Standards-related Regional Innovation and International Cooperation
https://journals.zycentre.com/sriic

ARTICLE

# Building a Technopark through Collaboration and Innovation with Pentahelix Model

***Iis Mariam*** * **, *Nining Latianingsih*** **, *Endah Wartiningsih*** **, *Nidia Sofa*** **, *Putri Fiana***

*Business Administration Department, Politeknik Negeri Jakarta, Depok 16425, Indonesia*

## ABSTRACT

This research examines the role of technoparks in Indonesia as innovation ecosystems that bridge academia and industry through Collaborative Knowledge Creation and the Pentahelix model. While technoparks are designed to integrate research, business, and government support, persistent challenges limit their effectiveness, including bureaucratic delays in Memorandum of Understanding/Memorandum of Action processes, inconsistent funding, and uneven industrial commitment, where partnerships are often perceived merely as corporate social responsibility. Using Soft Systems Methodology, this research analyzes data from several institutions. The findings highlight systemic misalignments between conceptual models and real practices, underscoring the need for reforms in policy, incubation, and dissemination mechanisms. Systematically desirable and culturally feasible changes include streamlining cooperation procedures, expanding incubation to accelerate commercialization, and strengthening media as a knowledge diffuser. Evidence shows that corrective actions have been initiated through the development of career support, intellectual property management, Small and Medium Enterprises assistance, and entrepreneurship incubation. This research was conducted in three provinces (Aceh, West Sumatra, and West Java). The results show that the presence of technoparks on campus has increased collaboration and cooperation, particularly in Micro, Small, and Medium Enterprises (MSME) business development, which Collaborative Knowledge Creation and Pentahelix concept implemented. The research concludes that embedding Collaborative Knowledge Creation

*CORRESPONDING AUTHOR:
Iis Mariam, Business Administration Department, Politeknik Negeri Jakarta, Depok 16425, Indonesia; Email: iis.mariam@bisnis.pnj.ac.id

ARTICLE INFO
Received: 15 May 2025 | Revised: 2 July 2025 | Accepted: 10 July 2025 | Published Online: 17 July 2025
DOI: https://doi.org/10.63385/sriic.v1i2.280

CITATION
Mariam, I., Latianingsih, N., Wartiningsih, E., et al., 2025. Building a Technopark through Collaboration and Innovation with Pentahelix Model. Standards-related Regional Innovation and International Cooperation. 1(2): 1–13. DOI: https://doi.org/10.63385/sriic.v1i2.280

and Pentahelix principles can transform a technopark into an inclusive and sustainable platforms that strengthen competitiveness, entrepreneurial growth, and community empowerment.

***Keywords:*** Collaborative Knowledge Creation; Pentahelix; Technopark

# 1. Introduction

This research explains the concept of Collaborative Knowledge Creation (CKC) and the pentahelix in building technoparks as an effort to increase cooperation between academic institutions and external parties, especially in developing small and medium enterprises.

Innovation is the core force behind organizational growth and a source of ideas and opportunities that enhance individual lives while strengthening the global economy [1]. Integrating science, education, and business is a fundamental condition for building an innovation based economy. In many developed nations, technology parks have proven to be a powerful mechanism of integration, enabling all phases of innovation to take place within one setting, beginning with idea generation and extending to market realization [2]. Technoparks serve as platforms that connects industry, universities, and entrepreneurs to develop research and projects aligned with industrial needs while also benefiting from government incentives [3]. Technoparks serve as joint platforms and research hubs where industry and universities converge, enabling universities to conduct scientific studies and projects aligned with industrial demands. Since people are the core force of innovation, a technopark should act as an innovation ecosystem that enables knowledge transfer and collaboration through public–private partnerships, research commercialization, university spin- offs and startups, business incubators, and technology transfer centers [2]. A technopark (also known as a Science Park or Technology Park) is: (a) A physical and institutional facility that supports collaboration between universities, industry, government, and other parties in developing and implementing technological innovations, (b) Typically, it includes: business incubators, research centers, prototyping facilities, and industrial networks.

In addition to functioning as platforms for science–industry collaboration, technoparks are increasingly regarded as strategic environments for CKC, knowledge is not only transferred but also co-created among stakeholders, enabling innovations to arise from collective interaction rather than from isolated efforts. This perspective aligns with the Pentahelix model, which extends the traditional Triple Helix (university–industry–government) by incorporating the roles of communities and media. Within the technopark, the Pentahelix approach ensures that innovation becomes more participatory, socially grounded, and broadly distributed. Universities and industries contribute through research and commercialization, governments provide regulatory and infrastructural support, communities offer user-driven insights, and media channels accelerate the diffusion of knowledge. Together, CKC and the Pentahelix model reinforce the role of technoparks as innovation ecosystems that not only create economic value but also promote sustainable and community-oriented development. Although the Triple and Quadruple Helix models could be applied, the Pentahelix model was chosen because it explicitly includes civil society, allowing a more comprehensive analysis of multi-stakeholder collaboration among government, industry, academia, media, and communities in this context. Building on this framework, while many studies link these helix models to technoparks, this study contributes new insights by applying the Soft Systems Methodology (SSM) across multiple provinces, highlighting the role of media in facilitating collaboration, and examining the incubation curriculum for MSMEs, thereby extending both the practical and theoretical understanding of multi-stakeholder engagement in technopark development.

