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WHAT DRIVES SUCCESSFUL SUSTAINABLE TECHNOLOGY TRANSFER IN EMERGING OPEN INNOVATION ECOSYSTEMS: INSIGHTS FROM SOUTHEAST EUROPE

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ABSTRACT

Southeast European transition economies continue to struggle with turning innovative ideas into sustainable commercial successes. This paper examines the factors that drive effective and lasting Technology Transfer (TT) within emerging open innovation ecosystems in Bosnia and Herzegovina, Serbia, North Macedonia, and Albania. Unlike earlier studies that focus on a single country or rely on limited methods, this research adopts a comprehensive mixed-methods approach, combining a two-round Delphi study, focus groups, a needs analysis, and a survey of 100 companies.

Using Partial Least Squares Structural Equation Modelling (PLS-SEM) on data collected from companies and research institutions, the study demonstrates that robust Intellectual Property Protection (IPP) exerts a significant and direct influence on enhancing technology transfer. In contrast, innovation capabilities alone do not significantly affect transfer outcomes. Instead, network dynamics strengthen these capabilities, which in turn support technology transfer — but only when embedded within solid institutional frameworks.

These findings challenge the common assumption that innovation capabilities are sufficient for successful technology commercialization. They emphasize the critical importance of institutional quality and cooperation networks in transitional economies.

At the theoretical level, the study integrates resource-based, institutional, and open innovation perspectives to address the "innovation-implementation" gap. Practically, it highlights key policy priorities: strengthening IPP enforcement, establishing specialized IPP courts, and fostering partnerships between universities and industry, as well as within innovation clusters. For companies and universities, developing absorptive capacity and engaging in cross-border collaborations are essential for maximizing the benefits of external knowledge.

While limited by its regional focus and cross-sectional design, this research offers a nuanced framework for sustainable technology transfer in Southeast Europe and underscores the need for further comparative and longitudinal studies to deepen our understanding of this phenomenon.

KEYWORDS: *sustainable entrepreneurship, technology transfer, R&D and IPP, transitional economies, commercialization of innovation*

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1. INTRODUCTION

Given the growing complexity of knowledge, companies increasingly recognize that relying solely on internal resources is insufficient to sustain competitiveness (Terhorst et al., 2025). As competition in the digital economy intensifies, companies are under pressure to innovate more openly and collaboratively to remain competitive globally. To address this challenge, many companies are adopting diverse innovation approaches, such as evolving their business models (Ricardo & Darek, 2021) and forming cross-border partnerships (Radziwon & Bogers, 2019).

Technology transfer within Open Innovation Ecosystems (OIEs) represents a critical process for knowledge exchange and value creation across organizational boundaries. As the demand for greener and more sustainable business practices increases, sustainability-oriented entrepreneurship has become an important focus within entrepreneurship research (Gast et al., 2016). This topic is particularly relevant because research on environmental innovation lies at the core of the Europe 2020 strategy, shaping the region's path towards sustainable growth and competitiveness (Ferreira et al., 2020).

Scholarly interest in Eco-innovation (EI) is growing rapidly (Chistov et al., 2021; Cornejo-Camanares et al., 2021; De Marchi et al., 2022; Demirel & Kesidou, 2019; Huang et al., 2016; Prokop et al., 2022; Przychodzen & Przychodzen, 2015; Xavier et al., 2017; Yang et al., 2024; among others, as cited in Parrilli et al., 2025). In emerging economies, adopting a sustainable mindset is essential, as public policy interventions are often temporary, while organizations must ensure their long-term viability (Guerrero & Siegel, 2024).

While traditional economic theory has emphasized innovation as a central driver of growth (Link & Siegel, 2007), Baumol (2010) notes that entrepreneurial innovation, in particular, is the most significant source of improvement in economic performance (Guerrero & Siegel, 2024). In response, numerous countries and regions have introduced policies aimed at stimulating entrepreneurial innovation as a pathway to stronger economic growth. Among the most notable initiatives are efforts to develop innovation and entrepreneurial ecosystems within universities and their surrounding regions — an approach that has gained increasing attention in the fields of innovation and entrepreneurship over recent decades (Guerrero & Siegel, 2024).

The concept of the "entrepreneurial ecosystem" can be traced back to Moore's (1993) seminal work, which highlighted the interrelationships among actors in the post–start-up phase. Since then, a growing body of scholarship has broadened this perspective by examining both the formal and informal interactions that shape such ecosystems. Scholars including Isenberg (2010), Mason and Brown (2014), Stam (2015), Spigel (2017), Thomas and Autio (2020), and Xu and Dobson (2019) have emphasized the multiple pillars underpinning entrepreneurial ecosystems, including policy frameworks, markets, financial resources, culture, human capital, support mechanisms, mentorship, and universities.

The establishment of an innovation ecosystem (IE) revitalizes enterprises by fostering collaboration among diverse actors within the system. Such collaboration expands access to resources for innovation and development, thereby enhancing participants' innovative capacity and improving their long-term survival prospects (Yuan & Li, 2024). Chesbrough (2003) developed the concept of open innovation (OI), underscoring the value of integrating external knowledge and resources into the innovation process. The success of OI partnerships depends largely on the relational dynamics that sustain collaboration. Central to this is trust, which fosters the psychological safety necessary for individuals to engage openly and to facilitate the exchange of tacit knowledge essential for navigating uncertainty and advancing innovation (Edmondson & Bransby, 2023). Equally important is knowledge sharing, which provides the mechanism through which ideas and expertise circulate, laying the foundation for effective problem-solving and collective ideation (Blomqvist et al., 2024; Gubbins & Dooley, 2021; Scuotto et al., 2020, as cited in Terhorst et al., 2025).

This research seeks to provide deeper insights into *the factors influencing sustainable technology transfer in emerging OIEs in the developing transitional economies of Southeast Europe*. Our study is distinct from at least two perspectives. Methodologically, it adopts a comprehensive mixed-methods approach (Galindo-Martin et al., 2025), combining qualitative and quantitative techniques. It begins with a systematic literature review on sustainable innovation, technology transfer, open innovation, and intellectual property rights, which informed the design of structured interviews for a focus group and a two-stage Delphi study. In addition, quantitative analysis was conducted on a sample of 100 companies from four Southeast European countries. This multi-layered design is particularly suitable for capturing the complexity of innovation ecosystems in transitional economies, where institutional, cultural, and network factors dynamically interact.

Beyond identifying key actors, factors, activities, and strategies for knowledge spillover and sustainable innovation technology transfer in emerging OIEs in four Southeast European countries (Bosnia and Herzegovina, Serbia, North Macedonia and Albania), the implications of our research are threefold. From the theoretical perspective, the complex and comprehensive methodological approach, which investigates the needs of the real sector and academic community for closer academia-to-business (A2B) collaboration within emerging OIEs, as well as peer-to-peer collaboration among companies, offers a concrete contribution to the theory of OI.

The practical implications for government policies are reflected in the clearly articulated needs for institutional support to strengthen A2B cooperation, as outlined in recommendations for developing OIEs in developing economies. These focus on strengthening innovation network dynamics and providing innovation commercialization support. On the one hand, higher education institutions (HEIs) should promptly engage in the process of building university campuses as entrepreneurial ecosystems integrated into broader regional and national OIEs, enhancing collaboration with the real sector through joint research, student internships, education, mentorship, and other forms of collaboration. On the other hand, companies should also take proactive steps towards establishing both formal and informal partnerships with the academic community. Finally, this study offers recommendations for managers of micro and small enterprises that lack internal R&D to strengthen their research absorption capacities and strategically collaborate with universities and other actors within the entrepreneurial innovation ecosystem.

The remainder of this paper is structured as follows. The next section reviews the literature on technology transfer and sustainable entrepreneurship within open innovation ecosystems (OIEs). This is followed by a methodology section detailing the sample, model specification, and empirical strategy. The subsequent section presents the empirical findings, which are then discussed in relation to existing research. The final section summarizes the main conclusions, highlights the study's limitations, and suggests directions for future research.

2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

Open innovation (OI) is increasingly recognized as a key driver of sustainable development, as demonstrated in recent mixed-method analyses at both the microeconomic and macroeconomic levels (Galindo-Martin et al., 2025). Audretsch et al. (2024) find that companies with relatively low levels of R&D investment initially benefit from intra-industry knowledge spillovers; however, beyond a certain threshold, further R&D investment tends to internalize capabilities and reduce their dependence on external spillovers. Conversely, companies that do not invest in R&D tend to rely more heavily on industry spillovers to sustain or even increase innovation-related sales, while simultaneously optimizing their internal resource use and minimizing R&D costs (Audretsch et al., 2024).

Developing countries, especially transitional economies in Europe, seek to catch up with developed economies through various strategic approaches, including sustainable economic development and cooperation to support the creation of entrepreneurial ecosystems based on OI.

OI activities are commonly divided into two types: inflow (outside-in) knowledge transfer and outflow (inside-out) knowledge transfer (Enkel et al., 2009). Building on the literature on OI (Bogers et al., 2017; Chesbrough, 2003, 2024a; Enkel et al., 2009; von Krogh et al., 2018), both the breadth and depth of external search emerge as critical factors in predicting process- innovation performance in manufacturing companies (Lorenz et al., 2021).

The literature on OI distinguishes between three OI strategies: inbound, outbound, and coupled (Chesbrough, 2024a; Radicic & Petković, 2023). The direction and intensity of knowledge flows within OIEs serve as key indicators of the effectiveness of technology transfer. Inbound (outside-in) knowledge-flow metrics involve external knowledge acquisition through corporate start-up collaborations, supplier-sourced innovation, university partnerships, and in-licensing activities (Pop, 2022). Coupled-innovation metrics, on the other hand, include balanced measures of bidirectional knowledge exchange through strategic partnerships, joint ventures, and collaborative innovation networks (Pop, 2022).

Inbound (outside-in) innovation emphasizes the absorption of external knowledge and technologies into companies' R&D and development processes, thereby relying on mechanisms such as collaborations with universities, start-ups, or customers (Chesbrough, 2024b; Holgersson et al., 2024). In contrast, outbound (inside-out) innovation focuses on transferring internal knowledge to external actors—through mechanisms such as licensing, spin-offs, or joint ventures—to extract additional value from underutilized intellectual property (Cassiman & Valentini, 2016). As De Zubielqui et al. (2016, cited in Terhorst et al., 2025) emphasize, this trajectory is primarily concerned with monetizing internal knowledge and shifting the locus of innovation beyond the firm's boundaries. Outbound activities allow companies to monetize their R&D by licensing or selling intellectual property, thereby generating additional revenue while also distributing innovation-related risks (Chesbrough, 2006). A more integrative approach is that of coupled innovation, where organizations simultaneously engage in inbound and outbound flows through strategic alliances, joint platforms, or ecosystems that enable co-creation and shared value (Camilleri et al., 2023; Gassmann & Enkel, 2004). Coupled open innovation involves a collaborative exchange of ideas, knowledge, and innovations both within organizations and across their external networks (Gassmann & Enkel, 2004; Sabando-Vera et al., 2022, as cited in Oliveira & Rua, 2024). Accordingly, open innovation (OI) suggests that a company seeking to develop a new technology can draw on external knowledge—such as existing technologies, university expertise, public–private collaborations, or connections with start-ups—while simultaneously advancing and disseminating its own innovations. This may include collaborating with other companies and organizations in joint development projects, granting licenses for various applications, and engaging in other forms of knowledge exchange (Chesbrough, 2019). Key indicators of technology commercialization include the number of licenses executed, spin-offs created, and market adoption rates of transferred technologies (Pujotomo et al., 2022).

