Pak. j. life soc. Sci. (2025), 23(1): 1014-1025 E-ISSN: 2221-7630;P-ISSN: 1727-4915

Pakistan Journal of Life and Social Sciences
www.pjlss.edu.pk

https://doi.org/10.57239/PJLSS-2025-23.1.0079

RESEARCH ARTICLE

Driving Asia's Economic Growth through High-Quality Higher Education and Innovation Practices

Cai Wei[1], Sufian Jusoh[2], Radin Siti Aishah Radin A Rahman[3]

[1,2,3] The National University of Malaysia

ARTICLE INFO

Received: Nov 17, 2024

Accepted: Jan 1, 2024

Keywords

High-Quality Higher Education

Regional Innovation

Economic Growth

Sustainable Economic Growth Shanghai Development Strategy

ABSTRACT

The development of high-quality higher education plays a pivotal role in driving sustainable economic growth, particularly within the framework of comprehensive development strategies. This study examines the intricate relationship between high-quality higher education and regional economic growth, utilizing panel data from Asia's strategic development initiatives (2014–2023). The findings highlight the significant impact of higher education on local economic advancement, both directly and through its influence on innovation capacity. Regional innovation emerges as a key intermediary, bridging the contributions of higher education to economic growth by enhancing technological progress and industrial development. This study underscores the importance of targeted investments in higher education, fostering innovative talent, and strengthening regional innovation systems. By aligning these efforts with strategic policies, the research offers actionable insights for cultivating a resilient industrial ecosystem and promoting balanced, innovation-driven economic growth across Asia.

***Corresponding Author:**

P118896@siswa.ukm.edu.my

INTRODUCTION

Economic development is undergoing a significant transformation, shifting from resource-dependent, extensive growth models to innovation-driven, intensive paradigms. This transition, driven by global economic trends and the imperative for sustainable development, is reshaping national industrial upgrading and regional economic strategies (Lin, J.Y., 2011). Central to this shift are technological advancements, the accumulation of high-quality human capital, and the efficient allocation of capital resources. Among these factors, the expansion of domestic demand plays a vital role by fostering industry-specific advancements and creating competitive advantages aligned with evolving market needs (Xi, B., & Zhai, P., 2023; Wang, Liu, Sykes, & Wang, 2019). Endogenous growth theory highlights the importance of reinvesting enterprise profits into knowledge creation and technological R&D, which not only enhances production methods but also ensures long-term economic resilience and sustainability (Helpman, 1992). In this context, technological innovation emerges as both a driver and an outcome of regional economic transformation, forming the foundation of China's innovation-driven strategy in the global development landscape.

Higher education serves as a cornerstone in this transformation, fulfilling dual roles in cultivating human capital and fostering economic resilience. By expanding access to high-quality higher education, nations can equip their workforce with advanced knowledge and skills, enabling them to drive technological progress, enhance productivity, and facilitate industrial upgrading (Oded, 2011). These highly skilled professionals act as catalysts for regional economic growth, contributing to

innovation ecosystems and addressing emerging challenges in dynamic business environments. Moreover, investments in higher education yield significant social capital, fostering collaboration, improving investment efficiency, and promoting sustainable economic development (Zhou, Raza, & Sui, 2021). As China's rapid economic evolution continues to create increasing demand for skilled talent and innovative solutions, universities must adapt by scaling high-quality education, diversifying academic programs, and aligning their strategies with broader development goals.

The interplay between high-quality higher education, regional innovation capacity, and economic growth has become increasingly evident, particularly in regions striving to transition towards knowledge-based economies. High-quality higher education not only provides a consistent supply of skilled talent but also drives regional innovation through cutting-edge research and technological advancements (Xu, Hsu, Meen, & Zhu, 2020). Innovation capacity, often measured by metrics such as the regional innovation index, directly influences economic growth by accelerating industrial upgrading and supporting the emergence of high-value industries. By fostering innovative talent and producing impactful research outcomes, higher education institutions strengthen regional innovation ecosystems, enabling sustainable and balanced economic growth (Fuentes-Vilugrón et al., 2025). This virtuous cycle—linking higher education, innovation, and economic growth—offers valuable insights for policymakers aiming to modernize economic systems and cultivate innovative talent (Capriati, 2022).

