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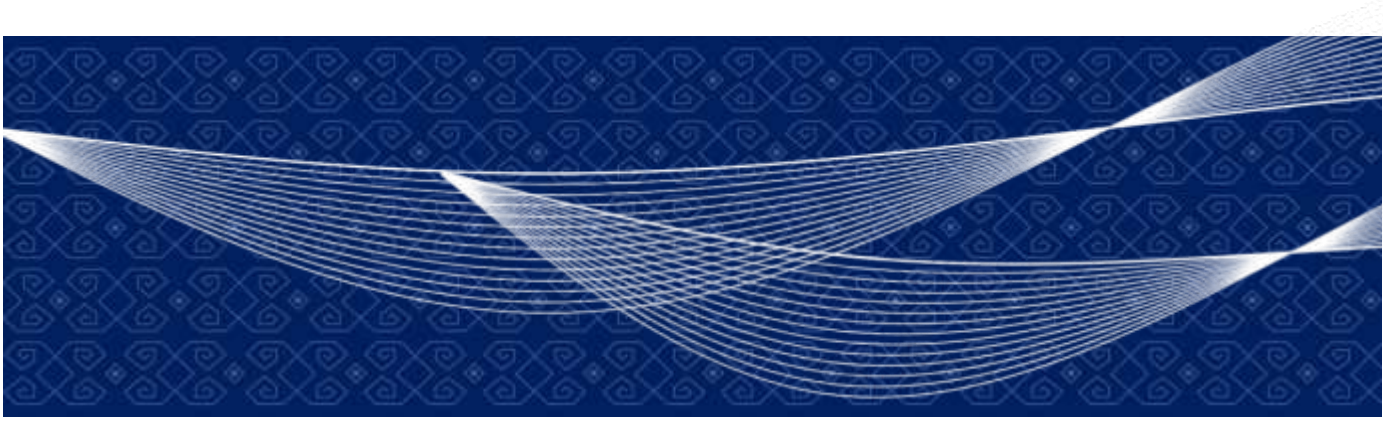

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WORKING PAPER

STRATEGIES TO ADDRESS THE RISK OF THE MIDDLE-INCOME TRAP: HUMAN CAPITAL, TECHNOLOGY, AND PRODUCTIVITY – LESSONS LEARNED FROM KOREA, CHINA, VIETNAM, AND THAILAND

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Abstract

This study investigates the structural challenges hindering Indonesia's transition toward an innovation-driven, high-income economy, focusing on the interconnected roles of human capital, productivity, and technological capability. Using a mixed-method approach that combines 2SLS econometric modelling with extensive qualitative evidence from national focus group discussions across universities, government institutions, and industry stakeholders, the study finds that weaknesses in education quality, fragmented talent pipelines, and persistent gaps in university-industry collaboration significantly suppress Indonesia's innovation output. The quantitative results demonstrate that human capital exerts a strong causal influence on productivity and income, yet its impact is constrained by weak R&D ecosystems and low patent generation capacity. Qualitative insights further reveal systemic misalignment across education policy, labour-market demand, and research commercialization, producing a "human capital paradox" in which increased educational attainment does not translate into proportional economic gains. These findings underscore the urgent need for an integrated national strategy that simultaneously strengthens foundational education, expands R&D capacity, and builds cohesive innovation ecosystems to accelerate Indonesia's escape from the middle-income trap.

Keywords: Emerging Economies, Human Capital, Innovation Ecosystem, Middle-Income Trap, Productivity

JEL Classifications: O15, O31, O47, O53, I2

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1. Introduction

1.1. Background

Over the past 20 years, Indonesia has made substantial economic progress, lifting millions of people out of poverty and attaining upper-middle-income status. In 2024, Indonesia's GDP per capita rose to USD 4,925.43, placing it firmly within the World Bank's upper-middle-income category (World Bank, 2024). However, this progress has introduced new challenges. Economic growth has begun to slow, and the mechanisms that once drove expansion are now showing signs of fatigue. Without a structural transformation, Indonesia risks remaining in a prolonged phase of moderate-income growth, thereby limiting further improvements in living standards.

This situation illustrates a widespread issue confronting many middle-income economies. As wages increase, these countries lose competitiveness in labour intensive sectors compared to lower-income economies. Simultaneously, their relatively low productivity, weak innovation capacity, and limited technological upgrading hinder competition with high-income countries in knowledge- and capital-intensive sectors. This state, often called the middle-income trap, leads to stagnant growth and restricted long-term development potential (ADB, 2017). Empirical research indicates that the trap's persistence is closely tied to sluggish productivity growth, inadequate human-capital development, and a constrained ability to climb the technology ladder (Ke, 2024).

In Indonesia, a transition from growth predominantly fueled by factor accumulation to growth anchored in productivity and value creation is necessary to circumvent this trap. Enhancing domestic production by engaging in higher value-added activities across sectors and deepening integration into GVCs is vital for sustaining long-term growth. The quality of human capital characterized by the knowledge, skills, and experience of the workforce remains central to this transition.

Although Indonesia is classified as upper-middle-income country, it still encounters substantial human-capital limitations. Its human-capital index stands at 0.54, placing it 96th among 175 countries and behind regional counterparts such as Singapore, Malaysia, and Vietnam (World Bank, 2020). This reflects ongoing difficulties in educational quality, skill development, and workforce preparedness. When skill acquisition does not match capital accumulation and technology uptake, economies experience reduced returns and slower growth (Kim & Coxhead, 2024). Additionally, research indicates that continuous gains in innovation and productivity, especially through higher TFP growth, are essential for countries to move from middle to high income (Kim & Park, 2017).

Several Asian economies have demonstrated that sustained growth beyond middle-income status is neither automatic nor accidental. Their development trajectories often reflect a gradual progression from adopting foreign technologies to adapting them to local conditions and eventually building indigenous innovation capacity. This "Copy–Substitute–Modify–Innovate" pattern has been central to the successful structural transformation of economies, such as the Republic of Korea. By the mid-1990s, Korea had achieved high-income status, supported by sustained investment in education, institutional reform, and the deliberate cultivation of high-skill human capital. Comparative evidence suggests that such experiences offer important lessons for other middle-income countries seeking to upgrade their economic structures (Murach et al., 2018).

The development path of Indonesia diverges from this trajectory. Compared with economies such as Korea, as well as the more recent experiences of China and Vietnam, Indonesia's growth model remains heavily reliant on resource-based sectors with limited movement toward higher value-added activities. This structural

dependence increases exposure to external commodity price shocks and constrains productivity growth. Consequently, improvements in human capital alone, if not accompanied by industrial upgrading and technological transformation, may be insufficient to secure a durable transition out of the middle-income range. Instead, such a mismatch risks reinforcing the very conditions associated with the middle-income trap.

These structural challenges are compounded by demographic constraints. Indonesia is currently approaching its demographic dividend peak, which is expected to occur in the 2030s. Population aging is projected to intensify fiscal pressures and dampen growth potential beyond this period. If meaningful gains in human capital quality, innovation capacity, and productivity are realized only after this window closes, Indonesia may face a "too little, too late" scenario, where economic upgrading is no longer supported by demographic momentum.

Despite a substantial body of literature examining the determinants of the middle-income trap, significant gaps remain in understanding how human capital translates into innovation-led growth in the Indonesian context. Existing studies often analyze human capital accumulation, R&D investment, and productivity growth in isolation or rely heavily on aggregate quantitative indicators that obscure institutional and structural rigidities. In particular, empirical work addressing the persistent "conversion failure" in Indonesia is limited, i.e., the question of why rising educational attainment has not resulted in proportional increases in innovation output or industrial productivity. This conversion failure is further exacerbated by fiscal allocation biases. While the constitutional mandate earmarks 20% of the state budget for education, this figure encompasses broad components that do not directly contribute to research and development (R&D) capacity, such as basic school operational funds (BOS) and budgets for non-academic governmental training institutions (Perguruan Tinggi Kedinasan).

This research seeks to address this gap by examining the systemic transmission mechanisms in Indonesia that link human capital quality to innovation and productivity growth. Using a mixed-method approach that combines econometric analysis with institutional diagnostics, the study explores how ecosystem failures, such as regulatory fragmentation and weak linkages between academic research and industrial demand, contribute to Indonesia's low-innovation equilibrium and hinder its escape from the middle-income trap.

1.2. Problem Statement and Research Question

Despite Indonesia's attainment of upper-middle-income status, the country continues to encounter structural constraints that impede productivity growth and innovation. Existing research frequently relies on aggregate measures of human capital, which provide limited understanding of the influence of specific skill profiles, regional disparities, and workforce adaptability on innovation outcomes. Furthermore, institutional weaknesses such as fragmented policy implementation, insufficient absorption of research outputs, and low rates of patent commercialization hinder Indonesia's capacity to translate human capital accumulation into innovation-driven growth.

Given these challenges, this study aims to address the following research questions:

1. What is the current state of human capital development, technological innovation, and productivity in Indonesia?
2. What is the relationship between human capital indicators, technological innovation, productivity, and the risk of the middle-income trap in Indonesia?

3. What are the main challenges facing Indonesia in developing human capital, particularly in public education, and in innovation and technology, including patent development and commercialization?
4. What policy recommendations, with priority timeframes, can reduce Indonesia's risk of falling into the middle-income trap?

1.3 Research Objective

This study aims to formulate comprehensive strategies for Indonesia to escape the middle-income trap by strengthening human capital, fostering innovation, and enhancing productivity. Specifically, the objectives are:

1. To assess the current state of human capital, innovation, and productivity, emphasizing education quality and soft skills
2. To identify the causal relationships between human capital, innovation capacity, productivity growth, and economic resilience.
3. To diagnose structural challenges in education systems and the innovation ecosystem, specifically regarding patent development and commercialization.
4. To formulate evidence-based policy recommendations with priority timeframes to cultivate an innovation-oriented culture and reduce technological dependence.

