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K-DIGINDEX: A COMPOSITE METHODOLOGY FOR MEASURING DIGITAL COMPETENCE OF HUMAN CAPITAL IN AZERBAIJAN'S DIGITAL ECONOMY

Kanan K. Hasanov

Azerbaijan University of Architecture and Construction, Ayna Sultanova str. 5, Baku, Azerbaijan

kanan.hasanov@azmiu.edu.az

Abstract. The rapid advancement of digital technologies has fundamentally reshaped labour market requirements, making the measurement and management of digital competence a strategic priority for both policy-makers and organisations. Existing frameworks, however, predominantly capture infrastructure-level indicators while neglecting the granular, individual-level competence dimensions that drive productivity in a digitally transformed economy. This paper introduces K-digiIndex, a standardised composite index designed to measure individual and organisational digital competence across five core components: Technical Proficiency Score (TPS), Digital Problem-Solving Ability (DPSA), Adaptation and Digital Tools Adoption (ADT), Critical Digital Security (CDS), and Continuous Learning Culture (CLC). The index is operationalised through a 31-item standardised questionnaire yielding a weighted score on a 0–100 scale, calculated as K-digiIndex = [(TPS/40)×0.25 + (DPSA/30)×0.20 + (ADT/25)×0.15 + (CDS/30)×0.20 + (CLC/30)×0.20] × 100. Drawing on an empirical study of 2,000 respondents aged 14–34 across nine Azerbaijani cities and structured interviews with 500 employers, the paper maps sectoral and regional digital competence disparities and demonstrates the index's diagnostic and policy utility. Macroeconomic simulations indicate that aligning reskilling expenditure with a 0.30% of GDP threshold generates 3.4 AZN of additional GDP per every 1 AZN invested. The study contributes a replicable national-level measurement tool that bridges the gap between aggregate digital-economy indicators and actionable human capital management decisions.

Keywords: digital competence, human capital, K-digiIndex, composite index, digital economy, Azerbaijan, reskilling.

1. Introduction

The transition to a digital economy represents one of the most profound structural shifts of the twenty-first century. The World Economic Forum (2023) estimates that 85 million jobs will be displaced while 97 million new roles will emerge by 2025 as a result of the division of labour between humans, machines, and algorithms. Within this context, digital

competence — the ability to use digital technologies confidently, critically, and creatively — has emerged as a central dimension of human capital value.

For transition and emerging-market economies, the challenge is compounded: while infrastructure investments have expanded connectivity, the human capital base required to translate digital access into economic productivity remains under-developed (World Bank, 2022). Azerbaijan exemplifies this dynamic. Between 2015 and 2024, ICT's share of GDP rose from 1.9% to 2.9%, broadband household penetration reached 78%, and 4G mobile coverage extended to 97% of the population (Ministry of Digital Development and Transport of the Republic of Azerbaijan, 2024). Yet employer surveys reveal that 68% of Azerbaijani firms now prioritise digital skills over formal educational credentials when hiring — a signal that supply-side competence has not kept pace with demand-side transformation.

The measurement gap is a critical bottleneck. Most existing digital literacy indices — the EU's Digital Economy and Society Index (DESI), the ITU's ICT Development Index, the OECD's Programme for the International Assessment of Adult Competencies (PIAAC) — are designed for cross-country comparison at the aggregate level. They are poorly suited to the diagnostic, organisational, and individual-level decisions that human resource managers, training providers, and policy implementers must make in practice (Vuorikari et al., 2022; OECD, 2021).

This paper addresses this gap by presenting K-digiIndex, a national-context-adapted composite index developed from both a systematic review of competence frameworks and an original empirical study conducted in Azerbaijan. The remainder of the paper is structured as follows: Section 2 reviews relevant literature; Section 3 describes the methodology; Section 4 presents empirical findings; Section 5 demonstrates the diagnostic and policy applications of K-digiIndex; Section 6 concludes.

2. Literature Review

Human capital theory, originating with Schultz (1961) and Becker (1964), treats knowledge, skills, and competencies as productive assets in which individuals and societies invest to generate economic returns. Endogenous growth models by Lucas (1988) and Romer (1990) extended this framework by embedding human capital accumulation as the engine of long-run growth. These classical foundations, however, were developed before the digital revolution and therefore lack the conceptual apparatus to address digital competence as a distinct and strategically important form of human capital.

The concept of digital competence has been approached through several distinct frameworks. The European Commission's DigComp 2.2 framework (Vuorikari et al., 2022)

defines five competence areas — information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving — across eight proficiency levels. While DigComp is methodologically rigorous and widely cited, its European focus and foundation in self-assessment limit its direct applicability in national-level labour market diagnostics outside the EU context.

Brynjolfsson and McAfee (2014) argued that the "second machine age" demands new cognitive skills — creative intelligence, complex communication, and non-routine problem-solving — that complement rather than compete with automation. More recent contributions by Susskind (2020) and Jesuthasan and Boudreau (2022) further decompose the future-of-work skill set into task-level competencies, emphasising the need for granular, updatable measurement tools rather than static qualification-based proxies.

At the country level, the OECD's PIAAC (2021) offers longitudinal, internationally comparable data on adult competencies including problem-solving in technology-rich environments. However, PIAAC is resource-intensive, conducted infrequently, and does not cover Azerbaijan. The ITU's ICT Development Index captures infrastructure and usage dimensions but provides no individual-level competence granularity (ITU, 2023). The World Bank's Human Capital Index (2023) integrates health and education outcomes but does not disaggregate digital skills.

Azerbaijan-specific studies have examined aspects of digital transformation (Gasimli, 2021; Musayev, 2022; Nabiyeva, 2023), yet none has proposed a standardised national composite index linking individual digital competence scores to organisational HR decisions and government expenditure policy. This gap motivates the development of K-digiIndex.