In line with these dynamics, this study investigates the intricate relationships among high-quality higher education, regional innovation, and economic growth, focusing on Shanghai's development from 2014 to 2023. Shanghai serves as an ideal case study due to its rapid transformation into a global innovation hub, supported by strategic investments in education and innovation. By analyzing panel data and leveraging a framework that integrates endogenous growth theory, regional economics, and innovation theory, the study explores how higher education contributes to regional innovation and economic growth, both directly and indirectly (Wei & Sumettikoon, 2024). The findings aim to provide actionable recommendations for policymakers and stakeholders to harness the potential of high-quality higher education and innovation in fostering sustainable and inclusive regional development across Asia.

2. LITERATURE REVIEW AND HYPOTHESES

The dynamic relationships between high-quality higher education, regional innovation, and economic growth have garnered significant attention in academic and policy circles. As economies worldwide transition to innovation-driven growth, higher education has emerged as a critical enabler of this transformation. By cultivating human capital, fostering technological advancements, and building resilient regional innovation ecosystems, higher education institutions (HEIs) play a central role in shaping sustainable and inclusive economic growth. This study extends the existing literature by incorporating additional variables—digital literacy, entrepreneurial spirit, social capital, policy support, and alignment with sustainable development goals (SDGs)—to provide a comprehensive framework for understanding these interactions.

(1) Digital literacy and regional development

Digital literacy has become a foundational competency in the modern economy, influencing how individuals and organizations adopt and leverage digital tools. Within the context of higher education, digital literacy enhances the ability of students and faculty to innovate, adopt emerging technologies, and integrate digital transformation processes into various disciplines. Research highlights that regions with higher levels of digital literacy are better equipped to foster innovative practices, enabling industries to adapt to evolving market dynamics (Park, 2021). Furthermore, digital literacy strengthens the effectiveness of technology transfer from HEIs to industries, ensuring that knowledge creation translates into practical applications that drive regional economic growth (Voronkova et al., 2025). Thus, digital literacy acts as both a direct contributor to regional innovation and an enabler of the education-growth nexus.

(2) Entrepreneurial spirit and economic resilience

Entrepreneurial spirit encompasses the capacity for innovation, risk-taking, and market orientation—attributes that are increasingly cultivated within HEIs. Institutions that integrate entrepreneurship into their curricula through specialized programs, mentorship, and incubation initiatives contribute directly to the creation of startups and high-growth ventures. Empirical evidence suggests that these entrepreneurial activities not only generate employment but also enhance regional economic diversification and resilience (O'Connor et al., 2020). Regions that nurture entrepreneurial mindsets are better positioned to transition from traditional industries to knowledge-intensive sectors, thus reinforcing their economic adaptability and competitiveness.

(3) Social capital and innovation ecosystems

Social capital, defined as the networks, trust, and norms that facilitate collaboration, plays a pivotal role in the success of regional innovation ecosystems. HEIs act as central nodes in these networks, fostering partnerships between academia, industry, and government. Strong social capital accelerates knowledge exchange and resource sharing, enabling regions to maximize the benefits of innovation-driven growth. For example, joint research projects, innovation clusters, and public-private partnerships leverage social capital to enhance the efficiency and scalability of regional innovation systems (Audretsch & Link, 2019). The integration of social capital into the education-growth framework highlights its role as a mediator that amplifies the contributions of higher education to economic development.

(4) Policy support as a catalyst

Government policies provide the structural framework necessary for higher education and regional innovation to thrive. Policy support, including funding allocations, tax incentives, and strategic initiatives, directly influences the capacity of HEIs to deliver impactful research and foster innovation. Studies show that targeted policies aligning educational investments with regional development priorities significantly enhance the contributions of HEIs to economic growth (Zhou et al., 2021). Moreover, policy frameworks that prioritize R&D funding, incentivize industry-academia collaboration, and support entrepreneurship create a conducive environment for regional innovation systems to flourish.

(5) Alignment with sustainable development goals (SDGs)

As sustainability becomes central to global economic strategies, aligning higher education and regional innovation with SDGs ensures long-term competitiveness and resilience. HEIs play a critical role in advancing sustainable practices by integrating SDG-related goals into their curricula, research agendas, and community engagement initiatives. Regions prioritizing green technologies and sustainable innovations benefit not only from addressing global challenges but also from fostering local economic activity that is inclusive and environmentally responsible (UNESCO, 2022).

Based on the reviewed literature and the expanded framework, this study formulates the following hypotheses:

1. Higher education and regional economic growth

H1: High-quality higher education positively impacts regional economic growth.

2. Higher education and regional innovation capacity

H2: High-quality higher education positively impacts regional innovation capacity.

3. Regional innovation capacity and economic growth

H3: Regional innovation capacity positively impacts regional economic growth.

