



(2024/25 KSP-ADB Joint Consulting)

**Azerbaijan: Transforming
Higher Education into Innovation Hub
– focusing on Sumgayit State University**

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List of Abbreviations

Abbreviation	Full Description
ANAS	Azerbaijan National Academy of Science
BME	Big and Middle Enterprises
EATDA	State Agency for Science and Higher Education
EHEA	European Higher Education Area
IDDA	Innovation and Digital Development Agency
KAIST	Korea Advanced Institute of Science and Technology
KIST	Korea Institute of Science and Technology
MDDT	Ministry of Digital Development and Transportation
MSE	Ministry of Science and Education
POSTECH	Pohang University of Science and Technology
SST	State Statistical Committee
SSU	Sumgayit State University
SOCAR	State Oil Company of the Republic of Azerbaijan
TKTA	Azerbaijan Quality Assurance Agency

Abstract



The Azerbaijan Higher Education Innovation Hub Transformation Project is a policy consulting initiative jointly implemented by the Korean government and the Asian Development Bank under the Knowledge Sharing Program. The project aims to transform Sumgayit State University (SSU) into a regional innovation hub in Azerbaijan. Initiated at the proposal of former SSU Rector Rufat Azizov, the project was carried out from early 2025 through late 2025. The Azerbaijani government has recently drafted a new Higher Education Law that promotes innovation and entrepreneurship, expands university autonomy, and strengthens quality assurance (currently pending parliamentary approval). These measures reflect the government's strong interest in improving national industrial competitiveness through structural reform of the higher education sector. Sumgayit, long known for petrochemicals and heavy industry, is one of Azerbaijan's key industrial zones and is now shifting toward technology-intensive industries such as computer engineering, green energy, and robotics. Because Azerbaijani universities have traditionally remained education-oriented, their ability to meet industrial needs and generate innovation has been limited. Against this backdrop, the project sought to reform Azerbaijan's higher education ecosystem by leveraging Korea's development experience and to produce a comprehensive master plan and implementation strategy for turning SSU into a regional university–industry innovation hub. The project was supervised by Korea's Ministry of Economy and Finance and managed by the Export–Import Bank of Korea; implementation was carried out by the Korea Advanced Institute of Science and Technology (KAIST) and Ars Praxia Co., Ltd. On the Azerbaijani side, the Ministry of Science and Education (MSE) and SSU participated as partner institutions, identifying policy needs and supporting field investigations.

At the project initiation stage, representatives from both countries convened for a kick-off meeting and workshop. The opening session, held in Baku on February 2025, presented the overall schedule and cooperation framework and reaffirmed a shared vision for the innovation-hub transformation. Immediately thereafter, the Korean research team conducted the first field mission to assess the educational and industrial landscape in Sumgayit. The team held in-depth interviews with SSU's current and former executives to identify operational challenges and reform priorities, and it discussed core issues in higher education reform with senior MSE officials. The former rector elaborated on his vision to reposition SSU as a research-oriented university through international collaboration under the KSP initiative, while the vice-rector reported on current operations and constraints. The dean of natural sciences described the challenges of moving from a teaching-centered to a research-oriented institution. The director of the innovation center and faculty members shared outcomes and limitations of a decade of entrepreneurship and industry–academia cooperation efforts. The team also met with MSE advisors to identify policy and regulatory bottlenecks and began preliminary discussions with major industrial stakeholders such as SOCAR, the State Oil Company of Azerbaijan. SOCAR executives expressed a clear intention to establish a high-profile national research laboratory within Azerbaijan, moving beyond reliance on Turkish facilities and existing collaborations with Baku Higher Oil School. These early engagements clarified industrial demand and the potential for cross-sector cooperation and helped set the strategic

direction for the consultancy.

The field investigation phase comprised three rounds of missions. The second field mission focused on SSU's internal operations and the region's science and technology infrastructure. The team visited laboratories, the innovation center, and classrooms; conducted interviews and surveys with faculty and students; and analyzed institutional needs and expectations. In parallel, it held extensive discussions with private-sector partners including SOCAR and Pasha Group, confirming an openness to expand collaboration in chemical engineering, digital transformation, and green energy. A visit to the Sumgayit Technology Park showed that, contrary to expectations for a research-intensive zone, the site still functions largely as a secondary industrial complex centered on storage and maintenance. This underscored the need to strengthen regional innovation infrastructure and to consider an independent research institute alongside university-based capacity. The third mission proceeded during a leadership transition at SSU that temporarily slowed on-campus reform momentum. The Korean team therefore engaged more broadly with the MSE, the Ministry of Digital Development and Transport, the Innovation and Digital Development Agency, and key industry representatives to identify alternative drivers of innovation. In particular, the team visited the Sabah City development near Baku, a government-led initiative to build an innovation cluster by attracting technology-focused facilities and university campuses. Meetings with the Sabah City taskforce explored institutional options for a national research institute and for formalizing international cooperation. The taskforce indicated that land and other incentives could be provided to corporate or consortia-led R&D institutions prepared to invest. Meanwhile, the Sumgayit municipal administration acknowledged the lack of a concrete plan for regional R&D investment incentives. Taken together, these missions provided a comprehensive picture of academia–government–industry dynamics and confirmed that SSU alone cannot achieve innovation transformation without integrated policy support and purposeful corporate participation.

Across the missions, the team conducted an extensive diagnosis of SSU's education and research environment. SSU has a long tradition in chemistry, physics, and mathematics that aligns with the regional industrial base, yet academic outputs remain weakly linked to industrial application and emerging technologies. An analysis of scholarly output from 2022 to 2024 showed concentration in traditional disciplines, and many faculty members had limited experience with joint research or technology commercialization. Graduate and undergraduate students expressed strong demand for entrepreneurship education and practical innovation programs. At the same time, internal change was visible: younger faculty were creating startup clubs and innovation spaces, and more students sought international training and advanced technical coursework. Building on these findings, the team integrated relevant Korean university practices to design concrete capacity-building measures for SSU.

The mid-term workshop in Baku in May 2025 reviewed interim findings from the first two missions and discussed next steps. The Korean team presented preliminary policy recommendations derived from diagnosis and comparative analysis of Korean cases. Participants, including MSE officials, SSU leadership, and industry representatives, provided feedback on feasibility and prioritization. The government reaffirmed its commitment to institutional reform and fiscal support

for hub development, and SSU pledged to separate short-term deliverables from long-term objectives for phased implementation. Based on the discussion, the team refined the recommendations and finalized the structure of a comprehensive policy package.

Capacity-building in Korea followed in early summer 2025, enabling Azerbaijani policymakers and university leaders to study Korea's innovation-oriented higher education system firsthand. Over one week, a seven-member delegation composed of MSE officials, SSU executives, and representatives from SOCAR and Sabah.Hub joined an intensive program. The curriculum covered Korea's approaches to university–industry cooperation and R&D innovation, including KAIST's research-centered model, the Brain Korea 21 program for graduate researcher development, and the Leaders in Industry–University Cooperation initiative for campus-based innovation ecosystems. The delegation visited the Korea Institute of Science and Technology to learn about national research institute operations and toured the KAIST Startup Incubation Center to examine entrepreneurship support. Policy workshops with government agencies explored pathways to localize these experiences. Designed as a practical program, the training helped participants identify actionable steps upon return. Participants emphasized the value of a virtuous cycle among universities, research institutes, and industry, and the importance of sustained human capacity development and network building in addition to institutional reform. The program strengthened mutual understanding and deepened bilateral cooperation.

The final workshop in late September 2025 presented conclusive findings and the policy roadmap. The Korean delegation delivered the final report titled “Transforming Azerbaijan's Higher Education into an Innovation Hub – focusing on Sumgayit State University” and explained the core recommendations and implementation plan. The central proposal was to establish a world-class independent research institution and strengthen universities' innovation capacity. Three scenarios were presented. Option 1 would create a large-scale national research institute accompanied by an innovation center on the SSU campus; with adequate resources and inter-ministerial coordination, it could deliver transformative results. Option 2 would establish a medium-scale integrated research-and-innovation complex, for example in Sabah City, and expand it over time into a national hub; this balanced, phased approach combines realistic budgeting with scalable impact and was assessed as the most feasible under current conditions. Option 3 would restructure SSU's existing innovation center and upgrade laboratories with modest investment, producing quick, visible results while forming a base for longer-term programs. After evaluating political and fiscal feasibility and operational pros and cons, stakeholders converged on Option 2 as the most viable way forward, capable of evolving into a national model. To ensure success, they recommended forming a government-wide coordination body, establishing sustainable financing, and enacting legal and institutional adjustments. Both sides agreed to incorporate these refinements into the report and to explore follow-up cooperation under future ADB–KSP initiatives. Senior officials from the MSE, SSU faculty and staff, industry leaders, and representatives from the Korean Embassy and ADB discussed practical avenues for expanding international partnership.

In conclusion, the project provided a comprehensive blueprint for higher education reform in Azerbaijan. The analysis confirmed that Azerbaijani universities can become innovation-driven

institutions through strategic government support and targeted investment in research capacity. Success will require strong governmental commitment, consistent policy direction, and a triple-helix collaboration framework linking universities, research institutes, and industry. Priority should be placed on strengthening human capital in digital technologies and entrepreneurship. Korea's experience suggests that independent, autonomous research institutes can catalyze technological advancement, while national programs such as BK21 and LINC can raise research productivity and institutionalize university–industry knowledge exchange. At the same time, potential risks—such as short-term performance pressure and morale concerns in academia—should be mitigated through careful monitoring and feedback. The project outcomes are expected to serve as a practical policy guide for the Azerbaijani government and for SSU's strategic planning. The initiative has also deepened cooperation between Korea and Azerbaijan, laying the groundwork for sustained partnership. As both sides continue to share expertise and mobilize resources, Azerbaijan's transition to an innovation-oriented higher education ecosystem is likely to materialize, contributing to the country's post-oil economic transformation and long-term industrial development.

I. Project Overview

1. Background and Objectives

The KSP (Knowledge Sharing Program) initiated since 2004 by the Ministry of Economy and Finance in South Korea to meet rising demand for applying policy implications from the Korean development model to spread sustainable prosperity abroad. This platform for development cooperation aims to facilitate knowledge creation, knowledge sharing, capacity development, policy change, and stronger cooperation with partnership countries. 76 partnership countries in Asia, CIS region, Latin America, Africa, Middle East and North Africa, and Oceania (Australia) have participated in those projects over years. 9 international organizations such as World Bank, OECD and Asia Development Bank support the program financially and administratively to deliver the intended spread of knowledge, technology and development model.

1.1. Background

This Korea-Azerbaijan cooperation program (Azerbaijan: Transforming Higher Education into Innovation Hub – focusing on Sumgayit State University) was initiated by the former Rector of Sumgayit State University, Dr. Rufat Azizov, to facilitate academy-industry collaboration and invite external support to stimulate structural transformation of Azerbaijani universities towards research-oriented institutions. Sumgayit region is a core industrial district in Azerbaijan notably known for its oil refining and heavy and chemical industry. Industries in Sumgayit, with the expected support from the academy, lately try to diversify their domains into more technology-intensive areas such as computer science, green energy, robotics, etc. In this regard, these domains of future interests of Azerbaijan overlap with what South Korean industry and university have relative strength in technology, industrialization, and academy-industry collaboration globally.

South Korea also has accumulated abundant experiences over the last half a century in developing research institution that functioned as a major state engine to boost the *leap-frogging* industrialization along with technological innovation. As we will discuss, the Korea Institute of Science and Technology (KIST) founded in 1966 was one of the first notable attempts of the state research institution, followed by Korea Advanced Institute of Science and Technology (KAIST), Pohang University of Science and Technology (POSTECH) and other notable research institutions to achieve not only scientific innovation but also successful industrial translation.

In retrospect, the success story of South Korea in terms of gaining industrial competence and invigorating academy-industry collaboration was never a unilateral trajectory. For instance, while adopting the national strategies to facilitate research-oriented university and academy-industry collaboration since the late 1990s, mainly through the government-initiated policies of Brain Korea

21 (BK21) and Leaders in INdustry-university Cooperation (LINC), Koreans have witnessed trial and error, conflict, misunderstanding, and procedural shortcomings in the legislative, administrative and academic practices as well as successful institutional transformation and solid outcome to ensure technological competence.

The authors in this report would like to share both good practices and limitations South Korea has envisaged in a candid manner, so that our Azerbaijani partners can understand the underlying context and make use of Korea's knowledge transfer to their own. Essentially, a state-driven leadership mattered significantly in the early development stage, and well-designed strategy to implement the transition of national resources to private sector followed in the later stage of development.

1.2. Objectives

The objective of this project is to study the actual circumstances of Azerbaijan and Sumgayit region (along with Sumgayit State University) and help make the South Korean practices useful to the recipient country with concrete implementation plan of bilateral cooperation between South Korea and Azerbaijan. A few sub-tasks stand as important to deliver this end:

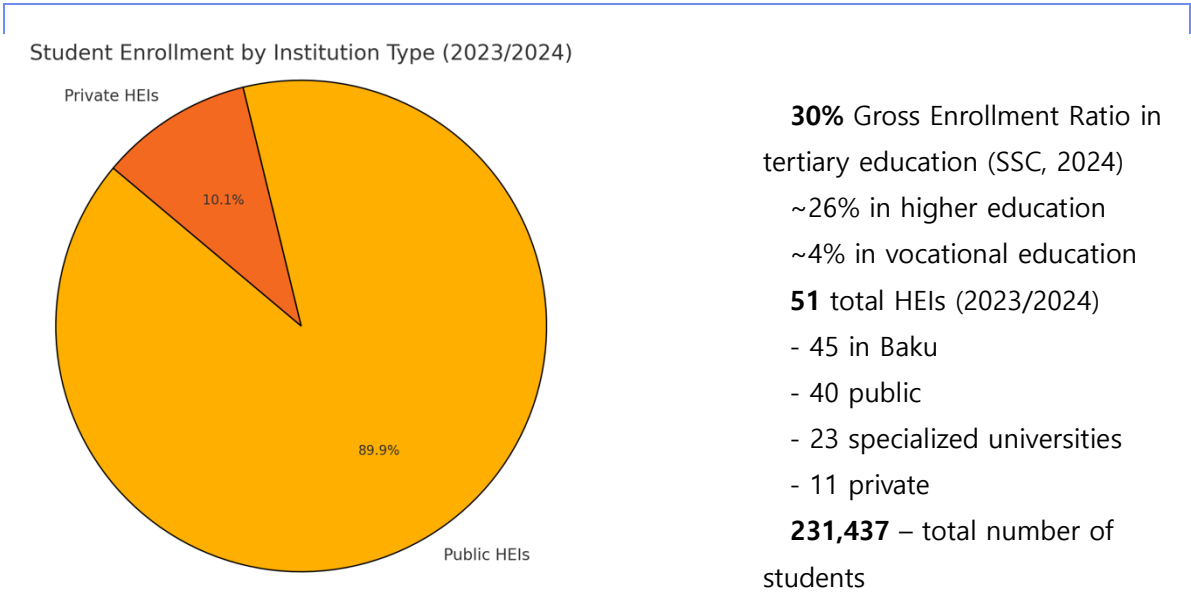
- ① Analyze and summarize the current status of higher education system in Azerbaijan**
- ② Assess the status of Sumgayit State University and Sumgayit region**
- ③ Find pathways to encourage research-oriented practices in the institution**
- ④ Identify required knowledge and skill-sets in Azerbaijan**
- ⑤ Suggest implementation plan to transfer key knowledges from Korea to Azerbaijan**

2. Higher Education in Azerbaijan & Need for Cooperation

2.1 Higher Education in Azerbaijan

As of 2025, Azerbaijan’s higher educational landscape includes a total of 51 Higher Education Institutions (HEIs), out of which 40 are state funded and 11 are privately owned. The Ministry of Education and Science oversees 20 public and 11 private institutions, while 13 public institutions fall under the authority of different state bodies, with additional 7 public institutions managed by specific government entities such as military or aviation training. A notable characteristic of Azerbaijan’s higher education landscape is its geographic concentration. Overwhelming majority of higher education institutions, around 85% (SSC,2025) are situated in and around capital city Baku, reinforcing the capital’s dominance in academic, professional and student life. While the total number of institutions stands at 51, they differ very much in governance and specialization. In total, 231,437 students are enrolled in Azerbaijani HEIs, with 208,110 attending public universities (89.9%) and 23,327 (10.1%) enrolled in private ones. The latest admission figures indicate a continued dominance of bachelor’s programs, with approximately of 88% of new students enrolling at the undergraduate level and 12% at the master’s level.

Figure 1 | Higher Education System of Azerbaijan



The higher education sector in Azerbaijan has been evolving rapidly over the years, shaped by both inherited Soviet legacy as well as many contemporary reforms. Historically modeled on the Soviet system, the Higher Education Institutions in the country have, over time, absorbed various policy approaches from the EHEA (European Higher Education Area) and, more recently, management practices adopted mainly from the far west. Around 20 years ago, accession of Azerbaijan to Bologna process in 2005 marked an important turning point, that gradually introduced different reforms such as the three-cycle system (adoption of Bachelor-Master-Doctorate structure), ECTS (European Credit Transfer and Accumulation System) and Diploma Supplement which had to be mandatory for graduates in order to improve transparency of their qualifications to facilitate global recognition of their degrees. More rigorous internal and external quality assurance

mechanisms have been put in place such as development of National Quality Assurance System aligned with the European Standards and Guidelines (ESG) and an establishment of Azerbaijani Agency for Quality Assurance (TKTA) to regulate accreditation of the institutions and support quality enhancement. These and other reforms have led to the increase of student and staff mobilities mainly through the Erasmus+ program, facilitating mutual recognition of studies and qualifications. Azerbaijan has also implemented important reforms to improve recognition mechanisms in line with the Lisbon Recognition Convention. There has been a notable shift towards Learning Outcomes and Competency Based Education, many study program curricula were redesigned to emphasize learning outcomes, student centered learning and employability of graduates. All of this have resulted in increased university autonomy and institutional responsibility promoting governance, academic affairs, and financial management.

The diversity of the higher education system also increased over the past few decades, driven by deliberate policy changes that are aiming at redefining institutional identities. The transformation of mono-specialty institutes into a broader Higher Education Institutions and the introduction of the “research university” following 2016 Education Law and establishment of State Agency for Science and Higher Education (EATDA) in 2022 as defined by Presidential Decree No.302 (president.az). Simultaneously with the establishment of the EATDA, the Ministry of Education was renamed as Ministry of Science and Education, thus reflecting its expanded mandate over scientific research. As part of this reform, several graduate-level research institutes that were previously under the Azerbaijan National Academy of Sciences (ANAS) were transferred to the Ministry’s jurisdiction, making a big structural shift towards closer integration of education and research, signaling of strategic realignment aiming at enhancing innovation and improving coordination between higher education and research, thus modernizing the governance framework in line with international best practices. Today, Azerbaijan features 9 comprehensive universities offering multidisciplinary programs and 31 institutions focused on more narrowly defined academic fields.

Despite the emergence of private universities in the early years of independence, public universities continue to dominate both perception and enrolment. Known for their larger ability to accommodate more students, 87 percent of students pursue their studies in public universities such as UNEC or Baku State University, which are getting the majority number of undergraduates. In recent years, there has been a notable shift towards increase in university autonomy. Many public HEIs have adopted the state of public legal entities, thus allowing them to exercise a greater level of discretion in administrative, financial and most importantly academic matters. This shift combined with the gradual merging of research institutes with universities have paved the way for the new governance mechanisms, such as university boards, and introduced incentive schemes for academic staff to engage in more research-oriented activities.

The higher education system of Azerbaijan operates within a centralized regulatory body, with the Ministry of Science and Education being the main authority responsible for oversight and coordination. However major policy shifts, institutional reforms as well as budgetary decisions require approval at the highest levels of government, including the Cabinet of Ministers. Much of the sector’s governance continue to be shaped by various presidential decrees and national development strategies such as ‘Azerbaijan 2030: National Priorities on Socio-Economic Development’¹ and 'Socio-economic development strategy for 2022-2026'². The foundational legal instrument currently in force is the Law on Education that was adopted in 2009, which defines the overall structure, objectives and principles of education system. This law establishes the key roles, rights, and obligations of students, academic staff, and educational institutions, while outlining

¹ <https://president.az/en/articles/view/50474>

² <https://brussels.mfa.gov.az/files/shares/2022%202026%20Social%20and%20Economic%20Development%20Strategy.pdf>

governance responsibilities, national education standards and funding models. Since 2020, a separate and more specialized Law on Higher Education has been in the drafting phase, intended to provide a clearer, more modern framework, tailored specifically to the needs of higher education institutions and sector as a whole. As of 2024, the draft law had undergone extensive consultation, generating more than 300 formal recommendations for revision and refinement. The proposed legislation is seeking to address emerging trends in innovation and entrepreneurship, promote institutional autonomy, and improve clarify around quality assurance, financing, and international collaboration. The absence of a modern, fit-for-purpose legal framework have always raised concerns for international academic exchanges. In the absence of legal mechanism to formally recognize participation in exchange programs, many state universities rely on outdated practices such as issuing a formal academic leave of absence (traditionally used only in cases of long-term illness or other personal circumstances) to justify student’s temporary departure during the mobility. This workaround not only reflect the current legal gaps, but can also create confusion for both students and institutions, undermining the implementation of international mobility schemes, particularly such as Erasmus+ or Mevlana or any other exchange program.

While the adoption of the new law has been delayed, inevitably it is expected to streamline regulatory processes, enhance transparency, and provide a more adaptive legal base capable of supporting ongoing reforms in the sector. As of first quarter of 2025 however, the legislation remained pending approval of Azerbaijani parliament.

2.2 Science and Higher Education

Azerbaijan’s approach to research and scientific development is defined in the 2016 Law on Science, which lays out the state’s strategic vision for strengthening of knowledge-based society. This legislation sets the foundational principles for how scientific activities are to be organized and funded to be integrated with other national priorities and/or strategies, in particular education and economic development.

One of the biggest novelties introduced by this Law, was the formal recognition of research universities, the institutions that combine academic instruction with advanced science and research practices. This model is set to further strengthen the interaction between teaching and research, ultimately creating an environment where students and faculty actively contribute to science.

This Law articulates a broad set of values to stimulate innovation and academic excellence. These include protection of scientific freedom, promotion of ethical standards in research in support for open scientific environment. These are designed to bring Azerbaijan’s research ecosystem closer to international benchmarks.

Table 1 | Research funding as % of GDP and % of Public Expenditure (SSC 2024)

Year	2005	2010	2015	2020	2021	2022
Amount	28,800,000	92,800,000	113,200,000	143,600,000	151,800,000	167,800,000
% of GDP	0.23%	0.22%	0.21%	0.20%	0.16%	0.13%
% of Public expenditure	1.35%	0.79%	0.64%	0.54%	0.55%	0.52%

Scientific research in Azerbaijan remains predominantly driven by the public sector. As of 2023,

a total of 131 institutions were actively involved in research-related activities. Most of them (approx. 65%) were dedicated research organizations, while higher education institutions accounted for 30% of the total. Private sector participation in comparison is limited, comprised of only around 5% of all research activities (SSC, 2024)

Over the year, the number of institutions engaged in research has shown a gradual decline, a trend most evident among privately operated research centers. This reduction, however, showcase structural changes in expanding and sustaining a diverse research ecosystem, particularly outside of a state supported institutions. Despite different efforts to stimulate the involvement of private sector in the process, research remains heavily centralized within state-controlled or state funded bodies.

As it can be seen from the table above, although total research funding in Azerbaijan has increased by nearly 139 million AZN (approx. \$8.18 million) since 2005, this growth has not translated into a stronger financial commitment related to the broader economy. In fact, both the share of research expenditure in GDP and its proportion of overall public spending have steadily declined over the years (SSC, 2024).³

On the other hand, Higher Education Institutions (HEIs), while formally engaged in research activities, face significant structural limitations in terms of capacity and resources. Only very few of them are somewhat equipped to conduct research at a level that meet international quality standards. A key constraint lies in in the extremely limited budget allocated to research within universities. According to State Statistical Committee of Azerbaijan, HEIs continue to receive only a total of 11% of the total national budget for research and development, a figure that remained stagnant despite modest increases since 2000. Moreover, the internal composition of HEIs budgets further compounds the issue, usually 2/3 of university funding is consumed by salary and administrative expenses, leaving very little space for investment in those usually expensive research infrastructure, projects, or innovation initiatives. This underinvestment also affects Azerbaijan's ability to engage in major international research programs and frameworks. Participation in the European Union's Horizon programmes – known globally as the world's largest research and innovation activities (with programme budget over 100 billion euros) – has remained strikingly low for years. Azerbaijan currently stands out as the only country in the broader region, that is not formally associated with Horizon Europe thus limiting the opportunities despite being eligible for association and benefiting from some capacity-building support under earlier EU-funded cooperation frameworks. As a result, Azerbaijani universities and research institutions have had minimal visibility within European research consortia, missing out on those vital opportunities for collaboration, knowledge transfer, and access to modern day research agendas and scientific activities.

2.3 Quality Assurance in Higher Education

In Azerbaijan, the legal and regulatory environment often significantly restricts the autonomy of Higher Education Institutions (HEIs) to independently develop or dismiss their academic programs.

³ While absolute research funding has increased, Azerbaijan's overall GDP and government budgets have grown at a much faster pace, particularly due to the expansion of the oil and gas sector, especially during booming oil prices back at that time. This has decreased the relative weight of research spending. National priorities during that period have been focused more on military and defense (Karabakh conflict) as well as infrastructure and social programs. Finally, there are many structural challenges such as for instance limited private sector engagement in R&D, weak innovation ecosystems, and very modest commercialization of research outputs.

The universities are not permitted to independently launch or discontinue academic programs without prior approval from the Ministry of Science and Education (MSE). As a result, student admission is confined to programs that have already received official authorization, limiting institutional flexibility and responsiveness to emerging academic and labor market needs.

In the context of Bologna Process, a National Qualifications Framework (NQF) serves as a vital tool for structuring and aligning a country's qualifications with the overarching goals of the European Higher Education Area (EHEA), ensuring transparency, comparability, and recognition, contributing to quality assurance by establishing clear learning outcomes and qualification levels that support consistent evaluation and recognition of academic standards across the higher education system. Program design and delivery are subject to regular monitoring under the NQF, which obliges institutions to implement internal quality assurance mechanisms, periodically update their assessment practices, and align teaching approaches with defined learning outcomes. The Azerbaijani National Qualifications Framework (AzNQF) was officially adopted in July 2018 by Ministerial Decree. It is an eight-level, comprehensive framework with qualifications from general, vocational, higher and further education. An EU-funded Twinning project⁴ contributed to the strengthening the institutional and technical capacity of responsible bodies and helped align Azerbaijan's qualifications framework with the European Qualifications Framework (EQF) in line with Bologna process requirements. Program design and delivery are subject to regular monitoring under the National Qualifications Framework (NQF) that requires institutions to maintain internal quality assurance systems, update assessment methods, and align teaching practices with defined standards. Universities are obliged to undergo periodic external quality evaluations- most notably accreditation- overseen by the Agency for Quality Assurance in Education (TKTA). These evaluations are intended to ensure compliance with both national benchmarks and internationally recognized practices for credential recognition. Importantly, even the discontinuation of academic programs is subject to formal review and typically depends on TKTA's recommendations during accreditation cycles.

In terms of language of instruction, although higher education institutions in Azerbaijan retain some discretion over the language of instruction, this autonomy operates within the framework of national regulations. According to the State Standard and Program of Higher Education of the Ministry of Justice⁵, Azerbaijani language is designated as official language for instruction at tertiary level. Yet, universities are permitted to offer programs in foreign language, subject to their institutional capacity and academic resources. What they do in some universities, such as Baku State University and Azerbaijan Medical University, mostly attract students from neighbouring countries such as Turkey and Iran.

