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Digital Industry: Talent Mapping and Triple Helix Partnerships for Strengthening Services Exports

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ABSTRACT

The digital industry drives global economic growth, developing countries such as Indonesia face persistent digital talent gaps and weak institutional collaboration that constrain competitiveness in digital services exports. This study aims to examine the role of digital talent mapping and the Triple Helix model as strategic mechanisms for strengthening digital services exports in emerging economies, with a focus on Indonesia. This study employs a systematic literature review (SLR) conducted through five stages: problem identification, literature search, inclusion and exclusion screening, data extraction and synthesis, and thematic analysis. A total of 25 peer-reviewed journal articles and policy reports published between 2023 and 2025 were analyzed. The results show that advanced economies have effectively integrated data-driven talent mapping with institutionalized Triple Helix collaboration, leading to stronger innovation ecosystems and sustained growth in digital services exports. In contrast, Indonesia faces structural barriers, including misaligned curricula, fragmented labor market information systems, and limited coordination among government, industry, and academia. These findings indicate that aligning talent intelligence systems with Triple Helix-based governance is critical for enhancing digital services export performance. This study highlights the strategic importance of integrated talent mapping and collaborative innovation frameworks for improving export competitiveness in emerging economies

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1. INTRODUCTION

The rapid advancement of digital technologies has profoundly changed the way modern economies operate. Economic activities are no longer driven solely by physical production and trade in goods, but increasingly rely on data, digital platforms, and cross-border information flows. In this context, the digital economy has emerged as a key source of growth, with digital and digitally deliverable services becoming one of the most dynamic components of international trade [1]. Services such as software development, information technology consulting, digital finance, online education, and creative digital content allow countries to reach global markets without the traditional limitations of distance and large-scale physical infrastructure [2].

Alongside these opportunities, however, many countries face growing challenges in adapting their human capital

and institutional systems to the demands of the digital economy [3]. One of the most frequently cited constraints is the widening gap between the skills required by digital industries and those produced by existing education and training systems. Empirical studies consistently show that digital transformation is progressing faster than workforce readiness, resulting in persistent shortages of skilled digital professionals [4] [5]. In emerging economies such as Indonesia, this gap is particularly evident, as universities and training institutions often struggle to keep pace with rapid technological change and evolving industry standards.

In response to this challenge, talent mapping has gained increasing attention as a strategic approach to workforce development [6]. Talent mapping refers to a systematic effort to identify current and future skill needs and to align them with education policies, training programs, and labor market planning. Evidence from countries with more advanced digital ecosystems suggests that talent mapping can improve workforce preparedness when it is supported by reliable labor market data and integrated into national development strategies [7]. Nevertheless, in many developing countries, talent mapping initiatives remain fragmented and largely reactive, limiting their effectiveness in supporting long-term economic objectives such as export growth [8].

Human capital development alone, however, is insufficient to ensure success in the digital economy. Innovation-driven growth also depends on the quality of collaboration among key societal actors. This is where the Triple Helix model, which emphasizes interaction between government, industry, and academia, becomes highly relevant [9]. From a policy perspective, the Triple Helix framework has been widely promoted as a means of strengthening innovation ecosystems by facilitating knowledge exchange, encouraging technology transfer, and ensuring that educational outputs are aligned with market needs. Empirical evidence from advanced economies demonstrates that structured and sustained collaboration among these actors can accelerate innovation and support the expansion of high-value digital services [10].

In Indonesia, efforts to strengthen digital talent and innovation ecosystems have been initiated through various programs and policy initiatives. However, empirical findings indicate that coordination among government agencies, higher education institutions, and industry actors remains limited [11]. Weak institutional linkages, outdated curricula, and the absence of integrated labor market intelligence continue to constrain the country's ability to translate digital potential into competitive services exports. As a result, Indonesia's participation in global digital services trade remains below its potential, despite strong domestic demand and a large, young workforce [12].

Against this background, integrating talent mapping within a well-functioning Triple Helix framework represents a critical strategic challenge for Indonesia and other emerging economies. While previous studies have examined digital talent development and Triple Helix collaboration as separate issues, relatively little attention has been given to their combined role in strengthening digital services exports [13]. Therefore, this literature review seeks to synthesize recent academic and policy-oriented studies on the digital industry, talent mapping, and the Triple Helix model. By reviewing empirical evidence, conceptual frameworks, and comparative experiences published between 2023 and 2025, this study aims to identify key patterns, structural gaps, and policy-relevant insights that can inform more effective strategies for enhancing competitiveness in the global digital economy [14].

2. RESEARCH METHODS

This literature review employs a qualitative, integrative approach to synthesize current academic and policy-based knowledge on the role of talent mapping and Triple Helix partnerships in strengthening digital services exports. The methodological design is based on a systematic literature review (SLR) framework, structured in five stages: (1) problem identification, (2) literature search, (3) inclusion and exclusion criteria, (4)

data extraction and synthesis, and (5) thematic analysis.

2.1 Research Questions

To guide the review, the following research questions were formulated:

1. What are the latest developments and practices in talent mapping within the digital industry?
2. How does the Triple Helix model support the development of digital innovation ecosystems?
3. In what ways do talent strategies and Triple Helix collaborations contribute to services export growth?
4. What challenges and gaps exist in aligning talent development with digital trade expansion?

2.2 Literature Search Strategy

The literature search was conducted using academic databases including Scopus, Web of Science, ScienceDirect, Google Scholar, and relevant policy repositories such as OECD iLibrary, World Bank Documents, and UNCTAD reports. Keywords used in combination included: "digital industry", "talent mapping", "Triple Helix", "digital services exports", "innovation ecosystems", and "workforce development in ICT" Boolean operators (AND, OR) and filters were applied to narrow results to English-language peer-reviewed articles, conference papers, policy reports, and working papers published between January 2023 and April 2025.

