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RESEARCH

The impact of digitalization and virtualization on technology transfer in strategic collaborative partnerships

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Abstract
Digitalization and virtualization are integral parts of today's competitive and dynamic business environments. Yet very little is known about the impact of digitalization and virtualization on technology transfer in strategic collaborative partnerships. Therefore, examining the impact of digitalization and virtualization on technology transfer in strategic collaborative partnerships holds much potential for contributing to the ongoing discussions in the technology transfer literature. This introductory article to the Special Issue reflects on the contributions of the Special Issue articles to the research on technology transfer and reveals three central themes through which the articles as a whole contribute to research in technology transfer: Theme 1 describes the role of digitalization in technology transfer outcomes, Theme 2 focuses on extending the understanding of knowledge transfer capabilities to include digital and virtual capabilities, and Theme 3 illustrates how technology transfer facilitators and intermediaries continue to play an important role in technology transfer in the digital world. We conclude the introductory article by proposing four promising avenues for future research on technology transfer in the digital age. These include Avenue 1: Understanding context specificity and temporality, Avenue 2: Focusing on capabilities and government policy, Avenue 3: Bridging distance, and Avenue 4: Protecting against threats.

Keywords Digital · Virtual · Artificial intelligence · AI · Technology transfer · Knowledge transfer · Value creation · Partnership · Collaboration

1 Introduction

Digitalization and virtualization are critical in competitive and dynamic business environments (Adomako et al., 2021; Del Giudice et al., 2021; Pagnozzi et al., 2022; Teruel et al., 2022). Digitalization refers to increase in use of digital technologies (Arslan et al., 2021; Ritter & Pedersen, 2020; Vrontis et al., 2021), such as artificial intelligence (AI) (Brown et al., 2024), blockchains and digital finance (Butticè & Vismara, 2022; Singh et al., 2024), social networking (Scuotto et al., 2017), digital platforms (Scott, 2024), the internet of things (Li et al., 2015), robotization (Jungmittag, 2021), 3D printing (Holzmann et al., 2020), and big data (LaValle et al., 2011). Virtualization describes the adoption of

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cloud computing technologies that enable “on-demand access to different applications and services by sharing pool of configurable computing resources (e.g. networks, servers, storage)” (Condoluci & Mahmoodi, 2018, p. 66). Given their multiple potential benefits, countries and organizations across the globe have become involved in digitalization and virtualization (Adebanjo et al., 2021). For example, European Union’s Digital Decade policy progamme sets specific targets and objectives for digital transformation of skills, businesses, infrastructure, and public services (European Commission, 2024). As another example, organizations like Uber, Airbnb, and Facebook are seeking disruptive innovation through digitalization and virtualization to gain first mover advantage and to keep pace with technological advancements in the hyper competitive global environment (Geissinger et al., 2020; Li et al., 2019).

In today’s dynamic technological environment, it is imperative to seek technological knowledge not only internally but also externally through strategic collaborative partnerships (Cozza & Zanfei, 2016; Tian & Li, 2017; Vrontis et al., 2021). Strategic collaborative partnerships enable capturing the additive and multiplicative synergies in technological innovation (Harrigan et al., 2017), which helps to overcome innovation barriers (Antonioli et al., 2017). Various actors, including supranational institutions, countries, organizations, and innovation teams seek to encourage boundary-spanning activities that allow participation in strategic collaborative partnerships in which technological knowledge and capabilities are exchanged and created through technology transfer.

In the context of collaborative partnerships, technology transfer can be understood as the process of transferring technology or components of technology and related knowledge across the boundaries of two social entities (Battistella et al., 2016). Collaborative partnerships relevant for technology transfer take many forms and include e.g. national and regional innovation systems (Acs et al., 2017; Nebojša, 2021), national research institutes (Chen et al., 2022), innovation ecosystems (Panetti et al., 2020), regional and local clusters (Kiese, 2019), science and technology parks (Giaretta, 2014), mergers and acquisitions (M&As) (Harrigan et al., 2017), joint ventures (Chuang-Jen et al., 2020), strategic alliances (Leischnig & Geigenmúller, 2020), digital social entrepreneurship (Ibáñez et al., 2022), inventor networks (Fritsch & Zöllner, 2020), spin-offs (Corsino et al., 2019), and public–private partnerships through e.g. university technology parks and federal laboratories (Choi et al., 2022).