This flexibility has led to multilingual academic environment across the country. In addition to Azerbaijani language, degree programs are commonly delivered in Russian and English. In a rare and only case, in the French-Azerbaijan University (UFAZ) which is hosted by Azerbaijan State Oil and Industry University, the language of instruction is dual: in French and Azerbaijani.⁶ Such examples illustrate the growing emphasis on internationalization and linguistic diversity in higher education of the country, particularly in institutions that are seeking broader academic cooperation and student mobility. This emphasis on internationalization is intentional. The Agency for Quality Assurance in Education (TKTA) explicitly includes internationalization of higher education as a criterion in its accreditation standards, looking for the number of international teacher and student

⁴ <https://www.etf.europa.eu/sites/default/files/document/Azerbaijan.pdf>

⁵ https://erasmusplus.org.az/images/uploader/82baa-State%20standards%20and%20programs%20for%20higher%20education_2010_ENG.pdf

⁶ Korean language is taught at Baku Engineering University, and also at other institutions such as the Azerbaijan University of Languages, where there is a Korean Cultural/Studies Center ([The Korean Cultural Centre - ADU](#)).

exchanges and number of joint projects, thus encouraging institutions to enhance their global engagement also through multilingual programs and international collaborations.

2.4 The Significance of Cooperation with South Korea

In recent years, Azerbaijan's higher education system has undergone significant transformations, aligning closely with the country's ambitious socio-economic and strategic objectives. A significant milestone in the education landscape was establishing the State Agency for Science and Higher Education, reflecting Azerbaijan's commitment to integrating research and education within a cohesive governance structure. Legislative enhancements, such as amendments introducing a credit transfer system across vocational and higher education, facilitate greater mobility and flexible learning pathways, critical components for nurturing an innovative academic environment.

Despite these advancements, challenges persist. The transition from theoretical education towards practical, industry-aligned learning remains limited, with the private sector still relatively underrepresented in curricular development and applied research initiatives. Vocational Education and Training (VET) institutions' collaboration with industry remains predominantly internship-based, pointing to the potential for deeper engagement, particularly in STEM fields and digital technology specializations.

The socio-economic strategy emphasizes aligning higher education outputs more closely with labor market demands, particularly in emerging sectors such as renewable energy, digital technology, and sustainable industrial practices. Azerbaijan has also embraced digital transformation in education, significantly enhancing the digital educational resources and infrastructure. Digitalization efforts have substantially increased the capacity for remote and hybrid learning modalities, preparing both students and educators for future challenges. However, further enhancement in digital literacy, especially among faculty and researchers, remains essential to fully exploit these investments.

Comparatively, the trajectory of innovation in higher education in Azerbaijan could benefit significantly from international best practices, particularly those exemplified by Korea's robust university-industry cooperation models, targeted innovation strategies, and sustained funding mechanisms for research and commercialization initiatives. Benchmarking research and academic institutions against Korean universities known for robust industry collaboration could help guide strategic planning and capacity building, driving its transformation into an innovation-centric institution.

Given the traditional concentration of chemical and heavy industries in Sumgayit, the development of specialized research center focused, among other things, on green energy, sustainable materials and process engineering would be highly beneficial, considering Azerbaijan's strategic objectives as highlighted during COP29 held in Baku, to replace a significant portion of traditional energy sources with renewables (such as wind, solar, hydro and green hydrogen)⁷.

⁷ <https://cop29.az/en/sustainability/energy-transition-initiatives>

Table 2 | Expected Benefits of the Project

Category	Republic of Korea	Azerbaijan
Technical Effects	<ul style="list-style-type: none"> - Technology transfer and knowledge accumulation through triangular cooperation (ADB, Azerbaijani government, and Korea). - Formulation of strategies for higher education in Azerbaijan by analyzing Azerbaijan’s technological status, based on KAIST’s development experience. - Enhanced higher education exchange benefiting educators, researchers, public institutions, and the private sector. - Enhancement of technological outcomes from previous ADB vocational education and training projects in Azerbaijan. 	<ul style="list-style-type: none"> - Increased expertise of SSU reflecting demand from Sumqayit’s chemical industry/science parks. - Improvement of SSU’s industry-academia cooperation and entrepreneurial programs and curriculum reform. - Establishment and promotion of comprehensive governmental, economic, social, legal, and institutional programs. - Enhanced higher education exchanges benefiting educators, researchers, public institutions, and the private sector.
Economic Effects	<ul style="list-style-type: none"> - Facilitating Korean companies' entry into industrial infrastructure and technological cooperation areas through project expansion. - Opportunities for Korean companies and technologies to collaborate with SSU, local industries, domestic universities, and advanced technologies. - Cooperation with diverse domestic and international institutions and local partners for project implementation, reflecting conditions and capabilities to achieve Azerbaijan’s innovation goals. 	<ul style="list-style-type: none"> - Establishing an innovation foundation by linking higher education institutions with regional industrial technologies: <ul style="list-style-type: none"> • Developing regional industries • Providing high-quality workforce - Fostering an environment conducive to startups. - Creating practical industry-academy cooperation and employment opportunities through BME-centered collaboration. - Developing a project pool aligned with Azerbaijan’s higher education innovation program, serving as a bridge for expansion into Central Asia.
Social and Environmental Effects	<ul style="list-style-type: none"> - Contributing to industrial and environmental development energy sector and contributing to environmentally friendly and sustainable economic development internationally. - Identifying and planning new infrastructure and support projects based on experience gained through the KSP program. 	<ul style="list-style-type: none"> - Cultivating technical personnel aligned with industry demand and establishing related governmental policies. - Disseminating outcomes through industry-academia cooperation programs utilized by higher education institutions and industries.

The recent introduction of vocational and entrepreneurship-focused courses demonstrates a strong governmental push towards enhancing graduates' employability. Still, scaling these programs to match labor market dynamics and industry specifics, particularly in Sumgayit's oil, chemical, and heavy industry sectors, is vital. Expanding practical exposure through co-developed curricula with local industrial partners, dual academic-industry supervision of thesis work (for example) and

jointly applied research would significantly strengthen outcomes.

A comprehensive framework fostering deeper university-industry collaborations through internships, joint research, and spin-off startups would amplify the impact of these educational reforms and, most importantly, incentivize faculty participation in industrial research. In conclusion, Azerbaijan's higher education sector is strategically positioned for transformation into innovation-driven centers of excellence. Realizing this potential requires continued policy support, targeted investments in research infrastructure, strategic capacity building in digital and entrepreneurial skills, and robust international cooperation. Sumgayit State University, equipped with strengthened institutional frameworks and industry linkages, and other relevant institutions in Azerbaijan have significant opportunities to lead this transformation, contributing meaningfully to Azerbaijan's broader socio-economic development goals.

3. The Operation of Project

3.1. Setting Project Objectives

○ This project primarily aims to materialize exchange and collaboration outcomes between Sumgayit State University (SSU) and Korean institutions, with a long-term vision of promoting cooperation in Azerbaijan's higher education and innovation sectors.

○ To achieve this, the project's main deliverable will be a master plan for regional industry-academia innovation, accompanied by concrete innovation implementation strategies for future bilateral cooperation between Azerbaijan and Korea.

○ As a gateway for sustained cooperation, the project will formulate and support educational and industry-academia programs, conduct training for capacity building, and manage related activities.

Figure 2 | Establishment of Project Objectives

Level	Content	Timeline
Influence	Promotion of cooperation and exchange in the field of higher education and innovation in Azerbaijan	Long-term (~2030)
Outcome	Realization of cooperation outcomes between Sumgayit State University (SSU) and Korean institutions	Mid-term (~2026)
Results	<ul style="list-style-type: none"> - Establishment of Regional Industry-Academia Innovation Master Plan - Innovation Implementation Strategy - Improvement and Collaboration in Educational Programs - Capacity Building - Project Management 	Short-term (~2025)
Activities	<ul style="list-style-type: none"> - Establish development plans - Stage-wise detailed plans - Suggest Korea-Azerbaijan institutional collaboration plans - Support for industry-academia cooperation programs - Local training programs - Performance management and systematic operations 	Immediate actions

3.2. Details of Implementation Direction

- Detailed implementation approaches for the project are outlined in the table below.
- The project activities will be conducted in the following order:
 - ① Establishment of the master plan and implementation strategies,
 - ② Operation and support of training and educational programs,
 - ③ Provision of policy recommendations, and
 - ④ Organization of a final reporting workshop.

Table 3 | Detailed Implementation Approaches

[Implementation Direction 1] Diagnosis of Higher Education Innovation Status in Azerbaijan	
Main Activities	<ul style="list-style-type: none"> - Assess recent industry and education policy support for strengthening SSU capabilities tailored to industries in Sumgayit. - Analyze departmental performance using surveys and bibliographic data analysis based on the Triple Helix evaluation model (refer to Appendix). - Investigate changes in Azerbaijan's labor market, industry structure, employment structure, and evolving technical skill demands. - Conduct diagnostic analysis of SSU's curriculum, industry partnerships, entrepreneurship education, technology commercialization, startup education, educational capacities, and teaching methodologies. - Conduct surveys targeting SSU professors, researchers, and alumni to assess current industry-academia collaboration, research capacities, and limitations at SSU.
Implementation Methods	<ul style="list-style-type: none"> - Literature review and expert consultation - Data analysis
[Implementation Direction 2] Strengthening Innovation Capacities at SSU: Current Status and Strategies	
Main Activities	<ul style="list-style-type: none"> - Review of policies related to technological transition and innovation in Korean higher education institutions. - Analyze innovation strategies of Korean universities responding to industry needs (e.g., LINC 3.0 leading university programs). - Analysis of entrepreneurship programs: <ul style="list-style-type: none"> • Industry-Academia Cooperation Groups: region- and university-focused collaboration programs • Startup Education Programs: Customized youth entrepreneurship support programs - Conduct invitation-based training, local training, and Training-of-Trainers (ToT) programs.
Implementation Methods	<ul style="list-style-type: none"> - Literature review and field survey

[Implementation Direction 3] Strategies to Activate R&D at SSU	
Main Activities	<ul style="list-style-type: none"> - Propose a strategic innovation plan and 10-year roadmap aligned with SSU's development plans. <ul style="list-style-type: none"> • Include actionable strategies for education, research, industry-academia cooperation, entrepreneurship, and startup support. - Establish implementation plans for cooperation among SSU, local companies, and Korean institutions. <ul style="list-style-type: none"> • Suggest plans for research commercialization, personnel exchanges, and joint educational programs. • Benchmark Korea Institute of Science and Technology (KIST) to identify initial industry-academia cooperation strategies. - Perform outcome monitoring, evaluation, Project Design Matrix (PDM) performance measurement, management, and follow-up activities.
Implementation Methods	<ul style="list-style-type: none"> - Literature review, on-site surveys, institutional interviews, stakeholder consultations, expert advisory
[Implementation Direction 4] Capacity-building Training for Ministry of Science and Education and SSU	
Main Activities	<ul style="list-style-type: none"> - Training program for policy practitioners (in Korea): <ul style="list-style-type: none"> • Approximately 7 representatives from Azerbaijan's Ministry of Science and Education and SSU senior management. • Lectures related to topics of demand, discussions on cooperation between key stakeholders, visits to related institutions. • Discuss follow-up projects and cooperation strategies following the KSP project. - Organize a local final reporting workshop: <ul style="list-style-type: none"> • Share and disseminate research outcomes, collect local feedback, and engage in promotional activities. • Conduct high-level government meetings to propose policy implementation based on research outcomes.
Implementation Methods	<ul style="list-style-type: none"> - Conduct domestic training with cooperation from partner institutions, organize local reporting workshops, and conduct interviews

3.3. Invitation Training & Training for Azerbaijani Policymakers

- Capacity-building training will be conducted once, focusing on:
 - Korean-Azerbaijani joint pathways for higher education and industry-academic innovation.
 - Leadership courses, innovation ecosystem workshops, and high-level policy workshops covering Korean higher education innovation history and policy.
 - Invitees include Azerbaijani government (MSE policymakers), university representatives (SSU innovation center director, stakeholders), and enterprise representatives (directors from SOCAR and SABAH.HUB).
 - Policy workshops with MSE policymakers will discuss and derive significant industry-academia cooperation policy recommendations.
 - Training lectures and materials will be provided in advance, detailing Korean industry-academia cooperation case studies and institutional approaches, enabling trainees to independently address related challenges.

Table 4 | Invitation Training Implementation Plan (Draft)

Category		Details
Participants / Duration		Approximately 7 participants / 1 week
Target participants		Ministry of Science and Education (MSE), SOCAR, SABAH HUB, and SSU representatives
Training Contents	Policy Workshop	<ul style="list-style-type: none"> - Training Azerbaijani MSE officials and SSU representatives on Korean higher education and industry-academia cooperation cases and history. - Discussing higher education and industry-academia cooperation policy directions.
	Industry-Academia Cooperation Innovation Ecosystem Course	- Introduction of successful Korean industry-academia cooperation cases (BK21, LINC programs) and strategy development targeting SOCAR and SSU.
	Start-up Innovation Ecosystem Course	- Introduction of KAIST's successful Start-up education programs and strategy development.
	Customized Strategy Discussions and Strategy Specification	- Establishing a vision for innovation in Azerbaijani higher education and industry-academia cooperation, specifying cooperation strategies, and deriving policy recommendations.

3.4. Project Management

○ Project Management activities include performance monitoring and evaluation, performance measurement and management, project monitoring and evaluation, and finally post-project management as shown in Table 5.

Table 5 | Project Management Plan

Category	Details
Performance Monitoring and Evaluation	<ul style="list-style-type: none"> • Monitoring of quantitative/qualitative performance indicators • Measurement of quantitative indicators
PDM Performance Measurement and Management	<ul style="list-style-type: none"> • Measurement of project outcomes based on the Project Design Matrix (PDM) • Outcome measurement at each project phase (initiation, mid-term, and completion) • Supplementation, revision, and management of the PDM through consultation with KSP when necessary
Project Monitoring and Evaluation	<ul style="list-style-type: none"> • Organization of initiation, mid-term, and final reporting workshops, and preparation of reports • Regular inspections and risk management, preparation of inspection reports (semiannual and annual reports)
Post-Project Management	<ul style="list-style-type: none"> • Establishment of post-project management plans

3.5. Project Execution Organization

- The implementation organization for this project consists of two institutions: KAIST and Ars Praxia.
- To facilitate innovation transformation in Azerbaijan’s higher education, researchers from KAIST, Korea’s leading science and technology university, will collaborate closely with consultants from Ars Praxia, an institution experienced in international innovation projects.

Table 6 | Work Division

Category		Lead Research	Research Team	PM	RA
Project Management	Overall Project Management and Coordination with Relevant Institutions	●		○	
	Task Execution Planning and Scheduling	●	○	○	
Policy Consulting	Literature Review and Case Studies		●		○
	Detailed Field Surveys	●	○	○	○
	Basic Data Analysis		●		○
	In-depth Interview Planning and Implementation	○	●		○
	Deriving Recommendations	○	●		○
Advisory and Dissemination of Research Results	Policy Seminar Planning	●	○	○	
	Initiation/Mid-term/Final Reporting Workshops	●	○		○
	Other Dissemination Activities			●	○
Other Dissemination Activities	Training Program Planning	●		○	
	Lecturing		●		
	Preparation and On-site Support			●	○

● Main ○: Support

Table 7 | Work Division Plan by Implementing Organization

Category	Task Description	KAIST	Ars Praxia Co., Ltd.
Contract & Project Initiation	Contract Signing	●	△
	First Field Survey	△	●
	Preparation of Inception Report	●	△
Second Field Survey	Program Collaboration with Sumqayit State University	△	●
	Regional Industry-Academia Cooperation Matching	△	●
Mid-term Reporting	Mid-term Reporting Workshop	●	●
	Preparation of Mid-term Report	●	●
ToT & Invitation Training	Local ToT Program	●	△
	Invitation Training	●	△
Final Reporting	Local Final Reporting Workshop	●	●
	Preparation of Final Report	△	●

4. The Methodology of Research

4.1. Analysis of Innovative Structure in Azerbaijan

- The overall framework of the research and assessment of the recipient country Azerbaijan, along with Sumgayit and SSU, is based on the Triple-Helix model and its perspective
 - Industry-academy cooperation involves multilateral interactions including government and regional communities, not just bilateral university-industry relations
 - Triple-Helix model best captures the internal dynamics of government-industry-university relationships, and provides a suitable analytical framework to identify the required institutional support
 - Additionally, the research team considered the regional government and community that could provide incentives to Industry-academy cooperation. In our field study, we researched the current status and operation of Sumgayit region and Sabah City that engage in regional development.

Figure 3 | Conceptual Diagram of the Triple-Helix Model

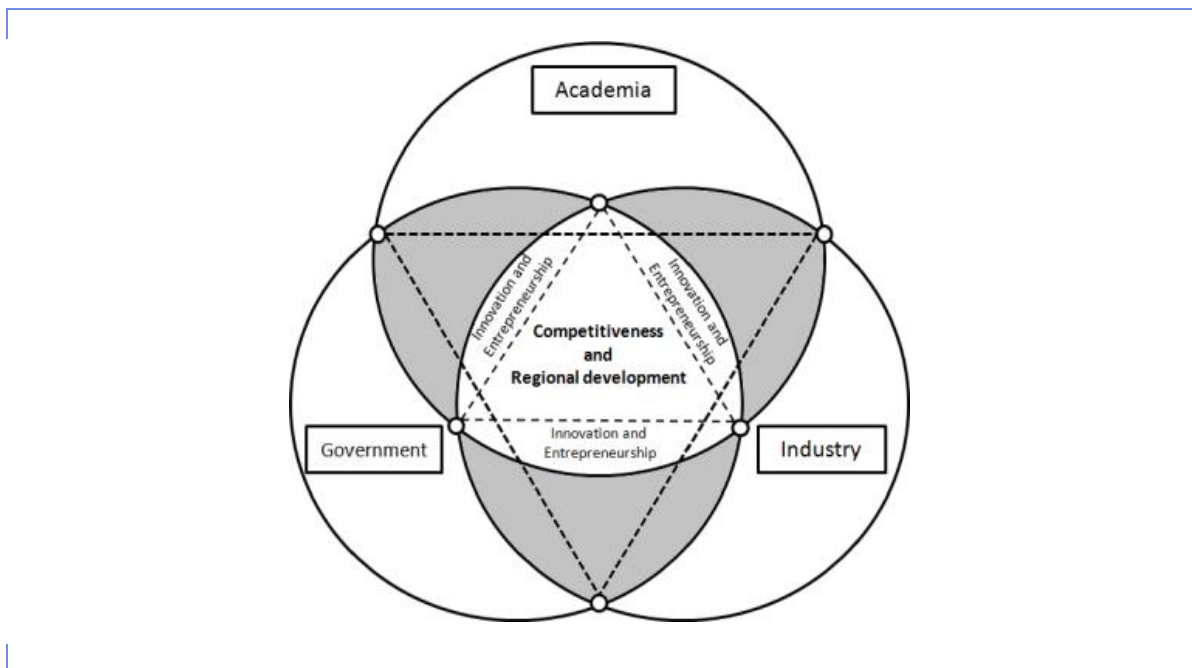
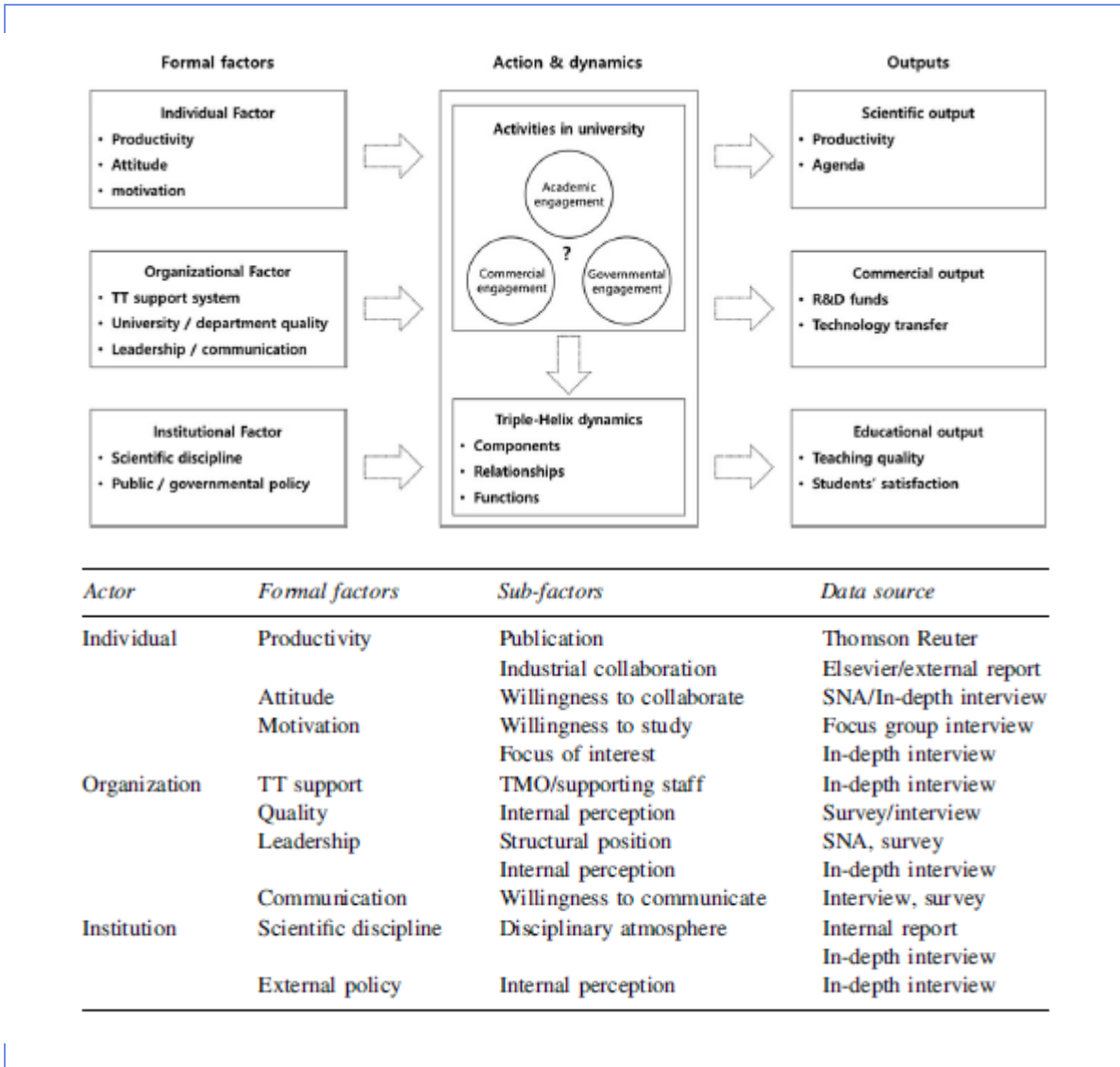


Figure 4

Framework and Methodology for Measuring University Innovation Performance Based on the Triple-Helix Model



- Our field research in SSU especially reflects the evaluative Triple-Helix model of academic engagement developed by Kim & Jang's (2021).

- The evaluative model takes into account of individual (productivity, attitude, motivation), organizational (Technology Transfer support system, quality of main departments and faculties, leadership and communication skill-sets of academic leaders), and institutional (scientific discipline, regional and governmental policy); and analyzes the dynamics of Triple-Helix interaction of academic-commercial-governmental components.

- The researcher forecasts the scientific, commercial and educational outputs from its current status and advises to adjust stakeholders' engagement plan to expect better outcomes.

4.2. Research Methods

○ Quantitative research

- Our filed research applies various kinds of quantitative research methods including statistical analysis, bibliometric research, social network analysis, etc.
- Most of quantitative analyses are focused on the key industrial and academic domains that Azerbaijan has core interests: Chemical engineering, physics, mathematics, food science and technologies, and computer science. These domains were selected after the consultation from faculty members of SSU, and open to be expanded.
- The key objective of quantitative analysis is to extract objective measurement in terms of research performance in SSU and, to a certain extent, Azerbaijan as a whole.
- The bibliometric and social network analysis combined are expected to derive key researchers who demonstrate crucial position in global networking as well as high academic performance, leaving clues to utilize Azerbaijani talents who work abroad in crucial technological domains
- To complement, rather moderate scope of survey was conducted to study the expectation of SSU members regarding the academic performance and future development

○ Qualitative research

- The field research conducted in Azerbaijan by Ars Praxia engages discussions with a number of personnels and organization
- At SSU, either in-depth or Focus Group Interview (FGI) have been conducted to understand the mindsets, desires and key concerns of faculty members and students
- Discussions with external business groups such as SOCAR and Pasha Group Holding had more practical approach. We have continued discussions on how to bring innovation in the Sumgayit region, what is needed to be done, and how foreign agencies could collaborate on the national innovation project of Azerbaijan
- Until the end of this project, we continue to engage with key stakeholders, persons and organizations, and will extract methods of international cooperation for the innovation in the higher education sector of Azerbaijan

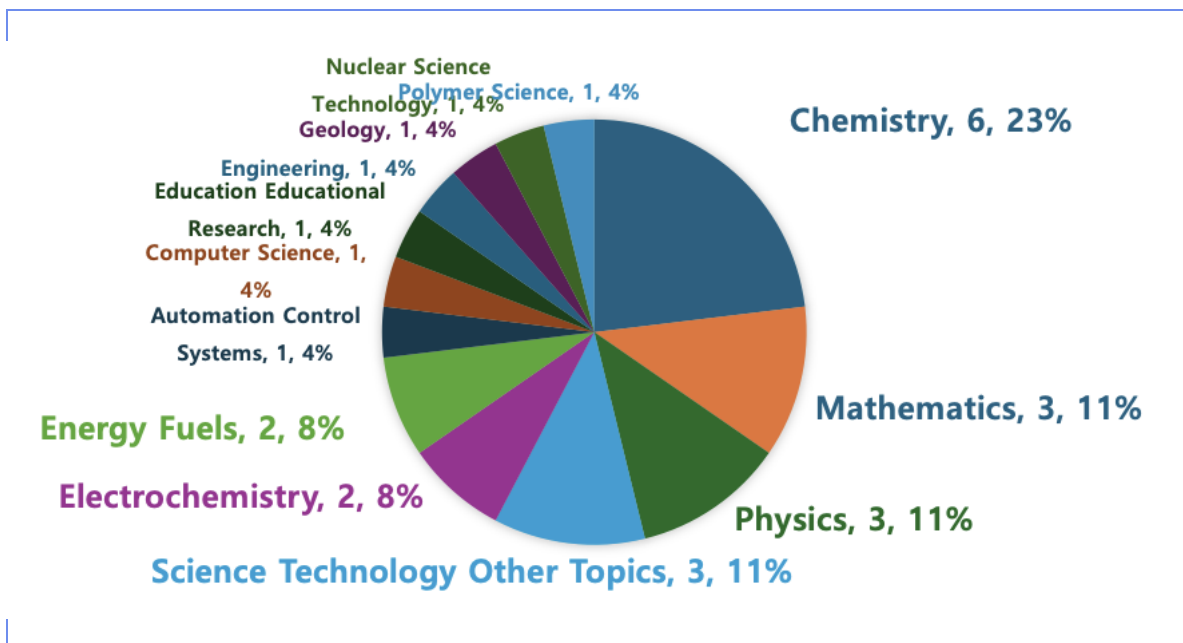
II Analysis of Azerbaijan and Sumgayit State University

1. The Status of Sumgayit State University

The Sumgayit State University (hereafter SSU) is one of the representative educational institutions in Azerbaijan that has accumulated history and capabilities of key academic domains closely related to industrial practices. For instance, the concentration of research outcomes (academic publications) in chemistry, physics, mathematics, energy fuels as depicted in Fig 5 reflect Sumgayit region's industrial interests. Regardless, our initial field research informs that the academic practices and research outcomes have weak relevance to industrial application from a qualitative perspective.

Figure 5

Number and proportion of publication by disciplines in SSU (2022-24)⁸



⁸ The data research was conducted by Ars Praxia by collecting the raw data from Web of Science (www.webofscience.com). Our research team categorized academic articles by disciplinary domains that are published by five Azerbaijani universities (Sumgayit State University, Baku Engineering University, Azerbaijan State Oil and Industry University, ADA University, Baku Higher Oil School).