2.3 Inclusion and Exclusion Criteria

a. Inclusion criteria:
   1) Publications addressing at least one of the three focal topics: talent mapping, Triple Helix collaboration, or digital services exports.
   2) Empirical studies, case studies, or conceptual/theoretical works offering insights relevant to digital economy ecosystems.
   3) Works focused on both developed and developing country contexts for comparative understanding.

b. Exclusion criteria:
   1) Articles prior to 2023 unless cited as foundational theoretical references.
   2) Studies focusing solely on digital infrastructure or manufacturing without direct relevance to services trade or human capital.
   3) Non-English publications without a certified translation.

2.4 Data Extraction and Thematic Synthesis

Each selected article was read and evaluated using a structured data extraction sheet capturing:

1. Author(s), year, and publication outlet
2. Country/region of focus
3. Main research objectives
4. Methodological approach

Key findings related to talent mapping, Triple Helix, or services exports. A thematic synthesis approach was applied to identify recurring concepts, frameworks, challenges, and emerging models. The themes were then organized under three main categories: Talent Development Strategies, Triple Helix Dynamics, and Export-Oriented Digital Innovation. As illustrated in Figure 1, this study applies a structured data extraction and thematic synthesis framework to analyze the selected literature and organize the findings into three core themes: Talent Development Strategies, Triple Helix Dynamics, and Export-Oriented Digital Innovation.

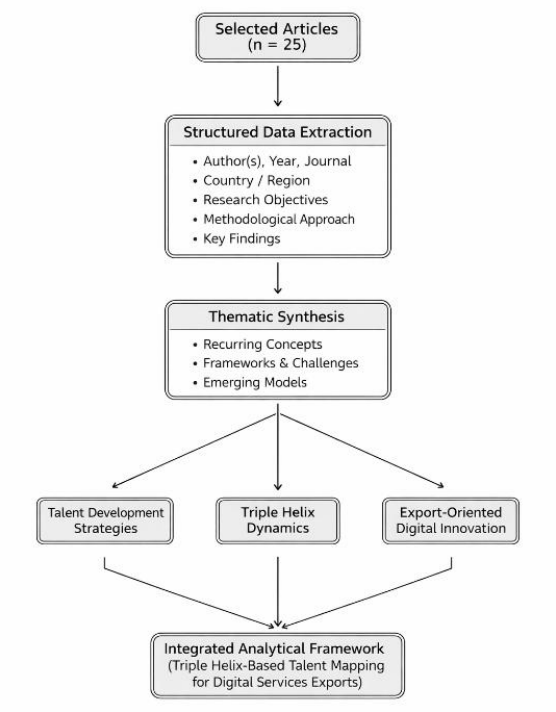

Figure 1. Talent Development Strategies

3. RESULTS AND DISCUSSION

3.1 The Digital Talent Gap: Challenges and Strategic Responses

The global digital economy has witnessed exponential growth, but it is concurrently burdened by a significant talent gap. Multiple studies confirm that this gap is most pronounced in sectors such as artificial intelligence, data science, cybersecurity, and software development [15], [16]. In Indonesia, the shortfall is particularly acute, with an estimated annual deficit of 600,000 digital professionals, which could reach over 9 million by 2030 if unaddressed [16], [17].

This shortage stems primarily from a misalignment between educational institutions and labor market requirements [18]. Emphasize that university curricula have not kept pace with the rapid evolution of digital technologies, resulting in graduates who lack job ready digital competencies. [19] argue that in developing countries like Indonesia, higher education is still theory focused, with minimal integration of hands-on, project-based learning in high demand areas.

Comparatively, countries in the Global North have invested significantly in lifelong learning, micro credentials, and digital learning platforms to facilitate continuous skill development. Such initiatives have proven effective in narrowing the digital skills divide, yet Indonesia's national education strategy lacks sufficient focus and funding to replicate these models at scale.

3.2 Triple Helix Collaborations: Catalysts for Innovation and Export Growth

The Triple Helix model integrating university, industry, and government actors has been widely validated as a powerful mechanism for fostering innovation and regional competitiveness [20], [21].

Developed economies such as South Korea and Singapore have successfully institutionalized the Triple Helix framework through innovation clusters, government R&D incentives, and cooperative education models [22]. By contrast, Indonesia's implementation remains disjointed. Although initiatives like Kampus Merdeka aim to enhance university-industry engagement, their national impact is limited by inconsistent

policy support and insufficient coordination [23], [24].

3.3 Talent Mapping: Aligning Skills with Industry Needs

Alent mapping is increasingly recognized as a strategic process for synchronizing educational outcomes with industry requirements, particularly in the fast-evolving digital sector. It involves the use of advanced technologies such as artificial intelligence, big data analytics, and labor market information systems to predict future skill demands and inform policy and curriculum development.

Advanced economies such as the USA, South Korea, and Germany employ realtime, AI-powered platforms that aggregate data from job postings, labor statistics, and educational outputs to identify emerging skills gaps and evolving occupational demands. For example, the U.S. integrates tools like LinkedIn Talent Insights and O*NET to provide up-to-date information to policymakers and training providers. South Korea's national skills registry feeds directly into curriculum planning and vocational training initiatives.

By contrast, Indonesia's current talent mapping initiatives rely heavily on manual surveys, outdated census data, and fragmented reports. These methods are often reactive rather than predictive, offering limited utility for real-time policy decisions. The absence of a centralized, AI-enabled labor market intelligence platform means that Indonesian educational institutions and government bodies are often unprepared for the pace of digital transformation.

Furthermore, Indonesia lacks systematic feedback mechanisms between industry and academia, resulting in delayed updates to training programs and misalignment with employer expectations. The country's employment data is often not disaggregated by skills, making it challenging to tailor interventions to specific sectors or technologies.

