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COLLABORATIVE ECOSYSTEMS AND KNOWLEDGE CREATION: ANALYSIS OF DETERMINANTS AND MECHANISMS

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***ABSTRACT**. The main aim of this study is to explore the potential role of Social Capital (SC) and Collaborative Culture (CC) in participation in Collaborative Ecosystems (CES) and the impact of these ecosystems on creating Collaborative Knowledge Innovation (CKI). This study also aims to examine the potential impact of organisational learning, resource sharing and digital transformation as mechanisms that mediate the impact of participation in CES on CKI. To conduct this empirical study, data was collected from 257 managers of technology companies. Smart PLS was used to estimate the research model and test hypotheses.*

The results show that SC and CC in participation in CES significantly impact participation in CES. The findings also reveal that organisational learning, resource sharing and digital transformation play significant mediating roles in the relationship between CES and CKI. The findings of this study provide valuable theoretical and practical insights into the link between these determinants and mechanisms integrated into a unified framework.

KEYWORDS: social capital; collaborative culture; collaborative ecosystems; collaborative knowledge creation; digital transformation.

JEL: O33; O34; D8.

Introduction

Challenges are increasing in today's business environment making it impossible for any single organisation to remain isolated from collaboration with players in its environment (Wondolleck, Yaffee, 2022; Dalenogare *et al.,* 2023). Recent studies confirm that collaboration has become a requirement for survival in today's business world, which is changing at an unpredictable speed, as organisations realise more than ever the need to actively participate in Collaborative Ecosystems (CES) and foster an environment that supports creating novel knowledge and utilising it to generate innovation (Sharmelly, Ray, 2018; Wondolleck, Yaffee, 2022; Khalatur *et al.,* 2022; Kuruppuarachchi *et al.,* 2023). These ecosystems typically bring together different actors, such as business organisations, government agencies, non-profit organisations and individuals, to work collaboratively to address complex challenges and generate new opportunities for innovation (Yan *et al.,* 2018; Machova *et al.,* 2023).

A major driving force for participation in CES is that no single organisation possesses all the resources, knowledge, or capabilities to survive and grow (Adner, Kapoor, 2016; Graça and Camarinha-Matos, 2017). Exchanging or creating novel knowledge that enables participants to develop their competitive capabilities and exploit opportunities or confront threats enhances the value of participation in CES. Relying on an organisation's network of relationships with its environment for continuity and growth encourages scholars to study the potential role of Social Capital (SC) in enabling it to exchange knowledge and participate in collaborative networks. It also inspires scholars to explore the extent of the impact of a Collaborative Culture (CC) that enhances collaboration, mutual support and collective intelligence inside and outside the organisation with its partners to participate in CES. It also inspires exploration of the impact of CC promoting collaboration, mutual support and a collective mindset with a wide range of stakeholders on participation in CES.

Knowledge flows openly, transcending traditional organisational boundaries through the networks and channels of CES. This open communication enables participants to collaboratively share information and solve problems that provide creative solutions (Wondolleck, Yaffee, 2022; Wirtz, Müller, 2023). As organisations collaborate with different partners within the ecosystem, they gain access to new perspectives, innovative ideas and novel approaches, speeding up the process of knowledge generation and the development of cutting-edge services, products, opportunities and solutions (Adner, Kapoor, 2016; Shonubi, 2023). Furthermore, CES empowers organisations to leverage external knowledge sourced

from specialised startups or research institutions (Sharmelly, Ray, 2018). This utilisation of partnerships offers a gateway to domain-specific expertise and cutting-edge technological advancements, fostering an environment that encourages organisational learning and adaptability.

The current body of academic literature provides partial insights into each of these individual components in the context of ecosystems, highlighting the necessity to achieve a comprehensive understanding of the relationships that connect them. While many scholarly studies have examined the impact of SC on organisational performance, there is a significant gap in research identifying its role within CES. Although prior research underscored the significance of a CC in fostering collaboration and knowledge exchange within organisations, there is a gap in the literature when it comes to understanding the relationship between CC and an organisation's willingness to participate in and contribute to such ecosystems.

The literature reveals a significant research gap within empirical investigations that explore the impact of CES on Collaborative Knowledge Innovation (CKIP) performance. Furthermore, current research lacks studies aimed at understanding mechanisms through which CES may influence knowledge innovation performance. While it is evident that participation in these ecosystems can broaden an organisation's knowledge base, there is a need to study the directions and conditions under which such knowledge is translated into innovations. More specifically, the intermediary role played by organisational learning, resource sharing and digital transformation within this context remains underexplored. Understanding how organisations within CES collaboratively acquire, adapt and develop their knowledge pools, as well as how they share resources and the role of digital transformation in fostering innovation, represents a pivotal step in uncovering the intricacies of this phenomenon.

The gaps in existing literature have motivated this study to address three fundamental questions: Q1: Do SC and CC play a significant role in participation in CES?

Q2: Do CES significantly impact CKI performance?

Q3: Do organisational learning, resource sharing and digital transformation mediate the potential impact of CES on the performance of CKI?

Addressing the research questions, this study employs SC theory that confirms the impact of inter-organisational relationships on collaboration, knowledge exchange and participation in value creation (Steinmo, 2015; Westerink *et al.,* 2017). It also resorts to the resource-based view (RBV), which links the organisation's survival and continuity to obtaining resources and capabilities and harnessing them to serve the organisation's goals and improve its performance. This theory emphasises the importance of collaboration between organisations to enable them to access resources, which enhances their competitive capabilities in the unstable contemporary business environment (Hunt and Davis, 2012; Ozdemir *et al.,* 2023). However, this study expects a significant role of SC and CC in participation in CES. It also supposes a significant role of CES in CKI. Furthermore, this study expects a significant mediating role of organisational learning, resource sharing and digital transformation in the impact of CES on the performance of CKI.