Yet very little is known about the impact of digitalization and virtualization on technology transfer in strategic collaborative partnerships. However, these technologies are likely to play multiple vital roles. First, technology transfer of digital and virtual technologies is increasingly amongst the key goals of strategic collaborative partnerships. For instance, many M&As involve the acquisition of digital capabilities (Yu & Yan, 2022), such as AI and robotization. As another example, university technology transfer (Miller et al., 2016) increasingly includes research around digital technologies and virtualization. Our current understanding remains limited as to the specific practices, strategies, challenges, and outcomes in transferring digital and virtual technologies in strategic collaborative partnerships, in terms of the similarities and differences compared with the transfer of other types of technologies. This is a critical aspect as even Europe is still lacking in developing strong digital regional clusters to connect young innovators and established firms in digital industries (Veugelers, 2018). Second, digital technologies and virtualization influence the technology transfer process per se in strategic collaborative partnerships (Adomako & Nguyen, 2024). The use of digital technologies—such as AI and shared technology platforms—can facilitate internal integration and external collaboration (Liu & Wang, 2024) as well as facilitate resource mobilization (Inceoglu et al., 2024). Thus, in strategic collaborative partnerships, digitalization can help to connect and transfer technological resources across different countries, sectors, industries, firms, and teams. On the other hand, the ability of digital and virtual technologies to transcend physical barriers in technology transfer increases cultural, social, and organizational complexities (e.g. cultural/technological distance, organizational structure transformation, regulatory and legal challenges related to the protection of sensitive data) that bring unprecedented challenges to technology transfer dynamics (Galera-Zarco et al., 2020; Kohtamäki et al., 2018; Pagnozzi et al., 2022) and require decisive and timely managerial and public policy responses.

Accordingly, examining the impact of digitalization and virtualization on technology transfer in strategic collaborative partnerships offers many intriguing research opportunities that hold great potential to add novel aspects to the ongoing conversations in the technology transfer literature. With this Special Issue, our aim is to advance understanding of the role of digitalization and virtualization in technology transfer in strategic collaborative partnerships. In this introductory article to the Special Issue, we will discuss the contributions of the Special Issue articles to the research on technology transfer. We will conclude with a reflection of promising avenues for future research on technology transfer in the digital age.

2 Contributions of the special issue articles in the context of technology transfer literature

Taken as a whole, the Special issue articles advance research on technology transfer in the age of digitalization through three overarching themes. Theme 1 describes the role of digitalization in technology transfer outcomes by examining the relationship between digitalization and technology transfer outcomes across countries (Ferrer-Serrano et al., 2025). Theme 2 extends our knowledge on technology transfer capabilities by elaborating further on how individuals and organizations can effectively manage technology transfer and innovation process through organizational capabilities (Yang et al., 2025) and managerial capabilities (Hassan et al., 2025), including digital and virtual capabilities. Theme 3 contributes to discussions on technology transfer facilitators and intermediaries by elaborating on how innovation intermediaries continue to play an important role in technology transfer in the digital world (Jabbar et al., 2025; Kim et al., 2025; Spigarelli et al., 2025). Table 1 presents an overview of the articles included in the Special issue. In the following we will discuss the contributions of the Special Issue articles based on these three themes.

