The Current State and Challenges of Science and Technology Innovation in Indonesia: An NVivo-Based Analysis

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ABSTRACT

Indonesia's "Golden Indonesia 2045" seeks to bring about a paradigm shift in the country's development model towards new technologies. Although Indonesia's digital economy and innovative development indicator has ambitious prospects, the country lags in research intensity, human resources, knowledge acquisition, and local research collaboration. This study uses qualitative policy-document analysis with the help of the NVivo tool to investigate how Indonesian policies and strategies address science and technology, economic growth, and quality of life to identify factors that foster innovation-growth in the country. The article argues that economic growth fosters innovative growth by providing resources, developing industries, accumulating human and material resources, and coordinating research in the community. The study also shows that a better quality of life leads to the creation of demand and the availability of human-capital which is conducive to new development. Recent health statistics on Indonesia's innovation performance provide evidence for this work, as the country has improved its ranking in the global innovation rankings from 85th by 2020 to 55th by 2025, but human-capital and research still need much improvement. This study concludes that the major policy challenge for Indonesia in its next stage of development is to convert the growth into sustained increases in R&D investment and innovation activity as health, education, public, and entrepreneurial sectors are incorporated into research. The paper provides a valuable contextual perspective on the innovation-growth strategies applicable to other developing countries.

Keywords: science and technology innovation; national innovation system; economic development; quality of life; NVivo; Indonesia; innovation policy

1. Introduction

Global technological change is evolving into an integral part of market development. As the world's second largest economy in the Association of Southeast Asian Nations (ASEAN), Indonesia is currently at the crossroads of the "Golden Indonesia 2045" vision and the transition from resource development to economic regeneration. The latter is particularly evident in the country's digital economy, entrepreneurial lifestyle, and innovation activity. Indonesia ranked 55th out of 139 economies in the Global Innovation Index (GII) in 2025, down from 85th in 2020, indicating significant but persistent gaps in national development.

The innovation challenge for Indonesia is best framed as a transformation challenge – how to transform the scale of the economy, market power and public resources into lasting research capabilities, learning and useful innovation. The OECD (2024) estimates that total expenditure on R&D was 0.09% of GDP in

2013, rising to 0.28% by 2020 – still well below the ASEAN average of 1.07%. The small research workforce and the limited R&D activities of private firms also constrain the potential for innovation.

Therefore, the innovation system of Indonesia is shown in Figure 1.

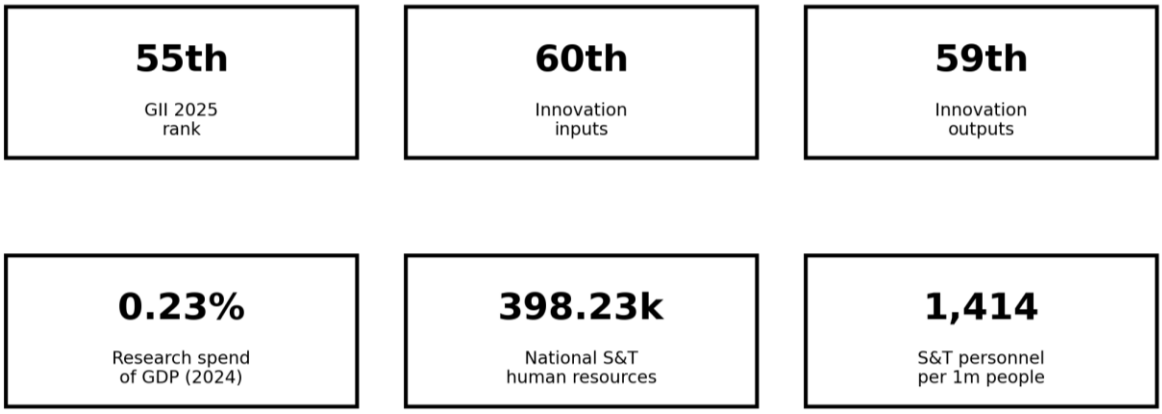

Figure 1. Indonesia innovation system: evidence snapshot (WIPO, 2025; BRIN, 2025).

The discussion on innovation also increasingly involves institutional restructuring. The establishment and expansion of the National Research and Innovation Center (BRIN) was intended to pool fragmented research resources. At the same time, reciprocity may be less effective if financial processes, organizational autonomy, and incentive design do not account for long periods of scientific work. Thus, innovation performance cannot be assessed solely based on economic indicators; it is also necessary to examine the institutional structure that influences demand behavior and resource allocation.

Existing research on Indonesia focuses on macroeconomic indicators, digital transformation in specific areas, smart city initiatives, or specific aspects of corporate innovation. However, the relationship between political discourse and economic growth, environmental protection, and innovation sector intention has not been extensively studied. This paper aims to fill this gap by analyzing the policy-relevant literature and methodology through a qualitative research approach to understand development trends and pathways in Indonesia. The NVivo software will be used to analyze the articles and videos provided, and the results will be compared to current national and international benchmarks.