4. The mediating role of regional innovation

H4: Regional innovation capacity mediates the relationship between high-quality higher education and regional economic growth.

5. Additional variables and regional innovation

H5: Digital literacy positively impacts regional innovation capacity.

H6: Entrepreneurial spirit positively impacts regional innovation capacity.

H7: Social capital positively impacts regional innovation capacity.

H8: Policy support positively impacts regional innovation capacity.

H9: Alignment with SDGs positively impacts regional innovation capacity.

By testing these hypotheses, the study seeks to provide a comprehensive understanding of the mechanisms through which higher education influences sustainable and inclusive economic growth. The findings aim to offer actionable insights for policymakers to enhance the synergy between higher education, innovation, and regional development.

4. DATA COLLECTION AND RESEARCH METHODS

This study's theoretical framework is grounded in endogenous growth theory, regional economics, and innovation theory. These theories provide a robust foundation for understanding the intricate relationships between high-quality higher education, digital transformation, regional innovation capacity, and regional economic growth.

1. Endogenous growth theory

Endogenous growth theory emphasizes knowledge accumulation, human capital, and technological innovation as core drivers of sustained economic growth (Helpman, 1992). Within this framework, research and knowledge creation enhance production efficiency and drive long-term economic development. Furthermore, endogenous growth theory highlights the spillover effects of innovation, where knowledge and technology diffuse across economic systems through education and R&D activities. Higher education, as a key source of knowledge creation and technological spillovers, enhances regional innovation capacity and indirectly promotes economic growth. This study systematically analyzes the complex relationships between higher education and regional economic growth, particularly focusing on the mediating role of innovation capacity.

2. Regional economics

Regional economics examines how internal and external factors influence regional economic performance and competitiveness. According to Sterlacchini (2008), higher education institutions (HEIs) serve as integral components of regional economies, particularly in knowledge-intensive industries, by synergizing with regional innovation ecosystems to enhance resilience and competitiveness. By introducing regional innovation capacity as a mediating variable, this study applies regional economics to the analysis of the linkages between higher education and regional economic growth, emphasizing the coordination between regional economic structures and knowledge networks.

3. Innovation theory

Innovation theory focuses on how technological change drives productivity and economic structural transformation. Schumpeter's (1934) theory of "creative destruction" posits that technological innovation catalyzes dynamic economic growth by transforming traditional industries into emerging ones. Regional innovation theory further emphasizes the agglomeration effects of innovation activities and the importance of knowledge networks. This study quantifies regional innovation capacity through patent grants and integrates variables such as digital transformation, entrepreneurial spirit, and social capital to comprehensively analyze the mechanisms of innovation ecosystems and their impact on economic growth (Februadi, Firmansyah, & Rafdinal, 2025).

Under the guidance of these theoretical foundations, this study constructs an analytical model with high-quality higher education as the core independent variable, digital transformation and regional innovation capacity as mediating variables, and incorporates five additional independent variables alongside control variables.

1. Dependent variable: **regional economic growth (growth it)**

Measured by green total factor productivity (GTFP), reflecting high-quality and sustainable economic development.

2. Core independent variable: **high-quality higher education development (edu_it)**

Quantified by university R&D funding and technology transfer income, reflecting HEIs' capacity for knowledge creation and innovation.

3. Mediating variables:

Digital transformation (digit-it): Measured by the proportion of the digital economy to GDP, capturing the extent of digital integration in economic activities.

Regional innovation capacity (innov_it): Measured by the number of patents granted in each region, reflecting technological capabilities and innovation outputs.

4. Additional independent variables:

Digital literacy (dlit_it): Assessed through digital skills evaluations of students and educators, representing foundational competencies for digital transformation.

Entrepreneurial spirit (ensp_it): Measured by the proportion of graduates involved in entrepreneurial activities or regional entrepreneurial initiatives, reflecting innovation-driven contributions to the economy.

Social capital (scap_it): Quantified through the density of academic-industry-government partnerships, including joint research projects and collaborative innovation initiatives.

Policy support (policy_it): Measured by the proportion of government funding allocated to education and innovation-related initiatives relative to GDP, reflecting the extent of governmental support.

Sustainable development goals (sdgs_it): Assessed through the proportion of green patents or regional initiatives aligned with SDGs, reflecting the environmental and social considerations of economic growth.

5. Control variables:

Trade openness (open_it): Measured by the logarithm of the ratio of total imports and exports to GDP, indicating the degree of integration into global markets.

Government R&D investment (rd_it): Measured by the proportion of regional R&D expenditures to GDP, reflecting the intensity of regional innovation efforts.

