

“Forecasting vocational workforce readiness in Indonesia’s new capital: A system dynamics and foresight approach”

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FORECASTING VOCATIONAL WORKFORCE READINESS IN INDONESIA'S NEW CAPITAL: A SYSTEM DYNAMICS AND FORESIGHT APPROACH

Abstract

This study aims to forecast how the relocation of Indonesia's new capital to East Kalimantan will impact regional economic development, labor market dynamics, and vocational education readiness. Employing an integrated system dynamics and foresight methodology, the study models the interdependencies among economic transformation, industrial shifts, and future workforce requirements. The analysis combines qualitative foresight data, gathered through in-depth interviews and focus group discussions with 66 key stakeholders (16 government and education policymakers, 30 leaders of large industries, and 20 SME representatives), with system modeling to simulate long-term trends and policy impacts. The simulation results indicate a significant structural transition from a resource-based economy to a service-oriented and low-carbon economic model, leading to a sharp projected increase in labor demand across green and digital-intensive sectors. These projections underscore the urgent need for a vocational education system that is more adaptive, technologically relevant, and environmentally aligned. However, anticipated challenges such as persistent skill mismatches, inadequate stakeholder engagement in policy design, and outdated curricula may hinder vocational institutions from effectively responding to emerging labor market demands. This study highlights the strategic importance of modernizing vocational education and establishing stronger collaborative frameworks among government, industry, and educational institutions. By forecasting workforce readiness under multiple development scenarios, the research provides actionable insights to support evidence-based policymaking and the creation of a resilient, future-oriented innovation ecosystem in East Kalimantan.

Keywords

career, skills, transformation, industry, labor, sustainability

JEL Classification

J24, O25, L52, Q01

INTRODUCTION

The relocation of Indonesia's new capital city, Nusantara (IKN), to East Kalimantan represents not only a geographic and political realignment but also a profound economic transformation. This initiative is strategically aimed at reducing the country's dependency on extractive industries, such as oil, gas, and mining, by cultivating a diversified, service-oriented, and low-carbon economy. While infrastructure development dominates policy discourse, the deeper scientific problem lies in understanding how East Kalimantan's historically resource-dependent labor force can transition toward meeting the demands of a future-oriented, innovation-driven economy.

Current labor market structures in East Kalimantan are misaligned with the human capital needs of emerging sectors such as green ener-

gy, digital services, and sustainable urban development. Without appropriate workforce transformation, this misalignment may lead to structural unemployment, increased inequality, and reduced regional competitiveness. Although vocational education is recognized as a critical tool for equipping the workforce with relevant skills, empirical evidence on its alignment with regional economic transitions – particularly in the context of IKN – remains limited. This raises several key questions: How prepared are vocational institutions to deliver future-relevant training? To what extent are governance mechanisms facilitating effective collaboration between industry and education? And are the current policy reforms sustainable and responsive to labor market evolution?

In response to these challenges, Presidential Regulation No. 68 of 2022 was enacted to revitalize Indonesia's Technical Vocational Education and Training (TVET) system. This regulation introduces a demand-driven model that emphasizes direct industry participation in curriculum design, internships, and skills development programs. It also mandates integrated cooperation among ministries, local governments, and vocational institutions to create a dynamic and adaptive skill development ecosystem aligned with regional industrial shifts.

This transformation occurs against the backdrop of Indonesia's Vision 2045 and the approaching demographic bonus projected to peak by 2030. In this context, vocational education plays a strategic role in enhancing national human capital. However, beyond increasing enrollment, the effectiveness of vocational training must be assessed in terms of its alignment with actual labor market needs. Strengthening synergies among public institutions, private sector actors, and educational stakeholders is essential to ensure that vocational graduates possess industry-relevant competencies. This study, therefore, examines the extent to which vocational education in East Kalimantan is responding to these systemic shifts, to inform more effective policy design, stakeholder collaboration, and labor market preparedness to support the long-term success of Nusantara.

1. LITERATURE REVIEW

In the broader context of economic development and vocational education transformation, various economic theories provide valuable insights into the interplay between institutions, labor markets, and human capital investment. A theoretical framework grounded in Institutional Theory, System Dynamics Theory, Human Capital Theory, and Endogenous Growth Theory enables a deeper understanding of how vocational education systems can be optimized to meet industry demands and drive sustainable economic progress. These perspectives, when integrated, offer a multidimensional approach to workforce development, highlighting the need for adaptive policies that foster innovation, economic resilience, and long-term growth in an increasingly globalized labor market.

A well-functioning institutional framework is fundamental to ensuring that economic policies, including those related to vocational education, effectively support sustainable development and labor market efficiency. Institutional

Theory, which was developed by North (1990), emphasized the role of formal and informal institutions in shaping economic behavior, policy effectiveness, and organizational performance. Institutions – comprising regulatory frameworks, norms, and social structures – played a crucial role in determining how economic actors interacted and adapted to changes in labor markets and educational systems (Scott, 2001). In the context of vocational education, institutional arrangements were essential for aligning education policies with labor market needs, particularly in economies undergoing rapid industrialization and large-scale infrastructure development (DiMaggio & Powell, 1983). Empirical evidence suggested that strong institutional frameworks enhanced policy implementation, ensuring that investments in human capital contributed to sustainable economic growth (Acemoglu & Robinson, 2012). Moreover, institutional adaptability was critical for fostering a vocational education system that met industry demands, facilitated skill formation, and supported innovation-driven economic development (Rodrik, 2007).

Building upon the role of institutions in shaping policy implementation, System Dynamics Theory provides a complementary perspective by analyzing the complex interactions between education, labor market dynamics, and economic structures. Developed by Forrester (1961), this theory employed a system-based approach to understanding how interconnected variables influenced one another through causal relationships and feedback loops. In the context of economics and labor markets, system dynamics facilitated the dynamic analysis of how policy changes, labor demand fluctuations, and vocational education systems shaped economic structures and innovation capacity (Sterman, 2000). This approach utilized stock-and-flow models and causal loop diagrams to identify systemic patterns and leverage points – critical areas within a system that could drive significant change (Meadows, 2008). For example, in vocational education, system dynamics was used to assess how increased investment in workforce training contributed to long-term productivity and industrial competitiveness (Richardson, 1991). Research further indicated that system dynamics analysis helped evaluate the interconnections between labor policies and economic growth while also accounting for external factors such as globalization and technological advancements (Lane, 2000). Additionally, this approach had been widely applied in public policy planning to assess the long-term impact of structural changes in labor markets and education systems (Forrester, 1994). By examining these intricate interactions, system dynamics theory offered deeper insights into designing evidence-based and sustainable policies, particularly in fostering an innovation ecosystem that was responsive to evolving economic and social dynamics (Wolstenholme, 1990). Thus, this theory serves as a robust analytical framework for understanding how vocational education policies and labor market dynamics interact to drive sustainable economic development.

