, p. 2). They recognize that digital transformation fosters fundamental changes in organizational structures (Verhoef *et al.*, 2021), what Besson and Rowe (2012) and Baiyere *et al.* (2020) call "deep structural change." Drawing on institutional theory, Hinings *et al.* (2018) equate digital transformation to institutional change that dramatically alters contextual force (p. 55). Digital transformation is also associated with a redefinition of value propositions that leads to changes in organizational identity (Wessel *et al.*, 2021). In the same vein, Verhoef *et al.* (2021) show that digital transformation is "the most pervasive phase" of a three-stage process, following digitization and digitalization (p. 891), thus depicting it as both a process (or major part of a process) and outcome. Chanias *et al.* (2019) treat digital transformation as a holistic form of IS business transformation that results in radical economic and technological changes at both organizational and sectoral (or even broader) levels. The contextual and "relational" aspect of digital transformation is addressed by Lanamäki *et al.* (2020), who argue that digital transformation conceptualizations are disclosed within the boundaries of organizations. In addition, Scott and Orlikowski (2021) analyze industry standards tensions that emerge in the process of digital transformation.

3. Manifestation of paradoxical tensions in digital transformation initiatives

The process of digital transformation entails paradoxes (see Gregory *et al.*, 2015) and is inevitably associated with competing demands (Danneels and Viaene, 2022). A paradox is the simultaneous presence of contradictory and mutually exclusive elements (Quinn and Cameron, 1988). Similarly, according to paradox theory, tensions are "persistent contradictions between interdependent elements" (Schad *et al.*, 2016, p. 6), and surface due to contradictions in embedded structures, practices, cultures and artifacts (Hargrave and Van de Ven, 2017). However, although research has shown that organizations are rife with tensions, paradoxical tensions are more likely to be generated in some contexts than others. For instance, strategic alliances generate tensions when managers need to balance collaboration and competition (Jarzabkowski *et al.*, 2013). According to a study by Jarvenpaa and Wernick (2011) on paradoxical tensions in open innovation networks, the main reported tensions are rooted in conflicts between and among relationships, boundaries and organizational structure. In the same discourse, Pinske *et al.* (2018) refer specifically to the "cluster paradox" as a situation in which ambiguous relations between stability and change, generated through the contradictions between homogeneity and heterogeneity, can lead to tensions.

Drawing on the paradoxical tradition, we adopt a meta-theoretical paradox lens (Smith and Lewis, 2011; Schad *et al.*, 2019) that enables exploration of how and why tensions emerge when organizing digital transformation initiatives. Following other authors, we perceive that inherent tensions may become salient, or experienced by organizational actors as

contradictory, in specific situations (Smith and Lewis, 2011; Soh *et al.*, 2019; Wimelius *et al.*, 2021; Agarwal *et al.*, 2022). Moreover, contextual triggers linked to a plurality of perspectives, (rapid) change and/or scarcity, may be present and trigger tensions when organizations embark on a digital transformation (Soh *et al.*, 2019). For instance, Svahn *et al.* (2017) recognize various tensions that incumbent firms face during digital transformation processes, including a plurality of views regarding new revenue streams (see also Soh *et al.*, 2019). In the same spirit, Gregory *et al.* (2015) illustrate complexities in digital transformation projects that call for changes in leadership roles, decision-making and structure (Smith, 2014). Scarcity involves resource limitations and allocations that can affect digital transformation initiatives (Smith and Lewis, 2011; Smith, 2014). For instance, Miron-Spektor *et al.* (2018) demonstrate that tensions that emerge from resource scarcity affect performance and innovation.

Smith and Lewis (2011) identify four categories of tensions: learning, belonging, performing and organizing. Learning tensions are prominent during periods of change (Jarzabkowski *et al.*, 2013), and surface as dynamic system changes, renewals or renovations. They involve transitions from past to new knowledge (Smith and Lewis, 2011) and include contradictions between radical and incremental change (see also Agarwal *et al.*, 2022). For instance, Wimelius *et al.* (2021) recognize an inherent tension in the technology renewal that accompanies digital transformation, as an organization needs to "destroy" its current technological foundation (see also Smith and Lewis, 2011) while building a new one. Tumbas *et al.* (2018) show that the nascent Chief Data Officer role changes the logic of the IT profession and jeopardizes the associated identity, and, hence belonging. The complexity of digital transformation can also generate tensions of belonging or identity when actors seek simultaneously to be distinctive and homogenous (Smith and Lewis, 2011). Hence, organizing tensions surface when interactions between complex systems create competing organizational designs and objectives. These tensions encompass contradictions between collaboration and competition (Smith and Lewis, 2011).

4. Research methodology
Digital transformation promotes value creation (Hinings *et al.*, 2018) through knowledge dissemination and value transfer (Nambisan *et al.*, 2017), so the orchestration of these processes is crucial for success. However, although contemporary organizations have clearly engaged in digital transformation to varying degrees, there is still little understanding of the systematic organizational changes required to seize all the opportunities it can provide. The next section describes the methodology applied in our quest to elucidate the tensions involved and their effects.

4.1 Research approach
Since the objective of our study was to identify tensions that arise in digital transformation processes and explore their effects, which are clearly socio-technical phenomena, a qualitative appropriate seemed appropriate (Mason, 2002; Ritchie and Lewis, 2o03).

There are diverse established ways to conduct a qualitative study (Ritchie and Lewis, 2003), but a systematic and flexible design is essential to capture rich data and obtain correspondingly rich insights (Mason, 2002). In addition, a case study is regarded as suitable for exploring contemporary phenomena, and based on Yin's (2003) classification, we applied an exploratory (or 'contextual') holistic single case study design. We consider the focal forestry cluster as an organization, a single unit of analysis in a specific context. Moreover, from the beginning, we sought to keep our case study open and transparent, as recommended by Flyvbjerg (2006). This entailed striving to record the diversity, complexity, and in some

cases contradictions, of our respondents' assumptions, experiences and sentiments in order to provide a well-rounded presentation rather than a mere summary of their expressed ideas.