This study makes three contributions. First, it contributes to the discussion by reframing the issue in terms of social and sectoral constraints rather than purely technical ones. Second, it adds the issue of quality of life to the innovation-industry discussion and argues that issues of health, education, public services, and social welfare are central to the production and management of human resources. Finally, it uses qualitative policy analysis in conjunction with current external indicators to distinguish between

policy incentives and institutional strengths and weaknesses.

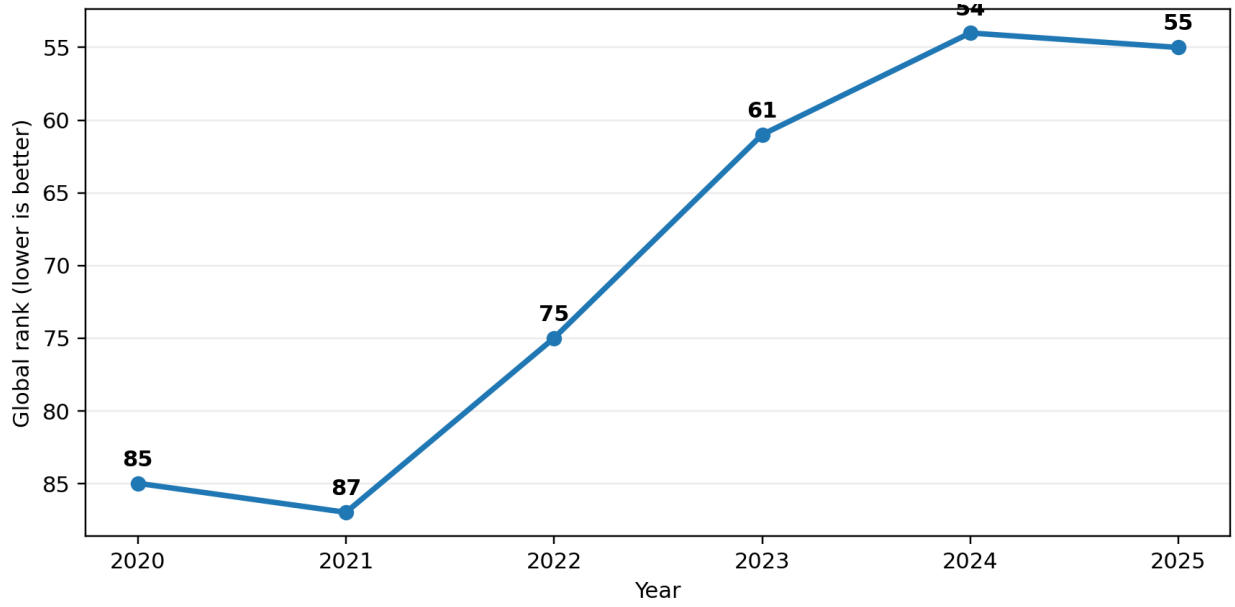

Figure 2. Indonesia's Global Innovation Index ranking, 2020–2025

Source: WIPO Global Innovation Index 2025. Year-to-year comparisons should be interpreted with attention to methodology and data availability.

2. Theoretical Background and Hypotheses

2.1 National Innovation Systems and Economic Development

National Innovation Systems (NIS) theory views innovation as a collaborative effort between firms, universities, research institutes, government agencies, financial institutions, and other entities, and not as a single innovative activity (Nelson, 1993). By this, it can be said that economic growth enables innovation by providing greater access to resources, increasing market size, expanding infrastructure, absorbing talent, and demanding more products and processes. Endogenous-growth theory Similarly it highlights the importance of knowledge accumulation, human capital, and technological change as key drivers of growth (Romer, 1990). Within the firm, the idea that capturing talent ensures that simply accessing new technologies is not enough; the organization must also have the capacity and skilled personnel to integrate knowledge for it to function (Cohen & Levinthal, 1990).

In Indonesia, digitalization, financial inclusion, industrialization, and the development of MSMEs create new avenues through which economic growth can foster innovation. Digital spaces reduce research and marketing costs, and financing can ease barriers to technology adoption. However, the impact depends on the quality of the system and the ability of companies and research organizations to convert resources into education and business (Anatan & Nur, 2023; Kristyanto & Jamil, 2023).

Hypothesis H1:Economic development has a positive effect on science and technology innovation capacity.

2.2 Quality of Life and Innovation Capacity

Quality of life is often viewed as an outcome of development, but it can also be an input to innovation(Yao et al,2026). Better health, education, transportation, access to information and communication, and public transport serve to reduce barriers to learning and collaboration, improve the availability of skilled workers, and stimulate demand for new technologies. These concepts are related to

the capabilities approach, which emphasizes the multiple opportunities people have to develop and use their skills.