In this study, the focus is not on measuring technology transfer outputs directly but on examining how entrepreneurs and managers perceive the enablers and barriers to sustainable technology transfer within emerging OIEs. Although this focus may be viewed as a limitation, the research makes a distinct contribution by analyzing innovation network dynamics, external support mechanisms, systemic barriers, and the innovation capabilities of actors in transitional economies. The novelty of this study lies in its application of a comprehensive mixed-methods approach with an underexplored context in the literature on emerging economies.

2.1. Open innovation ecosystem actors and drivers of open innovation: Innovation network dynamics

Open innovation (OI), a paradigm introduced by Chesbrough (2003), highlights the intentional flow of knowledge across organizational boundaries to accelerate internal innovation and facilitate the external commercialization of ideas (Terhorst et al., 2025). The challenges of technology transfer within OIEs in developing and transitional economies are complex and multifaceted, encompassing issues such as trust, knowledge sharing, and the dynamics of collaborative problem-solving. Identifying the key drivers that promote OI is crucial for adopting the most effective measures to support sustainable development (Galindo-Martin et al., 2025). Collaboration with external partners strengthens technological capabilities and catalyzes innovation (Vaca et al., 2023). While the potential benefits of OI are clear, the lack of institutional support, inadequate infrastructure, and limited access to funding remain significant barriers to the successful transfer of technology. Companies must make substantial investments in internal capabilities to effectively access and absorb inter-industry spillovers. By contrast, in regions characterized by strong localized intra-industry spillovers, companies can enhance their innovation performance with relatively minimal investment in internal R&D (Audretsch et al., 2024). The development of technologies and innovations for sustainable development has progressed considerably, with several thematic areas emerging as central and giving the field a clearer identity (Gonzalez-Urango et al., 2025). Within this context, the success of open innovation (OI) partnerships depends on the effective management of key relational dynamics—most notably trust, knowledge sharing, and collaborative problem-solving (Terhorst et al., 2025).

In emerging economies, limited R&D resources often prompt organizations with an entrepreneurial innovation orientation to leverage public and private financial support (Guerrero & Siegel, 2024). In a Delphi study conducted by Galindo-Martin et al. (2025), although experts believed that OI could promote sustainable development, they expressed limited consensus and agreement on how this occurs. According to expert assessments, human capital, institutional support structures, and market opportunities are key drivers of open innovation (OI). In particular, their ratings and open comments highlighted the importance of training in soft skills, a supportive institutional climate, and robust ICT infrastructure as critical enablers of OI. Moreover, the findings suggest that OI can generate feedback effects, such as improving access to financing and strengthening human capacities (Galindo-Martín et al., 2025). Although relational dynamics are widely recognized as critical to the success of OI partnerships, relatively few studies adopt a multi-layered perspective that captures their complex interplay comprehensively (Russo et al., 2020; Ali et al., 2021; Cai et al., 2024, as cited in Terhorst et al., 2025). Much of the empirical research to date tends to isolate individual dimensions of OI, thereby overlooking how these layers intersect and interact within real-world partnerships (Terhorst et al., 2025). Building on this discussion, the following hypothesis is proposed.

H1: Innovation network dynamics amongst key actors and available open innovation drivers are directly correlated with successful sustainable technology transfer

2.2. Key challenges of sustainable technology transfer in open innovation ecosystems

Innovative businesses cannot evolve in isolation, and many of today's most influential innovations are too complex to be developed and commercialized by individual companies alone (Moore, 1993). Start-ups, as newly established small companies, face significant liabilities due to their limited size and lack of experience when entering competitive markets (Primario et al., 2024). Identifying objective and verifiable indicators of this process is crucial for evaluating its effectiveness and ensuring its long-term sustainability. One primary indicator is *the rate of technology adoption*, which reflects the successful integration of innovations into practical applications. Carayannis and Campbell (2019) argue that adoption rates—measured through deployment metrics such as the number of licenses issued or products launched—provide a quantifiable indicator of technology transfer success. Similarly, *patent filings and citations* serve as verifiable proxies for innovation output and knowledge diffusion. According to Lee and Kim (2021), the number of co-patented technologies between ecosystem actors signals effective cross-organizational collaboration, a hallmark of OI.

Another key indicator is *resource efficiency*, which ties sustainability to the outcomes of technology transfer. Horbach and Rammer (2020) emphasize that sustainable OIEs prioritize technologies that minimize environmental impact, such as renewable energy solutions and circular economy practices. Metrics such as reductions in carbon emissions or energy consumption per unit of output provide objective evidence of this alignment. Additionally, *economic performance indicators*, such as revenue growth or job creation linked to the transfer of technologies, demonstrate the ecosystem's capacity to generate value. West and Bogers (2017) note that companies in OIEs often report higher returns on investment when technology transfer is paired with open collaboration, measurable through financial statements or employment data. The *level of stakeholder engagement* is also a critical indicator, reflecting the inclusivity and resilience of the ecosystem. Dahlander and Gann (2010) highlight that *the frequency of joint projects, workshops, or knowledge-sharing events between actors*—tracked via participation logs or partnership agreements—indicates robust technology transfer channels. Finally, the *longevity of innovation outcomes*, such as the sustained use of transferred technologies over time, underscores sustainability. A study by Enkel et al. (2020) suggests that longitudinal tracking of technology lifecycles, through case studies or database analysis, reveals whether transfers yield enduring benefits.

In addition to their traditional roles in teaching and research, universities have increasingly expanded their engagement in knowledge transfer activities (Compagnucci & Spigarelli, 2024). Within higher education institutions (HEIs), technology transfer offices (TTOs) play a pivotal role in reinforcing the university's function as a transformative institution in sustainability-oriented innovation systems. In particular, they play a crucial role in promoting the commercialization of sustainable innovations emerging from R&D (Gonzalez-Urango et al., 2025).

Technology Transfer Offices (TTOs) serve as intermediaries that facilitate the commercialization of new technologies, with the broader goal of enhancing economic competitiveness (Borrás et al., 2024). However, their effectiveness remains contested. Borrás et al. (2025) argue that TTOs often lack the flexible mandates necessary to adequately evaluate societal needs and impacts. They also face challenges in collaborating and co-creating with unfamiliar social actors. Technological and strategic bottlenecks have recently emerged as key areas of inquiry in research on innovation ecosystems (Draschbacher et al., 2025).

Hagedoorn and Zobel (2015) and Bigliardi and Galati (2016) demonstrate that robust supporting factors (e.g., funding, infrastructure) and stable Intellectual Property Protection (IPP) systems enhance technology transfer and commercialization in OIEs. Hagedoorn and Zobel (2015) find that companies engaged in OI exhibit a strong preference for governing their interfirm relationships through formal contracts. Moreover, despite the open nature of OI, companies continue to regard intellectual property rights (IPR) as highly relevant for safeguarding their innovative capabilities. However, Alexy et al. (2013) caution that stringent IPP might inhibit knowledge sharing in collaborative settings.

Research into the impact of IPP on technology transfer reveals a complex relationship influenced by factors such as the strength of IPRs, the nature of the technology, and the economic context of the countries involved. Branstetter et al. (2006) examined how U.S. multinational companies adapted their technology transfer strategies in response to intellectual property rights (IPR) reforms implemented across 16 countries between 1982 and 1999. Their findings show that stronger IPR protection was associated with increased royalty payments, higher R&D expenditures by foreign affiliates, and a rise in patent applications abroad—effects that were particularly pronounced among affiliates of parent companies heavily reliant on U.S. patents prior to the reforms. These results suggest that enhanced IPR protection can stimulate technology transfer by elevating the value of intellectual assets in foreign markets.

Wakasugi and Ito (2009) investigated the impact of strengthened intellectual property rights (IPRs) on technology transfer within Japanese multinational corporations. Using firm-level panel data, they found that stronger IPR protection produced results consistent with evidence from studies of U.S. companies. Xu (2023) examined the relationship between IPR protection and technology transfer in Chinese investments in Southeast Asia, finding that while challenges such as cultural differences, legal environments, and uncertainty surrounding IPR hinder transfer processes, opportunities also arise in the form of market entry, faster innovation cycles, and enhanced competitiveness. The study underscores the pivotal role of governments in strengthening legal frameworks, fostering talent exchange, and advancing sustainable development and social responsibility. Accordingly, we propose the following hypothesis.

H2: The breadth and prevalence of key supporting factors for the commercialization of innovations, along with a stable intellectual property protection system, increase the chances of successful knowledge transfer in emerging innovation ecosystems.

2.3. Key factors for enhancing R&D and innovation absorptive capacities of companies

In accordance with the resource-based theory (Barney, 1991), start-ups and SMEs suffer from a lack of internal R&D innovation capacities, and access to financial and human resources. This resource scarcity underscores the importance of cooperation and active participation in innovation ecosystems for SMEs. Beyond collaborating with selected actors within the ecosystem, studies such as Primario et al. (2024) highlight the value of *coopetitive* relationships—defined as a hybrid activity that combines cooperation and competition among companies with the aim of creating value within the ecosystem that can generate significant benefits for participating companies. Primario et al. (2024) refer to this type of relationship within the innovation ecosystem as "peer innovation".

For micro-enterprises, which typically lack in-house R&D capacity, innovation ecosystems are vital in enabling open innovation (OI) practices. Their role is evident in supporting the effective implementation of OI, mitigating associated risks, and strengthening the overall capacity of these small companies (Oliveira & Rua, 2024). Moreover, Oliveira and Rua (2024) emphasize that innovation ecosystems are instrumental in co-creating value, knowledge, resources, and capabilities within micro-enterprises—factors that are essential for their survival and growth in competitive environments.

Drawing on time-lagged data from 257 manufacturing companies in Vietnam, Adomako and Nguyen (2025) find that a sustainability orientation negatively affects company's innovation speed. However, their results also show that R&D agility moderates this relationship by reducing the adverse effect of sustainability orientation on innovation speed. Innovation speed—defined as the time required for companies to move from initial R&D investment to large-scale production, market promotion, and eventual product launch (Mansfield, 1988)—tends to slow when companies devote greater effort to sustainability-related activities, yet this effect can be mitigated by higher levels of R&D agility (Adomako & Nguyen, 2025). Recent studies have further expanded our understanding of the factors that enhance R&D and innovation capacities (Bogers et al., 2016). Tse et al. (2021) showed that local government support positively moderates the relationship between foreign companies' local R&D investment and their innovation performance, with the effect being more pronounced for international joint ventures than for wholly owned subsidiaries. This finding underscores the importance of both institutional support and collaborative structures in enhancing innovation outcomes, particularly in transitional economies.

Bertello et al. (2023) reported that 90% of organizations have already adopted or plan to implement key open innovation practices within the next three years, underscoring the growing recognition of collaborative approaches to innovation. Their research further shows that open innovation has progressed through three distinct phases: an initial stage centered on case studies, a second stage focused on firm-centric value capture, and the current stage, which addresses broader challenges such as sustainability and digitalization.

In the context of transitional economies, Cricchio and Di Minin (2024) found that open innovation (OI) in China has been adopted as a new concept layered onto established practices, with the government playing a central role in orchestrating innovation activities. Their systematic review underscores how China's distinctive institutional environment—marked by strong state involvement in steering R&D and supporting domestic firm innovations—creates a context for innovation that differs significantly from Western models.