Extending the discussion on policy and system dynamics, Human Capital Theory further reinforces the importance of investment in education and training as a driver of economic resilience and workforce adaptability. Introduced by Becker (1964), this theory posited that investments in education and training enhanced workforce skills, ultimately driving economic growth by improving

productivity and innovation capacity. Education was not merely an individual benefit but a crucial determinant of national economic development, as a well-trained workforce contributed to higher efficiency and competitiveness across industries (Schultz, 1971). Empirical studies demonstrated that investment in human capital, particularly in vocational education, significantly impacted labor market outcomes by reducing unemployment and fostering economic resilience (Psacharopoulos & Patrinos, 2018). Moreover, vocational education played a pivotal role in equipping workers with both technical and soft skills, ensuring that workforce competencies aligned with evolving industry demands (Hanushek et al., 2011). Research also suggested that strengthening vocational education systems contributed to regional development, as areas with robust training programs tended to experience higher rates of job creation and economic diversification (Bassanini & Scarpetta, 2002). This transformation was particularly crucial in emerging economies, where aligning education with labor market needs helped bridge skill gaps and enhanced employment opportunities (OECD, 2019). By prioritizing human capital investment, policymakers created a workforce that was not only adaptable but also capable of driving industrial growth and supporting broader economic ambitions (Goldin, 2016). This strategic approach ensures that education systems remain responsive to labor market dynamics, ultimately fostering sustainable economic development on a global scale.

To further understand the long-term impact of human capital investment on economic growth, the Endogenous Growth Theory provides a valuable framework for analyzing sustained economic expansion driven by education and innovation. Pioneered by Romer (1986) and Lucas (1988), this theory emphasized that long-term economic growth was primarily driven by internal factors such as human capital accumulation, innovation, and research and development (R&D) investment, rather than external technological shocks (Romer, 1986; Lucas, 1988). Unlike neoclassical growth models that assumed diminishing returns to capital, Endogenous Growth Theory suggested that knowledge spillovers and technological progress could lead to sustained growth by enhancing productivity and fostering innovation-driven industries (Aghion & Howitt, 1992). Empirical stud-

ies indicated that investments in education, particularly vocational training, played a crucial role in equipping the workforce with the skills necessary for an innovation-based economy (Hanushek & Woessmann, 2020). Moreover, regions with a strong commitment to human capital development and supportive policies for R&D tended to experience higher rates of economic diversification and resilience (Barro, 2001). In a global context, the transformation of vocational education and the promotion of innovative sectors served as key drivers of sustained economic growth, particularly as economies transitioned toward knowledge-based industries (Jones & Vollrath, 2013). Additionally, studies showed that targeted policies supporting entrepreneurship, infrastructure, and digital transformation could amplify the effects of human capital and innovation, reinforcing the cycle of endogenous growth (Aghion et al., 2014). By leveraging these factors, economies achieved long-term sustainability, reduced dependence on traditional industries, and enhanced their competitive advantage in global markets (OECD, 2021; Dogan Basar et al., 2025).

Economic transformation relies on multiple interconnected factors that drive sustainable growth and development. Prior studies emphasized that investment and innovation were key drivers of economic transformation, requiring strong collaboration between governments, industries, and educational institutions (Lestari et al., 2022; Achmad et al., 2023). The increasing demand for skilled labor in infrastructure development and emerging industries necessitated an adaptive vocational education system to align workforce competencies with evolving market needs. Additionally, public sector innovation played a crucial role in improving development outcomes, ensuring that policy frameworks effectively supported economic growth and social welfare (Hilmawan et al., 2023b). Rural and regional development strategies were also essential for fostering economic resilience, particularly in communities undergoing rapid urbanization. Policies that promoted local economic empowerment, including support for small and medium-sized enterprises (SMEs) and investment in sustainable infrastructure, contributed to inclusive growth (Hilmawan et al., 2023a; Hardani et al., 2025). From a fiscal perspective, the efficiency of government budgets and fiscal au-

tonomy significantly influenced economic transformation, requiring strategic resource allocation to optimize public investment (Musviyanti et al., 2022). Furthermore, social aid policies mitigated socioeconomic disparities, enhancing community welfare amid large-scale economic transitions (Langi et al., 2023). The role of knowledge management and digital transformation was also critical in strengthening SMEs, which served as catalysts for regional and national economic growth. Digitalization fostered innovation, improved business competitiveness, and expanded market access, further accelerating economic transformation (Riadi et al., 2023; Surahman et al., 2023). In this context, the narrowing economic gap between developed and developing economies was facilitated by rapid growth and structural transformation; however, its environmental impact remained uncertain, emphasizing the need for policies that balanced economic growth with sustainability (Artan et al., 2024). In Indonesia, the palm oil industry served as a key example of sectoral transformation, where government support, community empowerment programs, and environmental management strategies were essential to ensuring long-term sustainability (Hariyanti et al., 2024). Additionally, the shift from goods-based to service-based economies in developed nations presented new challenges, as Baumol's Cost Disease in the service sector had contributed to rising CO₂ emissions, highlighting the need for increased R&D investment, particularly in communication and education services, to enhance environmental sustainability (Dezfuli et al., 2025).