4.2 Investigating the context: sector analysis and case study description

Elucidation of the tensions associated with digital transformation initiatives in a complex socio-technical context is important for theoreticians and practitioners, both generally and in the Swedish forestry industry particularly, for two main reasons. First, following technological spillovers from other domains and industries (Müller *et al.*, 2019), the forestry industry has undergone rapid digitalization in recent years (Nylén and Holmström, 2011), which has generated both challenges and opportunities in the sector (Holmström, 2020). Second, Sweden has very high forest cover (KSLA, 2009), a long tradition of forest exploitation and management, and for more than a century forest resources have played major roles in Sweden's industrial development (Siiskonen, 2013; Simonsson *et al.*, 2015). Since the mid-19th century forestry has become a thriving sector, especially in the north, and during the 20th century there were substantial increases in annual timber production (the Swedish Forestry Agency, 2015). A new 'Swedish forestry model' emerged following the Forestry Act of 1993. The objectives now include the promotion of sustainable development (Lindahl *et al.*, 2017) and preservation (or restoration) of forest biodiversity (Siiskonen, 2013) in addition to production goals. The product portfolio has also expanded. Today, the forestry industry provides numerous opportunities for employment, and Sweden is the second-largest exporter of forest products, and the third-largest combined exporter of pulp, paper and saw wood products globally (Simonsson *et al.*, 2015; Scordato *et al.*, 2018), with an annual net value of exports exceeding €10 billion (Sandberg *et al.*, 2014).

Clearly, the forest-based sector plays a major role in the Swedish economy, and global forestry, so it is important to ensure the continuation of its international competitiveness, sustainability and productivity. Equally clearly, this will require the effective use of digital technologies (Scholz *et al.*, 2018). However, the use and implementation of digital technologies generate tensions that can either promote or hinder transformation initiatives.

To illuminate the tensions, we focus on processes in the Cluster of Forest Technology and the interactions of its members. The cluster was formed and started its innovation journey in June 2010. It includes 10 forest machinery and component manufacturing companies that employ approximately 1100 people. Most of the companies are located in the area around Umeå municipality. The objective of this economic association is to drive technological innovation in the forestry industry through cooperation, thereby accelerating the successful generation of commercial products. Specifically, in the context of the cluster, the heterogeneity of actors creates an innovative ecosystem that enables knowledge creation and sharing to reinforce the members' internal digital competence and market awareness. Thus, membership is seen as providing drivers for collaborative activities, improving competitiveness, expanding networking and enabling ideation and knowledge transfer through, for instance, seminars, workshops, events and collaborative activities with external partners. Moreover, the cluster is intended to provide robust foundations for projects to develop the forestry industry through the transformation of digital innovation processes and products by creating a nexus of collaboration that harnesses synergistic efforts of researchers, students, financiers and forestry companies.

To meet these objectives, the cluster embraces new digital technologies with the apparent potential to enhance forest management and associated operations. The boundless and flexible nature of digital technologies (Yoo *et al.*, 2010a) has expanded the cluster boundaries and facilitated knowledge flow by transferring external information and knowledge internally. Digital technologies engender digital transformation that fosters the development of new products/services within the cluster and are intended to enhance

customer experiences. Examples include semi-autonomous or autonomous machines with (for example) smart crane control systems based on robot technology that improve machine operators' efficiency and shorten training times, various kinds of software that enhance planning, performance-enhancing visualization tools, and remote forest scanning and assessment systems. To explore external knowledge and engage in interactive ideation, the cluster uses a digital platform that helps the collection of ideas from outside its nexus. Thus, digital technologies are providing diverse opportunities for ecologically, economically and socially sustainable solutions.

The cluster's vision is to drive future innovative initiatives and transform processes and products in the forestry industry. To do so, the cluster develops and embraces practices and technologies that promote equality, biodiversity and other objectives linked to the European Union's and United Nations' sustainability goals. These objectives also shape and reflect the cluster's identity and need for mutual learning (Pinske *et al.*, 2018). In addition to addressing these multi-level concerns, the member companies must also confront challenges posed by the less bounded model of innovation, involving intense diffusion of knowledge, with partners who include direct competitors and other types of tensions.

4.3 Sampling method

Since the aim of the study was to investigate the roles of tensions in the cluster, we used a homogenous purposive sampling approach to recruit respondents, i.e. we sought informants who seemed well placed to provide valuable relevant information (Ritchie and Lewis, 2003). The candidates included representatives of each organization involved in the cluster, and they had both similar positions and intimate knowledge of their respective organizations' participation in cluster activities. Hence, they all had a high likely ability to provide insights regarding pertinent challenges and opportunities. The cluster has 10 member firms, and the CEO of the cluster helped us to contact key participants representing all these firms. The selected respondents were mostly CEOs of the member firms, and some held positions in the cluster committee. The informants also included a Umeå municipality staff member who had been working closely with the cluster on projects. We attempted to contact all of the CEOs but could not reach one of them, so one CEO represented two member firms. To maintain anonymity, the informants were designated Respondents A to I (Table 2).

4.4 Data collection

The interviews are the primary source of data analyzed in this paper. However, we also collected data from various documents and observations of events. The objective was to gain rich, well-rounded insights regarding the cluster, its processes and digital innovation projects (past and present), together with a further understanding of the forestry industry.

