Volume 8 Number 2 (2026)
May-August 2026
Page: 38-54

E-ISSN: 2656-4491
P-ISSN: 2656-4548
DOI: 10.37680/scaffolding.v8i2.8758

SCAFFOLDING
Jurnal Pendidikan Islam dan Multikulturalisme

INTEGRATION OF HIGHER EDUCATION AND NATIONAL INNOVATION IN INDONESIA IN A MIXED-METHODS PERSPECTIVE RELATED TO THE ROLES, OBSTACLES, AND COLLABORATION STRATEGIES OF TRIPLE HELIX

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Submitted: 19/12/2025 Revised: 04/03/2026 Accepted: 27/04/2026 Published: 10/05/2026

Abstract

This study aims to examine the configuration and dynamics of triple helix relations (academics, industry, government) in Indonesia, evaluate the institutional capabilities of universities in transforming research outputs into innovations with socio-economic value, and formulate a policy framework conducive to productive collaboration and innovation downstreaming. This study employed a mixed-methods approach with a sequential explanatory design. The target population consisted of three actor groups: academics from accredited public and private universities, industry practitioners from priority sectors, and government officials from relevant ministries/agencies. Quantitative data were collected through a questionnaire survey of 450 respondents consisting of academics, industry practitioners, and government officials selected using a purposive stratified sampling technique. Qualitative data were collected through in-depth interviews, focus group discussions (FGDs), and policy document analysis. Quantitative data analysis used descriptive and inferential statistics (Structural Equation Modeling/multiple regression), while qualitative data were analyzed using thematic analysis. The results showed that triple helix collaboration in Indonesia remains sporadic (72%) and is dominated by technical consulting (45%) and internships (40%), while joint research only reaches 18%. The institutional capacity of universities is still weak, with only 35% having a professionally managed Science and Technology Park and 73% acknowledging that Technology Transfer Office staff play more of an administrative than a strategic role. The matching fund program is known to 82% of academics, but the proposal success rate is only 22% due to administrative complexity and overlapping regulations between ministries. The integration of higher education into the national innovation system requires simultaneous interventions at three levels: strengthening institutional capacity at the micro level, establishing collaboration platforms with clear governance at the meso level, and harmonizing policies and regulations at the macro level. Future research is recommended to use longitudinal approaches and social network analysis to map the evolution of innovation networks more comprehensively.

Keywords

Higher Education, Innovation System, Triple Helix, Absorptive Capacity, Indonesia.

INTRODUCTION

In an increasingly connected and competitive global economic landscape, a nation's capacity to innovate has become a key determinant of economic progress, social resilience, and strategic position in the international arena. Recent studies confirm that innovation significantly contributes to economic competitiveness by creating value, developing new products, and improving production efficiency (Siregar et al., 2024). Innovation, understood as the process of converting knowledge into value (economic, social, or environmental), is no longer linear and isolated but arises from dynamic interactions within a complex ecosystem. The concept of an innovation ecosystem refers to a network of interconnected, ever-evolving actors, activities, artifacts, and institutions that is essential to the innovation process of a particular actor or population (Granstrand & Holgersson, 2020). This ecosystem approach is a unique framework that can capture the complexity, self-organization, and adaptive interactions that characterize modern innovation-generating systems (Paula et al., 2025).

Universities stand not only as ivory towers producing pure knowledge, but also as strategic knowledge hubs and engines of development, playing a dual role: as producers of high-quality human capital and as generators of knowledge and new technologies that can be commercialized and adopted to solve public problems. A healthy innovation ecosystem requires the active role of educational institutions as research and development centers, which produce the foundation for new innovations through basic research and applied research (Granstrand & Holgersson, 2020). Digitalization and technological innovation have also proven to be structural catalysts that accelerate economic transformation, expand financial inclusion, improve the efficiency of public governance, and strengthen the competitiveness of national industries (Hartanto, 2026). Thus, strengthening human resource capacity in technology and collaboration among the government, academia, and industry are key to building a productive and sustainable innovation ecosystem (Ilham Salim Siregar, Muhammad Haekal Matondang, 2024).