1. Theoretical Background

Scholarly attention directed towards CES has surged in the past few years. Scholars attribute the growing attention to CES to two main aspects. The first is the escalating belief in collaboration among business stakeholders as a lifeline for survival and maintaining

competitiveness (Adner, Kapoor, 2016; Graça, Camarinha-Matos, 2017). The second reason is an increased interest in knowledge acquisition and how to find new sources to acquire it (Sharmelly, Ray, 2018; Wirtz, Müller, 2023). However, the literature implies that much effort is needed to explore the drivers and outcomes of participation in CES, particularly in the context of complex developments relating to the business world and digital transformation, which have transferred the importance of collaboration and acquiring knowledge to new horizons.

Studies have shown an interest in CES governance (Sharmelly, Ray, 2018; Wielopolski, Bulthuis, 2023). The literature also intended to focus on the drivers of participating in these collaborative platforms (Yan *et al.,* 2018; Lee, Kim, 2022). A wide range of studies has been conducted on the challenges and limitations of participation in CES (Fabricius *et al.,* 2001; Behnken *et al.,* 2016; Graca, Camarinha-Matos, 2917). The contribution of CES to fostering innovation witnessed growing attention among scholars (Adu-Kankam, Camarinha-Matos, 2023; Fu *et al.,* 2023). Developing digitalisation strategies to leverage participation in CES has become a hot topic recently (Yang *et al.,* 2020; Dalenogare *et al.,* 2023; Shonubi, 2023). Although there is an increasing tendency to study the role of ecosystems in providing a supportive environment for innovation (Adner, Kapoor, 2016; Granstrand, Holgersson, 2020; Klimas, Czakon, 2022), the literature reveals a lack of studies exploring the role of CES in the development of CKI. Hence, it can be concluded that there are no previous studies on the mechanisms through which CES may affect innovation, especially in CKI.

Generating and applying knowledge that drives innovation are among the dynamic capabilities that today's organisations aim to develop. Scholars emphasise the importance of collaboration to provide innovative ideas and solutions by harnessing external knowledge and resources in confronting complex challenges and maintaining competitiveness (Liu *et al.,* 2013; Yang *et al.,* 2022). While prior research has broadly studied diverse subjects interrelated to knowledge-driven innovation, CKI did not gain considerable attention. A substantial body of research has intended to investigate the determinates of CKI (Peschl and Fundneider, 2014; Zheng and Yu'na, 2016). Studies have also examined the potential function of digital solutions in producing CKI (Peschl and Fundneider, 2014; Bai and Li, 2020). However, the literature reveals an absence of studies exploring the direct or mediating impact of dynamic capabilities, such as organisational learning, resource sharing and digital transformation, on CKI.

1.1 Collaborative Ecosystems (CES)

CES is a dynamic, inclusive and open collaborative network that promotes the exchange of knowledge, sharing resources and cultivating innovation across diverse participating entities in a wide variety of areas, including industries, academia, technologies and public policy (Dyke *et al.,* 2005; Wielopolski, Bulthuis, 2023). These entities may include companies, individuals, and institutions that work together and engage in collaborative efforts, resource sharing and the joint pursuit of innovative objectives (Graça, Camarinha-Matos, 2017; Lee, Kim, 2022). They invest in open collaboration and exchanging knowledge (Sharmelly, Ray, 2018). However, studies show that such diversity enriches the ecosystem by providing a multitude of perspectives and a broad range of knowledge domains (Brody *et al.,* 2006; Wondolleck, Yaffee, 2022).

1.2 Collaborative Knowledge Innovation (CKI)

CKI is a strategic approach to creating knowledge and innovation that prioritises active collaboration and sharing of tangible and intangible resources and capabilities among stakeholders, including companies, institutions, individuals and the entire ecosystem (Xiuhong, 2012; Bai, Li, 2020). Scholars emphasise that CKI is rooted in the belief that no single organisation has all the necessary resources and knowledge for excellent innovation (Peschl and Fundneider, 2014). They also confirm that organisations proactively participate and contribute to open collaboration with their partners to gain access to a wider knowledge pool and create innovative ideas and solutions that cannot be reached individually (Xu, Yu, 2013; Shi *et al.,* 2022).

1.3 Social Capital (SC)

SC theory is a sociological and economic framework that emphasises the importance of social networks, relationships and connections in not only improving individual and collective well-being but also driving economic and social growth (Rastrollo-Horrillo, Rivero Diaz, 2019; Zmyślony *et al.,* 2020). Cai *et al*. (2021) confirmed that SC is seen as a form of capital that individuals and organisations can invest in and draw upon for various purposes. Scholars also conceptualised it as resources embedded within social networks and relationships (Roxas, 2021; Lee *et al.,* 2023). Strong SC fosters collaboration and teamwork. According to the studies, it fosters trust among stakeholders, which is very important for collaboration and value co-creation (Musavengane, Kloppers, 2020; Halstead *et al.,* 2022).

1.4 Collaborative Culture (CC)

A CC represents an environment within an organisation or society that highly values, promotes and actively engages in collaboration and cooperation (Quicke, 2000; Kumar *et al.,* 2021). The literature reveals that this culture focuses on working collectively, sharing both knowledge and resources and fostering strong relationships among individuals and organisations (Chow, 2012; Kumar *et al.,* 2016). Scholars emphasised that CCs often welcome and incorporate innovative technology and related tools that facilitate collaboration (Nugroho, 2018; Toledo and Leon, 2019). In such a culture, conflicts are perceived as opportunities for personal and organisational growth and enhancement, rather than as destructive elements (Kumar *et al.,* 2016; Kucharska, 2017). Conflict resolution is approached constructively, with disagreements being addressed respectfully.