The transformation of vocational education is closely tied to broader structural shifts driven by large-scale economic transitions, including capital relocations and shifts toward knowledge-based economies. Yusuf et al. (2023) highlighted that such transitions often facilitated a shift from resource-intensive industries to service-oriented and low-carbon economies, leading to an increase in the service sector and a reduction in carbon emission intensity. This transformation underscores the growing demand for a highly skilled workforce, reinforcing the role of vocational education in equipping workers with competencies aligned with emerging industries. However, as Syaban and Appiah-Opoku (2023) emphasized, rapid economic transitions also posed challenges

in balancing economic growth with environmental sustainability. Addressing these challenges requires an education system that fosters green skills and adaptability, ensuring that the workforce is prepared for sustainable industrial shifts. From a governance perspective, Perwira et al. (2024) cautioned that expedited decision-making processes and limited public deliberation in large-scale development projects might have impacted the inclusivity of economic policies, particularly those related to vocational education reforms. This highlights the necessity of participatory approaches in shaping educational strategies that align with long-term regional development goals. Furthermore, Harihanto (2023) underscored that sustainable urban and economic development hinged on the integration of education and workforce policies within a long-term economic framework. Similarly, Susantono et al. (2024) argued that strategic investments in vocational education were essential for fostering innovation, industrial competitiveness, and economic resilience, particularly in regions undergoing rapid structural transformation. By aligning vocational training with broader economic and environmental objectives, policymakers can enhance workforce readiness and drive sustainable economic growth.

Research on vocational education has consistently highlighted its critical role in enhancing workforce readiness while also addressing structural challenges across diverse national contexts. Ariyani et al. (2021) emphasized that vocational education served as a key mechanism for strengthening human capital in Indonesia; however, persistent issues such as high unemployment rates and regional labor market imbalances remained significant barriers to its effectiveness. Globally, vocational education was recognized as a fundamental driver of economic development, ensuring that workforce skills aligned with industry demands and facilitating smoother labor market transitions (McGrath & Yamada, 2023). To maintain relevance in an increasingly dynamic and technology-driven global economy, vocational education must evolve alongside industrial and technological advancements. While vocational training was traditionally aligned with key economic sectors such as agriculture, industry, and forestry, it required modernization to address the shifting demands of emerging industries and sustainability-oriented

economies (McGrath, 2012; McGrath & Yamada, 2023). Curricula that integrated specialized training in fields such as non-timber forest product engineering, industrial chemical technology, and product design played a crucial role in fostering local innovation and enhancing economic resilience (Cheng, 2017). Strengthening vocational education through industry collaboration, updated pedagogical approaches, and digital integration is imperative for ensuring workforce adaptability and competitiveness, particularly in regions undergoing significant structural transformation

Vocational education plays a fundamental role in shaping workforce readiness and economic resilience across diverse regional contexts. Blinova et al. (2015) found that vocational education played a critical role in mitigating youth unemployment risks in Russia, with its effectiveness shaped by regional economic and demographic factors. This underscored the importance of region-specific vocational training programs that aligned with local labor market demands, ensuring that graduates possessed industry-relevant skills. Similarly, Suharno et al. (2020) examined the historical development of vocational education in Indonesia, noting that despite government efforts to expand vocational school enrollment, graduates often faced employment difficulties due to persistent skill mismatches. This highlighted the urgent need to modernize vocational curricula to reflect evolving industry requirements, particularly in high-growth sectors such as industrial chemical technology and product design (Cheng, 2017).

The effectiveness of vocational education in facilitating school-to-work transitions varies across countries, depending on program design and labor market conditions. The positive impact of vocational education on youth employability was further evidenced by Muja et al. (2019), who found that vocational training in the Netherlands facilitated school-to-work transitions, although this effect was not necessarily contingent on regional unemployment levels. This suggested that well-structured vocational programs incorporating modern technological advancements could enhance workforce readiness, even in economies with varying labor market conditions. Inderanata and Sukardi (2023) emphasized the significance of practical, demonstration-based learning ap-

proaches in vocational guidance, as traditional instructional methods often failed to equip graduates with the competencies required by industry. Enhancing the practical relevance of vocational training is essential for closing skill gaps and ensuring that graduates remain competitive in both domestic and international labor markets.

Global economic transformations necessitate continuous reforms in vocational education to align with industry needs and technological advancements. From a broader perspective, Tabbron and Yang (1997) argued that global economic transformations necessitated a more adaptable and technologically proficient workforce, requiring vocational education reforms that emphasized industry collaboration, competency-based curricula, and stronger integration with academic education. In this context, the modernization of vocational education was particularly relevant for resource-rich regions, where economic diversification and industrial innovation were key development priorities. By integrating emerging disciplines such as non-timber forest product engineering and industrial chemical technology into vocational curricula, educational institutions could better equip students with specialized skills that contribute to both local economic resilience and global market competitiveness (McGrath & Yamada, 2023).

This study aims to forecast the impacts of Indonesia's new capital relocation (IKN) to East Kalimantan on regional economic development, labor market dynamics, and vocational education readiness by employing a system dynamics and foresight approach. Specifically, it seeks to simulate future labor demand trends, identify critical skill requirements across emerging industries, and evaluate the capacity of vocational education systems to respond to these shifts. The study also formulates evidence-based policy recommendations to strengthen collaboration among government, industry, and educational institutions in building a resilient and innovation-oriented vocational workforce ecosystem.

2. METHOD

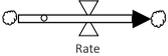
This study employs system dynamics and foresight analysis to assess the economic, employment, and vocational education impacts of

relocating the national capital (IKN) to East Kalimantan. These methods are used to understand the complex interactions between increasing labor demand, skill requirements, and the adaptation of vocational education to regional economic changes. Additionally, this study aims to identify innovative sectors driving economic growth and formulate policy recommendations to strengthen collaboration between government, industry, and educational institutions in creating a sustainable innovation ecosystem.

The system dynamics approach is utilized to model the interconnections between key factors in economic development and vocational education. This model includes variables such as economic growth, rising labor demand, the role of vocational education in workforce preparation, and policy interventions promoting industrial innovation and infrastructure investment (Ghaffarzadegan & Richardson, 2011; Saleh et al., 2010; Sterman, 2000). The model is developed using Vensim software, beginning with the creation of a causal loop diagram (CLD) to illustrate causal relationships between variables. This diagram is then translated into a stock-flow diagram for policy scenario simulations. The data for modeling were sourced from local government reports, vocational education statistics, and stakeholder interviews (Forrester & Forrester, 2011).