Respondent	Time working with the cluster	Interview duration
Respondent A	7 years	45 min
Respondent B	2 years	72 min
Respondent C	3 years	46 min
Respondent D	2 years	43 min
Respondent E	7 years	50 min
Respondent F	7 years	35 min
Respondent G	7 years	52 min
Respondent H	9 years	44 min
Respondent I	2 years	40 min

Table 2.
Time that each
respondent had
worked with the
cluster, and durations
of the interviews

First, we collected information from the cluster's website about its processes and stages of use of specific digital technologies in the processes. We also reviewed annual reports and press releases concerning the cluster as a whole and individual companies to gather contextual data about the role and implementation stage of digital technologies in the cluster. In addition, we participated in all-day events, arranged by the cluster, that included the demonstration of some of the newest shippable digital forest products and services, most of which are outcomes of collaborations between the cluster and external actors. During the events, we observed at first hand the cluster's role in enabling digital transformation processes, through both factual presentations of the products/services and discussions with representatives of the cluster's member companies. As these events take place annually, we had the opportunity to observe the progress in products/services. The observation also provided insights regarding the cluster's role in initiating and overseeing network activities of member companies and other actors. Mason (2002) has characterized participant observation as a qualitative approach that can prompt the researcher to immerse in the experience. Accordingly, these events permitted deeper investigation of the underlying tensions, behaviors and relations when all the member companies were interacting in the same social context.

We also conducted in-depth individual interviews to investigate the personal perspectives of each respondent (Ritchie and Lewis, 2003). In these interviews, we applied a semi-structured approach, informed by the collected data, that allowed us to cover key identified issues regarding tensions and associated issues in a flexible manner, allowing the respondents to convey freely their opinions. Thus, the interview guide included both open and closed questions. During the interview process, two researchers participated, posing questions interchangeably to generate a "conversion with purpose" ambience (Mason, 2002, p. 67). As recommended by Bryman (2016), we began each interview with informal questions to start smoothly and asked follow-up questions to enable further exploration of focal topics and illuminate expressed feelings and ideas (Ritchie and Lewis, 2003). During the interviews, we attempted to create a flexible, relaxed and interactive environment, striving to ensure that we properly understood the interviewees' responses and that all interviewer-respondent communication was clear (Mason, 2002). Moreover, following suggestions by Ritchie and Lewis (2003), we audio-recorded all the interviews while avoiding taking many notes that could distract our respondents or force them to pause. In total, we conducted 10 interviews, one of which was a pilot interview and thus excluded from the results and analysis, conducted to test the interview flow and possible needs for modification (Mason, 2002; Bryman, 2016). The interviews lasted between 35 and 72 min (Table 2). Most were held through Skype or mobile (cell) phones to eliminate distance barriers, but four of them were face-to-face interviews.

4.5 Interview data analysis
First, we transcribed each interview and then applied thematic analysis to capture, interpret and analyze the common patterns (themes) and experiences expressed in the interviewees' responses, as defined by Braun and Clarke (2006). Since thematic analysis is an iterative process, we re-considered and engaged with our data throughout all the phases, attempting not only to acquire semantic (descriptive) level information but also to explore underlying assumptions and conceptualizations. In this process, we followed the five-phase framework (familiarization with the data, generation of initial codes, grouping of codes into categories, creation of sub-themes and creation of final themes) proposed by Braun and Clarke (2006).

During the familiarization phase, we thoroughly read the transcripts to gain a general understanding of the data, highlighting concepts and units. In the initial coding stage, we started to systematically organize the data (Maguire and Delahunt, 2017), seeking simple

descriptive extractions, or words drawn directly from the transcripts, for each identified assumption and concept. As the underlying assumptions regarding tensions could be context-dependent, we coded all the available data in a line-by-line manner. This is a time-consuming approach, but we believe it is essential to minimize the risks of missing potentially divergent perspectives. First, each researcher separately coded each transcript, and then we compared, discussed and modified our codes. This process was repeated until all data had been consensually coded (Maguire and Delahunt, 2017).

After creating initial codes for the whole dataset, we started to group them into descriptive categories based on their similarities. Some of the initial codes were merged in this process to improve clarity and facilitate further analysis. The categories were then merged into sub-themes, based on their interdependencies, to capture the significance of our data (Gioia *et al.*, 2013). In the last step, we examined the meaningfulness of the sub-themes in relation to the broader overall themes and their ability to provide an overview of the data, then renamed them to encapsulate, as well as possible, the essence of the themes (Braun and Clarke, 2006). The final themes are leadership, knowledge flow, collaboration and competition, network creation and asymmetric power. Three of those themes (knowledge flow, collaboration and competition) correspond to the sources of main tensions. However, all these themes are interrelated, and we believe they not only capture the overall assumptions and concepts expressed by our respondents, but also tally with information in the scrutinized documents.

5. Empirical findings
This section presents results from the case study. As mentioned above, we identified five themes that correspond to tensions (Appendix 1) with strong interdependencies. The following section describes findings regarding each of these themes in detail.

5.1 Leadership
The cluster was launched to increase innovation, transform business, drive technological development and enhance customer satisfaction in the Swedish forestry industry. Despite a successful track record in terms of involvement in successful launches of new (digital) products and services, it still faces challenges such as insufficient funding, copious bureaucracy and scarcity of human resources. Here, we present findings regarding these challenges, which were mentioned by all respondents, and the importance of strong leadership to manage the tensions that arose.

Most of the respondents expressed beliefs that excessive bureaucracy has restrained smooth practices in the working environment, hindered product development and innovation processes and reduced the satisfaction of member companies. The cluster members expressed an understanding of the need for administrative processes in the cluster, but most also expressed a need to streamline them for the common benefit. For example, Respondent D stated that "*Getting the money must become easier for us because if it takes too long, we'll run our design projects without the cluster. If it's too complex, we won't use the cluster for the money, we'll do it ourselves!*" In the same vein, Respondent C mentioned that "*The cluster has been growing, it involves more administrative work and that affects its efficiency [. . .] and slows the innovation a bit.*"

All respondents expressed interest in contributing more actively to the cluster, but as Respondent D said, "*Sometimes there's too much work with the cluster for me, I don't really have the time for all these meetings.*" Time scarcity and overload have undermined the focus on the cluster, as the members have increasingly prioritized their individual business operations. Thus, some respondents explicitly or implicitly recognized a need for more

employees to enhance the effectiveness, and reduce the time consumption, of the management processes.