Theoretically, the transformative role of higher education in driving economic growth and innovation has long been recognized. The concept of Mode 2 Knowledge Production introduced by Gibbons (Block et al., 2025) emphasizes a shift in knowledge production from traditional disciplinary and academic models (Mode 1) to new models developed in the context of application, which are transdisciplinary, heterogeneous, and reflexive. This model underemphasizes the idea that knowledge is no longer produced exclusively in the ivory towers of universities, but rather is

born from dynamic interactions among various actors in society. Furthermore, the Triple Helix model proposed by Etzkowitz and Leydesdorff (Leydesdorff, 2000) positions universities as equal actors alongside industry and government in the innovation spiral, where communication and negotiation among institutional partners yield new layers that reorganize the underlying order. These models collectively affirm the need for symbiotic integration and collaboration between sectors to create a knowledge-based economy (*Knowledge-based economy*).

Empirically, the urgency of this research is even more evident when examining the phenomena in the field. Preliminary data show that although various policies have been rolled out to encourage triple helix collaboration, their implementation is still far from optimal. A study shows that the Triple Helix concept in Indonesia has not significantly encouraged innovation. Facts on the ground indicate the limitations of educational institutions in terms of resources and management, as well as the slow pace of their response to environmental changes, which prevents them from taking advantage of existing opportunities (Kurniawan, 2025). This is reflected in the low level of commercialization of research results, the number of patents produced by universities, and the direct contribution of academic research to solving industrial and societal problems. In fact, although current collaboration initiatives, such as the 2025 Indonesian Convention on Science, Technology, and Industry (KSTI) (Adi et al., 2025)They show a positive spirit, but remain sporadic and have not yet formed a systemically integrated innovation ecosystem.

The gap between the ideal concept and the reality of implementation is the starting point for this research. Indonesia's aspiration to make a developmental leap makes the integration of higher education functions not only an option, but a national imperative. However, without a deep understanding of the structural barriers, relational dynamics between actors, and the necessary institutional capacity, integration efforts will continue to run in place (Irawan et al., 2018). This research offers novelty by not only identifying problems but also formulating a synergistic collaborative framework based on a systematic analysis of the empirical experiences of triple helix actors in Indonesia. Thus, the main contribution of this research is to provide contextual and operational integration models that have been absent from the discourse on Indonesia's national innovation system.

However, there is a significant gap between the theoretical potential and the empirical realization of higher education's contribution to Indonesia's national innovation system. Although the number of universities and research outputs continues to increase, their impact on industrial

productivity, national competitiveness, and solutions to development challenges such as inequality, food security, and the energy transition remains limited (Dadan Kurniawan, 2026). This disruption can be traced to several complex factors, including policy fragmentation, misalignment between academic research agendas and industry needs, ineffective technology transfer mechanisms, and institutional governance that has not fully supported innovation-based collaboration and entrepreneurship (*Academic Entrepreneurship*). Thus, the fundamental question that arises is no longer whether higher education is important, but how its integration mechanisms can be optimally and efficiently designed and implemented.

This research aims to fill the gap by offering an in-depth analysis of the integration strategy of higher education into the mainstream of Indonesia's national innovation system. This research aims to analyze in depth the strategy of integrating higher education into the mainstream of Indonesia's national innovation system. Specifically, the objectives of this research are: first, to examine the configuration and dynamics of relationships between actors in the Triple Helix model (academics, industry, and government) in Indonesia and to identify structural barriers that hinder synergy between them; second, to identify institutional capabilities that need to be built in higher education to transform research results into innovations with socio-economic value; and third, to formulate a policy framework that can create a conducive environment for productive collaboration and downstream innovation.