In Indonesia, Bandung Techno Park illustrates the tangible role of technoparks in fostering regional innovation and competitiveness. Its effectiveness can be seen through performance indicators such as the number of startups established, the scale of economic activity generated, and the creation of innovative products, all of which contribute to local economic growth [4]. Moreover, the park's business incubation program has played a critical role in advancing entrepreneurial ventures by providing structured mentoring, resource accessibility, and strong networking support, which are essential for sustaining early-stage innovation [5]. Besides Bandung, there is also Solo Technopark, which offers education and training programs in fields such as manufacturing mechanics, manufacturing design, welding, underwater wet welding, and the Oil and Gas Skill Center Indonesia, aiming to enhance human resource quality with both hard and soft skills to stay competitive in the job market [6]. The purpose of this study is to examine how technoparks can be developed as innovation ecosystems through the integration of academic and industrial collaboration. Specifically, the study aims to analyze the role of innovation and CKC in strengthening the competitiveness of organizations, while applying the Pentahelix model to ensure broader stakeholder involvement. By drawing on new data from interviews conducted in 2024 with leading institutions such as Bandung Telkom University, Universitas Syiah Kuala (USK), and Politeknik Negeri Padang (PNP), this research seeks to identify effective strategies that enable universities, industries, governments, communities, and media to synergize in building sustainable technoparks. The technoparks concept at Syiah Kuala University (USK) in Banda Aceh focuses on the development and application of innovative technologies, particularly in the coffee and cocoa sectors, with a "Hi-Tech" foundation. Its primary goal is to increase the added value of superior regional products and bridge the gap between academia and industry, creating an environment that encourages collaboration, incubation, and commercialization of research results. PNP has several real examples that approach the techno park concept, such as the development and utilization of technology in vocational programs, innovation through student and lecturer projects, and the potential for developing supporting facilities for industrial research and development, although there are no facilities explicitly named "techno park" as is common in research universities.

Particular contributions in this paper are outlined as follows:

1. Proposing a cooperation model that enhances economic value, entrepreneurial growth, and supports inclusive, community-driven innovation
2. Identifying systemic gaps and providing policy recommendations to strengthen cooperation and ensure sustainability in vocational education partnerships.
3. Demonstrating how CKC and the Pentahelix approach in technoparks can reduce collaboration barriers, improve graduate competencies, and align innovation with industry needs.

The rest of the paper is organised as follows. The related works are presented in Section 2. The proposed methodology is introduced in Section 3. Results and discussion, along with open issues, are provided in Section 4. Finally, Section 5 concludes the key findings and outlines potential future directions.

## 2. Materials and Methods

University-Industry Collaboration (UIC) produces highly skilled and efficient business graduates capable of meeting the demands of industry, addressing globalization, supporting the knowledge-based economy, and fulfilling labor market needs both domestically and internationally [7]. The triple helix concept is a collaborative model between three key actors in innovation development: higher education (academics), industry (business), and government. Collaboration between the three is crucial because they have complementary roles in creating a strong and sustainable innovation ecosystem. The triple helix concept plays a key role in fostering collaboration and innovation within organizations and businesses. It turns out that the triple helix concept can encourage innovation and technology that universities produce through research and new knowledge. The role of industry applies these research findings into tangible products/services, and the government creates policies that support the downstreaming of technology and also innovation, because without collaboration, research can simply become a pile of documents without any real application. The triple helix concept can also increase national competitiveness, because collaboration accelerates the commercialization of local innovation, which impacts the growth of a knowledge-based economy. Therefore, countries that successfully build an effective triple helix tend to be more competitive globally [7, 8]. Resource efficiency and effectiveness in the triple helix also drive industry to utilize research facilities and human resources from universities, reducing R&D costs. The role of universities can include receiving research funding from industry or the government. The government can collaborate with the other two actors to implement more targeted development programs. The triple helix can also have a solution to social issues, such as renewable energy, health, education, and the environment cannot be solved by one party alone.

Furthermore, the triple helix collaboration enables the development of research-based, applicable, and policy-legitimate solutions, strengthening regional innovation ecosystems. At the local level, triple helix collaboration can create innovation clusters rooted in local potential [8, 9].

Knowledge, learning, and innovation are the most important factors for competitiveness in the globalization era and a knowledge-based economy, especially for business development that requires speed in responding to technological changes and being able to win the competition. Strategic partnerships with suppliers, customers, and universities can enhance knowledge sharing, improve access to complementary resources, and lower R&D risks and costs [9]. University-Industry Collaboration is effective in transferring technology, turning research into commercial use, and creating innovative products and services [10]. In this context, technoparks serve as platforms that extend the benefits of University-Industry Collaboration by facilitating the application of research outcomes within specific regions. Technoparks are expected to close existing gaps and support mining regions in adapting to the new economy [11]. Referring to the International Society of Science Park and Technopark [12], the essential characteristics that should be understood are as follows: (a) established to foster businesses grounded in knowledge and technology, (b) the presence of operational interactions between universities or other educational institutions, (c) the creation of a management structure that facilitates technology transfer and provides conditions for entrepreneurs to operate and optimize their business activities, and (d) the participation of large corporations or startups as commercial actors addressing customer demands. There are general principles needed as key factors to build a successful science park or technopark [13], namely: (a) vision and leadership, (b) network development,(c) commitment and trust, (d) interactive learning, and (e) circulation of success.