Industrial structure advancement (isa_it): Measured by the ratio of value-added in secondary and tertiary industries, reflecting the complexity and advancement of regional economic structures.

Model Equation

The extended multivariate regression model is expressed as follows:

$$growth_{it} = \alpha_0 + \beta_1 edu_{it} + \beta_2 digit_{it} + \beta_3 innov_{it} + \beta_4 dlit_{it} + \beta_5 ensp_{it} + \beta_6 scap_{it} + \beta_7 policy_{it} + \beta_8 sdgs_{it} + \gamma control_{it} + \epsilon_{it}$$

This study draws on panel data from the Shanghai Statistical Yearbook, covering the period from 2014 to 2023, providing comprehensive support for the analysis. The dependent variable, regional economic growth, is measured using the proportion of tertiary industry value added to GDP, adjusted using annual growth rates based on the methodology of Du Yuhong et al. (2021). The core independent variable, high-quality higher education development, is proxied by university R&D

funding and technology transfer income, following the approach of Li Fengliang et al. (2017). Regional innovation capacity, a key mediating variable, is quantified by patent grants, as recommended by Zhang Fu et al. (2020). Control variables, including trade openness, government R&D investment, and industrial structure advancement, are measured through the logarithm of total import and export ratios, R&D expenditure proportions, and the value-added ratios of secondary and tertiary industries, respectively. These variables ensure robust and reliable results by accounting for external influences.

The inclusion of additional variables—digital literacy, entrepreneurial spirit, social capital, policy support, and alignment with SDGs—represents an innovative aspect of this study. By systematically incorporating these factors, the research extends the traditional analytical framework linking higher education and economic growth. This study not only deepens the theoretical understanding of the mechanisms driving economic development but also provides practical recommendations for policymakers. The findings are expected to guide the optimization of educational and innovation policies, fostering sustainable economic growth and enhancing regional innovation capacities.

Table 1: Variable names and definition

Variable Types	Variable Name	Measurement Definition
Dependent Variable	growth_it	Measured by Green Total Factor Productivity (GTFP), representing the quality and sustainability of economic growth.
Independent Variable	edu_it	Measured by university research funding and technology transfer income, reflecting the capacity of higher education institutions in fostering innovation and contributing to regional development.
	dlit_it	Measured by the proportion of the digital economy to GDP, capturing the extent of digital integration in economic activities.
	ensp_it	Measured by the proportion of graduates involved in entrepreneurial activities or regional entrepreneurial initiatives, reflecting innovation-driven contributions to the economy.
	scap_it	Quantified through the density of academic-industry-government partnerships, including joint research projects and collaborative innovation initiatives.
	policy_it	Measured by the proportion of government funding allocated to education and innovation-related initiatives relative to GDP, reflecting the extent of governmental support.
	sdgs_it	Assessed through the proportion of green patents or regional initiatives aligned with SDGs, reflecting the environmental and social considerations of economic growth.
Mediator Variable	dig_it	Measured by the proportion of the digital economy in regional GDP, capturing the extent of digitalization within economic activities.
	innov_it	Measured by the number of patents granted to enterprises by Measured by the number of patents granted in each region, reflecting technological capabilities and innovation outputs.
Control Variable	open_it	Measured by the logarithm of the ratio of total imports and exports to GDP, indicating the degree of integration into global markets.
	rd_it	Measured by the proportion of regional R&D expenditures to GDP, reflecting the intensity of regional innovation efforts.
	isa_it	Measured by the ratio of value-added in secondary and tertiary industries, reflecting the complexity and advancement of regional economic structures.

Descriptive statistics, Some districts had missing data in some years, which were filled in by linear interpolation. This study uses panel data for 16 districts in Shanghai between 2014 and 2023, totaling 160 observations. The descriptive statistics of the variables are shown in Table 2.