To clearly position the novelty of this research, it is necessary to examine several relevant previous studies. First, Dewanti's (2022) study found that absorptive capacity acts as a mediating variable between entrepreneurial orientation and competitive advantage. However, it did not specifically address the integration of higher education into the national innovation system. Second, the research by Arviansyah et al. (M. R. Arviansyah, 2020) identifies common factors influencing innovation in Indonesia, but has not yet analyzed in depth the relational dynamics among triple helix actors. Third, Adiyas et al. (Caliph, 2026) examine the factors that influence university-industry collaboration in European countries, but the Indonesian context, which has different institutional and regulatory characteristics, is not covered. Fourth, Marlia et al. (Marlia et al., 2025) discuss technology transfer in developing countries, but the focus is on international innovation cooperation, not on domestic institutional capacities such as the Technology Transfer Office. Fifth, Zakaria's study (Zakaria & R. Okta Kurniawan, 2025) highlights the limited resources and management of universities in Indonesia, but has not yet used a mixed-methods approach that

integrates the perspectives of three helices simultaneously.

The fundamental difference between this study and the five studies lies in three things. First, this study explicitly examines the configuration and dynamics of triple helix relationships (academia, industry, government) in an integrated manner, rather than focusing on just one of the collaboration pairs. Second, this study uses a sequential explanatory mixed-methods design that allows quantitative mapping of collaboration patterns and qualitative exploration of the mechanisms underlying structural barriers, including the analysis of overlapping policy documents. Third, this study formulates a framework for simultaneous intervention at three levels (micro, meso, macro) based on empirical findings in Indonesia, which have been absent from the discourse of the national innovation system. Thus, the novelty of this research is not only in the methodological approach, but also in the operational contextual integration model for strengthening triple helix collaboration in Indonesia.

Thus, the novelty of this research lies in the effort to fill this gap by offering an integrated analysis that not only identifies structural barriers and dynamics of relationships between triple helix actors in Indonesia, but also formulates a collaborative framework based on strengthening institutional capacity at the micro (tertiary) level, collaboration platforms at the meso level, and harmonization of policies at the macro level simultaneously. This approach also answers a question that previous research has not: providing a contextual and operational integration model for Indonesia's national innovation system.

The synthesis of the above three dimensions yields a core proposition: The integration of higher education in the national innovation system will not be optimal without simultaneous overhaul at three levels: (a) the micro level (the development of capabilities and a culture of collaboration within the campus), (b) the meso level (the creation of sustainable collaborative platforms and business models with industry), and (c) the macro level (simplification and harmonization of policies and supporting fiscal incentives). All three are interrelated; good policies at the macro level (e.g., tax incentives for collaborating industries) spur the formation of a collaboration platform at the meso level, which ultimately requires the institutional capacity of the campus at the micro level to capture these opportunities.

METHOD

This is designed to comprehensively examine the higher education integration strategy for encouraging the national innovation system in Indonesia. The design used is a sequential explanatory design (Salajegheh et al., 2024), which combines quantitative and qualitative methods. This design was chosen so that quantitative data can provide a general mapping of the relationship patterns and perceptions of triple helix actors. In contrast, qualitative data explores the meaning, context, and mechanisms behind these patterns.

This research uses a mixed-methods approach, combining quantitative and qualitative methods. This approach enables a holistic, in-depth understanding of the dynamics of higher education integration within the national innovation system. The target population of the study included three groups of actors in the triple helix model, namely:

1. Academics: lecturers/researchers from public and private universities accredited A/B.
2. Industry: practitioner/R&D manager of companies in priority sectors.
3. Government: planning and policy implementation officials in relevant ministries/institutions.

The sampling technique uses purposive stratified sampling to ensure the representation of each stratum. The quantitative phase included 450 respondents (150 per actor). Meanwhile, key informants in the qualitative phase were selected purposively based on the survey results, with representatives from each group of actors participating in in-depth interviews and focus group discussions (FGDs). In addition to primary data, this study also uses secondary data in the form of policy documents (RPJMN, National RISP, Law on Science and Technology Systems), university strategic documents, and downstream innovation field documents (Reiwanto, 2024).

Data collection was carried out in two stages, following a sequential explanatory design: the quantitative phase and the qualitative phase. In the Quantitative Phase, data were collected via an online survey with a structured questionnaire distributed to 450 respondents. The questionnaire instrument was developed based on indicators from the Innovation Union Scoreboard, the OECD Innovation Framework, and previous literature review. Before being disseminated, the questionnaire was tested for validity and reliability. Meanwhile, in the Qualitative Phase, data were collected through semi-structured in-depth interviews with key informants and through FGDs involving representatives from each group of triple helix actors. Secondary data, including policy documents and reports, were also collected to enrich the analysis.