The technology transfer process, which bridges academia and industry, has been identified as particularly important for the commercialization of innovation in transitional economies (WIPO, n.d.). Maresova et al. (2019) state that universities play a pivotal role in the commercialization of research, with Technology Transfer Offices (TTOs) serving as intermediaries between researchers and industry to ensure that knowledge creators are correctly credited for their findings.

However, challenges remain in implementing collaborative approaches to innovation. Dall-Orsoletta et al. (2022) found that outbound innovation (sharing knowledge externally) is less common than inbound practices (absorbing external knowledge), suggesting an imbalance in collaborative approaches. Their exploratory study also noted that the challenges associated with implementing collaborative approaches are varied and contingent on local circumstances, indicating that collaboration is not uniformly effective across different contexts. Additionally, Maresova et al. (2019) identified poor relationships between universities and industry, as well as inadequate funding, as significant challenges in many emerging economies. Their systematic review found that there is no universally accepted model for technology transfer in the literature, suggesting that commercialization approaches must be tailored to specific contexts.

Digital technologies have also emerged as key enablers of innovation. Yuba et al. (2023) emphasized that knowledge management is shifting beyond internal organizational processes to encompass external dimensions, with digital platforms and big data analytics playing a crucial role in enhancing the resilience of innovation ecosystems. Their analysis of technology management trends further indicates that technological capabilities enhance innovation potential not only through internal development but also by fostering external collaboration. Therefore, based on numerous potential benefits of R&D within companies and a collaborative approach to R&D on sustainable technology transfer, we formulate the third hypothesis:

H3: Innovative capabilities within companies and a collaborative approach to R&D, increase the chances of successful innovation commercialization in transitional countries.

3. METHODOLOGY AND RESEARCH RESULTS

This study applied both qualitative and quantitative approaches to provide a comprehensive understanding of the factors that drive successful sustainable technology transfer within emerging open innovation ecosystems (OIEs) in Southeast Europe. The methodology and results of each approach are presented in the following sections.

3.1. Qualitative Research Results

Qualitative research consisted of focus groups analysis and a Delphi study, conducted within Horizon USE IPM project on the topic "Challenges and Opportunities of the Technology Transfer and Sustainable Entrepreneurship in Open Innovation Ecosystem in Developing Transitional Economies".

3.1.1. Focus group analysis results

During the period June-July 2024, four focus groups were implemented on the subject "Challenges and Opportunities of Technology Transfer and Sustainable Entrepreneurship in Open Innovation Ecosystems in Developing Transitional Economies", one in each of the four Southeast Europe countries (Albania, Bosnia and Herzegovina, North Macedonia, and Serbia). They gathered a total of 21 participants who represented a variety of expertise areas, including entrepreneurship, business management, applied sciences, public administration, and technology transfer. Their diverse experiences provided a rich perspective on the key issues facing technology transfer and sustainable entrepreneurship in transitional economies. The interviewees included CEOs and senior managers, as well as experts specializing in technology transfer and sustainable entrepreneurship, representing both the government sector and higher education institutions. Each interviewee brought several years of experience in their field. They came from a range of professional backgrounds and held formal education in different areas, with many having substantial expertise in innovation management. Those involved in entrepreneurship had successfully run their own businesses and shared valuable insights about the innovation management skills that contribute to business success. Notably, the focus group participants represented a balanced mix of genders, with nine female and 12 male participants.

The focus group, as a qualitative method, was used to explore participants' opinions, attitudes, beliefs, feelings, and behaviors related to the challenges and opportunities of technology transfer and sustainable entrepreneurship in emerging OIEs in developing transitional economies in Southeast Europe (Bosnia and Herzegovina, Serbia, North Macedonia, and Albania). Focus groups are often used in the early stages of research to generate ideas, identify issues, or explore new phenomena (Krueger & Casey, 2015). This method is especially useful in studies like ours, where interaction among participants can reveal social norms or shared meanings that may not emerge in individual interviews (Morgan, 1997). This method complemented the Delphi study, which was conducted on the same subject. The research instrument consisted of a protocol that included a list of discussion topics based on the fundamental categories of technology transfer within the Open Innovation Ecosystems (OIEs). The participants were asked questions divided into several segments:

(I) national innovation ecosystem and the key ac-

tors in the OIE;
(II) key challenges of technology transfer and sustainable entrepreneurship in OEIs in developing transitional economies;
(III) intellectual property rights protection (IPPR), and
(IV) identification of possible government incentives and new policies that support collaboration in technology transfer.

The main conclusions of the Focus groups are given in the text below.

Related key actors within OIEs, focus group participants identified businesses, higher education institutions, science and technology parks, laboratories, accelerators, clusters, and innovation hubs as key actors in the OIEs, as well as chambers of commerce and *local and state government institutions*. When examining the national innovation ecosystem, the participants addressed several challenges, including insufficient cooperation between academic institutions and businesses for the more efficient transfer of knowledge and innovations, complex procedures for the IPP, a lack of reliable innovation funds, the need to improve the educational system, and the need for the *development of legal regulations*.

The focus group discussion further revealed key challenges regarding technology transfer in OIEs, including an insufficient understanding of what technology transfer essentially entails, a lack of legal and regulatory frameworks to support technology transfer, and *unclear regulations concerning institutional investors*. The participants also highlighted the disconnection between research and commercialization, the lack of sufficient funding and poor access to capital, insufficient market capacity for absorbing new technologies, and the need for innovation-driven change in mind-sets, especially among young people and new generations. They also suggested that a more strategic approach to technology transfer, including better planning and support, is necessary.

Regarding the current state of intellectual property protection (IPP), the participants agreed that *there is limited awareness of its importance and insufficient understanding of what constitutes intellectual property*. This lack of knowledge leads to a failure to properly protect innovations. There was also recognition that the IPRs protection process is long and complicated, with often confusing administrative steps. Furthermore, *innovations generated at HEIs lack clear ownership regulations*. The respondents stressed that educating innovators and other stakeholders about IPP is essential.

The focus group further examined the role of government incentives and new policies in fostering collaboration around technology transfer. Most participants emphasized that the state should play a central role in shaping a supportive environment for innovation and technology transfer, providing both financial and non-financial forms of assistance. Such measures are typically directed towards promoting innovation, facilitating the commercialization of research, and strengthening partnerships between academia, industry, and public institutions.

Several government-driven initiatives were proposed, including:

- Innovation grants: Direct financial support for R&D collaborations between academia, start-ups, and industries.
- Tax deductions/Credits: Incentives for companies investing in R&D, especially those working with universities and research institutions.
- Public-Private Partnerships (PPPs) for technology transfer: Collaboration between public research institutions and private companies to share resources, risks, and rewards in technology transfer projects.
- Industrial clusters, Development hubs and Innovation centers: Ecosystems that promote collaboration between academia, industry and government to foster collaboration and technology transfer.

However, the focus group also noted some concerns, such as *corruption in the selection process for government support programs and difficulties in monitoring and ensuring the proper use of funds*. There was a general call for greater political stability and security in the observed countries and the region (USE IPM, 2024, p. 124-134).

3.1.2. Delphi study results

A Delphi study is a qualitative research method used to achieve consensus among a panel of experts through multiple rounds of structured questionnaires, typically with anonymous responses and controlled feedback (Brewer et al., 2023). It is especially suitable for research areas where empirical data may be limited and expert judgment is essential, such as forecasting, policy development, and identifying priorities or best practices (Hsu & Sandford, 2007). The Delphi method is valuable in exploring complex issues, building theoretical frameworks, and supporting decision-making in uncertain or emerging fields (Okoli & Pawlowski, 2004).

The goal of the Delphi study on the topic: "Challenges and Opportunities of the Technology Transfer and Sustainable Entrepreneurship in Open Innovation Ecosystem in Developing Transitional Economies" within the Horizon USE IPM project was to gain a deeper insight into the challenges and opportunities of technology transfer and sustainable entrepreneurship in emerging open innovation ecosystems in developing transitional economies of Southeast Europe (Albania, Bosnia and Herzegovina, North Macedonia and Serbia) and to propose policy recommendations and training programs. The research instrument was the Questionnaire for experts, in the first and second round of research (attached in the Appendix).

Following the Delphi method, all experts remained anonymous, with only the researcher conducting the interviews knowing their identities. To be selected, experts needed to meet specific criteria: they had to have at least a higher education degree, hold a management position within their organization—whether in the private, government, or non-government sector—and have either at least five years of general work experience, a minimum of two years in a managerial role, or at least three years of experience running their own business.

In-depth interviews were conducted face-to-face, via telephone or some form of online video streaming communication. The average duration of each interview was approximately 30. The sample for Delphi study consisted of 21 experts from four countries (Serbia, Albania, Bosnia and Herzegovina, and North Macedonia), comprising six entrepreneurs, four environmental and sustainability managers, four CEOs or other managers, three technology officers, and three data engineers or IT developers. Thirteen participants were male, while seven participants were female. The first and the second round of the Delphi study were conducted in June and July 2024. The same experts participated in both rounds of the research. The results of the Delphi study are summarized below.

The key actors in the innovation open system identified by the experts involved in the Delphi study were: *universities, research institutions, start-ups, SMEs, and large corporations, government bodies, investors and incubators*. Regarding knowledge-acquisition channels, the experts mentioned *conferences, trade fairs, scientific journals, industry associations, standardization documents, social networks, open business platforms, and crowdsourcing*. According to the experts, obstacles and challenges in the IPP system include the *high costs and complexity of the patent system, lack of awareness and education on IPR, weak enforcement mechanisms for IPP, delays in registration of patents and trademarks, etc*.

As the main challenges of technology transfer and sustainable entrepreneurship within the OIEs, experts pointed out *the shortage of qualified workforce, limited financial resources and investments, weak collaboration between industry and research institutions, legal and regulatory challenges,* and *the lack of commercialization and market-entry strategies*. On the other hand, they emphasized practices that could boost and improve technology transfer, such as *government grants for research and innovation, collaboration between universities and companies, investment in research infrastructure and technology parks, tax incentives for research and development activities, public-private partnerships to stimulate innovation*. They agreed that active government practices toward supporting collaboration in research and innovation and knowledge spillover could be beneficial for the business in terms of implementing research and development activities (Horizon USE IPM, 2024, pp. 135-149).

3.2. Empirical analysis

A theoretical model was first developed on the basis of a comprehensive review of the existing literature. In this model, *Technology Transfer was identified as the dependent variable, while innovation network dynamics, external support for innovations, innovation system barriers, and innovation capabilities* were classified as independent variables, encompassing all research hypotheses. Subsequently, the content domains of the constructs were defined, and scales were selected from a curated pool of potential items derived from relevant studies. This pool was further refined based on feedback and criticism from experts in the field, ensuring the robustness and relevance of the measurement items used in the research.

Utilizing the qualitative data gathered from the first round of empirical research, which consisted of in-depth interviews, along with insights from a systematic literature review, a questionnaire was designed for the second round of research. This instrument was distributed to the same experts who participated in the initial Delphi study to achieve consensus on key challenges and requirements for technology transfer from the business sector, particularly regarding support from academic institutions or government agencies.

To enhance the efficiency of the research, several questions were either consolidated or modified in response to overlapping or similar responses. Experts were invited to express their evaluations using a Likert scale ranging from 1 to 5, with the following meanings assigned to each grade: 1 – Completely insignificant, 2 – Insignificant, 3 – Partially significant, 4 – Significant and 5 – Very significant. The questionnaire was developed and used for data collection during the period from June to July 2024. Data was gathered from all four transitional countries: Serbia, Albania, Bosnia and Herzegovina, and North Macedonia, with a sample of 100 companies. In each of the participating countries, 25 questionnaires were distributed.