2.1 Theme 1: The role of digitalization and virtualization in technology transfer outcomes

The role of digitalization and virtualization in technology transfer outcomes is important to examine. Digitalization and virtualization can have many beneficial effects, such as improvements in operation and communication, increased productivity, business model transformation (Adomako & Nguyen, 2024), and resilience to disruptive events (Autio et al., 2021), which can be advantageous to technology transfer. However, possible negative effects have been reported as well, including aspects such as technology addiction, technostress, security and privacy concerns, and experience of ambivalence (Turel et al. 2021), which could potentially constitute technology transfer barriers. In this Special Issue, Ferrer-Serrano et al. (2025) take a macro approach by comparing European countries based

Table 1 Summary of the Special Issue articles (in the order of appearance in the Special Issue)

Authors	Article title	Special issue theme[a]	Method/sample	Key contributions	Suggestions for future research[b]
Ferrer-Serrano et al. (2025)	More digitalization does not always imply more technology transfer: an analysis with the Horizon Europe strategy	Theme 1: The role of digitalization in technology transfer outcomes	Quantitative Horizon Europe and the Digital Economy and Society Index (411 collaborative projects in 31 countries with 2,890 organizations)	Countries at intermediate levels of digitalization are the most effective in the technology transfer ecosystem To achieve a position of centrality in the technology transfer network, the required digitalization characteristics are connectivity, human capital, and integration of digital technology	Longitudinal studies to examine the dynamic evolution over time (Avenue 1: Understanding context specificity and temporality) Expanding the analyses to countries outside of Europe (Avenue 1: Understanding context specificity and temporality)

Table 1 (continued)

Authors	Article title	Special issue theme[a]	Method/sample	Key contributions	Suggestions for future research[b]
Yang et al. (2025)	More relational or more digital? The synchronous and ambivalent influences of firm capabilities on value co-creation	Theme 2: The role of digital and virtual capabilities in technology transfer	Quantitative A survey of 340 Chinese manufacturing companies	Firms' relational capability and digital capability increase value co-creation, which in turn increases the firms' innovation performance The congruence of relational and digital capability linearly increases value co-creation The incongruence of relational and digital capability has an inverted U-curve effect on value co-creation	Longitudinal studies to examine the dynamic evolution over time (Avenue 1: Understanding context specificity and temporality) Exploring the influence of other capabilities, such as big data analytics capabilities and market-sensing capabilities and their (in) congruence on value co-creation (Avenue 2: Focusing on capabilities and government policy; Avenue 4: Protecting against threats) Identifying potential contingency factors, including market, institutional, and competitive factors (Avenue 1: Understanding context specificity and temporality)

Table 1 (continued)

Authors	Article title	Special issue theme[a]	Method/sample	Key contributions	Suggestions for future research[b]
Hassan et al. (2025)	Examining the impact of e-leadership on strategic innovation at work: a moderated mediation model	Theme 2: The role of digital and virtual capabilities in technology transfer	Quantitative A survey of 241 employees in the US information technology and software industry	E-leadership is positively associated with inter-team coordination, which in turn contributes to strategic innovation Inter-term cooperation mediates the relationship between e-leadership and strategic innovation Knowledge integration capability positively moderates the impact of e-leadership on inter-team cooperation	Conducting longitudinal or case studies to examine the effects over time (Avenue 1: Understanding context specificity and temporality) Examining the effects in transitional and under-developed economies (Avenue 1: Understanding context specificity and temporality) Exploring additional antecedents of strategic innovation (Avenue 2: Focusing on capabilities and government policy)

Table 1 (continued)

Authors	Article title	Special issue theme[a]	Method/sample	Key contributions	Suggestions for future research[b]
Jabbar et al. (2025)	Help those helping others—the role of universities in facilitating digitalization and virtualization in non-profit organizations	Theme 3: Technology transfer facilitators and intermediaries in the digital age	Qualitative Interviews of 13 UK non-profit organizations	Universities play an important role in transferring knowledge for digitalization and virtualization for nonprofits. This includes sharing technical knowledge and resources and designing, guiding, and implementing digital platforms to facilitate collaboration In collaboration between non-profit and for-profit organizations, it is important to consider trust, goal alignment, and digital imbalances	Exploring the processes in other national and cultural contexts (Avenue 1: Understanding context specificity and temporality)
Spigarelli et al. (2025)	Blockchain unlocking collaborative opportunities for environmental sustainability through innovation intermediaries	Theme 3: Technology transfer facilitators and intermediaries in the digital age	Qualitative Interviews of 12 European digital innovation hubs	Blockchain technology facilitates SME collaborative opportunities for environmental sustainability through tracking and tracking products and services Innovation intermediaries in general, and digital innovation hubs in specific, can help SMEs to adopt blockchain technologies, which facilitates resource mobilization and entrepreneurial experimenting	Examining the effects across different sectors and technologies (Avenue 1: Understanding context specificity and temporality) Focusing on specific sustainable development goals and European Green Deal targets (Avenue 2: Focusing on capabilities and government policy)