Demand-pull theories of innovation also refer to how new environmental needs and market demands can shape the cycle of technological development (Mowery & Rosenberg, 1979). Telemedicine, smart city, social entrepreneurship, e-government, and social commerce are examples of technologies in Indonesia that can create application environments for experimentation and innovation industries (Megawat et al., 2024; Panjaitan et al., 2023; Pribadi et al., 2024).

The question of quality of life is also very important to consider in order to attract and retain top talent. Careers in research are long-term commitments and require significant investment in education: the researcher's career and scope must be predictable and robust. Thus, a national innovation strategy that fails to take into account health, education, and social issues will inevitably waste scientific and human resources within it.

Hypothesis H2:Quality of life has a positive effect on science and technology innovation capacity.

So ,The framework of this study is shown in Figure 2.

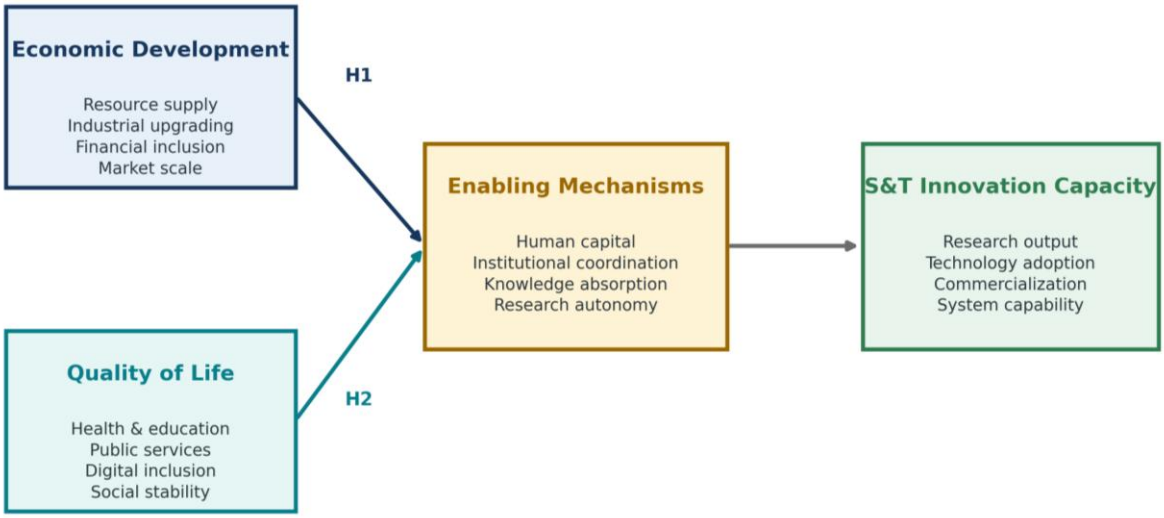

Figure 3. Integrated conceptual model of the study.

Source: Author's synthesis based on the national innovation systems, endogenous growth, absorptive capacity, and demand-pull perspectives.

3. Research Methods

3.1 Research Design and Data Sources

The nature of this study was determined by the research methodology, which used qualitative research guided by policy-text analysis as its primary method. The value case involved a contextual description of the relationships between Indonesia's scientific and technological sectors and technology sectors, including innovation and growth outcomes, including economic growth and quality of life. The document set includes official science and technology policies, national strategic plans, technology policy documents, BRIN roadmaps, and sets of policy-related research reports on research funding, industrial development, human resources, economic development, digital transformation, and public services.

The papers were selected based on their relevance to the context in which innovation policies are developed or implemented. Attention has been paid to concepts related to economic growth, science and technology, industrial development, human capital, quality of life, public policy, research funding, and

environmental cooperation. The purpose was exploration rather than quantitative: the coding was used to analyze policies, relationships, challenges and strategies.

3.2 NVivo Coding Procedure

NVivo 14 was used as the primary source for transcript organization and coding. The coding process followed a three-pronged approach to multiple coding best practices (Lindqvist et al., 2023). The first was open coding, which was used to clarify recurring ideas and policy statements. The second stage consisted of axial coding, which combined the concepts and expressions identified in the previous step into categories such as economic growth, innovation, downstream, human capital, quality of life, and public policy. The third coding process was selective coding, which explored the relationships between the categories and the two explanatory avenues at the center of this study.

Matrix coding questions were used to examine overlap and narrative proximity between selected groups. The analysis was designed to identify patterns in the policy context rather than to quantify or predict causal impact events. Color and map functions were used for visual assessment. To minimize comprehension biases, assessment tools included clarity of categories and co-analyzed themes relative to the original literature.

A methodological limitation was considered, that the paper does not report a full reproducible coding-frequency table, intercoder coefficient or exported NVivo node matrix therefore, the reported results are qualitative thematic evidence rather than specific quantitative results. The problem is not formulated as a conclusion but a force and is included in the analysis entirely without contradicting the other statements.So, as shown in Table 1.