The system dynamics approach consists of six key stages. First, problem identification, which involves analyzing major challenges in economic growth and employment due to the IKN relocation. Second, system conceptualization, mapping relationships between the workforce, vocational education, and industrial transformation. Third, model formulation, where key variables and their causal relationships are translated into mathematical models. Fourth, simulation and validation, aimed at testing the model's accuracy in representing regional economic realities. Fifth, policy analysis, where various policy scenarios are tested to assess long-term impacts on employment and vocational education. Sixth, policy implementation, generating evidence-based recommendations to improve workforce readiness and the effectiveness of vocational education in East Kalimantan.

Table 1. Stock & flow diagram symbols

Name	Symbol	Description
Box Variable (Level Variable)		Represents accumulated quantities in the system. In the IKN context, this includes the number of skilled workers, the capacity of vocational education institutions, and the number of businesses operating in construction, tourism, and retail sectors
Rate (Flow Variable)		Represents changes in stock over time. Examples include the rate of increase in labor demand in construction and service sectors, the graduation rate from vocational education in civil engineering, construction management, and architecture, and the growth rate of new businesses due to rising migration to IKN
Auxiliary Variable (Supporting Variable)	Auxiliary Variable	Represents constants or parameters that influence the system. Examples include vocational education curricula aligned with industry needs, workers' skill levels in communication and problem-solving, and policy incentives for post-harvest and seafood processing industries
Dependency Link (Connector)		Indicates cause-and-effect relationships between variables in the system. For instance, the availability of vocational training programs affects the number of skilled workers, economic growth in tourism and retail increases demand for hospitality and marketing professionals, and investment in agroforestry industries creates new opportunities for local product exports.

In addition to system dynamics, this study applies foresight analysis to explore future scenarios regarding economic shifts and labor demand in East Kalimantan. The foresight process began with structured interviews and focus group discussions with stakeholders from government, education, and industry, whose insights were systematically coded to identify priority drivers of change, including demographic trends, industrial diversification, and technological adoption (Cook et al., 2014; Miles et al., 2016). These drivers were then translated into scenario narratives through horizon scanning and Delphi consultations, ensuring that each scenario reflected plausible pathways of regional development. To assess future skill demands, stakeholders evaluated emerging occupational requirements and competencies linked to key economic sectors identified during the inter-

views, such as green energy, digital services, and advanced manufacturing. The scenarios and skill projections were subsequently validated through regional workshops, where participants reviewed their feasibility and policy relevance. This approach ensured that foresight outcomes not only captured potential economic transformations but also provided concrete implications for vocational education and workforce readiness in response to the IKN relocation (Cook et al., 2014; Miles et al., 2016; Wiebe et al., 2018).

Foresight analysis is conducted using the STEEPV framework (Social, Technological, Economic, Environmental, Political, and Value), beginning with horizon scanning to identify key factors influencing economic development and employment in East Kalimantan. This process involves

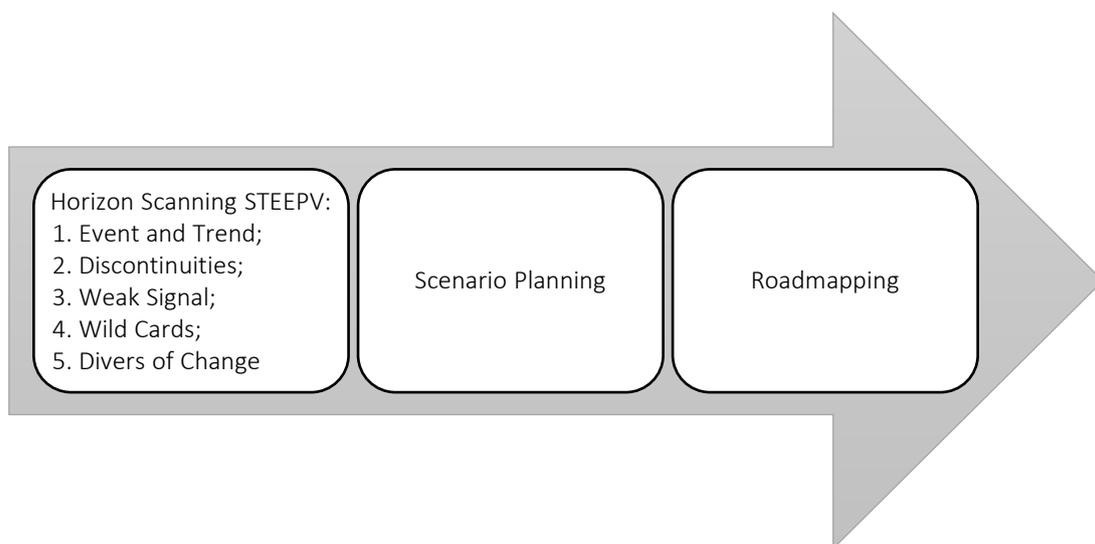


Figure 1. Scenario planning with STEEPV

focus group discussions (FGDs) and Delphi consultations with experts and stakeholders. To ensure methodological rigor, the findings from these discussions underwent a two-stage validation process. First, a simulation and verification stage within the System Dynamics methodology was conducted by comparing the consistency of model outputs with historical data and cross-checking causal linkages with expert judgments. Metrics such as plausibility, coherence with existing policies, and alignment with observed economic and labor trends were applied to assess internal validity. Second, external validation was carried out through a series of regional roadshows in multiple cities and districts, where participants from government, industry, and education sectors provided feedback on the plausibility and applicability of the scenarios. This triangulation of expert review, simulation consistency, and stakeholder feedback increased confidence in the robustness of the foresight outcomes. The final results include scenario planning and the development of strategic roadmaps, which provide evidence-based policy recommendations for strengthening vocational education and workforce readiness in response to economic changes due to the IKN relocation.

Data collection for this study involves two main sources: primary data and secondary data. Primary data are obtained through in-depth interviews with policymakers, vocational educators, and industry leaders in East Kalimantan in 2023 and 2024. A total of 66 leaders from various sectors participated in this study, including 16 policymakers, comprising the Regional Secretariat (1), Chamber of Commerce and Industry (2), Education Office (7), Vocational High Schools (2), Manpower Office (2), and Regional Development Planning Agency (2). Additionally, 30 large industry leaders and 20 SME leaders also participated in interviews and focus group discussions. Participants were selected using purposive sampling based on their relevance, expertise, and direct involvement in vocational education and workforce development. Policymakers were chosen from institutions responsible for education, labor, and regional planning; large industry leaders represented companies with significant workforce demands; and SME leaders were included to capture perspectives from smaller-scale enterprises engaged in vocational employment.