CKC is a concept that fosters innovation, and its application within organizations has become essential for surviving global competition, as innovation requires extensive knowledge and strong competencies. CKC is a process in which various parties (with diverse backgrounds) jointly create, share, and develop knowledge to solve problems or create innovation [14]. Therefore, knowledge comes not only from academia, but also from practical industry experience, government policies, and even the community. CKC is part of organizational knowledge creation, where knowledge is created through interactions between tacit knowledge and explicit knowledge between individuals and groups within the organization [15, 16]. There is the process of working together to identify, generate, share, and spread knowledge and expertise so it can be reused, understood, and learned [17, 18]. The concept of CKC describes a process in which multiple individuals collaborate to generate new information and knowledge, which can then support organizational innovation and development [5]. There are four key stages in the process of creating collaborative knowledge [15]: (a) exploring and sharing, (b) interpreting and analyzing, (c) negotiating and revising, and (d) combining and creating. The concept of CKC emphasizes joint efforts in generating and sharing knowledge. The triple helix concept then developed into the quadruple helix concept, which explains the existence of collaboration from the community or environment. The quadruple helix model emphasizes the importance of the public role in the innovation process and strategic decision-making, including in the business world [19]. In business, quadruple helix can be inclusive such as: (a) participatory innovation, customers, communities, NGOs, and the general public are involved in the innovation process, (b) integrating knowledge from various sources, business innovation combines from scientific research (academia), technology and production (industry), policy (government), values, needs, and aspirations of society (civil society, (c) the role of communities as partners, not just consumers, and communities are involved as collaborative partners, not just target markets, (d) responsive to social and environmental issues, business innovation is directed at solving real problems in society, (e) Cross-sector collaboration for comprehensive solutions which the company collaborates with universities for R&D and talent development, government for making regulations, incentives, and joint projects, communities doing product trials, needs validation, (f) transparency and information disclosure that business are more open in their communications, especially when making strategic decisions that impact society [19, 20]. The development of the quadruple helix model is the pentahelix. The Pentahelix model complements this by encouraging collaboration among diverse stakeholders to maximize organizational outcomes. The pentahelix serves as a reference for fostering collaboration among stakeholders to provide optimal support in achieving organizational goals [21, 22]. The dimensions of the Pentahelix consist of: (a) academia, (b) business actors, (c) society, (d) government, and (e) media [22]. Therefore, the Pentahelix model is a systemic and collaborative approach that unites five important elements (academia, business, government, society, media) to produce inclusive, adaptive and sustainable innovation in facing the complexity of social, economic and environmental problems [23]. The relationship between the pentahelix model and technopark is that the pentahelix describes how collaboration framework occurs, while technopark is a physical and digital container or ecosystem where that collaboration occurs. Technoparks are usually managed by universities or local governments, involving the industrial sector and other strategic partners. In the globalization era, the relationship between technoparks, academic institutions, and external parties is very close and strategic, because both strengthen each other in creating a dynamic and globally competitive innovation ecosystem [22, 23].

This research applies a systems thinking approach using the Soft Systems Methodology framework as outlined by Checkland and Poulter [24]. Data collection was conducted through interviews, observations, literature reviews, and documentation to ensure a comprehensive understanding of the research context. The organizations involved in this extended research include Telkom University, USK, and PNP. These organizations serve as representative cases for analyzing technopark implementation as a platform for innovation and collaborative knowledge development.

Three semi-structured interviews were conducted between August 2024 and July 2025 with key informants who held direct responsibilities in managing technopark programs. The participants included: (i) Ade Irma Suryani, SE., M.Si, the Head of the Business Management Study Program at Universitas Syiah Kuala (USK), (ii) Dr. Primadona, SE., M.Si, the Head of the Business Administration Department at Politeknik Negeri Padang (PNP), and (iii) Boy Syahputra, S.Sos., M.Sc., Ph.D, the Marketing Manager of Bandung Techno Park at Telkom University (Tel-U). A purposive sampling strategy was applied to ensure the inclusion of participants directly involved in university-industry collaboration, partnership agreements, and startup incubation. Each interview lasted between 45 and 90 minutes.

Data were analyzed using thematic analysis by identifying and categorizing key information into themes such as collaboration bottlenecks, innovation support mechanisms, and technopark outputs. These themes were then systematically mapped to the stages of the Soft Systems Methodology (SSM) and the Pentahelix framework, ensuring consistency between empirical evidence and theoretical interpretation.

To ensure methodological rigor, triangulation was conducted through the application of the CATWOE framework (customers, actors, transformation process, weltanschauung, owners, and environmental constraints). This process validates the collaboration dynamics and enhances the reliability and trustworthiness of the findings.

The application of Soft System Methodology in this study follows the structured stages from the first to the fifth, while the sixth stage represents the analysis results derived from research discussions. The seventh stage, which marks the implementation phase, is interpreted through the lens of CKC combined with the Pentahelix model. The integration of Pentahelix highlights the multi-stakeholder synergy required for sustainable innovation. The analytical process consists of: (a) identifying what is considered problematic, (b) expressing the problem situation, (c) formulating the root definition of relevant purposeful activity systems, (d) developing conceptual models of the systems (holons) described in the root definition, (e) comparing these models with the real-world situation, (f) determining changes that are systematically desirable and culturally feasible, and (g) taking action to improve the problem.

# 3. Results

The research findings on the collaboration of academia and industry in Indonesia reveal that Soft Systems Methodology provides a systematic framework to understand and address complex multi-actor dynamics involving academia, industry, government, communities, and media. The seven stages of Soft System Methodology are applied as follows:

**Step 1: Problem Situation Considered Problematic**

Interviews across Telkom University, USK, and PNP highlight recurring challenges: bureaucratic delays in Memorandum of Understanding/Memorandum of Action (MoU/MoA) processes, delay in fund allocation, uneven industry readiness, and the perception of collaboration as corporate social responsibility rather than strategic innovation. These issues restrict the full realization of Pentahelix synergy in technopark ecosystems.