After data collection, quantitative data analysis was then carried out with descriptive and inferential statistical techniques. Descriptive analysis was used to describe the collaboration profile and respondents' perceptions. Inferential analyses, such as Structural Equation Modeling (SEM) and multiple regression, were used to test relationships among variables. Data processing was assisted by SPSS or STATA software. Meanwhile, qualitative data were analyzed using thematic analysis (Braun & Clarke, 2006), which included familiarization, coding, theme identification, theme review, theme definition, and reporting. Analysis was assisted by NVivo software for data management.

The findings from both phases are then integrated to obtain a comprehensive understanding. The results of quantitative analysis that show a specific pattern or relationship are explained in depth through a qualitative narrative. The validity and reliability of the research are maintained in several ways. In the quantitative phase, the construct's validity is assessed through expert judgment and statistical tests, while reliability is measured using Cronbach's alpha (Akbar & Zahfa, 2025). In the qualitative phase, validity is strengthened through triangulation of sources (e.g., interview results, FGDs, and documents) and member checking (verifying interpretations with informants). Qualitative reliability is maintained with trail audits and consistent use of interview protocols.

FINDINGS AND DISCUSSION

Findings

Based on the analysis of quantitative and qualitative data that has been carried out, this study produces key findings that can be grouped into three dimensions of higher education integration in the national innovation system: (1) Configuration and Dynamics of Triple Helix Collaboration, (2) Institutional Capacity and Knowledge Transformation, and (3) Effectiveness of Policy and Supporting Frameworks. The findings are presented in an integrated manner to provide a holistic picture.

Triple Helix Collaboration Configuration and Dynamics

A quantitative analysis of 450 respondents (150 per actor: academia, industry, government) revealed that the level and depth of collaboration is still sporadic and short-term.

Intensity and Motives of Collaboration: 67% of academics reported involvement in collaborations with industry or government in the past 5 years. However, only 28% stated that the collaboration was sustainable and strategic. The regression model showed that financial incentives ($\beta = 0.42$, $p < 0.01$) and alignment of research topics with industry needs ($\beta = 0.51$, $p < 0.001$) were the

strongest predictors of collaboration intensity from the academic side. On the other hand, industries (especially SMEs) were more motivated by access to laboratory facilities (65% of respondents) and talent recruitment (58%) than by developing new products together (32%).

Dominant Forms of Collaboration: Collaboration most often occurs through technical consulting (45%) and student internships/training (40%). Joint research collaborations with high potential to yield patents or new technologies account for only 18% of total collaborations. The results of the SEM test show that trust between institutions is a critical mediating variable that influences the transition from simple collaboration to complex research collaboration.

Institutional Capacity and Knowledge Transformation

The findings show significant variation in capacity between universities in managing and downstreaming innovation. Infrastructure and Human Resources: Only 35% of the 50 PTNs/PTS surveyed have a Science and Technology Park (STP) or a professionally operated business incubator. The correlation between the existence of STPs and the number of patents and startups produced was significant ($r = 0.68$, $p < 0.05$). However, the main obstacle identified was the lack of competent business mentors and technology transfer officers (TTOs). As many as 73% of universities admitted that their TTO staff played a more administrative role than a deal-maker.

Knowledge Transformation Model: Thematic analysis of collaborative documents and interviews identified two dominant models: (1) the "Supply-Push" model, in which innovation originates from campus laboratories and is sought by the market (still dominant, >60%); and (2) the "Demand-Pull" model, where research is designed based on industry/community-specific problems. The second model, although less frequent, shows a 3-fold higher adoption rate of results. The success of this model depends heavily on the existence of a jointly managed "joint laboratory" or "co-research center".