3.4 Synergizing Talent Mapping and Triple Helix for Enhanced Services Exports

A consistent trend in the literature that was reviewed is that the combination of effective talent mapping and strong collaboration within a Triple Helix dynamic greatly strengthens digital services export capability. Building on the results of Estonia, South Korea and the UK have established mature big data related talent roadmap systems that incorporate coordinated institutional collaboration between government, industry and academia (GIA), so as for the workforce to remain resilient against a fast evolving digital transformation. [25], [26].

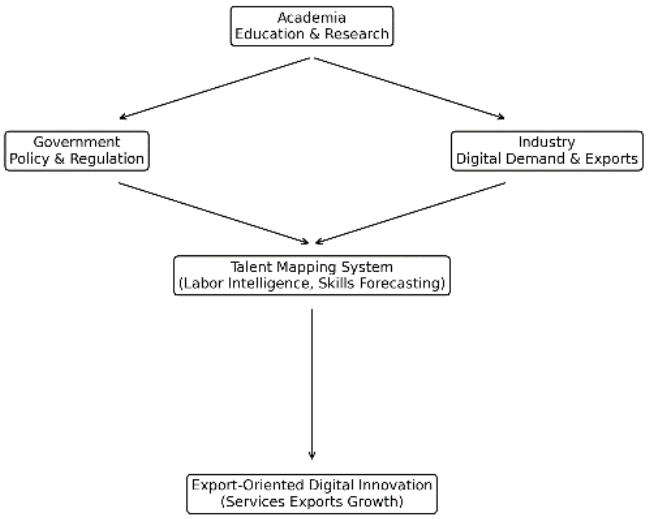

Figure 2. Talent Mapping

As can be observed from Figure 2, talent mapping functions as an 'integrationist' linking policy direction, academic knowledge production and industry- driven skill demand. This congruence enables to foster export-oriented digital innovation ecosystems through matching human capital formation with innovation governance and demand needs. In more digitalized economies, such interactions have given rise to digital clusters and scalable service exports.

Indonesia, however, has yet to build a cohesive national infrastructure that synchronizes talent development and innovation governance. While isolated programs exist within ministries and universities, their lack of coordination and resource-sharing limits their potential for catalyzing digital services growth. Table 1 presents a comparative overview of digital talent development strategies.

Table 1. Comparison of Digital Talent Development Strategies

Country	Approach	Strengths	Gaps in Indonesia
South Korea [27]–[35]	Lifelong learning, innovation clusters	High digital literacy, strong policy support	Lack of integration and national coordination
USA [36]– [45]	Upskilling via private platforms, MOOCs	Industry-led, scalable	Limited industry-academia collaboration
Singapore [46]–[56]	Skills Future, government-funded reskilling	Government support, centralized framework	Fragmented efforts, low funding
Indonesia [57]–[73]	Kampus Merdeka, limited tech bootcamps	Policy intent exists	Executional gaps, weak curriculum industry fit

Source: Processed primary data (2025)

Across selected countries, highlighting differences in policy approaches, institutional strengths, and persistent gaps that continue to limit the effectiveness of talent development initiatives in Indonesia. Table 2 compares the role of Services Exports Insights and Gaps.

Table 2. Comparison of Services Exports Insights and Gaps

Country	Triple Helix Elements	Outcomes Achieved	Gaps in Indonesia
South Korea [27]–[35]	Government grants, industrial PhD programs	Tech-driven export expansion	Weak regulatory alignment
Singapore [46], [47], [56], [48]–[55]	Structured public-private academic boards	Innovation hubs, strong digital exports	Lack of institutional collaboration
Finland [74]– [83]	University spin-offs, tech incubators	Strong R&D ecosystem	Low commercialization of research
Indonesia [57], [58], [67]– [73], [59]– [66]	Limited industry-academia partnerships	Fragmented programs, limited impact	Need for cohesive national innovation system

Source: Processed primary data (2025)

Triple Helix elements in supporting services exports across countries, demonstrating how coordinated government industry academia collaboration contributes to stronger export outcomes, while highlighting institutional gaps that constrain Indonesia's export performance. Table 3 illustrates cross-country differences in talent mapping practices and levels of integration, showing that advanced economies employ data-driven and institutionalized systems, while Indonesia's approach remains fragmented, manual, and weakly connected to policy formulation.

Table 3. Talent Mapping Practices and Adoption

Country	Talent Mapping Method	Integration Level	Gaps in Indonesia
USA [36]– [45]	AI-driven platforms, LinkedIn data	Nationwide, automated	Lacks real-time platforms
South Korea [27]– [35]	National skill registries, AI foresight	Embedded in policy	Absence of predictive analytics
Germany [84]– [90]	Sectoral councils, industry feedback loops	Regularly updated datasets	Minimal industry feedback mechanisms
Indonesia [57], [58], [67]– [73], [59]– [66]	Surveys, manual assessments	Sporadic, pilot-level	Outdated, low integration with policy

Source: Processed primary data (2025)

Table 4 demonstrates how effective integration between talent mapping and Triple Helix models is associated with stronger digital services export performance in advanced economies, while Indonesia's fragmented approach reflects the absence of a cohesive national strategy linking talent development and innovation governance.

Table 4. Synergies Between Talent Mapping and Triple Helix Models

Country	Integration Strategy	Export Performance	Gaps in Indonesia
Estonia [91]– [101]	Digital talent map linked to innovation hubs	Leading e-service exporter	No unified database or coordination mechanism
South Korea [27]– [35]	Triple Helix-driven national skills councils	Software, cloud growth	Lack of shared vision between academia and industry
UK [102]– [107]	Skill foresight units within innovation centers	ICT and fintech expansion	Underdeveloped foresight capacity
Indonesia [57], [58], [67]– [73], [59]– [66]	Isolated talent development and innovation	Modest export growth	No national strategy uniting talent and innovation

Source: Processed primary data (2025)

4. CONCLUSION

This study concludes, based on a systematic synthesis of recent empirical and policy-oriented literature, that the effectiveness of digital services exports in emerging economies is strongly influenced by the degree of integration between talent mapping mechanisms and Triple Helix collaboration. The findings show that countries with institutionalized, data driven talent mapping systems embedded within coordinated government industry academia frameworks such as Estonia, South Korea, and the United Kingdom demonstrate more consistent growth in export oriented digital innovation.