Table 1 (continued)

Authors	Article title	Special issue theme[a]	Method/sample	Key contributions	Suggestions for future research[b]
Kim et al. (2025)	Fostering collaborative opportunities for AI start-ups: case of a hybrid business incubator in Seoul	Theme 3: Technology transfer facilitators and intermediaries in the digital age	Qualitative Interviews of the AI Yangjae Hub in Seoul, South Korea	The hybrid business incubator helps early-stage start-up firms through network development, complementary technologies, and matchmaking activities with external firms in order to facilitate collaboration opportunities, including business opportunities, financial investment, and technological collaboration	Conducting further comparative case studies to understand sectoral, regional, and national characteristics (Avenue 1: Understanding context specificity and temporality; Avenue 3: Bridging distance)

[a]The main Special Issue theme to which the article contributes to

[b]Selected suggestions for future research as portrayed in the Special Issue articles; The avenues refer to the Avenues 1–4 for future research put forward in this introductory article

on data from Horizon Europe and the Digital Economy and Society index. Interestingly, they find that European countries with intermediate levels of digitalization tend to be the most effective at technology transfer, which suggests a more complex, non-liner relationship between digitalization and technology transfer. In addition, the authors show that, to achieve a central position in the technology transfer network, connectivity, human capital, and integration of digital technology are important. The authors contribute by illustrating the relationship between digitalization and technology transfer in collaborative projects and establishing significant differences across countries. The authors also show and explain how intermediate levels of digitalization result in superior technology transfer outcomes. This contributes to the technology transfer literature more broadly by illustrating how the technology transfer antecedents can show more complex non-linear relationships, suggesting that high levels of digitalization by themselves are not necessarily a panacea for technology transfer. In the context of digitalization, the study also contributes by illustrating the specific dimensions of digitalization that are driving technology transfer.

2.2 Theme 2: The role of digital and virtual capabilities in technology transfer

The role of individuals and organizations in effectively managing technology transfer and innovation processes through various capabilities is an important aspect of technology transfer. Previous studies point to many different types of capabilities that facilitate technology transfer, such as technological and innovation capabilities (Wang and You, 2020), technology commercialization capabilities (Kim et al., 2011), organizational capabilities (Palaco et al. 2022), relational capabilities (Dyer & Singh, 1998), employee capabilities (Soares & Torkomian, 2021), and managerial capabilities (Leischnig et al., 2014). To further expand the understanding on the role of capabilities in technology transfer, Yang et al. (2025)'s study focuses on the role of relational and digital capabilities on value co-creation of Chinese manufacturing companies. While the importance of relational capabilities has been discussed in prior studies on strategic collaborative partnerships (Bellini et al., 2019; Dyer & Singh, 1998; Giaretta, 2014), the novelty of Yang et al.'s (2025) study comes from examining the complex interplay and configuration of firm's relational capabilities and digital capabilities. The findings of Yang et al. (2025) show how congruence of relational and digital capabilities linearly increases value co-creation, which suggests synergistic effects between the two types of capabilities. However, incongruence of relational and digital capabilities has an inverted-U-curve effect. These results suggest that high relational capabilities combined with low digital capabilities lead to more value co-creation than high levels of digital capabilities combined with low levels of relational capabilities. As technology transfer is an important mechanism for value co-creation in strategic collaborative partnerships, the study of Yang et al. (2025) highlights the importance of balancing relational and digital capabilities, which more broadly contributes to advancing the socio-technical congruence theory in the context of technology transfer. From the broader congruence and capability-based theories, the study emphasizes the importance of considering the novel digital capabilities as part of the firm's broader capability base and resource alignment.