The needs analysis aims to identify the key challenges related to technology transfer, open innovation, sustainable entrepreneurship, and intellectual property rights as perceived by the business community, irre-

TABLE 1 Number of companies per country

Large		Company size			Total
		Medium	Small		
Country	Albania	16	8	1	25
	Bosnia and Herzegovina	8	11	6	25
	North Macedonia	5	10	10	25
	Serbia	4	10	11	25
	Total	33	39	28	100

NOTES. Authors' presentation.

spective of industry type or company size. Furthermore, since the purpose of the needs analysis was to gather information and gain a deeper understanding of the various dimensions of technology transfer and sustainable entrepreneurship within the OIEs in developing transitional economies, the focus group participants were asked a series of questions organized into five distinct segments (explained in Section 3.1.1.).

3.2.1. Sample structure

Among the companies included in the sample, the predominant category is medium-sized enterprises, comprising 39 entities, followed by large companies (33) and small companies (28)*. When analyzing the sectors of these companies, the highest representation is observed in the information and communications sector, accounting for 34%, followed by the manufacturing industry at 30%, and financial and insurance activities at 8%.

In terms of gender distribution, the sample comprised 39 females and 61 males. The majority of managers held higher education qualifications, with 42% having completed the second cycle of studies in social sciences and humanities, 19% in the first cycle of studies in social sciences and humanities, and 18% in the second cycle of studies in technical sciences. Remarkably, only 1% of the managers in the sample had completed only secondary education.

The research sample consists of 100 companies. In each participating country, 25 questionnaires were collected. The following table describes the sample according to company size in each country.

From the total number of companies in the sample, most are medium-sized companies (39), followed by large companies (33), and finally small companies (28). In terms of company activities, the largest representation in the sample is from the information and communications sector (34%), followed by the manufacturing industry (30%), and financial and insurance activities (8%).

3.3. Variables

The identification of the factors gathered from the existing literature on the topic of technology transfer led to the development of an initial study model, which consists of four latent variables (constructs).

It should be emphasized that within the framework of the model, an exogenous construct is defined as independent, while an endogenous construct depends on other constructs. The literature provides the following observations regarding the indicators.

3.4. Methodology

The research methodology applied in this study examines the relationships between independent (predictor) and dependent (response) variables, grounded in quantitative and causal research paradigms, to test hypotheses and theories explaining causal relationships. A cross-sectional design was adopted to collect data at a single point in time, combining a questionnaire survey with a Delphi study, focus groups, and a needs analysis aimed at identifying the main determinants of technology transfer. Ultimately, 100 responses from managers were deemed suitable for analysis, leading to the application of Structural Equation Modeling (SEM) for both measurement analysis and hypothesis testing, which used Partial Least Squares Structural Equation Modelling (PLS–SEM) (Hair Jr. et al., 2014; Henseler et al., 2015; Richter et al., 2015; Manley et al., 2021) and path modeling techniques.

To identify the primary factors that lead to suc-

* The classification of enterprises by size was carried out according to the EU definition of SMEs (https://single-market-economy.ec.europa.eu/smes/sme-fundamentals/sme-definition_en).

TABLE 2 Company's activity

Activity	Frequency	Percentage	Valid Percentage	Cumulative Percentage
Area C: Manufacturing industry	30	30.0	30.0	30.0
Area D: Production and supply of electricity, gas, steam and air conditioning	4	4.0	4.0	34.0
Area E: Water supply, sewerage, waste management and environmental rehabilitation (remediation) activities	2	2.0	2.0	36.0
Area F: Construction	3	3.0	3.0	39.0
Area G: Wholesale and retail trade, repair of motor vehicles and motorcycles	1	1.0	1.0	40.0
Area J: Information and Communications	34	34.0	34.0	74.0
Area K: Financial and insurance activities	8	8.0	8.0	82.0
Area L: Real estate business	2	2.0	2.0	84.0
Area M: Professional, scientific and technical activities	1	1.0	1.0	85.0
Area N: Administrative and auxiliary service activities	1	1.0	1.0	86.0
Area O: Public administration and defense, compulsory social insurance	3	3.0	3.0	89.0
Area P: Education	3	3.0	3.0	92.0
Area Q: Health care and social work activities	5	5.0	5.0	97.0
Area S: Other service activities	1	1.0	1.0	98.0
Area U: Organization of extraterritorial organizations and bodies	2	2.0	2.0	100.0
Total	100	100	100	

NOTES. Authors' presentation.

cessful technology transfer, we used the PLS-SEM, implementing SmartPLS v.4.1.1. The use of the PLS-SEM technique, rather than the more commonly applied multiple regression analysis or covariance-based SEM, is preferred because of the interdependence among latent constructs (Hair Jr. et al., 2014) and its less restrictive assumption, which often qualify PLS-SEM as a distribution-free approach (Astrachan et al., 2014; Hair et al., 2017). The PLS-SEM methodology presents numerous advantages, making it particularly applicable not only to this study but also to quantitative technology transfer research in general. This is supported by recent studies, including those of Hafeez et al. (2023), Ariaparsa and Ebrahimi (2023), and Stolze and Sailer (2022).

The first significant advantage of using PLS-SEM is its foundation in a series of ordinary least squares (OLS) regression models, which allows it to address complex causal-predictive frameworks effectively, even when working with limited sample sizes. This is particularly critical in the context of our research, where the availability of data may be constrained, yet robust conclusions about relationships among variables are needed.

Second, PLS-SEM can accommodate formative constructs, which capture various dimensions of a construct and allow for a more nuanced understanding of the underlying phenomena. For instance, as argued by Chin (2010), this characteristic of PLS-SEM aligns perfectly with the complexities of our study. These constructs are better suited to be represented in a formative manner, enabling a more thorough exploration of their diverse influences on transfer project outcomes. Furthermore, given the relatively small sample size,

TABLE 3 Latent variables and indicators

Construct	Items	Subitems
Innovation Network Dynamics (Bacon et al., 2019; Chesbrough, 2020; Thomas & Autio, 2020)	What are the key actors of an open innovation ecosystem?	KA1: Universities and research institutions
		KA2: Start-ups, SMEs, medium-sized enterprises and large corporations
		KA3: Government bodies that support funding and policy
		KA:4 Investors
Innovation Capabilities (Audretsch et al., 2024; Gonzalez-Urango et al., 2025; Tse et al., 2021)	How do you perform R&D?	RD1: Regulatory support and streamlined processes for intellectual property protection
		RD2: Establishing research centers focused on innovation
		RD3: Conducting market research to guide product development
		RD4: Participation in collaborative research projects with global partners
	How do you implement innovative solutions?	INN1. We use internal R&D teams to develop new solutions
		INN2. We engage external experts to support innovation
	Aspects of open innovations strategies	IMP1: Innovation culture within the organization
		IMP 2: Technological infrastructure
		IMP3: Leadership and management support
	Factors for successful commercialization of innovations	COMM1: Market access and marketing orientation of the organization
		COMM2: Intellectual property protection (patents protection, copyrights, trade secrets, industrial design rights, trademarks, and branding)
		COMM3: Product adaptation to market needs
		COMM4: Partnerships with industrial entities
Intellectual property protection (Bigliardi & Galati, 2016; Chesbrough, 2024a; Dahlander & Gann, 2010; Hagedoorn & Zobel, 2015; Lee & Kim, 2021)	Legal and regulatory factors	LEG1: National intellectual property laws
		LEG2: International agreements and conventions
		LEG3: Administrative procedures for rights protection
	Obstacles in the intellectual property protection system	OBS1: High costs and complexity of the patent system
		OBS2: Lack of awareness and education on intellectual property rights
		OBS3: Insufficient enforcement mechanisms for IP protection
		OBS4: Lack of harmonization with international IP standards
	Challenges in the intellectual property protection system	CH1: Harmonizing national IP laws with international standards
		CH2: Encouraging innovation while ensuring fair competition
		CH3: Addressing piracy and counterfeiting effectively
		CH4: Promoting cross-border cooperation and information sharing
		CH5: Balancing the interests of IP holders with public access to knowledge

Technology Transfer (Carayannis et al., 2018; Guerrero et al., 2019; Guerrero & Link, 2022; Pujotomo et al., 2022)	Main challenges of technology transfer and sustainable entrepreneurship in the open innovation ecosystem in your country	TTCH1: Insufficient financial resources and investments
		TTCH2: Weak collaboration between industry and research institutions
	Financial factors	FIN1: Availability of grants and subsidies
		FIN2: Opportunities for private investment
		FIN3: Access to angel investors, venture capital, and crowdfunding
		FIN4: Tax incentives for research and development
		FIN5: Costs and return on investment
	Government incentives	GOV1: Tax credits and deductions for research and development activities
		GOV2: Grants and funding programs for collaborative research projects
		GOV3: Subsidies for technology commercialization efforts
		GOV4: Regulatory support and streamlined processes for intellectual property protection

NOTES. Authors' presentation of key constructs derived from the literature.

there is a need for a methodology that has substantial statistical power. PLS-SEM provides this capability, enabling us to derive insights that might otherwise be unattainable with traditional methods that require larger datasets. However, a potential limitation of PLS-SEM should be acknowledged. Unlike some other modeling techniques, PLS-SEM does not provide global goodness-of-fit indices, such as the χ^2 significance test, the comparative fit index (CFI), or the root mean square error of approximation (RMSEA). These metrics are commonly employed to evaluate how well a model fits empirical data. Instead, as in regression analysis, interpretation in PLS-SEM focuses on path coefficients and R^2 values (Goller & Hilkenmeier, 2022).

Nevertheless, given that the primary objective of this research is *to identify the elements of the innovation ecosystem that most effectively predict technology transfer success*, this limitation is of minimal concern (Goller & Hilkenmeier, 2022). On the basis of theoretical considerations and a thorough review of the relevant literature, a preliminary theoretical model was developed to examine the various factors that may influence technology transfer. The model includes indicators represented as yellow squares, exogenous and endogenous constructs illustrated by blue circles, and their relationships indicated by arrows, as shown in the proposed model (Figure 1). All indicators and data were processed and analyzed in an Excel spreadsheet using SmartPLS v.4.1.1. Software and a PLS-SEM were implemented.

This analysis aims to clarify the final endogenous construct of *technology transfer* by employing a PLS-SEM, which incorporates three latent constructs: *innovation network dynamics, innovation capabilities,* and *intellectual property protection*. Following the development of the model, the SmartPLS software was run for the first time, yielding three significant outcomes: the outer loadings of the indicators, the path coefficients, and the coefficients of determination (R^2) for the endogenous latent variables (Ringle et al., 2015).