Table 1. Analytical Framework

Construct	Core dimensions	Illustrative indicators / policy signals
Economic development	Resource supply; industrial upgrading; financial inclusion; market scale	R&D funding; digital infrastructure; MSME finance; downstreaming
Quality of life	Health; education; mobility; environmental services; public-service access	Telemedicine; smart cities; e-government; public infrastructure
Innovation capacity	Knowledge of production; technology absorption; commercialization; coordination	Research output; firm R&D; university–industry links; innovation outputs
Institutional conditions	Funding governance; research autonomy; policy coordination; incentives	BRIN arrangements; tax incentives; multi-year funding; researcher careers

4. Results

4.1 Economic Development and Innovation Capacity

Thematic analysis based on NVivo coding shows that economic growth was generally seen as the basis of Indonesia's innovation potential in the materialized narratives. Specifically, there are four key mechanisms through which economic growth affects a country's innovation capacity. These include the provision of resources, the development of industries, the accumulation of human capital, and the promotion of social cohesion (Paudel,2025). While economic growth results in increased resources (in terms of both financial and market capabilities), their true impact on the innovation process depends on their prioritization and use in a particular organizational context.

Funding is a very important limit. According to BRIN, the expenditure on national research was IDR 50.27 billion by 2024, with higher education institutions providing 71.02% of the total (BRIN, 2025). As shown in Figures 4 and 5.

While the strength of higher education reflects the role of universities as critical centers of innovation, it is important to note the need for comprehensive development of an innovation-funding system that includes firms and other research-intensive industries.

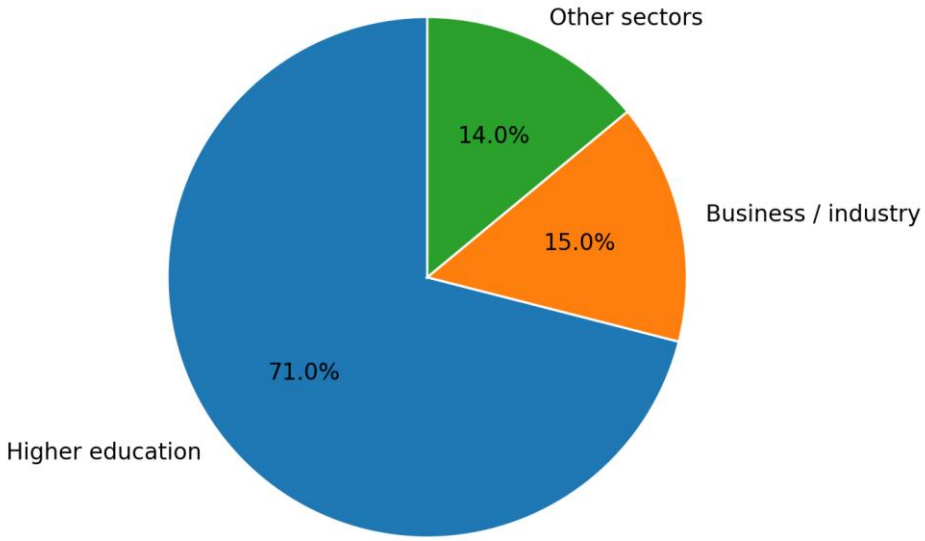

Figure 4. Distribution of national research expenditure by performing sector, 2024 (BRIN, 2025)