**Step 2: Problem Situation Expressed**

The second step involves explaining the problem situation deemed problematic, presented in a specific form and represented through a rich picture. This rich picture illustrates analysis one, analysis two, and analysis three [24] regarding industrial collaboration with higher education. Universities attempt to transfer academic knowledge into industrial innovation, industries show varying levels of commitment, governments provide limited but crucial policy support, communities expect empowerment, and media serve as a dissemination channel. Yet, structural obstacles such as slow bureaucracy and resource limitations hinder effective collaboration. **Figure 1** below explains the rich picture of this research.

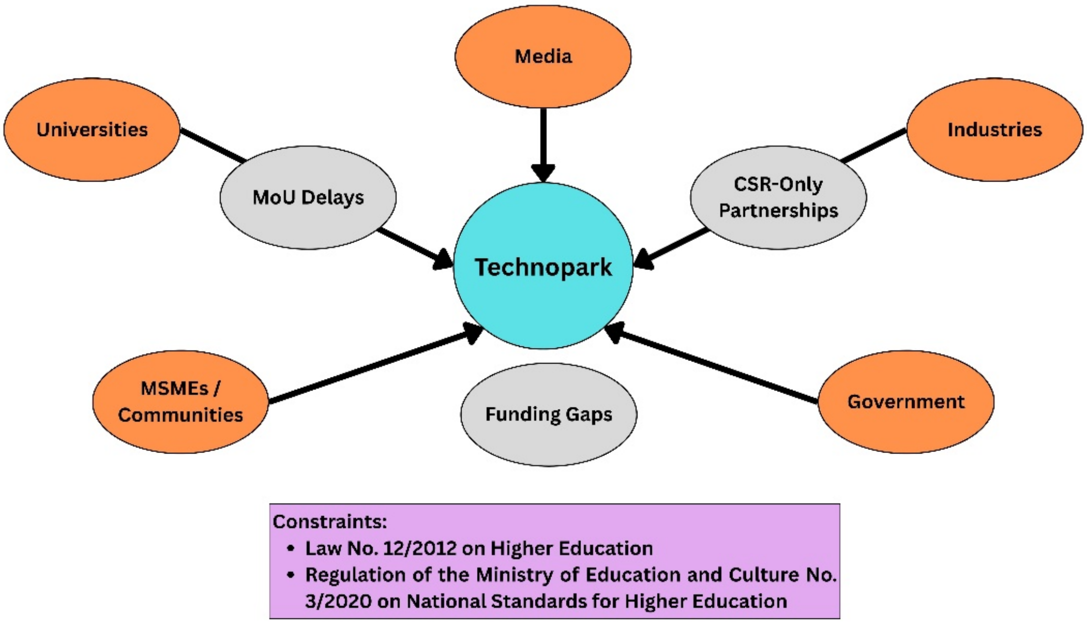


**Figure 1.** Rich Picture.

**Figure 1** illustrates the technopark as the central hub, surrounded by key stakeholders: universities, industries, government, MSMEs/communities, and media. Arrows indicate knowledge and resource flows connecting each actor to the hub. Bottlenecks (grey ovals) represent systemic challenges, including MoU delays, CSR-only partnerships, and funding gaps. Constraints (box) highlight regulatory such as Law 12/2012 and regulation 3/2020.

Building on the rich picture shown in **Figure 1**, the findings were then categorized into the stages of Soft Systems Methodology (SSM). **Table 1** summarizes this alignment by linking empirical evidence with each step of the framework.

**Table 1.** Mapping of SSM Stages.

| SSM Stage | Analytical Output | Empirical Evidence | Implication for Technoparks |
|---|---|---|---|
| Problematic situation | Interview transcripts, observation notes | "The MoU/MoA process with the bank may take longer, with the program duration being 6 months." (Ade Irma, USK) | Bureaucratic delays hinder collaboration |
| Problem expressed | Draft Rich Picture | Barriers: MSMEs need legality, industries reluctant to collaborate (Primadona, PNP) | Expectation gaps between academia and industry |
| Root definition | Statement of purpose | "Technopark as a cross-sector hub to transform research into startups and MSME products." (Ade Irma, USK; Boy Syahputra, Tel-U) | Sets the analytic lens |

**Table 1.** *Cont.*

| SSM Stage | Analytical Output | Empirical Evidence | Implication for Technoparks |
|---|---|---|---|
| Conceptual models | CATWOE/3E tables | Actors = lecturers, MSMEs, industries; Customers = students, MSMEs, government. (Ade Irma, USK; Primadona, PNP) | Frames a systemic perspective |
| Comparison | Ideal vs. observed table | Ideal = Fast MoU; Reality = 2 weeks and possibly more. (Primadona, PNP) | Gap identification |
| Desirable & feasible change | Action list | "Digitalization of MoU process should be accelerated." (Primadona, PNP) | Policy suggestion |
| Action to improve | Implementation cases | 1,000 labeled products (USK), 41 IPs (PNP), 10 startups/year (Tel-U) | Proof of traction and impact |

Source: Data processed, 2025.

**Step 3: Root Definition**: As shown in **Table 2**, in this research, the root definition describes a human activity system that will be analyzed or proposed as a solution to a complex problem (soft problem). A system of human activities aimed at creating cross-sector collaboration with Pentahelix in knowledge management to support Technoparks as innovation hubs, enabling them to have a real impact on local economic and technological development, within the constraints of available policies and resource capacity.

**Step 4: Conceptual Models**

Referring to the root definition above, academia is positioned to respond to the needs and rapid changes of today's industrial world. To analyze this problem of institutional collaboration in strengthening organizational competitiveness, the CATWOE and 3E frameworks[24] are applied. These frameworks help to clarify the system components, stakeholders, and performance criteria that shape the technopark ecosystem, as shown in the following tables (**Tables 3–5**).