3.5. Empirical results

The assessment of the formative measurement model considered convergent validity, potential multicollinearity, the magnitude of the outer weights, and their

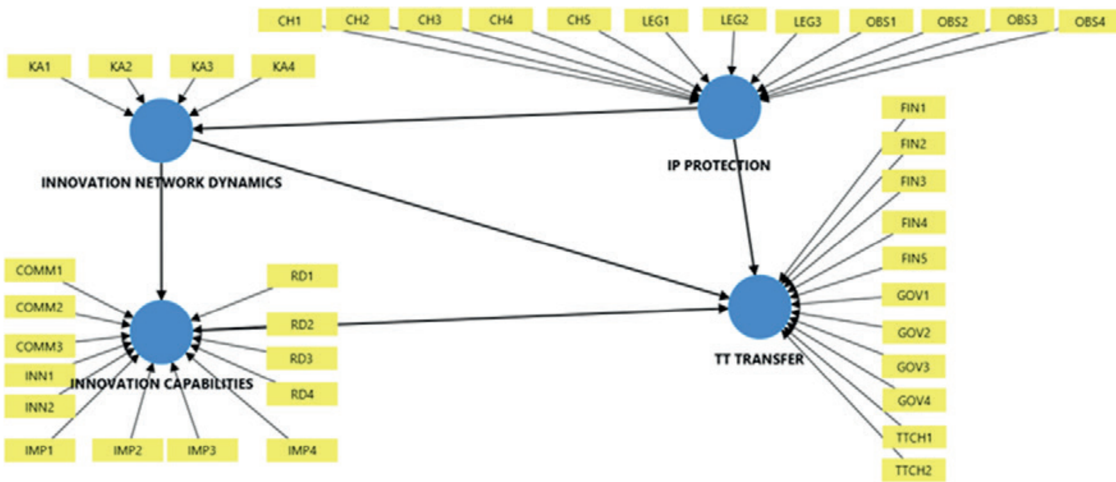

FIGURE 1 Initial Theoretical Model

NOTES. Authors' proposal of the initial theoretical model based on research results.

statistical significance, in line with the guidelines proposed by Hair et al. (2019). Initially, we started with 40 indicators. To evaluate the convergent validity of the formative measurement model, a separate redundancy analysis was conducted for each latent construct, thereby ensuring that the formative indicators appropriately reflect the underlying conceptual domain. This analysis assessed the correlation between the formative measurement and an indicator corresponding to the same construct, with the expectation that this correlation should exceed 0.7 (Hair et al., 2017). For constructs that are operationalized as formative, it is not necessary for the indicators to be correlated. Rather, they should encompass various dimensions of the construct to collectively represent a common factor. To establish the viability of conceptualizing *Innovation network dynamics*, *Intellectual property protection*, and *Innovative capabilities* as formative constructs, it is essential to confirm the absence of collinearity issues among the indicators. This verification involves calculating the Variance Inflation Factor (VIF), which serves as an index that indicates the extent to which the variance of an estimated regression coefficient is inflated due to collinearity (Sohil et al., 2021). A VIF value of five or higher indicates that the indicators are sufficiently independent (Hair et al., 2021). Therefore, careful attention to these metrics is crucial for ensuring the robustness and reliability of the formative measurement model under study. When the VIF for certain indicators within a formative measurement model exceeds the predetermined critical thresholds, it becomes advisable to consider either eliminating the problematic indicator or merging collinear indicators into a new composite indicator, as suggested by Avkiran and Ringle (2018).

Table 4 shows the Variance Inflation Factor (VIF) values calculated for the indicators associated with the four formative constructs examined.

To evaluate potential multicollinearity concerns in the measurement and structural models, we assessed the Variance Inflation Factor (VIF) values for the outer model (Table 4) and the inner model (Table 5).

The outer VIF values, which capture multicollinearity among indicator variables, ranged from 1.099 to 3.315. Although several indicators—most notably those linked to the governance and observability constructs—displayed values slightly above the conservative benchmark of 3.3, none exceeded the widely accepted threshold of 5. This finding indicates that multicollinearity at the indicator level is minimal and unlikely to introduce estimation bias. Similarly, the inner VIF values, which assess multicollinearity among latent constructs within the structural model, ranged from 1.000 to 2.613, remaining well below the critical cut-off of 5. Taken together, these results confirm the absence of problematic multicollinearity, thereby reinforcing the stability and reliability of the bootstrapped path-coefficient estimates. The results indicate that collinearity has reached a *notable level within the Technology Transfer construct among the formative indicators*, posing challenges for the precise estimation of the Partial Least Squares (PLS) path model. Consequently, careful evaluation of VIF values is essential, along with the application of appropriate remedial measures to mitigate collinearity and ensure both accuracy and reliability in the analysis of formative constructs.

To further examine the significance and relevance of the outer weights, the bootstrap results for the

TABLE 4 Outer model collinearity statistics (VIF)

Indicators	VIF	Indicators	VIF	Indicators	VIF	Indicators	VIF	Indicators	VIF
CH1	1.670	**COMM1**	1.352	**GOV1**	2.433	**IMP4**	1.242	**LEG3**	1.865
CH1_1	1.623	**COMM2**	1.099	**GOV2**	3.041	**K4**	1.181	**OBS1**	2.226
CH2	1.750	**COMM3**	1.492	**GOV3**	3.315	**KA1**	1.391	**OBS3**	2.185
CH2_1	1.563	**FIN1**	1.827	**GOV4**	2.222	**KA2**	1.244	**OBS4**	2.578
CH3	1.988	**FIN2**	1.623	**IMP1**	1.458	**KA3**	1.417	**RD1**	2.325
CH4	2.138	**FIN3**	1.663	**IMP2**	1.186	**LEG1**	1.712	**RD2**	2.366
CH5	2.170	**FIN5**	1.472	**IMP3**	1.352	**LEG2**	2.091		

NOTES. Authors' calculations.

TABLE 5 Inner model collinearity statistics (VIF)

	Original sample (O)	**Sample mean (M)**	**2.5%**	**97.5%**
INNOVATION CAPABILITIES -> TT TRANSFER	2.613	2.942	1.822	4.557
INNOVATION NETWORK DYNAMICS -> INNOVATION CAPABILITIES	1.000	1.000	1.000	1.000
INNOVATION NETWORK DYNAMICS -> TT TRANSFER	1.932	2.278	1.508	3.444
IP PROTECTION -> INNOVATION NETWORK DYNAMICS	1.000	1.000	1.000	1.000
IP PROTECTION -> TT TRANSFER	1.803	2.131	1.292	3.512

NOTES. Authors' calculations.

measurement models of the formative constructs are presented in Tables 6 and 7 below. These results enable an assessment of the magnitude of the outer weights, which reflect the relative contribution of each indicator to the construct (regression weight), as well as the outer loadings, which capture the absolute contribution of an indicator (correlation weight). The analysis primarily focuses on identifying outer weights that are statistically significant and different from zero, as such weights are crucial for evaluating the role of formative indicators within the composite construct.

The absence of statistical significance in an indicator's weight does not necessarily indicate that the measurement model is of low quality. Instead, it is recommended to also assess the absolute contribution of a formative indicator, which can be evaluated through its loading on the construct. At a minimum, the loading should be statistically significant. Loadings of 0.50 or higher suggest that the indicator makes a meaningful absolute contribution to the construct, regardless of its relative weight. Only when both weights and loadings are low or non-significant should the indicator be considered for removal (Hair et al., 2021).

We observed that although 29 out of the 34 outer weights were not statistically significant, all corresponding outer loadings exceeded the threshold of 0.50. Given their substantial contribution to the development of the constructs, these indicators were retained in the model.

3.5. Evaluation of the Structural Model

Once the measurement model was confirmed to meet the established standards of validity and reliability, and the non-significant indicators were refined, attention shifted to evaluating the structural model. As García-Machado (2017) notes, the structural model represents the hypothesized relationships among la-

TABLE 6 Outer weights for formative indicators

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
CH1 -> IP PROTECTION	0.177	0.184	0.171	1.039	0.299
CH1_1 -> TT TRANSFER	0.457	0.448	0.176	2.599	0.009
CH2 -> IP PROTECTION	-0.025	0.000	0.192	0.128	0.899
CH2_1 -> TT TRANSFER	0.264	0.207	0.155	1.699	0.089
CH3 -> IP PROTECTION	0.309	0.235	0.167	1.855	0.064
CH4 -> IP PROTECTION	0.231	0.255	0.136	1.701	0.089
CH5 -> IP PROTECTION	0.093	0.064	0.144	0.644	0.520
COMM1 -> INNOVATION CAPABILITIES	-0.002	-0.017	0.147	0.016	0.987
COMM2 -> INNOVATION CAPABILITIES	0.112	0.119	0.137	0.816	0.415
COMM3 -> INNOVATION CAPABILITIES	0.400	0.386	0.158	2.538	0.011
FIN1 -> TT TRANSFER	0.077	0.063	0.124	0.617	0.537
FIN2 -> TT TRANSFER	-0.023	-0.011	0.175	0.129	0.897
FIN3 -> TT TRANSFER	0.092	0.152	0.170	0.544	0.587
FIN5 -> TT TRANSFER	0.222	0.165	0.124	1.795	0.073
GOV1 -> TT TRANSFER	-0.031	-0.014	0.155	0.201	0.841
GOV2 -> TT TRANSFER	0.176	0.187	0.172	1.026	0.305
GOV3 -> TT TRANSFER	-0.025	-0.053	0.177	0.140	0.889
GOV4 -> TT TRANSFER	0.263	0.222	0.162	1.620	0.105
IMP1 -> INNOVATION CAPABILITIES	0.137	0.109	0.148	0.925	0.355
IMP2 -> INNOVATION CAPABILITIES	0.170	0.145	0.133	1.278	0.201
IMP3 -> INNOVATION CAPABILITIES	0.532	0.438	0.185	2.877	0.004
IMP4 -> INNOVATION CAPABILITIES	-0.082	-0.039	0.134	0.615	0.538
K4 -> INNOVATION NETWORK DYNAMICS	0.574	0.511	0.197	2.919	0.004
KA1 -> INNOVATION NETWORK DYNAMICS	0.302	0.276	0.233	1.299	0.194
KA2 -> INNOVATION NETWORK DYNAMICS	0.480	0.473	0.176	2.720	0.007
KA3 -> INNOVATION NETWORK DYNAMICS	0.088	0.089	0.257	0.341	0.733
LEG1 -> IP PROTECTION	0.090	0.143	0.196	0.456	0.649
LEG2 -> IP PROTECTION	0.134	0.071	0.172	0.777	0.437
LEG3 -> IP PROTECTION	0.210	0.184	0.181	1.163	0.245
OBS1 -> IP PROTECTION	0.068	0.078	0.155	0.435	0.664
OBS3 -> IP PROTECTION	0.279	0.244	0.198	1.413	0.158
OBS4 -> IP PROTECTION	-0.155	-0.145	0.167	0.927	0.354
RD1 -> INNOVATION CAPABILITIES	0.365	0.371	0.239	1.523	0.128
RD2 -> INNOVATION CAPABILITIES	-0.145	-0.136	0.209	0.696	0.486

NOTES. Authors' calculations.