1.5 Organisational Learning

Organisational learning is the process through which businesses acquire, generate, maintain and share knowledge and insights to enhance their performance and adapt to evolving circumstances (van Winkelen, 2010; Argote *et al.,* 2021). It nurtures a culture of ongoing improvement and innovation, factors that can contribute to elevated performance and long-term success (Patky, 2020; Tu and Wu, 2021). According to scholars, effective communication and the sharing of knowledge among employees are critical components of organisational learning (van Winkelen, 2010; Oh and Kim, 2022). However, the literature confirmed that organisational learning leads to adaptive behaviours and continuous

improvement (Argote *et al.,* 2021; Zhang *et al.,* 2023). Insights gained through learning guide organisations in adjusting their strategies, processes and practices to align more effectively with their objectives and the evolving external environment.

1.6 Resource Sharing

Resource sharing describes the process of distributing and employing various resources, including physical assets, fundamental infrastructure, knowledge, competencies, or financial resources, among individuals or organisations to achieve mutual benefits and enhance efficiency (Wasiuzzaman, 2019). It involves making these resources accessible to those who require them, whether temporarily or continuously, rather than each party independently keeping their duplicate resources (Mehrotra *et al.,* 2020). According to the literature, resource sharing takes various forms and finds applications in diverse contexts (He *et al.,* 2019; Ratilla *et al.,* 2021). It may include sharing tangible resources like equipment, facilities, vehicles, or office facilities. Collaborating by sharing and exchanging information, knowledge, research and expertise among employees or experts to foster collective learning and problem-solving is another form of resource sharing (Li, Fang, 2021).

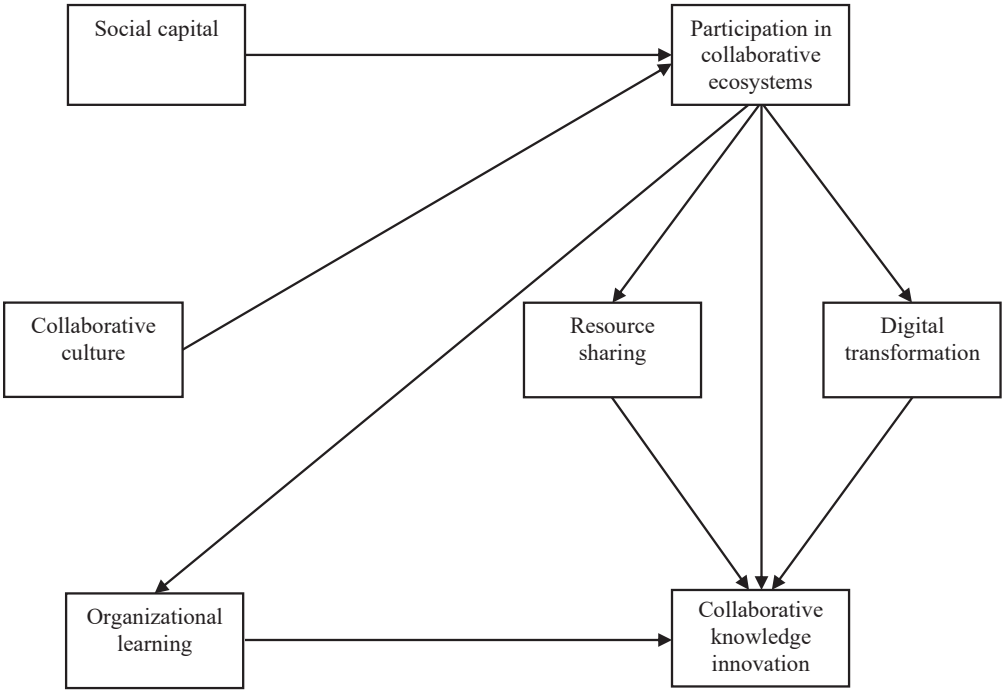
1.7 Digital Transformation

Digital transformation is a type of business transformation that is driven by harnessing and integrating the potential of technologies and digital solutions into an organisation's strategies, operations and interactions (Burchardt, Maisch, 2019; van Meeteren *et al.,* 2022). It is an ongoing process that requires strategic planning, continuous learning and commitment to continue at the forefront of the digital era and technological innovations (Hossain and Lassen, 2017; Dalenogare *et al.,* 2023). Effective implementation of a digital transformation strategy enhances competitiveness and customer satisfaction and exploits novel opportunities for growth and innovation (Burchardt, Maisch, 2019; Kuruppuarachchi *et al.,* 2023). However, the literature revealed that these strategies vary according to the organisation's industry, objectives and level of digital maturity (Imran *et al.,* 2021; van Meeteren *et al.,* 2022; Pertuz *et al.,* 2021).

2. Research Model and Hypotheses

Drawing from the analysis of existing literature and identified research gaps, this study posits that SC and CC significantly impact participation in CES. As shown in Figure 1, the research model also proposes that CES play a significant role in creating CKI. Furthermore, it proposes a significant mediating role of organisational learning, resource sharing and digital transformation in the impact of participation in CES on CKI.

However, the next sub-sections include a more detailed discussion of these proposed relationships, accompanied by the related hypotheses.



Source: created by the authors.