The primary data were gathered through foresight workshops, FGDs, and Delphi consultations. Meanwhile, secondary data include government reports, academic studies, and labor market analyses. Additionally, this study received ethical approval from the Board of Postgraduate Studies and Research at Samarinda State Polytechnic (reference number 2188/PL7.14/2024) and was reviewed by the Institute for Research and Community Service to ensure compliance with ethical standards, including the Helsinki Declaration. Written informed consent was obtained from all participants, who were clearly informed about the study's purpose, confidentiality measures, and their voluntary participation.

3. RESULT AND DISCUSSION

The relocation of Indonesia's new capital city (IKN) Nusantara is projected to serve as a major socioeconomic catalyst for East Kalimantan, with wide-ranging implications for economic performance, labor market dynamics, and vocational education systems. This study forecasts the long-term impact of the capital relocation on the development of vocational education by integrating system dynamics modeling with qualitative stakeholder analysis. The forecasting model is constructed and calibrated using secondary data sourced from Statistics Indonesia (BPS), East Kalimantan's Regional Development Planning Agency (Bappeda Kaltim), and official government reports covering the period from 2010 to 2023. Key macroeconomic variables include GRDP at constant prices (ADHK), gross fixed capital formation, and labor force statistics.

Under a baseline assumption of 5% annual economic growth, a capital-output ratio (KOR) of 3.95, and technological elasticity of 0.375, East Kalimantan's GRDP is projected to grow from Rp537.6 trillion in 2023 to Rp1,567.3 trillion by 2045 (Table 2). These results are explicitly derived from dynamic stock-flow simulations, which include modules on capital accumulation, production capacity, labor absorption, and savings behavior. The simulation indicates that every 1% increase in GRDP contributes to approximately 6,000-7,000 additional vocational jobs, particularly in sectors linked to urban development and infrastructure.

Table 2. Historical and projected GRDP of East Kalimantan (2010–2045) (in trillion Rupiah)

Year	GRDP (ADHK)	Notes
2010	383.3	Historical (BPS)
2015	445.3	Historical (BPS)
2020	528.8	Historical (BPS)
2023	537.6	Latest official data (BPS)
2025	592.8	Model projection (5% growth)
2030	756	Model projection (5% growth)
2035	964.1	Model projection (5% growth)
2040	1,229.00	Model projection (5% growth)
2045	1,567.30	Model projection (5% growth)

To strengthen the model’s assumptions, data were drawn from BPS labor surveys, the Ministry of Education’s Dapodik system, and the Ministry of Labor. The baseline parameters used in the model, such as capital intensity, saving propensity, and the capital-labor ratio, are listed in Table 3.

As economic growth accelerates, vocational labor demand is projected to increase by 37.4%, from 382,000 in 2023 to approximately 525,000 by 2045, according to the simulation model. This is supported by the employment sub-model, which connects GRDP expansion to sectoral employment needs. In contrast, vocational unemploy-

ment is projected to rise slightly to 46,000 by 2045, representing a 39% increase from the 2023 level of 33,000, driven by delays in job placement and skill mismatch. These values result directly from baseline dynamic simulations that incorporate job waiting periods, dropout rates, and labor attrition, as detailed in Table 4.

Primary data were collected during 2023–2024 from 66 respondents, comprising 16 policymakers (from provincial and city-level education and labor departments), 30 large industry leaders (in construction, mining, hospitality, and logistics), and 20 SME representatives from Balikpapan, Samarinda, and surrounding regions. The respondents were purposively selected to reflect the key stakeholders in vocational education and employment. Interviews and focus group discussions identified structural weaknesses in vocational training, such as outdated curricula, limited mobility of graduates, and mismatched expectations between education output and industry needs.

Information on the capacity of vocational education institutions, including annual enrollment and graduation data, was obtained from the Ministry of

Table 3. Baseline scenario assumptions for GRDP, investment, and capital-labor ratio (KLR)

No.	Aspect	Assumption	Baseline Scenario
1	Initial Provincial GRDP	East Kalimantan GRDP (ADHK) in 2010	Rp383.3 trillion
2	Initial Economic Growth Rate	East Kalimantan’s LPE in 2010	0.05 per year
3	Capital-Output Ratio (KOR)	Capital / GRDP	3.95 years
4	Elasticity of Economic Growth to Technology	5% growth leads to 3% technology increase	0.375 (dmnl)
5	Sensitivity of Technology to KLR	–	0.96 (dmnl)
6	Average Capital Lifetime	–	20 years
7	Capital Intensity	Physical capital vs. labor dependence	0.4 (c)
8	Capacity Utilization Factor	Impact of COVID-19 on capacity	0.96-1.00 (dmnl)
9	Marginal Propensity to Save	Portion of income saved	0.25-0.32 (dmnl)

Note: dmnl represents the unit for rate (the speed or level of change) in system dynamics models.

Table 4. Baseline and policy scenario assumptions for GRDP, investment, and capital-labor ratio (KLR)

No.	Aspect	Assumption	Baseline Scenario	Policy Scenario
1	Initial Vocational Student Population	Enrollment in SMK & Polytechnics (BPS-Statistics Indonesia, 2022)	74,299 students	Potential increase
2	Vocational Study Duration	Average program length	4 years	–
3	Average Vocational Working Age	National labor force standards	20 years	Extendable
4	Dropout Rate	From vocational schools/universities	0.05/year	Reduced
5	Job Waiting Period	Tracer study averages	0.9 years	Shortened significantly
6	Mortality Rate of Vocational Workers	Based on BPS life expectancy	0.03/year	–
7	Mortality Rate of Job Seekers	Based on WHO & local sources	0.005/year	–