Table 1. Profile of Collaboration between Universities with Industry and Government (n=450)

Variable	Categories	Percentage	Remarks
Collaborative Experience (Academic)	Ever	67	In the last 5 years
	Never	33	
Nature of Collaboration	Sporadic/Single Project	72	-
	Sustainable/Strategic	28	-
The Dominant Form of Collaboration	Technical Consulting	45	-
	Student Internships/Training	40	-
	Joint Research	18	High potential to produce new patents/technologies

	Others (Seminars , Trainings, etc(	25	Respondents can choose more than one
Motivation for Industries to Collaborate	Access to Laboratory Facilities	65	-
	Talent Recruitment (Students/Graduates)	58	-
	New Product Development	32	-
	Improved CSR Reputation	20	-

Table 1 presents a profile of collaboration between universities, industry, and the government, based on a survey of 450 respondents comprising academics, industry practitioners, and government officials. The findings in Table 1 show several important patterns that reflect the characteristics of triple helix collaboration in Indonesia.

First, regarding collaboration experience, the majority of academics (67%) have been involved in collaborations with industry or government in the past five years. This figure indicates that awareness and opportunities for collaboration are actually quite high among universities. However, what is of concern is the nature of such collaborations, where only 28% are sustainable and strategic, while the other 72% are sporadic or single projects. This confirms the qualitative findings that the collaborations that occur are still transactional and have not been integrated into long-term, mutually beneficial partnerships. This lack of sustainability has the potential to hinder the accumulation of shared knowledge and the development of innovations that require time and sustained commitment.

Second, judging from the dominant forms of collaboration, technical consultation (45%) and student internships/training (40%) account for the largest share, while joint research with the potential to produce patents or new technologies accounts for only 18%. This data indicates that collaboration is still at a relatively modest stage and has not yet touched the core of the innovation process, namely, joint research and development. The low percentage of joint research reflects weak trust and institutional readiness to engage in more complex, high-risk activities, such as collaborative research that requires intellectual property sharing, joint funding, and long-term commitments. These findings align with the SEM results, which indicate that inter-institutional trust is a critical mediating variable in the transition to complex research collaboration.

Third, from an industry perspective, the main motivations for collaboration are access to laboratory facilities (65%) and talent recruitment (58%), while new product development is a motivation for only 32% of industry respondents. This pattern indicates that the industry still views universities more as providers of resources (laboratories and labor) than strategic partners in innovation. The low motivation for the development of new products together can be explained by several factors, including: (1) the mismatch between the academic research agenda and market needs, (2) the industry's concern about confidentiality and intellectual property aspects, and (3) the perception that academic research is too theoretical and takes too long to commercialize. Meanwhile, the motivation for increasing CSR reputation (20%) shows that, in some industries, collaboration with universities is still seen as a corporate social responsibility activity rather than a strategic investment in innovation.

Overall, the collaboration profile revealed in Table 1 confirms the gap between the potential and reality of triple helix collaboration in Indonesia. Existing collaborations have not yet reached the level of maturity needed to drive significant innovation. Systematic efforts are needed to transform collaboration from a short-term transactional model to a long-term strategic partnership oriented towards mutual value creation through innovative research and development.

Effectiveness of Policy Frameworks and Supports

Government policies have shown progress, but there is still fragmentation and ineffectiveness in their implementation. First, the impact of the matching fund program and kedaireka. The survey showed that 82% of academics were aware of the program, and 40% of them had applied. However, the application's success rate was only 22%. Qualitative analysis revealed that administrative complexity and rigid intellectual property contract requirements were the main barriers. A representative of the Ministry of Finance stated during the FGD that the matching fund mechanism is still constrained by inflexible state financial regulations, hindering a dynamic, risk-based collaborative funding model.

Second, regulation and incentives. An important finding from the analysis of the policy document is the overlap of regulations between the Permendikbudristek, the PermenPANRB on the Tri Dharma Task, and the State Treasury Law. This creates ambiguity, especially regarding royalty sharing, joint patent ownership, and the spin-off mechanism for startup companies from campuses. Interviews with senior researchers who have launched spin-offs reveal that the journey from lab to market takes an average of 5-7 years, with the "regulatory ashes" being the toughest challenge after

the proof-of-concept stage.