Furthermore, financial barriers have not only slowed the innovation and product development processes but also exacerbated the difficulties associated with bureaucracy. *Inter alia*, obtaining funds was described as a difficult and time-consuming process that shifted the main focus from the cluster objectives to seeking grants. As Respondent B noted, "*For me, one thing that's tricky is the funding, that every year we have to look for new money all the time.*"

These issues seem to stem from the current cluster's functionality and practices. Applications for grants from external funding agencies following official procedures are essential, so the accompanying bureaucracy cannot be avoided. However, some respondents expressed a need for better leadership oriented toward enhancing the cluster's management, productivity and future success. Desired characteristics and competencies for the leader(s) included business-orientation, together with deep knowledge of each company's interests, objectives and expectations of the cluster. Respondent A argued that "*It's very important to have right-minded people with good knowledge of the cluster companies.*" Besides coordinating and managing interactions in the cluster, some respondents also stressed that the leader should be constantly aware of technological changes and digital trends. The respondents seemed to strongly appreciate leaders capable of fostering the cluster's absorptive capacity and playing an instrumental role in guiding firms successfully through the digital transformation process.

However, managing interactions of many companies with conflicting interests, but the same demands and expectations of gaining competitive advantage, is challenging. Therefore, the cluster leader(s) should be decisive, determined, judicious and demonstrably fair in order to manage tensions by establishing appropriate balances between conflicting desires and objectives that arise in the cluster, foreseeing and maximizing the opportunities for digital transformation in order to help every company to grow.

> You really need a good boss, regardless of whether it's the chairman of the board or CEO of the cluster. A strong person is needed, because otherwise he or she will be trampled very quickly. There are 10 strong companies in the cluster and everyone wants to grow, everyone wants their piece of the cake. So, one of the key things is to have a boss in the group.

To summarize, the data clearly showed that all the member companies face similar issues, and all want to improve their operations, products, services and productivity by embracing digital technologies. However, effective leadership is essential to handle emerging tensions and meet these objectives.

5.2 Knowledge flows
All participants explicitly referred to external knowledge and digital competence as crucial assets and stated that the opportunity to improve access to them was the main reason for their company joining the cluster. Thus, this section presents findings regarding the knowledge flows in the cluster, and their fundamental role, together with internal knowledge, in the cluster's development.

All respondents recognized the importance of external knowledge for long-term cluster survival. Respondent C mentioned that, "*I see many reasons for the cluster to exist, but without that (external knowledge) [. . .], I would say that a lot of the reasons [. . .] would evaporate. It's absolutely critical!*" Moreover, all the cluster's members recognized the importance of exploiting external knowledge for realizing opportunities, filling gaps in internal knowledge, and both transforming and optimizing the work activities. Thus, the respondents particularly appreciated the cluster's capacity to enhance digital innovation and transformative

initiatives by enabling the incorporation of external ideas into their existing innovation processes. As explained by Respondent E: "*You need inspiration or knowledge from other technical areas or new ideas [to cross-fertilize] existing R&D efforts.*" Some respondents also clearly perceived this as a key means to improve the members' technologies and/or practices. This process provides not only knowledge and awareness of current and future digital trends but also incentives for the members to move out of their comfort zones, cross boundaries and try new creative solutions. Most respondents mentioned a need for external knowledge to push their companies beyond current boundaries for long-development and transformation.

The cluster receives external help mostly for scientific tests of products under development and broadening market understanding. However, the respondents stated that external knowledge is not exploited fully, and there is still room for more experimentation and creativity. Most respondents underscored the necessity of continuous improvement in terms of technological awareness and the use of digital technologies as drivers to increase efficiency. Respondent C argued that "*What we're doing is to improve the technology used for industrial forestry to be more efficient, and in this automation plays a key role.*" Thus, digital technologies are regarded as particularly vital, major foci of external knowledge exploitation, and drivers of continuous development. For instance, the improvement of autonomous forest machinery can improve safety, increase productivity and reduce both time consumption and adverse environmental consequences of operations. Most respondents also recognized the importance of harnessing the contributions of universities, research institutions and experts such as consultants in transformation efforts and technological research. For example, Respondent D stated that, "*We need to use other partners and the universities. There are different companies with relevant expertise, there are different specialists outside academia, and I don't think we're using those partners as much as we should.*" In the same spirit of utilizing external ideas and expertise, the respondents perceived the cluster's digital platform as a springboard for ideation and additional source of inspiration for new ventures and competence development.

The cluster also tries to foster a culture of openness among its member companies by sharing research results. In that context, Respondent C recognized the willingness of the cluster to share outcomes, saying that "*There are no secrets and I recognize the good intentions and care from the cluster. They are eager to really distribute relevant findings to all member companies. I think that is positive openness.*" The cluster's capability to increase internal competencies by exploiting external knowledge was manifested during an all-day event when key results from the cluster were demonstrated. The participants valued the presentation of new digital technologies and most expressed interest, for instance, in the possibilities afforded by Artificial Intelligence (AI) platforms and Augmented Reality (AR) mobile applications. In sum, external knowledge and resource exploitation are critical assets for cluster evolution. The combination of external and internal knowledge drives the innovation processes in a cluster and increases the possibility of success. Digital technologies play key roles, not only in terms of facilitating and accelerating knowledge sharing but also in creating the requirements for clusters' evolution and survival. As Respondent E noted, "*In order to achieve long-term development, you need to mix different technologies, different knowledge and marry them together.*"

5.3 Collaboration and competition
This section describes our findings regarding collaboration between competitors, and the associated tensions. All the respondents stressed that "*The leading companies also need to cooperate in the group*" in order to develop projects, seize benefits, acquire external knowledge and tackle common issues. An overall observation derived from all the interviewees' responses is that keeping these competitors together is important for success but challenging.