TABLE 7 Indicator's outer loadings

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
CH1 -> IP PROTECTION	0.533	0.521	0.120	4.447	0.000
CH1_1 -> TT TRANSFER	0.819	0.774	0.141	5.814	0.000
CH2 -> IP PROTECTION	0.436	0.418	0.144	3.029	0.002
CH2_1 -> TT TRANSFER	0.680	0.588	0.192	3.537	0.000
CH3 -> IP PROTECTION	0.798	0.710	0.163	4.891	0.000
CH4 -> IP PROTECTION	0.772	0.728	0.125	6.199	0.000
CH5 -> IP PROTECTION	0.690	0.625	0.136	5.080	0.000
COMM1 -> INNOVATION CAPABILITIES	0.490	0.435	0.193	2.539	0.011
COMM2 -> INNOVATION CAPABILITIES	0.285	0.269	0.168	1.695	0.090
COMM3 -> INNOVATION CAPABILITIES	0.718	0.674	0.145	4.958	0.000
FIN1 -> TT TRANSFER	0.461	0.451	0.151	3.048	0.002
FIN2 -> TT TRANSFER	0.520	0.491	0.199	2.615	0.009
FIN3 -> TT TRANSFER	0.567	0.562	0.188	3.022	0.003
FIN5 -> TT TRANSFER	0.592	0.487	0.201	2.940	0.003
GOV1 -> TT TRANSFER	0.600	0.541	0.154	3.909	0.000
GOV2 -> TT TRANSFER	0.569	0.528	0.159	3.582	0.000
GOV3 -> TT TRANSFER	0.592	0.534	0.147	4.020	0.000
GOV4 -> TT TRANSFER	0.654	0.588	0.157	4.171	0.000
IMP1 -> INNOVATION CAPABILITIES	0.547	0.499	0.139	3.928	0.000
IMP2 -> INNOVATION CAPABILITIES	0.483	0.444	0.163	2.965	0.003
IMP3 -> INNOVATION CAPABILITIES	0.749	0.653	0.197	3.809	0.000
IMP4 -> INNOVATION CAPABILITIES	0.202	0.206	0.167	1.209	0.227
K4 -> INNOVATION NETWORK DYNAMICS	0.771	0.706	0.190	4.049	0.000
KA1 -> INNOVATION NETWORK DYNAMICS	0.468	0.442	0.190	2.469	0.014
KA2 -> INNOVATION NETWORK DYNAMICS	0.783	0.737	0.150	5.219	0.000
KA3 -> INNOVATION NETWORK DYNAMICS	0.462	0.422	0.223	2.066	0.039
LEG1 -> IP PROTECTION	0.559	0.555	0.149	3.756	0.000
LEG2 -> IP PROTECTION	0.752	0.664	0.163	4.616	0.000
LEG3 -> IP PROTECTION	0.645	0.576	0.180	3.582	0.000
OBS1 -> IP PROTECTION	0.641	0.587	0.163	3.941	0.000
OBS3 -> IP PROTECTION	0.672	0.609	0.163	4.129	0.000
OBS4 -> IP PROTECTION	0.582	0.541	0.158	3.685	0.000
RD1 -> INNOVATION CAPABILITIES	0.568	0.554	0.151	3.764	0.000
RD2 -> INNOVATION CAPABILITIES	0.439	0.423	0.146	3.001	0.003

NOTES. Authors' calculations.

TABLE 8 Explained variance

Endogenous Latent Variable	R-square	R-square adjusted	Interpretation
Innovation capabilities	0.807	0.806	substantial
Innovation network dynamics	0.010	0.006	weak
Technology transfer	0.922	0.921	substantial

NOTES. Authors' calculations.

TABLE 9 Hypothesis testing for effect size (f^2) analysis

Relationship	f squared	T statistics (lb /STDEVl)	P values	Results
Innovation Capabilities → TT Transfer	0.000	0.002	0.999	No effect
Innovation Network Dynamics → Innovation Capabilities	0.924	2.092	0.037	Large effect (significant)
Innovation Network Dynamics → TT Transfer	0.013	0.246	0.805	Negligible effect
IP Protection → Innovation Network Dynamics	0.327	0.955	0.340	Medium effect (not significant)
IP Protection → TT Transfer	1.554	1.932	0.053	Significant effect (marginal significance)

NOTES. Authors' calculations.

tent variables. Its assessment focused primarily on its predictive capability, which is a central purpose of Partial Least Squares Structural Equation Modelling (PLS-SEM), as well as on the interplay among the constructs.

In line with established guidelines, the evaluation considered the algebraic sign, significance, and relevance of the path coefficients, the explanatory power reflected in R^2 values, and the effect size f^2 (Hair et al., 2019, 2021). In evaluating the structural model, the coefficients of determination (R^2) for the endogenous latent variables were examined to assess predictive accuracy. R^2 values represent the proportion of variance explained by the exogenous constructs, with values above 0.10 generally considered meaningful (Hair et al., 2017; Falk & Miller, 1992). More specifically, R^2 values are classified as substantial (≥0.75), moderate (≥0.50), or weak (≥0.25) (García-Machado, 2017). To account for potential bias arising from multiple exogenous predictors, adjusted R^2 values were also reported.

To assess the impact of excluding an endogenous construct from the model, the effect size (f^2) was calculated (Fauzi, 2022; Hair et al., 2022; Ali et al., 2018; Chin et al., 2020). Following Cohen's (1988) guidelines, f^2 values above 0.02 indicate a small effect, those above 0.15 a medium effect, and those exceeding 0.35 a significant effect. The results of the f^2 analysis are presented in Table 9.

The analysis presented in Table 9 indicates that the link between Innovation Network Dynamics and Innovation Capabilities yielded a significant and large effect size (f^2 = 0.924, p = 0.037), suggesting that network dynamics play a crucial role in shaping an organization's innovation capabilities. This aligns with the existing literature, which emphasizes the strategic importance of inter-organizational relationships in capability building. The direct impact of Innovation Capabilities on Technology Transfer is negligible (f^2 = 0.000, p = 0.999), suggesting that while capabilities are vital, their influence on technology transfer may be mediated or moderated by other factors such as institutional frameworks or collaborative dynamics. Intellectual Property Protection exerts a substantial effect on Technology Transfer (f^2 = 1.554) with marginal statistical significance (p = 0.053), highlighting its potential role as a foundational enabler for effective knowledge transfer. This finding, although just above the conventional threshold for significance ($p < 0.05$), is theoretically meaningful and warrants further investigation in policy and practice contexts. The pathway from IP Protection to Innovation Network Dynamics exhibits a medium effect size (f^2 = 0.327) but lacks statistical significance (p = 0.340), indicating that while IP protection may influence networking behaviors, the relationship is likely contingent upon other contextual variables. The effect of Innovation Network Dynamics on Technology Transfer is negligible (f^2 = 0.013, p = 0.805), indicating that the benefits of network dynamics may primarily be realized indirectly, such as through

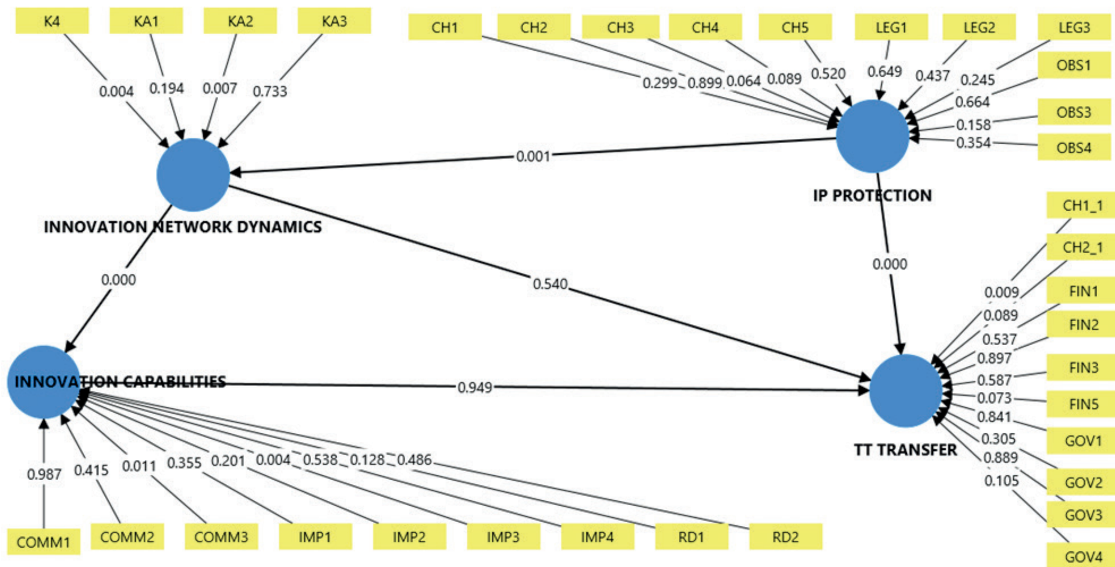

FIGURE 2 Proposed final model

NOTES. Authors' proposal of the theoretical model based on research results.

their impact on capability development, rather than via a direct influence on technology transfer. Upon refining the non-significant indicators and relationships and reorganizing the constructs, Figure 2 presents our final proposal for a more concise explanatory model.

3.6. Predictive Validity Assessment

To evaluate the model's predictive performance, the PLS-predict procedure was applied, with results assessed using Q^2, Root Mean Squared Error (RMSE), and Mean Absolute Error (MAE). According to Shmueli et al. (2019), predictive relevance is established when Q^2 values exceed zero, while strong predictive power is indicated when prediction errors are lower than those of a simple benchmark model, such as a linear model (LM). The results confirm that all key outcome constructs achieved Q^2 predict values above zero, thereby demonstrating the model's predictive relevance. Among them, the Technology Transfer (TT) construct stands out, with a high Q^2 predict of 0.570 and relatively low RMSE (0.710) and MAE (0.537), reflecting strong predictive accuracy. Innovation Capabilities displayed moderate predictive strength (Q^2 predict = 0.249; RMSE = 0.873; MAE = 0.668), whereas Innovation Network Dynamics yielded a lower yet acceptable Q^2 predict of 0.092.

Taken together, these findings provide robust evidence of the model's predictive validity, particularly for Technology Transfer, which demonstrates the strongest predictive performance among the tested constructs.

3.7. Multi-Group Analysis (MGA) and Measurement Invariance (MICOM)

To assess the robustness of the structural model across countries and subgroups, both the Multi-Group Analysis (MGA) and the Measurement Invariance of Composite Models (MICOM) procedures were conducted. The MICOM procedure evaluated configural and compositional invariance using permutation tests. The results indicated that full measurement invariance was not established across all groups, as some constructs showed significant differences in their correlations ($p < 0.05$). For example, when comparing Bosnia and Herzegovina with North Macedonia, significant differences emerged for IP Protection ($p = 0.047$) and Technology Transfer (TT) ($p = 0.020$), suggesting variations in the means or variances of these constructs between the two countries. Comparable differences were observed in the Serbia–North Macedonia comparison for Innovation Network Dynamics ($p = 0.144$) and Technology Transfer ($p = 0.339$).

By contrast, several other comparisons, such as Serbia and Albania, revealed no significant differences, pointing to partial measurement invariance. Given these outcomes, the interpretation of MGA results re-

TABLE 10 Multigroup Analysis

Structural Path	Country Comparison	Δ (Difference)	p-value	Statistical Interpretation
Innovation Network Dynamics → Innovation Capabilities	Serbia vs. North Macedonia	1.625	0.005	**Significant**
	Albania vs. North Macedonia	1.498	0.036	**Significant**
	Bosnia and Herzegovina vs. North Macedonia	1.682	0.000	**Highly significant**
Innovation Capabilities → Technology Transfer	Serbia vs. Albania	−1.326	0.055	*Marginally significant*
	Serbia vs. Bosnia and Herzegovina	−0.753	0.117	Not significant; *directionally notable*
IP Protection → Innovation Network Dynamics	Serbia vs. Bosnia and Herzegovina	−0.294	0.084	*Marginal*
	Bosnia and Herzegovina vs. North Macedonia	0.160	0.307	Not significant
Other Paths (e.g., Innovation Network Dynamics → Technology Transfer; IP Protection → Technology Transfer)	Albania vs. Bosnia and Herzegovina	−0.922	0.202	Not significant; *moderate variability observed*

quires caution, emphasizing the differences that are both statistically robust and theoretically meaningful. The MGA results further examined whether the structural path relationships varied significantly ($p < 0.05$) across country and subgroup pairs, revealing notable differences in several key paths.