Figure 1. **Research Model**

2.1 SC and Participation in CES

CES attracts diverse stakeholders and participants collaborating to achieve common objectives, relying on trust and shared values (Fabricius *et al.,* 2001; Wielopolski, Bulthuis, 2023). SC encompasses the relationships, networks and norms that promote collaboration among organisations and individuals (Steinmo, 2015; Westerink *et al.,* 2017). Trust is an integral part of SC and the foundation of interaction with the members of social networks (Zmyślony *et al.,* 2020; Roxas, 2021; Lee *et al.,* 2023). According to studies, trust contributes to developing innovation ecosystems' dimensions (Musavengane, Kloppers, 2020; Halstead *et al.,* 2022). Effective communication and relationships with other ecosystem members foster an environment of collaboration (Graça, Camarinha-Matos, 2017; Fu *et al.,* 2023). Scholars affirmed that the mature SC enables open communication, transparency and mutual respect, which promotes productive collaboration among stakeholders (Westerink *et al.,* 2017; Rastrollo-Horrillo, Rivero Diaz, 2019). Ecosystem members can access the expertise and competencies of others through the channels of SC (Rastrollo-Horrillo, Rivero Diaz, 2019). Such access fosters critical knowledge and skills, such as problem-solving, which enhances the organisation's ability to innovate. Therefore, this study proposes:
H1: SC significantly impacts participation in CES.

2.2 CC and Participation in CES

A CC serves as a driver for fostering collaboration within and among organisations (Quicke, 2000; Kumar *et al.,* 2021). When these organisations become part of CES, they bring with them an inherent desire for collaboration and interaction with external partners, stakeholders and other ecosystem participants. This, in turn, elevates the overall efficacy of collaborative efforts. A CC nurtures an environment characterised by open and transparent communication channels. This facilitates the exchange of ideas, information sharing and the facilitation of constructive dialogues among employees and with external partners (Chow, 2012; Mohd Noor *et al.,* 2015). Such capabilities of communication extend to interactions within CES, where effective communication stands as an indispensable element for success. A CC underscores the significance of trust among team members within an organisation, leading to a tendency to trust external partners within CES (Kucharska, 2017; Barrane *et al.,* 2021). Such trust enhances decision-making processes, curtails conflicts and promotes a more productive working environment. Scholars confirmed that CCs place a premium on sharing knowledge among organisational members (Chow, 2012; Kumar *et al.,* 2016). When firms participate in CES, they usually contribute significant knowledge and expertise to share, thereby enriching the overall knowledge within the ecosystem (Brody *et al.,* 2006; Wirtz, Müller, 2023). Furthermore, organisations with a CC are more inclined to accept change and effectively respond to evolving business environment dynamics (Quicke, 2000; Kumar *et al.,* 2021). This flexibility extends to the organisation's capacity to adapt to the dynamic nature of CES. Scholars confirmed that CES often necessitate long-term commitment and sustained efforts (Nedbal *et al.,* 2013; Wirtz and Müller, 2023). ***Consequently, this study posits:***

H2: CC significantly impacts participation in CES.

2.3 CES and CKI

CES connect a diverse range of participants, including companies, professionals and researchers from varied fields and backgrounds (Dyke *et al.,* 2005; Wielopolski, Bulthuis, 2023). This combination of knowledge sources contributes to the ecosystem's common repository of knowledge. When organisations participate in such ecosystems, they gain access to a broader range of knowledge, viewpoints, competencies and experiences than they would in isolation (Wondolleck, Yaffee, 2022; Dalenogare *et al.,* 2023). When organisations collaborate within an ecosystem, they can share information, data and knowledge more efficiently, thus improving the agility of knowledge transfer, reducing the learning curve and minimising redundant efforts. As a result, the innovation process becomes faster and more streamlined, leading to a shorter time-to-market for new products, services, or solutions (Sharmelly, Ray, 2018; Shonubi, 2023). Participation in CES fosters an innovation culture, where organisations within these ecosystems are frequently more open to exploring, learning from failures and adapting to changing conditions (Yan *et al.,* 2018; DiVito, Ingen-Housz, 2021). This culture of innovation encourages continuous improvement and cultivates a mindset of exploration and creativity. CES have the power to develop sustainable knowledge ecosystems in which knowledge is not only generated but also maintained, accumulated and continually built upon. However, studies confirmed that effective storage and retrieval systems guarantee that the ecosystem's collective knowledge continues to be available for future innovation efforts (Nedbal *et al.,* 2013; Shonubi, 2023). Therefore, it can be hypothesised:

H3: *CES* significantly impacted the creation of CKI.

2.4 The Mediating Impact of Organisational Learning

Organisational learning relates to the acquisition, processing and application of knowledge inside an organisation to improve performance and adapt to changing situations. This involves individual learning, group learning and the development of a learning-oriented culture (Nugroho, 2018; Argote *et al.,* 2021). CES offer a conducive environment for organisational learning. These ecosystems expose firms to a diverse range of competencies and viewpoints, promoting a culture of exploration and learning (Graça, Camarinha-Matos, 2017; Kuruppuarachchi *et al.,* 2023). According to Sensuse, Bagustari (2019), learning-skilled organisations can effectively absorb knowledge from collaborative partners, integrate it into their current knowledge base and apply it to innovate. Scholars confirm that organisational learning promotes a culture of continuous improvement, which is essential for CKI (Zhang *et al.,* 2011; Peschl, Fundneider, 2014). It facilitates the transfer of knowledge acquired within ecosystems to the organisation's internal processes, where it can be transformed into innovative solutions (Sensuse and Bagustari, 2019). Studies also emphasised that organisational learning enhances the organisation's capabilities in terms of knowledge absorption, adaptation and application, making it more effective at knowledge innovation (Li *et al.,* 2014; Bo *et al.,* 2020). Organisational learning guarantees that collaboration-based innovation is a continuous process, thus raising the value of collaborative business networks (Nugroho, 2018; Oh and Kim, 2022). However, scholars confirm that as organisations actively engage in CES to drive innovation, their ability to learn and adapt is crucial in translating collaborative potential into tangible innovative outcomes (Yan *et al.,* 2018; Klimas and Czakon, 2022). ***Accordingly, it can be proposed that:***

H4: Organisational learning significantly mediates the impact of CES on CKI.