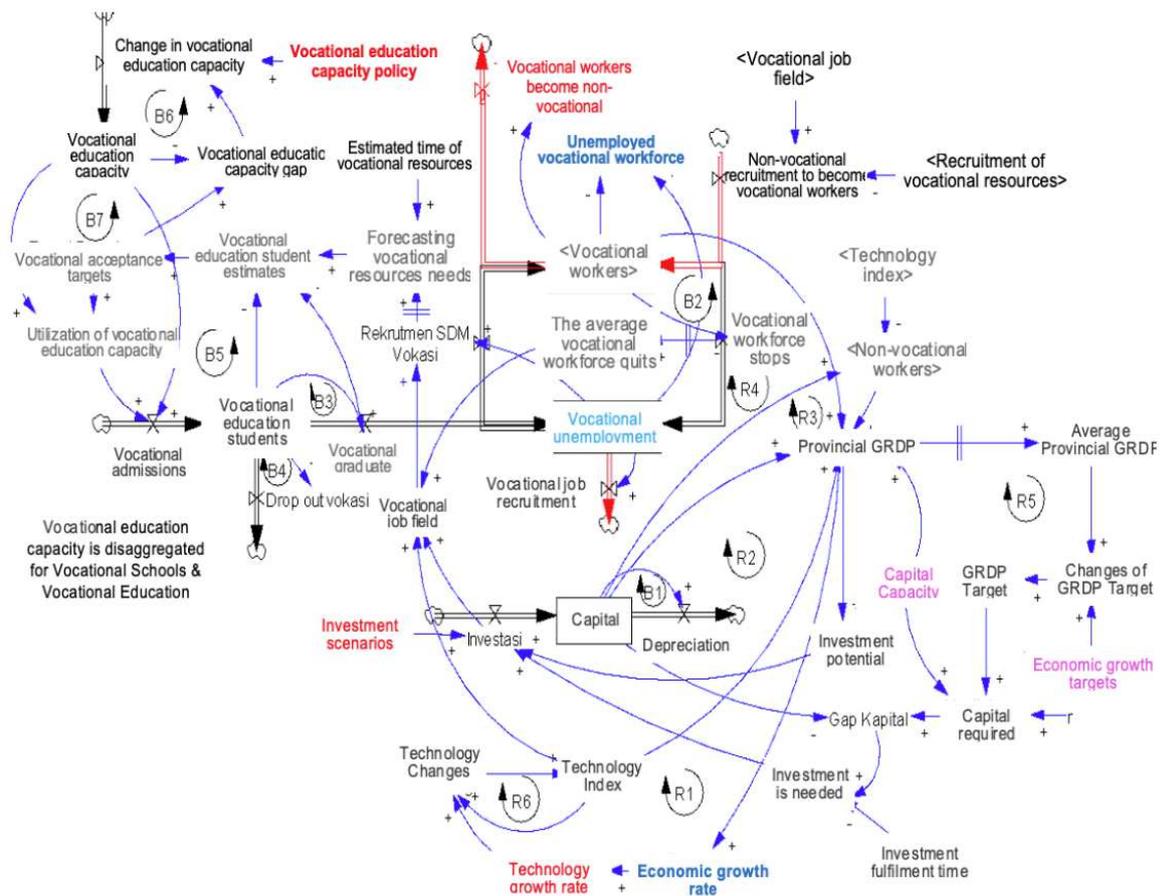


Figure 2. Causal loop diagram of economics and employment

Education’s Dapodik system and BPS education statistics (Table 4). These data are essential to map the supply of skilled labor and anticipate potential mismatches. The integration of system dynamics modeling, macroeconomic projections, and stakeholder insights ensures that this study presents a comprehensive and data-driven forecast for aligning vocational education with labor market demands in East Kalimantan post-IKN relocation. For instance, simulations show that reducing the average job-search period from 0.9 years to 0.5 years could lower projected vocational unemployment in 2045 from 46,000 to under 40,000 individuals.

The study highlights the importance of both technical expertise and soft skills in navigating this economic transformation. Insights from foresight analysis reveal that leadership, problem-solving, and communication skills are essential for professionals adapting to regional economic shifts. Stakeholders emphasize the need for training programs that cultivate these competencies, ensuring that vocational

education institutions produce a workforce capable of responding to evolving industry demands. The causal loop diagram (CLD) in Figure 2 illustrates the feedback relationships between economic growth, employment, and vocational education. The model shows how policy interventions in education and workforce development influence labor supply and demand, creating reinforcing loops that either accelerate or hinder regional development. Empirical data from 2010 to 2023 show that East Kalimantan’s vocational workforce increased from 264,000 to 382,000 workers, while vocational unemployment declined from approximately 45,000 to 33,000 individuals. In contrast, simulations project that without policy intervention, vocational unemployment could exceed 45,000 by 2045, even under continued economic growth, highlighting the urgency of policy and curriculum alignment.

Key innovation sectors identified in this study include post-harvest technology, seafood processing, and local product development. System