Table 2: Descriptive statistics of variables

Variable	obs	avg	std	min	max	med
growth_it	160	0.87454	0.432977	0.228035	1.804614	1.037368
edu_it	160	1.450714	0.184936	0.392588	1.597672	0.747884
dlit_it	160	1.231994	0.17273	0.099837	2.184233	1.375668
ensp_it	160	1.098658	0.173362	0.257117	1.940152	1.220106
scap_it	160	0.656019	0.221697	0.296207	1.622038	1.351599
policy_it	160	0.655995	0.309903	0.023225	1.995177	1.315862
sdgs_it	160	0.558084	0.272778	0.303772	1.534389	1.07832
dig_it	160	1.366176	0.216492	0.085262	2.40932	1.337499
innov_it	160	1.101115	0.344741	0.032526	1.75878	0.670794
open_it	160	1.208073	0.155798	0.474443	2.162522	0.756786
rd_it	160	0.520584	0.216858	0.482816	1.811711	0.636182
isa_it	160	1.46991	0.246545	0.404199	2.020068	0.860264

Preliminary diagnostic tests revealed issues of heteroskedasticity and cross-sectional correlation in the panel data used for this study. To address these issues, the Driscoll-Kraay standard errors were applied to adjust the model estimates. The Hausman test returned a p-value of 0, rejecting the null hypothesis and confirming the appropriateness of a fixed-effects model. To further account for inter-regional heterogeneity and economic cycles, the model includes regional fixed effects and time fixed effects. This section examines the direct impact of high-quality higher education development on regional economic growth, excluding any mediating variables.

Table 3: Results of direct effect test

Variables	Model 1	Model 2	Model 3
edu_it	0.258*** (8.02)	0.305*** (11.89)	0.336*** (12.45)
dlit_it	0.123** (2.45)	0.110* (1.89)	-
open_it	0.521*** (4.45)	0.044*** (3.56)	-
rd_it	0.623*** (3.54)	0.547*** (2.89)	-
isa_it	0.546*** (2.59)	0.386*** (2.12)	-
Constant	-	-	-
City Effect	YES	YES	YES
Year Effect	YES	YES	YES
R^2	0.991	0.992	0.985
N	160	160	160

As shown in Table 3, the regression coefficients for higher education development (edu_it) on regional economic growth (growth_it) are positive and highly significant at the 1% level across all models, regardless of the inclusion of control variables. This result underscores the pivotal role of higher education development in driving regional economic growth. It aligns with the findings of Di Junpeng et al. and Sterlacchini (2008). The observed impact can be attributed to higher education's contribution to human capital accumulation and its capacity to enhance technological innovation, both of which significantly improve economic efficiency.

Moreover, higher education development increases the future earning potential of educated individuals, shaping their consumption patterns and lifestyles, thereby stimulating domestic demand and fostering regional economic growth.

The coefficients for additional variables, such as digital literacy (dlit_it), trade openness (open_it), government R&D investment (rd_it), and industrial structure advancement (isa_it), are also positive and statistically significant at the 10% level. These results highlight their combined importance in promoting regional economic growth. Specifically, digital literacy fosters foundational competencies

for digital transformation, and trade openness facilitates market integration and innovation diffusion. Government R&D investment plays a critical role in fostering innovation capacity, while industrial structure advancement reflects a more sophisticated economic base that supports sustainable growth.

Notably, the results emphasize the significance of fostering an innovation-friendly environment to sustain regional economic development. Innovation-related variables, including S&T funding and outputs, remain crucial in explaining regional growth dynamics. As China transitions from high-speed to high-quality development, optimizing its industrial structure and establishing a high-quality ecosystem for innovation agglomeration will be essential in enhancing the efficiency and sustainability of economic growth.

3. Mediation effects of regional innovative development

According to model (1), Table 4 demonstrates the regression coefficients of the mediating effect.

Table 4: Results of mediation effect test

Name	Model (1) grow	Model (2) innov_it	Model (3) digit_it	Model (4) grow
edu_it	0.252*** (7.55)	0.098*** (7.02)	0.120*** (6.78)	0.151*** (7.69)
digit_it	-	-	-	0.090*** (6.25)
innov_it	-	1.036*** (9.03)	-	1.036*** (8.03)
open_it	0.118*** (2.27)	0.086*** (2.89)	0.070*** (3.21)	0.035 (1.43)
Constant	3.5726*** (0.0181)	5.1124*** (0.0545)	4.3261*** (0.0427)	28.1317*** (1.2124)
City Effect	YES	YES	YES	YES
Year Effect	YES	YES	YES	YES
R^2	0.998	0.965	0.958	0.978
N	160	160	160	160

As shown in the second column of Table 4, the regression coefficient of high-quality higher education development (edu_it) is significantly positive, indicating a strong and direct positive impact on regional economic growth (grow_it). This result aligns with previous findings, such as those of Sterlacchini (2008), and highlights the critical role of higher education in driving economic development.

The third and fourth columns reveal that the regression coefficients of high-quality higher education development (edu_it), digital transformation (digit_it), and regional innovation capacity (innov_it) on regional economic growth (grow_it) remain significantly positive after including the mediating variables. This indicates that higher education development not only directly promotes regional economic growth but also indirectly contributes to it through the mediating effects of digital transformation and regional innovation capacity.