2. Analysis of Stakeholders and Institutional Environment

2.1. Initial Field Research

The main purpose of field research is to identify key interests and stakeholders in the recipient country. Even if expressed needs look obvious, more often, ways to meet with those requirements and deliver them can turn out to be far more complex activities than expected. There could be various, conflicting, perceptions and interests among actors in the country and organizations. Institutional procedure and socio-cultural practices often require hermeneutic exploration to set up a reliable implementation plan. Even so, actual delivery becomes another stage of challenge.

The initial field research was conducted during February 11-20 in Baku city and Sumgayit region immediately after the inception ceremony. The main objective is to understand general atmosphere of SSU and Azerbaijan, and construct a framework to initiate higher educational consulting. The activity mainly comprised interviews with current and former key staffs of SSU to identify challenges and tasks of the organization. In addition, some in-depth discussions were carried out with a staff engaged in higher education policy in the Ministry of Science and Education and the former rector of SSU who initiated the international cooperation by applying for the Knowledge Sharing Program (KSP) last year.

After the initial discussion with key staffs and advisors in SSU⁹, the structure of interview (see Table 8) reflected key academic domains of interests in Sumgayit State University. The consecutive interviews are also designed to have an accumulative structure to link key concerns and areas of development, which will lead to identify key areas and activities to collaborate with South Korean counterparts.

To begin, the interview with the former Rector of SSU, Rufat Azizov, clarified the initial intention and vision of his application for the KSP scheme. The vice Rector, Konul Abasli, informed the current operation of SSU. The Dean of Natural Sciences, Rashad Salimov, explained the pedagogic trajectory of scientific studies in Azerbaijan and SSU, sharing key concerns to transform from a teaching-oriented university to a more rigorous research center. Ahamd Ahmadzada, advisor to the Rector, described current efforts and challenges in adopting AI and digital transformation in the university, along with various activities to encourage students to participate in innovative activities. Javanshir Mammadov, Head of Innovation Center in SSU, explained his decade-long efforts to establish an environment for start-up challenges within SSU and discussed how to promote industrial cooperation that is yet to be realized. Azada Aliyeva offered the interviewers a few interesting insights how what kind of emerging technologies begin to draw interest in Azerbaijan, and what kind of support young scholars and students alike might need from external support and international cooperation.

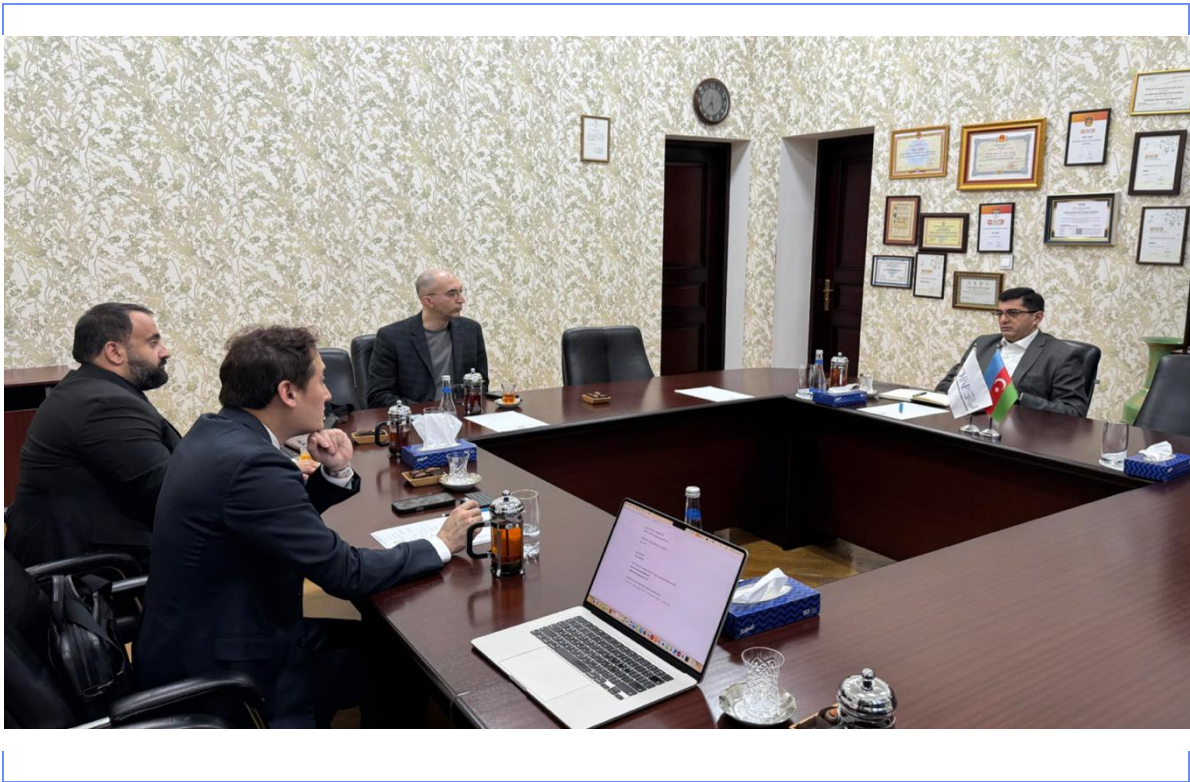
⁹ The discussion was organized by vice rector Konul Abasli on February 11.

Table 8 | List of Key Interviewees

Name	Institution/Role	Main Content of Interview
Rufat Azizov	Former Rector of SSU	- Initial purpose of KSP - Applied methodology of innovation in SSU - Current challenges and needs for cooperation
Konul Abasli	Vice Rector of SSU	- General status of SSU - Orientation of field research
Rashad Salimov	Dean of Natural Sciences in SSU	- Performance of chemistry & biology domains - Challenges and tasks in academic activities
Ahmad Ahmadzada	Advisor to the Rector in SSU	- Current status of IT education in SSU - Status of industrial cooperation - Challenges and tasks for digital transformation
Javanshir Mammadov	Head of Innovations Center	- Status of start-up eco-system in Sumgayit - Challenges and tasks for industrial cooperation
Azada Aliyeva	Senior Lecturer in SSU	- Emerging industrial research domains - Potential areas of cooperation with S. Korea
Vusala Qurbanova	Senior Advisor in MSE	- Current policy and status of higher education - Impending tasks for innovation - Key areas of cooperation with S. Korea
Gadir Aliyev	Director of SOCAR	- Key needs of industry - Demands to potential Korean partnership

The Korean team also had a meeting with senior advisor to Ministry of Science and Education then, Vusala Qurbanova, who clarified impending tasks for innovation in Azerbaijani higher educational environment, and discussed possible areas of cooperation with South Korea. As these interviews made interviewers realize the importance of potential role that private sector might play, the research team had a preliminary meeting with some representative state-owned companies like SOCAR (State Oil Company of AzeRbaijan). From this initial meeting with the director of SOCAR, Gadir Aliyev, the Korean team noticed the intention and potential willingness of SOCAR to establish a high-profile laboratory domestically. Currently, despite affiliated universities like Baku Higher Oil School more or less functions as an academic collaborator, the major research facility of SOCAR is located in Turkey.

Figure 6 | Interview with Rufat Azizov (the former Rector of SSU)



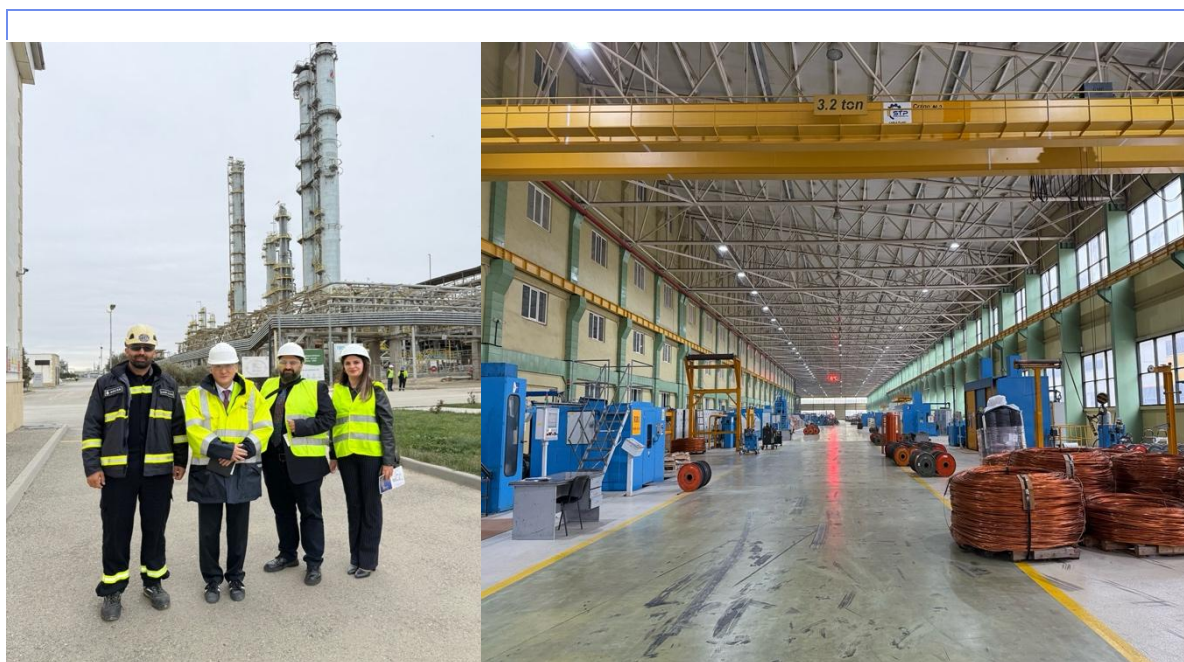
2.2. The 2nd Field Research

The second field research followed during April 9-16 in Baku city and Sumgayit region. The second visit had multiple purposes: 1) Take a look at Science & Technology related facilities in Sumgayit and SSU, 2) Assess the current operation and people’s perception in SSU, 3) Identify key stakeholders and their interests in Azerbaijan. In particular, interviewer(s) had more engaging

discussions with staff members in private sectors to bring concrete issues of innovation on table.

The visit to SOCAR Downstream facility and Science Technology Park (STP) in Sumgayit offered an overview of the technological operation in the region. As some staff members in SOCAR expressed in our discussion, wide range of cooperation is open to international faculty members and industrialists especially in the domain of chemical engineering, digital transformation and green energy. The STP that is managed by SOCAR company largely functions as a subsidiary manufacturing area that accommodates the needs of main contractors in infrastructure parts (factory maintenance). Unlike the usual expectation of ‘science and technology park’ that entices research labs of AI or digital technologies or latest form of biotechnologies, the STP in Sumgayit regions remains as a traditional (secondary) industry complex with its storage area.

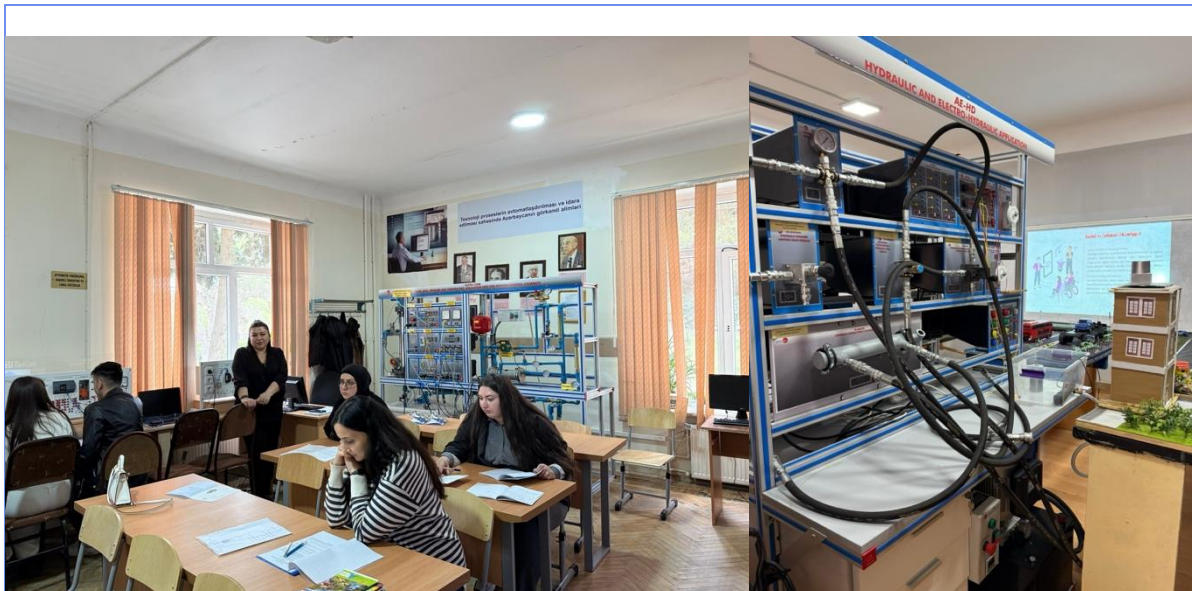
Figure 7 | Visit to SOCAR Downstream (left) and STP in Sumgayit (right)



A series of interviews with the acting rector, faculty members and graduate students in SSU also helped us to understand and assess the current innovative capability of the university. With a meeting with the Acting Rector, Aminagha Sadigov, we could understand that SSU was formulating strategies to adapt to the rising demands of the Ministry of Science and Technologies that stress the significance of research-oriented university and industrial collaboration. One of the noticeable strategies initiated by Aminagha Sadigov who took the office in this February was an attempt to incorporate a local research institute within the SSU remit. While the approach sounds reasonable for future development, our brief tour of the campus and related facilities made us conclude that more immediate investment measures should be adopted to actualize innovative actions in the university and Sumgayit region.

Other than the outdated experimental equipment in chemistry, mechanical and electrical engineering, fixated mindset of faculty members and educational methods add difficulties in innovative activities. In the FGI with five junior faculty members, one testified that the ratio of the actual performative requirement at the university between teaching and research was 9 to 1. When asked if they expected to be a good researcher or teacher in SSU, all replied, “teacher.” The homogeneous educational system and governance in Azerbaijan have not yet offered incentive for faculty members to engage in research activities, much less industrial collaboration. Even if the head of Innovation Center, Javanshir Mammadov, has made efforts to establish the innovation facility in the university and urged students to seek for creative works, the regular academic course remain to be theoretical only; and one of respondents from the student focus group said the frequent warning students get from the instructor would be, ‘Don’t touch it [machine].’

Figure 8 | Innovation Center and class in SSU



While both the faculty’s and graduate the student’s focus groups felt pride in SSU’s recently augmented academic status spurred by more rigorous research activities (SSU acquired the 5th in QS rank and enlisted within the 1200th global ranking in 2024-25 period), interviewees similarly pointed out weaknesses of their academic organization in the lack of practical experience, big projects, and overseas student exchange. They also expressed concerns about the consistency of the former leadership of Rufat Azizov that had inspired and persuaded academic members to engage in more pragmatic activities. We also circulated on-line survey to faculty members and graduate students’ to understand their general opinion of the SSU’s current status and needs.

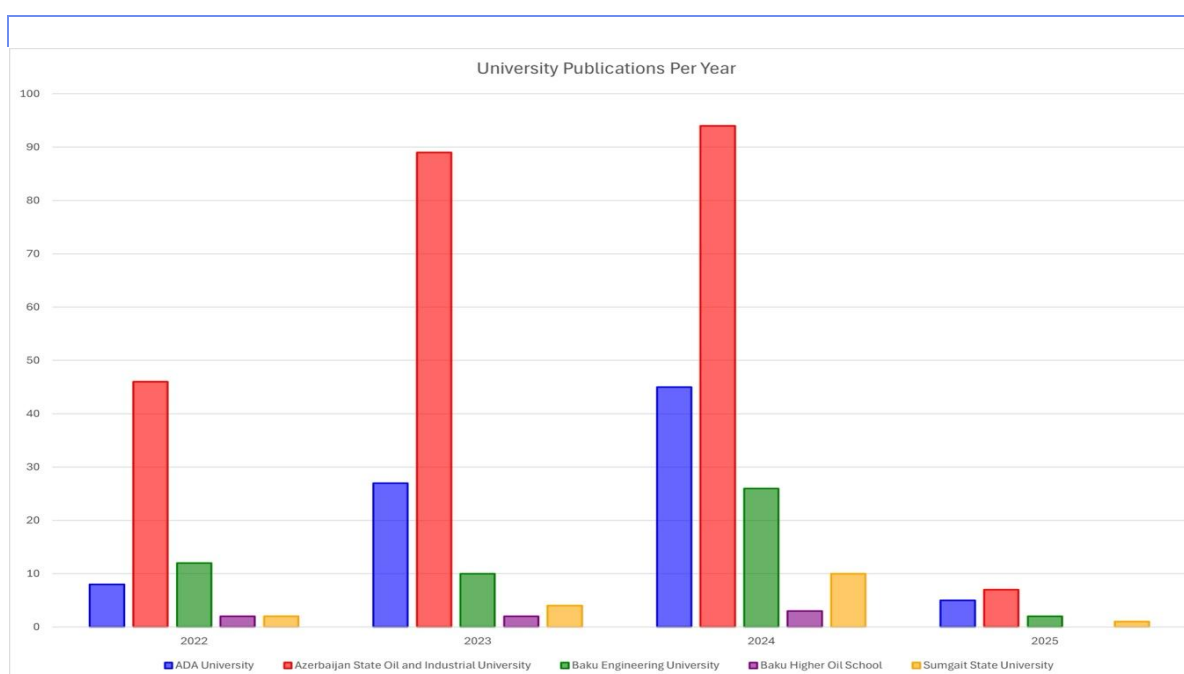
Our second field trip clarified that, in order to facilitate innovation in Sumgayit region, the academic transformation of SSU alone will not be sufficient to accomplish the end. Despite the change of higher educational policy orientation, the homogeneous pedagogical structure and embedded practices among faculty members would be slow to adapt to the arising technological and industrial demands. While the additional support of government should be considered, more active engagement from the private sector should be also scrutinized.

Currently, there are an on-going develops of districts around Baku city, and the Sabah City is one of the recent construction projects. It plans to develop an innovative cluster, supervised by the Ministry of Science and Technology, by accommodating a few technology universities and develop innovative facilities to encourage knowledge transfer. Our research team visited the construction site and had in-depth discussion with the CEO of Sabah City project task force, Nihat Majidov, to explore ways to institutionalize international cooperation to stimulate innovation in the academy and industry. While much remains to be discussed for concrete implementation, Nihat Majidov pointed out that Sabah City could offer incentives by providing land to participating company or consortium if the stakeholder(s) intends to develop research institute and innovation center at national or regional scale. In comparison, Sumgayit City Office had no clear plan to support or incentivize investment of research-oriented regional development at the moment.

3. The Status of SSU and Current Challenges

The former Rector of SSU, Dr. Rufat Azizov, who initiated and carried out the KSP scheme, emphasized that the change of mindset of academic staffs was the foremost and on-going challenges in the Azerbaijani organization. Although there has been decades' efforts to overcome the lingering pedagogic legacy of former Soviet Union, the observed mindset and daily practices of the majority of faculty members are excessively teaching-oriented; and their content of teaching is more often than not repetitive and outdated. Although some key members of SSU agreed to the vision of the former Rector and made efforts to reestablish the identity of the higher educational institution over the last couple of years, such movement for transformation is, from our observation, not without hesitation and resistance among the members of SSU.

Figure 10 | Number of publications of 5 major universities in Azerbaijan

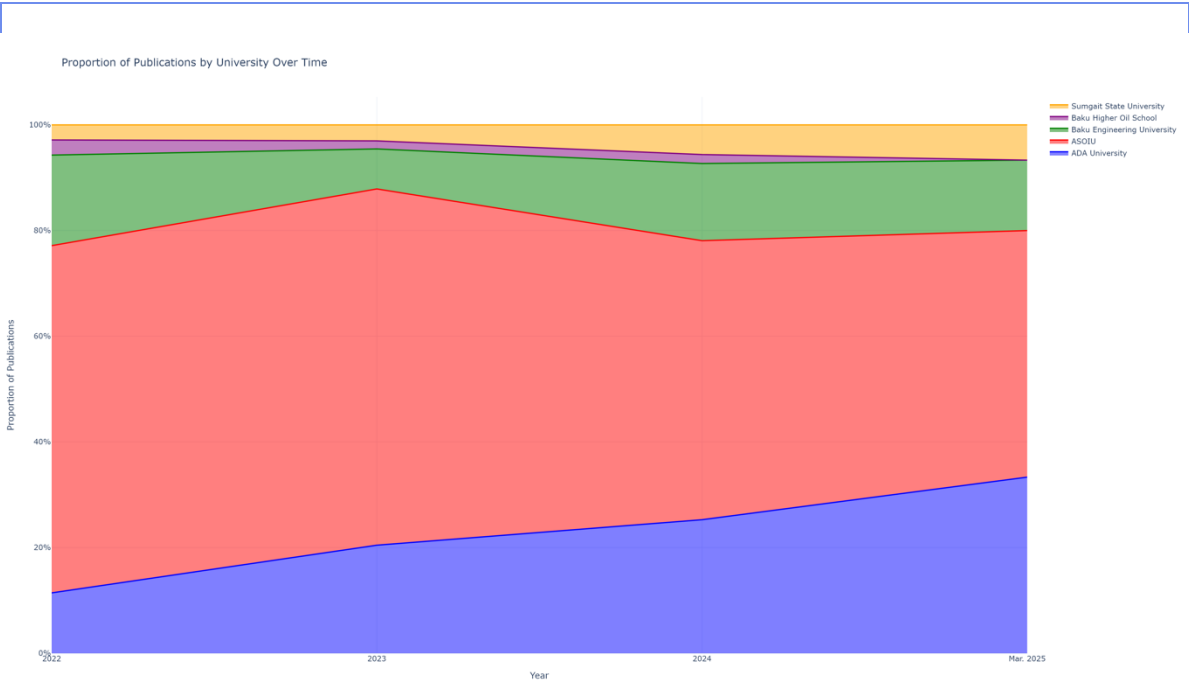


The recent efforts to engage with industry and foster research-oriented practices to make use of academic knowledge is rather slow and weak. According to our bibliometric analysis, the number of patent in SSU in the recent 3 years is as few as 17 that mostly stem from “cellulose activation” processing. Such patenting needs to adapt to a global standard, and should file for more globalized platform such as the United States beyond the current application to Eurasian Patent Office (EPO). On the other hand, while there has been efforts to build up as many as 100 start-ups in the Sumgayit region, according to our interview with the head of Innovation Center (Javanshir Mammadov), none of them are currently making any profit. The Technopark and Innovation Center in Sumgayit lack adequate research facilities and supporting staffs to attract industrial stakeholders.

Research-wise, on the other hand, the number of publication in major fields (chemistry, physics, food science and technology, mathematics, and computer science) are on the rise along with other competitive universities (Fig. 10). At a relative proportion among the five universities (Fig. 11),

Sumgayit State University is gaining more proportion since 2023. In comparison, Baku Higher Oil School (BHOS) has limited publication while ADA university shows significant increase in the number of publication in the five major domains. Baku Engineering University (BEU) has been producing more academic papers than SSU, but remain to be stagnant in terms of relative proportion.

Figure 11 | Proportion of publications of 5 major universities in Azerbaijan



From the statistical point of view, the Sumgayit State University and other nearby academic institutions’ transformation to more practical knowledge creation has only begun. If we inspect the Sumgayit region, an inertia only to repeat the past practice is still strong, and there is a lack of clear vision and strategy to identify and develop key technologies, management structure, and operation. Neither university nor industry are willing to set up plan and challenge beyond seeking some research grants that are scattered across regions. In this regard, any risk of distorting current institutional efforts for innovation and transformation to another form of “paperwork” is not delusional. While an arduous path awaits to observe some concrete outcome, there should be a catalysis to accelerate the development of relatively “underdog” universities like SSU, BEU and BHOS.

While consistent policy and institutional efforts are prerequisite to eventual success in the region, a quick move to fill in the knowledge gap and bring about concrete results, e.g. the increase of employment of graduates, internship opportunities, academic publication and patent, engaged collaboration between university and companies, etc., will convince the validity of the reform. Hence, Sumgayit and nearby region need a new establishment to foster a more effective research platform to induce academy-industry collaboration. On the other hand, students must benefit from the cooperative ecosystem. Enhanced research capability through a higher-profile facilities will equip students with improved competence to contribute to industrial activities and nurture the grounds for practical application.

Table 9 | Area of expected development (Based on the frequency of comments)

Area of interest	Faculty members	Graduate students
Equipment	●	○
Laboratory	●	○
Research Center	●	
ICT / Digitalization	○	●
Internationalization	○	●
Teaching program		●
Research project	●	●
Organizational reform	○	○

● Strong ○: Moderate

From the survey conducted during the second field research, there are notable points faculty members and graduate students made. In those responses, faculty members emphasized the needs for more modern laboratories and equipment, promoting digitalization, English language skills of teachers, development of targeted research projects, enhancement of project management and innovative structures of the university, the establishment of a research center that attracts young students, a mobility program to encourage faculty members to experience foreign institutions through internship and conference, etc.

Graduate students showed more interest in internationalization, ICT development, and organizational reform. In the open-ended responses for free comments, there are calls for ‘strengthening innovation and commercial cooperation with foreign countries’, ‘ICT-oriented development’, ‘foreign teachers with international experience’, ‘internationalization of educational programs at the master's level, conducting more practice-oriented classes.’ One respondent mentioned that the industrial collaboration project with BP (British Petrol) was not satisfactory because students were not involved in production experience and the project was not well organized.

To summarize, faculty members basically express strong interest in the improvement of educational infrastructure. Graduate students show higher expectations in ICT development, internationalization and enhancement of teaching program. Both groups share strong interest in the development of research projects with industry and foreign institution. If expressed cautiously, some of those respondents feel that there should be an improvement of organizational structure to better manage educational program and external projects in the university.

In regard to the needed equipment and facilities, we conducted separate survey to staffs who were respectively in charge of innovation center of SSU and ICT department – Javanshir Mammadov and Ahmad Ahmadzada. The requirement of facilities (See Appendix I) covers a certain area of power engineering, automation and control, mechatronics and robotics, computer engineering and networking, logistics and transport technologies, house of innovation creative

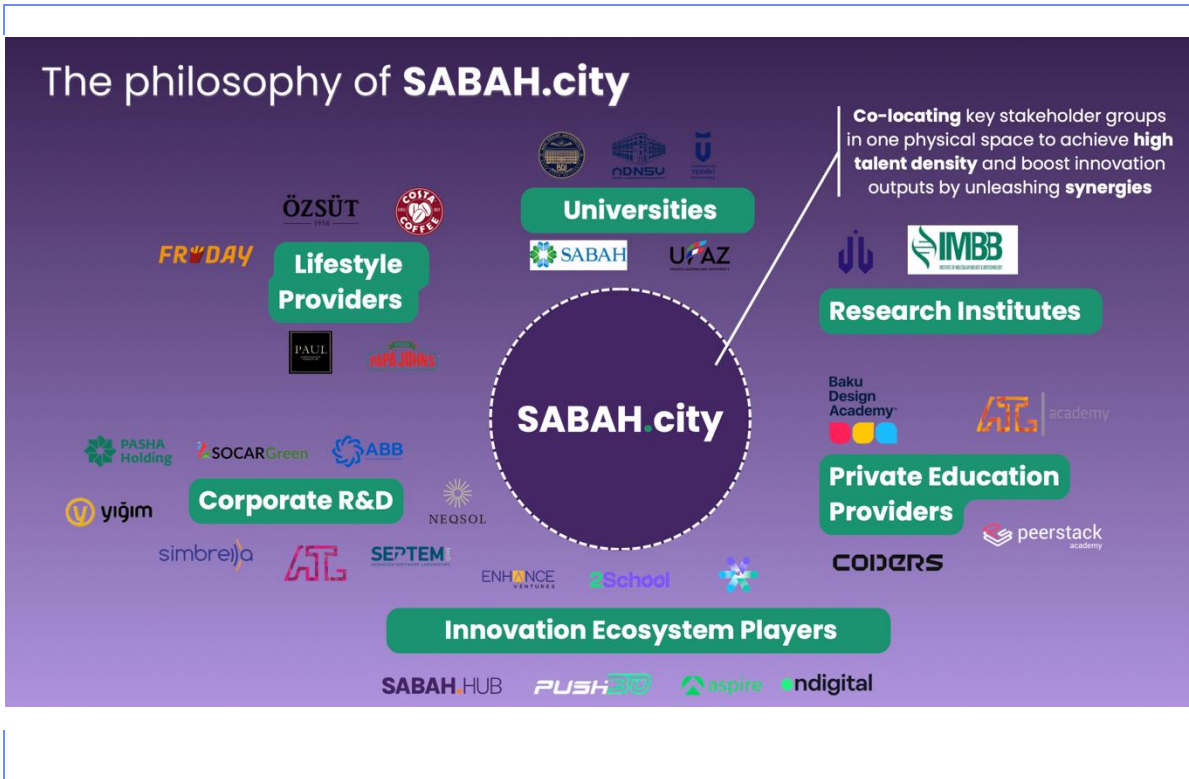
center, and equipment for computer science laboratory. The estimated cost is around 450,000 US dollar. Finding ways to subsidize and procure the required items through international cooperation could facilitate continued engagement.