The findings reveal noteworthy cross-country differences in how network dynamics influence innovation capabilities. In North Macedonia, this relationship appears to differ from patterns observed in other countries, likely reflecting distinct local conditions such as institutional arrangements, policy frameworks, or other contextual factors. Regarding the link between innovation capabilities and technology transfer, the results suggest that this relationship is highly context-dependent, tending to be stronger in environments that are more innovation-driven or resource-rich.

Variation was also observed in the way IP protection shapes innovation network dynamics. Although not always statistically significant, the results indicate that the influence of IP regimes on network formation may differ depending on the strength of legal enforcement or the prevailing culture of collaboration. By contrast, relationships such as Innovation Network Dynamics → Technology Transfer and IP Protection → Technology Transfer generally did not exhibit consistent differences across groups, though moderate variations appeared in specific comparisons, for example between Albania and Bosnia and Herzegovina.

Taken together, the MGA and MICOM analyses underscores cross-country nuances in the mechanisms through which innovation capabilities contribute to technology transfer. These insights carry several implications:

- *Policy alignment with local realities*: Innovation and network-building strategies should be adapted to the specific institutional and cultural contexts of each country, particularly where networks are underdeveloped or poorly aligned with existing structures.
- *Strengthening IP protection*: Robust IP frameworks can stimulate network formation, but their effectiveness depends heavily on the quality of enforcement and the level of trust among actors.
- *Targeted capability-building*: Since the role of innovation capabilities in enabling technology transfer varies across regions, tailored initiatives to strengthen capacity in lagging areas or groups could generate significant improvements.

4. DISCUSSION

The PLS-SEM analysis demonstrates that IP Protection exerts a strong and statistically significant direct effect on Technology Transfer (β = 0.832, t = 5.591, p < 0.001). Within Southeast European open innovation ecosystems (OIEs); this finding highlights the central role of robust IPP regimes as a key determinant of effective technology transfer. Stronger IPP frameworks in transitional economies foster greater flows of technology and knowledge, consistent with Schumpeterian models suggesting that enhanced IP protection facilitates long-term transfers from advanced to developing economies (Zheng et al., 2020). By contrast, weak or unstable IPP environments undermine cross-border knowledge flows and increase risks for innovators. These results imply that Southeast European economies can accelerate sustainable technology transfer by reinforcing legal frameworks and ensuring consistent IP enforcement.

In addition to its direct impact on Technology Transfer, *IP Protection was also found to significantly influence Innovation Network Dynamics* (β = 0.497, t = 3.289, p = 0.001), which subsequently exert a strong positive effect on Innovation Capabilities (β = 0.693, t = 9.894, p < 0.001). These results are consistent with empirical evidence supporting manufacturing upgrading and technological advancement (Zhang et al., 2025). This indirect pathway underscores that effective IP protection not only safeguards knowledge but also fosters a collaborative climate that enables companies and universities in transitional economies to co-create knowledge and build innovation capacity.

By contrast, the direct effects of Innovation Network Dynamics (β = 0.079, p = 0.540) and Innovation Capabilities (β = −0.010, p = 0.949) on Technology Transfer *were not statistically significant*. These findings suggest that innovation capabilities, while necessary, do not independently generate technology transfer outcomes in transitional economies. As noted by Wang and Liu (2022), R&D and innovation capabilities require complementary institutional and collaborative mechanisms to be effectively translated into technology transfer. This interpretation is consistent with our model: capabilities represent potential, but their materialization into technology transfer depends on absorptive capacity, network linkages, and supportive policy frameworks.

At the same time, our analysis confirms that Innovation Network Dynamics *exert a decisive influence* on Innovation Capabilities. Companies embedded in dense and well-functioning innovation networks accumulate knowledge and resources more effectively, thereby strengthening their innovative potential. Evidence from European universities supports this view, showing that network centrality within open innovation ecosystems is positively associated with higher innovation productivity and absorptive capacity (Huggins et al., 2020). For Southeast European ecosystems, these findings underscore the importance of strengthening regional and cross-border networks through EU programs, industrial clusters, and public–private partnerships as crucial levers for translating capabilities into sustainable technology transfer.

With respect to mediation, the analysis reveals that IP Protection exerts a significant indirect effect on Innovation Capabilities through Innovation Network Dynamics (β = 0.344, t = 2.690, p = 0.007), underscoring the role of networked innovation processes in capability development. By contrast, the indirect effects of IP Protection and Innovation Network Dynamics on Technology Transfer were not statistically significant, suggesting that the influence of IP Protection on transfer outcomes operates primarily through direct pathways rather than via intermediate innovation constructs.

Institutional mechanisms further amplify this effect. For example, evidence from China shows that the establishment of specialized IP courts has substantially enhanced corporate innovation by stimulating R&D investment and increasing companies' willingness to transfer technology (Nie et al., 2024). Drawing on these insights, transitional economies in Southeast Europe could strengthen technology transfer by introducing similar measures, such as training specialized IP judges, streamlining patent enforcement procedures, and establishing well-resourced technology transfer offices equipped with legal expertise.

Our results ultimately underscore the pivotal role of open innovation networks and strong university–industry collaboration in enhancing innovation capacities. Universities serve as critical knowledge hubs, raising companies' technological readiness and facilitating the commercialization of research outputs. Evidence from systematic reviews confirms that open innovation–based collaborations between academia and industry accelerate technology transfer by strengthening absorptive capacity and generating tangible outcomes such as spin-offs, licenses, and joint research projects (Padilla Bejarano et al., 2023). In the context of Southeast Europe, embedding universities more deeply into open innovation ecosystems will be essential for advancing sustainable technology transfer, enabling research results to evolve into market-ready innovations.

5. CONCLUSION AND IMPLICATIONS

From a methodological perspective, this study makes a significant contribution by employing a comprehensive mixed-methods approach (Galindo-Martin et al., 2025). Combining qualitative and quantitative techniques, it integrates a systematic literature review on sustainable innovation, technology transfer, open innovation, and intellectual property protection to inform the design of structured interviews, a focus group, and a two-stage Delphi study. This multi-layered approach enhances the robustness of the findings and offers a replicable framework for future research in similar contexts.

5.1. Theoretical contributions

This study advances theoretical understanding of open innovation ecosystems (OIEs) in Southeast Europe's transitional economies by highlighting the critical interplay between institutional frameworks and network dynamics in enabling technology transfer (TT).

First, our findings reaffirm that strong intellectual property protection (IPP) is a central driver of effective TT in these contexts. This underscores the pivotal role of formal institutions and extends the knowledge spillover theory by demonstrating that knowledge flows from advanced to developing regions depend on the presence of robust IP regimes that safeguard innovators' rights. In our Southeast European sample, strict IP enforcement consistently enhanced TT outcomes, aligning with broader evidence that stronger patent rights accelerate international technology flows (Zheng et al., 2020; Nie et al., 2024).

Second, we show that firm-level innovation capabilities—such as R&D investments—are insufficient on their own to ensure the successful commercialization of technology. This challenges assumptions derived from developed economies and refines resource-based perspectives by illustrating that collaborative networks and supportive institutional frameworks must complement internal capabilities in transitional economies. Without these, R&D capacity rarely translates into effective TT, a view supported by recent research on emerging markets (Wang & Liu, 2022). Our findings therefore advance theory by demonstrating that innovation capabilities achieve their full impact only when embedded in strong institutional environments and networked ecosystems (Audretsch et al., 2024).

Third, the results highlight the catalytic role of innovation network dynamics in building organizational capabilities, even though their direct effect on TT is limited. Companies and universities deeply embedded in open innovation networks accumulate knowledge more effectively and enhance their absorptive capacity, which in turn fosters innovation outcomes. This finding strengthens open innovation theory by confirming that network centrality enhances innovation productivity (Huggins et al., 2020). By situating this within Southeast Europe, our study demonstrates that cross-border EU programs, clusters, and university–industry partnerships are crucial mechanisms for developing capabilities that prepare companies for TT.

Finally, our results emphasize that the benefits of networks and capabilities on TT are realized only when combined with strong institutional support. In this sense, the influence of OIEs on TT is institutionally contingent, linking open innovation theory with institutional and innovation systems perspectives in transitional economies. This contribution builds upon insights from China's innovation ecosystems, where government-led networks have been shown to enhance innovation outcomes (Cricchio & Di Minin, 2024). We extend this perspective to Southeast Europe by demonstrating that institutional quality—particularly IP protection—must evolve in tandem with collaborative networks to transform innovation potential into concrete transfer results.

In summary, this study offers a contextualized framework for sustainable technology transfer in transitional economies, demonstrating how institutional quality and network connectivity jointly facilitate the translation of innovation capabilities into market-ready technologies. Theoretically, this advances understanding of the persistent 'innovation–implementation' gap in developing regions and establishes a comparative basis for examining how emerging economies worldwide convert innovation inputs into sustainable economic outcomes (Audretsch et al., 2024; Padilla Bejarano et al., 2023).

5.2. Policy and Managerial Implications

For policymakers, a central priority is the establishment of stronger and more reliable intellectual property protection (IPP) regimes. Creating specialized IP courts and training judges in patent law would ensure quicker and more consistent rulings, thereby providing the legal certainty innovators and investors require. Experience from countries such as China illustrates that such reforms can stimulate corporate R&D and accelerate technology diffusion (Nie et al., 2024). Streamlining patent procedures and clarifying enforcement mechanisms would further encourage cross-border knowledge inflows. At the same time, governments must go beyond legislation by investing in the infrastructure of innovation networks—supporting regional clusters, promoting public–private partnerships, and leveraging EU programs to connect local actors with international research communities (Audretsch et al., 2024). Direct funding for joint R&D projects and hubs in priority domains, such as green technologies, can help companies strengthen their absorptive capacity. Collectively, these measures position governments as active orchestrators of innovation ecosystems, a role that has been shown to accelerate their maturation (Cricchio & Di Minin, 2024).

For companies, particularly SMEs with limited internal R&D resources, external collaboration is not optional but essential. Building partnerships with universities, joining industry consortia, and engaging with global innovation networks provide access to knowledge and expertise that would otherwise remain out of reach. To fully exploit these opportunities, companies must also invest in their absorptive capacity through staff training, improved knowledge management systems, and cultivating a culture that rewards knowledge sharing and co-creation (Huggins et al., 2020). Appointing dedicated "innovation champions" to interface with universities and research institutes can ensure a steady inflow of external ideas. Stronger IP regimes also create safer conditions for companies to pursue patents, license technologies, and spin off innovations without fear of losing ownership rights.

For universities and research institutes, adopting the role of the "entrepreneurial university" is crucial. Beyond their traditional missions of teaching and research, universities in Southeast Europe should act as knowledge hubs and brokers of collaboration. Expanding Technology Transfer Offices, simplifying spin-off procedures, and incentivizing faculty to patent and commercialize their research findings are important steps. Evidence suggests that initiatives such as joint laboratories, student internships, and start-up accelerators substantially accelerate the commercialization of technology (Padilla Bejarano et al., 2023). Participation in international networks such as Horizon Europe or Erasmus+ can further expose researchers to new ideas and funding opportunities. Equally important is curriculum reform—integrating innovation management and IP literacy to equip graduates with the skills needed to bridge science and industry.