The collaborative spirit was also apparent during two all-day events dedicated to the digital transformation of forest management. We observed how the cluster members seized this opportunity to discuss presentations and explore ideas related to the new digital technologies' impacts and potential benefits for their businesses. The high level of collaboration among the cluster members and external stakeholders was clearly manifested during the forestry events. For example, the improvement and development of new products were clearly outcomes of fruitful collaborations between cluster members and external partners.

However, although the respondents have a common objective to innovate and transform their business models, many of them noted a high level of competitiveness among the member companies, and in some cases conflicts of interest, particularly among direct competitors. Unsurprisingly, this has hindered the development of trust among the members. Thus, generally, all members recognize the need to avoid operating in a vacuum and improve their practices to get mutual technological benefits. For instance, Respondent D stated that "*More different industries benefit from the same type of cooperation between companies,*" while Respondent G perceived the cluster as "*A platform to discuss and develop solutions and find opportunities to solve the problems we're going to face in the next couple of years.*" To address these tensions, collaboration mainly occurs in the primary steps of project development, such as testing, and then the companies continue with separate development of their products.

Collaboration among the companies is facilitated through various events, such as seminars, workshops and demonstrations where new products/services are presented. All the member companies appreciated this as a beneficial approach for enhancing the ideation process and knowledge flows. Moreover, some respondents emphasized the need to increase collaboration and openness to external partners in order to increase the scale of their operations and boost sustainability. For example, Respondent H said that, "*Now that we've completed all our small projects, we're increasingly considering bigger projects and we need to cooperate more in the future,*" showcasing a willingness to turn from past knowledge to future initiatives and transit from an incremental change toward radical innovation efforts. The respondents recognized the importance of mutual collaboration, but the sense of competition still remains. This is consistent with expectations, since forestry companies have traditionally tended to protect their IP rights strongly and to be quite competitive. Some respondents regarded the competition as a manageable tension that does not negatively affect the intra-cluster balance. However, knowledge leakage among the cluster members poses challenges that may increase secrecy and erode trust, thus hampering idea generation and knowledge exchange in the cluster. For example, Respondent G mentioned that, "*It's not easy for the company to share its information with others. I think no company does this readily [. . . telling others your ideas . . .] raises issues of trust and who we can share information with.*"

Consequently, as Respondent E commented: "*When it's about our product, we're more likely to have discussions with researchers than with other companies.*" This effort to protect their ideas is aligned with IP-related challenges. Our findings indicate that the cluster *per se* does not apply an IP strategy since most of the ideas developed within it are owned by the member companies. Instead, there is a well-established intention among cluster members to eliminate issues regarding ownership of the end products. All respondents claimed that their companies have not experienced IP violations in the cluster context, but they are quite concerned and protective of the ownership of their ideas and patents to avoid possible negative consequences. In sum, while collaboration and openness are consistently highlighted as an important duality that drives the cluster's activities and willingness to innovate, limited trust among the members still hinders collaboration.

5.4 Network creation
The representatives of almost all member companies, of all sizes, believed that the cluster has established a good reputation. As Respondent D stated: "*The cluster's brand is very strong and needs to be protected.*" The brand is presented as a bridge to the business world and a facilitator of connections. As outlined in this section, all the respondents highlighted the importance of having a good name in the business market and regarded networking as a major incentive for membership in the cluster. The cluster members benefit from a wide network nexus in various ways, including the ease of establishing collaborations with tech start-ups for exploring knowledge and optimizing work practices. Moreover, all the member companies, regardless of size and positional power, seem to gain benefits from the network provided by the cluster and recognize the advantages of the broader networking capacities and potential to explore new possibilities enabled by digital technologies. Events organized by the cluster offer member companies opportunities for such exploration and provide venues for them to establish new relationships.

The respondents also highlighted the need to increase the number of external partners, including (for instance) small and medium companies. Fostering and maintaining network activities were also mentioned as necessities for the cluster's future. All respondents associated networks with successful development, innovation, sustainability and stronger (digital) competence. They even referred to connections as the most productive features of the cluster. Therefore, despite claims that the work is hindered by bureaucratic procedures, networks and networking have played key roles in keeping the actors together. For example, Respondent H stated that "*The work we're doing in the cluster is not always productive, I would say. The most productive elements are the connections.*" The respondents expressed perceptions that the cluster network has enhanced knowledge exchange, generated inspiration and presented ideas from external industries, as illustrated by the following comment by Respondent B: "*This network is really good when we can call each other and help out and say what is the best thing we can do.*"

The respondents clearly regarded the strong brand as an asset that should be protected and one of "*the things that are the best outcomes of the cluster work*" (Respondent C). The good reputation has created a positive experience that has made the members feel proud of the cluster. The strong brand was also described as a key resource for expanding external connections and "*really push other external partners to be interested in this cluster*" (Respondent H). As stated by Respondent A, "*I think the good reputation of the cluster is very important. That's what makes people listen to the cluster.*" The strong brand extends beyond the forestry industry and the good reputation explains why "*A lot of other clusters are interested in what we've done and many are also interested in the cluster here in this area*" (Respondent H).

In sum, the networking and good reputation of the cluster are interrelated and interdependent, highly regarded by the respondents, and crucial for both the cluster's functionality and its sustainable performance.

5.5 Asymmetric power
We identified some conflicting perceptions among the members of the power relationships within the cluster, and varying indications of causal relations between dominance in and benefits from it. More than half of the respondents expressed opinions that members' acquisition of knowledge and technology was related to their existing resources and size, but others claimed that members obtained roughly equal benefits. Similarly, we detected divergence in views about distributions of resources, focal knowledge and even companies' perceptions of their positions in the cluster. Findings regarding these aspects are presented in this section.