4. Implication and Strategic Orientation

From the national perspective, the future of Azerbaijan will not only rely on abundance of resources like oil and natural gas but also human resource development. From our analysis of researchers’ collaborative (co-authorship) network (see Appendix II), quite a number of key players with Azerbaijani origin are positioned in some main global components. It is vital for the Azerbaijani government to induce some best talents working abroad and foster international collaboration to enhance research capacity. However, the current salary structure in the academy is rather homogeneous and low-profile in compensation.

Therefore, a novel design of institutional platform to attract academy-industry cooperation is necessary to expect an effective innovation through academic engagement in the future. For the regional development of Sumgayit, an external stimulus to motivate high-profile research that is globally competent and applicable to industrial innovation will work as a catalysis to bring about changes in national education and corporate activities. As noted in the previous section, Sabah City is under construction with innovation cluster to attract foreign investment and create ‘high talent density’ by integrating the capabilities of corporate R&D, universities, and research institutes.

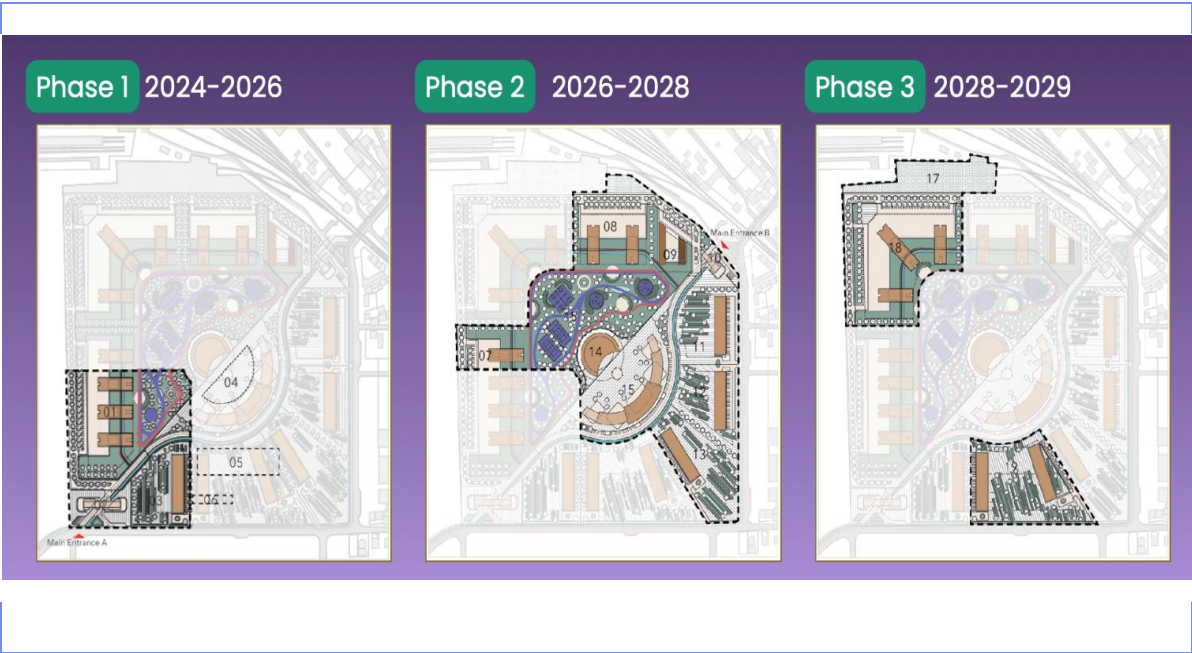
Figure 12 | The vision of Sabah.city



From our field research, we summarize that Azerbaijani research institutions require a strong and consistent governmental policy to establish a research-oriented and innovative platform to link

the existing university and industry. Through our interviews with directors of SOCAR, Sabah.hub and Pasha Group Holding, the research team have witnessed some potential areas to facilitate collaboration between big Azerbaijani enterprises and universities while foreign institutions like Korean universities and laboratories might provide the needed skill-sets and technologies to accelerate innovative capacity building. The Azerbaijani economy and industry are predominantly occupied by state-run BMEs. Therefore, unlike the global convention to promote SMEs, at least for the time being, it could be more effective for Azerbaijan to focus on developing the research link between core BMEs and academic institutions to claim visible outcome. Also, there should be a refined program to incubate start-ups and explore new technologies and business models. The industrial innovation and the development of higher education are integral components to interact each other. And the existing faculty members and students should not be alienated from the institutional transformation. Programs to facilitate participation of those actors in a novel research platform and nationwide innovation centers should be considered.

Figure 13 | The construction plan of Sabah.city



We conclude that South Korea can present a number of successful cases and transfer relevant experiences in this regard. The history of Korea that firstly developed state-run research institute in 1970s, Korea Institute of Science and Technology (KIST) presents how a national research system with concentrated resources and higher aim at the development stage can contribute to needed technological progress and eventual diffusion of innovation. Korea’s reform of higher educational programs since 2000s, the BK21 (Brain Korea 21st century) and the LINC (Leaders IN Industry-University Cooperation), can be significant references for systemic transformation. Next chapter explain these institutional trajectories.

III Case study on Korea's experience

1. Brain Korea (BK) 21: Strategies and Achievements

BK21 Plus (Brain Korea 21+) was a governmental program (2013–2019) designed to nurture world-class graduate schools and outstanding research personnel through intensive support for master's/doctoral students and emerging researchers. It integrated achievements and lessons from previous BK21 phases (1999-2012) and WCU (World Class University), aiming at developing creative postgraduate talent for a creative economy, reinforcing research-centered universities, and enhancing regional graduate schools' educational/research capabilities. By operating on the principle of selective and focused support, BK21+ provided scholarships for graduate students, salaries for emerging researchers, and funding for international academic activities, building world-class research-centered universities. For Azerbaijani universities' transition to a research-oriented institution, adopting BK21+ experiences could include stable financial support expansion for graduate students and emerging researchers, incentive systems for faculty research enhancement, introduction of research-focused semesters, and expansion of international collaborative research exchanges.

1.1. Background of the BK 21 Project

1.1.1. Background

1) Overcoming the Financial Crisis and Enhancing National Competitiveness

The Brain Korea 21 (hereinafter "BK21") project was an educational reform initiative launched by the Kim Dae-jung administration (1998-2003) to prepare for the 21st-century knowledge-based society. At that time, Korea was experiencing a financial crisis, and the competitiveness of individuals, industries, and the nation was a major national reform agenda.

To improve national competitiveness and overcome the national crisis, the quantity and quality of knowledge created by individuals and groups needed to become the source of competitiveness. Particularly, to lead the creative knowledge-based society of the 21st century, developing creative talent capable of creating and operating new knowledge and technologies emerged as the most important national task (Ministry of Education & Korea Research Foundation, 2007).

2) Challenges to Cultivating Creative Talent

Korea's elementary, secondary, and higher education systems were inadequate for nurturing creative talent and generating new knowledge in the beginning of the century. The BK21 project launched with the recognition that the existing education system would be inadequate to the emerging knowledge-based society. In the hierarchical university structure, elementary and secondary education was drifting toward rote memorization of fragmented knowledge for university entrance exams, and the increasing burden of private education costs on parents called for special educational reform measures.

Korea's research capabilities and education level in higher education were significantly lower than those of advanced countries in 1999. According to the 1998 IMD World Competitiveness Yearbook, Korea's international competitiveness in human resources ranked 22nd, and the number of SCI (Science Citation Index) papers, one of the indicators of international academic and research levels, ranked 17th. In 1997, Korea's total number of papers was only 82% of the number of papers from Japan's top two universities (Tokyo University and Tohoku University).

3) Strong Resistance and Opposition from Professors

The BK21 project started in 1999 and has continued through Phase 1 (1999-2005), Phase 2 (2006-2012), Phase 3 (2013-2020), and Phase 4 (2021-2027), spanning about 30 years as a research-centered graduate school development project. In the summer of 1999, when Phase 1 was planned by the government, around 900 professors from universities nationwide gathered at Myeongdong Cathedral to hold a large-scale protest demanding the cancellation of the BK21 project. Professors who participated in the rally claimed that the project would "solidify the hierarchical structure of universities through preferential support for a few universities, deepen the gap between regions due to concentration of support in the metropolitan area, and bring about new problems such as dependent academic development and competition for graduate school admissions" (Yonhap News, July 8, 1999).

In public hearings for planning the project, the education community argued: 1) the non-democratic and hasty nature of the policy-making process, 2) the solidification of monopolistic university structures and the decline of regional universities, and 3) the intensification of bureaucratic control over universities and academia. As an alternative, they proposed establishing a consultative body involving the Ministry of Education, the University Presidents' Council, and university faculty associations to promote university reform based on the principles of participatory democracy, and dividing the country into several regions to develop regional research-centered universities that could concentrate research capabilities within each region (Ministry of Education & Korea Research Foundation, 2007).

However, as the paradigm shift toward a knowledge-based economy was rapidly approaching, and with structural adjustments and competitiveness enhancement becoming national agendas due to the IMF financial crisis, policymakers felt compelled to pursue a breakthrough for strengthening the fundamental competitiveness of higher education through the principles of 'world-class graduate school development' and 'selection and concentration'. As a result, while some of the academic

community's opinions were accepted and the scope of supported universities was expanded, Phase 1 of the project was implemented with modified content from the original plan, becoming the first large-scale national project to embed the cliché of 'selection and concentration' in our education sector.

1.1.2. Project Objectives and Principles

1) Project Objectives

The objective of Phase 1, which began in 1999, was: To alleviate the distorted competition for undergraduate admissions and normalize elementary and secondary education, and to break down the monopolistic hierarchical structure based on university reputation and revitalize a culture of competition and cooperation in the university community. Additionally, it aimed to develop world-class graduate schools in a short period to lead the knowledge-based society as a national strategy.

2) Project Principles

Principle 1: Selection and Concentration

Dramatically enhancing universities' knowledge and technology production capacity was one of the most important responsibilities of the government preparing for the 21st century. However, education funding was too limited to develop all academic fields simultaneously. The realistic strategy was to concentrate limited resources on a small number of science and engineering fields that could secure international comparative advantage in the near future and have a significant impact on scientific and industrial development. Focusing on information technology and life sciences in the science and technology fields, which were central to this project, was an inevitable choice. Furthermore, rather than supporting all universities simultaneously, the decision to selectively support fields with competitive potential at universities that demonstrated a willingness to undertake reform and restructuring aligned with the principle of selection and concentration.

Principle 2: Nurturing Creative Academic Successors

At that time, the core of future national competitiveness was seen as creative talent, and universities were expected to play a central role in producing capable academic successors to lead our knowledge industries. The BK21 project provided stable research foundations for young researchers and offered graduate students various financial and administrative support, research participation opportunities, and extensive international exchange opportunities to establish a foundation for cultivating creative academic successors.

Principle 3: Linking Financial Support with University Structural Reform

The BK21 project linked research capacity enhancement funding with university reforms such

as reducing undergraduate enrollment, reforming admissions systems, strict faculty performance evaluation, opening graduate school doors, and implementing centralized research fund management. Reforms in university systems and culture were necessary not only for the development of universities themselves but also to normalize creative education-based elementary and secondary education, which had been suffering from the rigid hierarchical structure among universities and the distortion of standardized entrance examinations.

Principle 4: Balanced Development of Knowledge Base

The project sought to strengthen the knowledge base overall by supporting the substantiation of undergraduate programs at regional universities through industry-academia cooperation, and through the development of graduate schools in humanities and social sciences and core areas across all academic fields. This was a mechanism to compensate for problems arising from the principle of selection and concentration.

1.1.3. Main Aspects of the Project

1) Basic Project Structure

The BK21 project started with a simple program structure in terms of content, and this approach has been maintained up to Phase 4, which is currently in progress. There are two main types of support: one is to select educational research units (teams) by academic field to support graduate students and new researchers so they can concentrate on their studies and research with stability; the other is to support international activities and research output efforts for these academic successors (in Phase 4, graduate school innovation funding was added separately).

2) Project Sustainability and International Influence

This financial support project has uniquely maintained its core purpose throughout changes in six administrations (Kim Dae-jung, Roh Moo-hyun, Lee Myung-bak, Park Geun-hye, Moon Jae-in, and Yoon Suk-yeol). While many other university financial support projects have appeared and disappeared over the past 30 years, the BK21 project has secured an independent status and been implemented stably. This BK21 project has also influenced graduate school support projects in other countries, with programs such as Germany's Excellence Initiative Program and Japan's Centers of Excellence (COEs) benchmarking it.

3) Project Scale and Structure

Starting with 121 project groups and 317 project teams in Phase 1 in 1999, the project expanded to 356 project groups and 213 project teams in Phase 2, 270 project groups and 280 project teams

in Phase 3, and 403 education research groups and 176 education research teams in Phase 4. A massive budget has been invested in this project to enhance world-class research competitiveness: 1.34 trillion won in Phase 1, 1.75 trillion won in Phase 2, and 1.88 trillion won in Phase 3. Although there have been changes in the detailed types of projects in each phase, the project has generally maintained its core of selecting and supporting competitive departments while also creating and disappearing some programs designed to support graduate schools as professional school units.

A distinctive feature is the consistent distinction between national and regional units, reflecting balanced consideration for regional graduate schools, and maintaining a structure that supports both large departments (educational research groups) and small groups (educational research teams) formed by excellent professors within departments. This was a mechanism to compensate for problems arising from the principle of selection and concentration.

1.2. Contents and Key Achievements of Each Phase

1.2.1. Phase 1 (1999-2006)

1) Core Strategies and Budget

Phase 1 of the BK21 project aimed to establish a high-quality human resource development system through "intensive development of graduate schools of world-class standard" and "specialization of regional universities," and was implemented in connection with university education reforms such as reducing undergraduate enrollment, opening graduate school doors, implementing centralized research fund management, and strengthening faculty performance evaluation systems. Beginning in September 1999 and ending in February 2006, Phase 1 received a total budget of 1.34 trillion won (approximately 1 billion US dollar).

2) Project Announcement and Application Requirements

Phase 1 was announced in June 1999 after gathering university opinions, studying foreign cases, and holding public hearings since 1998. For science and technology fields, areas directly related to national competitiveness and those that could secure international competitive advantage were designated: 1) information technology (electrical, electronic, computer, software, etc.), 2) medicine, dentistry, pharmacy, 3) agricultural life sciences, 4) biology, 5) mechanical engineering, 6) materials science, 7) chemical engineering, 8) physics, 9) chemistry, and 10) other fields meeting application requirements and project plans. The number of project groups for each field was limited to three university project groups for information technology, biology, and mechanical engineering, and up to two university project groups for other fields.

Application units were restricted to university-affiliated project groups with undivided graduate school recruitment units, which presupposed the participation of all professors and graduate students in the academic organization. Project groups could be formed by a single university or by two universities in collaboration, with collaborations between geographically proximate universities encouraged. The size requirements for project groups were specified as follows: at least 50 professors for information technology, medicine, dentistry, and pharmacy; at least 30 professors for mechanical engineering and agricultural life sciences; and at least 20 professors for biology, materials science, chemical engineering, physics, and chemistry.

Universities participating in the project were required to implement certain institutional reforms: 1) improving undergraduate admission systems (broader recruitment units), 2) reducing undergraduate student quotas, 3) opening graduate school doors (accepting at least 50% of graduates from other universities), 4) linking faculty performance evaluation to personnel decisions (promotion, tenure, etc.) and compensation (annual salary system, etc.), 5) establishing support systems for industrialization of project outcomes (industry-academia cooperation committees, venture business promotion, technology transfer-related organizations, regulations, fund establishment, etc.), and 6) other requirements such as broader undergraduate recruitment units than graduate school recruitment units, centralized management of external research funds by the university president, and creating a competitive research environment necessary for research-centered university systems.

Participating universities were also required to present performance targets: First, for professors/research, targets included 1) the number and impact factor of SCI-level international journal publications, 2) international patents, etc.; Second, for graduate students/education, targets included 1) publication of doctoral dissertations in international journals, 2) foreign language instruction, etc.; Third, plans for domestic and international industry employment after degree completion; Fourth, self-sustainability plans related to industry-academia cooperation after the project period; Fifth, other items such as 1) submission of curriculum reform drafts at the project group level, benchmarking world-class foreign graduate schools, 2) establishing websites for project groups/teams and participating professors, 3) international cooperation (long-term overseas training for graduate students), 4) participation of professors from foreign universities as dissertation committee members, etc.

Requirements for the composition of project groups were specified. Project groups were to consist of project teams formed to carry out tasks, with each project team centered around one project responsibility professor, participating professors, and graduate students (doctoral and master's programs). Project teams were to be organized so that 30-40% of all professors could become project responsibility professors.

Qualifications for members, especially professors, were also specified. The project group leader needed to be able to stably manage the project until its completion, possess outstanding research experience, and have both the will for educational reform and management skills to oversee the entire project group. Specifically, the project team leader (project responsibility professor) needed to be able to stably carry out the project for at least the next 10 years and have at least 4 research achievements (SCI-level international journal publications, international patents, etc.) over the past 3 years. Among the entire faculty of the project group, including project responsibility professors, at least 40% needed to have at least 2 research achievements (SCI-level international journal publications, international patents, etc.) over the past 3 years.

Eligibility conditions for participating graduate students specified that they must be full-time registered master's or doctoral students who could dedicate at least 40 hours per week to project-related research and coursework at the graduate school, with master's students not having exceeded 2 years since admission, doctoral students not having exceeded 4 years since admission, and integrated master's-doctoral program students not having exceeded 6 years since admission. Military service and leave of absence periods were not included in these time limits.

University project groups selected through competitive applications signed agreements with the government regarding institutional reforms, project goals, and government support, with agreements to be terminated in case of violations. The government annually verified the achievement of matching funds, expenditure of funds by item/purpose, and key aspects related to project goals and task performance. In particular, interim evaluations were conducted on institutional reforms in 2000, 2001, and 2002. Comprehensive interim evaluations of university project groups were conducted in 2002 and 2004, comparing multiple project groups and transferring 20% of the lowest-performing project group's funding to the highest-performing project group.

3) Budget Allocation by Field and Use of Project Funds

Approximately 7 billion won was allocated for information technology, 5 billion won for medical (dental/pharmaceutical) life sciences, 4.5 billion won for mechanical engineering, 3.5 billion won for agricultural life sciences, 3 billion won for materials science and chemical engineering, and 2.5 billion won for biology, physics, and chemistry.

The use of project funds was specified as follows: at least 45% for graduate student support, 25% for new research personnel support, 20% for major expenses related to project execution, 10% for university-initiated international cooperation, and 15% for government/university joint international cooperation projects.

4) Strengthening International Cooperation

University-initiated international cooperation was encouraged, including 1) short-term overseas training for advisors/graduate student teams and 2) inviting foreign professors.

Government/university joint international cooperation projects were also promoted, including 1) long-term overseas training for graduate students and 2) providing partial initial setup costs for international cooperation programs such as on-site industry-academia cooperative field training abroad, after government review.

5) Comprehensive Evaluation Criteria for Science and Technology Fields

The evaluation criteria for Phase 1 BK21 included:

- Requirements and institutional reform evaluation (100 points)
- Project group requirements (20 points): Appropriateness of alliance between main university and participating universities, appropriateness of professor composition, integration of graduate school departments
- Institutional reform requirements (80 points): Improvement of undergraduate admission systems, reduction of undergraduate student quotas, opening of graduate school doors, establishment of support systems for commercialization of project outcomes, broader recruitment units for undergraduate programs, centralized research fund management
- Project group and project plan evaluation (300 points)
- Project group composition requirements (140 points): Qualifications of project group members, research capabilities of the project group, budget and matching funds
- Key performance targets by sector (80 points): Appropriateness of benchmarking, concreteness and feasibility of professor/research sector goals, concreteness and feasibility of graduate student/education sector goals, project group self-sustainability plan, content of project group curriculum reform, web-site utilization plan, international cooperation plan with foreign graduate schools
- Project team project execution plan (80 points): Appropriateness of project execution teams, importance, demand, and expected effects of project content such as industry-academia cooperation

6) Recommendations from the Foreign Advisory Committee

In August 1999, a foreign advisory committee held three evaluation meetings at UCLA's Sunset Village and Engineering IV building to evaluate applications from science and technology fields and exchange opinions with the planning and coordination committee members and Ministry of Education officials regarding the successful implementation of the BK21 project. The foreign scholars made the following recommendations:

- Selected universities should strengthen interdisciplinary research.
- Each selected university should form an external advisory committee to regularly review the progress of the selected programs and connect the selected university with other institutions.

- Interim evaluations should be conducted every three years.
- Selected universities should be allowed to flexibly adjust their budgets within the limits consistent with project objectives.
- Selected universities should establish and implement firm policies to recruit and respect excellent and creative students and professors.
- Selected universities should establish and implement firm policies that value education (teaching).
- Selected universities and the Ministry of Education should consider qualitative evaluation criteria and processes, and when applying quantitative criteria, adjust them through external expert evaluation.
- Selected universities should accelerate reforms and raise their targets.
- Selected universities should develop and implement programs to strengthen design skills and synthesis education in relevant departments.
- Selected universities should establish and implement policies regarding professors' external professional activities.
- Project tasks should be reviewed to integrate similar projects and be reviewed every 1-3 years.

7) Major Project Achievements

The project showed clear results in indicators directly reflecting its performance, particularly in research achievements. In science and technology SCI papers, Korea's total paper count advanced from 19th globally (9,444 papers in 1998) to 12th globally (23,515 papers in 2005) by the end of the project. This represents an approximately 150% increase compared to the start of the project. Considering that over 34% of Korea's total SCI papers received support from this project, the project made a significant contribution to the country's total SCI paper count.

Aggregating the research achievements of Phase 1 BK21 by project area, considering the characteristics, target audiences, foundations, and conditions of each project area, science and technology fields produced 40,389 SCI papers by professors, 6,903 by new researchers, and 21,002 by graduate students. In humanities and social sciences, professors published 694 papers, new researchers 225.3 papers, and graduate students 160.4 papers in international academic journals, while professors published 1,997.7 papers, new researchers 1,059 papers, and graduate students 1,041.7 papers in domestic specialized academic journals.

The BK21 project can be defined as a high-quality human resource development project. Therefore, the social contribution of the trained personnel is an important indicator for judging the

success of the entire project. In the strictest sense, the impact and contribution of personnel trained through project support could be accurately measured by tracking their careers over a considerable period after degree completion. However, at the current point after project completion, the effect of the project can be partially measured by identifying the career paths of the trained personnel.

Looking at the entire BK21 project, 83% (22,475) of master's degree recipients pursued doctoral studies, studied abroad, or found employment in related companies, while 91% (7,375) of doctoral degree recipients found positions as postdoctoral researchers, university faculty members, researchers, or in related companies, demonstrating achievements that align with the project's aim of developing high-quality human resources and nurturing academic successors.

Above all, the development of excellent project groups in science and technology fields was a significant achievement. For example, Seoul National University's Mechanical Engineering project group conducted "International Collaborative Product Design and Manufacturing" lectures simultaneously at the University of Michigan, Berlin Technical University, and Seoul National University through real-time video classrooms. This was the first remote video lecture attempted worldwide and received the Computerworld Honours award in 2002 through joint recommendation by Cisco Systems and SBC Communication. This video lecture system was implemented as part of the BK21 international exchange and cooperation support project.

Additionally, Gyeongsang National University's BK21 Agricultural Life Sciences project group produced outstanding young researchers, including Dr. Min-chul Kim (Max Planck Institute, Germany), Dr. Won-do Heo (Stanford University researcher, USA), and student Ho-hee Jang, who published papers in world-renowned academic journals such as Cell, Nature, and Science. All received their doctoral degrees with BK support, and Dr. Min-chul Kim is currently working at the Max Planck Institute, having started with long-term overseas training. Professor Young-hee Lee's team from Sungkyunkwan University's BK21 Physics project group developed technology to convert metallic nanotubes into semiconductor carbon nanotubes (featured as the cover article in Advanced Materials journal in 2002), which is being evaluated as a core technology that could dominate the global semiconductor market until 2010. Professor Lee has been participating in the BK21 project since March 2001 and continues to produce excellent research results.

1.2.2. Phase 2 (2006-2012)

1) Core Objectives

Phase 2 of the BK21 project had more clearly defined goals than Phase 1. It aimed to develop research-centered universities ranked in the global top 10 in specific fields through the cultivation of outstanding talent. Three core directions were established: First, concentrating on developing world-class research groups through the stable cultivation of core high-quality personnel in promising future technology fields and academic successors in basic science and humanities; Second, enhancing the foundation for improving university education and research capabilities through infrastructure construction for research-centered universities, and establishing a demand-centered human resource development system through strengthened industry-academia cooperation; Third, developing regional graduate schools to lead regional innovation through specialization and

concentrated development of R&D human resource clusters by region.

Through these efforts, the plan was to develop 10 field-specific research-centered universities of world-class standard by 2012 and place Korea's SCI paper ranking in the top 10 globally. By 2012, the goal was to reach the global top 10 in knowledge transfer from universities to businesses and increase the rate of technology transfer from universities to the private sector from 10.1% to 20%. The implementation plan was to support over 20,000 outstanding master's and doctoral students annually from 2006.

2) Core Strategies

First, field-specific graduate school specialization was promoted through selective intensive support for key specialization fields autonomously chosen by universities. In selecting project groups and evaluating performance, universities' concentration of human and material resources in specialization fields and their willingness and achievements in implementing this were evaluated, encouraging voluntary institutional reform and restructuring for establishing research-centered graduate school systems. Institutional reforms were somewhat reduced and modified compared to Phase 1, focusing only on essential systems for building research-centered university foundations, such as centralized research fund management, faculty performance evaluation systems, and faculty recruitment rates (requirements for university admission system improvement and undergraduate quota reduction were excluded).

Second, emphasis was placed on enhancing the responsiveness of graduate education and research to industry needs through industry-academia cooperation. R&D field-specific customized human resource development programs involving domestic (Federation of Korean Industries, etc.) and foreign companies (Microsoft, etc.) were introduced, incentives for university (faculty) participation in industry-academia cooperation were strengthened by increasing the weight of industry-academia cooperation indicators in project group evaluation and faculty performance evaluation (especially for applied fields), and systems for institutionalizing and enhancing the efficiency of industry-academia cooperation support were focused on, with efforts to develop plans for expanding actual industry investment, such as establishing industry-academia cooperation funds by domestic companies.

Third, university autonomy was expanded and accountability strengthened (evaluation and management system innovation). Competition opportunities were expanded through flexible adjustment of minimum professor numbers (Critical Mass) by academic field, considering field-specific characteristics. The government's ex-ante, quantitative-centered regulations, which had been pointed out as a problem in Phase 1, were shifted to ex-post qualitative evaluation management, requiring universities to provide their own rationales for the standards and project plans they established. University (project group) self-evaluation was made mandatory, and a professional continuous evaluation system involving foreign scholars, industry representatives, etc., was operated.