2. Literature Review

2.1. Conceptual Framework and System Thinking

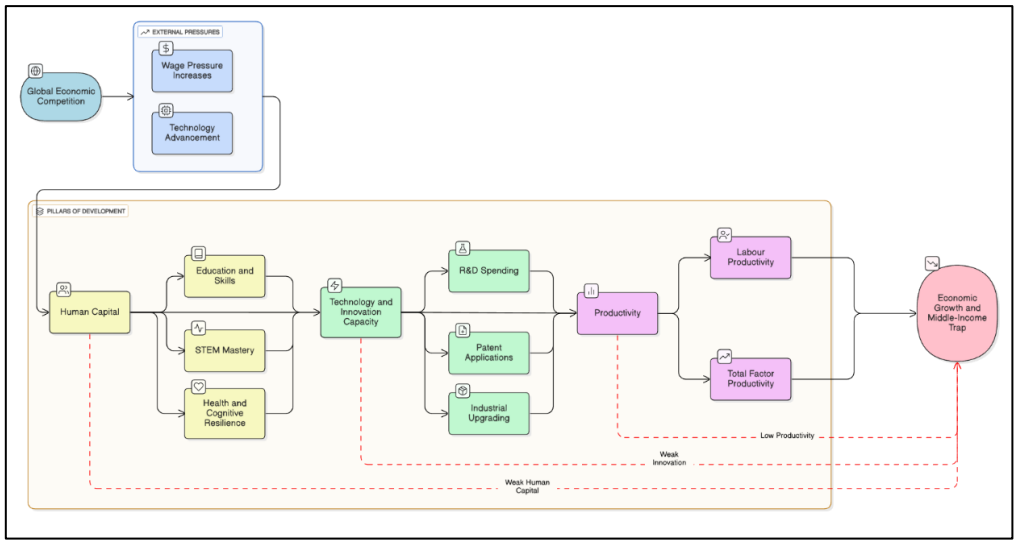

Figure 2.1 Human Capital–Innovation–Productivity Framework

This conceptual framework weaves together human capital formation, technological capability, and productivity dynamics to shed light on the middle-income trap. Rather than treating economic upgrading as a simple process of accumulating capital, it is understood here as a complex transformation of a system in which these three elements interact and reinforce one another. Human capital equips individuals with the skills necessary to adopt and adapt to new technologies, while technology itself both drives and reflects the broader process of modernization. Productivity, in turn, acts as the crucial link that translates knowledge and innovation into measurable economic progress, chiefly through improvements in efficiency and shifts in economic structure. To break free from the middle-income trap, it is essential to integrate these components in a coordinated way; a weakness in any one aspect can create bottlenecks that hold back progress. Drawing on the experiences of countries like South Korea and China, this framework highlights a

key causal chain: Human Capital → Technology → Productivity → Economic Upgrading. This chain is further strengthened by feedback loops, as economic growth fuels continued innovation and advancement.

To further ground this theoretical perspective, a systems-thinking diagram (see Appendix 1.1) illustrates the dynamic interventions required for this transformation. The model depicts how the development of human capital through well-aligned education, digital literacy, and vocational training, and the cultivation of a strong technology and innovation ecosystem work together to reinforce productivity growth. These mutually reinforcing loops are what ultimately propel the transition toward a sustainable high-income economy. At the same time, the model highlights systemic barriers, such as funding shortfalls, regulatory obstacles, and weak connections between industry and academia, that exert downward pressure and can impede forward progress. For this reason, the entire system must be anchored in a foundation of integrated, continuous national policy, designed not only to strengthen the positive drivers but also to systematically dismantle these persistent barriers.

2.2. Previous Studies and Theoretical Foundations

The literature on the middle-income trap converges on the idea that it is not a singular phenomenon, but rather a complex developmental impasse shaped by the interplay of competitiveness, innovation, and structural transformation. Gill and Kharas (2007) describe this trap as a plateau where economies, having lost their edge in labor-intensive sectors, struggle to generate sufficient innovation to move forward. This view is echoed by the Asian Development Bank, which highlights how rising wages erode comparative advantage (Lin & Trap, 2012). While Robertson and Ye (2013) emphasize the persistent failure to reach high-income status, Im and Rosenblatt (2013) suggest that these patterns may be cyclical, underscoring the need to understand the underlying dynamics rather than viewing the trap as an inevitable outcome.

Human capital formation emerges as a foundational element in the broader system that determines whether economies can escape the middle-income trap. High-quality education, particularly in STEM disciplines, equips the workforce with the skills necessary to drive innovation and adapt to technological change (Rujiphoch, 2020). The evidence presented by Eichengreen, Park, and Shin (2013) underscores that countries with robust human capital and a strong high-technology export base are better positioned to withstand growth slowdowns. In Indonesia, however, persistent weaknesses in learning outcomes, reflected in a Human Capital Index of 0.54 (World Bank, 2020), continue to constrain productivity growth (Basri & Putra, 2016), illustrating how gaps in human capital can create bottlenecks that impede economic upgrading.

Technological capability, especially in manufacturing, functions as a critical lever within the system of economic upgrading required to overcome the middle-income trap (Zhou & Hu, 2021). Yet, when economies rely too heavily on imported technology, the development of indigenous innovation capacity is stifled (Leven, 2021). The slow diffusion and adoption of new technologies further restrict productivity improvements (Resnjanskij et al., 2021). In contrast, Vietnam's experience demonstrates how coordinated, state-led investment in research and development can reinforce the innovation ecosystem and accelerate progress (Klingler-Vidra & Wade, 2020). Indonesia's continued lag in patent output and R&D expenditure, as reported by WIPO (2023), highlights the systemic barriers that must be addressed to foster sustained technological advancement.

Total Factor Productivity (TFP) serves as the crucial link that translates advances in human capital and technology into sustained economic growth and

enhanced competitiveness (Sasidharan & Padmaja, 2018). The findings of Lee and Park (2023) reinforce that TFP growth is the distinguishing feature of economies that successfully transition to high-income status. However, the effectiveness of industrial policy coordination depends on the strength of institutions (Doner & Schneider, 2016), and Indonesia's productivity continues to be constrained by persistent mismatches between educational outcomes and labor market needs (Kruss, 2020). Taken together, these studies underscore that the middle-income trap is fundamentally rooted in the dynamic interplay among human capital, technological capability, and productivity, with weaknesses in any one area creating systemic barriers to progress.

2.3. Benchmarking Comparative Experiences from Other Countries

A comparative analysis underscores that overcoming the middle-income trap hinges on the integrated advancement of human capital, technological capability, and productivity. In China, the alignment of long-term R&D initiatives with expansive educational reforms has fostered a robust ecosystem for innovation, as evidenced by the role of mass higher education in driving breakthroughs across frontier sectors and underpinned by sustained infrastructure investment. Vietnam's experience illustrates how targeted Socio-Economic Development Strategies, with a focus on literacy and vocational training, have translated into measurable gains in high-tech manufacturing competitiveness, as reflected in rapid improvements in PISA scores and an explicit policy commitment to raising the TFP share of growth above 55 percent. Thailand's "Thailand 4.0" initiative demonstrates the importance of digital readiness and institutional modernization in facilitating a shift toward high-value innovation. South Korea's trajectory, marked by coordinated Five-Year Economic Plans and the 3i strategy of investment, infusion, and innovation, highlights the decisive role of strong institutions and STEM excellence in achieving high-income status, as noted by UNDP (2017).

Taken together, these cases reveal that successful transitions are characterized by the deliberate alignment of human capital development with industrial and technological priorities, sustained investment in research and development, and cohesive institutional frameworks. For Indonesia, the central implication is that educational reforms must be systematically integrated with sectoral strategies in manufacturing and technology, ensuring that advances in skills and knowledge directly reinforce broader economic transformation.

3. Data and Methodology

3.1. Data

This study employs both primary qualitative data and secondary quantitative data to examine the relationship between human capital, innovation capacity, and economic performance in Indonesia. The mixed-method approach allows qualitative insights to contextualize and support the interpretation of quantitative findings.

Primary qualitative data were obtained through Focus Group Discussions (FGDs) and in-depth interviews involving stakeholders from academia, industry, and government. Participants included representatives from several institutions in West Java (Telkom University, SMAN 5, PEP Bandung, ITB, IPB, UI), Yogyakarta (UGM), and East Java (ITS, UNAIR, KEK Singhasari), as well as policy actors from the Ministry of Higher Education, Science, and Technology, the National Agency of Drug and Food Control (BPOM), and Intellectual Property rights practitioners. Such qualitative findings complement and contextualize the statistical results derived from the econometric model.

Secondary quantitative data were sourced from internationally recognized databases, including the World Bank World Development Indicators, Penn World Table (PWT) 10.01, OECD Statistics, World Health Organization (WHO), and the World Intellectual Property Organization (WIPO), covering multiple economies for the period 2010 – 2023. The Human Capital Index in this study is constructed using three proxy dimensions: (1) Education, represented by years of schooling and the rate of return to education (PWT/Barro-Lee); (2) Health, measured through stunting prevalence among children under five and adult survival rates (WHO/WB); and (3) Survival, captured by the under-five survival rate per 1,000 live births (World Development Indicators). In addition to the Human Capital Index, other variables utilized include GDP per capita, labour productivity, patent applications (innovation proxy), gross capital formation, trade openness, and foreign direct investment.

Table 3.1. The construction of the Human Capital Index in this study follows the methodological framework developed by Kraay (2018) under the World Bank's Human Capital Project. In this approach, the HCI aggregates three main components, such as education, health, and survival into a single index that measures the expected productivity of the next generation relative to a benchmark of complete education and full health. Specifically, education is proxied by learning-adjusted years of schooling, health by adult survival rates and stunting prevalence, and survival by the probability of reaching age five. This aggregation interprets each component in terms of its contribution to worker productivity, yielding an index that ranges from 0 to 1, where higher values indicate a greater share of potential human capital realized.

Table 3.1 Summary of Variables

No	Variable	Notation	Unit	Hypo	Source
1.	GDP per Capita	$GDPcapita_{it}$	US$ (constant, PPP)		WB/OECD
2.	Human Capital Index	HCI_{it}	Scale (0-1)	+	PWT, WHO, WB
3.	Productivity	$Productivity_{it}$	Output per worker/hour	+	WB/PWT
4.	Patent Applications	$Patent_{it}$	Application, resident	+	WIPO
5.	R&D Expenditures	$R\&D_{it}$	% of GDP	+	WB
6.	Gross Capital Formation	GCF_{it}	% of GDP	+/-	WB
6.	Foreign Direct Investment	FDI_{it}	% of GDP	+/-	WB
7.	Trade Openness	$Trade_{it}$	% of GDP, net inflows	+/-	WB

To address potential endogeneity, particularly between human capital and income levels, this study employs the Two-Stage Least Squares (2SLS) estimation technique. This approach allows for more consistent and unbiased parameter estimates by correcting simultaneity and omitted variable bias. The use of 2SLS has been well-established in empirical growth literature, especially in examining the causal relationship between institutions, human capital, and economic development (Acemoglu, Gallego, & Robinson, 2014); (Oketch, 2006). In this study, instrumental variables such as research expenditure, innovation inputs, and institutional quality

are employed to strengthen identification and ensure the robustness of the estimation results.

3.2. Variable Selection

Variable selection relies on established frameworks linking human capital, innovation, and development. GDP per capita acts as the dependent variable representing economic performance. The central explanatory variable is the Human Capital Index (HCI), capturing workforce productivity through education and health. Control variables include labour productivity (efficiency), Gross Capital Formation (domestic investment), Foreign Direct Investmentand trade openness. Innovation capacity is proxied by patent applications and R&D expenditures, reflecting both knowledge output and investment. Operational definitions are presented in Table 3.2.