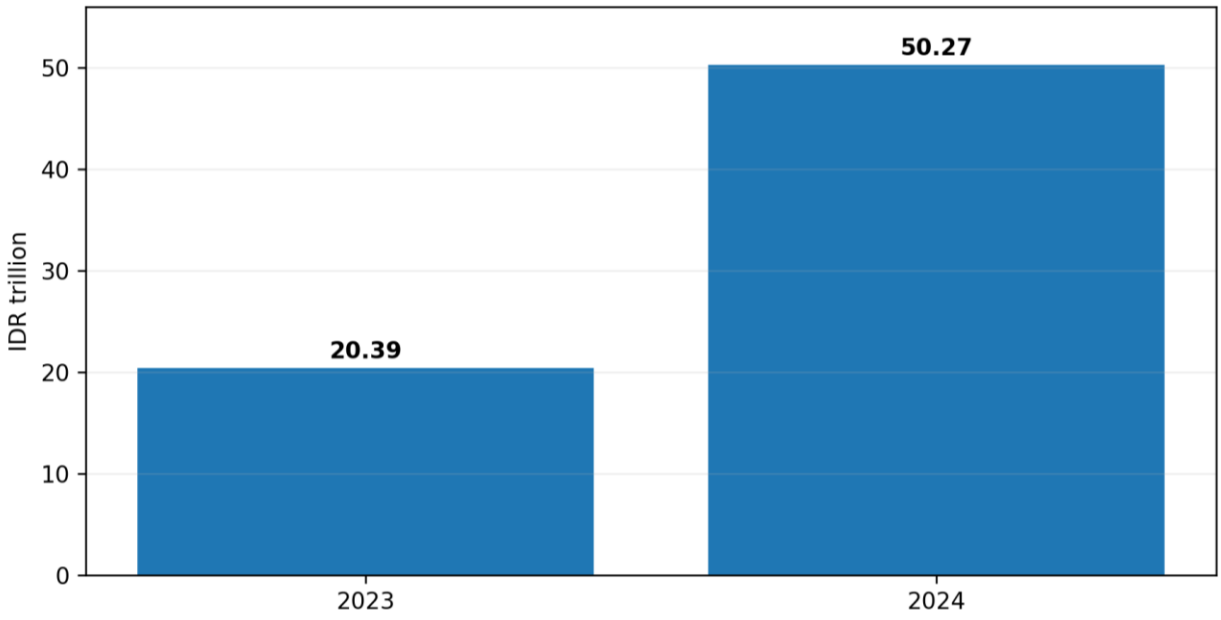

Figure 5. National research expenditure rose from IDR 20.39 trillion in 2023 to IDR 50.27 trillion in 2024 (BRIN, 2024).

Industrial expansion brings with it a demand for more educational and value-added sectors. Thus, the Indonesian downstream strategy can enable innovation when implemented along with some complementary elements, such as long-term investment, technical education, domestic supplier development, and research linkages. In their absence, industrialization can increase production without a corresponding improvement in the technological capacity of the population.

The integration of human capital and social networks underpins the system in the long run (Subedi,2024). Teaching and learning ensure the availability of skilled workers capable of adopting new technologies while university-industry relationships and research funding determine the flow of knowledge within the system. WIPO (2025) notes that collaboration in research and development between universities and business is Indonesia's strength, but the country is underperforming in human resources and research.Table 2 restores the full author-year, paper-title, and findings information from the translated version and places it directly within the economic-development results where it supports Hypothesis H1.

Table 2. Literature Evidence on Economic Development and Science and Technology Innovation

Author(s) and Year	Paper Title	Main Findings / Relevance to This Study
Rizal et al. (2023)	Indikator Iptek, Riset, dan Inovasi Indonesia 2023	Analyzes Indonesian research funding, S&T human resources, research performance, and total factor productivity. It shows that R&D and innovation are important foundations for productivity and economic development, while also identifying weak R&D investment and limited enterprise research participation.
WIPO (2023)	Global Innovation Index 2023: Innovation in the Face of Uncertainty	Evaluates global innovation performance and reports Indonesia's improvement in university–industry R&D cooperation, innovation clusters, entrepreneurship policy, and start-up financing, while noting weaknesses in education investment, R&D, and knowledge creation.
Anatan & Nur (2023)	Micro, Small, and Medium Enterprises' Readiness for Digital Transformation in Indonesia	Finds that finance, human resources, marketing, operations management, and knowledge access affect MSME digital transformation. University knowledge transfer can improve firms' technology-absorption capacity.
OECD (2024)	OECD Economic Surveys: Indonesia 2024	Shows that low R&D investment, limited business R&D participation, and a small researcher base constrain Indonesia's innovation capacity. It recommends stronger education, digital infrastructure, and innovation policy.
World Bank (2024)	Indonesia Economic Prospects: Unleashing Indonesia's Business Potential	Argues that enterprise financing, better business conditions, competition, and structural reform can raise private investment and productivity, creating stronger conditions for industrial upgrading and technological innovation.
Rizal et al. (2024)	Indonesia Science, Technology, Research, and Innovation Indicators 2024	Reviews Indonesia's research budget, S&T human resources, research outputs, and the contribution of innovation to economic development. It supports the view that R&D resources, human capital, and technology transfer from the foundation of national innovation capacity.

Author(s) and Year	Paper Title	Main Findings / Relevance to This Study
Kristanti & Saptono (2024)	Evaluation of the Super Tax Deduction Policy on Research and Development Activities in Indonesia	It shows that tax incentives can lower firm-level R&D costs and encourage private-sector research, but policy uptake remains limited because of implementation and expenditure-recognition barriers.
Lahadalia, Wijaya, & Subroto (2024)	From Aimless Stray to Charting the Way: Financing Policy Reforms to Bolster Indonesia's Downstreaming Strategy	Analyzes industrial financing for Indonesia's downstreaming strategy and argues that high-value manufacturing needs long-term capital, government guarantees, equity support, and technological accumulation.
Isa, Nurohman, & Qurniawati (2024)	Innovation Capabilities and Performance of Small and Medium-Sized Enterprises in Indonesia	Finds that human-resource management, knowledge sharing, and entrepreneurial orientation improve SME innovation capacity and performance, confirming the role of organizational knowledge in sustained innovation.
BRIN (2025)	Indikator Iptek, Riset, dan Inovasi Indonesia 2025	Assesses Indonesia's innovation system across government, higher education, business, and non-profit sectors. It emphasizes R&D expenditure, S&T personnel, research performance, and innovation's contribution to economic development.