The results further indicate that Indonesia's limited performance in digital services exports is not solely attributable to skill shortages, but to structural fragmentation in talent development and innovation governance. As evidenced in the comparative analysis, Indonesia's talent mapping practices remain largely manual, sporadic, and weakly connected to policy formulation, while Triple Helix interactions are characterized by limited coordination and unclear role alignment. This disconnect constrains the translation of digital talent development into scalable export outcomes.

Overall, the study finds that talent mapping functions most effectively when positioned as an integrative mechanism within the Triple Helix model, aligning workforce development with innovation policy and market demand. Therefore, strengthening digital services export capacity in Indonesia requires not only expanding digital skills supply, but also

institutionalizing coordination among government, academia, and industry through centralized talent intelligence systems and coherent innovation governance. These findings contribute to the literature by demonstrating that the synergy between talent mapping and the Triple Helix model is a critical determinant of export competitiveness in the digital economy.

REFERENCES

[1] A. Ahi, N. Sinkovics, and R. Sinkovics, "E-commerce Policy and the Global Economy: A Path to More Inclusive Development?," *Manag. Int. Rev.*, vol. 63, pp. 27–56, 2022, doi: 10.1007/s11575-022-00490-1.

[2] M. Peters, "Digital trade, digital economy and the digital economy partnership agreement (DEPA)," *Educ. Philos. Theory*, vol. 55, pp. 747–755, 2023, doi: 10.1080/00131857.2022.2041413.

[3] P. K. Tee, L.-C. Wong, M. Dada, B. L. Song, and C. Ng, "Demand for digital skills, skill gaps and graduate employability: Evidence from employers in Malaysia," *F1000Research*, vol. 13, 2024, doi: 10.12688/f1000research.148514.1.

[4] D. Nyale, S. Karume, A. Kipkebut, and F. Mukudi, "Digital skills landscape: A systematic review of current academic programs, industry demands, and the digital divide's impact on graduate competencies," *Ind. High. Educ.*, 2025, doi: 10.1177/09504222251370105.

[5] S. Surono, "Enhancing Workforce Adaptability Through Structured Digital Literacy Skill Set and Competency Standard: A Research and Development Study," *Edunity Kaji. Ilmu Sos. dan Pendidik.*, 2025, doi: 10.57096/edunity.v4i8.419.

[6] C. Robb *et al.*, "Talent Policy: Problems and Solutions," *Polit. Q.*, 2025, doi: 10.1111/1467-923x.13538.

[7] R. Chinoracký, N. Stalmasekova, R. Madleňák, and L. Madleňáková, "Are Nations Ready for Digital Transformation? A Macroeconomic Perspective Through the Lens of Education Quality," *Economies*, 2025, doi: 10.3390/economies13060152.

[8] Y. Cai, N. Nordin, and S. Panatik, "A Textual Analysis of the Chinese Global Talent Management Policy: From a Policy Instruments Perspective," *SAGE Open*, vol. 14, 2024, doi: 10.1177/21582440241300485.

[9] Y. Cai, "Neo-Triple Helix Model of Innovation Ecosystems: Integrating Triple, Quadruple and Quintuple Helix Models," *Triple Helix*, 2022, doi: 10.1163/21971927-bja10029.

[10] F. Fidanoski *et al.*, "The triple helix in developed countries: when knowledge meets innovation?," *Heliyon*, vol. 8, 2022, doi: 10.1016/j.heliyon.2022.e10168.

[11] M. Oktoviano *et al.*, "Efforts to Strengthen Digital Talent to Improve the Quality of Human Resources Towards A Golden Indonesia 2045," *JIPOWER J. Intellect. Power*, 2025, doi: 10.63786/jipower.v2i1.39.

[12] T. Samsuri, W. Widiana, W. Lasmawan, and G. P. Suharta, "Transforming Higher Education Curriculum Based on the Indonesian National Qualifications Framework (KKNI) to Address Human Re-source Challenges in the Industrial Revolution 4.0 Era," *Path Sci.*, 2025, doi: 10.22178/pos.119-11.

[13] S. Sipakoly, "Digitalization and the Global Competitiveness of Exported Services," *J. Econ. Manag. Sci.*, 2025, doi: 10.37034/jems.v7i3.136.

[14] A. Hailu, "The role of university–industry linkages in promoting technology transfer: implementation of triple helix model relations," *J. Innov. Entrep.*, vol. 13, pp. 1–17, 2024, doi: 10.1186/s13731-024-00370-y.

[15] R. B. Esthi, I. Setiawan, and S. S. Heriyanti, "Digital Talent Mapping Based on Digital Knowledge," *J. Ilm. Glob. Educ.*, vol. 5, no. 3, pp. 2275–2287, 2024, doi: https://doi.org/10.55681/jige.v5i3.3367.

[16] R. T. Abubakar, F. T. Andhikaputra, R. Artisa, E. Ramdani, and S. Lestari, "Strengthening the Digital Talent Ecosystem to Support Digital Transformation in Indonesia," 2024.

[17] L. Kusumawati and E. Prasojo, "Strategy of the Financial Services Authority in Developing Digital Talent Competence in the Financial Technology Era in the Banking Sector," *Publica J. Pemikir. Adm. Negara*, vol. 15, no. 1, pp. 206–216, 2023.

[18] A. Thuda, R. Kartono, M. Hamsal, and A. Furinto, "The Effect of Digital Talent and Digital Capability on Bank Performance: Perspective of Regional Development Bank Employees," in *In Proceedings of the International Conference on Business Excellence*, 2023, pp. 2053–2069.