2.5 The Mediating Impact of Resource Sharing

CES include various interconnected entities that work together to create a collaborative environment. These ecosystems are characterised by open communication, cooperation and shared objectives (Graça and Camarinha-Matos, 2017; Fu *et al.,* 2023). CES often consist of organisations with complementary resources, including expertise, technology, data and funding (Lee, Kim, 2022; Shonubi, 2023). Furthermore, studies have confirmed the role of resource sharing in eliminating barriers to collaborative innovation (Marcon, Ribeiro, 2021; Ruichang, Hongying, 2022). Scholars confirm that resource sharing enables participants to collaboratively generate innovative solutions that outperform what they might do individually by providing access to various resources and enhancing knowledge exchange (Marcon, Ribeiro, 2021; Ruichang, Hongying, 2022). Sharing resources among participants can help accelerate the innovation process (Adner, Kapoor, 2016; Musavengane, Kloppers, 2020). For instance, the sharing of data or research findings can significantly reduce the time required for problem-solving and idea development. CES often involve shared risks and rewards (Graça, Camarinha-Matos, 2017; DiVito, Ingen-Housz, 2021). Resource sharing is closely linked with knowledge exchange within CES. As organisations share resources, they also share tacit knowledge, best practices and lessons learned (Sharmelly, Ray, 2018; Wirtz, Müller, 2023). Such exchange of knowledge enhances the quality and relevance of innovations (Zheng, Yu'na, 2016; Shi *et al.,* 2022). Hence, it can be posited that:

H5: Resource sharing significantly mediates the impact of CES on CKI.

2.6. The Mediating Impact of Digital Transformation

Digital solutions encompass a broad spectrum of technologies, tools and platforms that enable organisations to convert their processes into digital formats, gain access to insights derived from data and improve collaboration (Abdalla, Nakagawa, 2021; Sraml Gonzalez, Gulbrandsen, 2022). Adopting digital solutions and significantly modifying how firms run and interact with their stakeholders is what digital transformation implies. One of the most important advances in digital solutions is the development of data analytics and big data capabilities, which have enabled ecosystem organisations to extract valuable insights from huge and diverse data sets (Hernandez-Almazan *et al.,* 2022). These tremendous advances in accessing and analysing data in real-time have improved the quality of the decision-making process, exploration of emerging market trends and agility in adaptation through innovative ideas and solutions. Scholars confirmed that digitalisation solutions have contributed to improving business processes and raising their efficiency by facilitating the development and implementation of novel ideas, accelerating the cycle of innovation (Burchardt and Maisch, 2019; Al-Omoush *et al.,* 2020). Moreover, scholars emphasise that digital transformation expands the scope of CES and their members' capabilities for creating knowledge innovation (Nedbal *et al.,* 2013; Dalenogare *et al.,* 2023). Therefore, this study proposes:

H6: Digital transformation significantly mediates the impact of CES on CKI.

3. Research Methodology

3.1 Measurement and Development of the Instrument

To achieve its objectives, this empirical study adopts the quantitative method by developing a questionnaire to collect data from the targeted population. Measurement items derived from pertinent literature were employed to represent the research constructs, including CKI, CES, SC, CC, organisational learning, resource sharing and digital transformation (see *Table 1*).

Table 1. Measures sources

Construct	Items	References
CKI	5	***Du Chatenier et al., 2009; Liu et al., 2013; Bai and Li, 2020.***
CES	5	***Yan et al., 2018; Graça and Camarinha-Matos, 2017; Shonubi, 2023.***
SC	4	***Rastrollo-Horrillo and Rivero Diaz, 2019; Al-Omoush et al., 2020.***
CC	4	***Kumar et al., 2016; Kucharska, 2017; Toledo and Leon, 2019.***
Organisational learning	4	***Nugroho, 2018; Argote et al., 2021.***
Resource sharing	4	***Wasiuzzaman, 2019; Mehrotra et al., 2020; Ozdemir et al., 2023.***
Digital transformation	4	***Burchardt and Maisch, 2019; Abdalla and Nakagawa, 2021; Imran et al., 2021.***

Source: created by the authors.

Four experts in knowledge management, business innovation, organisational culture and digital transformation have reviewed the 35-item questionnaire (see *Table 2*) to confirm its validity for relevance, logical flow, clarity and consistency.

Table 2. Construct and measures

Construct	*Code*	*Items*
CKI	*CKI*	*Our firm's leadership believes that no single company has all the necessary knowledge and resources for innovation.*
	CK2	*Our company actively supports participation in both intra and inter-organisational teams to harness diverse expertise for innovation.*
	CK3	*Collaborative knowledge creation has led to the development of innovative products and services in our company.*
	CK4	*Collaborative knowledge creation has improved our company's adaptability to changing market conditions.*
	CKI5	*Shared specialised knowledge with external partners enables our company to create innovative ideas and novel solutions when addressing complex or niche problems.*
CES	*CES1*	*We actively engage with various stakeholders in the industry to exchange knowledge and resources.*
	CES2	*Collaborative efforts have expanded our expertise and knowledge in the industry.*
	CES3	*Our company frequently collaborates with other companies to solve common problems.*
	CES4	*We actively seek opportunities to partner with others to explore new business ventures.*
	CES5	*Our company attends conferences, meeting webinars, or events related to the industry to connect with potential collaborators.*
SC	*SC1*	*We have cultivated strong relationships with external partners and stakeholders, grounded in trust and mutual respect.*
	SC2	*Our organisation actively seeks opportunities to expand and foster its social capital networks.*
	SC3	*Our company leverages its social networks to access valuable information, resources, or opportunities.*
	SC4	*Our company has a formal strategy for structuring and leveraging social capital*
CC	*CC1*	*Our company champions a culture of transparent communication and the exchange of ideas among team members.*
	CC2	*Employees are encouraged to collaborate across departments and teams to tackle challenges.*
	CC3	*Collaborative projects are highly valued and rewarded in our organisational culture.*
	CC4	*Collaboration is regarded as a foundational skill set for employees in our company.*
Organisational learning	*OL1*	*Our company invests in programs for training and development to enhance employee skills and knowledge.*
	OL2	*Knowledge acquired through collaborative projects is systematically documented and disseminated throughout the entire company.*
	OL3	*We have a culture of continuous learning and adaptation*
	OL4	*Our company reviews and updates its operations and practices to incorporate new knowledge and best practices.*
Resource sharing	*RS1*	*Resource sharing is a vital component of our company's overall strategy.*
	RS2	*Our company is open to resource-sharing, including data, expertise and infrastructure.*
	RS3	*We proactively collaborate with partners to combine resources and reduce duplication of efforts.*
	RS4	*Our company has established transparent mechanisms for resource-sharing with other companies.*
Digital transformation	*DT1*	*Our company continually adapts to emerging digital technologies.*
	DT2	*We have a clear Digital Transformation strategy in place.*
	DT3	*Our company has integrated digital solutions to streamline collaboration with partners.*
	DT4	*We heavily invest in technology infrastructure to support digital transformation initiatives within our collaborative projects.*