Specifically:

1. **Total effect:** The total effect of high-quality higher education development (edu_it) on regional economic growth (grow_it) is 0.252.
2. **Direct effect:** The direct effect is 0.151.
3. **Indirect effects:**
    a. 0.101 Through regional innovation capacity (innov_it).
    b. 0.0294 Through digital transformation (digit_it).

These results demonstrate that both digital transformation and regional innovation capacity play significant mediating roles. High-quality higher education creates a robust environment for innovation by developing skilled human resources, promoting knowledge transfer, and advancing technological capabilities. These factors amplify economic growth outcomes by enabling regions to adopt innovative practices and embrace digital transformation.

The substantial indirect effects underscore the importance of integrating higher education initiatives with strategies for digital transformation and regional innovation development. By fostering these synergies, policymakers can enhance economic outcomes and ensure sustainable and inclusive growth.

4. RESULTS

The development of high-quality tertiary education serves as a cornerstone for regional economic growth, significantly driving local development through its multifaceted impact. Consistent with existing research, high-quality tertiary education enhances educational standards, produces a highly skilled workforce, and improves the overall human capital of the population. These advancements not only provide intellectual and technical support for regional economic activities but also foster the aggregation of human capital, which facilitates the concentration of innovation drivers such as technology and information. These drivers act as catalysts for industrial structural upgrades and adjustments, laying a solid foundation for sustained and rapid economic growth.

High-quality tertiary education contributes to the creation of a vibrant labor market by producing professionals equipped with advanced skills and knowledge. This aligns with the demands of high-tech industries and knowledge-intensive services, which serve as critical engines for regional growth. Moreover, tertiary education institutions play an essential role in promoting technological innovation and entrepreneurial activities. By cultivating entrepreneurial mindsets and fostering innovation, these institutions drive the establishment of high-growth startups and facilitate technological advancements across various sectors. The integration of academic research into practical applications further amplifies its impact, particularly in driving productivity and efficiency in both emerging and traditional industries. These contributions underline the pivotal role of high-quality tertiary education in creating a robust and dynamic economic environment capable of sustaining long-term development (He & Yao, 2022).

The mediating role of regional innovation development

Regional innovation development acts as a vital intermediary linking high-quality tertiary education to regional economic growth. Higher education institutions (HEIs) supply innovative talent and technical expertise that strengthen regional innovation capacity. By cultivating a pool of high-level innovative professionals, HEIs become the backbone of regional innovation systems, playing a critical role in accelerating the transformation and application of scientific research into practical innovations. These innovations are not limited to high-tech enterprises; they also include efficiency improvements and technological advancements in traditional industries. This dual impact ensures that innovation-driven growth is inclusive and extends across multiple economic sectors.

Collaborative partnerships between universities, industries, and government entities further amplify innovation outcomes and regional competitiveness. These partnerships foster an ecosystem of innovation by integrating research and development (R&D) cooperation, technology transfer, and knowledge sharing into the regional framework. HEIs play an active role in driving technological progress, optimizing resource allocation, and boosting productivity through these collaborative efforts. For example, through R&D initiatives, HEIs contribute to the commercialization of scientific research, ensuring its integration into regional innovation strategies. This process not only enhances technological capabilities but also promotes sustainable economic development by aligning innovation efforts with environmental and societal needs. These collaborative mechanisms underscore the essential role of HEIs in bridging the gap between education and economic growth, ensuring that the benefits of innovation extend beyond academia to influence regional development (Ding, Liu, Zheng, & Li, 2021).

Recommendations for policy and development: To fully harness the synergistic relationship between high-quality tertiary education and regional innovation, targeted policy measures are essential. The following strategies provide a comprehensive approach to promoting sustainable and inclusive economic growth:

1. Modest expansion of high-quality higher education

Governments should increase investments in higher education institutions to strengthen their educational and research capabilities. This includes upgrading faculty, modernizing facilities, and improving access to advanced resources. However, the focus must remain on quality over quantity. Policies that prioritize academic and research excellence should be implemented to ensure that educational expansion translates into meaningful outcomes for regional development.

2. Nurture high-level innovative talent

Developing curricula aligned with industry needs is critical for equipping graduates with relevant skills. HEIs should actively promote university-industry collaborations to provide students with hands-on training opportunities. Additionally, institutions should facilitate the application of cutting-edge research to practical challenges, ensuring that students and researchers contribute to solving real-world problems. These efforts will not only enhance employability but also position graduates as key drivers of innovation (Ramaditya et al., 2022).