[19] N. E. Asyikin and S. Fahmy, "Digital talent assessment for the Malaysian tourism industry," *Int. J. Synerg. Eng. Technol.*, vol. 3, no. 1, pp. 10–18, 2022.

[20] H. Etzkowitz and R. Viale, "Polyvalent Knowledge and the Entrepreneurial University: A Third Academic Revolution?," *Crit. Sociol.*, vol. 36, no. 4, pp. 595–609, 2010, doi: 10.1177/08969290510365921.

[21] L. Leydesdorff and M. Fritsch, "Measuring the Knowledge Base of Regional Innovation Systems in Terms of a Triple Helix Dynamics," *arXiv Prepr. arXiv0911.3412*, 2009.

[22] A. Supriadi, I. Permana, D. R. Afandi, E. Arisondha, and A. Kusumaningsih, "The triple helix model: university-industry-government collaboration and its role in smes innovation and development," *Int. J. Econ. Lit.*, vol. 2, no. 1, pp. 75–90, 2024.

[23] F. Fitriani, "Success Factors in Triple Helix Coordination: Small-Medium Sized Enterprises in Western Java," *Etikonomi*, vol. 18, no. 1, pp. 15–28, 2019, doi: 10.15408/etk.v18i1.11548.

[24] M. A. I. Muzakir, "Government-Pulled Triple Helix for Supporting National Aircraft Industry in the Global Value Chain with Typology Hierarchy," *Perspekt. J. Ilmu Adm.*, vol. 1, no. 1, 2021, doi: 10.33592/perspektif.v1i1.78.

[25] S. H. Quartey and O. Oguntoye, "Understanding and promoting industrial sustainability in Africa through the Triple Helix approach: a conceptual model and research propositions," *J. Knowl. Econ.*, vol. 12, no. 3, pp. 1100–1118, 2021.

[26] H. Etzkowitz and L. Leydesdorff, "The Dynamics of Innovation: From National Systems and 'Mode 2' to a Triple Helix of University–Industry–Government Relations," *Res. Policy*, vol. 29, no. 2, pp. 109–123, 2000, doi: 10.1016/S00487333(99)00055-4.

[27] H. Lee, "Analysis of the impact of digital literacy on life satisfaction (2019–2022) for older adults in South Korea: a national community-based panel study," *Sci. Rep.*, vol. 14, 2024, doi: 10.1038/s41598-024-71397-0.

[28] M. Jang, M. Aavakare, S. Nikou, and S. Kim, "The impact of literacy on intention to use digital technology for learning: A comparative study of Korea and Finland," *Telecomm. Policy*, p. 102154, 2021, doi: 10.1016/j.telpol.2021.102154.

[29] J.-H. Yoon and K. Sim, "Why is South Korea's renewable energy policy failing? A qualitative evaluation," *Energy Policy*, vol. 86, pp. 369–379, 2015, doi: 10.1016/j.enpol.2015.07.020.

[30] L. Sopybayeva and S. Kozhirova, "Peculiarities Of South Korea's Educational Policy In The Context Of National Modernization And Globalization," *Kazakhstan Orient. Stud.*, 2025, doi: 10.63051/kos.2025.3.75.

[31] S. Lee, J. Paavola, and S. Dessai, "Deeper understanding of the barriers to national climate adaptation policy: the case of South Korea," *Mitig. Adapt. Strateg. Glob. Chang.*, vol. 28, 2022, doi: 10.1007/s11027-022-10038-1.

[32] M. J. Park, "Social Dialogue as Coordination Politics with Multifacet Characteristics : How to Explain the Failure in Making Social Compromises in South Korea?," *Ctizen&the World*, 2023, doi: 10.35548/cw.2023.12.43.1.

[33] J.-S. Choi and J. Kim, "Dancing between Nordic and neoliberal: Lifelong learning in South Korea," *J. Adult Contin. Educ.*, vol. 24, pp. 17–25, 2018, doi: 10.1177/1477971417751738.

[34] H. Lee and S. Yi, "Corporate Education for Digital Transformation in the Semiconductor Industry: Proactive Consideration in Early Implementation Phase," *IEEE Access*, vol. 13, pp. 78107–78119, 2025, doi: 10.1109/access.2025.3565486.

[35] D. J. Kang, "Building Mechanism of Lifelong Learning," pp. 146–152, 2021, doi: 10.2991/assehr.k.210508.027.

[36] A. L. Rossoni, E. P. G. De Vasconcellos, and R. L. De Castilho Rossoni, "Barriers and facilitators of university-industry collaboration for research, development and innovation: a systematic review," *Manag. Rev. Q.*, pp. 1–37, 2023, doi: 10.1007/s11301-023-00349-1.

[37] A. Ayoub, R. Amin, and Z. A. Wani, "Contribution of developed countries towards MOOCs: an exploration and assessment from a representative platform Coursera," *Asian Assoc. Open Univ. J.*, vol. 15, pp. 251–262, 2020, doi: 10.1108/aaouj-03-2020-0016.

[38] E. Tereshchenko, E. Salmela, E. Melkko, S. Phang, and A. Happonen, "Emerging best strategies and capabilities for university–industry cooperation: opportunities for MSMEs and universities to improve collaboration. A literature review 2000–2023," *J. Innov. Entrep.*, vol. 13, pp. 1–45, 2024, doi: 10.1186/s13731-024-00386-4.

[39] S. Vengathattil, "Future-Proofing AI Talent in The United States: The Role of Academia in Meeting Industry Demands," *Int. J. Manag. Sci. Inf. Technol.*, 2025, doi: 10.35870/ijmsit.v5i1.3837.

[40] S. Gupta, I. And, S. Kumar, and U. India, "Impact of MOOC Participation on Career Advancement and Skills Development," *J. Informatics Educ. Res.*, 2025, doi: 10.52783/jier.v5i2.2524.

[41] Z. Khan, Student, A. Patel, and A. Info, "Leveraging Industry-Academic Partnerships for Skill Development in the Digital Economy," *Int. J. Web Multidiscip. Stud.*, 2025, doi: 10.71366/ijwos234123.