Table 3.2 Variables Description

Variable	Notation	Description
GDP per Capita	GDPcapita	Average economic output per person, indicating living standards.
Human Capital Index	HCI	Measures education, health, survival, and skills quality of labour
Labor Productivity	Productivity	Output efficiency per worker or per hour worked
Patent applications, residents	Patent	Domestic patent applications, reflecting innovation
R&D Expenditures	R&D	Total spending on research and experimental development (Often measured as % of GDP)
Gross Capital Formation (% of GDP)	GCF	Investment in fixed assets as a share of GDP
Foreign Direct Investment, net inflows (% of GDP)	FDI	Net inflows of foreign capital relative to GDP
Trade (% of GDP)	Trade	Total exports and imports relative to GDP, showing openness

3.3. Model Spesification

To examine the impact of human capital on economic performance while addressing potential endogeneity concerns, this study employs a Two-Stage Least Squares (2SLS) panel-data estimation framework. The 2SLS estimator is chosen because it addresses the potential endogeneity between human capital and income levels by using exogenous instruments that influence human capital but do not directly affect economic performance (Wooldridge, 2010). This approach yields consistent estimates when simultaneity or reverse causality is suspected in the relationship between human capital and GDP per capita.

Endogeneity arises because higher levels of income may themselves improve educational attainment, health outcomes, and survival conditions, generating a bidirectional relationship between human capital and GDP per capita. To obtain consistent estimates, the Human Capital Index (HCI) is treated as an endogenous

regressor, while patent applications and R&D expenditures are used as instrumental variables. These instruments reflect innovation capacity and knowledge-based investments that shape human capital formation through education and skill upgrading, yet are plausibly exogenous to contemporaneous income shocks.

The first stage estimates the predicted component of human capital (HCI_{it}) as follows:

$$HCI_{it} = \alpha_0 + \alpha_1 Patent_{it} + \alpha_2 R\&D_{it} + \alpha_3 Productivity_{it} + \alpha_4 FDI_{it} + \alpha_5 GCF_{it} + \alpha_6 Trade_{it} + \mu_{it} \quad (1)$$

where HCI_{it} is the Human Capital Index for country i in year t, and $Patent_{it}$ and $R\&D_{it}$ capture innovation-driven knowledge accumulation. Patent applications and R&D expenditures are expected to be relevant instruments because they proxy innovation capacity and knowledge creation that contribute to human capital formation, but they should not affect GDP per capita except through their impact on human capital. Instrument relevance and strength are evaluated using first-stage F-statistics (Cragg–Donald and Kleibergen–Paap statistics), while over-identification validity is assessed using Hansen's J-test.

The second stage then uses the predicted value of human capital, $\widehat{HCI_{it}}$ to estimate its causal effect on economic performance:

$$GDPcapita_{it} = \beta_0 + \beta_1 \widehat{HCI}_{it} + \beta_2 Productivity_{it} + \beta_3 FDI_{it} + \beta_4 GCF_{it} + \beta_5 Trade_{it} + \varepsilon_{it} \quad (2)$$

where ln ($GDPcapita_{it}$) denotes the natural logarithm of GDP per capita, ($\widehat{HCI_{it}}$) is the instrumented human capital measure obtained from Equation (1), and the remaining variables control for production efficiency, external capital flows, investment accumulation, and openness to international trade. This specification employs a fixed-effects panel 2SLS framework with clustered standard errors to isolate causal effects by correcting for endogeneity and unobserved heterogeneity, though its robustness relies on instrument validity and linearity assumptions.

3.4. Instrument Validity and Limitations

While patent applications and R&D expenditures are theoretically relevant as instruments for human capital that capturing innovation-driven knowledge accumulation and incentives for skill upgrading, they may also be indirectly correlated with income through channels other than HCI. Higher-income economies tend to spend more on R&D and generate more patents, which in turn can affect GDP per capita directly via productivity and export competitiveness. To mitigate this concern, the empirical includes productivity, foreign direct investment, capital formation, and trade openness as controls, and exploits the panel dimension with country fixed effects to net out time-invariant structural differences. Nonetheless, the exclusion restriction cannot be tested directly and must be interpreted as an identifying assumption supported by the diagnostic tests. Therefore, should be viewed as indicative of the strength and direction of the human capital and growth relationship, rather than as mechanically precise point estimates.

4. Results / Analysis

4.1. The Existing Economic Conditions of Indonesia: A Comparative Analysis of Income, Human Capital, Productivity, and Innovation

4.1.1. The Development of GDP per Capita in (ASEAN+3) Countries

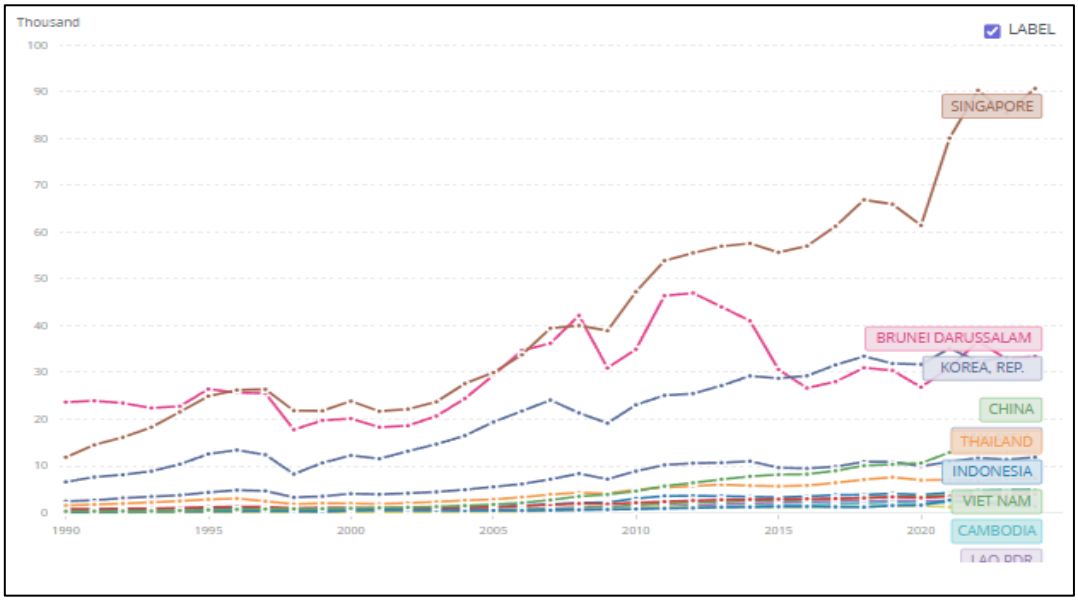

Figure 4.1 Trends in GDP per Capita (log Scale) among ASEAN+3 Countries
Source: World Bank (1990-2024)

Indonesia's GDP per capita has experienced a steady upward trajectory over the past thirty years, with the 1998 Asian Financial Crisis representing the sole major disruption. This growth has positioned Indonesia at the midpoint of the ASEAN+3 income distribution, situated between higher-performing economies such as Malaysia, Thailand, and China, and lower-income countries including Cambodia, Lao PDR, and Myanmar. Yet, the persistent disparity with advanced economies like South Korea and Singapore underscores the incomplete nature of Indonesia's convergence and highlights the structural challenges that continue to impede its transition toward high-income status.

Table 4.1 frames the comparative trajectories of countries by the duration spent within each income category, providing a lens through which to assess vulnerability to the middle-income trap. As of 2024, Indonesia has only recently entered Upper-Middle Income status ($4,925.43), following a protracted 36-year period in the Lower-Middle Income bracket and just 3 years in its current category. This extended progression stands in contrast to the more rapid and transformative paths taken by Malaysia ($11,867.26) and China ($13,303.15), both of which have achieved high-income status through sustained structural upgrading. Thailand's transition, completed after 21 years in the Upper-Middle Income range, further illustrates the importance of dynamic economic transformation. In contrast, Vietnam ($4,717.29) remains in a similar position to Indonesia, though its recent momentum may signal an earlier escape. The persistence of Indonesia in lower income categories points to underlying weaknesses in growth dynamics and underscores the need for accelerated, coordinated reforms to catalyze the transition to high-income status.

Table 4.1 MIT Classification South-East Asia Country + South Korea & China

Country	GDP pc 2024	Class	No. of years (1950-2024)				Status		Total
			L	LM	UM	H	LMIT	UMIT	MIT
Indonesia	4925.43	UM	36	36	3	0	✓		✓
Viet Nam	4717.29	UM	52	22	1	0			
Malaysia	11867.26	UM	19	27	15	0		✓	✓
Brunei Darussalam	33417.84	H	1	7	0	51			
Cambodia	2627.88	LM	55	19	0	0			
Lao PDR	2123.98	LM	61	14	0	0			
Myanmar	1359.26	LM	54	21	0	0			
Philippines	3984.83	LM	27	48	0	0	✓		✓
Singapore	90674.07	H	0	28	10	37			
Thailand	7345.14	UM	26	28	21	0		✓	✓
Timor-Leste	1343.15	LM	23	12	0	0			
China	13303.15	UM	42	17	16	0		✓	✓
South Korea	33121.37*	H	19	19	7	29			

***Note: South Korea's GDP per Capita for 2024 does not exist, so the previous year 2023 was used.**

Table 4.2 provides a stark contrast, illustrating the swift transitions of high-income economies. Countries like Japan and Israel treated middle-income status as a brief transitional phase; Japan, for instance, spent only 9 years in the Upper-Middle income category before reaching high-income status. Conversely, Indonesia's 36-year tenure in the Lower-Middle bracket and sluggish entry into the Upper-Middle category highlights a lack of upward momentum. This prolonged stagnation underscores the structural difficulty of escaping the trap compared to advanced economies that successfully leveraged innovation and industrial policy to accelerate their ascent.

Table 4.2 MIT Classification for High-income Countries

Country	GDP pc 2024	Class	No. of years (1950-2024)			
			L	LM	UM	H
Japan	32475.89	H	1	17	9	48
USA	85809.90	H	0	0	12	63
Israel	54176.68	H	0	19	17	39
Switzerland	103669.87	H	0	0	9	66
Sweden	57723.23	H	0	4	14	57
Austria	56833.20	H	0	14	12	49
Belgium	55954.61	H	0	11	12	52
France	46150.49	H	0	10	11	54
United Kingdom	52636.79	H	0	3	20	52
Czechia	31706.62	H	0	0	16	19
Canada	54282.62	H	0	0	19	56
Hungary	23310.75	H	0	51	10	8
Netherlands	68218.73	H	0	5	15	55

4.1.2. Productivity, Human Capital, and Innovation

Escaping the middle-income trap requires sustained productivity growth driven by innovation, as countries failing to enhance efficiency struggle to transition to high-income levels (Tuncel & Gursel, 2016). Indonesia's productivity has followed a gradual upward trend, driven primarily by factor accumulation rather than substantial improvements in efficiency or technology. This modest trajectory lacks the transformative momentum needed for high-income transition, causing the gap with high-performing peers to widen.