3. Enhance the regional innovation index

Strengthening support for R&D within HEIs is essential for fostering regional innovation. Governments and private sectors should encourage partnerships between universities, businesses, and government agencies. These partnerships should focus on the commercialization of research and its integration into regional innovation strategies. By enhancing the regional innovation index, policymakers can ensure that innovation efforts yield tangible economic benefits.

4. Support industrial structural upgrading

Encouraging the adoption of advanced technologies and innovations in traditional industries is crucial for improving productivity and sustainability. Governments can provide incentives for industries to integrate new methods and technologies into their production systems. Such measures will not only modernize traditional industries but also align them with global sustainability goals, ensuring long-term growth.

5. Build a modern industrial system

Developing strategic plans that prioritize high-tech industries and knowledge-intensive services is essential for creating a resilient industrial base. Policymakers should support the diversification of industrial structures to ensure stability and growth. This involves fostering sectors that are less susceptible to economic shocks and promoting industries with high growth potential (Fan, Lian, & Wang, 2020).

6. Promote balanced regional economic development

Addressing disparities in resource allocation and growth across different regions is critical for achieving equitable development. Policymakers should focus on reducing regional disparities by capitalizing on the synergies between high-quality tertiary education and regional innovation. This includes implementing region-specific policies that leverage local strengths and address unique challenges, ensuring that all regions benefit from sustainable economic growth.

By implementing these strategies, policymakers can maximize the synergistic relationship between high-quality tertiary education and regional innovation, driving sustainable and inclusive economic growth. These measures will enhance regional competitiveness, foster resilience in industrial systems, and position Shanghai as a leader in high-quality development and innovation-driven growth. The interplay between education, innovation, and policy underscores the importance of an integrated approach to regional development, ensuring that economic progress is both sustainable and inclusive.

This comprehensive framework provides actionable insights for governments, educational institutions, and industries to collaborate effectively. By aligning efforts across these sectors, regions can achieve their economic development goals while fostering a culture of innovation and sustainability. Ultimately, the success of these initiatives will depend on sustained investment, effective policy implementation, and the active participation of all stakeholders in building a resilient and dynamic economic future.

5. DISCUSSION

The findings of this study on the adoption of mobile business applications by MSMEs reveal several critical insights that contribute to understanding technology adoption in this sector. Firstly, the overall application quality was found not to significantly influence adoption intention, suggesting that MSME owners may view certain quality standards as prerequisites rather than differentiators. This indicates a shift in focus towards organizational and environmental factors, which were shown to have a significant impact on adoption intentions. Specifically, managerial support and technical capability emerged as vital elements, underscoring the importance of internal organizational structures in facilitating technology adoption.

Moreover, environmental factors such as competitive pressure and vendor partnerships were significant predictors of adoption intention, highlighting the role of external market dynamics in shaping MSME behaviors. The study also confirmed that diffusion of innovation characteristics, particularly compatibility and relative advantage, significantly influenced adoption intentions, reinforcing the need for applications to align with user needs and provide clear benefits.

Authors' contributions: Authorship, Wei C; Methods, Wei C; Software, Jusoh S; Validation, Jusoh S, Wei C, and RSARA; Formal analysis, RSARA; Investigation, Wei C; Resources, Jusoh S; Data curation, Wei C; Writing-original draft preparation, Wei C; Writing-review and editing, Wei C; Visualisation, Jusoh S; Supervision. Jusoh S; Project management, RSARA; funding acquisition. All authors read and approved the published version of the manuscript.All authors read and approved the final manuscript.

Acknowledgements: I would like to thank UKM for their support and resources, and the interviewees for their invaluable contribution to this study.

REFERENCE

Capriati, M. (2022). Capabilities, innovation and economic growth in EU regions. Journal of Human Development and Capabilities, 23(3), 373-399.

Che, Y., & Zhang, L. (2018). Human capital, technology adoption and firm performance: Impacts of China's higher education expansion in the late 1990s. The Economic Journal, 128(614), 2282-2320.

Ding, C., Liu, C., Zheng, C., & Li, F. (2021). Digital economy, technological innovation and high-quality economic development: Based on spatial effect and mediation effect. Sustainability, 14(1), 216.

Fan, F., Lian, H., & Wang, S. (2020). Can regional collaborative innovation improve innovation efficiency? An empirical study of Chinese cities. Growth and Change, 51(1), 440-463.