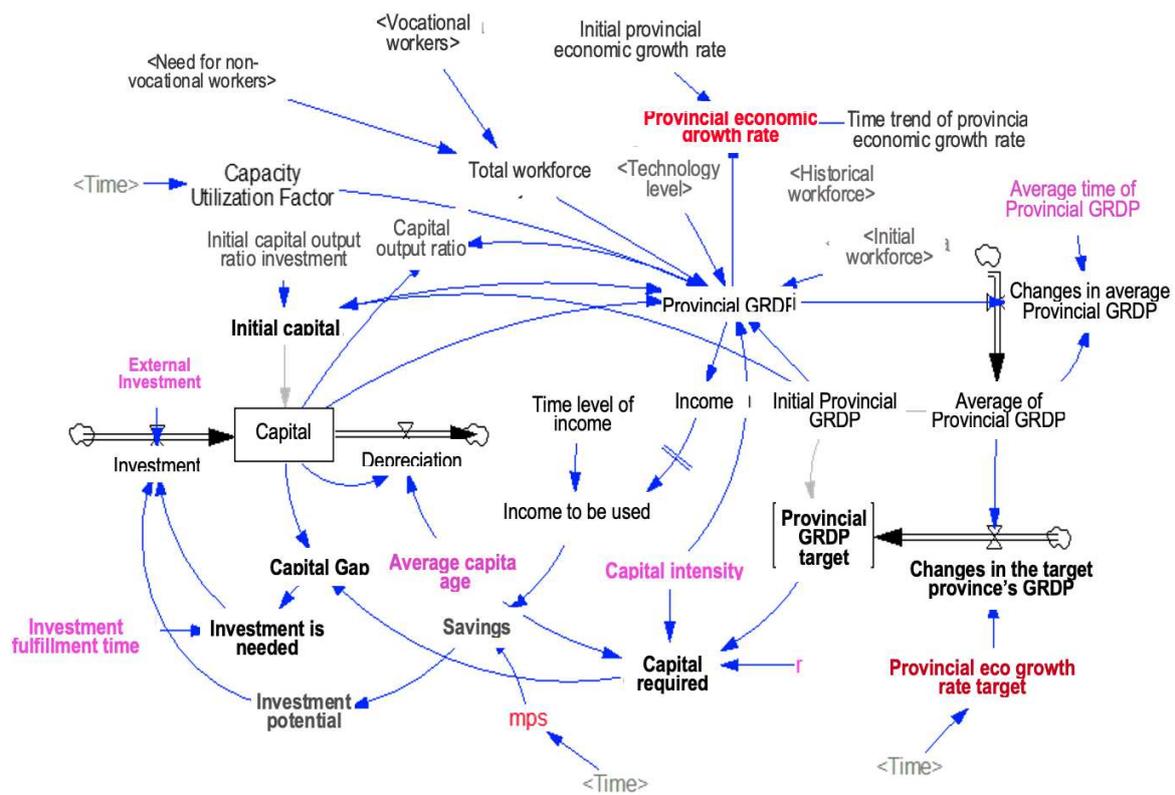


Figure 3. Stock flow diagram of economics and investment

dynamics simulations (Figure 3) reveal that East Kalimantan’s agricultural commodities, such as Dayak onions and Kerayan rice, present potential to increase regional GRDP by 1.5-2% annually through value-added processing, while coastal resources position the seafood industry to generate over 20,000 new jobs by 2045. The commercial expansion of non-timber forest products and agroforestry goods also supports long-term economic sustainability. To meet the skill requirements of these emerging industries, vocational education must integrate fields such as industrial chemical technology, food engineering, and information systems alongside conventional agricultural training. Model projections suggest that vocational labor demand will reach 525,000 by 2045, supported by steady growth in vocational school admissions, which are expected to climb to 33,000 students annually. Survey results from industry stakeholders show that over 70% of future job demand centers on digital competencies, including programming, data analysis, and content creation, whereas demand for roles such as tellers, receptionists, and traditional administrative staff is expected to decline.

The employment model developed in this research explains the dynamics of labor supply and demand, where investment-driven job creation is influenced by vocational graduate availability. Historical labor force data indicate that between 2010 and 2023, East Kalimantan’s labor force grew from approximately 1.64 million to 1.86 million individuals, with employment rising from 1.48 million to 1.75 million, and unemployment decreasing to 106,000. The stock-flow diagram (SFD) in Figure 4 captures broader economic interactions involving capital accumulation, income generation, and savings, all of which shape East Kalimantan’s long-term economic prospects. From 2010 to 2023, regional GDP rose from Rp383.3 trillion to Rp537.6 trillion, with investment increasing from Rp97.1 trillion to Rp157.5 trillion. Model simulations forecast GDP to reach Rp1.35 quadrillion and investment to reach Rp400 trillion by 2045, equivalent to an average annual increase of 5.2% and 5.8% respectively, under assumptions of stable capital-output ratios, technology elasticity, and capital utilization rates. These projections underscore the need for strategic, multisectoral interventions linking government, industry, and education to develop a resilient and future-ready vocational ecosystem.