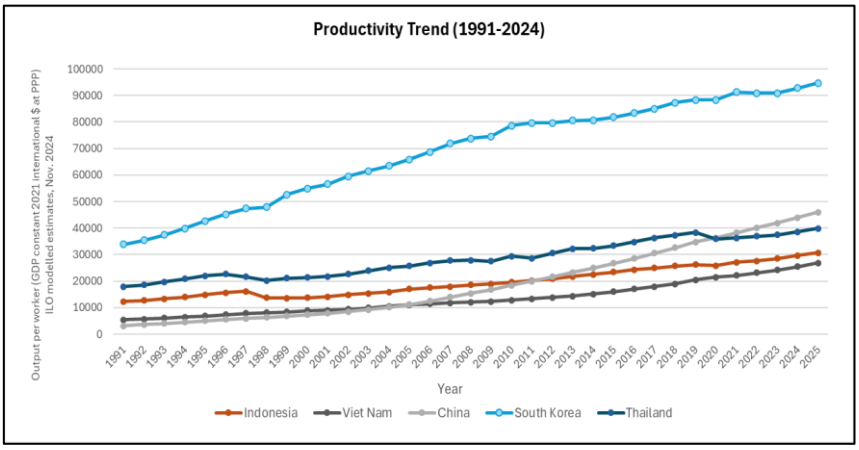

Figure 4.2 Trends in Productivity of Indonesia and Lesson Learned Countries
Source: International Labour Organization - ILOSTAT (1991-2024)

In contrast, South Korea has surged dramatically, reaching productivity levels of nearly $90,000 per worker by 2024 through a successful transition into high-tech industries. China overtook Indonesia in the early 2000s via rapid export-led industrialization and upskilling , while Vietnam has demonstrated impressive growth driven by FDI and global value chain integration. Meanwhile, Thailand shows signs of plateauing, with slowed momentum relative to its regional peers. Without bold reforms to enhance innovation and technological adoption, Indonesia risks remaining trapped in the upper-middle-income bracket. Furthermore, productivity does not exist in isolation; it rests on a foundation of human capital. As demonstrated by South Korea and China, rapid productivity gains require antecedent investments in education and workforce quality.

Indonesia's Human Capital Index (HCI) remains the lowest among the lesson-learned countries, consistently lagging behind Vietnam, Thailand, China, Malaysia, and South Korea. While modest annual improvements (0.41%–0.47%) were recorded between 2016 and 2019, the onset of the COVID-19 pandemic in 2020 triggered a sharp contraction of -0.52%. This negative trend persisted through 2021–2024, with growth fluctuating between -0.69% and -0.82%, signaling enduring weaknesses in education quality and health services during the post-pandemic recovery.

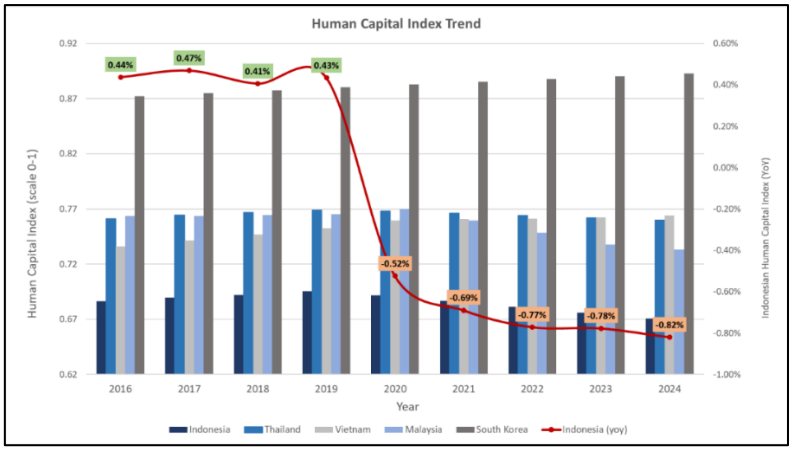

Figure 4.3 Trends in Human Capital Index of Indonesia, Lesson-Learned Countries
Source: World Bank, processed (2016-2024)

Based on previous studies, innovation is a critical factor for escaping the middle-income trap, with patent activity serving as a key indicator of a country's capacity to commercialize ideas. Indonesia's patent application rate remains the lowest among the comparison group, consistently trailing behind Vietnam, Thailand, and significantly outpaced by China and South Korea. While Indonesia showed early momentum with 10.87% growth in 2017, this was unsustainable, followed by sharp contractions in 2018 (-6.20%) and 2020 (-10.70%), indicating a lack of resilience.

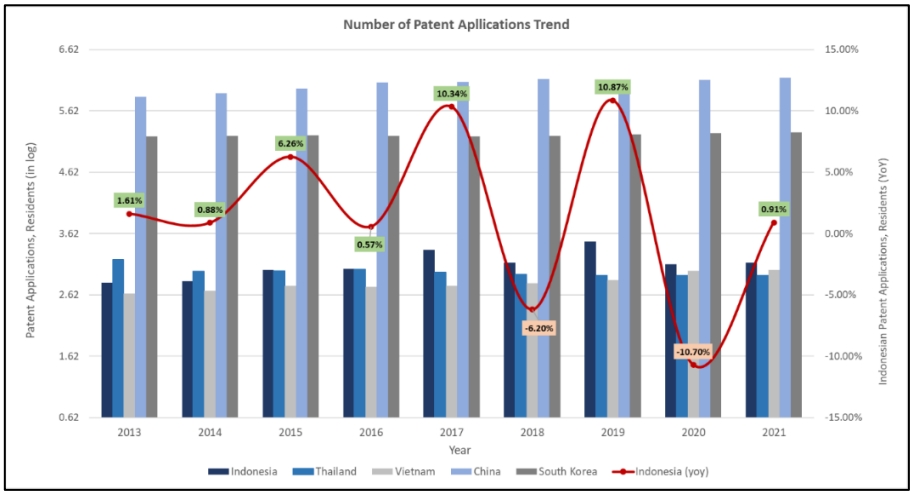

Figure 4.4 Trends in Number of Patents of Indonesia and Lesson Learned Countries
Source: World Intellectual Property Organization - WIPO (2013-2021)

In contrast, South Korea and China demonstrate robust, sustained growth driven by mature innovation ecosystems and large-scale R&D investment. Even Vietnam and Thailand exhibit steadier upward trajectories, reflecting stronger institutional alignment. The persistent gap highlights Indonesia's weak institutional support, limited R&D funding, and low capacity to translate research into commercially viable technologies.

To examine the relationship between income performance and its drivers, Appendix 1.2 plots productivity, Human Capital Index (HCI), and patent applications against GDP per capita. Across all three dimensions, Indonesia consistently falls below the linear fit line, indicating that its underlying growth drivers are underperforming relative to its current income level. Specifically, Indonesia's

productivity is lower than expected, suggesting structural inefficiencies, whereas countries like South Korea and Singapore exhibit more efficient growth. Similarly, Indonesia's HCI trails the trend line, reflecting gaps in workforce readiness, in stark contrast to Vietnam, which achieves better human capital outcomes at a similar income level. Finally, the innovation gap is most pronounced; Indonesia produces significantly fewer patents than expected, ranking among the lowest performers in the region, while innovation leaders like China and South Korea demonstrate strong alignment between innovation output and income. This consistent deviation from the trend line suggests Indonesia's economic foundation is fragile, reinforcing its vulnerability to the middle-income trap.

4.2. The Relationship Between Human Resource Indicators, Innovation, Productivity, and the Risk of a Middle-Income Trap in Indonesia

4.2.1. Overview and Estimation Framework

Building on the descriptive findings, this section employs a Two-Stage Least Squares (2SLS) framework to quantify the causal linkages explaining Indonesia's vulnerability to the middle-income trap. To address endogeneity between income and human capital, the model utilizes patent applications and R&D expenditures as instrumental variables, representing exogenous innovation inputs that drive human capital accumulation without being directly affected by contemporaneous income shocks. The estimation proceeds in two stages: first, predicting the Human Capital Index (HCI) based on innovation and control variables (productivity, FDI, GCF, trade openness); and second, regressing the instrumented HCI on GDP per capita. The analysis concludes with diagnostic checks and a heterogeneity test using a "lesson-learned countries" dummy to benchmark against successful regional transitions.

4.2.2. Main Model Estimation Results

The results of the main 2SLS model highlight the pivotal roles of innovation and productivity in shaping human capital and, through it, economic growth.

Table 4.3 First-Stage Estimation Results for the Determinants of Human Capital (Instrumental Variable Regression)

VARIABLES	(1) Human Capital index*
Patent (in log)	**0.0685****
	(0.0338)
RnD Expenditures	**0.172*****
	(0.0251)
Productivity (in log)	0.863***
	(0.119)
Gross Capital Formation	-0.130***
	(0.0234)
Foreign Direct Investment	0.0981
	(0.104)
Trade	-0.00364***
	(0.000742)
Observations	317
Number of id	23
R-squared	0.455

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

As detailed in Table 4.3, both patent applications (β =0.0685) and R&D expenditures (β =0.172) emerge as statistically significant determinants of human capital1, confirming that innovation investments drive skill enhancement through knowledge spillovers. Productivity also exerts a dominant positive influence (0.863, p < 0.01). Conversely, gross capital formation (-0.130) and trade openness (-0.0036) exhibit significant negative relationships3, implying that factor accumulation and economic openness alone fail to enhance human capital without supportive innovation systems.

Table 4.4 Second-Stage Estimation Results of the 2SLS Model: The Impact of Human Capital on Economic Performance

VARIABLES	(1) GDP capita (in log)
Human Capital index	**0.269****
	(0.121)
Productivity (in log)	**0.846*****
	(0.177)
Gross Capital Formation	**0.0754*****
	(0.0235)
Foreign Direct Investment	-0.0833
	(0.0623)
Trade	0.000472
	(0.000754)
Observations	317
Number of id	23
R-squared	0.580

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The second-stage results (Table 4.4) confirm that human capital causally drives economic performance, with the instrumented HCI showing a significant positive coefficient (0.269, p < 0.05). Productivity exerts the dominant influence (0.846, p < 0.01), serving as the primary transmission channel linking education to output, while gross capital formation contributes positively but to a lesser extent (0.0754, p < 0.01). Conversely, the statistical insignificance of FDI and trade openness implies that external inflows do not automatically generate growth without the domestic absorptive capacity rooted in innovation and skilled human resources.