For intellectual property offices and agencies, modernization is urgently needed. Simplifying registration procedures, introducing online submissions, and providing fast-track options for high-potential technologies would help reduce bottlenecks for innovators. Outreach initiatives—such as training workshops on patenting, licensing, and international IP treaties—can raise awareness among SMEs and researchers who often lack specialized legal expertise. Advisory services, voucher schemes, and legal clinics offered in collaboration with universities and business associations could prevent promising inventions from stalling at the protection stage. Aligning national IP regulations with EU standards would not only harmonize legal frameworks but also strengthen investor confidence in the region.

Implementing these measures requires cross-sectoral coordination, but the potential benefits are substantial. Stronger legal protections, more dynamic collaborative networks, and modernized institutions can create a virtuous cycle: improved technology transfer reinforces the innovation ecosystem, which in turn generates further innovation. For Southeast European economies in transition, such a strategy represents a realistic and sustainable pathway towards innovation-driven growth.

5.3. Limitations and Suggestions for Future Research

While this study provides novel insights into technology transfer (TT) and open innovation ecosystems (OIEs) in Southeast Europe, several limitations must be acknowledged. First, the analysis is based on a regional focus and a sample of approximately 100 companies, which may limit the generalizability of the findings to other transitional economies. Because innovation ecosystems vary considerably across contexts, future research should extend the analysis to multiple regions—such as Central and Eastern Europe, East Asia, and Latin America—to determine whether intellectual property protection (IPP) and innovation networks play similarly decisive roles, or whether different institutional conditions generate distinct dynamics.

Second, the study employs a cross-sectional design, capturing only a single point in time. This approach restricts the ability to examine how TT processes and policy impacts evolve. Future studies would benefit from adopting longitudinal or panel data designs, which could better identify causal relationships and track the long-term effects of reforms such as strengthened IP laws, targeted national innovation programs, or regional EU initiatives.

Third, the quantitative model focused on a limited set of constructs—IPP, innovation networks, and innovation capabilities—while other potentially influential factors, such as companies' absorptive capacity or the quality of university–industry collaboration, were considered only indirectly. Future research could broaden the model by incorporating mediating variables like trust among partners, the role of venture capital, or human capital dynamics, including brain drain and brain gain. Complementary qualitative studies could further deepen the understanding of how robust IP regimes foster open innovation.

Moreover, greater attention should be devoted to outbound open innovation activities in transitional economies. Evidence suggests that companies in emerging markets tend to rely heavily on inbound knowledge flows while engaging less in outbound practices such as licensing, spin-offs, or international partnerships. Investigating the cultural, institutional, and incentive-based barriers to outbound innovation could provide valuable insights into ecosystem maturity and guide policies that encourage spin-offs, entrepreneurial mobility, and researcher exchanges.

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Ultimately, future research should explicitly consider sustainable and inclusive approaches to technology transfer. As Southeast Europe advances toward EU convergence, it is robust IP regimes influence the diffusion of green technologies and how innovation networks can more effectively integrate peripheral regions and smaller companies. Addressing these questions would not only fill current knowledge gaps but also support the design of more resilient, equitable, and innovation-driven ecosystems in the region.

CRediT authorship contribution statement:

Conceptualization, S.P., J.P., and V.B.; methodology, S.P. and V.B.; software, VB.; validation, M.R. and E.P.; formal analysis, S.P., J.P., and V.B.; investigation, M.R., and E.P.; resources, S.P., J.P., V.B., M.R., and E.P.; data curation, V.B.; writing—original draft preparation, S.P.; writing—review and editing, J.P., V.B., M.R. and E.P.; visualization, S.P. and V.B.; supervision, S.P. All authors have read and agreed to the published version of the manuscript.

Institutional Review Board Statement

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Informed Consent Statement

Informed consent was obtained from all subjects involved in the study. All participants in the focus group discussions, the Delphi study, and the needs analysis survey signed consent forms prior to their involvement and agreed to the use of their responses for research purposes.

Data Availability Statement

The data presented in this study are available upon request from the corresponding author. The data are not publicly available due to privacy and confidentiality agreements with participants.

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Conflicts of Interest

The author declares no conflicts of interest.

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Appendix: Confirmed Research instrument in Delphi study (questionnaire)

Questions	Answers				
1. What are the key actors of an open innovation ecosystem?	1 - Completely insignificant	2 - Insignificant	3 - Partially significant	4 - Significant	5 – Very significant
a) Universities and research institutions	1	2	3	4	5
b) Start-ups, small and medium-sized enterprises, and large corporations.	1	2	3	4	5
c) Government bodies that support funding and policy.	1	2	3	4	5
d) Investors	1	2	3	4	5
2. How significant are the following aspects for the implementation of open innovation strategies?	1 - Completely insignificant	2 - Insignificant	3 - Partially significant	4 - Significant	5 – Very significant
a) Innovation culture within the organization	1	2	3	4	5
b) Technological infrastructure	1	2	3	4	5
c) Leadership and management support	1	2	3	4	5
3. How significant are the following factors for successful commercialization of innovations?	1 - Completely insignificant	2 - Insignificant	3 - Partially significant	4 - Significant	5 – Very significant
a) Market access and marketing orientation of the organization	1	2	3	4	5
b) Intellectual property protection (patents protection, copyrights, trade secrets, industrial design rights, trademarks and branding)	1	2	3	4	5
c) Product adaptation to market needs	1	2	3	4	5
d) Support for entrepreneurship and start-up companies	1	2	3	4	5
4. What are the main challenges of technology transfer and sustainable entrepreneurship in the open innovation ecosystem in your country?	1 - Completely insignificant	2 - Insignificant	3 - Partially significant	4 - Significant	5 – Very significant
a) Insufficient financial resources and investments	1	2	3	4	5

b) Weak collaboration between industry and research institutions	1	2	3	4	5
5. To what extent do the following financial factors influence technology transfer?	1 - Completely insignificant	2 - Insignificant	3 - Partially significant	4 - Significant	5 – Very significant
a) Availability of grants and subsidies	1	2	3	4	5
b) Opportunities for private investment	1	2	3	4	5
c) Access to angels' investors, venture capital and crowdfunding	1	2	3	4	5
d) Tax incentives for research and development	1	2	3	4	5
e) Costs and return on investment	1	2	3	4	5
6. To what extent are the following government incentives significant in supporting collaboration in technology transfer	1 - Completely insignificant	2 - Insignificant	3 - Partially significant	4 - Significant	5 – Very significant
a) Tax credits and deductions for research and development activities	1	2	3	4	5
b) Grants and funding programs for collaborative research projects	1	2	3	4	5
c) Subsidies for technology commercialization efforts	1	2	3	4	5
d) Regulatory support and streamlined processes for intellectual property protection	1	2	3	4	5
7. How you perform R&D activities?	1 - Completely insignificant	2 - Insignificant	3 - Partially significant	4 - Significant	5 – Very significant
a) Collaboration with universities and external partners	1	2	3	4	5
b) Establishing research centers focused on innovation	1	2	3	4	5
c) Conducting market research to guide product development	1	2	3	4	5
d) Participation in collaborative research projects with global partners	1	2	3	4	5

8. How do you implement innovative solutions in your company (organization)?	1 - Completely insignificant	2 - Insignificant	3 - Partially significant	4 - Significant	5 – Very significant
a) We use internal R&D teams for developing new solutions	1	2	3	4	5
b) We engage external experts to support innovation	1	2	3	4	5
9. How significant are the following legal and regulatory factors for intellectual property protection?	1 - Completely insignificant	2 - Insignificant	3 - Partially significant	4 - Significant	5 – Very significant
a) National intellectual property laws	1	2	3	4	5
b) International agreements and conventions	1	2	3	4	5
c) Administrative procedures for rights protection	1	2	3	4	5
10. How significant are the following obstacles and challenges in the intellectual property protection system?	1 - Completely insignificant	2 - Insignificant	3 - Partially significant	4 - Significant	5 – Very significant
Obstacles:					
a) High costs and complexity of the patent system.	1	2	3	4	5
b) Lack of awareness and education on intellectual property rights.	1	2	3	4	5
c) Insufficient enforcement mechanisms for IP protection.	1	2	3	4	5
d) Lack of harmonization with international IP standards.	1	2	3	4	5
Challenges:					
a) Harmonizing national IP laws with international standards	1	2	3	4	5
b) Encouraging innovation while ensuring fair competition	1	2	3	4	5
c) Addressing piracy and counterfeiting effectively	1	2	3	4	5
d) Promoting cross-border cooperation and information sharing	1	2	3	4	5
e) Balancing the interests of IP holders with public access to knowledge	1	2	3	4	5

ŠTO POTIČE USPJEŠAN ODRŽIVI TRANSFER TEHNOLOGIJE U NASTAJUĆIM OTVORENIM INOVACIJSKIM EKOSUSTAVIMA: SPOZNAJE IZ JUGOISTOČNE EUROPE

SAŽETAK

Tranzicijska gospodarstva jugoistočne Europe i dalje se suočavaju s izazovima u pretvaranju inovativnih ideja u održive komercijalne uspjehe. Ovaj rad istražuje čimbenike koji potiču učinkovit i dugotrajan transfer tehnologije (TT) unutar nastajućih otvorenih inovacijskih ekosustava u Bosni i Hercegovini, Srbiji, Sjevernoj Makedoniji i Albaniji. Za razliku od ranijih istraživanja koja se usredotočuju na jednu zemlju ili koriste ograničene metodološke pristupe, ovo istraživanje primjenjuje sveobuhvatan mješoviti pristup (mixed-methods), koji uključuje dvokružnu Delphi studiju, fokusne grupe, analizu potreba te anketu provedenu među 100 poduzeća.

Primjenom metode parcijalnih najmanjih kvadrata za strukturno modeliranje jednadžbi (PLS-SEM) na podacima prikupljenima od poduzeća i istraživačkih institucija, studija pokazuje da snažna zaštita intelektualnog vlasništva (IPP) ima značajan i izravan utjecaj na poboljšanje transfera tehnologije. Nasuprot tome, same inovacijske sposobnosti ne utječu značajno na ishode transfera. Umjesto toga, dinamika mreža jača te sposobnosti, koje potom podržavaju transfer tehnologije — ali samo kada su ugrađene u čvrste institucionalne okvire.

Ovi nalazi dovode u pitanje uobičajenu pretpostavku da su inovacijske sposobnosti dovoljne za uspješnu komercijalizaciju inovacija. Naglašavaju ključnu važnost institucionalne kvalitete i mreža suradnje u tranzicijskim gospodarstvima.

Na teorijskoj razini, istraživanje integrira resursno utemeljeni, institucionalni i pristup otvorenih inovacija kako bi se adresirao jaz između inovacije i implementacije. Na praktičnoj razini, ističu se prioriteti politika: jačanje provedbe zaštite intelektualnog vlasništva, uspostava specijaliziranih sudova za IPP, poticanje partnerstava između sveučilišta i industrije te unutar inovacijskih klastera. Za poduzeća i sveučilišta, razvoj apsorpcijskog kapaciteta i uključivanje u prekogranične suradnje ključni su za maksimiziranje koristi od vanjskog znanja.

Iako je istraživanje ograničeno regionalnim fokusom i presječnim dizajnom, ono nudi nijansiran okvir za održivi transfer tehnologije u jugoistočnoj Europi te naglašava potrebu za daljnjim komparativnim i longitudinalnim studijama kako bi se produbilo razumijevanje ovog fenomena.

KLJUČNE RIJEČI: *održivo poduzetništvo; transfer tehnologije; istraživanje i razvoj (R&D) i zaštita intelektualnog vlasništva (IPP); tranzicijska gospodarstva, komercijalizacija inovacija*