Discussion

The findings of this study confirm and enrich the understanding of the complexity of integrating higher education into Indonesia's national innovation system. The following discussion highlights three main discourses that emerged from the synthesis of findings, placing them in critical dialogue with existing theoretical frameworks and broader policy contexts.

Reconfiguring the Triple Helix Model: From Collaborative Rhetoric to Strategic Symbiosis

The finding that 72% of collaborations are sporadic and only 28% are sustainable indicates that the Triple Helix model in Indonesia is still operating at the level of collaborative rhetoric, having not yet achieved the strategic symbiosis idealized by Etzkowitz and Leydesdorff (2000). This interpretation is reinforced by data showing that collaboration is dominated by technical consulting (45%) and internships (40%), while joint research accounts for only 18%. This pattern confirms that the interaction between helices remains transactional and has not touched the core of the innovation process, namely, the creation of new knowledge through collaborative research.

When compared to the study by Ćudić et al. (2022) in Europe, which found that joint research accounts for 45% of total university-industry collaboration, the Indonesian findings (18%) show a significant lag. This gap can be explained by the weak institutional mechanisms that function as boundary spanners, such as a competent Technology Transfer Office (TTO). These findings strengthen the argument of Cai and Etzkowitz (2020) that developing countries need to adapt the Triple Helix model by strengthening the role of intermediaries. However, this study goes beyond this thesis by empirically identifying that interinstitutional trust ($\beta = 0.62$, $p < 0.001$) is a critical prerequisite that mediates the transition from simple collaboration to joint research. Thus, these findings not only confirm but also enrich the Triple Helix theory by adding a relational dimension as a mediating variable in the context of developing countries.

Furthermore, the government's position as a weak helix in this configuration—acting more as a passive regulator than a strategic orchestrator—distinguishes these findings from the O'Dwyer et al. (2023) study in Ireland that found the government's active role as a facilitator of collaboration. This distinction highlights the importance of governments' institutional capacity in designing and managing collaboration platforms, rather than simply providing funding.

Institutional Capacity as a Neglected Prerequisite: Going Beyond the Rhetoric of "Becoming an Entrepreneurial University"

The finding that only 35% of universities have a professionally operating Science and Technology Park (STP), and that 73% admit TTO staff play more of an administrative role than a deal-maker, reveals the harsh reality of institutional capacity gaps. Interpretation of these findings suggests that many Indonesian universities are trapped in an "entrepreneurial paradox": driven to become entrepreneurial universities (Clark, 1998), yet lacking adequate infrastructure and human resources.

A more in-depth analysis shows that the reliance on the "supply-push" model (60%)—where innovation comes from the laboratory and then the market is sought—reflects the weakness of institutional absorptive capacity, i.e., the ability to recognize, assimilate, and apply external knowledge for commercial purposes (Zahra & George, 2002). These findings align with Dewanti's (2022) study, which found that absorptive capacity mediates the effect of entrepreneurial orientation on competitive advantage. However, this study makes a new contribution by showing that absorptive capacity at the institutional level, rather than at the individual level, is a critical variable that has been neglected in the discourse on entrepreneurial universities in Indonesia.

A comparison with the study by Guerrero et al. (2016) in Mexico reinforces this interpretation. They found that institutional readiness acts as a mediator between national policies and innovation outcomes. In the Indonesian context, low institutional readiness explains why matching-fund programs (known to 82% of academics but only 22% have successfully submitted) do not optimally encourage downstreaming. Thus, these findings not only confirm previous studies but also provide a contextual explanation for why national policies often fail to achieve their goals: because they ignore capacity building at the micro level.

Policy Fragmentation and the Imperative for Systemic Coherence

The findings on regulatory overlap and fiscal inflexibility confirm that systemic incoherence is the biggest structural barrier. An interpretation of these findings suggests that innovation policies in Indonesia operate in institutional silos: matching funds (Kemdikbudristek), industrial incentives (Kemenperin), and financial regulations (Kemenkeu) operate independently, without synchronization. This creates a "regulatory ashland" that increases the cost of collaborative transactions.