Table 4.5 Instrument Validity Test Table for 2SLS Estimation (Main Model)

Validation Test	Statistic	Value	P-value
Underidentification (Kleibergen–Paap LM)	Chi-sq (2)	24.49	0.0000
Weak Identification (Kleibergen–Paap F)	F	19.93	-
Stock–Yogo Critical Value (10% maximal IV size)	F (critical)	19.93	-
Overidentification (Hansen J)	**Chi-sq (1)**	**2.458**	**0.1169**

The validity of the instrumental variables is verified through diagnostic, The Kleibergen–Paap LM test ($x^2 = 24.49$, $p < 0.01$) rejects the null of under-identification, confirming the model is properly identified. The Kleibergen–Paap F-statistic (19.93) exceeds the Stock–Yogo critical value, ruling out weak instrument bias. Finally, the Hansen J-test ($x^2 = 2.458$, $p = 0.1169$) fails to reject the null of instrument exogeneity, confirming that the selected instruments are valid and uncorrelated with the error term. Together, these diagnostics ensure that the estimated coefficients can be interpreted as causal relationships rather than mere correlations.

4.2.3. Heterogeneity Test: Lesson-Learned Countries and Structural Contrasts

To capture structural differences in the innovation-human and capital-growth relationship, a heterogeneity test employs a dummy variable for "learning countries" (South Korea, China, Malaysia, Thailand, Vietnam).

Table 4.6 2SLS IV Regression First-Stage for Instrument Variables Using Lesson-Learned Country Dummy

VARIABLES	(1) Human Capital index
Patent (in log)	**0.0623***** **(0.0197)**
RnD Expenditures	**0.168***** **(0.0119)**
Productivity (in log)	0.670*** (0.0508)
Gross Capital Formation	-0.0710*** (0.00760)
Foreign Direct Investment	0.287*** (0.0986)
Trade	0.000443 (0.000325)
Observations	56
Number of id	4
R-squared	0.979

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The first-stage results (Table 4.6) demonstrate stronger relationships than the main model, with patent applications ($\beta = 0.0623$, $p < 0.01$) and R&D expenditures ($\beta = 0.168$, $p < 0.01$) explaining nearly all variance in human capital ($R^2 = 0.979$). This indicates that in innovation led economies, robust institutional linkages enable the efficient transformation of innovation into human capital accumulation.

Table 4.7 2SLS IV Regression Second-Stage for GDP per Capita (Lesson-Learned Countries Dummy Model)

VARIABLES	(1) GDP capita (in log)
Human Capital index	**0.438**** **(0.170)**
Productivity (in log)	**0.820***** **(0.193)**

VARIABLES	(1) GDP capita (in log)
Gross Capital Formation	0.0308
	(0.0199)
Foreign Direct Investment	**0.340*** **
	(0.106)
Trade	0.000109
	(0.000586)
Observations	56
Number of id	4
R-squared	0.964

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The second-stage results (Table 4.7) confirm that returns to human capital are higher in mature systems (β = 0.438, p < 0.05). Productivity remains the dominant driver (β = 0.820, p < 0.01), while Foreign Direct Investment becomes significant (β = 0.340, p < 0.01), implying that FDI contributes to growth only when supported by advanced absorptive capacity.

Table 4.8 Instrument Validity Test Table for Lesson-Learned Countries Model

Validation Test	Statistic	Value	P-value
Underidentification (Kleibergen–Paap LM)	Chi-sq (2)	7.283	0.0262
Weak Identification (Kleibergen–Paap F)	F	107.19	-
Stock–Yogo Critical Value (10% maximal IV size)	F (critical)	19.93	-
Overidentification (Hansen J)	**Chi-sq (1)**	**1.103**	**0.2937**

Instrument validity is confirmed in Table 4.8, where the Kleibergen–Paap F-statistic (107.19) indicates strong instruments and the Hansen J-test (p = 0.2937) supports exogeneity, validating that the divergence between Indonesia and these peers stems from genuine institutional differences.

4.3. The Relationship Between Human Resource Indicators, Innovation, Productivity, and the Risk of a Middle-Income Trap in Indonesia

Qualitative evidence from multi-regional Focus Group Discussions (FGDs) and institutional visits provides a nuanced understanding of the systemic constraints shaping Indonesia's human capital and innovation landscape. Unlike quantitative analysis, stakeholder narratives illuminate real-world frictions and institutional bottlenecks, revealing a consistent pattern: the national ecosystem is fragmented, weakly coordinated, and structurally misaligned from foundational education to research commercialization.

4.3.1. Fragmented Human Capital Formation: Systemic Misalignment from Schooling to Workforce

Stakeholders emphasize that Indonesia's human capital formation suffers from deep structural fragmentation. At the secondary level, a fundamental contradiction exists between the Ministry of Education's Kurikulum Merdeka, which promotes flexible, individualized learning pathways—and the rigid subject prerequisites of public university (PTN) admissions. SMAN 5 Bandung noted that students narrowing their focus utilizing the curriculum's flexibility often face strategic disadvantages in PTN entrance exams that still demand broad subject mastery. Additionally, the Zoning System (Sistem Zonasi), while intended to democratize access, has inadvertently reduced competition and created heterogeneous student quality, complicating academic mobility.

This misalignment persists in higher education. Engineering-focused institutions like ITS and Telkom University report that while students excel technically, they lack complementary "soft skills" (business literacy, leadership) required by innovation industries. Furthermore, labour market conditions incentivize a "brain drain" toward low-innovation sectors (e.g., banking, civil service), draining the R&D talent pipeline. In vocational education, employers' preference for S1 degrees over D3 graduates undermines the Vocational Education Revitalization agenda, discouraging applied training tracks.

4.3.2. Weak Technology and Innovation Ecosystems: Structural Bottlenecks in R&D Capacity, Patent Generation, and Technology Diffusion

This misalignment persists in higher education. Engineering-focused institutions like ITS and Telkom University report that while students excel technically, they lack complementary "soft skills" (business literacy, leadership) required by innovation industries. Furthermore, labour market conditions incentivize a "brain drain" toward low-innovation sectors (e.g., banking, civil service), draining the R&D talent pipeline. In vocational education, employers' preference for S1 degrees over D3 graduates undermines the Vocational Education Revitalization agenda, discouraging applied training tracks.

Although Kemendiktisaintek has introduced demand-driven schemes like Ajakan Industri (matching funds) to ensure industries serve as off-takers, stakeholders emphasize that the ecosystem remains underdeveloped. The lack of a unified governance framework across ministries raises transaction costs, creating a "valley of death" where prototypes fail to reach commercialization due to the absence of multi-year funding models and industrial co-development.

4.3.3. Commercialization and Industry Absorption Failures: The Missing Link in Indonesia's Innovation Chain

The failure to bridge the university–industry divide represents a critical loss of economic value. Industry actors often perceive academic research as competition rather than collaboration. Conversely, universities struggle with cumbersome licensing procedures and a lack of commercial expertise in Technology Transfer Offices (TTOs). The case of Universitas Indonesia (UI) illustrates these friction points. Despite having advanced internal systems like the Intellectual Property Information System (IPIS) and a Royalty-Sharing Regulation (70:30 split favoring inventors), UI reports a commercialization conversion rate of less than 1% (approx. 80 licensed out of 10,000+ assets). Uncertainty regarding market adoption and regulatory requirements stalls progress. While the government's KSTI 2025 (National Science and Technology Index) mandate attempts to articulate systemic solutions, implementation gaps remain vast, and initiatives like KEK Singhasari's

crowdfunding proposals remain isolated examples rather than integrated national norms.

4.3.4. Structural Constraints Beyond Education and Technology: Governance, Coordination, and Nutritional Foundations

Constraints extend beyond the classroom and laboratory. Stakeholders from BPOM and ministries highlighted National Stunting Reduction efforts, noting that Indonesia's HCI of 0.54 reflects persistent health deficits that irreversibly impair cognitive potential. Furthermore, governance fragmentation is cited as a major hurdle. Despite the proliferation of Science Techno Parks (STP) and entrepreneurship programs at universities, these initiatives often operate in silos. There is a noted absence of an integrated national talent strategy coordinating the Ministry of Education, Ministry of Industry, and Ministry of Manpower, preventing bottom-up institutional creativity from catalyzing broader structural transformation.

4.3.5. Human Capital as a Necessary but Insufficient Driver of Innovation-Led Growth

The qualitative insights confirm that human capital, while essential, is not independently transformative. Indonesia faces a "Human Capital Paradox" where increased educational attainment does not translate into proportional productivity gains due to systemic barriers. The challenge lies not merely in producing skilled graduates, but in constructing a cohesive ecosystem capable of converting skills into technological learning and industrial upgrading. Without addressing the misalignment in curriculum, funding rigidity, and commercialization failures, Indonesia risks maintaining an equilibrium of abundant but underutilized talent, a defining characteristic of the middle-income trap.

4.3.6. Structural Challenges in Indonesia's Intellectual Property and Commercialization Ecosystem

A critical systemic challenge identified by practitioners is the persistent weakness in Indonesia's intellectual property (IP) governance. Stakeholders note that IP is often treated as an administrative formality rather than a strategic economic asset, reinforcing a structural bias toward physical rather than cognitive assets. This is compounded by weak enforcement capacity within the Directorate General of Intellectual Property (DJKI) and the absence of transparent appeals mechanisms in regulatory bodies like BPOM, which creates heightened uncertainty and disincentivizes high-risk innovation.

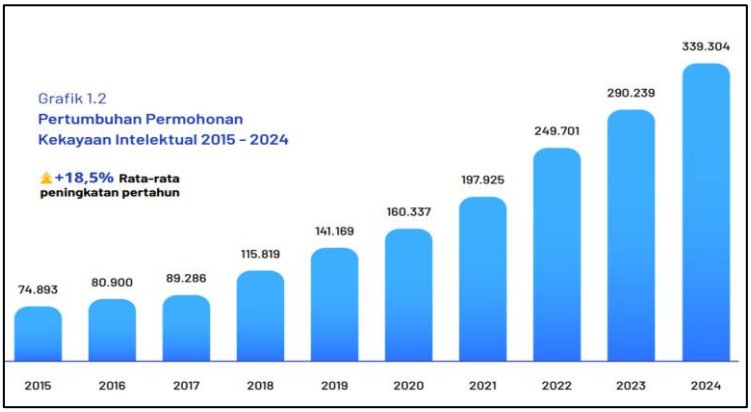

Figure 4.5 Growth of Intellectual Property Applications in Indonesia 2015-2024

Source: The Book "Satu Dekade Kekayaan Intelektual dalam Angka" by the Directorate General of Intellectual Property (DJKI)

Furthermore, a systemic mismatch exists between university-generated patents and industry needs. Many academic patents are produced to meet promotion metrics or grant requirements rather than to address demand-driven technological challenges, resulting in a low commercialization rate and high maintenance costs for unutilized assets. The ecosystem also suffers from market failures in IP financing, particularly the lack of a secondary market for IP assets and the reluctance of banks to accept IP as primary collateral. Combined with an industrial base dominated by low-complexity sectors (e.g., food, herbal products), these constraints trap technologies at the prototype stage and hinder the development of a knowledge-driven economy.