[42] A. Stich and T. Reeves, "Massive open online courses and underserved students in the United States," *Internet High. Educ.*, vol. 32, pp. 58–71, 2017, doi: 10.1016/j.iheduc.2016.09.001.

[43] L. Li, "Reskilling and upskilling the future-ready workforce for industry 4.0 and beyond," *Inf. Syst. Front.*, pp. 1–16, 2022.

[44] F. A. Ajayi and C. A. Udeh, "Review Of Workforce Upskilling Initiatives For Emerging Technologies In It," *Int. J. Manag. & Entrep. Res.*, 2024, doi: 10.51594/ijmer.v6i4.1003.

[45] J. Weinhardt and T. Sitzmann, "Revolutionizing training and education? Three questions regarding massive open online courses (MOOCs)," *Hum. Resour. Manag. Rev.*, 2019, doi: 10.1016/j.hrmr.2018.06.004.

[46] S. Kim, Z. Chen, J. Tan, and A. Mussagulova, "A case study of the Singapore SkillsFuture Credit scheme: preliminary insights for making lifelong learning policy more effective," *Asian J. Polit. Sci.*, vol. 29, pp. 192–214, 2021, doi: 10.1080/02185377.2021.1917431.

[47] Z. Y. Lim, J. H. Yap, J. W. Lai, I. Mokhtar, D. Yeo, and K. Cheong, "Advancing Lifelong Learning in the Digital Age: A Narrative Review of Singapore's SkillsFuture Programme," *Soc. Sci.*, 2024, doi: 10.3390/socsci13020073.

[48] C. Chua, J. Soo, and K. Raza, "Work-integrated (adult) learning: Un-stigmatizing blue-collar adult learners in Singapore by embracing visibility," *J. Adult Contin. Educ.*, vol. 30, pp. 112–130, 2024, doi: 10.1177/14779714241228847.

[49] N. T. A. Quyen, "An Analysis Of The Singaporean Preparation For The Future Workforce And Recommendations For Vietnam," *VNU J. Foreign Stud.*, 2019, doi: 10.25073/2525-2445/vnufs.4397.

[50] M. Fung, "Developing a Robust System for Upskilling and Reskilling the Workforce: Lessons from the SkillsFuture Movement in Singapore," *Educ. Asia-Pacific Reg. Issues, Concerns Prospect.*, 2020, doi: 10.1007/978-981-15-7018-6_39.

[51] S. Kuruvilla and R. Chua, "How Do Nations Increase Workforce Skills? Factors Influencing the Success of the Singapore Skills Development System," *Glob. Bus. Rev.*, vol. 1, pp. 11–47, 2000, doi: 10.1177/097215090000100102.

[52] P. Narot and N. Kiettikunwong, "Manpower Planning and Lifelong Learning in Singapore: Implications for Older Workers," *Educ. Elder. Asia Pacific*, 2021, doi: 10.1007/978-981-16-3326-3_9.

[53] G. Gan, "Singapore's Experience in Analyzing the Labor Market Using Artificial Intelligence and Big Data Analytics," *Educ. Asia-Pacific Reg. Issues, Concerns Prospect.*, 2020, doi: 10.1007/978-981-15-7018-6_31.

[54] V. Seidmann *et al.*, "Skillsets For Future-Ready Older Workers: Skills Gaps And Learning Barriers In Singapore," *Innov. Aging*, vol. 7, p. 324, 2023, doi: 10.1093/geroni/igad104.1078.

[55] E. Engriyani and R. Madhakomala, "The Implementation of Non-Formal Education and Training Programs to Encourage the National Economy Concerning the Unemployment Rate in Southeast Asia," *Int. J. Soc. Sci. Hum. Res.*, 2023, doi: 10.47191/ijsshr/v6-i11-52.

[56] M. F. Osman, "Upskilling for Non-PMETs: Challenges and Opportunities in the Policy Landscape," *Singapore Labour J.*, 2023, doi: 10.1142/s2811031523000207.

[57] M. Hisjam, E. N. A. Zain, and P. Laksono, "A Study on the Gap Between the Competencies of Industrial Engineering Undergraduate Students and the Competency Requirements of the Job Market in Indonesia," *Asean J. Eng. Educ.*, 2024, doi: 10.11113/ajee2024.8n2.175.

[58] R. Angriani, I. Indrawan, A. Fransiska, and S. Naimah, "Analisis Program Pendidikan Vokasi Dalam Menghadapi Tantangan Industri," *J. Ilm. Manajemen, Ekon. dan Akunt.*, 2025, doi: 10.55606/jurimea.v5i1.870.

[59] D. Keriapy and I. S. Tondang, "Mengenalkan Keterampilan dan Pendidikan yang Dibutuhkan pada Era New Digital Economy Melalui Program Kampus Merdeka," *Abdi Psikonomi*, 2022, doi: 10.23917/psikonomi.vi.1391.

[60] S. Rahmani and J. Dwiridotjahjono, "Penerapan Technology Academy Dalam Meningkatkan Soft Skill Melalui Program Studi Independen Kampus Merdeka Pada PT Revolusi Citra Edukasi (Revou)," *Digit. Bisnis J. Publ. Ilmu Manaj. dan E-Commerce*, 2023, doi: 10.30640/digital.v2i3.1317.

[61] N. L. Khomsah, M. Syahri, and A. Tinus, "Strengthening Link and Match 8+i Program in Vocational Education," *Acad. Open*, 2025, doi: 10.21070/acopen.10.2025.11076.

[62] R. A. Wibowo, N. Myau-Lyau, N. N. A. Christy, and A. -, "The Challenges for Indonesia to Integrate Dual Vocational Education and Training System," *J. Tech. Educ. Train.*, 2022, doi: 10.30880/jtet.2022.14.02.008.