In similar vein, the study of Hassan et al. (2025) examines the role of managerial capabilities in technology transfer, with a focus on a specific type of digital managerial capability—e-leadership. Building on the theorizing of Larson and DeChurch (2020), the authors describe e-leaders as leaders who are familiar with digitalization technology and understand how to align digital technology with the organizational goals, including effectively managing virtually located employees. Through a quantitative survey of employees in the

US information technology and software industry, the authors show how e-leadership can facilitate inter-term coordination, which in turn contributes to strategic innovation. Knowledge integration capability further positively moderates the influence of e-leadership on inter-team cooperation. Thus, through lowering communication barriers and helping to connect team members, e-leaders can facilitate positive collaborative innovation outcomes. More broadly, the study contributes to the literature on technology transfer in collaborative contexts by emphasizing the specific type of leadership skills needed in the digital age, as illustrated through the concept of e-leadership. This adds to our prior knowledge on the types of leadership skills required for successful technology transfer.

2.3 Theme 3: The role of technology transfer facilitators and intermediaries in the digital age

Technology transfer often involves technology transfer facilitators and intermediaries,[1] such as national technology platforms (Proskuryakova et al., 2017), technology consultants, brokers, agents, intermediation agencies, universities, business incubators, and technology transfer offices (Battistella et al., 2016; O'Kane et al., 2021; Palaco et al. 2022). It is important to examine the effect of digital technologies and virtualization on the role of technology transfer facilitators and intermediaries. Managing strategic collaborative partnerships in the digital era is further complicated by the increasing heterogeneity of the various actors and stakeholders across the technology transfer ecosystem (Lee & Trimi, 2021; Sahasranamam & Soundararajan, 2021), which makes the role of technology transfer intermediaries particularly important and interesting to examine.

The Special Issue features three articles that illuminate the role of innovation facilitators and intermediaries in new, digitally embedded ecosystems. The article of Jabbar et al. (2025) examines the collaboration of UK non-profit organizations with universities. Collaboration with universities has been identified as an important source of knowledge and technology transfer in prior studies (Link & Sarala, 2019; Menter, 2024; Zhang & Liu, 2024). To advance prior studies on university knowledge transfer ecosystems, the case study of Jabbar et al. (2025) paints a detailed picture of how universities can facilitate digitalization and virtualization of nonprofits by sharing technical knowledge and resources by designing, guiding, and implementing digital platforms that facilitate collaboration in the university ecosystems. In line with Yang et al. (2025), the study of Jabbar et al. (2025) also points to the importance of relational aspects, in this case trust, goal alignment and digital imbalances between stakeholders, which are critical for value co-creation in university ecosystems. Contributing to the discussions around the broader societal roles of the universities, the authors emphasize the critical role of universities as facilitators of transferring knowledge that allows for digitalization and virtualization for nonprofits, which contributes to the discussions on technology transfer beyond the for-profit sector.

In addition, though a focus on innovation intermediaries—i.e., European digital innovation hubs—the study of Spigarelli et al. (2025) shows the facilitating role of blockchain technology to enhance collaboration with SMEs in order to enhance environmental sustainability. The article of Spigarelli et al. (2025) connects to the article of Jabbar et al. (2025) on university ecosystems because universities are often amongst the primary stakeholders in digital innovation hubs. While the role of different types of innovation intermediaries has been acknowledged in the prior literature on technology transfer, digital innovation

[1] For a comprehensive review on innovation intermediaries, please refer to Zhang and Liu (2024).

hubs are new types of innovation intermediaries, which remain largely unexplored in the literature. Following Crupi et al. (2020), the authors describe digital innovation hubs as a new type of innovation intermediary that orchestrates collaborative networks to support technology development and adoption at SMEs. Digital innovation hubs help to overcome cooperation barriers across the different actors in the ecosystem so that environmental sustainability targets can be achieved (Spigarelli et al., 2025). The qualitative findings of Spigarelli et al. (2025) show how digital innovation hubs help SMEs to adopt blockchain technologies, which in turn contributes to resource mobilization and entrepreneurial experimenting.