Some respondents had not perceived any differences in power among cluster members. For example, Respondent G stated that, "*I've never been in a meeting where somebody put himself or herself in a dominant position over others. I think it feels quite equal,*" indicating that there were no hierarchies in the cluster. Similarly, Respondent A thought that "*there are good connections between member companies,*" and Respondent H mentioned that there are no dominant players. She/he also indicated that influence and benefits may be related to levels of companies' activities, since "*It's more up to the company to propose a project,*" and "*if you're not in the mood to engage in projects within the cluster, of course you'll be a bit of an outsider. It's up to the companies to make themselves powerful by coming up with new projects.*"

Other respondents clearly felt that there were substantial differences in members' positional power and associated variations in potential benefits. However, there may be inverse relationships, as the most powerful players may tend to obtain relatively little benefit because "*They are less open-minded about inputs in their product development than the other companies. They have their strategies, their way to do research*" (Respondent C). Some respondents also argued that the benefits of cluster membership are not linked to the companies' resources and sizes: the benefits may vary at times, but overall, they are roughly equally distributed. For example, Respondent B said, "*Sometimes I think one company obtains more benefit, but at other times another company may get more benefit. So, it depends on how many projects they're engaged in.*"

Another potentially important factor is that powerful actors have the resources to contribute more to collaborative activities, and direct interests in high proportions of the technology the cluster is investigating or developing, so their decisions and strategies will strongly influence the cluster's success. Thus, the main players are important engines for the cluster, but the other companies "*are parts of the business environment that makes them important*" (Respondent E). The dominant actors may also face difficulties because they have to stay close to the agenda. However, some respondents believed that the positional power acquired by some actors provided them with clear advantages. For example, Respondent D stated that, "*We get money when we have some new product ideas, but some of the members get more of the resources than others for sure.*" Thus, the smaller players could be left with very little support, according to this view. Moreover, in contrast to some of the other mentioned respondents, Respondent D believed that the size of companies did affect their role and importance in the cluster. Thus, she/he regarded the dominant actors as technological gatekeepers that acquire most resources and dictate decision-making in the cluster.

6. Discussion and contributions

Digital transformation initiatives are highly complex processes (Porfírio *et al.*, 2021), as organizations embarking on them may embrace changes in work practices (Hess *et al.*, 2016), business models (Loebbecke and Picot, 2015; Warner and Wäger, 2019), identities (Wessel *et al.*, 2021) and established cultures and routines (Gurbaxani and Dunkle, 2019). As both the literature review and our case study show, the complex dynamics of digital transformation inevitably engender tensions. The unbounded nature of digital technologies opens new value pathways, which may be enthusiastically pursued, but this will not be enough if practitioners do not overcome the tensions that emerge in digital transformation processes. Against this backdrop, it is clear that even though digital transformation has received substantial attention, there is still a need for further exploration of the triggers and roles of tensions that emerge in digital transformation processes. Thus, we have posed and addressed the research question "*How and why do tensions affect the trajectory of digital transformation initiatives in the forestry industry?*"

Our study contributes to the emerging research field of digital transformation management in several ways. First, by summarizing major themes in recent research on

digital transformation. Then, by building on the existing literature, and drawing on research on paradoxical tensions in digital transformation and our case study, we provide rich insights into the ways in which digital technologies can enable organizations to seize opportunities by exploring the tensions that may arise in the digital transformation process. We extend the set of identified tensions, and how they may hinder a cluster from seizing all the opportunities offered by digital transformation and exploiting the full potential of digital technologies. We found that although the digital transformation processes engendered by the innovation initiatives in our case are still at a preliminary stage, they have established a fertile environment that fosters collaboration among most of the members. Moreover, we suggest organizational adjustments that may be required to manage those tensions effectively, particularly in a cluster environment. In this manner, we also contribute to the ongoing discussion on tensions that emerge in innovation clusters when embracing digital transformation endeavors.

Specifically, we identified three research streams with assumptions, concepts and findings that explain important aspects and outcomes of tensions that emerge in digital transformation processes (enabled and accelerated by the boundless nature of digital technologies) both generally and in our focal context. We find that they provide a holistic view of the socio-technical process of digital transformation. The contextual triggers of plurality, change and resource scarcity coexist in digital transformation efforts, creating tensions that can profoundly affect outcomes (Smith and Lewis, 2011; Soh *et al.*, 2019). The tensions emerging from and between knowledge flow, collaboration and competition seem to be the most intense and tightly associated with the use, implementation and boundless nature of digital technologies. Hence, they appear to be major determinants of the fluxes of digital transformation processes. Leadership also has a substantial role to play in balancing and managing contradictory dynamics. Therefore, leadership that embraces the paradoxical mindset (Smith *et al.*, 2016) and orchestrates the tensions between interdependent contradictions is highly important when organizing and strategizing for digital transformation.

Prior to discussing the theoretical and practical implications of our study, limitations that constitute a starting point for future research need to be considered. Although, this study presents the ways in which tensions engendered by digital technologies may affect digital transformation initiatives, it is a single case study within the forestry context. Further research could include multiple and/or longitudinal case studies to investigate the strength of tensions among different clusters and how they are developed, shaped and changed during the digital transformation phase. This could provide deeper insights and indications of general patterns in the tensions, their effects and appropriate strategies to manage digital transformation in different cluster contexts beyond the forestry sector.

6.1 Theoretical implications

Digital technologies are not merely passive contextual elements of transformation processes, as they are often focal points and facilitators of openness (Yoo *et al.*, 2012; Schlagwein *et al.*, 2017; Nambisan *et al.*, 2019). Our case study demonstrates that digital transformation initiatives involve attempts to generate ideas, boost innovation and reinforce knowledge sharing (Dougherty and Dunne, 2012), processes that should be externally and internally distributed across and within organizational boundaries (Marion and Fixson, 2021). Previous research (e.g. Nambisan *et al.*, 2017; Hinings *et al.*, 2018), has highlighted that the use of digital technologies has allowed networking that crosses boundaries, extends to new industries, incorporates whole value chains and strongly facilitates the assimilation of diverse external ideas and knowledge. With this paper, we extend these insights by highlighting dynamic processes and emerging tensions that accompany the knowledge flows, learning and

collaborative endeavors when organizations engage in the complexity involved in digital transformation activities. Specifically, we recognized how the links between internal and external actors are key elements of collaborative communities that foster interaction among members, knowledge exchange and networking. In the focal cluster, digital technologies have broadened opportunities for network generation and diffusion of knowledge, laying foundations for a distributed agency (see Nambisan *et al.*, 2017) to enhance competences and achieve objectives. Thus, our findings align with the conclusion of Nambisan *et al.* (2017) that heterogeneity of actors in a cluster can promote innovation, but we also recognize that it can also engender tensions among the actors that impede digital transformation processes.