In addition to CATWOE and 3E, a logic model was developed to map the roles of Pentahelix actors across incubation stages, from inputs to impacts. This model provides a structured pathway that complements the rich picture in **Figure 1**: while the rich picture illustrates the messy reality, the logic model shows the idealized flow of activities and contributions, highlighting how academia, industry, government, communities, and media interact to achieve sustainable innovation outcomes.

**Table 2.** Root Definition for University Industry Collaboration.

| Root Definition | Process | System |
|---|---|---|
| RD | The policy formulation and collaboration process is established through partnerships among universities, industries, government, communities, and media in order to realize CKC as a concrete manifestation of Technopark development. | The system is operated by universities and their technoparks in the context of policy formulation (P), strengthened through interaction and communication at the externalization and sharing stages to reduce information asymmetry in cooperation networks (Q). This system facilitates the implementation of CKC across multiple actors within the Pentahelix model, ensuring that academic research is transformed into patents, startups, community empowerment programs, and commercialized products. |

Source: Data processed, 2025.

**Table 3.** CATWOE.

| Element CATWOE | Operational Definition | Empirical Evidence |
|---|---|---|
| Customers | MSMEs, industries, students, government | "56 MSMEs mentored, 24 cooperation agreements signed." (PNP) |
| Actors | Lecturers, research center managers, local government, industry partners | "We lack continuity of budget for startup incubation." (PNP) |
| Transformation | Research → IP/startups → commercialization | 70 research projects (USK), 41 IPs (PNP), BTP startup incubation (Tel-U) |

**Table 3.** *Cont.*

| Element CATWOE | Operational Definition | Empirical Evidence |
|---|---|---|
| Weltanschauung | Technopark as a regional innovation hub | "We see BTP as the backbone of regional innovation." (Tel-U) |
| Owners | University leaders, ministries | "The campus strategic plan determines collaboration direction." (PNP) |
| Environment | Bureaucracy, funding gaps, uneven industry readiness | "MoU approval requires long process." (USK) |

Source: Data processed, 2025.

**Table 4.** 3E.

| 3E Criterion | Focus | Empirical Evidence |
|---|---|---|
| Efficacy | Reducing information asymmetry | MSMEs in Aceh improved competitiveness through labeled products, supported by the Career Development Center (USK) |
| Efficiency | Optimizing resources | Cross-faculty incubator model; Tel-U applying iGracias LMS for integrated digital learning and collaboration |
| Effectiveness | Realization of outputs | PNP mentoring sustained 56 MSMEs; Tel-U incubates ~10 startups/year; >40 IPs registered by PNP |

Source: Data processed, 2025.

**Table 5.** Logic Model of Pentahelix Roles Across Technopark Development Stages.

| Actor (Pentahelix) | Inputs | Activities | Outputs | Outcomes | Impact |
|---|---|---|---|---|---|
| Academia | Research capacity, lecturers, students | Conduct R&D, curriculum integration, cross-faculty incubators | Publications, IP rights, startups launched | Skilled graduates, student entrepreneurs | Academic excellence, employability |
| Industry | Capital, market insights, networks | Mentoring, joint product development, curriculum feedback | Industrial prototypes, MoU/MoA with firms | Revenue growth for startups, stronger university–industry linkages | Economic competitiveness, technology transfer |
| Government | Policies, regulations, funding (matching grants, P3M, Bappenas support) | Provide incentives, digitalize MoU processes, reduce bureaucracy | Grants awarded, technopark regulations, multi-year agreements | Faster approvals, better coordination | Sustainable governance, innovation policy alignment |
| Community/ MSMEs | Local knowledge, product needs, MSME clusters | Participate in training, co-design solutions, mentoring | MSME products certified/labeled, incubation cases | Increased competitiveness of MSMEs, adoption of digital tools | Community empowerment, regional economic growth |
| Media | Public trust, communication channels (websites, portals, social media) | Promote technopark activities, disseminate research & innovation | Campaigns, press releases, digital showcases | Higher public awareness and engagement | Long-term diffusion of innovation, stronger ecosystem visibility |

Source: Data processed, 2025.

**Step 5: Comparison of Models and the Real**

To systematically compare the conceptual model with real-world practices, institutional indicators were first mapped to the logic model framework. **Table 6** summarizes key inputs, outputs, and outcomes from the three technoparks, providing an empirical snapshot of their initiatives. Building on this evidence, **Table 7** contrasts the ideal expectations with observed practices, identifying root causes of the gaps and proposing feasible changes with clear ownership and timelines.

**Step 6: Changes that are Systematically Desirable and Culturally Feasible**

Step 6 in the Soft System Methodology explains the process of implementing systematic changes that are both culturally feasible and technically necessary, so that technoparks can function more effectively. Implementation of a technopark in the systematically desirable step includes: (a) a startup incubator with access to investors and global markets, (b) research collaboration with joint research between campus and industry, (c) communication between actors through a technopark information system based on digital platform, and (d) media promotion to brand the technopark through social media & public events.

**Table 6.** Inputs, Outputs, and Outcomes of Technoparks (Logic Model Basis).

| Institution | Inputs | Outputs | Outcomes |
|---|---|---|---|
| USK (Aceh) | Career Development Center; Community service programs | 1,000 labeled products; 70 research projects; 35 community services | Upgraded MSMEs; graduates absorbed by industries |
| PNP (West Sumatra) | Research & Community Service Center; IP registration support | 41 IPs; 56 MSMEs mentored; 24 MoUs | Increased competitiveness; stronger industry networks |
| Tel-U (West Java) | BTP incubation curriculum; iGracias LMS | 10 startups/year; integrated OBE curriculum | Startups scaled; curriculum aligned with industry |

Source: Data processed, 2025.