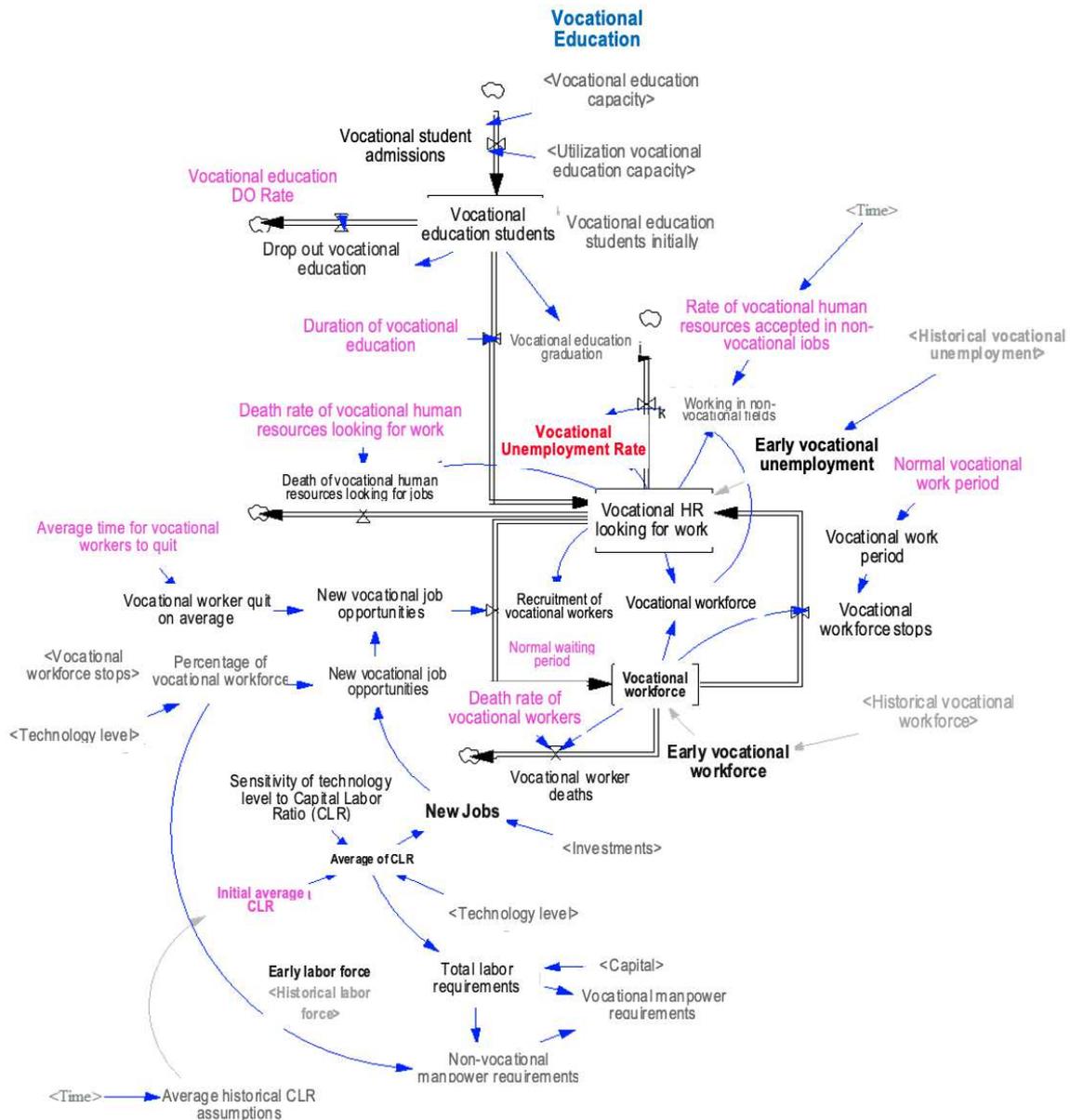


Figure 4. Stock flow diagram for vocational education

Figures 2 to 4 are methodologically connected, where the causal loop diagram (CLD) in Figure 2 serves as a conceptual framework that illustrates the reinforcing and balancing feedback loops between economic growth, investment, labor absorption, and vocational education demand. This qualitative map is then translated into stock-flow diagrams (SFD) in Figures 3 and 4, where the abstract causal relationships are operationalized into measurable stocks (such as capital accumulation, vocational graduates, and labor force) and flows (including investment inflows, job creation, and graduate output). The conversion process allows the feedback structures to be quantified and simu-

lated over time, thus providing a methodological bridge between the conceptual system dynamics model and the numerical simulations presented in the results. In this way, the SFD not only preserves the logic of the CLD but also enables policy experiments that demonstrate how changes in vocational education supply or investment levels propagate through the system and affect long-term labor market and economic outcomes.

The findings of this study, based on system dynamics simulations and foresight analysis, forecast a significant transformation in East Kalimantan's economic and labor landscape following the relo-

cation of Indonesia's capital city to Nusantara. The simulated economic trajectory shows a shift from a resource-dependent model to a service-oriented and low-carbon economy, consistent with Yusuf et al. (2023), who observed a 12% growth in the service sector and an 18% decline in carbon intensity in early transition stages. This structural shift is expected to amplify demand for a workforce equipped with digital and green skills. The model projects a steady rise in labor demand, particularly in construction, infrastructure, and service-related industries, confirming earlier observations by Syaban and Appiah-Opoku (2023) on the importance of aligning education systems with sustainable economic transitions.

The quantitative forecasts of labor supply and demand reveal critical mismatches between vocational graduate output and industry requirements. The simulation results indicate that while the vocational workforce in East Kalimantan increased from approximately 264,000 in 2010 to 382,000 in 2023, projected figures show this number reaching 525,000 by 2045. However, if vocational curricula remain outdated, the number of unemployed vocational graduates could surpass 45,000 by 2045, up from 33,000 in 2023. This reinforces the concerns raised by Ariyani et al. (2021), who emphasized that increasing vocational education access without curricular modernization can exacerbate unemployment. Additionally,

this study supports McGrath & Yamada's (2023) argument for technological adaptation in vocational training, especially in high-demand areas such as industrial chemical technology, agro-industrial engineering, and digital content creation. The inclusion of these skill domains into vocational curricula is critical for anticipating labor market needs and ensuring future workforce readiness.

Policy scenario simulations further underline the importance of collaborative governance in shaping effective vocational education reform. The model identifies participatory governance and public-private partnerships as leverage points that influence both workforce adaptability and job creation. This finding echoes Suharno et al. (2020), who argued that industry involvement in curriculum design is vital for improving graduate employability. Moreover, foresight data from stakeholder interviews confirms that over 70% of future job growth will be concentrated in digital-related fields, while administrative and manual jobs will likely decline. Aligning with Susantono et al. (2024), the study concludes that fostering institutional synergy among government, industry, and education stakeholders is key to developing a resilient innovation ecosystem. Future research should build on this model by examining the long-term impacts of vocational reforms on employment sustainability across dynamic sectors in post-relocation East Kalimantan.

CONCLUSION

This study examines how vocational education can be strategically aligned with workforce development in response to the relocation of Indonesia's new capital city (IKN) to East Kalimantan. The results show that economic transformation, marked by a transition from a resource-based to a service-oriented and low-carbon economy, will substantially reshape labor demand and skill requirements. The projections indicate sharp increases in demand for specialized labor in green industries, infrastructure development, and digital services, underlining the urgency for vocational education to prepare graduates with adaptive and future-ready competencies.

The findings reveal that curriculum reform, stakeholder collaboration, and targeted investment in emerging sectors are the most critical leverage points to align vocational training with future economic structures. Simulated scenarios further demonstrate that without structural reforms and stronger industry-education partnerships, skill mismatches and vocational unemployment may intensify by 2045. Conversely, when reforms are implemented, the model shows a more balanced and sustainable vocational ecosystem that supports long-term regional development goals.

From a policy perspective, the results highlight the need for participatory governance in vocational planning, immediate prioritization of green and digital skill development, and modernization of train-

ing pathways to meet projected industrial demands. Multi-stakeholder engagement among government, industry, and educational institutions emerges as essential for building a responsive, inclusive, and sustainable vocational education system.

AUTHOR CONTRIBUTIONS

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Formal analysis: Pandhu Rochman Suosa Putra, Adnan Putra Pratama, Rizky Yudaruddin.

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Methodology: Surahman Surahman, Karyo Budi Utomo, Pandhu Rochman Suosa Putra, Adnan Putra Pratama.

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Software: Surahman Surahman, Karyo Budi Utomo, Rizky Yudaruddin, Pandhu Rochman Suosa Putra, Adnan Putra Pratama.

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Writing – original draft: Karyo Budi Utomo, Pandhu Rochman Suosa Putra, Adnan Putra Pratama.

Writing – review & editing: Surahman Surahman, Rizky Yudaruddin.

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