Note. The table summarizes sources used to support the economic-development pathway in the study.

4.2 Quality of Life and Innovation Capacity

Qualitative research also provides evidence of a demand-side relationship between quality of life and innovation. Social issues in the areas of healthcare, urban mobility, environmental protection, food, and public transport provide key challenges around which strategic solutions can be crystallized and tested. In this sense, lifestyle stressors may be a marker of innovation, beyond their role as a means of success.

Clearly, healthcare is an area where telemedicine and digital health services are increasingly important. The unique challenges of an island-like geography, as well as differences in access to services, make telemedicine and related applications a compelling case for investigation. Research on telemedicine users in Indonesia has shown that factors such as accessibility and efficiency, as well as acceptance behavior, determine the uptake and sustainable use of telemedicine (Megawati et al., 2024). Similar trends can be observed in smart cities and government initiatives that rely on new technologies. Here, societal expectations in terms of accessibility, coupled with the transparency and responsiveness of public and private institutions, can lead to innovation and transformation in these areas (Panjaitan et al., 2023; Pribadi et al., 2024).

Further, these findings suggest that social policy and innovation policy are closely linked in practice: investments in health, education, digital, and smart city can simultaneously stimulate prosperity and optimize the accumulation, management, and use of human resources in research and innovation.Ttable 3 restores the quality-of-life literature evidence from the translated version and places it after the quality-of-life results where it directly supports Hypothesis H2.

Table 3. Literature Evidence on Quality of Life and Science and Technology Innovation

Author(s) and Year	Paper Title	Main Findings / Relevance to This Study
Panjaitan et al. (2023)	Diagnosing the Voids of Knowledge in the Transformation Process in Managing and Standardizing Smart City Development: The Case of the Government of Indonesia	Shows that smart-city development aims to improve quality of life, service efficiency, and participation, but also faces weak knowledge bases and uneven technical standards. It supports the demand-pull link between public-service needs and urban innovation.
Megawati, Machmud, & Alfarizi (2024)	Telemedicine and Transformative Health Access for Millennials-Gen Z: PLS-SEM Based Behavioral Exploration	Finds that inadequate healthcare access has pushed telemedicine growth in Indonesia. Demand for convenient, efficient, and fair health services becomes a driver of digital-health innovation.
Suryawan et al. (2024)	Smart Urbanism, Citizen-Centric Approaches and Integrated Environmental Services in Transit-Oriented Development in Jakarta, Indonesia	Examine Jakarta residents' preferences for waste management, transportation, green space, air quality, and public-facility access. Citizen demand for better urban services acts as a signal for smart transportation and environmental innovation.
Huwaida et al. (2024)	Generation Z and Indonesian Social Commerce: Unraveling Key Drivers of Their Shopping Decisions	It shows that information quality, utilitarian value, hedonic value, subjective norms, and self-efficacy shape social-commerce purchase intentions. Consumer demand pushes platforms to improve service models and digital functions.
Pribadi et al. (2024)	Nexus of Public Organization, Transparency, and Accountability in Indonesia's Digital Governance	Finds that skills, leadership, institutional rules, infrastructure, ICT, transparency, and accountability positively influence digital-government services. Public demand for efficient and transparent services can support digital-governance

		innovation.
Al-Kautsar Maktub, Handayani, & Sunarso (2025)	Citizen Acceptance and Use of the Jakarta Kini (JAKI) E-Government: Extended Unified Model for Electronic Government Adoption	Uses data from Jakarta residents and workers to show that government capability, performance expectancy, information quality, service quality, self-efficacy, trust, risk, and user attitudes affect e-government use and feedback-driven service improvement.

Note. The table summarizes studies linking healthcare, smart cities, consumption upgrading, and digital governance with demand-oriented innovation.

4.3 Current Innovation-System Strengths and Weaknesses

External indicators confirm the trends observed in quality control. According to the WIPO 2025 report, Indonesia performs comparatively well in terms of institutions, domestic market size, labor policy, and university-industry R&D collaboration. At the same time, the country ranks very low in terms of human capital and research, in particular, the cost of education and the number of scientific and technical topics is lower than the level of production (WIPO, 2025). As shown in Figures 6 and 7.

This finding is consistent with the main trend identified in the paper: despite the existence of market and institutional potential, the cumulative Indonesian demand is uneven.As shown table 4.