**Table 7.** Comparison of Ideal Model and Observed Practices.

| Ideal (Concept) | Observed (Practice) | Root Cause (from Interviews) | Feasible Change | Owner | Timeline |
|---|---|---|---|---|---|
| Fast MoU/MoA | MoU takes 2 weeks and possibly more (USK, PNP) | Long bureaucracy; cautious industry partners | Digitalized MoU workflow; flexible SOPs | University + Government | Short-term |
| Consistent funding | Delays & lack of continuity | Reliance on grants, CSR sporadic | Multi-year agreements | Government + Industry | Medium-term |
| Industry as strategic partner | Industry treats collaboration as CSR duty | Weak incentives; no co-funding | Matching fund schemes | Industry + Universities | Medium-term |
| Integrated knowledge sharing | Fragmented initiatives across faculties | Weak coordination; adaptation barriers (Tel-U lecturers) | National Technopark Network | Ministries | Long-term |

Source: Data processed, 2025.

Culturally feasible means that the proposed changes must be socially and culturally acceptable to the actors involved. In this step, the implementation of a technopark includes: (a) a startup incubator with locally adapted incubation curriculum in learning process, (b) research collaboration by adjusting the mechanism so that campus bureaucracy does not become burdensome, (c) communication between actors using digital training for MSMEs and regional staff, and (d) media promotion that raises local values so that they can be accepted by society.

The findings suggest three desirable changes:

1. Strengthening trust-based collaboration through flexible Memorandum of MoU/MoA processes and personalized approaches, particularly for Micro, Small and Medium Enterprises (MSMEs).
2. Expanding incubation programs to bridge the gap between research and commercialization
3. Enhancing the role of media as a knowledge diffuser, ensuring community-level awareness and adoption of innovations.

### Step 7: Action to Improve the Problem

This stage focuses on real actions taken to fix complex problems and involves many stakeholders, such as in technopark management and how the system works. To ensure effective execution, several systematic steps are undertaken: (a) concrete steps to reduce system bottlenecks, improve process deficiencies, improve collaboration between actors, and implement new, more effective and efficient systems.

Systematic steps for technopark action are: (a) identify key issues within the technopark, (b) determine desirable and feasible changes (from the previous stage), (c) design specific actions based on these changes, (e) involve stakeholders in planning and implementation, (f) implementation in stages and be measurable, and (g) evaluate results and adapt strategies.

Evidence from the interviews suggests that the transition from conceptual models to practical actions is already underway, as universities and technoparks have begun implementing CKC and Pentahelix based initiatives to strengthen innovation, entrepreneurship, and community empowerment.

**Table 8** presents a comparative overview of the Pentahelix implementation. Several important patterns emerge that require further explanation. These are outlined in the following points.

**Table 8.** Implementation Pentahelix.

| Pentahelix | USK | PNP | Tel-U |
|---|---|---|---|
| Academia | 70 research projects, 35 community service programs (last 3 years), Career Development Center (CDC) linking students, alumni, and industry | 15 research projects, 18 internal grants, Registered 40+ intellectual property rights (last 2 years). | 100% digital learning, OBE |
| Industry | MoU/MoA with banks & PLN | 24 formalized partnerships (last 2 years). | FGD with industry for new curriculum |
| Government | Support from Bappenas, rector regulations | PNP strategic plan, P3M | Support from Ministry of Education and Culture & digital regulations |
| Community | Empowered villages in Aceh Besar, 1,000 labeled products | 56 guided MSMEs | Student business incubation at BTP |
| Media | USK website, collaboration portal | PNP website, lecturers/students' social media | iGracias portal, online thesis defense system |

Source: Data processed, 2025.

**Universitas Syiah Kuala-Aceh**

1. Established the Career Development Center (CDC) to connect students, alumni, and industries with the job market.
2. Initiated an entrepreneurship program targeting 1,000 product labels to strengthen the branding and competitiveness of local businesses.
3. Collaboration with government agencies and banking institutions enhanced funding and sustainability of these initiatives.

**Politeknik Negeri Padang-West Sumatera**

1. Registered over 40 intellectual property rights in the last two years.
2. Developed structured MSME mentoring programs, with 56 MSMEs supported to improve capacity and competitiveness.
3. Formalized 24 cooperation agreements with external partners.

**Telkom University Bandung-West Java**

1. Curriculum Transformation: Entrepreneurship-oriented curriculum integrating design thinking, creativity, innovation, and entrepreneurship courses, designed to prepare students for business incubation at Bandung Techno Park (BTP).
2. Business Incubation: Early-stage entrepreneurial training (semesters 1–5) followed by incubation programs in semester 6, complemented by cross-faculty collaboration to support idea execution and commercialization. The Bandung Techno Park Incubation Program (BTPIP) is an exclusive six-month incubation program, available not only to Telkom University academics but also to the general public looking to develop their businesses. This program focuses on helping startups grow faster through market projections, profit potential, and sustainable business strategies. Generally,

startups participating in BTPIP are entering the growth stage and require more intensive mentoring. BTPIP participants will receive a variety of excellent facilities, including bootcamps, mentoring, coaching clinics, demo days, business matching, and access to an extensive business network. To join BTPIP, there are several activities to do, such as: prospective participants can register through the link on the website, and will undergo a selection process based on predetermined criteria. Startups that pass the selection process will be selected among the 10 selected participants each year and have the opportunity to participate in the entire incubation program. The programs and services related to Bandung Techno Park's activities include recruiting tenants or startups for a one-year period through business incubation. BTP also provides space and supporting facilities for tenants and new startups that do not yet have their own offices, through rental office and virtual office programs. Furthermore, BTP also provides counseling for the implementation of Intellectual Property Rights (IPR) programs within the Intellectual Property Rights Center program. Besides that, BTP also carries out innovation development and research on the implementation of Big Data, software, and hardware for tenants and companies, both internally and externally, and all related stakeholders within the Big Data Consulting, Software Development, and Hardware Development programs.