Source: created by the authors.

It is important to note that the questionnaire employed a five-point Likert scale, with ratings ranging from 5 (indicating strong agreement) to 1 (indicating strong disagreement), to maintain consistency and comparability in respondents' assessments.

3.2 Data Collecting and Sampling

The Information and Communication Technology (ICT) sector, also referred to as the "tech sector", is an ideal area for performing this empirical study. The tech sector is well known for its collaborative minds, with many firms relying on partnerships, open-source initiatives and industry-wide collaboration. This sector places significant importance on the exchange of knowledge and the cultivation of innovative ideas. Tech firms frequently nurture a culture of continuous learning due to the rapid evolution of technology. This environment makes them an ideal setting for exploring the mediating impact of organisational learning on the potential relationship between CES and knowledge innovation. Furthermore, sharing resources, whether for infrastructure, research, or development, is a common practice in the tech sector, providing a wealth of opportunities to investigate the intricate dynamics of resource sharing and its mediating impact. Many other sectors that increasingly rely on technology-driven collaboration for their innovative activities can benefit from the insights derived from this study of the tech sector.

The sample of the study included top and middle managers. These management levels have pivotal positions within companies, enabling them to offer valuable perspectives on how CES influence CKI. Their strategic responsibilities, decision-making powers and active involvement in resource allocation render them ideal candidates for participating in this empirical study. Following a phone conversation, 19 tech companies agreed to take part in the study. An electronic version of the questionnaire was sent to companies. However, the process of collecting data extended over 40 days. Further information about the companies and participants is presented in *Table 3*.

Table 3. Profile of respondents

Firms	***No.***	***%***	***Respondents***	***No.***	***%***
Categories			***Position***		
Software Development Companies	***5***	26.3	***Top management***	***83***	32.3
Telecommunication Companies	***3***	15.8	***Middle management***	***174***	67.7
Hardware Manufacturers and Distributors	***4***	21.1	***Experience***		
IT Consulting and Services	***3***	15.8	***>10 years***	***39***	15.2
Cybersecurity Firms	***2***	10.5	***10–20 years***	***176***	68.5
Others	***2***	10.5	***<20 years***	***42***	16.3
Firm size			***Education***		
<250	***10***	52.6	***Diploma or less***	***66***	25.7
250–500	***6***	31.6	***BA***	***153***	59.5
>500	***3***	15.8	***Postgraduate***	***38***	14.8
Firm age			***Gender***		
<10	***9***	47.4	***Male***	***194***	75.5
11–20	***8***	42.1	***Female***	***63***	24.5
>20	***2***	10.5	***Total***	***257***	***100***
Total	***19***	***100***			

Source: created by the authors.

4. Data Analysis and Results

The statistical tool Smart PLS 4.0 was used to analyse the acquired data and assess the hypotheses. This analysis has two main parts: the measurement model and the structural model.

4.1 Assessment of the Research Model

The validity and reliability of the measurements (see *Table 4*) used for the study are assessed in this part of the analysis, as outlined by Hair et al. (2014, 2017). Most of the items on the scale, underlying their constructs, exhibited factor loading scores exceeding 0.60, indicating a satisfactory level of convergent validity. Items with a factor loading below 0.6 were excluded from further analysis. As a result, one item from each of SC (SC3), resource sharing (RS2) and digital transformation (DT3) were removed from the scale.

All constructs exhibited accepted internal consistency, as indicated by Cronbach's alpha and Composite Reliability (CR) values exceeding 0.80. The convergent validity of the constructs was assessed using the average variance extracted (AVE) test with a threshold of 0.50 to ascertain whether, on average, the related multiple items converge to measure the research variables. In other words, this test measures the extent to which the indicators' variance can be attributed to the underlying latent variable. However, the AVE scores for all constructs exceeded 0.50, indicating convergent validity and confirming the appropriateness of the study's measurement scale (Fornell-Larcker, 1981).

Table 4. Measurement model criteria

Construct	***Cronbach's alpha***	***CR***	***AVE***
CKI	0.716	0.732	0.540
CES	0.860	0.871	0.644
SC	0.897	0.899	0.765
CC	0.767	0.779	0.589
Organisational learning	0.761	0.754	0.578
Resource sharing	0.758	0.760	0.681
Digital transformation	0.790	0.789	0.706

Source: created by the authors.

This study has employed Fornell-Larcker's (1981) discriminant validity criteria as a measure for assessing the relationship between measures from different constructs.