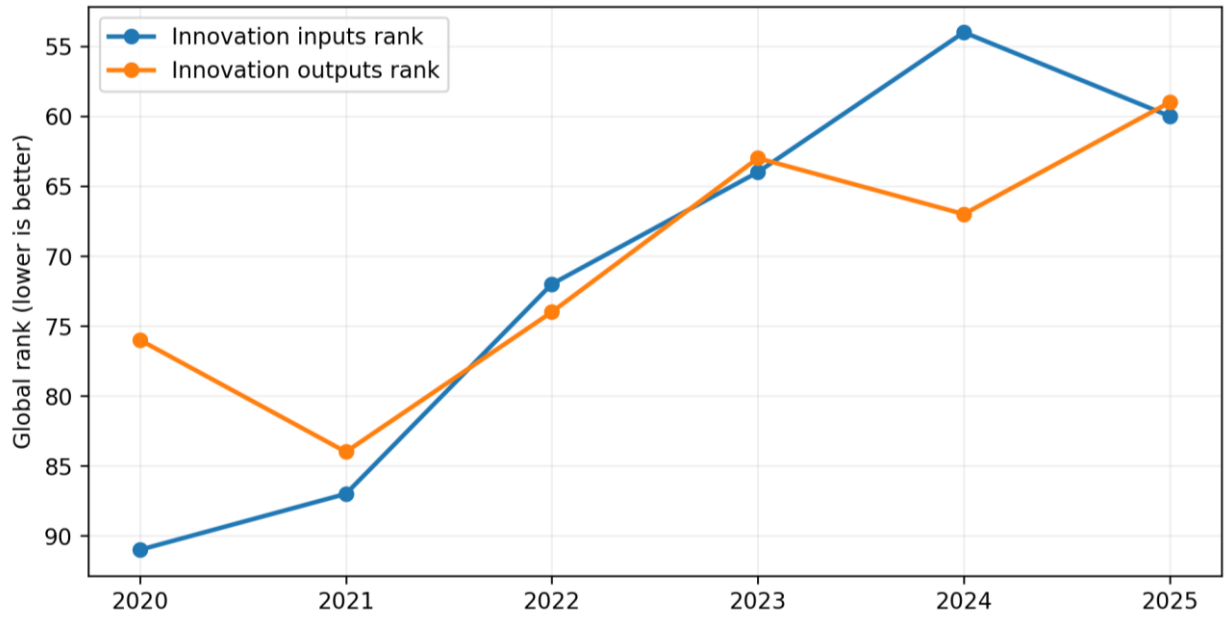

Figure 6. Indonesia's innovation input and output rankings, 2020–2025 (WIPO, 2025).

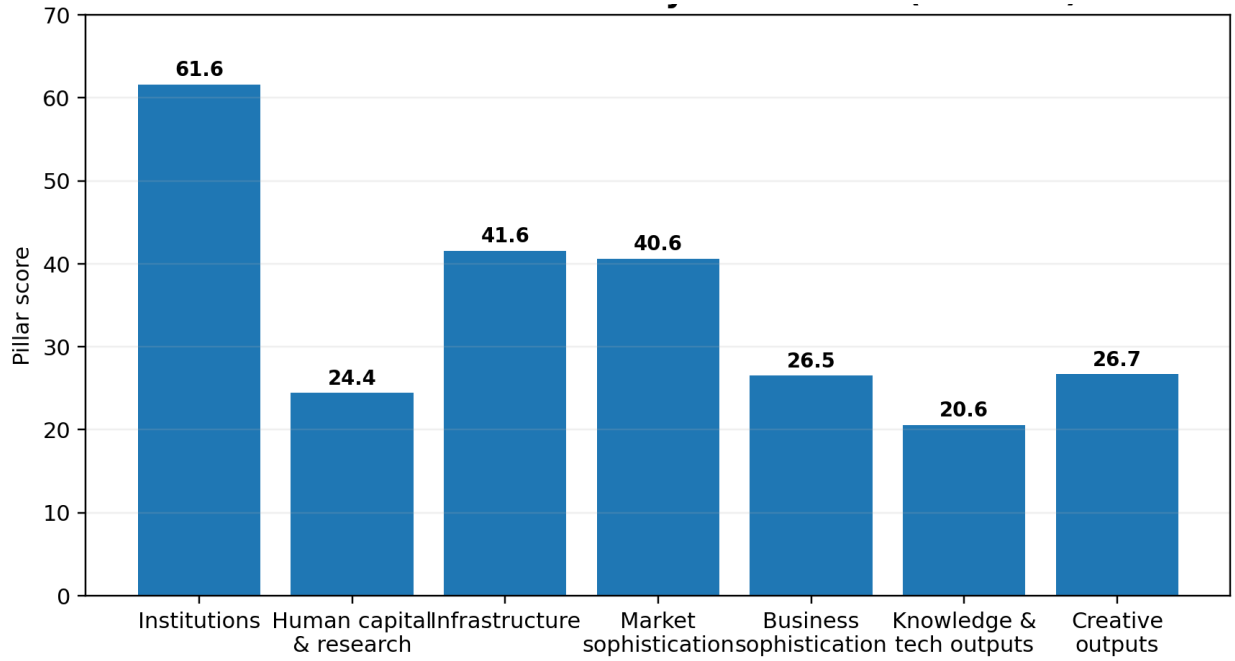

Figure 7. Indonesia's innovation-system profile across the seven GII pillars, 2025

Source: WIPO (2025). Scores reproduced from Indonesia's GII 2025 economy profile.