Finally, the study of Kim et al. (2025) further contributes to the topic of innovation intermediaries in technology transfer, through a qualitative examination of a technology-based hybrid business incubator in Seoul, South Korea, in the context of the AI Yangjae hub, which is a collaboration between the government and universities in order to assist early-stage AI start-up companies. The findings offer an important contribution through the illustration of the specific processes through which the hybrid business incubator assists technology transfer in the broader regional innovation system. The processes facilitating knowledge transfer include network development, exploration of complementary technologies, and matchmaking activities with external firms to facilitate further collaboration opportunities around business, financial, and technological aspects. By identifying and describing these processes, the study of Kim et al. (2025) furthers the understanding of how technology transfer processes around integrating digital technologies play out in the novel context of AI start-ups from the regional innovation perspective.

3 Avenues for future research

This Special Issue paves the wave for further research on the role of digitalization and virtualization on technology transfer in collaborative strategic partnerships. Guided by the findings of the Special Issue articles and reflecting on the remaining gaps in the literature, we propose four avenues to explore in future research: understanding context specificity and temporality, focusing on capabilities and government policy, bridging distance, and protecting against threats.

3.1 Avenue 1: Understanding context specificity and temporality

The findings of the Special Issue articles stem from diverse socio-cultural contexts—including China, South Korea, Europe, and the US—and from different kinds of technology transfer ecosystems—such as university ecosystems, digital innovation hubs, and AI hubs. While there are communalities in the findings across these different contexts, several of the Special Issue articles point to the importance of further studies in other contexts. Comparative studies in different socio-cultural, sectoral, and industry contexts can help to further answer questions such as: How do digitalization and virtualization shape technology transfer in basic research versus commercialization, high vs. low-medium technology firms (Borsano et al., 2024) developed versus emerging economies (Liu, 2024), business versus public partnerships, tightly versus loosely coupled networks, and closed versus open ecosystems? Longitudinal studies can help further answer questions such as: How do digitalization and virtualization shape technology transfer over time, for instance in early-stage start-ups vs. late-stage start-ups, in entrepreneurial firms vs. mature firm, in mature vs.

emerging industries (Audretsch & Belitski, 2024), and in short term collaborations vs. long term strategic alliances? Exploring these kinds of questions will help to further illuminate the boundary conditions and temporal dynamics of the phenomenon.

3.2 Avenue 2: Focusing on capabilities and government policy

Because value is co-created in digital and virtual innovation ecosystems, understanding the interdependencies between the actors and their capabilities becomes critical. As Yan et al. (2025) show, relational capabilities continue to be important in collaborative partnerships even in the digital age, suggesting more broadly that rather than solely focusing on digital capabilities, one needs to understand that synergistic effects of digital capabilities with other types of capabilities within the ecosystem, and the ways through which government policy can support capability development and sharing. Furthermore, the multitude of actors involved in technology transfer also points to the need to evaluate the impact of digitalization and virtualization on technology transfer in strategic collaborative partnerships on the basis of a wider set of performance dimensions and measures, including not only managerial and investor concerns, but also broader societal implications such as sustainable regional economic development (Wadid et al., 2018), technology spillovers (Audretsch et al., 2021), public and social value (Ibáñez et al., 2022), and the broader human dimension (e.g. justice, equity, diversity, and human capital development) (Leonchuk & Gray, 2019; Siegel, 2022; Waldman et al., 2021). These broader measures of performance, often evolving over a longer time, should guide the technology transfer considerations in government policy. While the Special Issue articles pave the way for understanding the role of digital capabilities in technology transfer in different kinds of innovation ecosystems, the following questions could benefit from further examination: What is the role of government policy in supporting the development and use of new kinds of managerial practices and organizational capabilities—including technological capabilities around green technology (Orsatti, 2024) and AI (Park, 2024)—that support value creation from technology transfer in the digital era? And what is the public sector role in supporting positive technology transfer outcomes stemming from digitalization and virtualization linked to broader societal outcomes—such as social innovation to address societal grand challenges (Adomako et al., 2024; Menter, 2024)—in closed and open innovation systems (Roh et al., 2023)?