Fourth, the 'selection and concentration' principle from Phase 1 BK21 was maintained. The best research groups in science and technology and humanities and social sciences were selected through open competition and received intensive support for seven years (2006-2012), with

guidance for concentrated support in core fields for creating future national wealth 10 years later. In science and technology, fields such as basic and original technology, promising future advanced technology, industries promising for an aging society, and convergence technology fields were selected; in humanities and social sciences, focus was placed on protective academic fields, practical academic fields, fields necessary for building an advanced society such as social welfare, and interdisciplinary (convergence) fields. In the professional service human resource development field, medicine, MBA (finance, logistics, IT management, etc.) were selected and supported.

Fifth, the character of the project as a graduate-level human resource development project was strengthened, and efficient linkage with national R&D projects was enhanced. Support focused on core human resource development, with basic academic fields emphasizing academic successor cultivation (focusing on academic achievements such as SCI papers) and applied science fields emphasizing human resource development leading technological development (focusing on industry-academia cooperation achievements such as patents and technology development). During evaluation, indicators related to human resource development, such as employment rates and curriculum innovation, were emphasized. Synergy effects were sought through linkage with other ministry projects, including national R&D projects.

Sixth, efforts were made to strengthen regional graduate schools' research capabilities for balanced regional development. A "Regional Outstanding Graduate School Development Project" was newly established to focus on developing specialization fields at regional graduate schools in connection with regional strategic industries, public institution relocation, and innovation city development. Support concentrated on the strengths of regional graduate schools, while introducing a system for new project group entry due to the elimination of underperforming project groups and differential support based on performance to strengthen competition.

3) Project Areas

The project areas were broadly categorized into science and technology, humanities and social sciences, core fields (all academic fields), regional outstanding graduate schools (newly established), and advanced professional service human resource development fields (newly established).

Science and technology fields included basic sciences (mathematics, physics, chemistry, biology/life sciences, earth sciences), applied sciences (information technology, mechanical engineering, materials science, chemical engineering, medical life sciences (including drugs, medical devices), agricultural life sciences (including food sciences, forest resources, etc.)), and interdisciplinary (convergence) fields (energy, environment, NT, BIT, NIT, SI fields, etc.).

Industry-academia cooperation programs with domestic and foreign companies were newly established for applied sciences and interdisciplinary (convergence) fields. The domestic company participation program was a joint research personnel development project based on agreements between companies and graduate schools on joint curriculum development and human resource development investment plans, with support for graduate students and new researchers, and efforts to promote actual industry investment such as establishing industry-academia cooperation funds by domestic companies. A Global Campus project was also introduced to promote high-quality professional human resource development through on-site industry-academia cooperation

experience abroad, particularly encouraging internship participation at on-site companies in Silicon Valley, etc. This program was promoted in connection with the Ministry of Science and Technology's international cooperation projects.

4) Support Content and Scale

The support content was similar to Phase 1, including research scholarships for master's and doctoral students, salary support for new researchers, funding for curriculum development and improvement within project groups (including performance bonuses within project groups), and international cooperation expenses such as long-term overseas training.

Support levels remained the same as Phase 1: 400,000 won per month for master's students, 600,000 won per month for doctoral students, 1.25 million won per month for postdoctoral researchers, and 2 million won per month for contract professors.

5) Major Achievements

Looking at the research achievements of Phase 2 BK21, the number of research papers per participating professor increased by 10.6% in basic science and technology fields and 15.5% in applied science and technology fields from the start of the project in 2006 to the final year in 2013. In humanities and social sciences, international journal papers increased by 57.5% and domestic journal papers by 23.8%. In professional services, business administration's international journal papers increased by 46.6% and domestic journal papers by 15.6%, while medical and dental fields saw a 2.9% increase in research papers. The impact factor per paper from participating professors increased by 29.7% in basic science and technology fields, 71.0% in applied science and technology fields, and 5.1% in medical and dental fields from the first year to the seventh year.

At domestic and international patent registrations, a key industry-academia cooperation achievement, domestic patent registrations increased by 34.9% and international patent registrations by 57.9% from the first year (2006) to the seventh year. Of the total 24,360 domestic patent registrations, the distribution by field was: applied science and technology 67.6%, core applied science and technology 15.6%, basic science and technology 8.6%, professional services (medical and dental) 4.1%, core basic science and technology 3.2%, humanities/social sciences/design/visual 0.8%, and core humanities/social sciences/design/visual 0.1%. This indicates that patent registrations by participating project groups in Phase 2 BK21 steadily increased, demonstrating excellent technical achievement both quantitatively and qualitatively through consistent patent registration efforts to enhance national competitiveness through technology development.

Industry support funding also increased significantly. By field, Phase 2 BK21 industry research funding amounted to 85,645 million won for basic science and technology, 911,800 million won for applied science and technology, 20,372 million won for core basic science and technology, 197,824 million won for core applied science and technology, 27,985 million won for humanities and social sciences, 11,363 million won for core humanities and social sciences, 13,751 million won for

professional services (business administration), and 167,629 million won for professional services (medical and dental). Overall, industry research funding increased by 31.0% from the first year to the seventh year.

1.2.3. Phase 3 (2013-2019)

1) Core Objectives

Phase 3 of the BK21 project, renamed as the BK21 PLUS project, was implemented with three policy objectives. First, to improve the quality of graduate education and research to build a foundation for developing global-level talent and strengthen the foundation for research-centered universities through infrastructure support, thereby enhancing the global capabilities of research-centered universities overall. Specific targets included increasing the number of universities in the QS university ranking top 200 from 6 in 2012 to 11 in 2019, and improving Korea's university SCI paper citation index ranking from 30th in 2011 to 20th in 2019. Second, to focus on developing high-quality talent in fields contributing to national growth engines and job creation, and creating conditions for graduate students to fully concentrate on education and research. The plan was to support approximately 15,000 outstanding master's and doctoral students and new researchers annually for seven years (2013-2019) in core high-quality personnel across academic fields and high-quality specialized personnel in convergence fields. Third, to enhance regional graduate school capabilities through linkage with small and medium-sized enterprises and regional industries, and to focus support on specialization centered on universities' strengths in departments (majors) to raise the overall level of education and research at regional graduate schools.

2) Basic Directions

First, to shift from the previous quantitative performance management-centered approach to a qualitative performance-centered management system and promote institutional improvements for research-centered universities to enhance the quality of graduate education and research.

Second, to strengthen the education and research capabilities and roles of regional universities by expanding the proportion of support for regional universities and linking with small and medium-sized enterprises and regional industries. To this end, approximately 35% of the total project budget and about 45% of the total number of project groups (teams) were allocated to regional universities.

- To closely link graduate education and research with related industries to provide field-oriented knowledge and technology support and supply high-quality master's and doctoral level talent, industry-academia cooperation performance and plans were reflected in evaluations.

- To newly establish support types for cultivating high-quality specialized personnel in fields meeting social demands, such as digital multimedia, cultural content, industrial/industrial/fashion design, tourism, and information security.

- To create conditions for graduate students to immerse themselves in education and research without financial worries by increasing support unit costs for graduate students and new researchers, reflecting factors such as inflation. To this end

- To create conditions for graduate students to immerse themselves in education and research without financial worries by increasing support unit costs for graduate students and new researchers, reflecting factors such as inflation. To this end, monthly support for master's students was increased from 500,000 won to 600,000 won, for doctoral students from 900,000 won to 1,000,000 won, and for new researchers from 2,000,000 won to 2,500,000 won.

3) Detailed Support Areas

Firstly, the Global Talent Development category aimed to strengthen university education and research capabilities in core national development fields to global standards. The focus was on fields previously supported through the World Class University (WCU) project, meaning convergence R&D fields for fostering the creative economy.

Second, the Specialized Professional Talent Development category focused on cultivating high-quality practical professional personnel in emerging high-value specialized fields and national strategic fields. Support areas included science and technology and humanities/social sciences, with priority given to graduate schools centered on specialized fields such as industrial/industrial/fashion design, digital multimedia, cultural content, tourism, information security, and special equipment.

Third, the Future Foundation Creative Talent Development category represented the traditional academic fields that the BK21 project had been supporting. Basic science fields included mathematics, physics, chemistry, biology, and earth sciences. Applied science fields included information technology (electrical, electronic, telecommunications, computer, etc.), mechanical engineering, applied life sciences (pharmacy, agriculture and forestry, veterinary medicine, applied biotechnology, etc.), construction, chemical engineering, materials science, and basic medical/dental/Korean medicine fields. Academic fields not included in these science and technology areas but necessary for future national development (e.g., energy, environment, information security, industrial engineering, etc.) that met application requirements were also eligible to apply. Humanities and social sciences support covered all fields and also supported convergence areas.

4) Industry-Academia Cooperation and Institutional Innovation

Industry-academia cooperation was further strengthened to cultivate field-oriented master's and doctoral level talent, focusing on areas that would be beneficial to companies in terms of technology development and human resource cultivation. Regional universities were evaluated with greater emphasis on cooperation with small and medium-sized enterprises and in regional specialization fields.

To reflect systematic efforts for improving the quality of graduate education and research in

evaluations, comprehensive academic management, establishment of graduate-centered academic systems, improvement of research support systems, and other institutional innovation efforts at the university level were evaluated. In particular, efforts and plans to establish effective research ethics, including related regulations and educational curriculum development at the university level, were evaluated.

5) Project Group Quality Management Plan

An interim evaluation was conducted in 2015 to ensure quality improvement of graduate schools and rigorous project group management. In connection with graduate school quality improvement measures, evaluation indicators including institutional improvements were developed to further enhance the quality of graduate education and research, and after evaluating two years of project performance and graduate school quality improvement measures, new project groups were selected for 2016 through competition between existing project groups and newly entering project groups.

Short-term and quantitative evaluations were avoided in favor of medium-term and qualitative evaluations. Annual evaluations were conducted with a focus on consulting to reduce the burden on project groups while encouraging their reform and development, and a specialized evaluation management system considering the characteristics of project types and academic fields was established. To this end, a continuous evaluation and feedback system was established by forming a standing evaluation and consulting group of evaluation experts.

6) Industry-Academia Cooperation Field Success Cases

Ulsan University and Ulsan City created an industry-academia fusion district and a techno industrial complex to foster small and medium-sized enterprises in precision chemistry and materials industries through industry-academia fusion. The Chemistry Department, to which the project team belonged, participated in the industry-academia fusion district project.

In February 2018, the department moved to the industry-academia fusion district and currently uses a newly constructed building, including corporate research centers, joint equipment centers, full-cycle laboratories, advanced lecture facilities, and dedicated equipment rooms, performing the central mission of industry-academia fusion research. Based on close cooperation with industrial companies, industrial research institutes, and national research institutes located in the Ulsan industry-academia fusion district, various industry-academia research cooperation programs are being implemented for the advancement of Ulsan's chemical industry. Through the "Project Lab" operated as part of the Ulsan industry-academia fusion district creation project, companies conduct necessary R&D while simultaneously enhancing students' practical capabilities.

Additionally, the project team actively supported the timely resolution of technical challenges faced by small and medium-sized precision chemical industries in Ulsan, including technology development, technology transfer, commercialization, technical guidance, and business consulting. A second qualitative excellence of the project team's industry-academia cooperation was the

development and active participation in educational programs responding to the technical education needs of industries and the local community. Non-degree programs such as "Education for Understanding Polymer Synthesis" were developed and operated to enhance the capabilities and re-educate employees of small and medium-sized enterprises in the Ulsan region. Furthermore, an "Industry-Academia Integration" agreement was signed with SKC to comprehensively operate various industry-academia cooperation programs, actively implementing programs such as the Ulsan University Technical Consulting Group (UTCG), graduate student scholarship support, student employment connections, and R&D project execution.

The project team also showed excellent performance in operating family companies, signing family company agreements with precision chemical industries and institutions in the region and expanding human and material exchanges to support the movement and new employment of graduate school graduates. Agreements were signed with a total of 45 companies and institutions, and exchange meetings for the joint growth of large, medium, and small companies were held at least once a year. Professors were matched with family companies by research field to operate four small consultative bodies, establishing an organic linkage system through regular exchanges to identify technology needs and develop research projects.

1.2.4. Phase 4 (2020-2027)

1) Basic Direction

The project's objectives focus on enhancing research capabilities in core academic fields and reforming the graduate school system to substantialize graduate education. To this end, support is divided into "Future Talent Development" and "Innovation Talent Development" to cultivate personnel who will lead innovative growth. The 8 core leading industries and 13 innovative growth engine fields were determined through interministerial collaboration.

Phase 4 of the BK21 project aims to develop world-class research-centered universities through the cultivation of master's and doctoral level talent who can proactively respond to social changes such as the Fourth Industrial Revolution and demographic changes. From September 2020 to August 2027, a total of 2.9 trillion won will be provided at a rate of 408 billion won annually. Support includes funding for graduate student research scholarships, new researcher salaries, internationalization expenses, and education research group (team) operating expenses, with monthly support of at least 700,000 won for master's students, 1,300,000 won for doctoral students, and 1,000,000 won for doctoral candidates. In particular, Graduate School Innovation Support funds are provided to support university-level institutional reform costs for developing world-class research-centered universities.

2) Project Scale and Structure

Phase 4 of the BK21 project supports approximately 19,000 master's and doctoral students

annually for 7 years, with an annual budget of 408 billion won from September 2020. The budget consists of Future Talent Development and Innovation Talent Development funding for education research groups, and Graduate School Innovation Support funds for university headquarters. Future Talent Development supports education research groups in science and technology, humanities and social sciences, and other basic and core academic fields. Innovation Talent Development supports education research groups in new industrial fields and industrial/social problem-solving fields to enhance the competitiveness of new industrial fields and cultivate convergence research personnel to lead the resolution of industrial and social problems. Graduate School Innovation Support funds aim to facilitate integration between academic fields and make university headquarters the center of institutional innovation, providing annual funding of 52.9 billion won to universities with at least 5 selected education research groups, distributed according to the number of education research groups, participating professors, and supported graduate students.

3) Selected Project Groups

For Phase 4 of the BK21 project, a total of 562 education research groups (teams) (386 education research groups, 176 education research teams) from 68 universities were preliminarily selected from among 695 education research groups and 364 education research teams from 93 universities. By detailed project type, 197 education research groups and 176 education research teams were selected for Future Talent Development, and 189 education research groups for Innovation Talent Development.

Universities receiving Graduate School Innovation Support funds (universities with 5 or more selected education research groups) include 10 in the national category and 9 in the regional category, and these universities will receive approximately 52.9 billion won in first-year funding in proportion to the number and size of selected project groups to begin formal work on establishing research-centered systems.

1.3. Reflections and Future Tasks

1.3.1. Reflections

The BK21 project has continuously evolved over the past 25 years, focusing on fostering research-centered universities and strengthening Korea's higher education system and research development capabilities. Through this large-scale national project, the development of multiple research-centered universities approaching world-class levels has been made possible, with achievements including the production of excellent research results to present to the world, internationalization of graduate schools, and comprehensive improvement of graduate education. Nevertheless, there are still many challenges to be addressed.

The BK21 project has played a decisive role in enhancing the overall research capabilities of Korean universities, driving both quantitative and qualitative growth in SCI papers, which are internationally renowned publications. In particular, since Phase 3, with the strengthening of qualitative evaluation of research achievements, Korean universities have had the opportunity to secure competitiveness in the international academic community. In addition, Phase 4 BK21 FOUR focuses on the social utilization of research outcomes (solving industrial and social problems) and strengthening research networks of regional universities to create a sustainable research environment.

However, as the project progressed, several issues emerged. First, when the focus was placed on research-oriented performance evaluation, the essential values of higher education were relatively marginalized. Graduate students' research immersion increased, but there was a tendency to restrict the diversity of educational processes and individual researchers' creative research activities. Second, the research capability gap between metropolitan and regional universities was not fully resolved. Despite the BK21 project being implemented in a direction that supported regional universities, differences in research environments and infrastructure between regional and metropolitan universities still have not been overcome. Third, as researchers' short-term performance-centered research tendencies continued, criticism was raised that long-term research support was insufficient.

1.3.2. Future Tasks

First, in the reality of increasingly contracting domestic graduate schools, the BK21 project should guide graduate schools to become attractive spaces for the MZ generation and other young generations. An attractive space must start with securing attractive and excellent professors. Therefore, future BK21 projects should focus on discovering and fostering the world's best faculty. It is necessary to develop policies that secure multiple professors who can conduct outstanding teaching and research at the global level, support the recruitment or development of faculty who can conduct global-level lectures and experiments, and provide various support for their living conditions. Through this, policies that balance research and education are needed. While the current BK21 project is evaluated based on research performance, measures should be developed to substantialize graduate education and enhance not only students' research capabilities but also their

educational experiences. To this end, it is necessary to reflect elements such as the qualitative improvement of graduate student education, innovation in teaching methods, and interdisciplinary convergence education in project evaluation criteria.

Second, financial restructuring of support systems is needed so that academic successors can stably enter graduate school doors. Beginning in 2025, there will be significant changes in the way graduate students are supported, with the introduction of life encouragement funds (stipends) for science and engineering graduate students. In the future, regardless of academic field, there is a need for special measures to support full tuition for at least full-time doctoral students, and the BK21 project should consider shifting to a performance-based support system. Moving away from the past method of focusing on writing papers, graduate programs should recognize the importance of the opportunity to develop one's career and design new policies with a significant emphasis on supporting student career and professional development at the graduate school level.

Third, the recent focus in global higher education is the cultivation of super research universities. Super research universities refer to higher education institutions that cultivate top-tier talent through innovative scientific research across all academic fields, including natural sciences, engineering, humanities, social sciences, and arts (Baker, 2014). These universities are characterized by large-scale, field-intensive convergence research laboratories conducting research that previously depended on individual professors' academic capabilities. Above all, they are intensively conducting research to solve global problems beyond the national mission, which is naturally bringing fundamental changes to the role of faculty. Rather than building academic careers in isolation in research laboratories throughout their lives, they form teams for convergent or interdisciplinary research and actively develop research activities within global knowledge networks.

Fourth, the internationalization of higher education is one of the core functions of world-class universities, which ultimately means the internationalization of research personnel, research environment, and research activities, which needs to be further strengthened. The internationalization of research personnel refers to the international diversity of research subjects, including professors, postdoctoral researchers, doctoral students, master's students, and technicians from multiple nationalities. One major advantage of some advanced country higher education systems is the opportunity to become full citizens of the respective country after a certain period of demonstrating research capabilities. It is very important to attempt bold BK21 talent recruitment efforts to overcome the brain drain of excellent Korean postdoctoral researchers and doctoral students, while also focusing on securing excellent foreign talent. To this end, it is necessary to expand English-language courses so that foreign students can more easily complete graduate education in Korea, and to make changes to support all living environments and conditions from a global perspective, at least within the academic community of universities.

Fifth, strategies to continuously strengthen the research competitiveness of regional universities are needed. Efforts should be made to alleviate the concentration of research infrastructure and resources in the metropolitan area, strengthen collaborative research programs between regional and metropolitan universities to reduce research gaps, and introduce customized research support policies for regional universities to develop research capabilities suited to regional characteristics.

In conclusion, the BK21 project has made a significant contribution to strengthening Korea's research competitiveness over the past 25 years, and continuous improvements and innovations are

needed in the future. By securing excellent faculty and research personnel to make graduate departments attractive spaces, a harmony of excellent research and outstanding education should be achieved. While promoting balanced development between regional and metropolitan universities and ensuring the sustainability of research support and diversification of research evaluation methods, Korea's higher education and research environment should be further developed. Policy supplements and institutional improvements should continue to be made so that future BK21 projects can lead world-class research and educational innovation.

2. Korea's Institutional Framework for Industry-Academia Collaboration (LINC)

The LINC (Leaders in Industry-University Cooperation) project was a representative financial support program initiated in 2012 to enhance universities' capacities in industry-academia cooperation and stimulate regional industry innovation. Through LINC and subsequently LINC+, South Korean universities introduced practical models like internships, customized curricula, and family-company systems to foster an industry-academia-friendly university culture. Universities established cooperative networks with large and medium enterprises and introduced practical education tailored to corporate needs. Support programs for technical difficulties were implemented for mid-sized companies, facilitating technology transfer and research collaboration. To enhance industry-academia cooperation in Azerbaijan, introducing a large enterprise-centered cooperation model inspired by LINC is necessary, including establishing cooperation networks via family-company systems, practical industry-linked curricula, streamlined systems for technology transfer and joint research, and enterprise-customized human resource development tracks.

2.1. Overview

Korea's industry-academy collaboration policies have focused on strengthening the link between industry and academia while supporting universities in playing a central role in technology transfer and entrepreneurship. The legal and institutional foundation for industry-academia cooperation was established with the enactment of the "Industry Education Enhancement and Industry-Academia-Research Cooperation Promotion Act"(hereinafter the Industry-Academia Cooperation Act) in 2003. This included the establishment of industry-academic cooperation foundations, technology holding companies within universities, the introduction of the Industry-Academy Cooperation Professor System, and the creation of the National Industry-Academy Cooperation Committee.

Additionally, to promote university-based startups and support the growth of early-stage enterprises, Korea introduced the "Support for Small and Medium Enterprise Establishment Act" and the "Startup Support Act." These laws facilitated the implementation of policies such as university startup incubation centers, student entrepreneurship programs, and research-based startup promotion. Notably, the 2020 amendment to the Startup Support Act systematically restructured the stage-by-stage support for startup growth and provided a legal basis for fostering a startup-friendly university environment while strengthening entrepreneurship-linked education.

Alongside these efforts, the government has continuously refined industry-academy collaboration models through various initiatives, including the Leaders in INdustry-university Cooperation (LINC) program, technology transfer and startup support programs, and policies to promote joint research between academia and industry. In particular, the LINC program has played a significant role in supporting universities in establishing autonomous industry-academia collaboration models, evolving through three phases of development.

Table 10 | Status of Legal and Institutional Frameworks for Industry-Academia-Research Cooperation

Category	Legal Basis (Current Law)	Key Content
Succession of Invention Rights in National Universities (2001)	Patent Act (Article 10)	<ul style="list-style-type: none"> Provides a legal basis for national universities, managed under a special act, to succeed the invention rights and commercialization rights of faculty members.
Establishment of Industry-Academic Cooperation Foundations (2003)	Industry-Academia Cooperation Act(Article 25)	<ul style="list-style-type: none"> Allows universities to establish industry-academic cooperation foundations as independent legal entities, enabling them to engage in contractual agreements, manage intellectual property, and facilitate technology transfer.
Establishment of Technology Holding Companies within Universities (2007)	Industry-Academia Cooperation Act(Article 36-2)	<ul style="list-style-type: none"> Enables universities to create technology holding companies to commercialize university-owned technologies and establish subsidiaries for business expansion.
Establishment of University-Affiliated Research Institutes (2007)	Industry-Academia Cooperation Act(Article 37)	<ul style="list-style-type: none"> Provides legal grounds for the establishment of collaborative research institutes within universities in partnership with national and local governments, research institutes, and industries.
Introduction of Industry-Academia Cooperation Professorship System (2011)	Higher Education Act (Article 15)	<ul style="list-style-type: none"> Allows universities to appoint professors dedicated to industry-academia collaboration to facilitate cooperative research and technology commercialization.
Inclusion of Industry-Academia Cooperation Performance in Faculty Evaluations (2017)	Public Educational Officials Act (Article 11-4)	<ul style="list-style-type: none"> Mandates that faculty evaluations for reappointment consider industry-academia collaboration achievements, including student education, academic research, and guidance on technology commercialization.
Establishment of the National Industry-Academia Cooperation Committee (2017)	Industry-Academia Cooperation Act(Article 14)	<ul style="list-style-type: none"> Provides the legal basis for the National Industry-Academia Cooperation Committee, which deliberates on key policies related to industry-academia collaboration and enhances policy coordination under the Prime Minister’s Office.
Reform of the Startup Support System (2020)	Startup Support Act (Revised)	<ul style="list-style-type: none"> Establishes a systematic framework for stage-specific startup support, enhances a startup-friendly university environment, and strengthens entrepreneurship-linked education.

Source: Updated on the content of <Ministry of Education, 3rd Phase Leaders in Industry-University Cooperation (LINC 3.0) Promotion Plan, April 2021.>

2.2. Industry-Academia Cooperation Act

Industry-academy collaboration is one of the key policies aimed at enhancing national competitiveness and promoting industrial innovation. To provide institutional support for this initiative, the South Korean government enacted the Industry-Academy Cooperation Act in 2003. The primary objectives of this law are to foster close cooperation between universities and industries, facilitate the commercialization of research outcomes and startup activities, and cultivate practical and industry-oriented talent.

The Industry-Academy Cooperation Act requires universities to function as core hubs of industrial innovation beyond their traditional role as educational institutions. To achieve this, universities are mandated to establish dedicated industry-academic cooperation organizations, promote technology transfer and commercialization of research outcomes, and provide students with practical education opportunities. Additionally, the government supports industry-academia collaboration through R&D funding, financial subsidies, and performance evaluation systems, thereby creating a sustainable ecosystem for cooperation.

2.2.1. Key Objectives of the Industry-Academia Cooperation Act

The Industry-Academy Cooperation Act aims to go beyond simply encouraging collaboration between universities and businesses. Instead, it seeks to establish a sustainable innovation system by integrating industry and academia. Through this approach, the law contributes to technological innovation, economic growth, job creation for young professionals, and enhanced corporate competitiveness.

The primary objectives of the Industry-Academia Cooperation Act are as follows:

- Promoting University-Industry Collaboration: Encouraging the practical application of research outcomes in industrial settings and facilitating joint research projects between companies and universities.
- Enhancing Technology Transfer and Commercialization: Supporting the transfer of university-developed technologies to businesses and driving the creation of new products and industries.
- Fostering Industry-Oriented Talent: Enabling students to gain hands-on experience through industry collaborations, equipping them with the necessary skills to be immediately employable in industrial settings after graduation.
- Government Support and Oversight: Ensuring the continuous advancement of industry-academia cooperation through financial support, policy frameworks, and performance evaluation systems to maximize the effectiveness of collaboration initiatives.

2.1.2. Key Components of the Industry-Academia Cooperation Act

The Industry-Academy Cooperation Act institutionally ensures a structure in which universities can collaborate with businesses. To achieve this end, the Act includes the following key components:

Table 11 | Key Components of the Industry-Academia Cooperation Act

Component	Key Details
Mandating the Establishment of an Industry-Academic Cooperation Foundation	<ul style="list-style-type: none"> Requires universities to establish dedicated organizations to systematically manage industry-academia cooperation activities.
Support for Technology Transfer and Commercialization	<ul style="list-style-type: none"> Supports the transfer of research outcomes to businesses and promotes the operation of technology holding companies and technology licensing offices (TLOs).
Industry-Academia Linked Education and Internship Programs	<ul style="list-style-type: none"> Mandates programs such as capstone design projects and co-op internships, enabling students to gain hands-on experience through collaboration with companies.
Entrepreneurship and Business Support Programs	<ul style="list-style-type: none"> Supports the operation of university-based startup incubators and provides entrepreneurship education and startup funding programs.
Government Funding and Administrative Support	<ul style="list-style-type: none"> Provides R&D support, grants, tax benefits, and performance evaluation systems to encourage industry-academia collaboration activities.

Source: Based on the contents of the Industry Education Enhancement and Industry-Academia-Research Cooperation Promotion Act.

2.1.3. Key Provisions of the Industry-Academia Cooperation Act

1) Operation of the Industry-University Cooperation Foundation (IUC)

The Industry-Academy Cooperation Act mandates all universities to establish an Industry-University Cooperation Foundation (IUC) to systematically manage industry-academia collaboration.

The IUC serves as the central organization overseeing joint research with companies, technology transfer, startup support, and internship programs.

When businesses collaborate with universities for research and development (R&D), the IUC facilitates the cooperation process and enables access to government support programs.

The IUC helps create an industry-academia-friendly environment within universities and provides administrative support to ensure smooth collaboration with companies.

2) Support for Technology Transfer and Commercialization

To ensure that research outcomes generated by universities do not remain merely as academic papers but are effectively applied in industrial fields, the Act includes policies for technology transfer and commercialization.

- Universities operate Technology Licensing Offices (TLOs) to transfer research results to businesses and promote their commercial utilization.
- Universities are allowed to establish Technology Holding Companies, enabling them to commercialize research outcomes directly.
- The Act provides a framework for intellectual property (IP) protection and management to promote technology transfer and commercialization.