[63] W. M. Maharani, S. Zauhar, M. Makmur, and B. Haryono, "Understanding The Gap Between Policy and Implementation of Vocational Secondary Education To Realize Sustainable Development: The Case of East Java Province, Indonesia," *J. Law Sustain. Dev.*, 2024, doi: 10.55908/sdgs.v12i1.2291.

[64] H. Rosina, V. Virgantina, Y. Ayyash, V. Dwiyanti, and S. Boonsong, "Vocational Education Curriculum: Between Vocational Education and Industrial Needs," *ASEAN J. Sci. Eng. Educ.*, 2021, doi: 10.17509/ajsee.v1i2.33400.

[65] Suharno, N. Pambudi, and B. Harjanto, "Vocational education in Indonesia: History, development, opportunities, and challenges," *Child. Youth Serv. Rev.*, vol. 115, p. 105092, 2020, doi: 10.1016/j.childyouth.2020.105092.

[66] M. Gofur and S. Hasibuan, "Analysis of Industry Needs for Indonesian Vocational Education Services Using the EduQual-IPA Method," *IJIEM - Indones. J. Ind. Eng. Manag.*, 2025, doi: 10.22441/ijiem.v5i3.25318.

[67] F. Fitrianti, U. Haryaka, Y. Dwiyono, A. Azainil, A. Masruhim, and S. Sudarman, "Collaboration between Vocational Education and Industry to Enhance The Internship Competence of Students at SMK Negeri 8 Samarinda," *Borneo Educ. J.*, 2025, doi: 10.24903/bej.v7i2.2167.

[68] M. M. Ali, B. Triyono, and T. Koehler, "Evaluation of Indonesian Technical and Vocational Education in Addressing the Gap in Job Skills Required by Industry," *2020 Third Int. Conf. Vocat. Educ. Electr. Eng.*, pp. 1–6, 2020, doi: 10.1109/icvee50212.2020.9243222.

[69] B. Q. Pradipta, F. B. Hirawan, and S. Ragamustari, "Evaluation of policy in the vocational education system revitalization in Indonesia: Examining the teaching factory readiness of the industry," *J. Pendidik. Vokasi*, vol. 11, 2021, doi: 10.21831/jpv.v11i1.37693.

[70] Wargo, R. Arjmand, and L. U. Rahmah, "Indonesian Students' Readiness for the Workforce from the Perspective of the Merdeka Belajar Kampus Merdeka (MBKM) Curriculum," *Zabags Int. J. Educ.*, 2025, doi: 10.61233/zijed.v3i1.25.

[71] L. Santioso, "Industry Perspectives on Digital Competences Among MBKM Interns in Indonesia," *Return Study Manag. Econ. Bussines*, 2024, doi: 10.57096/return.v3i1.201.

[72] R. Muharam, U. A. Afrilia, and S. Sudarma, "Integrating Vocational Education and Industry through Public Policy: Towards Excellent and Competitive Human Capital," *Int. J. Multidiscip. Sci. Arts*, 2025, doi: 10.47709/ijmdsa.v4i2.6097.

[73] A. Helmy, B. Fairman, and A. Voak, "Managing the Challenges of Vocational Education and Training in Indonesia-The Mire of Uncertainty!," 2021.

[74] O. Juszczyk, J. Juszczyk, S. Juszczyk, and J. Takala, "Barriers for Renewable Energy Technologies Diffusion: Empirical Evidence from Finland and Poland," *Energies*, 2021, doi: 10.20944/preprints202112.0524.v1.

[75] T. Reunanen and D. Oliva, "Business creation activities to optimize the outcomes of RDI projects in an applied science university – The Spin&Launch incubator," *Creat. Innov. Entrep.*, 2024, doi: 10.54941/ahfe1004716.

[76] K. Lahikainen, J. Kolhinen, E. Ruskovaara, and T. Pihkala, "Challenges to the development of an entrepreneurial university ecosystem: The case of a Finnish university campus," *Ind. High. Educ.*, vol. 33, pp. 107–196, 2018, doi: 10.1177/0950422218815806.

[77] A.-J. Tahvanainen and T. Nikulainen, "Commercialization at Finnish universities: Researchers' perspectives on the motives and challenges of turning science into business," 2011.

[78] S. Shakeel, J. Takala, L. Zhu, and L. Zhu, "Commercialization of renewable energy technologies: A ladder building approach," *Renew. Sustain. Energy Rev.*, vol. 78, pp. 855–867, 2017, doi: 10.1016/j.rser.2017.05.005.

[79] M. Ampuja and M. Horowitz, "Doing 'more with less': the entrepreneurialization of Finnish higher education and innovation policy discourses in 2015–2019," *Scand. J. Educ. Res.*, vol. 69, pp. 303–317, 2024, doi: 10.1080/00313831.2023.2299988.

[80] S. Päällysaho *et al.*, "Key Aspects of Open Data in Finnish RDI Cooperation between Higher Education and Businesses," *Data Intell.*, vol. 3, pp. 176–188, 2021, doi: 10.1162/dint_a_00065.

[81] M. Kivijärvi, P. Patja, and M. Suoranta, "Shedding Light on Early Stage Academic Entrepreneurship: Finnish University Researchers' Views on Key Stakeholder Relations and Their Influence on the Research Commercialization Process," *J. Finnish Stud.*, 2020, doi: 10.5406/28315081.23.2.08.

[82] I. Kulkov, B. Berggren, K. Eriksson, M. Hellström, and K. Wikstrom, "The importance of financial resources and ownership of intellectual property rights for university spin-offs: the cases of Finland and Sweden," *J. Small Bus. Enterp. Dev.*, vol. 27, pp. 1125–1147, 2020, doi: 10.1108/jsbed-09-2019-0308.

[83] M. Häyrinen-Alestalo and U. Peltola, "The Problem of a Market-oriented University," *High. Educ.*, vol. 52, pp. 251–281, 2006, doi: 10.1007/s10734-004-2749-1.