Table 4. Selected GII 2025 Strengths and Weaknesses

Area	Indicator	Global rank	Interpretation
Strength	Domestic market scale	8	Large internal markets can support scaling and commercialization.
Strength	Entrepreneurship policies and culture	10	Policy environment is relatively supportive of entrepreneurial activity.
Strength	University–industry R&D collaboration	13	A platform exists for stronger knowledge transfer.
Weakness	Education expenditure (% GDP)	133	Human-capital investment remains a major structural concern.
Weakness	Scientific & technical articles / GDP	133	Knowledge of production is low relative to economic scale.
Weakness	Public research–industry co-publications	117	Formal collaboration does not yet translate consistently into joint knowledge output.
Weakness	GERD performed by business	79	Private-sector R&D depth remains limited.

5. Discussion

5.1 Why Economic Growth Does Not Automatically Become Innovation

The results of the paper indicate that the main issue is related to the fact that there are no significant economic opportunities. Specifically, according to the societal innovation system theory, for a society to flourish, resources must be allocated to link various agents, such as finance, firms, research institutions, and professionals. Given the strong Indonesian market and relatively high level of innovation, weak research and development intensity and lack of human resources leads to low displacement rates.

Experience and comparisons show the importance of this compound. Singapore has thus combined economic potential with sustainable investment in R&D, access to global technology, and integrated research facilities. The Philippines presents another risk; participation in high-tech value chains can be combined with strong domestic R&D where local knowledge accumulation is limited. China then shows how scale-up, higher education, industrial policy, and long-term technology investment, can interact to deepen domestic capabilities. Such comparisons should not be viewed as blueprints but should indicate the social tasks that Indonesia needs to undertake in its own context.

5.2 Quality of Life as Innovation Infrastructure

The second implication relates to the role of ethics. The latter should be seen as part of the innovation infrastructure. Only healthy, educated, secure, and digitally connected citizens can afford high-tech and long-lasting work. At the same time, local needs require new technologies and tools. These two factors contribute to innovation by providing new skills for entrepreneurs and creating new demands that the economy must meet.

This study is of relevance to Indonesia because of common innovation-seeking objectives, with regional differences in education, health, infrastructure and levels of digital access. A purely industrial approach to innovation may lead to underinvestment in the institutional foundations needed to sustain a technological capability over time. Integrating health, education, career research opportunities, and public service grassroots into its innovation strategy will increase its ability to positively impact both progressive and technological capabilities.

6. Research Limitations and Future Research

There are several limitations to this study. First, it focuses on the qualitative nature of domestic political and strategic documents, which is appropriate for analyzing local narratives and policy relations, but not necessarily necessary for determining causal relations between populations. Second, studying is competitive in nature and therefore fails to capture the potential for innovation, institutional restructuring and long-term accumulation of talent. Finally, policy literature varies in its definitions of innovation, ecosystems, and growth, complicating analysis.

Future research should integrate qualitative policy analysis while using private-sector panel data, survey research, and longitudinal studies. Research using structural equation modeling is needed to test the proposed relationships among quality of life, human capital, social environment, and innovation potential. Another research priority is the examination of specific innovative communities such as STEM researchers, recyclers, modern start-up firms, and industrial R&D to identify factors associated with their emergence and survival as well as their knowledge accumulation processes. The result is a study of Indonesian knowledge gardens, smart city projects, and mission-driven research that will help to understand whether improvements in public services or quality of life contribute to increased research and innovation.

7. Conclusion

Indonesia has shown considerable progress in its performance in innovation, but the country needs to move beyond the innovation cycle to develop its institutional capabilities for its next phase of development. Findings based on the NVivo study support the idea that economic development can promote knowledge and technology through resources, industrial development, human capital, and social cooperation. The research also provides a basis to support the hypothesis that ecosystems contribute to innovation by stimulating demand for new technologies and enhancing social conditions for the accumulation of knowledge and skills.

Taken together, the findings suggest that Indonesia should think about innovation as a system. Research funding, industrial policy, education, health, digital public, and research activities are some interrelated parts of the same capacity building process. Indonesia has the advantage of developing its large market, entrepreneurship, and innovation capabilities. The task ahead is to transform these into R&D intensities, greater access to knowledge, greater individual participation, and to restore an environment conducive to the retention and reproduction of scientific capacity.

In relation to emerging economies, the Indonesian case is notable because it reveals the fact that transition to innovative development is not only driven by technology adoption. Organizational institutions, capable of channeling economic resources into knowledge-based production, and a set of social conditions, necessary to ensure individuals' ability to acquire, accumulate and apply advanced skills, are both needed to drive sustainable change.

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