3) Industry-Academia Linked Education and Internship Programs

The Industry-Academy Cooperation Act includes various industry-linked education programs to help students apply theoretical knowledge gained at universities directly in industrial settings.

- Capstone Design: A practical, project-based program where students collaborate with businesses to solve real-world problems.
- Co-op Program: A long-term internship system that allows students to gain practical work experience at companies while continuing their studies.
- Industry-Academia Lecture Series: University professors and industry experts co-teach courses, enabling students to learn about the latest industry trends.

4) Entrepreneurship and Business Support Programs

To encourage entrepreneurship based on research outcomes, universities have established startup support systems, enabling faculty members and students to participate in entrepreneurship activities.

- Universities operate Startup Incubation Centers to nurture and support startups.
- Startup funding and investment linkages help accelerate the growth of startups.
- Faculty members and researchers who start a business are provided administrative support to allow them to manage both academic and entrepreneurial activities simultaneously.

5) Government Financial and Administrative Support

The government provides financial and administrative support to promote industry-academia collaboration under the Industry-Academy Cooperation Act.

- Grants and tax incentives are provided for university-business joint R&D projects.
- Additional research funding is allocated to universities and researchers with outstanding industry-academia collaboration records.
- A performance evaluation system is implemented to ensure the sustainability of industry-academia collaboration activities.

2.1.4. Virtuous Cycle through the Industry-Academy Cooperation Act

The Industry-Academia Cooperation Act aims to ensure that collaboration between universities and industries is not just a one-time project, but a sustainable and evolving system, creating a virtuous cycle of industry-academia cooperation.

- Universities function as innovation hubs, sharing research outcomes with businesses.
- Companies achieve technological innovation based on university research, thereby enhancing industrial competitiveness.
- Students gain practical experience and develop into highly skilled professionals who can immediately contribute to the industry.
- The government provides financial and policy support to sustain and strengthen this collaborative model.

This virtuous cycle of industry-academia cooperation serves as the foundation for the simultaneous growth of Korea's industry and education. It enables universities to evolve beyond traditional research institutions and establish themselves as key players in industrial innovation.

2.3. Startup Support Act: Promoting Tech Startups through Industry-Academia Cooperation

Industry-academia cooperation extends beyond research collaboration to include support for entrepreneurship based on technologies developed by universities and research institutions. To institutionalize this support, the Korean government has implemented the Support for Small and Medium Enterprise Establishment Act (hereinafter referred to as the Startup Support Act). This legislation enables universities and research institutions to play a key role in fostering entrepreneurship.

The Startup Support Act focuses particularly on technology-based startups (Tech-Startups), providing various support measures that allow professors and researchers to commercialize their research findings and students to engage in startup activities.

Closely linked to the Industry-Academia Cooperation Act, the Startup Support Act maximizes the effectiveness of industry-academia cooperation by promoting technology transfer and commercialization through entrepreneurship. Notably, it provides financial and administrative support for early-stage startup stability through startup incubation centers, technology holding companies, and university startup funds.

2.3.1. Key Objectives of the Startup Support Act

The Startup Support Act aims to encourage entrepreneurship and create an environment where startups can grow sustainably. This fosters the industrialization of research results, job creation, and the development of innovative new industries.

The main objectives of the Startup Support Act are as follows:

- Encouraging entrepreneurship at universities and research institutions: Establishing a system that supports professors, researchers, and students in launching startups.
- Promoting technology-based startups: Facilitating the commercialization of research outcomes to nurture high-tech startups and enhance global competitiveness.
- Developing startup infrastructure: Ensuring early-stage startup stability through startup incubation centers, technology holding companies, and startup funds.
- Providing financial and policy support: Establishing a legal and policy framework for startup support, offering financial assistance and tax benefits to startups.

2.3.2. Key Components of the Startup Support Act

The Startup Support Act includes various systems to promote entrepreneurship, enabling universities and research institutions to actively participate in the formation of startup ecosystems.

Table 12 | Key Components of the Startup Support Act

Component	Key Details
Support for University Startup Activation	<ul style="list-style-type: none"> Provides administrative and financial support for professors and students to launch startups, and reflects startup activities in academic performance evaluations.
Operation of Technology Holding Companies and Startup Incubation Centers	<ul style="list-style-type: none"> Allows universities to establish technology holding companies independently and operate startup incubation centers to foster startup enterprises.
Financial Support for Startups	<ul style="list-style-type: none"> Expands investment and funding support for early-stage startups through government and university-led startup funds.
Tax Benefits for Entrepreneurs	<ul style="list-style-type: none"> Provides tax reductions and financial incentives to ensure the stable operation of early-stage startups.
Entrepreneurship Education and Mentoring Programs	<ul style="list-style-type: none"> Operates entrepreneurship education and mentoring programs for students and researchers preparing for startups.

Source: Contents of the Support for Small and Medium Enterprise Establishment Act.

2.3.3. Key Provisions of the Startup Support Act

1) Support for University Startup Activation

The Startup Support Act includes various policies to promote entrepreneurship within universities, establishing a system that enables professors and students to launch startups.

- When professors and researchers establish startups, the act simplifies administrative procedures, allowing them to commercialize their research outcomes and reflect their entrepreneurial activities in research performance evaluations.

- To encourage student entrepreneurship, universities offer startup-related courses and operate education and incubation programs.

- Even after startups are launched, the act supports networking and investment connections to ensure stable growth.

2) Operation of Technology Holding Companies and Startup Incubation Centers

The Startup Support Act allows universities to establish their own Technology Holding Companies (University Holdings Company) to commercialize research outcomes and operate Startup Incubation Centers to support startup enterprises.

- Technology Holding Companies enable universities to establish and invest in companies directly based on research outcomes, fostering the commercialization of intellectual property (IP) and startup development.
- Startup Incubation Centers provide early-stage startups with office space, mentoring, business consulting, and investment opportunities, contributing to a stable growth environment.

3) Financial Support for Startups

The government and universities operate financial support programs to facilitate the growth of early-stage startups, ensuring they have access to the necessary funds.

- University and government-led startup funds (University Startup Fund) are established to directly invest in startups.
- The government provides low-interest loans and grants to reduce the financial burden on startups.
- Connections with venture capital (VC) firms and accelerators are facilitated to help startups secure external investments.

4) Tax Benefits for Entrepreneurs

The Startup Support Act offers tax benefits to reduce the financial burden on startups and ensure sustainable growth. Key provisions include:

- Corporate tax reductions and tax exemptions for a certain period after the startup is established.
- Tax credits for R&D expenses to encourage innovation in startups engaged in research and development activities.
- Tax reductions on technology transfer fees when startups acquire technologies for commercialization.

5) Entrepreneurship Education and Mentoring Programs

The Startup Support Act supports a variety of education and mentoring programs to enhance the entrepreneurial capabilities of students and researchers preparing for startups.

- Universities provide entrepreneurship education programs to teach students the fundamentals of starting and managing a business.
- Mentoring systems are established where experienced entrepreneurs and successful startup founders guide students and researchers.
- Startup competitions are co-organized by the government and universities to discover and support innovative startup teams.

2.3.4. Establishing a Sustainable Startup Support System

The Startup Support Act not only encourages entrepreneurship but also aims to establish a "self-sustaining startup support system" that ensures the continuous commercialization of research outcomes and the sustainable growth of startups.

- Universities and research institutions promote entrepreneurship and support the commercialization of research findings.
- Startups grow based on technological innovation, driving advancements across industries.
- The government provides policy and financial support to maintain a stable startup ecosystem.
- Startups create jobs and contribute to economic development, forming a virtuous cycle.

This self-sustaining ecosystem enables universities and businesses to grow together, fostering a long-term, sustainable startup environment.

2.4. Progress of Industry-Academia Collaboration Policies

South Korea's industry-academia-research cooperation policies have evolved progressively to facilitate collaboration between universities and industries and ensure the seamless transfer of research outcomes to the industrial sector. Initially, individual support programs were implemented to strengthen university research capabilities and promote industry-academia cooperation. However, as the policy framework advanced, more comprehensive and systematic measures were introduced to position universities as key drivers of industrial innovation.

Between 2004 and 2011, South Korea focused on laying the foundation for industry-academia collaboration through initiatives such as the Industry-Academy Cooperation-Oriented Universities Program, the Metropolitan Leading Industry Talent Development Program, and the Regional Research Hub Program. During this period, the primary objective was to connect university research and development (R&D) functions with industries while fostering a culture conducive to industry-academia cooperation.

From 2012 to 2016, the Leaders in Industry-University Cooperation (LINC) Phase 1 program was launched to reform the structural foundation of university-industry cooperation and enable universities to integrate education and research more closely with industry collaboration. This initiative consolidated previously fragmented cooperation support programs and shifted the focus from research-driven collaboration to more practical, hands-on engagement with industry. Key policies introduced under LINC Phase 1 included capstone design courses, on-site internships, and enhanced entrepreneurship education. Furthermore, institutional frameworks were established to facilitate structured collaboration between universities and industries. As a result, industry-academic cooperation foundations (IUCs) were strengthened within universities, creating a more systematic and structured collaboration model.

The LINC+ program (LINC Phase 2, 2017–2021) further expanded the autonomy of universities in designing cooperation models tailored to regional and industrial needs. While LINC Phase 1 focused on establishing internal university structures for industry-academia cooperation, LINC+ emphasized active collaboration between universities and industries, expanding industry-customized education, and strengthening research-industry linkages. During this phase, joint research projects between universities and companies increased, and education programs were aligned with corporate workforce demands. A major policy introduced under LINC+ was the socially customized education model, which aimed to train students with the skills and expertise required by industries, ensuring they were immediately employable upon graduation. Additionally, universities actively fostered entrepreneurial ecosystems, strengthened technology transfer frameworks, and supported commercialization efforts.

The ongoing LINC Phase 3 (LINC 3.0, 2022–present) aims to establish a sustainable cooperation ecosystem between universities and industries while reinforcing technology innovation leadership. While previous phases laid the foundation for university-industry collaboration, LINC 3.0 focuses on deepening university-industry partnerships through collaborative research, joint commercialization efforts, and direct industry applications of research outcomes. The program introduces three specialized tracks: Technology Innovation Leadership, Demand-Driven Growth, and Collaboration Infrastructure Development, allowing tailored support for universities based on their characteristics. A major goal of LINC 3.0 is to integrate university research with industrial

applications, fostering a systematic R&D-commercialization pipeline. Additionally, efforts are being made to enhance Industry Collaboration Centers (ICCs) and strengthen linkages between universities and technology holding companies, positioning universities as key facilitators of technology commercialization.

Alongside advancements in industry-academia cooperation policies, entrepreneurship and technology commercialization support have also expanded significantly. Various support programs have been introduced to promote university-led startups, foster a startup-friendly university environment, and strengthen joint research initiatives between academia and industry. Policies now emphasize commercializing university research through entrepreneurship, ultimately transforming universities from traditional educational institutions into innovation hubs that drive industrial and technological advancements.

Building on the structural improvements achieved through LINC, targeted support programs have also been implemented to focus on technology commercialization, spatial industry-academia collaboration, and specialized cooperation initiatives. This multi-layered support system ensures that industry-academia-research collaboration in South Korea continues to evolve and generate sustainable innovation-driven growth.

Table 13 | Current Status of University Technology Commercialization and Startup Support Policies

Program Name	Funding Scale (2021)	Key Features
University Intellectual Property Utilization Support (BRIDGE+)	General Universities: 24 institutions / 25 billion KRW	<ul style="list-style-type: none"> Supports the commercialization of university-originated intellectual property (IP), such as foundational technologies, patents, and knowledge assets, by providing assistance in the pre-commercialization process.
University Industry-Academia Cooperation Cluster Development Support	General Universities: 4 institutions / 8 billion KRW	<ul style="list-style-type: none"> Establishes and maintains industry-research clusters within universities by securing dedicated space and facilities for company-affiliated research institutes and promoting continuous collaboration between academia and industry.
Early Employment-Linked Contract Departments & Specialized Universities Development	General Universities: 8 institutions / 9.6 billion KRW Specialized Universities: 5 institutions / 6 billion KRW	<ul style="list-style-type: none"> Provides customized corporate-focused education within universities, integrating workplace-based learning programs to enhance practical skills required by industries.
School Enterprise Support Program	30 school enterprises / 7.48 billion KRW	<ul style="list-style-type: none"> Encourages hands-on training and entrepreneurship education through university-affiliated enterprises, linking academic activities with real-world industry needs.

Support for Industry-Academia Collaborative Research Activation	General Universities: 20 institutions / 15 billion KRW Total: 150 billion KRW	<ul style="list-style-type: none"> • Strengthens joint research projects between universities and industries, fostering innovation through problem-solving initiatives and technological advancements tailored to industry challenges.
Establishment of Startup-Friendly University Environments	General Universities: 15 institutions / 12 billion KRW	<ul style="list-style-type: none"> • Implements programs that promote startup-friendly university environments, supporting student entrepreneurship, faculty startups, and startup incubation programs.
Technology Holding Company Establishment and Operation Support	General Universities: 10 institutions / 10 billion KRW	<ul style="list-style-type: none"> • Supports the establishment and operation of university technology holding companies to commercialize university research outcomes and nurture startups.

Source: Ministry of Education (April 2021), ‘3rd Phase Leaders in Industry-University Cooperation (LINC 3.0) Promotion Plan.’

South Korea's industry-academia cooperation policies have evolved beyond conventional research-driven approaches toward fostering a sustainable collaboration ecosystem between universities and industries. The policy direction now aims to enhance the commercialization of university research and establish stronger linkages between academia and businesses. Moving forward, continuous policy improvements will be essential to ensure that university research outcomes are more effectively connected to industries, fostering innovation through deeper corporate collaboration.

2.4.1. Key Features and Implications of South Korea’s Industry-Academia Cooperation Legal Framework

South Korea's industry-academy cooperation laws are designed to institutionalize collaboration between industry and academia while ensuring that research outcomes contribute to industrial development. The legal framework aims to facilitate technology innovation, talent development, and startup promotion by enabling systematic cooperation between universities and industries. Notably, South Korea’s legal system for industry-academy cooperation is characterized by its focus on technology transfer and commercialization, startup promotion, practice-oriented education, and a structured government support system, allowing universities to function as innovation hubs rather than mere educational institutions.

This legal framework strengthens cooperation between universities and industries and facilitates the direct application of research outcomes to the industrial sector, offering key insights as follows:

1) Legalization of Industry-Academia Cooperation Contributes to a Sustainable Collaboration Framework

- The Industry Education Enhancement and Industry-Academia-Research Cooperation Promotion Act (Industry-Academia Cooperation Act) and Support for Small and Medium Enterprise Establishment Act (Startup Support Act) provide a stable institutional foundation for sustaining long-term university-industry collaboration.

- Universities are mandated to establish Industry-Academic Cooperation Foundations (IUCs), ensuring that collaborative research infrastructure is systematically supported.

- The legal framework is structured not just for short-term collaboration but for fostering a sustainable industry-academia cooperation ecosystem.

2) Facilitating Industrialization of Research Outcomes and Technology Transfer

- Technology Licensing Offices (TLOs) operate within universities to ensure that research results are effectively utilized in industrial applications.

- Policies that promote technology transfer and startup creation prevent research outcomes from remaining solely in academic publications and instead drive the development of new technologies and products.

- This enables universities to serve as key players in industrial technology innovation, while companies benefit from proven research outcomes to enhance their competitiveness.

3) Strengthening Practice-Oriented Education and Talent Development

- The Industry-Academia Cooperation Act mandates the inclusion of co-op programs, capstone design courses, and industry-linked education, integrating university curricula with industry needs.

- As a result, students gain not only academic knowledge, but also practical competencies required in real-world industrial settings, improving employment rates and workplace adaptability.

- Particularly, industry-academia cooperation programs linked to the LINC initiative contribute to strengthening practice-oriented education, creating a pipeline of industry-ready talent.

4) Enhancing Institutional Support for Startups

- The Startup Support Act promotes the establishment of startup incubation centers and university technology holding companies, fostering faculty and student-led startups.

- The government provides financial and administrative support through startup funds, subsidies, and tax incentives to ensure the stable growth of early-stage startups.

- South Korean universities are evolving beyond research and education institutions to become core entities in startup promotion, contributing to national innovation capacity.

5) Continuous Improvement through Government Financial Support and Performance Evaluation Systems

- The government financially supports university-industry cooperation initiatives while operating performance evaluation systems to assess their effectiveness.
- Incentive policies reward universities with strong industry-academia collaboration performance, encouraging active participation.
- Ongoing monitoring and policy adjustments enhance the effectiveness of industry-academia cooperation, making South Korea's model a benchmark for other countries.

2.4.2. Summary: Policy Implications of South Korea's Industry-Academia Cooperation Framework

South Korea's industry-academia cooperation legal framework provides a systematic foundation for sustained collaboration and innovation, facilitating the industrialization of research outcomes, startup promotion, and practice-oriented talent development. Notably, the Industry-Academia Cooperation Act and Startup Support Act play a crucial role in transforming universities into hubs of industrial innovation, thereby enhancing the country's technological competitiveness.

From this institutional framework, the following policy implications can be derived:

- A legal foundation for industry-academia cooperation enables long-term partnerships between universities and industries. South Korea has established a sustainable cooperation system through its Industry-Academia Cooperation Act, leading to greater research and development (R&D) activities between universities and industries.
- Strengthening technology transfer and startup support ensures that research outcomes generate tangible industrial value. The operation of TLOs and university technology holding companies has facilitated the commercialization of research results.
- Policies aimed at practice-oriented talent development need further reinforcement. South Korea's industry-academia cooperation policies continue to expand co-op programs and capstone design courses, supplying industry-specific skilled professionals.
- Sustained government support and performance evaluation systems maximize the effectiveness of industry-academia cooperation. Financial assistance combined with performance assessments ensures the efficient execution of collaboration policies, enhancing both sustainability and efficiency.

Moving forward, South Korea's industry-academy cooperation model is expected to evolve by incorporating digital transformation, global collaboration, and sustainable innovation ecosystems. This model can serve as a policy reference for other nations, particularly in fostering university-led industrial innovation.

For countries such as Azerbaijan, adopting an industry-academia cooperation system based on South Korea's experience requires tailored policy design that aligns with local industrial and higher education contexts. Strategic support for universities to act as key players in innovation, beyond research and education, is essential. Through this approach, a virtuous cycle of research commercialization, technological innovation, and economic growth can be established.

2.5. Purpose of the LINC Project

In the early 2000s, the weak linkage between higher education and industry in South Korea was consistently highlighted as a major issue. At that time, many universities operated primarily as research-oriented institutions, while companies faced challenges in securing a workforce with practical competencies. Many university research outcomes failed to transfer to the industrial sector, resulting in low technology commercialization rates. Furthermore, university-industry collaboration was often limited to short-term research projects, making it difficult to establish sustainable partnerships.

As a result, university research achievements did not significantly contribute to industrial development, and companies continued to struggle with securing skilled professionals essential for technological innovation. This structural issue persisted, hindering the alignment of university research with industrial needs. To address these challenges, the South Korean government launched the Leaders in INdustry-university Cooperation (LINC) Project in 2012. The LINC project aimed to foster organic collaboration between universities and industry, facilitate the commercialization of research outcomes, and promote practical applications of academic knowledge. Unlike previous individual university-industry cooperation support programs, the LINC project provided long-term and comprehensive support to enable universities to take the lead in industry-academia collaboration, ensuring a more sustainable and systematic approach.

The key policy backgrounds that led to the launch of the LINC project are as follows:

- Absence of a structured industry-university cooperation system: University departments responsible for industry collaboration were often nominally established, and structured cooperation models with businesses were lacking. As a result, university-industry partnerships lacked consistency and long-term engagement.
- Low commercialization rate of research outcomes: Technologies developed at universities often remained as academic publications, with limited industrial applications. Consequently, the return on R&D investment was low, and technology transfer and commercialization were insufficiently facilitated.
- Shortage of practice-oriented professionals: There was a lack of human resources equipped with the practical skills required by industries. Companies needed to invest additional resources in training new employees, increasing the burden on businesses.
- Disconnection from regional industries: Many universities, particularly in regional areas, lacked collaboration with local businesses, limiting their contribution to regional economic development. The weak linkage between universities and local industries led to inefficiencies in technology and talent supply.

The LINC project was introduced to address these issues and establish industry-academia collaboration as a core operational element of universities. Unlike fragmented short-term initiatives, LINC was designed as a long-term, structured program to encourage universities to proactively lead industry-university cooperation and establish a sustainable collaboration model.

2.6. Key Features of the LINC Project

The Leaders in INdustry-university Cooperation (LINC) Project was a national initiative launched to enhance South Korea's industry-academia-research collaboration framework. The project was designed to strengthen systematic university-industry partnerships and promote sustainable innovation driven by academia.

LINC was developed as a comprehensive policy framework that went beyond traditional research funding to establish universities as key drivers of industrial innovation. The project aimed to create a virtuous cycle in which universities, businesses, and local communities co-develop and grow together through sustainable collaboration.

The LINC project encompassed a wide range of initiatives, including institutional reforms, curriculum innovation, R&D collaboration, entrepreneurship promotion, and technology commercialization support. Since its initial launch in 2012, the project has undergone continuous refinement and evolved through three distinct phases: LINC (1st phase), LINC+ (2nd phase), and LINC 3.0 (3rd phase). Each phase introduced new objectives and implementation strategies, progressively enhancing the structure of university-industry cooperation.

The core differentiating features of the LINC project are as follows:

1) Industry-University Cooperation-Oriented University System

- The LINC project shifted universities from a research-centered operation model to a collaboration-driven framework, positioning them as key stakeholders in industry-academia cooperation.
- Dedicated university structures, such as Industry-University Cooperation Foundations (IUCs) and Industry Collaboration Centers (ICCs), were institutionalized to strengthen partnerships with businesses.
- Industry-academia collaboration outcomes were integrated into faculty evaluations and university financial management to ensure sustainability.

2) Introduction of a Demand-Driven Talent Development System

- LINC promoted industry-aligned educational programs to cultivate professionals equipped with the technical and practical skills required by businesses.
- Universities introduced Co-op programs, Capstone Design courses, and joint research projects to provide students with hands-on industry experience.

3) Strengthening Technology Transfer and Entrepreneurship Support

- The project emphasized the commercialization of university research by enhancing Technology Licensing Offices (TLOs), which facilitate the transfer of academic innovations to industry.
- Universities were encouraged to establish technology holding companies to commercialize their research outcomes and foster startups.

4) Development of Regional Industry-University Cooperation Models

- LINC strengthened linkages between universities and local industries, supporting customized R&D projects and collaborative research tailored to regional economic needs.
- The project provided regional universities with opportunities to grow alongside local industries, fostering localized innovation ecosystems.

5) Implementation of a Performance-Based Government Support System

- The South Korean government adopted a performance-based funding approach to encourage high-performing universities to engage actively in industry collaboration.
- Key performance indicators included technology transfer success rates, industry collaboration projects, graduate employment rates, and startup success rates.

Through this comprehensive and structured approach, the LINC project successfully established a long-term and institutionalized model for industry-academia collaboration. Unlike short-term funding programs, LINC created a framework where universities and businesses could continuously cooperate, ensuring the practical application of academic research to industry and economic development.

2.7. Evolution of the LINC Project

Since its launch in 2012, the LINC project has undergone continuous development, progressing through three phases: LINC (Phase 1) → LINC+ (Phase 2) → LINC 3.0 (Phase 3). In the initial phase, the primary focus was on establishing the foundation for industry-university cooperation and improving the university ecosystem. Over time, the project evolved to emphasize customized industry-academic collaboration and strengthening linkages with regional industries. Ultimately, it has expanded into a global and sustainable industry-university cooperation ecosystem.

1) LINC (Phase 1, 2012–2016): Establishing the Foundation for Industry-University Cooperation and University Reform

- The first phase of LINC aimed to establish a structured framework for university-industry collaboration and integrate industry-academic cooperation as a core component of university operations.

- To achieve this, dedicated organizational structures for industry cooperation, such as Industry Collaboration Centers (ICCs) and corporate collaboration offices, were introduced to facilitate active partnerships with businesses.

- Industry-linked education programs were strengthened with the introduction of co-op programs and capstone design courses, providing students with hands-on experience.

- Efforts were made to enhance technology transfer and industry collaboration by expanding university-led technology licensing and commercialization initiatives.

- To ensure long-term cooperation, the Industry-Academia Joint Research Support System and Family Company System were introduced, fostering sustained collaboration between universities and companies.

2) LINC+ (Phase 2, 2017–2021): Expanding Tailored Industry-Academic Cooperation and Strengthening Regional Industry Linkages

- The second phase focused on further advancing the industry-academic cooperation framework and expanding collaboration with regional industries.

- To localize industry-university collaboration, universities were encouraged to engage in joint R&D projects with regional industries, with an emphasis on supporting small and medium-sized enterprises (SMEs).

- To promote technology commercialization and startup support, universities were encouraged to expand startup incubation centers and activate technology holding companies to enhance commercialization efforts.

- The introduction of tailored industry-academic cooperation models allowed universities to develop specialized cooperation frameworks that fit their unique characteristics and strategic objectives.

3) LINC 3.0 (Phase 3, 2022–Present): Sustainable Industry-University Cooperation and Digital Transformation

- LINC 3.0 retains the foundational cooperation model while expanding global networks for industry-academic collaboration and reinforcing sustainable partnership structures.

- Greater emphasis has been placed on digital transformation and advanced technology integration, including artificial intelligence (AI), big data, and smart manufacturing technologies in industry-academic cooperation.

- The transition from short-term research collaborations to long-term strategic partnerships has been encouraged, enabling companies and universities to engage in sustained joint research and development initiatives.

- The functional enhancement of Industry Collaboration Centers (ICCs) and the expansion of university technology holding companies have been promoted, supporting the commercialization of research outcomes and strengthening the role of universities in industrial innovation.

Table 14 | Comparison of LINC Project Phases

Category	LINC (2012–2016)	LINC+ (2017–2021)	LINC 3.0 (2022–Present)
Core Objective	Establishing an industry-academic cooperation-friendly university ecosystem	Diversifying cooperation models and expanding industry-customized education	Fostering entrepreneurial universities and establishing a shared cooperation ecosystem
System Enhancement	Recognizing industry-academic cooperation performance as an alternative to traditional research output	Expanding industry-academic cooperation recognition in faculty promotion and tenure	Strengthening industry-academic cooperation-oriented faculty governance and operational systems
Industry-Academic Education	Focus on STEM-based industry-academic education (Co-op, Capstone Design)	Expansion across all academic disciplines, including humanities and social sciences	Developing industry-tailored talent and expanding online/global education
Corporate Collaboration & Support	Introduction of the Family Company System and expansion of corporate collaboration initiatives	Strengthening technology transfer, commercialization, and revenue generation from university-industry cooperation	Enhancing Industry Collaboration Center (ICC) functions and activating university technology holding companies

Target Institutions	General and vocational universities (Technology Innovation Track, Industry Immersion Track)	General universities (Advanced Industry-Academic Cooperation Track, Industry-Customized Program Track), Vocational universities (Leading Industry-University Cooperation Track, Industry-Customized Program Track)	New Categorization: Technology Innovation Leadership, Demand-Based Growth, Infrastructure Collaboration
Support Mechanism	Comprehensive package support for universities to enhance industry-academic cooperation	Universities developing their own models with tailored industry-academic collaboration	Customizing support based on university specialization
Outcomes & Future Direction	Establishing an industry-academic cooperation-friendly university ecosystem	Strengthening industry-academic collaboration within universities and enhancing industry-linked education	Strengthening technology commercialization, enhancing corporate partnerships, and ensuring sustainable collaboration frameworks

Source: Updated on the content of <Ministry of Education, ‘Basic Plan for the 3rd Phase Leaders in Industry-University Cooperation (LINC 3.0)’, January 2022.>

The LINC project has continuously evolved, transitioning from a simple university-industry research support initiative to a comprehensive program that positions universities as key players in industrial innovation. In its initial phase, the project focused on establishing cooperation frameworks between academia and industry. However, subsequent phases expanded the scope to strengthen regional industry linkages, facilitate technology commercialization, and enhance startup support, thereby broadening the role of universities beyond education and research.