[84] S. Eraslan and T. Götz, "An unconventional weekly economic activity index for Germany," *Econ. Lett.*, 2021, doi: 10.1016/j.econlet.2021.109881.

[85] T. Haipeter, "Digitalisation, unions and participation: the German case of 'industry 4.0,'" *Ind. Relations J.*, vol. 51, pp. 242–260, 2020, doi: 10.1111/irj.12291.

[86] S. Dierks, A. Schiersch, and J. Stede, "Industry Conversion Tables for German Firm-Level Data," *Jahrb. Natl. Okon. Stat.*, vol. 240, pp. 677–690, 2019, doi: 10.1515/jbnst-2019-0041.

[87] R. Lehmann and I. Wikman, "Quarterly GDP Estimates for the German States: New Data for Business Cycle Analyses," *Oxf. Bull. Econ. Stat.*, vol. 87, pp. 800–814, 2025, doi: 10.1111/obes.12653.

[88] U. Walwei, "The German industrial relations system under pressure: Structure, trends and outcomes," *New World Work*, 2021, doi: 10.4337/9781800888050.00012.

[89] M. Oberfichtner and C. Schnabel, "The German Model of Industrial Relations: (Where) Does It Still Exist?," *Jahrb. Natl. Okon. Stat.*, vol. 239, pp. 5–37, 2018, doi: 10.1515/jbnst-2018-0158.

[90] K. Koasidis *et al.*, "The UK and German Low-Carbon Industry Transitions from a Sectoral Innovation and System Failures Perspective," *Energies*, 2020, doi: 10.3390/en13194994.

[91] A. Hardy, "Digital innovation and shelter theory: exploring Estonia's e-Residency, Data Embassy, and cross-border e-governance initiatives," *J. Balt. Stud.*, vol. 55, pp. 793–810, 2023, doi: 10.1080/01629778.2023.2288118.

[92] V. R. Vatsa and P. Chhaparwal, "Estonia's e-governance and digital public service delivery solutions," *2021 Fourth Int. Conf. Comput. Intell. Commun. Technol.*, pp. 135–138, 2021, doi: 10.1109/ccict53244.2021.00036.

[93] M. Bauters, D. Tokranova, L. M. H. De Silva, and J. Mets, "The Exploration of Skill Gaps and Ecosystem Potential among Estonian Creatives," *Sustainability*, 2023, doi: 10.3390/su151813687.

[94] B. Dorjnyambuu, "Estonian Digital Entrepreneurship Ecosystem Based on Digital Platform Economy Index 2020," *J. Entrep.*, vol. 32, pp. 347–375, 2023, doi: 10.1177/09713557231184458.

[95] A. Hardy, "Estonia's digital diplomacy: Nordic interoperability and the challenges of cross-border e-governance," *Internet Policy Rev.*, vol. 13, 2024, doi: 10.14763/2024.3.1785.

[96] K. Rajamae-Soosaar and A. Nikiforova, "Exploring Estonia's Open Government Data Development as a Journey towards Excellence: Unveiling the Progress of Local Governments in Open Data Provision," *Proc. 25th Annu. Int. Conf. Digit. Gov. Res.*, 2024, doi: 10.1145/3657054.3657161.

[97] M. Kassen, "Open data and e-government – related or competing ecosystems: a paradox of open government and promise of civic engagement in Estonia*," *Inf. Technol. Dev.*, vol. 25, pp. 552–578, 2019, doi: 10.1080/02681102.2017.1412289.

[98] D. Azzopardi, P. Lenain, M. Molnár, N. Mosiashvili, and J. Pareliussen, "Seizing the productive potential of digital change in Estonia," *OECD Econ. Dep. Work. Pap.*, 2020, doi: 10.1787/999c7d5a-en.

[99] R. Kerner, "Service exporters in ICT-industries: measuring digital service trade of Estonia," *SSRN Electron. J.*, 2023, doi: 10.15157/tpep.vi1-2.22091.

[100] R. Kerner and M. Kitsing, "Small Is Beautiful And Important: Economies And Firms Trading In Digital Services," *J. Bus. Econ. Manag.*, 2023, doi: 10.3846/jbem.2023.18585.

[101] T. Hoffmann and M. C. S. Vásquez, "The estonian e-residency programme and its role beyond the country's digital public sector ecosystem*," *CES Derecho*, 2022, doi: 10.21615/cesder.6772.

[102] I. Mnohoghitnei, S. Scorer, K. Shingala, and O. Thew, "Embracing the Promise of Fintech," *Int. Polit. Econ. Glob. eJournal*, 2019.

[103] E. Emmanuel, Z. Syed, and O. Chuks, "Financial Technology and Economic Growth in the United Kingdom (2007-2023): Econometric Descriptive Analysis," *South Asian J. Soc. Stud. Econ.*, 2025, doi: 10.9734/sajsse/2025/v22i3972.

[104] P. Vijayagopal, B. Jain, and S. A. Viswanathan, "Regulations and Fintech: A Comparative Study of the Developed and Developing Countries," *J. Risk Financ. Manag.*, 2024, doi: 10.3390/jrfm17080324.

[105] A. Marszk and E. Lechman, "Reshaping financial systems: The role of ICT in the diffusion of financial innovations – Recent evidence from European countries," *Technol. Forecast. Soc. Change*, vol. 167, p. 120683, 2021, doi: 10.1016/j.techfore.2021.120683.

[106] N. Fayad, A. Awdeh, J. A. Mrad, G. El Mokdad, and M. Nassar, "The Impact of Technological Development on the Productivity of UK Banks," *FinTech*, 2025, doi: 10.3390/fintech4030045.

[107] Z. Wu, "The Rise of Digital Banking in the UK Financial Sector and Its Impact on Commercial Banks," *Adv. Econ. Manag. Polit. Sci.*, 2024, doi: 10.54254/2754-1169/120/20242553.

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