3. Industry-Linked Collaboration: Development of new concentrations such as Machine Learning in Business through industry-focused FGDs, ensuring curriculum relevance to market and industrial needs.

# 4. Discussion

The findings of this study show that the technopark in Indonesia serve as an important platform for University–Industry Collaboration (UIC) through the use of CKC and the Pentahelix model. This result aligns with previous studies [14–16], which highlight that collaborative knowledge creation and the Pentahelix approach play a crucial role in expanding networks, fostering innovation, and supporting community-based development. Initiatives such as Bandung Techno Park (BTP) at Telkom University, MSME mentoring program at PNP, and the career center program at USK demonstrate how CKC practices can bridge the gap between academia and industry. These findings further strengthen the argument of [12, 20, 21, 23] that technoparks act as knowledge integration mechanisms, enabling innovation to move from ideas into commercialization.

In addition, the study [25] on electric vehicle (EV) technologies emphasizes that large-scale innovations can only thrive when supported by multidimensional evaluations. Similarly, both technopark development and EV advancement highlight the urgency of collaborative innovation across multiple stakeholders to achieve sustainability. The study points out that individuals must possess digital literacy and awareness to fully participate in modern society [26]. This perspective is highly relevant to technoparks, as their success depends not only on infrastructure and policy support but also on the readiness of human resources who are digitally literate, critical, and adaptive. Therefore, technoparks play a dual role, acting as catalysts of innovation while also fostering digital awareness as a key competence to face ongoing technological transformation [3, 4, 9].

# 5. Conclusions

This study shows how CKC, integrated with the Pentahelix framework, enables technoparks to function as inclusive platforms bridging academia, industry, government, communities, and media. The originality lies in combining systemic analysis with multi-stakeholder collaboration, an approach rarely applied in technopark research. The findings offer practical recommendations, including digitalizing MoU/MoA processes to reduce bureaucratic delays, establishing multi-year funding schemes for research continuity, and fostering cross-faculty incubators that connect academic outputs with industrial and MSME needs. These contributions extend the literature on innovation ecosystems while providing policymakers, universities, and industries with actionable strategies to strengthen cooperation, enhance graduate competencies, and drive sustainable community-based development.

This research is limited by its focus on three case institutions and qualitative interviews, which were conducted using purposive rather than systematic sampling. Quantitative indicators were available only in selected cases (e.g., intellectual property registrations, MSME mentoring activities, and startup counts). Future research could expand the scope to additional provinces, employ mixed-method approaches such as surveys or econometric analysis, and track long-term outcomes, including job creation, revenue growth, and regional competitiveness indices.

# Author Contributions

I.M. developed the research plan, conducted field investigation, and edited the manuscript. N.L. prepared the abstract, methodology, and literature study. E.W. contributed to data collection, analysis, and conclusion. N.S. contributed to checking data analysis. P.F. drafted the manuscript and the visualization. All authors have read and agreed to the published version of the manuscript.

# Funding

This research was funded by the Research and Community Service Center–Politeknik Negeri Jakarta in 2025, especially for the senior lecturer grant, and students from the Business Administration Department–Politeknik Negeri Jakarta.

# Institutional Review Board Statement

Not applicable.

# Informed Consent Statement

Not applicable.

# Data Availability Statement

Not applicable.

# Acknowledgments

The authors sincerely thank all individuals and institutions who supported this research, particularly the staff of Politeknik Negeri Jakarta.

# Conflicts of Interest

The authors declare no conflict of interest.

# References

[1] Stachel, R., Mussante, L., 2024. Corporate Entrepreneurship: Innovation in Global, Corporate Environments. In: Aldieri, L. (Ed.). Innovation – Research and Development for Human, Economic and Institutional Growth. IntechOpen: Rijeka, Croatia. DOI: https://doi.org/10.5772/intechopen.111805

[2] Smirnova, V., Latfullin, G., Baziyan, J., et al., 2019. Transfer of Knowledge and Its Impact on Integration Processes in the Technopark. In Proceedings of the International Conference on Man-Power-Law-Governance: Interdisciplinary Approaches (MPLG-IA 2019), Moscow, Russia, 24–25 September 2019; pp. 220–225. DOI: https://doi.org/10.2991/mplg-ia-19.2019.43

[3] Akaydın, A., 2023. The Role of Technoparks in the Innovation Ecosystem and a Model Proposal for Its Development: Technology Transfer and Development Center. International Journal of Business Science & Applications. 3(1), 80–103.

[4] Sudiana, K., Hendayani, R., 2020. Performance Management Practices in Science Technology Parks: Case Study of Bandung Techno Park. Jurnal Manajemen Indonesia. 20(1), 52–61.

[5] Mariam, I., Sofa, N., Wartiningsih, E., et al., 2022. Technopark: A Strategy to Build Partnership in Educational Institutions and Industrial Using Concept of Collaborative Knowledge Creation. In: Singh, S., Aurifullah, M., Kianmehr, P., et al. (Eds.). Smart Environmental Science Technology and Management. Technoarete Publishers: Chennai, India. pp. 19–23.