With the implementation of LINC 3.0, digital transformation and global collaboration have been emphasized, fostering long-term partnerships between universities and businesses. This shift has aimed to create a sustainable cooperation ecosystem that integrates advanced technologies and international networks, enabling universities to contribute more actively to industrial development.

The next challenge is to further refine systems that enable universities and businesses to co-create innovation and develop globally competitive talent. As universities increasingly play a central role in industrial transformation, ongoing policy support and institutional improvements are expected to enhance the sophistication of industry-academia cooperation models. These efforts will contribute to a more sustainable and structured ecosystem, ensuring that research outcomes are effectively commercialized and that practical, industry-ready talent is continuously cultivated.

2.8. Major Achievements of the LINC Project

Since its introduction in 2012, the LINC project has contributed to the continuous development of industry-academia collaboration, establishing a cooperative ecosystem between universities and industries. In particular, significant progress has been made in strengthening the industry-academic cooperation capabilities of universities, fostering practical talent, supporting corporate innovation, and discovering win-win models between universities and industries. This section analyzes the major achievements of the LINC project based on materials from the Ministry of Education (2022.1) and examines its impact on industry-academia cooperation policies.

2.8.1. University Competitiveness through Industry-Academia Cooperation

The LINC project has expanded the connection between universities and industries, promoting technology commercialization and entrepreneurship while establishing various cooperation models. As a result, the rate at which university research outcomes are transferred to industry has increased, and joint research activities with enterprises have been revitalized.

1) Expansion of University Specialization and Industry-Academia Cooperation Base

- Universities participating in the LINC project have strengthened their specialized fields through differentiation strategies, developing industry-specific cooperation models.
- A representative case is the "National Future Vehicle Specialized Industry-Academia Cooperation", which promoted automotive parts development and AI-based smart mobility research in collaboration with Hyundai Motor and SMEs.

2) Expansion of Technology Commercialization and Private Investment

- The technology commercialization revenue of LINC-participating universities increased significantly, from 68 billion KRW in 2014 to 198.5 billion KRW in 2021, a nearly threefold increase.
- The number of family company agreements between universities and businesses has also increased by over 10,000, forming a sustainable cooperation structure.

3) Creation of an Industry-Academia-Friendly Environment

- Institutional improvements were implemented to reflect industry-academia cooperation performance in university research evaluations, establishing a system for continuous collaboration.

2.8.2. Expansion of Demand-Oriented Talent Development Models

The LINC project has played a crucial role in bridging the gap between university education and industry needs by operating various programs to nurture practical talent.

1) Strengthening Industry-Linked Education and Field Training

- The LINC project institutionalized industry-academia education programs such as Capstone Design and Co-op internships to enhance students' problem-solving skills through project-based learning.

- This has led to the production of highly skilled graduates, capable of meeting industry demands immediately.

- A notable example is the Capstone Design Competition, where innovative student projects have been selected and applied in actual industrial settings.

2) Increase in Employment Rates and Strengthened Employment-Education Linkage

- The average employment rate of graduates from LINC-participating universities increased by 1.1% compared to non-participating universities during the 2017-2019 period.

- Particularly, a tailored employment model has been expanded, where students sign employment contracts before graduation, effectively eliminating the gap between job seekers and employers.

2.8.3. Corporate Innovation Support Models and Win-Win Cooperation

The LINC project has transformed universities from educational institutions into partners that support corporate innovation, introducing various enterprise support models.

1) Expansion of Corporate Innovation Support and Joint Research

- The use of university research infrastructure for joint R&D with SMEs and shared research equipment has been expanded.
- The corporate collaboration centers (ICC) have been developed to provide tailored support.
- As of 2020, LINC-participating universities established 55 specialized industry-academia joint research centers, applying research outcomes directly to industry.

2) Strengthened Industry Cooperation and Technology Transfer

- Joint R&D support with enterprises has increased, leading to greater technology transfer and patent licensing activities.
- Technology transfer revenue of LINC-participating universities grew from 12.4 billion KRW in 2014 to 46.97 billion KRW in 2021, a more than threefold increase.

Table 15 | Key Achievements of the LINC Project

LINC Project	Industry-Academy Joint Research (Cases)	Technology Transfer Revenue (Billion KRW)	Shared Research Equipment Support (Cases)	Number of Family Companies
2014	3,150	12.4	32,303	48,992
2021	4,697	46.97	70,777	71,772

Source: Based on the content of <Ministry of Education, ‘3rd Phase Leaders in Industry-University Cooperation Promotion Plan’, January 2022>

2.8.4. Sustainable Industry-Academia Cooperation Ecosystem

The LINC project has gone beyond short-term growth creation, working toward the long-term sustainability of industry-academia cooperation.

1) Development of Industry-Academia Collaboration Models for Local Problem-Solving

- Universities collaborated with local businesses and public institutions to develop regional problem-solving industry-academia projects, helping universities serve as drivers of local economic growth.

- A key example is the "CDS Big Data Analysis Competency Enhancement" project, which supported the training of big data professionals for regional industries.

2) Building a Performance-Based Support System

- The government introduced a performance-based funding system, where universities with excellent industry-academia collaboration records receive additional funding.

- Key evaluation indicators include technology transfer performance, the number of enterprise collaboration projects, graduate employment rate, and startup success rate, reinforcing the sustainability of industry-academia cooperation.

3) Establishment of a Long-Term Collaboration System Between Universities, Businesses, and Local Communities

- The project shifted beyond short-term cooperation models, encouraging long-term joint research and technology commercialization projects between universities and enterprises.

- This has contributed to the development of a sustainable industry-academia cooperation ecosystem.

The LINC project has played a critical role in structurally embedding industry-academia cooperation into university operations while fostering the commercialization of research outcomes. In particular, universities are evolving from educational institutions into strategic partners for industrial innovation, strengthening support for technology commercialization and startup ventures.

Looking ahead, LINC 3.0 is expected to further integrate digital transformation and global collaboration, continuing its trajectory as a key driver of industry-academia innovation partnerships.

2.9. Implications

The Leaders in INdustry-university Cooperation (LINC) project has played a significant role in transforming the collaboration framework between universities and industries in South Korea. By institutionalizing sustainable industry-academia cooperation models, LINC has contributed to shifting universities from mere educational institutions to key hubs of industrial innovation. Additionally, the program has actively promoted the commercialization of research outcomes while establishing a system for nurturing practical workforce talent. Based on these characteristics, the following key implications of the LINC project can be derived.

2.9.1. Key Characteristics and Implications of the LINC Project

1) Establishment of a Structured and Sustainable Industry-Academia Cooperation

- Unlike short-term project-based support programs, LINC has focused on building a long-term collaborative system that allows universities and industries to cooperate continuously.
- Dedicated university-industry cooperation infrastructures such as the Industry-Academic Cooperation Foundation (IACF) and the Industry Collaboration Center (ICC) have been strengthened to facilitate systematic research-to-technology transfer and commercialization.
- The government's performance-based funding model has encouraged universities to prioritize long-term investments in industry collaboration.

2) Promotion of Research Commercialization and Technology Business Development

- LINC has reinforced the role of Technology Licensing Offices (TLOs), ensuring that university research does not remain solely in academic publications but is actively utilized in real industrial applications.
- The revenue from technology transfer at participating universities has significantly increased, along with a strengthened startup ecosystem through support programs such as startup funding and incubation programs.
- Joint research projects between universities and industries and the utilization of technology cooperation centers have enhanced the role of universities as R&D partners for industries.

3) Development of Industry-Oriented Talent and Improved Employment

- The program has adopted customized educational curricula aligned with industry needs, ensuring that students acquire the skills required for immediate application in industrial settings upon graduation.
- Practical training programs such as Co-op internships, Capstone Design, and industry-academic joint courses have been expanded, providing students with real-world experiences beyond theoretical learning.
- The employment rate of graduates from LINC-participating universities has increased compared to non-participating institutions, particularly in socially customized education programs, which have reduced industry-academia skill mismatches.

4) Strengthened Regional Industry Linkages and Balanced Growth Contributions

- The program has supported all universities, including regional institutions, in fostering close collaboration with local industries, promoting balanced regional development.
- Universities have conducted regional R&D projects in collaboration with local enterprises, contributing to local economic growth and forming a sustainable industry-academia innovation ecosystem.
- Various mechanisms, such as technology transfer and joint research, have enabled small and medium-sized enterprises (SMEs) to access and utilize university research infrastructure, expanding opportunities for collaboration with regionally specialized industries.

5) Government-Led Performance-Based Support System

- The government has institutionalized performance-linked funding mechanisms, allocating additional support to universities that demonstrate strong industry collaboration outcomes.
- Key evaluation indicators include technology transfer performance, industry collaboration project execution, employment rates, and startup success rates, ensuring that universities integrate industry collaboration as a key strategic priority.
- Long-term government policy and funding commitments have ensured that industry-academia partnerships extend beyond temporary research projects to form a sustainable collaborative ecosystem.

2.9.2. Conclusion: Policy Implications of the South Korean LINC Project

The LINC project has successfully institutionalized university-industry collaboration, facilitating the commercialization of research outcomes and fostering industry-oriented talent development. This transformation has enabled universities to evolve beyond traditional educational institutions into key hubs for technological innovation. As a result, the project has contributed not only to strengthening South Korea's industrial technological capabilities but also to enhancing national competitiveness.

Based on these achievements, the key policy implications of the LINC project are as follows:

- **Legal and Institutional Infrastructure for Sustainable Industry Collaboration:** As demonstrated in South Korea's case, industry-academia cooperation is unlikely to sustain itself without a clear legal and institutional framework. A systematic support mechanism is essential to move beyond short-term, project-based cooperation.
- **Tailored Support for Technology Commercialization and Startups:** To ensure that research outputs effectively transition into industrial applications, institutions such as Technology Licensing Offices (TLOs), technology holding companies, and startup incubation centers must be actively supported and expanded.
- **Expansion of Industry-Aligned Curricula and Workforce Development:** Universities must enhance collaboration with industries to design curricula that reflect real-world workforce needs, fostering practical and employment-ready graduates.
- **Sustained Government Policy and Financial Support:** To ensure that industry-academia cooperation remains viable in the long term, a performance-linked funding model must be maintained, incentivizing universities to strengthen and sustain industry partnerships.

Going forward, the future development of the LINC model is expected to incorporate digital transformation, global collaboration, and sustainable innovation ecosystems. These advancements will further facilitate university-industry co-creation of innovations and contribute to enhancing national technological competitiveness.

South Korea's LINC model serves as a valuable benchmark for other countries aiming to design effective industry-academia collaboration policies. However, each country should review the specific context and tailor the model to its unique industrial and educational background of its own to establish the most effective collaboration framework.

3. The Foundation of KIST and its Strategies

We introduce South Korea's KIST (Korea Institute of Science and Technology) as a benchmarking model for the initial stage of Azerbaijan's industry-academia cooperation. During the 1960s-70s in Korea, industry-academia cooperation policies and establishment of policy research institutes were implemented, particularly through KIST. These early experiences and policy approaches are noteworthy to speculate on a successful state-led model of research foundation.

Although KIST was a national research institute, it prioritized cooperation with enterprises, laying a foundation for industry-academia collaboration. At that time, Korea lacked industrial technology capabilities and addressed this gap by establishing government-led R&D institutions. The KIST transferred research outcomes to industries and, with government support, engaged researchers in joint projects with companies. The KIST's success laid the groundwork for establishing the Korea Advanced Institute of Science and Technology (KAIST), Pohang University of Science and Technology (POSTECH), and became a model for government-funded research institutes (e.g., ETRI, KERI, KRISS) established in the 1980s.

3.1. Background of Establishment

As both domestic consumption and exports increased in 1970s, the need for diversification of export products, quality improvement, and enhancement of competitiveness became prominent in South Korea. The outdated factory facilities at the time required maintenance and improvement, while new process technologies had to be introduced or developed. Given that the outdated industrial infrastructure was almost wasteland, a group of experts was needed to objectively and comprehensively examine the policy feasibility and technological strategies for selecting and expanding new industries. Hence, the emergence of competent industrial research institution became an urgent issue.

Recognizing its limited technological capability, the government prepared to establish a research institute dedicated to the national promotion of science and technology policies and the introduction, adaptation, improvement, and development of industrial technology. The initial Proposal for the Establishment of an Industrial Research Institute was prepared in the early 1960s. Prior to the formulation of the First Five-Year Science and Technology Promotion Plan (1962–1966), the Economic Planning Board set up the Bureau of Technical Management on July 22, 1961, as a specialized administrative agency for science and technology. Later, on February 1, 1963, the Economic and Science Advisory Council was established as a policy organization. At that time, research activities at universities and corporate affiliated research institutions were weak, with most research being conducted by government-supported national and public research institutes. In 1964, national and public research institutes accounted for 67.4% of the total 86 research institutions, and they received 83.3% of the total research funding.

Technology transfer from research institutions to industry was difficult. Since the budgets were allocated from government funds, securing additional funding for new research activities was challenging. Researchers were not well compensated, and research activities mainly focused on technical surveys for administrative support rather than meeting industry demands. This environment made it difficult for research institutes to contribute to industrial development, and even valuable research findings often failed to be commercialized due to a lack of support. University-affiliated research institutions were faced financial constraints and had difficulties in recruiting top talents. Private companies, on the other hand, hesitated to actively invest in research due to uncertainties regarding capital recovery, and their research activities were primarily focused on product quality inspection.

Until the early 1960s, research institutions struggled in all aspects, including securing top talent, acquiring industrial technology information, obtaining funding for research equipment and operations, and conducting mid-to-long-term research that could be linked to the industrial sector. Before the establishment of the First Five-Year Science and Technology Promotion Plan (1962–1966), the Economic Planning Board set up the Bureau of Technical Management on July 22, 1961, as a specialized administrative agency for science and technology. Later, on February 1, 1963, the Economic and Science Advisory Council was established as a policy organization.

3.2. Brief History of KIST

During 1960s–1970s, the Korean government established a foundation for applied science research, the Korea Institute of Science and Technology (KIST), laying the groundwork for Korea’s industrial development. Throughout 1980s–1990s, the state focused on catching up with advanced technology mostly benefitting from the activities of KIST, driving Korea’s economic growth. The specialized higher educational institute of KAIST (Korea Advanced Institute of Science and Technology) was founded from the KIST’s operation, and became an independent academy in 1989. Since 2000s and on, the newly established institution of KIST lead the nation’s science and technology development by pioneering fundamental technologies for the future along with its sibling organizations spanning from the innovation.

Table 16 | Major events in KIST’s history

Year	Event	Details
1965.05.18	Joint statement by U.S. and South Korea on the establishment of an applied science and industrial technology research institute	<ul style="list-style-type: none"> Announced a joint statement covering 12 agenda items, including the establishment of KIST
1966.02.10	Establishment of KIST	
1969.10.23	Completion ceremony of KIST	<ul style="list-style-type: none"> Established to promote science and technology, economic development, and national strength

1989.06.30	Separation and relaunch of KIST	<ul style="list-style-type: none"> • KAIST separated from KIST
1996.02.16	Establishment of KIST Europe Research Center	<ul style="list-style-type: none"> • Opened in Germany • First overseas local subsidiary with research facilities capable of conducting independent research • Expanded the science and technology cooperation structure to Europe to diversify the science and technology cooperation system
2006.04.17	Completion of the Gangneung Branch Natural Products Research Institute	<ul style="list-style-type: none"> • Specialized research institute for natural products and the environment • Establishing a Northeast Asia R&D hub and a regional infrastructure for science and technology • Aiming to become a world-class research institute
2012.11.08	Completion of the Jeonbuk Branch Composite Materials Technology Research Institute	<ul style="list-style-type: none"> • Specialized research institute for composite materials • Aiming to become a central hub for advanced composite materials and parts research and development in the 21st century through world-class research on source and applied technologies

3.2.1. 1966–1980: Establishment and Early Growth of KIST

During the 1960s and 70s, the presidential leadership of Park Jung Hee focused its capability to attract foreign scientists (mostly Korean natives who work abroad) to lay the foundation for the research institute. This strategy provided technical solutions for issues arising during the introduction stage of relatively advanced technology and supported the industrial sector with the diffusion of innovative activities. The institute conducted foundational studies for government-lead initiatives in steel, heavy machinery, shipbuilding, and automobile industries.

In 1970s, the state initiated full-scale research and development activities, played a leading role in the development of domestic industrial technology through the development of current industrial technologies. The KIST played a role as a cradle of science and technology by establishing specialized research institutes such as the Shipbuilding and Ocean Research Institute and the Electronics and Telecommunications Research Institute (ETRI) as affiliated institutions to support the development of heavy industry. The government also established Korea Technology Advancement Corporation (K-TAC), which became the forerunner of the Korean venture industry, playing a bridging role in industrializing technologies developed by research institutes.

Table 17 | Major events in the early years

Year	Event	Details
Late 1961	The feasibility study of establishing a research institute is ordered.	<ul style="list-style-type: none"> • Identification of problems with public research institutes • President Park Chun Hee's determination to establish an industrial research institute is revealed
May 1965	President Park Jung Hee's official visit to the United States: Summit meeting with President Lyndon B. Johnson.	The direct impetus for the establishment of KIST, the proposal for joint support by the two governments
July 1965	A six-member research team led by Dr. Donald F. Horning, President Johnson's Special Advisor on Science and Technology, visits Korea.	<ul style="list-style-type: none"> • 'Hornick Report': Suggesting the duties and roles of the U.S. president <ol style="list-style-type: none"> 1. The president, together with the U.S. government, will promote the establishment of an applied science and industrial technology research institute in Korea 2. The President shall assign the responsibility for establishing the research institute to the Agency for International Development (AID) as soon as possible 3. The President shall have AID enter into a service contract with the designated industrial research institute
September 1965	On behalf of the U.S. government, the Battelle Memorial Institute signs a service contract with AID and dispatches a research team to Korea.	<ul style="list-style-type: none"> • The investigation team exchanged a wide range of opinions on the establishment of the institute with leading figures from the Korean government, industry, science and technology, and education • In December of that year, the team submitted a "Investigation Report on the Establishment and Organization of KIST" to the governments of South Korea and the United States (presenting specific plans for the legal entity, scope of work, operation and organization, relationship with sister institutes, and financial issues)
February 1966	Signing of the 'Agreement on the Korea-US Joint Support Project Plan' on the establishment and operation of the Korea's Economic Planning Board and the US's AID Research Institute	

There were supportive policy designs for commissioned research projects, promotion of long-term large-scale projects. They promoted technology transfer and commercialization, subsidized research to support government projects. Overall, the 1970s witnessed largely successful developments in practical application of research outcomes.

Table 18 | Major research and development achievements in the 1970s

Research projects	Main contents	Detailed projects
Promotion of technology transfer and commercialization	<ul style="list-style-type: none"> Established and implemented various systems for technical support on its own Implemented the Small-Scale Research Project System and the General Technical Support System in 1968, when there was a lack of awareness of the importance of fostering small and medium-sized enterprises 	<ul style="list-style-type: none"> Establishment of the Korea Technology Advancement Corporation (K-TAC) : Serves as a bridge to commercialize the research and development results of KIST Establishment of the Technology Introduction Consulting Center : Provides services such as consulting, guidance, mediation, feasibility review, and business agency for technology introduction, as well as analysis, evaluation, and dissemination of accumulated technical information, and promotion, follow-up management, and policy direction for research on digestion and improvement of introduced technologies
Research to support government projects	<ul style="list-style-type: none"> Systematically conducted research on data necessary for establishing and implementing policies for national projects. Researchers participated in various government-led meetings as advisors and greatly contributed to the establishment of national policies 	<ul style="list-style-type: none"> Participation in the construction plan for a comprehensive steel mill : For the petrochemical industry and the construction of a general steel mill, which were selected in the Second Five-Year Economic Development Plan, the government established the 'General Steel Mill Construction Promotion Task Force' in 1969, and the KIST research team participated in this task force to prepare a plan, which later became the foundation for POSCO to grow into a world-class steel company Study on the Development Plan for the Electronics Industry : In 1967, the government commissioned a research team at the Korea Institute of Science and Technology (KIST) to prepare a report on the promotion of the electronics industry in order to implement policies to systematically foster the domestic electronics industry. This report later became the basis for the enactment of the Electronics Industry Promotion Act Study on the Development Plan for the Machinery Industry : In 1969, ahead of the establishment of the Third Five-Year Economic Development Plan, the government commissioned the industrialization

		<p>planning sector to a joint research team of KIST and the US Battelle Memorial Institute. This report emphasized the heavy industry sector and selected promising items</p> <ul style="list-style-type: none"> • Study on the Development of the Automobile Industry : In 1971, faced with the task of realizing self-defense, the importance of fostering the machinery industry, which can simultaneously meet the needs of the civilian sector and the defense sector, emerged, and the third five-year economic development plan included the KIST research team's policy for the development of the automobile industry
<p>Successful examples of research and commercialization in the 1970s</p>	<ul style="list-style-type: none"> • Active research on chemistry and materials. • The electrical, electronic, and mechanical fields were also studied, but there are few examples of practical application due to the transfer of research to specialized institutes. 	<ul style="list-style-type: none"> • KIST uses large computers to promote the computerization of administration, including the College Entrance Examination and the Management Information System. • Successfully developed CFC (Freon) and industrialized it, and secured independent production technology by developing a continuous chemical process • Introduced a hygienic processing system and contributed to the revitalization of exports and domestic demand by developing red ginseng processing technology • Contributed to the localization of anti-tuberculosis drugs and the eradication of tuberculosis in Korea by successfully synthesizing ethambutol

3.3. Strategy and Institutional Framework of KIST

3.3.1. Success Factors of KIST

The success of KIST model is ascribed to a few factors:

- Securing autonomy and maximum independence: An independent Board of Trustees and a scientific community that maintained maximum independence
- Outstanding recruitment program: An innovative personnel approach to prevent talent drain

- Global network of ‘sister’ institutions: Established strong connections with other prestigious organizations worldwide, gaining recognition as the most successful facility in a developing country, emphasizing the importance of international collaboration

There were three fundamental ideals that are Securing research autonomy, ensuring financial stability, and creating a rational and dynamic research environment. Basic operational principles includes 1) prioritizing R&D for national development and accumulate research outcomes, 2) balancing applied research directly connected to industry with fundamental research that serves as its foundation, 3) maintaining close collaboration with industry to utilize research outcomes, 4) promoting exchanges and technological cooperation with domestic and international research institutions, 5) securing sufficient research personnel to encourage free and motivated research, 6) employing researchers on a contractual basis based on their abilities and research projects, and 7) establishing a responsible accounting system based on precise research cost calculations.

3.4. Institutional Framework

3.4.1. Enactment of the KIST Promotion Law (Passed in March 1967)

Efforts were made to ensure research autonomy while the government provided funding for construction, operation, and research activities. The government also granted national property to KIST either for free or as a loan. Instead of requiring government approval for business plans, KIST only needed to submit an annual business plan report to the responsible minister. Financial audits were conducted through an independent public accountant designated by the government.

3.4.2. Securing Research Personnel: Retaining Senior Researchers

To ensure stability in researchers’ lives, the system provided researchers with autonomy and financial stability. The KIST also offered competitive salaries that was set at two to three times the salaries of university professors at the time. The condition and welfare covered:

- On-campus housing: Provided apartments within the institute
- Health insurance: Established medical insurance contracts with the U.S., which was unavailable in Korea at the time
- Establishing Research Autonomy with minimal bureaucratic structure
- High level of independence for individual researchers

- Securing Research Equipment and Facilities: In the early years, responsibility for selecting and procuring research equipment was given to senior researchers establishing laboratories

3.4.3. Establishing a Research Operations System

Autonomy and independence of research units were guaranteed at various levels. Laboratory heads led project acquisition and research contracts. Senior researchers, as lab heads, had full control over research budgets but were held accountable for results. Laboratories were flexibly managed. New labs were created based on contract research, and existing labs were restructured or closed when projects ended. The Research and Development Office acted as a mediator between research sponsors and the institute, actively supporting contract research activities.

Package deal contract was the norm. The KIST annually prepared research plans in various fields, submitted them as a package to the government, and secured funding through negotiations, a model not commonly found in other institutes then. Instead of receiving operational costs from the government, KIST received research funds to maintain independence as a contract research institute. KIST was exempted from corporate tax, business tax, registration tax, property tax, acquisition tax, commodity tax, and customs duties. This allowed companies that outsourced research to KIST to treat contract research expenses as full tax-deductible costs. These tax incentives were extended to other government-sponsored research institutes.

The Research Project Review Committee was established in 1967 as the highest decision-making body to ensure diversity in research projects and appropriate allocation of government funding. The Research Division System and Sectoral Committees coordinated research projects among related laboratories. Sectoral committees composed of senior researchers coordinated research content, collaboration, and efficient utilization of research equipment.

The successful operation of KIST granted the spin-off and independence of affiliated research Institutions. The KIST's spin-offs were predominantly within the public sector, reflecting the government's use of KIST as a hub and incubator to expand the public research sector. KIST has spun off 18 public research institutions, and some senior scientists and engineers moved to these new institutions, becoming directors. Meanwhile, senior management positions at KIST are generally filled by internal senior scientists and engineers, and all presidents of KIST have been appointed from within the organization.

Table 19 | Spin-off public research institutions and agencies from KIST (Source: Wong & Park, 2021)

Spin-off institution	Name of institution
Public Research Institutions (18)	<ul style="list-style-type: none"> • KRISO (Korea Research Institute of Ships and Ocean Engineering) • KIOST (Korea Institute of Ocean Science & Technology) • KITECH (Korea Institute of Industrial Technology) • KIMM (Korea Institute of Machinery & Materials) • ETRI (Electronics and Telecommunications Research Institute) • KIER (Korea Institute of Energy Research) • KOTI (Korea Transport Institute) • KISTI (Korea Institute of Science and Technology Information) • KRIBB (Korea Research Institute of Bioscience and Biotechnology) • KFRI (Korea Food Research Institute) • KIT (Korea Institute of Technology) • KRICT (Korea Research Institute of Chemical Technology) • GTC (Green Technology Center) • KERI (Korea Electrotechnology Research Institute) • KARI (Korea Aerospace Research Institute) • NSRI (National Security Research Institute) • KIMS (Korea Institute of Materials Science) • KOPRI (Korea Polar Research Institute)
Think tank and agency (2)	<ul style="list-style-type: none"> • STEPI (Science and Technology Policy Institute) • KISTEP (Korea Institute of S&T Evaluation and Planning)
University	<ul style="list-style-type: none"> • KAIST (Korea Advanced Institute of Science and Technology)

IV Implementation Plan

1. Overall Assessment

1.1. Stage of Development

Overall, Azerbaijani higher education system is in the early stage of design and implementation for innovative change. The government aims to develop STEM (Science, Technology, Engineering and Mathematics) educational programs and adapt to the rapidly transforming technological trend that requires agile and fully skilled human resources. The recent AZCON academy project (Fig. 14), jointly initiated by the Ministry of Science and Education (MSE) and the Ministry of Digital Development and Transportation (MDDT), is a conspicuous example how Azerbaijan tries to embrace the reform of curriculum, internationalization, development of infrastructure and opportunity-creation in education.