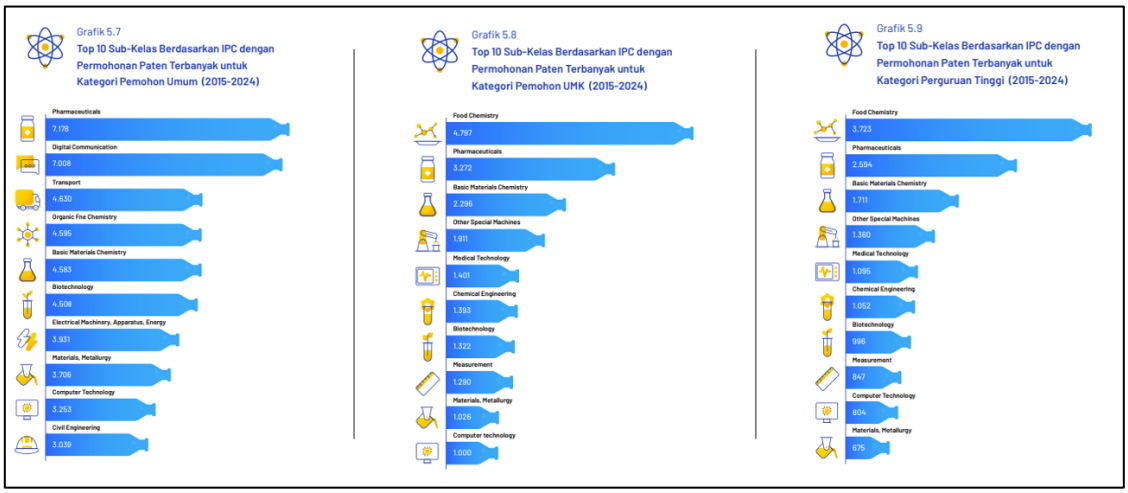

Figure 4.6 Top 10 IPC Sub-Classes with the Highest Number of Patent Applications for General Applicants, MSMEs, and Higher Education Institutions (2015–2024)

Source: The Book “Satu Dekade Kekayaan Intelektual dalam Angka” by the Directorate General of Intellectual Property (DJKI)

4.3.7. Fiscal Fragmentation and the "Budgetary Illusion" of the 20% Mandate

Qualitative evidence reveals a significant "budgetary illusion" within the 20% education mandate, which serves as a poor proxy for actual research and development (R&D) and high-level human capital investment. As illustrated in the Indonesian Paradox (Appendix 1.3), there is a profound disconnect between the constitutional requirements for the education sector and the reality of Indonesia's innovation output, where the actual Gross Expenditure on R&D (GERD) remains alarmingly low at only 0.28% of GDP. This illusion stems from deep sectoral fragmentation where the budget is increasingly diverted toward non-pedagogical social transfers and basic educational access, including the School Operational Assistance (BOS) and funding for religious institutions (Pesantren) rather than innovation-driven investment. Consequently, the 20% share of APBN acts as an ineffective metric for R&D capacity, as it encompasses broad social safety nets and routine expenditures that do not translate into technological upgrading or competitive intellectual capital.

Furthermore, the research gap is exacerbated by the misallocation of funds toward Higher Education Institutions (PTK) operated by various ministries, which prioritize bureaucratic vocational training over the fundamental research required for global competitiveness. This creates a funding tension with major public universities (PTN) like UI and ITB, which are expected to compete in global rankings despite lacking the dedicated research capital found in advanced economies. Unlike advanced "lesson-learned" economies where innovation is bolstered by significant private sector participation and research foundations, Indonesia remains dependent

on a top-down state budget that has seen no substantial structural changes despite ongoing policy arguments. Failure to structurally decouple dedicated R&D funding from routine operational costs results in systemic consequences, including potential brain drain, persistent skills mismatches, and a continued dependency on foreign technology, thereby hindering Indonesia's future competitiveness.

5. Implication / Policy Recommendation

5.1. Strengthening Human Capital Quality and Alignment Across the Education Pipeline

To resolve the structural disconnect between secondary education flexibility (Kurikulum Merdeka) and rigid university admissions, the establishment of a National Skills and Competency Framework is essential. This framework should define standardized micro-credentials, such as Data Literacy and Basic Coding, that universities are mandated to accept as valid prerequisites, thereby validating the competency-based approach of the new curriculum. Aligning with this recommendation, Kemendiktisaintek has currently begun aggressively expanding micro-credential programs, though integration with university admission criteria requires stronger regulatory enforcement. Furthermore, to address the STEM infrastructure deficit, a "National Digital Education Partnership" must be launched, offering tax incentives for private sector adoption of public schools. This initiative moves beyond sporadic CSR by ensuring multi-year commitments for hardware and teacher training, creating a sustainable model for technological readiness.

Simultaneously, revitalizing vocational education requires a "prestige-building" strategy to dismantle the systemic bias favoring academic degrees (S1) over vocational tracks (D3/D4). This entails mandating equal starting salaries and promotion tracks for vocational graduates within the civil service (ASN) and state-owned enterprises (BUMN), alongside rebranding institutions as "Polytechnic Institutes of Excellence" with rigorous aptitude-based entry standards. Consistent with this strategic direction, the government is currently assessing the upscaling of polytechnics into "Polytechnic Universities" to elevate their institutional reputation and capacity. By synchronizing these structural reforms with labor market incentives, Indonesia can effectively shift from a degree-oriented to a competency-based human capital pipeline.

5.2. Expanding Innovation Capacity Through R&D Reform and Long-Horizon Funding Mechanisms

To overcome innovation stagnation caused by short-term funding cycles, the national research architecture must undergo a fundamental redesign that supports long-horizon breakthroughs, directly operationalizing Asta Cita 4 (human capital mastery) and Asta Cita 5 (industrial downstreaming). This requires transitioning the National Research and Innovation Agency (BRIN) and the Ministry of Education from annual budget cycles to multi-year, mission-oriented "Grand Challenge" grants (3-5 years). These grants should target national priorities, such as food security and renewable energy, and be awarded exclusively to university-industry consortiums to enforce collaboration. Complementing this, the government must address the infrastructure deficit by establishing "National Shared Research Facilities" for high-cost technologies (e.g., biotechnology, advanced materials, AI). By democratizing access to specialized equipment through a competitive proposal system, these facilities will serve as collision spaces for academic and industrial researchers, fostering deep-tech innovation that no single entity could fund alone.

Simultaneously, fiscal incentives for private sector R&D require urgent streamlining to unlock their potential. The existing 300% Super Tax Deduction remains underutilized due to bureaucratic barriers, reforms must shift from complex cost-auditing to a simplified, online activity-verification model. To further stimulate the collaborative ecosystem, this incentive should be tiered, offering an enhanced rate (e.g., 350%) specifically for R&D conducted in partnership with domestic universities or polytechnics. The government is currently acknowledging these administrative hurdles and has initiated dialogues with industry associations (APINDO/KADIN) to simplify compliance procedures, aiming to increase the fiscal participation of the private sector in the national innovation agenda.

5.3. Closing the University-Industry Gap and Accelerating Commercialization (Hilirisasi)

To bridge the "valley of death" separating university prototypes from market viability, a key bottleneck in realizing Asta Cita 5 that structural incentives must force collaboration between academia and the private sector. A central recommendation is the institutionalization of a National "Innovation Voucher" Program, providing SMEs with vouchers (Rp 100-500 million) to purchase R&D services from universities. This demand-driven mechanism empowers SMEs while creating a revenue stream for research institutions. Consistent with this direction, the Directorate General of Research and Development (Ditjen Risbang) has currently designated Innovation Vouchers and matching funds as priority programs, though scaling these requires broader fiscal integration. Complementing this, the Ministry of Education must mandate and fund "Professor of Practice" roles to embed industry veterans within universities, ensuring that academic curricula and research agendas remain tethered to real-world industrial problems.

Furthermore, university Technology Transfer Offices (TTOs) require a fundamental transformation from passive administrative units into proactive "Venture Studios." This entails a radical shift in incentives: TTOs should be evaluated based on licensing revenue and spin-off creation rather than administrative patent filings. To operationalize this, TTOs must be staffed by business professionals and equipped with dedicated seed funds to take equity stakes in university spin-offs. This structure aligns institutional incentives with commercial success, turning universities into active engines of business creation rather than mere repositories of intellectual property.

5.4. Building an Integrated National Talent and Innovation Strategy Through Stronger Institutional Coordination

To overcome the governance fragmentation that hinders Asta Cita 3 (high-quality employment) and Asta Cita 4 (human capital acceleration), Indonesia requires a centralized authority to enforce a unified strategy. The establishment of a "National Council for Productivity and Innovation," chaired by the President, is proposed to set binding 5-year targets and resolve inter-ministerial conflicts, such as the disconnect between secondary curriculum reforms and university admissions. While the government has initiated coordination efforts through the formation of a Downstreaming Task Force (Satgas Hilirisasi) under Kemenko PMK (targeted for 2026), a permanent, high-level council involving the Ministers of Finance, Education, Industry, and the Central Bank Governor is necessary to ensure these strategic alignments are institutionalized beyond ad-hoc task forces.

To address real-time labor market mismatches, this Council must commission a "National Digital Talent Mobility Platform." This AI-powered marketplace would integrate data from universities, industry associations (KADIN/APINDO), and

certification bodies (BNSP) to map skill gaps and career pathways. It is noted that the Directorate of Talent at Kemendiktisaintek is currently developing a similar mobility platform; however, its scope is presently limited to researchers and lecturers. The recommendation is to significantly expand this existing initiative into a comprehensive national workforce tool, allowing policymakers and educational institutions to adapt curricula instantly based on live industrial demand data.

5.5. Strengthening Indonesia's Intellectual Property Governance and Commercialization Ecosystem

To transform Indonesia's intellectual property (IP) system from a passive administrative registry into an active economic enabler, governance must be reoriented toward dispute resolution and commercial incentives. A critical step is establishing an independent "Regulatory and IP Ombudsman" to issue binding decisions on regulatory delays and inter-agency contradictions, ensuring a clear path for innovators. This institutional reform would complement the government's ongoing Innovation Sandboxing initiatives, which currently seek to provide regulatory flexibility for new technologies. Simultaneously, academic incentives must shift from "publish or perish" to "innovate and implement" by introducing "Commercialization Viability Scores" for grants and weighing licensed patents or spin-offs equally with high-impact journals in promotion criteria. This aligns with the Directorate General of Research and Development's (Ditjen Risbang) recent strategic pivot, which has explicitly elevated 'innovation products' alongside publications as key performance indicators for higher education institutions.