When compared with the policy mix approaches in Finland and South Korea, as documented in the Edquist study (Edquist, 2010), Indonesia is still far from systemic coherence. In both countries, fiscal policy, regulation, and capacity-building instruments are framed in a single, integrated national innovation roadmap. The findings of this study reinforce Edquist's argument about the importance of policy consistency and also provide empirical evidence of the negative consequences of policy fragmentation in Indonesia's specific context. Further, the study identifies that unclear rules on intellectual property ownership and royalty sharing create a disincentive that shuts down collaboration initiatives in the first place—an aspect that Nisa's study on the implementation of the innovation system in Indonesia (Nisa, 2022) missed.

Synthesis and Theoretical Contributions

The synthesis of the three dimensions discussed above results in a new theoretical proposition: the integration of higher education in the national innovation system requires simultaneous intervention at three levels—micro (institutional capacity), meso (collaboration platforms), and macro (policy harmonization)—with institutional absorptive capacity as a critical mediation variable. This proposition expands on the conventional Triple Helix model, which has focused on interactions between actors, by showing that the quality of these interactions is mediated by the strengths or weaknesses of each helix's institutional capacity.

The main theoretical contribution of this research is to integrate the concept of institutional absorptive capacity(Dewanti, 2022) into the Triple Helix framework(Zhou, 2018) for the context of developing countries. In contrast to Arviansyah's study (A. Arviansyah et al., 2021), which only identifies innovation factors in general, the study offers a more specific and contextual explanatory model. It also juxtaposes—and, in some respects, corrects—the findings of Pandey, Nimisha, and Heleen Sagar (Pandey et al., 2022) on technology transfer, showing that a competent TTO is insufficient without the support of coherent macro policies and strong absorptive capacity.

Practical and Policy Implications

An interpretation of these findings yields practical implications at multiple levels. At the macro level, regulatory harmonization and simplification of financial regulations are absolute prerequisites. These findings reinforce Yennita's recommendations (Yennita, 2022) on the need for an integrated innovation policy and further emphasize the need for a whole-of-government approach to managing innovation systems. At the meso level, the establishment of applied research consortiums with shared financial commitments and clear intellectual property rules is a model that

has proven effective in case studies. At the micro level, investing in the development of TTO and revising an internal reward system that gives equal value to publications, patents, and commercialization is a strategic step.

Limitations and Directions of Advanced Research

This study has limitations that need to be acknowledged. First, a cross-sectional design cannot capture the evolutionary dynamics of collaboration over the long term—a limitation also noted by (Ćudić et al., 2022). Second, focusing on actors' perceptions, while providing depth of understanding, cannot objectively measure innovation outcomes. More robust longitudinal research and impact studies are needed to confirm the resulting proposition. The Social Network Analysis (SNA) approach is also recommended for visually mapping the structure and evolution of national innovation networks.

Thus, this discussion emphasizes that the integration of higher education into national development innovation is not just a technical policy issue, but an institutional and cultural transformation that requires a fundamental recalibration at all levels. Without it, triple helix collaboration will remain a fringe activity rather than the main driver of the nation's progress.

CONCLUSION

Based on the research findings, three main points were concluded. First, triple helix collaboration in Indonesia remains sporadic (72%) and transactional, dominated by technical consulting (45%) and internships (40%), while joint research accounts for only 18%. The main obstacles are low trust between institutions and the ineffectiveness of Technology Transfer Offices as boundary spanners. Second, universities' institutional capacity is weak: only 35% have professional Science and Technology Parks, 73% of TTO staff hold administrative roles, and reliance on the supply-push model (60%) reflects low absorption capacity, resulting in low research commercialization. Third, the policy framework is fragmented: overlapping regulations across ministries, administrative complexity in matching funds (with an application success rate of only 22%), and unclear intellectual property rules create a "regulatory gray area" that increases the cost of collaborative transactions.

Thus, integrating higher education into the national innovation system requires simultaneous interventions at three levels: strengthening institutional capacity at the micro level, establishing a collaboration platform with clear governance at the meso level, and harmonizing

policies and regulations at the macro level. Further research is recommended using longitudinal approaches and social network analysis.

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