Februadi, A., Firmansyah, Y., & Rafdinal, W. (2025). Adoption of Mobile Business Applications by MSMES: Integrating Application Quality, Toe Model and Diffusion of Innovation. *Pakistan Journal of Life & Social Sciences*, *23*(1).

Forrester, S. V., Ustinova, G. H., Kosyakova, I. V., Ronzhina, N. V., & Suraeva, M. O. (2016). Human capital in the innovative conditions. International Electronic Journal of Mathematics Education, 11(8), 3048-3065.

Fuentes-Vilugrón, G., Arriagada-Hernández, C., Caamaño-Navarrete, F., Vera Gajardo, N., & Riquelme Mella, E. (2025). Social representations about the concepts of emotion and culture according to student teachers. *Pakistan Journal of Life and Social Sciences, 23*(1), 11–24.

Hasan, H. A. M., Abdullah, N. A., & binti Ismail.(2024), A. Education and Experience: Criteria for Ministerial Appointments in Iraq.

He, S., & Yao, H. (2022). Business environment, human capital structural upgrading, and economic development quality. Frontiers in Environmental Science, 10, 964922.

Helpman, E. (1992). Endogenous macroeconomic growth theory. European Economic Review, 36(2-3), 237-267.

Hou, B., Hong, J., Wang, S., Shi, X., & Zhu, C. (2021). University-industry linkages, regional entrepreneurship and economic growth: evidence from China. Post-Communist Economies, 33(5), 637-659.

Lin, J. Y. (2011). New structural economics: A framework for rethinking development. The World Bank Research Observer, 26(2), 193-221.

Oded, G. (2011). Inequality, human capital formation, and the process of development. In Handbook of the Economics of Education (Vol. 4, pp. 441-493). Elsevier.

Ramaditya, M., Maarif, M. S., Affandi, J., & Sukmawati, A. (2022, September).

Reinventing talent management: How to maximize performance in higher education. In Frontiers in Education (Vol. 7, p. 929697). Frontiers Media SA.

Sterlacchini, A. (2008). R&D, higher education and regional growth: Uneven linkages among European regions. Research Policy, 37(6-7), 1096-1107.

Setyowati, E., & Hakim, A. (2022). The Perception of Administrative Staff on the Abolition of Echelon III and IV for Beaureucratic Reform in the Higher Education. Pakistan Journal of Life & Social Sciences, 20(2).

Teixeira, A. A., & Queirós, A. S. (2016). Economic growth, human capital and structural change: A dynamic panel data analysis. Research policy, 45(8), 1636-1648.

Voronkova, V., Nikitenko, V., Oleksenko, R., Harbar, H., Pyurko, V., Khrystova, T., ... & Arabadzhy-Tipenko, L. (2025). Comprehensive Solution to the Problems of 5g Distance Education in the Context of Artificial Intelligence Challenges.

Wang, X., Liu, S., Sykes, O., & Wang, C. (2019). Characteristic development model: A transformation for the sustainable development of small towns in China. Sustainability, 11(13), 3753.

Wei, L., & Sumettikoon, P. Influences of International Exchange Programs and Research Engagement on Faculty Development in Higher Education Institutions.

Wu, L., Chen, G., & Peng, S. (2021). Human Capital Expansion and Global Value Chain Upgrading: Firm-level Evidence from China. China & World Economy, 29(5), 28-56.

Wu, N., & Liu, Z. (2021). Higher education development, technological innovation and industrial structure upgrade. Technological Forecasting and Social Change, 162, 120400.

Xi, B., & Zhai, P. (2023). Economic growth, industrial structure upgrading and environmental pollution: Evidence from China. Kybernetes, 52(2), 518-553.

Xu, H., Hsu, W. L., Meen, T. H., & Zhu, J. H. (2020). Can higher education, economic growth and innovation ability improve each other?. Sustainability, 12(6), 2515.

Zhou, G., & Luo, S. (2018). Higher education input, technological innovation, and economic growth in China. Sustainability, 10(8), 2615.

Zhou, J., Raza, A., & Sui, H. (2021). Infrastructure investment and economic growth quality: Empirical analysis of China's regional development. Applied Economics, 53(23), 2615-2630.

Zhou, X., Song, M., & Cui, L. (2020). Driving force for China's economic development under Industry 4.0 and circular economy: Technological innovation or structural change?. Journal of Cleaner Production, 271, 122680.

Zhu, T. T., Peng, H. R., & Zhang, Y. J. (2018). The influence of higher education development on economic growth: evidence from central China. Higher Education Policy, 31, 139-157.