Table 5. Discriminant validity

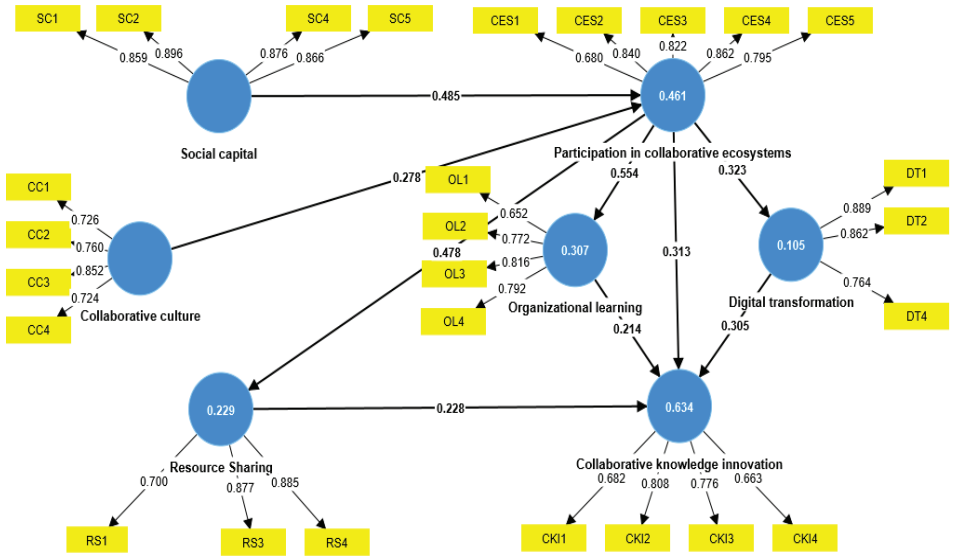
No.	Constructs	1	2	3	4	5	6	7
1	CES	0.802						
2	***CKI***	0.640	0.735					
3	SC	0.639	0.624	0.874				
4	CC	0.546	0.600	0.554	0.767			
5	Organisational learning	0.554	0.611	0.670	0.454	0.761		
6	Resource sharing	0.478	0.573	0.505	0.621	0.455	0.825	
7	Digital transformation	0.323	0.564	0.402	0.299	0.393	0.322	0.840

Source: created by the authors.

The results presented in *Table 5* demonstrate that the AVE for each construct surpassed the correlations with other constructs, confirming acceptable discriminant validity.

4.2 Estimating the Structural Model and Testing Hypotheses

The outcome of the PLS path analysis with coefficients for each relationship in the proposed research model is presented in *Figure 2*.



Source: created by the authors.

Figure 2. **Path Coefficient Analysis**

The outcomes of the hypothesis testing (see *Table 6*) indicate that SC (H1) and CC (H2) have a considerable impact on participation in CES. This study also confirms that CES significantly impact CKI (H3).

Table 6. Testing hypotheses

H	*Paths*	*β*	*T value*	*Sig.*	*The result*
1	***SC -> CES***	0.485	6.949	***0.000***	***Significant***
2	***CC -> CES***	0.278	3.751	***0.000***	***Significant***
3	***CES -> CKI***	0.313	6.924	***0.000***	***Significant***
4	***CES -> Organisational learning -> CKI***	***0.116***	***3.222***	***0.001***	***Significant***
5	***CES -> resource sharing -> CKI***	***0.110***	***4.197***	***0.000***	***Significant***
6	***CES -> Digital transformation -> CKI***	***0.101***	***3.727***	***0.000***	***Significant***

Source: created by the authors.

Furthermore, the results demonstrate that organisational learning (H4), resource sharing (H5) and digital transformation (H6) play a significant mediating role in the impact of participation in CES on CKI**.**

5. Discussion

The result of path analysis indicates that SC significantly impacts participation in CES. This finding accords with the role of SC in promoting continued collaboration and overcoming challenges that may arise during collaborative initiatives (Westerink *et al.,* 2017; Musavengane, Kloppers, 2020). It also agrees with prior research confirming the role of trust, a critical component of SC, in collaborative ecosystem relationships for resolving conflicts of interest and fostering a willingness to openly share resources, knowledge and ideas (Musavengane, Kloppers, 2020; Halstead *et al.,* 2022).

This study confirms that CC significantly impacts participation in CES, which is consistent with its role in fostering and driving collaboration within and among organisations (Quicke, 2000; Kumar *et al.,* 2021). Prior research has confirmed the role of CC in supporting communication, the exchange of ideas, information sharing and constructive dialogues among stakeholders (Chow, 2012; Mohd Noor *et al.,* 2015. These findings also agree with studies confirming the importance of CC in building trust (Kucharska, 2017; Barrane *et al.,* 2021), sharing knowledge (Chow, 2012; Kumar *et al.,* 2016) and commitment (Chow, 2012; Kumar *et al.,* 2016).

The results show that CES significantly impacts CKI. These outcomes align with studies confirming the role of CES, which includes a combination of knowledge sources, in generating cross-disciplinary ideas and innovative solutions (Yan *et al.,* 2018; Dalenogare *et al.,* 2023). Scholars have confirmed how collaborative efforts among organisations contribute to agile knowledge transfer and reduce the learning curve and redundant efforts, accelerating the innovation process for creating new products, services, or solutions (Sharmelly, Ray, 2018; Shonubi, 2023).

This study found that organisational learning significantly mediates the impact of CES on CKI. This finding is in line with the role of organisational learning capability in absorbing shared knowledge, competencies, ideas and viewpoints from the CES environment (Graça, Camarinha-Matos, 2017; Kuruppuarachchi *et al.,* 2023). It also agrees with studies that have confirmed the role of organisational learning in enabling organisations to absorb knowledge from collaborative partners, integrate it into their current knowledge base and apply it to innovate (Sensuse, Bagustari, 2019; Zhang *et al.,* 2023).