To bridge the financing gap for intangible assets, the government should partner with the private sector to launch a "National IP Commercialization Fund." Modeled on South Korea's public-private partnership framework, this fund would professionalize IP valuation, provide scale-up financing against equity or royalties, and create a secondary market for IP acquired from defaulted loans to prevent them from becoming "dead assets." While current programs like Matching Funds support collaborative projects, a specialized financial vehicle is required to de-risk IP-based lending and deepen the capital market for technology assets, ensuring that intellectual property functions as a tradable and bankable economic instrument.

5.6. Cultivating a Grassroots Innovation Pipeline: The Strategic Role of Bank Indonesia

To complement top-down ministerial reforms, Bank Indonesia is uniquely positioned to cultivate a "bottom-up" innovation pipeline by leveraging its regional network (Kantor Perwakilan Dalam Negeri - KPwDN) to operationalize the grassroots economic development of Asta Cita 6. This strategy entails transforming existing sporadic hackathons into a continuous "BI Innovation League," where challenge themes are co-designed with regional industries to address real economic friction points such as agricultural volatility or green technology adoption. To ensure sustainability, participation should be institutionalized as academic credit within university partnerships, with winning prototypes receiving structured incubation and pilot opportunities with state-owned enterprises (BUMN), thereby shifting the focus from short-lived competition enthusiasm toward tangible economic implementation.

Simultaneously, the Riset Grant Bank Indonesia (RGBI) must be reoriented from funding purely theoretical work to supporting commercialization. A dedicated "Hilirisasi Grant" track should be established to finance patent filings and prototype refinement for research that has already validated its market fit, prioritizing proposals with explicit industry partners. Furthermore, to capture the value of this

human capital, BI should systematize its support into a "BI Scholars" database, registering high-potential researchers for recruitment by major financial institutions (BI, OJK, LPS). By aligning regional research agendas with local economic challenges and creating a vetted talent pool, Bank Indonesia can effectively build a sustainable human capital ecosystem that directly solves the nation's pressing economic problems.

5.7. Reforming the Fiscal Mandate for Strategic Separation between R&D and Social Welfare and Routine Expenditures

To effectively address the middle-income trap, Indonesia must undertake a fundamental policy shift by redefining the constitutional 20% education mandate, which currently serves as a misleading proxy for research and development (R&D) investment. Qualitative analysis highlights a significant "budgetary illusion" where the 20% allocation is diluted by a fragmented mix of expenditures that do not directly support high-level innovation or pure education. This include the integration of School Operational Assistance (BOS) and funding for religious institutions (Pesantren) into the education share, which functions more as a top-down social transfer rather than a strategic investment in human capital. Furthermore, the inclusion of Perguruan Tinggi Kedinasan (PTK) within this mandate creates a fiscal bias, as these funds are utilized for bureaucratic training rather than the fundamental research necessary for global university competitiveness. Consequently, while public research universities (PTN) are expected to compete in global rankings, they face a severe funding gap because the 20% mandate remains structurally unchanged despite various fiscal arguments from authorities.

The central recommendation of this study is the structural decoupling of dedicated R&D funding from routine educational and social welfare expenditures. Indonesia must transition toward a fiscal model that prioritizes an explicit and increased budget for pure research, ensuring that innovation funding is no longer absorbed by administrative overhead or routine operational costs. To mirror the success of advanced innovation-led economies, the government must foster an "incentive-driven" ecosystem that shifts the R&D financial burden from a purely top-down state budget to one heavily supported by the private sector and specialized research foundations. By establishing a distinct, protected mandate for research that is separate from basic education and bureaucratic training, Indonesia can ensure that its human capital development is directly translated into the high-tech industries and technological breakthroughs required to drive productivity and achieve high-income status.

6. Conclusion and Further Research

This study concludes that Indonesia's vulnerability to the middle-income trap is not merely a result of isolated deficits in education or infrastructure, but rather a structural misalignment among its core development pillars: human capital, innovation capacity, and productivity. The quantitative evidence confirms that while human capital accumulation causally influences economic performance, its effectiveness is severely constrained by a lack of domestic absorptive capacity. Specifically, Indonesia consistently falls below the expected trend lines for productivity and patent intensity compared to "lesson-learned" economies (South Korea, China, Vietnam), indicating a systemic failure to translate educational gains into innovation-led growth.

Qualitative insights reveal that this "conversion failure" is driven by deep fragmentation. The human capital pipeline suffers from incoherence between secondary education policies (Kurikulum Merdeka) and university admissions, as

well as a mismatch between graduate competencies and industry needs. Simultaneously, the innovation ecosystem is hampered by short-term funding cycles and a "valley of death" that prevents research prototypes from reaching commercialization. This is exacerbated by the absence of a unified governance framework, resulting in silos between academia, industry, and government.

However, recent policy developments indicate that the government has begun to address these structural gaps, although implementation challenges remain. Ultimately, escaping the middle-income trap requires moving beyond the nominal fulfillment of the 20% education mandate. The current 'budgetary illusion', where innovation-led growth is expected from a budget largely composed of basic social spending and bureaucratic training must be dismantled. Structural reforms must prioritize the decoupling of R&D investments from routine operational expenditures and foster a multi-stakeholder funding ecosystem that incentivizes private sector participation, mirroring the successful trajectories of advanced innovation-led economies. Aligning with this study's recommendation to strengthen the talent pipeline, Kemendiktisaintek, through the Direktorat Bina Talenta Penelitian dan Pengembangan, is currently prioritizing the increase in both the quantity and quality of researchers to meet the benchmark of high-income countries (approximately a fourfold increase in researchers per million people). Furthermore, to resolve the mismatch between education and national priorities, the allocation of LPDP scholarships has been restructured to strictly align major selection and destination universities with national industrial needs, shifting away from a purely demand-driven model to a strategic, state-directed approach.

Regarding the research ecosystem, stakeholders acknowledge that the current annual budget cycles are insufficient. In response, Kemendiktisaintek is transitioning toward Multi-year Strategic Research schemes funded by LPDP and the state budget (APBN), distinguishing them from equity-focused "Priority Research." This aligns with the study's call for long-horizon funding. To address the infrastructure deficit identified in the focus group discussions, the government is facilitating Shared Facilities, where laboratories with high-specification equipment at the National Research and Innovation Agency (BRIN) are being opened for university utilization.

On the commercialization front, the study's proposals align with ongoing government initiatives, including the demand-driven Innovation Voucher, Innovation Sandboxing, and matching fund schemes currently executed by the Directorate General of Research and Development (Ditjen Risbang). To ensure these translate into economic value, a Downstreaming Task Force (Satgas Hilirisasi), coordinated by Kemenko PMK, is being prepared for full operation by 2026, alongside a Digital Talent Mobility Platform designed to bridge researchers with industry needs. However, significant barriers persist, notably the underutilization of the 300% Super Tax Deduction with only roughly IDR 60 billion realized out of a IDR 3 trillion target due to administrative complexities and a national R&D budget (IDR 3–4 trillion) that remains far below the critical threshold for structural transformation, necessitating urgent regulatory simplification and stronger fiscal support.

Further Research To deepen the strategic roadmap for Indonesia's Vision 2045, future research should evolve the current conceptual framework into a dynamic System Dynamics model to quantitatively simulate policy interventions, investment requirements, and time lags. Additionally, scholarship should pivot toward granular sectoral analyses, specifically within the Asta Cita priority sectors to tailor industrial policies, while simultaneously conducting longitudinal studies on vocational revitalization and impact evaluations of fiscal incentives to precisely identify and resolve the administrative bottlenecks hindering private sector R&D participation.

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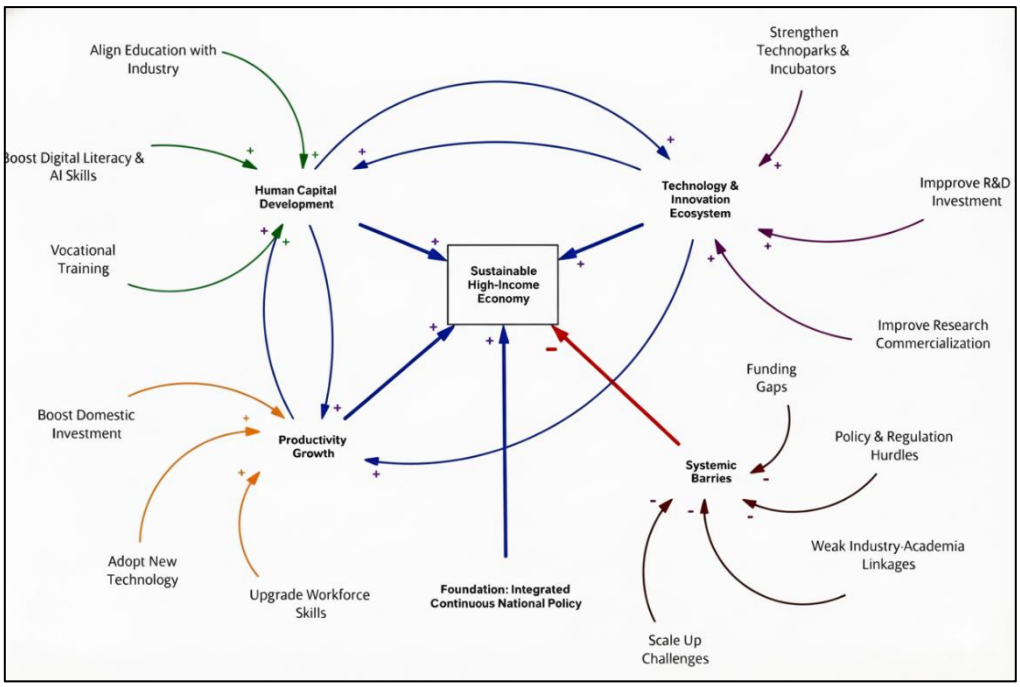
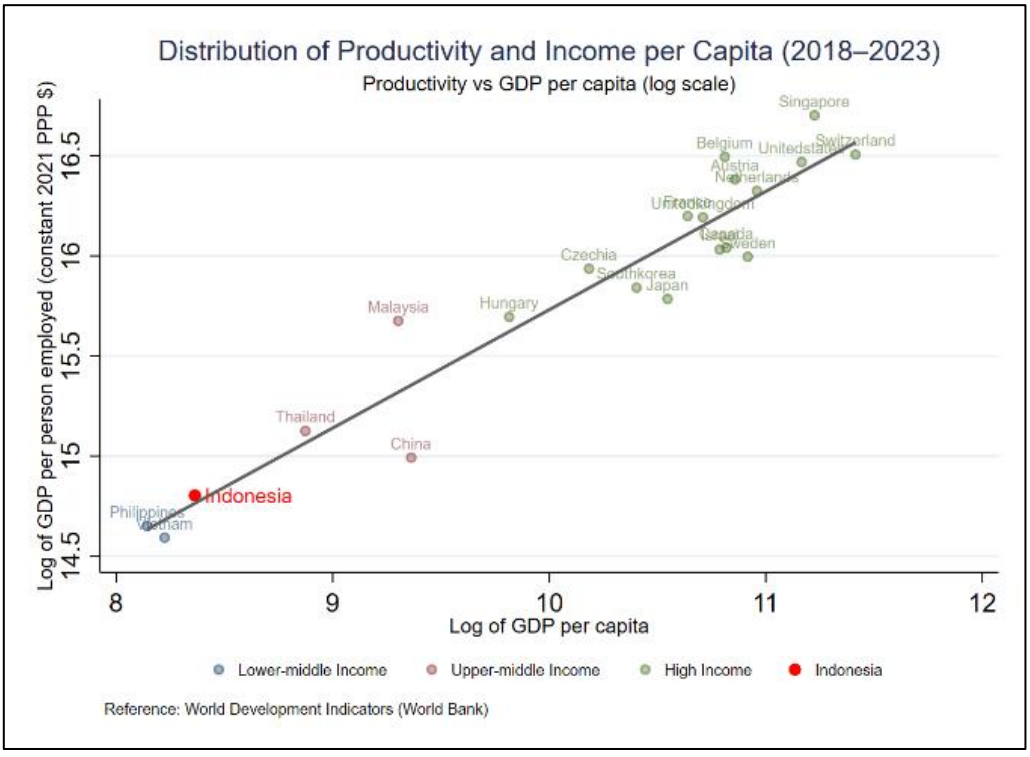
Appendix