Figure 14 | The concept of AZCON academy (Source: BCG report, 2025)

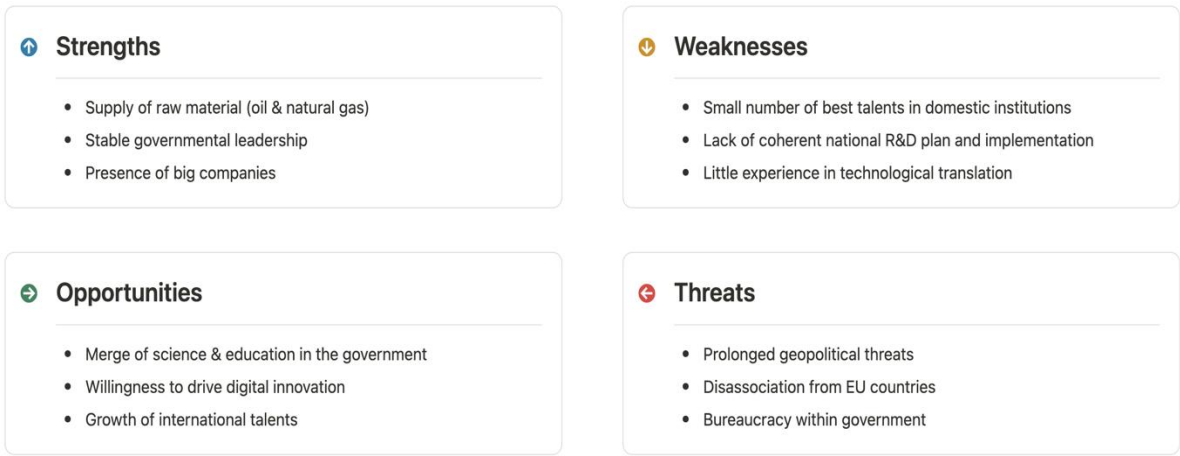


Source: BCG report <Azerbaijan IT Education Development', June 2025>

However, there is a noticeable gap between the design and practice. One notable reason, as will be discussed in the following section, is the lack of agency that can coordinate different actors in academy, government and industry. For instance, the internship program that is mandatory in every 4th year bachelor is often carried out apart from students’ background knowledge or practical interest, but there are few agencies that can balance the mismatch. From our observation, although the government seems to be fully aware of the importance of international cooperation to facilitate innovation, the capacity to engage and coordinate with foreign stakeholders is also very limited.

The Azerbaijani government should establish coherent plan and implementing body to bring science and education together. There should be a consistent and comprehensive roadmap to link between technological and higher educational milestones. While national industry is heavily dependent upon raw material (oil and gas) extraction and processing, the enhancement of existing sector (e.g. increasing efficiency of oil processing) and the attempt to diversification (e.g. production of new material or strategic investment to new industry), are conducted separately from R&D activities and operation in higher education. Considering the early stage of development in higher technology sector, the government’s more active initiative to drive national R&D system is prerequisite to any concrete outcome.

Figure 15 | SWOT analysis of Azerbaijan from innovation perspective



The government, however, is not without limitation. From our SWOT analysis, the state of Azerbaijan is under pressure from international and domestic threats. While the dispute with Armenia is not resolved yet, diplomatic activities are constrained by underlying conflicts with Russia and EU.¹⁰ Partly due to the bureaucracy in related ministries, the government is not actively pursuing diplomatic alternative so far. While developing ties with advanced and continuously growing East Asian countries like South Korea, Japan, and China could be a pathway, the state’s

¹⁰ Azerbaijan’s diplomacy is constrained by multiple fronts: tensions with Russia have escalated following arrests and retaliatory measures in July 2025 (Washington Post; AP News), while relations with the EU remain strained as Baku repeatedly summoned the EU Ambassador over concerns regarding the EUMA mission in Armenia (AZERTAC).

display of willingness and commitment to active cooperation is required in this early stage of international interaction.

There are emerging opportunities as the government is willing to lead technological innovation by newly establishing the Ministry of Science and Education and invest in digital education. The growth of young talents that utilize creative idea and knowledge especially in the novel ICT sector looks promising. Still, there are a number of obstacles in the operational level. First of all, the investment on ICT sector is neither cheap nor easy as it might look. The success rate of startups is very low, and it is usually a small number of global platforms that dominate the market. ICT industries like game apps, e-commerce, AI service are growingly overshadowed by corporate projects that require huge investment if success case by individual's wit and luck is not entirely out of hope.

From the organizational perspective, on the other hand, the merge of scientific and educational function in the government is more theoretically sound than to operate effectively in practice: It needs a lot of arduous efforts backed by strong central leadership. Reflecting the asserted "failure" of similar experience in South Korea during 2008-2012 when ex-president Lee Myungbak's government integrated the Ministry of Science and the Ministry of Education to bring synergy in innovative activities, differences in perspective, language, organizational convention between officials from the two groups were noticeable and sometimes lead to inter-departmental conflicts. In retrospect, not only the clarification of role and responsibility in the blurred zone of science AND education was critical, but the leadership and relative autonomy of salient actor (team or organization) that should assume either specific or long-term task was essential.

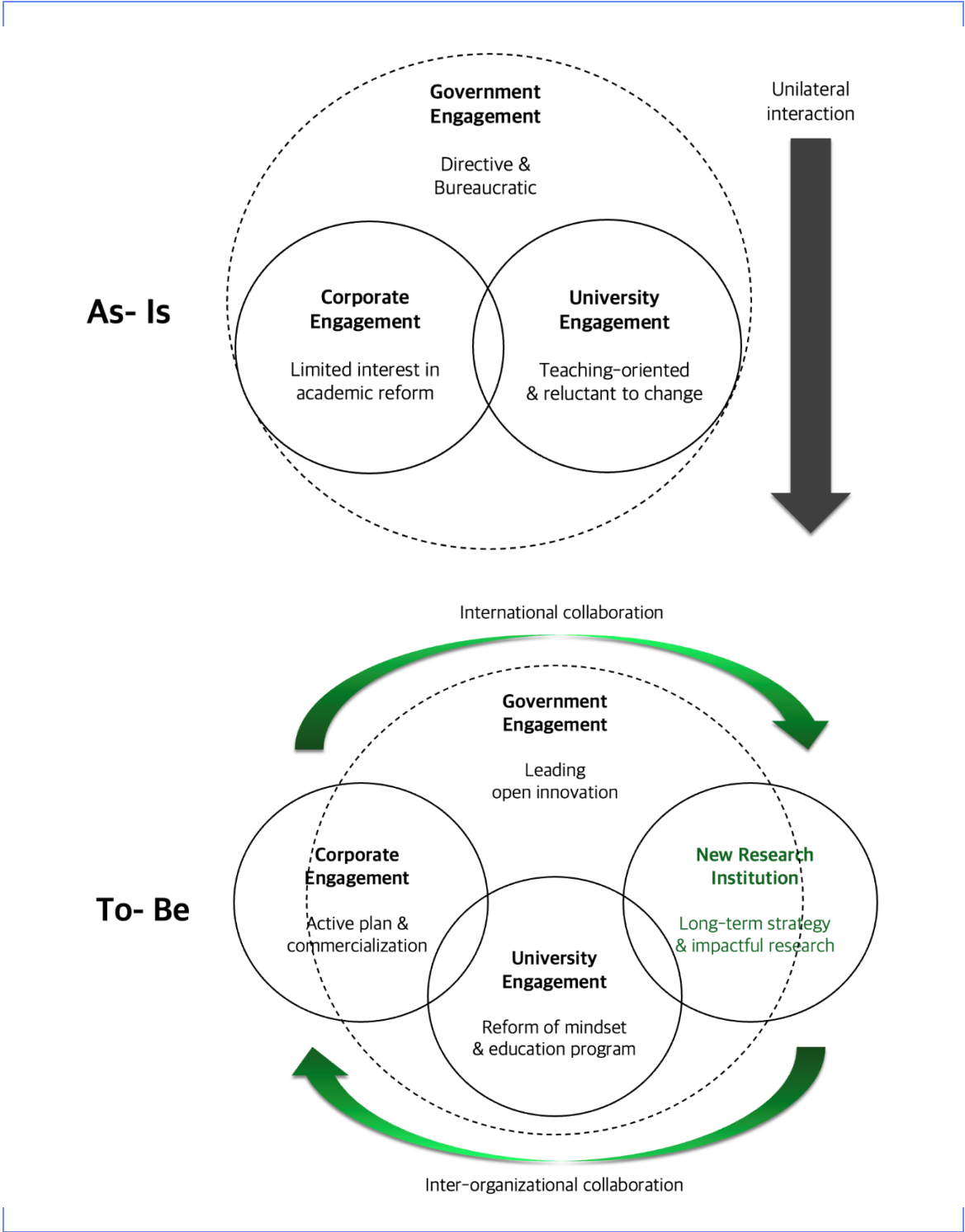
To conclude, we agree with the interviewed staffs of Sabah.hub that the state's attempt to invest in startups should not immediately dream of growing a few "unicorns"; But consider such trial as an educational process to let young talents to learn ICT skills and explore various cases of business translation of digital knowledge. More tangible commercialization of science is likely to occur among professional researchers who develop unique and practical solutions required by domestic and/or global corporations. Considering the weakness of Azerbaijan (Fig. 15) that has relatively small number of best, internationally renowned or promising, talents in domestic organizations, some new innovative research institution that secures independent leadership in technological development, as demonstrated by Korea's KIST model, is strongly recommended to induce foreign talents and educate domestic potentials. In doing so, Azerbaijan will better appropriate the current leverage or strength (Fig. 15) against international counterparts.

1.2. Interaction of Key Actors

As presented in the Methodology chapter, the innovation of academy and scientific knowledge heavily relies on the dynamic interaction of *Triple-Helix* actors: government, industry and academy. In the early stage of scientific development, the role of government turns out to be important. The government sets out plan, allocate national resources and drive institutional implementation. Currently, the Azerbaijani governmental bodies have engaged in various designs of reform in higher educational system and tried to lay the foundation of innovation. Still, the directive and bureaucratic nature of interaction with other actors, academy and industry, constrict their autonomy to take risks and make bold moves to technological and industrial leap-frogging. So far as the industry and the

academy are under a tight governmental control, the industry finds it difficult to communicate with university and seek common agenda, and vice versa (Fig. 16 below).

Figure 16 | The triple-helix interaction: As-Is and To-Be



From now on, the role of governmental engagement should evolve to lead open innovation domestically and internationally; and permit a certain space of autonomy for corporate engagement in R&D and related higher educational activities. To facilitate this transformation, the establishment of new research institution that enjoys independence and exercises long-term strategy for innovation and impactful research is significant. Once the institution at national scale is operational, its intermediary role and interaction with corporations and universities will stimulate transformative activities of these organizations. As the research institute mobilizes top-level talents and resources to meet technological tasks, it is also expected to motivate some faculty members in universities to collaborate for cutting-edge research; and help them to reflect their experience to improve educational program to train students for more practical research. Once the industry finds the capability of such research organizations, corporations can specify their demands of R&D and collaborate with academic institutions to translate scientific progress to commercialization. In this regard, the proposed new research institution can function as an effective mediator to facilitate inter-organizational and international cooperation.

2. Execution Plan

2.1. Plans For Implementation

Referring to the evaluative Triple-Helix model of academic engagement (Kim and Jang, 2021), 1) academic individual's productivity, attitude, and motivation, 2) organization's support of technological transfer, quality of operation and leadership, 3) institution's scientific discipline and policy are essential components to yield outputs such as productivity, agenda, R&D fund raising, technology transfer, teaching quality and student's satisfaction.

The organizational factor of Sumgayit State University (SSU) in particular, requires new establishment of technology management office (TMO) that deals with patenting and administrative support; and stable leadership for better management of inter organizational and innovative projects. Over the recent years, academic individual's attitude and motivation for industrial collaboration is gradually improving in SSU. However, constant governance and incentive structure should be designed to encourage continued efforts to engage in innovative practices and industrial collaboration. Hence, the institutional factor such as pedagogic discipline and public policy affects the behavior of individual and the operation of organization.

From a national perspective, we recommend that the Azerbaijani government should develop the capability of open innovation and allow more autonomy to industry and academy to engage in collaborative projects. Encouraging overseas cooperation will also work as an important stimulus. Our proposal of implementation plan is precisely about how to stimulate individual, organization, and institution for innovative practices and industrial cooperation by offering new institutional establishment and infrastructure. Considering the variety of circumstances and availability of resources, we propose three options:

Option 1: Establishment of research institute at national scale and construction of new innovation center in SSU

Option 2: Establishment of integrated complex of research institute and innovation center at regional level

Option 3: Moderate and limited investment in SSU by rebuilding innovation center and improving laboratory facilities

2.1.1 Option 1: National Research Institute & Innovation Center in SSU

The rationale for developing national research institute in Azerbaijan is grounded on the reality that existing universities cannot afford to attract best researchers especially those who are working overseas. New salary structure, independent environment and best facilities should be offered simultaneously. With this respect, we consider the KIST as a viable example to start with. It should be noted that the state will have to set up consistent roadmap for technological development in alliance with industrial planning.

Figure 17 | The budget estimation of national research institute (80 mil. euro)

Cost Category	Estimated Budget (EUR)	Details
1. Construction (sub-total)	39,000,000	State-of-the-art research facility with specialized lab infrastructure. Construction costs around €2,200–€2,500 per m² for high-spec labs with robust HVAC and safety systems.
1.1 Building & Utilities Construction (15,000+ m ² of labs, offices)	35,000,000	Main research buildings construction, designed for specialized chemistry and engineering research. Benchmarked against similar facilities like the CaixaResearch Institute (Spain, €110M for 20,000 m ²).
1.2 Dispatching Korean Construction Engineers	2,000,000	Technical expertise from Korea to ensure lab construction meets international standards. Knowledge transfer from KIST construction experience.
1.3 Construction Safety Systems	1,000,000	Enhanced safety infrastructure required for chemical engineering laboratories, including specialized ventilation and containment systems.
1.4 Sustainable Building (LEED, environmental management)	1,000,000	Environmental management and monitoring systems to achieve LEED certification, ensuring long-term energy efficiency and sustainability.
2. Equipment Provision (sub-total)	20,000,000	Cutting-edge scientific instruments for advanced laboratories. Major component (25% of total) necessary for world-class research capabilities.
2.1 Institute-Wide Facilities & Administrative Equipment	2,000,000	Shared equipment for library, meeting rooms, and general administrative functions across the institute.
2.2 Advanced Analytical Laboratory Instruments	4,500,000	High-end analytical equipment including NMR spectrometers and mass spectrometers. Single high-end NMR can cost €1-2M.
2.3 Pilot Plant & Process Equipment	6,000,000	Scaled-down versions of industrial chemical processes for testing and optimization, crucial for applied chemical engineering research.
3. Consulting Services (sub-total)	5,000,000	Expert architectural/engineering design (€2M), construction supervision (€1M), and capacity-building programs including training partnerships with KIST and initial operational support (€2M).
4. Taxes and Duties	8,000,000	Import VAT and customs duties on equipment and materials. Accounts for approximately 10% of the total budget, covering both local and international procurement.
5. Project Management (PEA/PMU)	1,500,000	Management costs for the project executing agency and project management unit. Covers administrative oversight throughout the multi-year implementation period.
6. Contingencies (~7.5%)	6,000,000	Reserve for unforeseen costs, scope changes, and price fluctuations. Industry standard practice for large scientific facilities, which often face unexpected geotechnical issues or materials price changes.
7. Service Charge	500,000	Administrative fees and service charges on external financing. Typical for international development projects with foreign funding components.
Total Project Budget	80,000,000	Aligned with international benchmarks such as VKIST (Vietnam, ~€60M) and comparable to the scale of modern research institutes like CaixaResearch Institute (Spain, €110M for 20,000 m²).

From the novel foundation, long-term and ambitious projects in manufacturing, military technology and ICT development will be promoted through the state's sponsorship and international cooperation as well. While university will play more modest role, establishment of novel innovation

center that facilitates exchange of faculty members with the national research institute and collaborative projects can stimulate gradual change of actors and institutions. The linkage between the national research institute and university through the channel of innovation center will work as a testbed of “triple-helix” cooperation. The estimated total cost of national research institute is 80 million euro and the innovation center in university, presumably SSU, is 20 million euro.

Figure 18 | The budget estimation of innovation center in university (20 mil. euro)

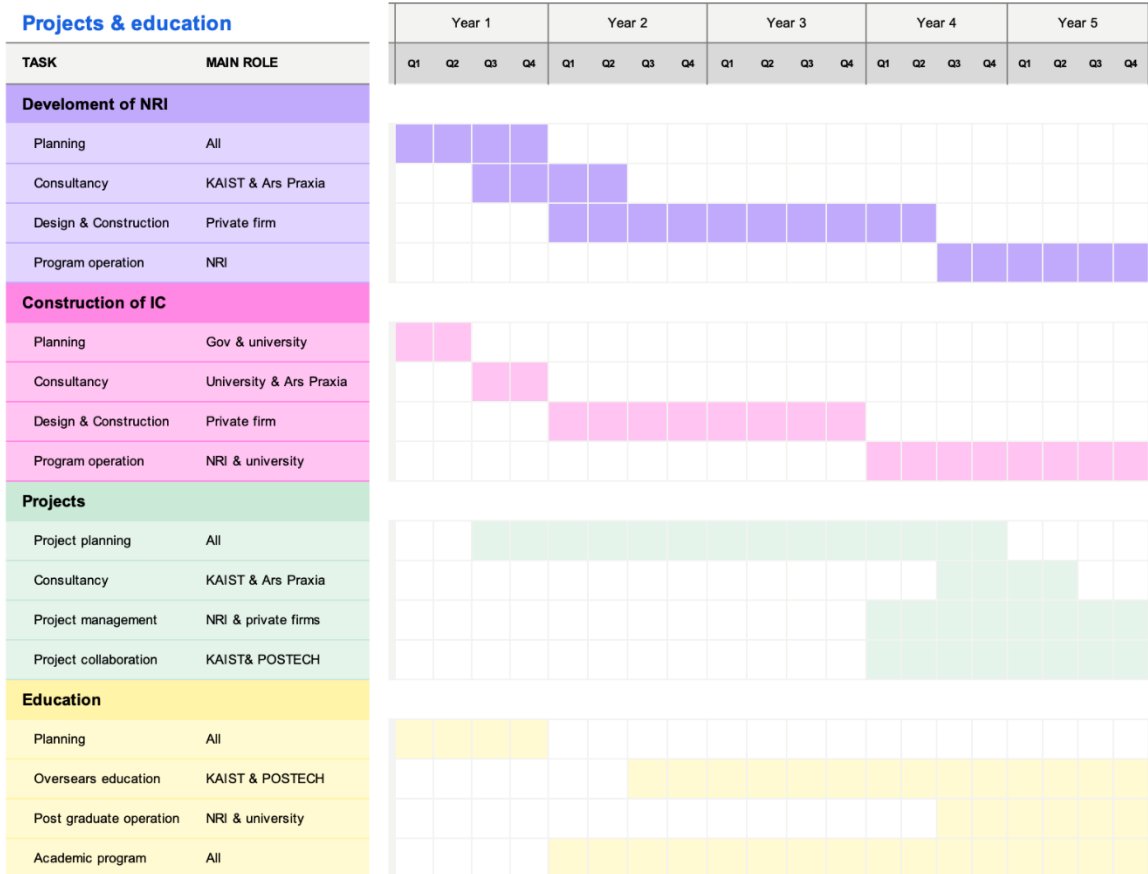
Cost Category	Estimated Budget (EUR)	Details
1. Construction (sub-total)	12,700,000	Building & Utilities Construction (€12.0M), Korean Construction Engineer's Cost (€0.2M), Construction Safety Measures (€0.2M), Sustainable Building/LEED certification (€0.3M)
2. Equipment Provision (sub-total)	3,000,000	Laboratory & IT Equipment including prototyping tools and high-speed network (€2.2M), Office Furniture & Collaboration Space Fixtures (€0.8M)
3. Consulting Services (sub-total)	1,100,000	Architectural Design & Bidding Services (€0.8M), Training & Capacity Building Programs (€0.3M)
4. Taxes and Duties	1,000,000	Import duties, VAT, and other applicable taxes
5. Project Management (PEA/PMU)	400,000	Project management and administration costs
6. Contingencies (~8%)	1,600,000	Reserve for unforeseen expenses, cost escalations, and scope changes
7. Service Charge	200,000	Administrative fees and service charges
Total Project Budget	20,000,000	Aligned with international benchmarks (e.g., Menai Science Park in Wales: ~€23M for 5,000 m²)

The envisioned first 5-year roadmap (Fig. 19) also includes overseas scholarship and master’s program for students from Azerbaijan offered by Global Digital Innovation School of KAIST and Department of Chemical Engineering of POSTECH. The established national research center, constructed for 2.5 years, and universities are expected to absorb most of master’s graduates as researchers who will actively mediate international cooperation with South Korea. Meanwhile, KAIST and Ars Praxia will contribute to implementing innovative projects that requires collaboration with Korean institutions.

Figure 19 | Implementation roadmap (Option 1)

Option 1

National research institute
Innovation center
Projects & education



2.1.2 Option 2: Regional Research Institute & Innovation Center

The second option considers circumstances that the government is not certain of quick investment in national research foundation. In this case, private sector can assume an important role to lead regional development by integrating the function of research organization and innovation center to foster commercial interest. we forecast that there would be initial technological improvement of existing industries like oil processing and downstream production by direct cooperation with national corporations.

If successful, the model can proliferate to national scale over years. As the Korean team discussed with the national oil company SOCAR, for example, the scale-downed research institute can meet immediate demands of R&D of company while seeking industrial diversification and technological development. The reason that innovation is integrated with the facilities is because

some of those successful research and researchers are likely to lead commercialization of knowledge and the foundation of promising startups.

Figure 20 | The budget estimation of regional research institute (60 mil. euro)

Cost category	Budget (Euro)	Details
1. Construction (sub-total)	30,000,000	State-of-the-art research facility with specialized lab infrastructure. Construction costs around €1,200–€1,500 per m² for high-spec labs with robust HVAC and safety systems.
1.1 Building & Utilities Construction (15,000+ m ² of labs, offices)	25,000,000	Main research buildings construction, designed for specialized chemistry and engineering research. Also include ICT research facilities, faculty & business offices, and playground space for innovation center. Benchmarked against similar facilities like the CaixaResearch Institute (Spain, €110M for 20,000 m ²).
1.2 Dispatching Korean Construction Engineers	2,000,000	Technical expertise from Korea to ensure lab construction meets international standards. Knowledge transfer from KIST construction experience.
1.3 Construction Safety Systems	1,000,000	Enhanced safety infrastructure required for chemical engineering laboratories, including specialized ventilation and containment systems.
1.4 Sustainable Building (LEED, environmental management)	1,000,000	Environmental management and monitoring systems to achieve LEED certification, ensuring long-term energy efficiency and sustainability.
2. Equipment Provision (sub-total)	15,000,000	Cutting-edge scientific instruments for advanced laboratories. Major component (25% of total) necessary for world-class research capabilities.
2.1 Institute-Wide Facilities & Administrative Equipment	2,000,000	Shared equipment for library, meeting rooms, and general administrative functions across the institute.
2.2 Advanced Analytical Laboratory Instruments	10,000,000	High-end analytical equipment including NMR spectrometers and mass spectrometers. Single high-end NMR can cost €1-2M.
2.3 Pilot Plant & Process Equipment	3,000,000	Scaled-down versions of industrial chemical processes for testing and optimization, crucial for applied chemical engineering and material science research.
3. Consulting Services (sub-total)	5,000,000	Expert architectural/engineering design (€2M), construction supervision (€1M), and capacity- building programs including training partnerships with KAIST/POSTECH/Ars Praxia and initial operational support (€2M).
4. Taxes and Duties	6,000,000	Import VAT and customs duties on equipment and materials. Accounts for approximately 10% of the total budget, covering both local and international procurement.
5. Project Management (PEA/PMU)	2,500,000	Management costs for the project executing agency and project management unit. Covers administrative oversight throughout the multi-year implementation period.
6. Contingencies	6,000,000	Reserve for unforeseen costs, scope changes, and price fluctuations. Industry standard practice for large scientific facilities, which often face unexpected geotechnical issues or materials price changes.
7. Service Charge	500,000	Administrative fees and service charges on external financing. Typical for international development projects with foreign funding components.
Total Project Budget	60,000,000	Aligned with international benchmarks such as VKIST (Vietnam, ~€60M) and comparable to the scale of modern research institutes like CaixaResearch Institute (Spain, €110M for 20,000 m²).

In this case, cooperative tasks linking Korean petrochemical industry, material science, environmental technology and digital transformation schemes can be developed in a concerted manner. This will help establish technological cooperation networks with relevant Korean enterprises and research organizations. Early research projects can induce a few Korean experts and promoting overseas exchange programs will entrench ground of technological cooperation between South Korea and Azerbaijan.

From our field research, we recommend Sabah City as a viable place to initiate this regional development strategy. The administrative team is already operational for regional development, land can be offered to participating corporation at a favorable condition, and other participating universities and research institutes can form a regional collaborative network. The government can utilize this case as a testbed and reflect on national research strategy in coming years.

This is regarded as an eclectic model that brings quicker results than Option 1. After the construction of relevant facilities, the leading corporation can commission and evaluate pragmatic research projects and flexibly adapt to changing technological and industrial trends. Successful cases can be transferred to domestic educational programs and foster international cooperation with a number of foreign countries.

V Conclusion

Azerbaijan is a country with remarkable potential to grow young talents and initiate technological progress. South Korea's experience of higher educational reform and industrial translation can inspire how to harness the talent, human resources, and innovative capacity to help Azerbaijan chart her own trajectories of progress. Azerbaijani institutions can focus on applying South Korea's own innovation sector to global challenges.

During the 1970s, South Korea firstly developed state-run research institute KIST that spurred technological progress and diffusion of innovation, which eventually spined off some of the most excellent higher educational institutions like KAIST. Korea's reform of higher educational programs since 2000s, the national BK21 and the LINC projects resulted in the rapid organizational transformation towards the commercialization of scientific knowledge. The higher educational reform was, however, not without cost. While research outcomes and business translation surged, there are concerns about weakening morale in education. The authors recommend our Azerbaijani partners to study these Korean practices with discretion and use them to apply to the state's own strategy. One advice this report has tried to convey is that there should be an independent institution with best talents, autonomy and consistent vision.

For practical implementation, the consultancy proposed three options: 1) national-level institution with an innovation center in SSU, 2) regional institution in Sabah City with gradual scaling, and 3) focused yet limited investment at SSU. All three options are valid on their own accounts, but differ considerably in ambition, cost, and sustainability. Option 1 (national-level institution with an innovation center in SSU) is highly transformative but financially and politically complex, requiring strong multi-stakeholder coordination. Option 3 (focused investment at SSU) would deliver quick results at low cost, but its long-term impact would remain limited unless framed as the first step of a broader and consistent program. Option 2 (regional institution in Sabah City with gradual scaling) can be a balanced approach: it combines a realistic investment level with the potential for growth into a national hub, while allowing time for piloting and evaluation.

Finally, the ultimate success will depend on the state's willingness to lead the role of open innovation and develop relevant ecosystem. By activating corporate and institutional participation in R&D and education, rooms for international cooperation will expand. The collaboration between Azerbaijan and South Korea will not be unilateral. Unique experiences and market environment Azerbaijan has been creating will also enlighten prospective Korean participants to engage in developing novel form of science and technology and seek mutual prosperity.

Literatures

Ministry of Human Resources Development (2006). Phase 2 BK21 Project Basic Plan. Seoul: Ministry of Human Resources Development.

Ministry of Education (2013). BK21 PLUS Project Basic Plan. Sejong: Ministry of Education.

Ministry of Education (2020.2). Phase 4 Brain Korea 21 Project Announcement Press Release. Sejong: Ministry of Education.

Ministry of Education (2020.8). Phase 4 Brain Korea 21 Project Selection Press Release. Sejong: Ministry of Education.

Ministry of Education & Korea Research Foundation (2007). Phase 1 Brain Korea (BK) 21 Project White Paper (Graduate Research-Centered University Development). Seoul: Ministry of Education & Korea Research Foundation.

Kim, Jin-young et al. (2022). Comprehensive Analysis of BK21 PLUS Project Performance and White Paper Publication. Policy Research-2021-01-BK21 Team. Daejeon: National Research Foundation of Korea.

Kim, Leo and Jang, Deok-ho (2019). Culturing Atmosphere for Spontaneous Innovation: Academic Action and Triple-Helix Dynamics in South Korea. *Higher Education Policy*

Jang, Deok-ho (2025). The Impact of the Brain Korea 21 Project on Korean Graduate Schools and Future Tasks. *University Education*, Issue 227. Seoul: Korean Council for University Education.

Baker, D. P. (2014). *The schooled society: The educational transformation of global culture*. Stanford University Press.

Yonhap News (1999.7.8.). 'Demand for BK21 Project Withdrawal' - Street March by 900 Professors <https://www.yna.co.kr/view/AKR19990708003000004>(Accessed: January 1, 2025).