Specifically, we extend the scope and informativeness of previous literature on digital transformation by bringing into the discussion the literature on tensions. We identify that despite the common objective to innovate and share a mindset of openness (Gurbaxani and Dunkle, 2019), performing and organizing tensions still emerge in the setting (Smith and Lewis, 2011). In other words, collaboration among heterogeneous actors may entail challenging pluralities of views and conflicting interests that hinder digital transformation endeavors. We expand the discussion by showing that there may be strongly differing opinions about the levels of asymmetric power and competition among actors, their own positions and power in the cluster, and the equality of resource distribution in digital transformation endeavours. Given the scarcity of time and human resources (Smith and Lewis, 2011), an impression that 'technological gatekeepers' are present may trigger tensions that increase the level of competition and hinder positive innovation outcomes. Thus, although collaboration is an essential element of such transformation initiatives, competition may be a stronger force than collaboration. Thus, we confirm and conclude that underlying tensions between collaboration and competition can become increasingly salient (Smith and Lewis, 2011; Wimelius *et al.*, 2021) in contexts characterized by rapid change and scarcity of time. Although we did not clearly identify tensions of belonging and identity, the identity will be adversely affected if organizing, learning and performing tensions are not managed adequately, especially as the role of digital technologies becomes increasingly pervasive. Accordingly, we deduce that collaboration can also be constrained by the convenient and less risky possibilities of cooperating with other external partners, including universities and research institutions.

Lastly, we combine our empirical findings and information retrieved from the literature into a process model (Figure 1) that clearly identifies tensions that arise during (and strongly influence) digital transformation initiatives generally and in the focal cluster particularly. They indicate that transformation initiatives involving the acquisition and use of digital technologies can foster collaboration, competition and knowledge flows. However, for this, there must be sufficient trust and avoidance of competition-related constraints, and hence effective management of tensions associated with undesirable knowledge leakage without (as far as possible) hindering collaborative innovation. Thus, there are clear needs for strong leadership to manage the knowledge flows, resource allocation and asymmetric power relations.
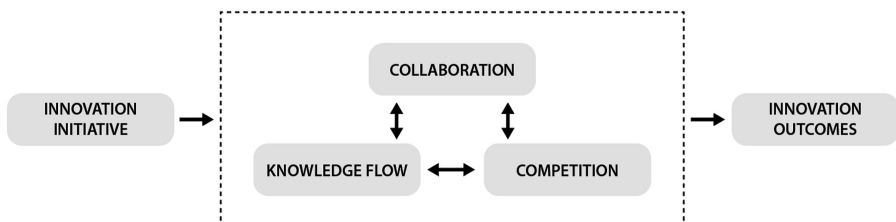

Figure 1.
Tensions in the digital transformation process

The cluster's main objectives are to gain external knowledge and accelerate the implementation and development of digital (and other) technologies. We identified three main tensions in the digital innovation process in the cluster: between knowledge flow and competition, between knowledge flow and collaboration and between collaboration and competition. Undesirable balances between conflicting desires and objectives constrain, whereas desirable balances foster, constructive communication and interactions among stakeholders, and hence innovation. For instance, unbalanced power relations may induce increases in competitiveness and hinder the establishment of the trust required for knowledge sharing and collaborative innovation. In contrast, sufficiently trustful exploitation of external knowledge in the use of digital technologies may foster establishment of a dynamic ecosystem that strongly promotes ideation and collaborative innovation.

6.2 Implications for practice

Based on findings of this and previous studies, we propose several practical recommendations for clusters or other organizations and managers seeking to embark on and manage digital transformation. First, we recognize that digital technologies may create tensions that hinder the trajectory of the digital transformation initiatives. By reviewing the literature and driven by our findings, we argue that the first step is to realize the need to design and implement an appropriate digital transformation strategy (see e.g. Bharadwaj *et al.*, 2013; Kane *et al.*, 2015) to orchestrate the contradictory dynamics of exploration and exploitation activities. Since tensions cannot be resolved, but must be managed, leadership is also required to change the cognitive frame toward a 'both/end' attitude (Smith *et al.*, 2016).

Second, when organizing for digital transformation, especially when more than one organization is involved, strategists and managers need to understand the importance of trust and the lack of it. The lack of trust is responsible for most cooperative failures. Stronger trust seems to have been established with external partners than among members of the cluster, although our findings indicate that limited trust in intra-cluster relationships can hinder effective management of the cluster and reinforce competitiveness. The desire to protect individual firms' interests with secrecy and outflank competitors seems to prevail over the need to establish trust, despite indications in our data of a seemingly positive relationship between trust and members' openness to digital innovation (Marion and Fixson, 2021). Thus, we argue that although limited trust is seemingly justified by competitiveness in the contemporary market, it has impeded the cluster's efforts to seize opportunities provided by digital innovation as fully as possible. The creation of a trustful environment that facilitates the management of exploration and exploitation and asymmetric tensions is crucial (Westergren and Holmström, 2012). Formulation of a robust, appropriate IP strategy is also crucial to minimize problems associated with knowledge leakage. We recognize the advantages of managing IP in a manner that improves business models and increases profits from competitors rather than preventing other members' use of protected technology. Since there are multiple and strong triggers of knowledge diffusion, it seems prudent to design a technology strategy that takes into account, and does not prevent, its rapid diffusion and imitation. We also argue that the reduction of cluster members' use of IP may have beneficial long-term effects through the facilitation of collaborative activities. Furthermore, our data corroborate findings that patents play a crucial role in traditional initiatives, especially in traditional industries such as Swedish forestry. Thus, there is a pervasive risk that competitors may acquire complementary assets and members of the cluster companies, of all sizes, are strongly aware of the need to avoid knowledge leakage. This seems to be more difficult for SMEs than for the larger members, but all perceive a need for an appropriate IP strategy.