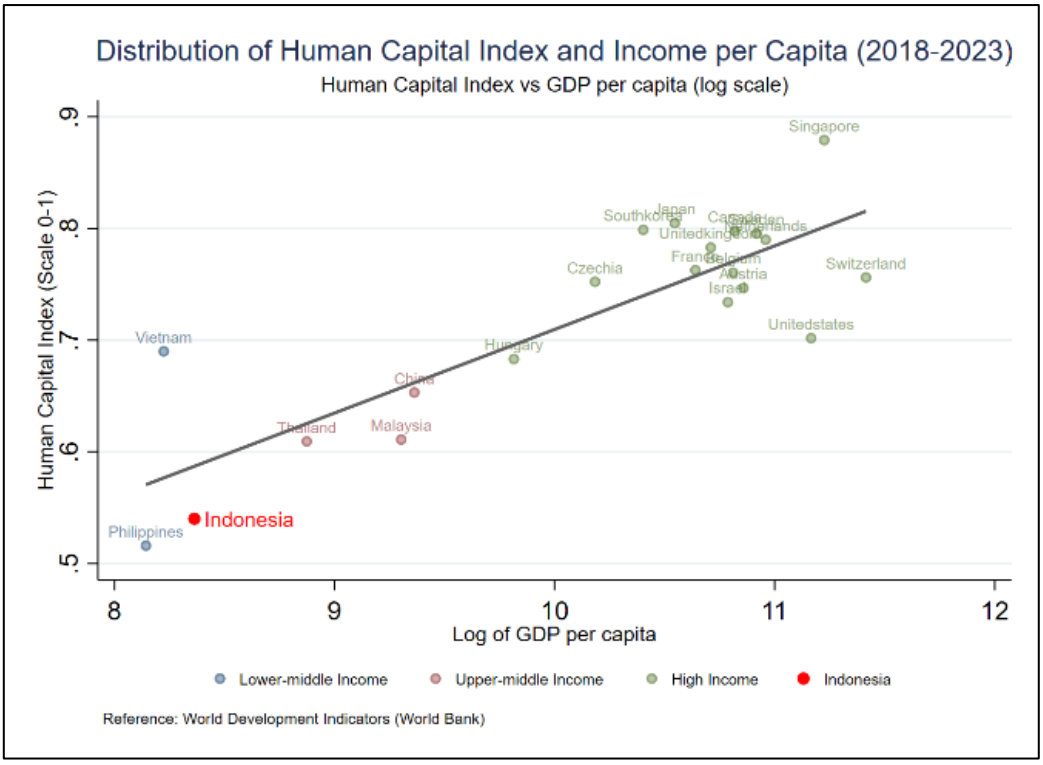
Appendix 1.1. System Thinking

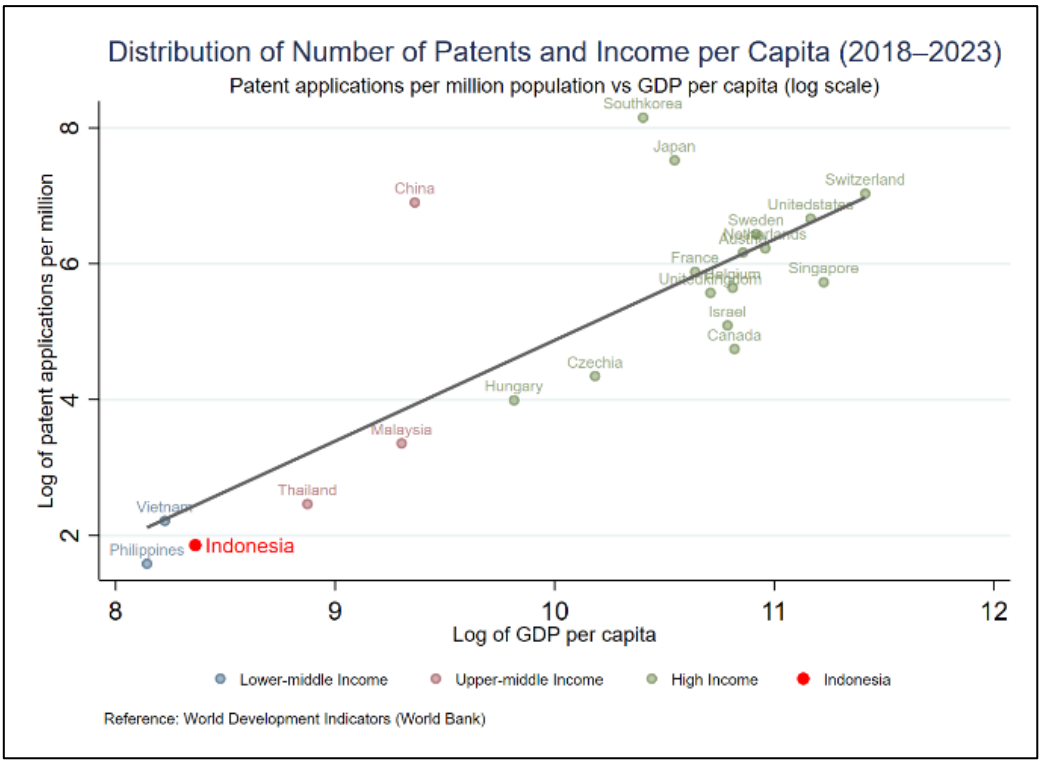


Appendix 1.2. Human Capital, Productivity, and Patent Applications in Relation to GDP per Capita

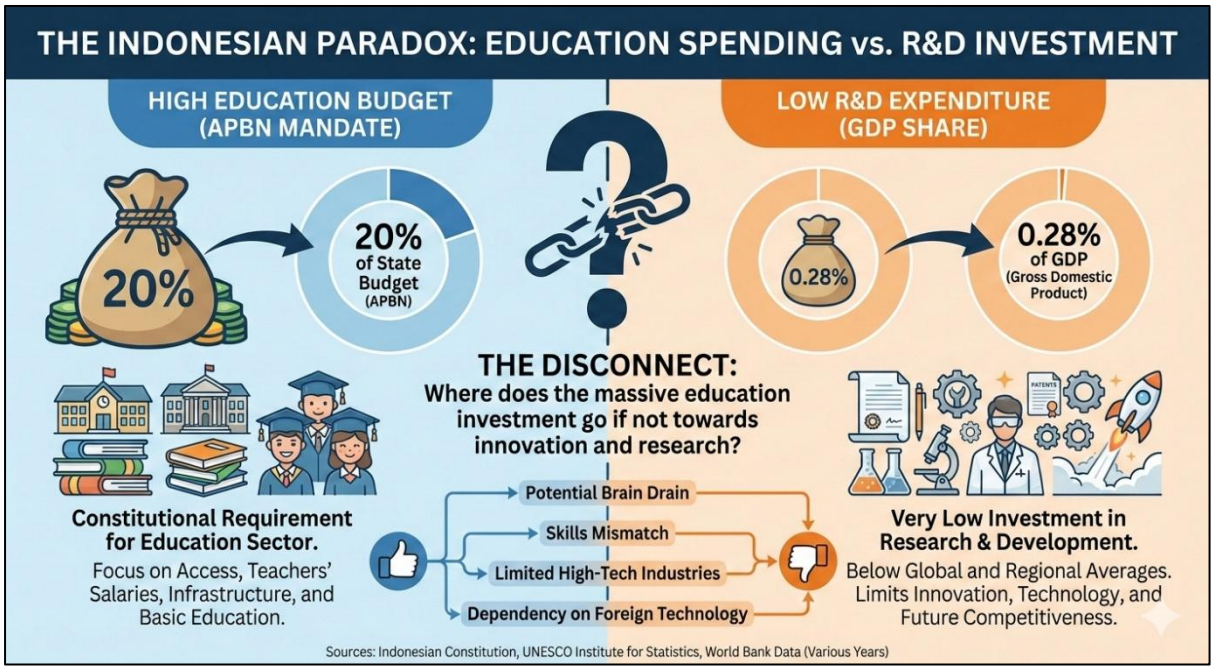
Source: World Bank (2018-2023)




Distribution of Human Capital Index and Income per Capita (2018-2023)
Human Capital Index vs GDP per capita (log scale)
Human Capital Index (Scale 0-1)
.5
.6
.7
.8
.9
8
9
10
11
12
Log of GDP per capita
Singapore
Southkorea
Japan
Unitedkingdom
Czechia
France
Belgium
Austria
Israel
Switzerland
Unitedstates
Vietnam
Hungary
China
Thailand
Malaysia
Indonesia
Philippines
Lower-middle Income
Upper-middle Income
High Income
Indonesia
Reference: World Development Indicators (World Bank)


Distribution of Number of Patents and Income per Capita (2018–2023)
Patent applications per million population vs GDP per capita (log scale)
Log of patent applications per million
2
4
6
8
8
9
10
11
12
Log of GDP per capita
Southkorea
Japan
China
Switzerland
Unitedstates
Sweden
France
Singapore
Israel
Canada
Czechia
Hungary
Malaysia
Thailand
Vietnam
Philippines
Indonesia
Lower-middle Income
Upper-middle Income
High Income
Indonesia
Reference: World Development Indicators (World Bank)

Appendix 1.3. Structural Gap between the 20% Education Mandate and National R&D Expenditure



Source: Indonesian Constitution, UNESCO Institute for Statistics, World Bank Data (Various Years)