[6] Oktafiani, F., Alfius, G., Fadillah, F.N., et al., 2023. The Role of the Education and Training Program at Solo Technopark in Enhancing Human Resource Quality in Surakarta. Jurnal Ilmiah Multidisiplin. 1(10), 161–166. DOI: https://doi.org/10.5281/zenodo.10081095 (in Indonesian)

[7] Uddin, S., Khan, M.A., Uddin, M.K., et al., 2015. University-Industry Collaboration (UIC) for Developing Highly Skilled and Productive Business Graduates in Bangladesh. Global Business and Management Research: An International Journal. 5(1), 31–41. Available from: https://www.researchgate.net/publication/264008059

[8] Chistov, V., Hermosilla, J., Aramburu, N., 2023. Open Eco-Innovation. Aligning Cooperation and External Knowledge with the Levels of Eco-Innovation Radicalness. Journal of Open Innovation: Technology, Market, and Complexity. 9(2), 100049. DOI: https://doi.org/10.1016/j.joitmc.2023.100049

[9] Jing, L.C., 2024. How Does University-Industry Collaboration Drive the Green Innovation? SAGE. 14(3), 1–19.

[10] Hajrizi, B., Shaqiri, A.B., Veliu, L., 2025. Advancing

Innovation through University-Industry Collaboration: Empirical Evidence from a Developed Economy. Multidisciplinary Science Journal. 7(8), e2025435. DOI: https://doi.org/10.31893/multiscience.2025435

[11] Kalenov, O., Kukushkin, S., 2018. Techno-Park Assistance in Mining Regions' Integration into the Innovative Economy. E3S Web of Conferences. 41, 04025. DOI: https://doi.org/10.1051/e3sconf/20184104025

[12] Aldianto, L., Mirzanti, I., Sushandoyo, D., et al., 2018. The Development of Science and Technology Parks in the Era of Industry 4.0: A Literature Review. Jurnal Manajemen Indonesia. 18(1), 68–76. DOI: https://doi.org/10.25124/jmi.v18i1.1261 (in Indonesian)

[13] Seo, J.H., 2006. The Korean Techno-parks as the Hub of Sub-national Innovation System: Case of Daegu Techno-park. In Proceedings of the National Workshop on Sub-national Innovation Systems and Technology Building Policies to Enhance Competitiveness of SMEs, 21–22 December, Kathmandu, Nepal.

[14] Busengdal, E., Amdam, R., 2023. Co-Creation as a Strategy for Expanding Networks and Creating a Broader Collaboration Profile for Implementing Integration Policies. Cogent Social Sciences. 9(1).

[15] Du Chatenier, E., Verstegen, J.A.A.M., Biemans, H.J.A., et al., 2009. The Challenges of Collaborative Knowledge Creation in Open Innovation Teams. Human Resource Development Review. 8(3), 350–381.

[16] Nonaka, I., Takeuchi, H., 1995. The Knowledge Creating Company: How Japanese Companies Create the Dynamics of Innovation. Oxford University Press: New York, NY, USA.

[17] Soemaryani, I., 2016. Pentahelix Model to Increase Tourist Visit to Bandung and Its Surrounding Areas through Human Resource Development. Academy of Strategic Management Journal. 15(3).

[18] Tjandra, A.S., Setyawati, C.Y., 2025. Collaborative Knowledge Creation as a Driver of Business Sustainability through Proactiveness and Agility in Beauty Brands. Edu Cendikia: Jurnal Ilmiah Kependidikan. 4(3), 1504–1512.

[19] Putro, Z.A.E., Nurhayati, I., Mariam, I., et al., 2020. Interdisciplinary Knowledge Sharing through Web-Based Seminars during the Work-from-Home Period. APTEKMAS: Jurnal Pengabdian Kepada Masyarakat. 3(4). Available from: https://jurnal.polsri.ac.id/index.php/aptekmas/article/view/2957 (in Indonesian)

[20] Caryannis, E.G., Campbell, D.F.G., 2012. Mode 3 Knowledge Production in Quadruple Helix Innovation Systems: 21st Century Democracy, Innovation, and Entrepreneurship for Development. Springer: New York, NY, USA.

[21] Monteiro, S.P.D.O., Carayannis, E.G., 2017. The Quadruple Innovation Helix Nexus: A Smart Growth Model, Quantitative Empirical Validation and Operationalization for OECD Countries. Palgrave Macmillan: New York, NY, USA.

[22] Subagyo, A., Handoko, R., Wahyudi, H., 2022. Pentahelix Policy Management Paradigm as a Model for Disaster Management in Bojonegoro Regency East Java. International Journal of Entrepreneurship and Business Development. 5(4), 739–750.

[23] Prasetyo, N.D., Arrsa, R.C., Haq, M.C.A., et al., 2023. The Juridical Framework of the Pentahelix Model in the Preparation of Regional Medium-Term Development Planning. Jurnal IUS Kajian Hukum dan Keadilan. 11(3), 569–588.

[24] Checkland, P., Poulter, J., 2006. Learning for Action. John Wiley & Sons: Chichester, UK.

[25] A-Razek, M.M., Ali, S.H.R., 2025. Assessing Performance, Economic and Environmental Impact of EVs. Standards-Related Regional Innovation and International Cooperation. 1(1), 1–16. DOI: https://doi.org/10.63385/sriic.v1i1.199

[26] Brummer, L., 2025. Conceptualizing Digital Awareness: Introducing a Definition via a Scoping Review of Digital Literacy and Digital Citizenship. Innovations in Pedagogy and Technology. 1(2), 41–55. DOI: https://doi.org/10.63385/ipt.v1i2.125