The findings of this study indicate that resource sharing significantly mediates the relationship between CES and CKI. These results are consistent with the notion that no single entity possesses all the necessary resources to innovate (Peschl and Fundneider, 2014; Xu *et al.,* 2018). They are also consistent with the earlier academic works considering ecosystems as platforms for participants to access and share diverse resources, enabling them to expand their innovation capabilities beyond what they could achieve individually (Adner, Kapoor, 2016; Ramakurthi *et al.,* 2022).

Conclusions

This study has aimed to explore the impact of SC and CC on participation in CES. It also aimed to examine the direct role of CES in creating CKI. Furthermore, the study has explored the potential mediating role of organisational learning, resource sharing and digital transformation in the impact of participation in CES on CKI. However, the results of this study support the presence of a significant positive effect of SC and CC that supports firms' participation in CES. This study also discovered a direct effect of participation in CES on the

creation of CKI. Moreover, the results confirm the mediating role of organisational learning, resource sharing and digital transformation in the impact of participation in CES on CKI.

This study provides valuable contributions and novel insights into theories of collaborative ecosystems, innovation, knowledge creation and social capital in several ways. It has integrated SC theory and the CC framework to explain the interactions between them in promoting collaborative engagement in the ecosystem. This study also provides new insights that contribute to understanding the antecedents and consequences of participation in CES. The findings contribute to the existing literature on how innovation is created in collaborative knowledge by exploring the importance of participation in CES and related mechanisms in developing this innovation paradigm. This study provides evidence on how participation in CES contributes to providing new resources and capabilities to companies and stakeholders, to foster knowledge innovation that contributes to the development of novel products, services and solutions, thus contributing to the development of RBV theory. It also contributes to the development of CES theory by exploring the mechanisms that transform participation in these ecosystems into value co-creation, including organisational learning, resource sharing and digital transformation. The outcomes of this study also contribute to the development of CKI theory by exploring the mechanisms that mediate the development of this dynamic capability.

The results of this study offer a new perspective on the link between SC, CC, CES and CKI, providing a roadmap for managers to design effective strategies for engagement in these ecosystems. Understanding the role of organisational learning, resource sharing and digital transformation in harnessing ecosystems to create CKI provides senior management with a better foundation and knowledge on how to manage and enhance their engagement in CES. Organisations should consider allocating resources to developing and maintaining strong supply chain networks, both within their internal teams and within their external partnerships. Enabling employees to openly share knowledge and skills, interact with external partners and embrace diverse perspectives creates an environment that fosters CKI. In addition, policymakers can play a key role in promoting environmental sustainability by regulating the regulatory frameworks that establish and regulate these environmental systems. This goal can be achieved by strengthening alliances and joint ventures, enhancing cross-sector collaboration, providing supporting infrastructure and offering incentives to encourage corporate participation in knowledge exchange initiatives. Policymakers can also support learning programs and initiatives that strengthen the ability to collaborate and advance digital literacy. In addition, it provides policymakers with the opportunity to promote research on the impact of sustainable ecosystems on innovation and to facilitate knowledge exchange between companies and stakeholders. This can contribute to shaping best practices and guidelines to enhance productive collaboration.

Despite its contributions, the present study has shortcomings, which can initiate new areas of study. This study may have the potential for bias because it exclusively focuses on IT firms in Jordan, where the findings may not apply to other industries or regions**.** Therefore, a similar study can be applied in different environments to validate our findings. Scholars can also employ a blend of quantitative and qualitative research techniques to gain a more comprehensive understanding of the mechanisms underlying SC, CC and their influence on CES. On the other hand, while the study examines organisational learning, resource sharing and digital transformation as mediating factors, it is expected that other unexplored variables play a role in the relationships between CES and CKI. Exploring additional contextual factors that may either moderate or mediate the examined relationships, including entrepreneurial

orientation, institutional pressures, relationship quality, governmental policies, industry regulations and market conditions, is needed in future research.

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BENDRADARBIAVIMO EKOSISTEMŲ IR ŽINIŲ KŪRIMAS: DETERMINANTŲ IR MECHANIZMŲ ANALIZĖ

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Santrauka

Pagrindinis šio tyrimo tikslas – ištirti galimą socialinio kapitalo (angl. *Social Capital,* SK) ir kolektyvinės kultūros (angl. *Collaborative Culture*, KK) vaidmenį dalyvaujant bendradarbiavimo ekosistemose (angl. *Collaborative Ecosystems,* BE) ir šių ekosistemų poveikį kuriant bendradarbiavimo žinių inovacijas (angl. *Collaborative Knowledge Innovation*, BŽI). Šiuo tyrimu taip pat siekiama ištirti galimą organizacinio mokymosi, išteklių dalijimosi ir skaitmeninės transformacijos kaip mechanizmų, tarpininkaujančių dalyvavimo BE poveikiui BŽI. Atliekant šį empirinį tyrimą duomenys buvo renkami iš 257 technologijos įmonių vadybininkų. Tyrimo modeliui įvertinti ir hipotezėms patikrinti naudota „SmartPLS“ programinė įranga. Rezultatai rodo, kad SK ir KK dalyvavimas reikšmingai veikia dalyvavimą BE. Išvados taip pat atskleidžia, kad organizacinis mokymasis, išteklių dalijimasis ir skaitmeninė transformacija atlieka reikšmingus tarpininkavimo vaidmenis santykyje tarp BE ir BŽI. Šio tyrimo išvadose pateikiamos vertingos teorinės ir praktinės įžvalgos apie šių determinantų ir mechanizmų, integruotų į vieningą sistemą, ryšį.

REIKŠMINIAI ŽODŽIAI: socialinis kapitalas; kolektyvinė kultūra; bendradarbiavimo ekosistemos; žinių kūrimas bendradarbiaujant; skaitmeninė transformacija.