3.3 Avenue 3: Bridging distance

While the role of distance in technology transfer in general has received abundant attention in the literature (e.g. Nebojša, 2021), the role of digital technologies in connection to distance remains underexplored. The Special Issue studies brought up the importance of technology transfer intermediaries in facilitating knowledge integration by helping to bridge technology differences and organizational culture differences especially between organizations from different sectors and when involving SMEs/start-ups in the innovation ecosystems. Further examining how distance can offer value creation opportunities for technology transfer in digital innovation systems, while also understanding the challenges that such differences can bring, remains an intriguing topic for the future research to examine. As Autio et al. argue (2021), by bridging distance, digitalization reduces dependence on transportation and co-location, but at the same time, digital resources can still face institutional and legal restrictions as well as location-bound differences in customer preferences. Especially, if technology transfer involves actors across countries at very different development levels (Palaco et al. 2022), scholars need to consider the broader external aspects such as the role of the broader institutional context, including differences across national and regional innovation systems along technological transformation infrastructures, institutional voids underlying digitalization and virtualization in emerging and developing economics (Amini Sedeh et al., 2022), and the complexities related to distance between countries, both national cultural (Vial, 2019) and technological (Enkel et al., 2018). Comparative studies can further address the role of distance and differences to answer questions such as: To what extent do organizational and national cultural differences, sectoral differences, technological differences, and other forms of "distance" impact regional and cross-cultural strategic collaborative partnerships, which are driven and influenced by technology transfer and digital transformations?

3.4 Avenue 4: Protecting against threats

While several of the SI articles highlighted the positive aspect of digitalization on technology transfer in collaborative relationships, they also refer to some threats, for instance, by suggesting that very high levels of digitalization or an unbalanced focus on digitalization–at the expense of other types of key resources and capabilities required in collaborative technology transfer—can be detrimental. Going even further, there is a need for future research to examine the possible "dark side" of the role of digitalization and virtualization (Turel et al. 2022) in technology transfer as new types of vulnerabilities may emerge in collaborative partnerships, which raises important questions, such as: What are the potential threats of technology transfer in strategic collaborative partnership in the virtual age? How do we protect proprietary technology and sensitive data, which is increasingly vulnerable through e.g. knowledge leaks? How do we protect against noncompliant technology transfer and technological invasion (Tang et al., 2023)? How do we protect technology transfer participants from negative effects such as technostress and feelings of ambivalence (Turel et al. 2021)? And why and when do firms avoid participation in entrepreneurial ecosystems, such as high-quality FinTech ventures avoiding participation in an accelerator (Browne et al., 2024)? As the digital technologies develop and mature, we are likely to become more aware of the potential negative technology transfer aspects. Understanding how to protect countries, organizations, and individuals against such threats is critical for sustainably creating value in technology transfer.

4 Conclusion

Digitalization and virtualization have become an integral part of technology transfer in strategic collaborative partnerships. In this introduction to the Special Issue, we reflected on how the Special Issue papers advance prior knowledge on knowledge transfer through three main themes. Theme 1 highlighted the relationship between digitalization and technology transfer outcomes, Theme 2 illustrated the interdependencies between digital and traditional technology transfer capabilities, and Theme 3 showcased new kinds of technology transfer facilitators and intermediaries in the digital age. We also offered four prospective avenues for future research. Avenue 1 calls for further understanding on context specificity and temporality, Avenue 2 suggests further examining capabilities and government policy, including digital and virtual capabilities, Avenue 3 calls for understanding how to bridge distance, and Avenue 4 requests studies on how to protect against threats.

We hope that this Special Issue helps to bring attention to the novel types of collaborative partnerships that can foster technology transfer in today's digitally and virtually connected societies. In addition, we hope that this Special Issue helps to illustrate some of the multifaceted changes—both opportunities and challenges—that these digital and virtual technologies are bringing to the research and practice of technology transfer. We hope that future research will continue to expand theoretical and practical understanding of the role of digitalization and virtualization in technology transfer.

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Declarations

Competing interests The authors declare no competing interests.

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