Similarly, there is a problematic need for mutual trust in knowledge sharing and interactive, collaborative activities.

Third, heterogeneity of knowledge, actors and industries is of utmost importance for transformation. Thus, we echo recommendations to promote the diversity of networked actors and domains and embrace the maximal inclusion of organizations (Pinske *et al.*, 2018) to minimize the risks of inertia. The heterogeneity of technology and implementation of solutions from other industries diminish risks of unpredictability while improving product development. *Inter alia*, the 'triple-helix' of innovation (academia, cluster and government) should be deployed to maintain the required heterogeneity, but clusters should also expand their networks beyond research institutions. Hence, we also recommend the creation of an ecosystem that includes whole value chains and a broadening of network activities, as both knowledge and abilities that generate innovation can be discovered anywhere in a cluster's value chain(s) or diverse sources elsewhere.

Lastly, surprisingly, we found that small and medium-sized companies tend to embrace openness and collaboration more willingly and dare to experiment more in terms of ideation. Hence, they tend to engage more strongly in transformation in efforts to maximize their competitiveness and attractiveness as partners, relative to their power bestowed by size in the cluster. These findings may positively affect attitudes toward digital transformation, prompting managers, organizations and cluster members to embrace the opportunities of digital technologies.

7. Conclusion and suggestions for further research

To identify tensions that affect digital transformation initiatives, elucidate their effects and explore ways to manage them, we conducted an exploratory case study, focusing on the Cluster of Forest Technology in northern Sweden. The study revealed tensions between collaboration, competition and knowledge flows that may strongly influence the outcomes of digital transformation and thus must be effectively managed. Leadership and network creation mediate the management of tensions. Our findings contribute to understanding of digital transformation management, highlight the importance of digital technologies in the process and identify key tensions that may arise and their effects. We also clearly show the importance of establishing appropriate balances between organizing and performing tensions, and then provide guidelines for managing the tensions, especially in a cluster environment. Thus, the paper offers insights that may be helpful for both researchers and practitioners, not only in the forestry industry but also in other contexts where digital innovation ventures are initiated. Tensions between collaboration, competition and knowledge flows may emerge in any industry and domain.

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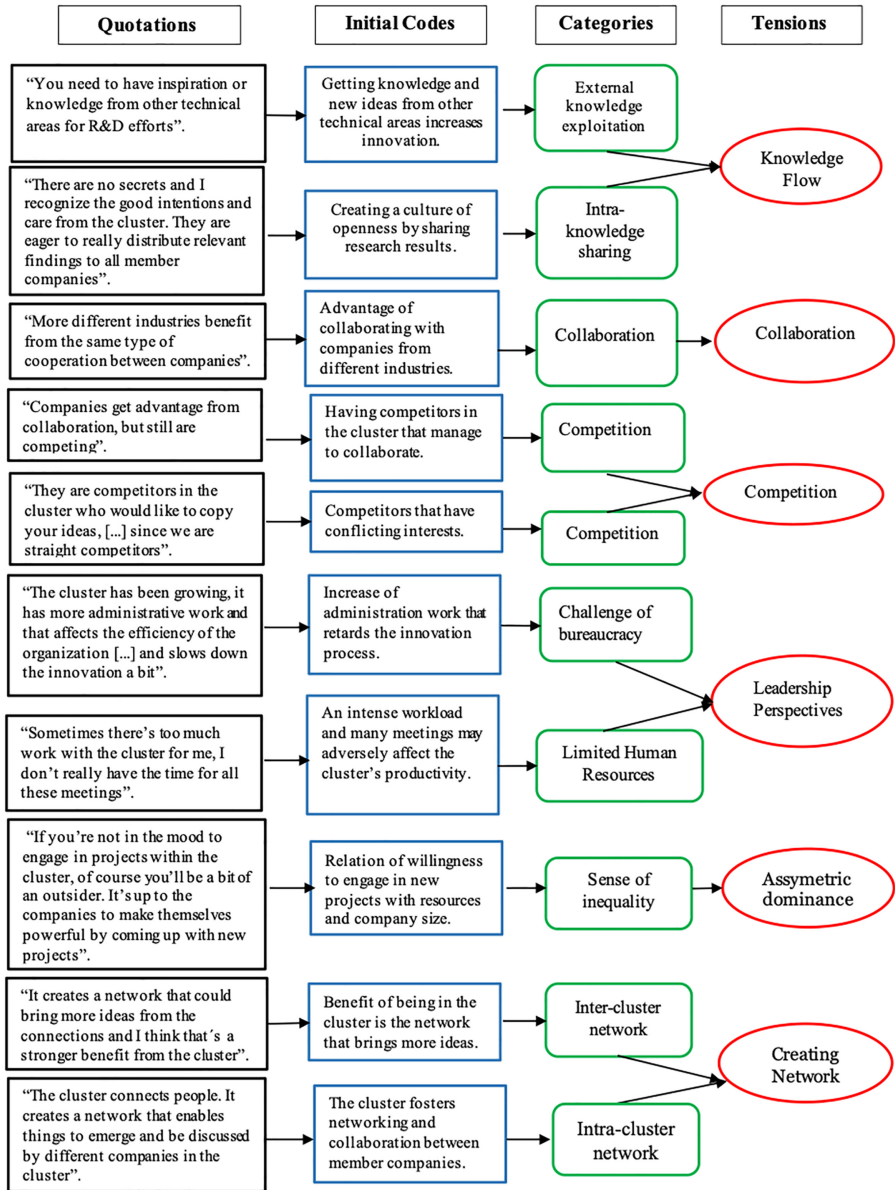
Appendix

Figure A1.
Coding themes

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