3. Methodology

The research design combines (i) a systematic review and synthesis of existing competence frameworks to derive the theoretical architecture of K-digiIndex, (ii) an original empirical survey to validate the instrument and generate diagnostic data, and (iii) macroeconomic simulation to estimate policy returns.

3.1 Instrument Design. K-digiIndex is operationalised through a 31-item standardised questionnaire structured across five components. Each item is scored on a 0–5 Likert-type scale. The five components and their parameters are shown in Table 1.

Table 1. K-digiIndex Components, Item Count, Weights, and Maximum Scores

Component	Code	Items	Weight	Max Score
Technical Proficiency Score	TPS	8	25%	40

Digital Problem-Solving Ability	DPSA	6	20%	30
Adaptation & Digital Tools	ADT	5	15%	25
Critical Digital Security	CDS	6	20%	30
Continuous Learning Culture	CLC	6	20%	30
TOTAL		**31**	**100%**	**155**

Source: compiled by the author.

Calculation Formula. The composite index is calculated as:

K-digiIndex = [(TPS/40)×0.25 + (DPSA/30)×0.20 + (ADT/25)×0.15 + (CDS/30)×0.20 + (CLC/30)×0.20] × 100

The maximum attainable score is 100. A respondent scoring 120 raw points across all blocks produces K-digiIndex = (120/155)×100 = 77.4, classified as "High" proficiency. The five-tier classification system is shown in Table 2.

Table 2. K-digiIndex Classification Scale

Score Range	Level	Recommended HR/Policy Action
0 – 20	Low	Enrol in foundational digital literacy programme
21 – 50	Moderate	Targeted reskilling intervention
51 – 70	Good	Specialised upskilling; stretch assignments
71 – 85	High	Expert roles; peer mentoring functions
86 – 100	Excellent	Innovation leadership; R&D appointment

Source: compiled by the author.

3.2 Empirical Survey Design. A stratified multi-city survey was conducted across nine Azerbaijani cities (Baku, Ganja, Sumgait, Lankaran, Shaki, and four additional urban centres) targeting individuals aged 14–34. Of 13,864 initial contacts, 2,000 valid responses were retained after quality filtering, yielding a stratified analytical sample. In parallel, structured interviews were conducted with 500 employers spanning ICT, finance, construction, and transport sectors.

3.3 Macroeconomic Simulation. To estimate the fiscal return to reskilling investment, panel data (2010–2024) on reskilling expenditure as a share of GDP, the K-digiIndex mean score, and labour productivity were subjected to regression analysis and scenario simulation. Infrastructure investment (fibre, 5G, cloud centres) and K-digiIndex scores exhibited a high correlation ($\rho = 0.71$, $p < 0.05$), but labour productivity only increased exponentially once reskilling expenditure rose above a threshold — identified at 0.30% of GDP.

4. Results

4.1 Regional Digital Competence Disparities. Table 3 presents the geographic distribution of the survey sample and key competence proxy indicators. The data reveal a pronounced Baku–region gap: Baku respondents were more likely to hold tertiary qualifications (75.1%) and less likely to have vocational/technical backgrounds (11.5%), while provincial centres such as Lankaran (28.4% technical) and Shaki (27.6%) showed higher proportions of vocationally trained respondents. K-digiIndex scores correlated strongly with urbanisation level and sector of employment.

Table 3. Survey Sample by City and Educational Profile (14–34 age group)

City	Initial contacts	Technical educ., %	Tertiary only, %
Baku	8,660	11.5	75.1
Ganja	1,204	16.6	70.5
Sumgait	1,771	11.3	68.2
Lankaran	352	28.4	61.4
Shaki	362	27.6	63.8
Other centres	1,515	21.0	64.8
TOTAL	13,864	16.2	70.5

Source: compiled by the author.

4.2 Sectoral Wage Dynamics and Skill Demand. Employer interview data demonstrate that digital skills are now the primary hiring criterion in 68% of Azerbaijani firms. Table 4 maps average monthly wages by sector (2021–2023) alongside the leading digital skills demanded by employers in each sector, confirming that wage premia are strongly associated with advanced digital competence requirements.

Table 4. Sectoral Average Wages (AZN) and Top Digital Skill Requirements (2021–2023)

Sector	2021	2022	2023	Key digital skills demanded
ICT	1,155	1,342	1,510	Programming, data analytics, cybersecurity
Finance & Insurance	1,280	1,410	1,620	Fintech, digital audit, blockchain
Construction	888	1,006	1,060	BIM, digital project management
Transport & Logistics	953	1,124	1,279	Digital logistics, IoT
Economy-wide average	840	840	934	General digital literacy

Source: compiled by the author.

4.3 Macroeconomic Simulation Findings. Regression modelling across the 2010–2024 panel identifies a non-linear relationship between reskilling expenditure and GDP growth. Below the 0.30% of GDP threshold, incremental reskilling investment yields diminishing returns owing to coordination failures and infrastructure mismatches. Once the threshold is crossed, each 1 AZN of reskilling expenditure generates an estimated 3.4 AZN of additional GDP — a multiplier consistent with human capital investment elasticity estimates reported for Central and Eastern European economies (OECD, 2021; World Bank, 2022). Table 5 summarises the simulation results under three expenditure scenarios.

Table 5. GDP Return to Reskilling Investment — Simulation Results

Scenario	Reskilling spend (% GDP)	GDP multiplier (AZN per 1 AZN)	K-digiIndex avg. target (2030)
Conservative	0.13 (2018 level)	1.2	52
Baseline	0.22 (2024 level)	2.1	63
Target	0.30 (policy threshold)	3.4	75

Source: compiled by the author.

5. Discussion. The findings carry several important implications. First, K-digiIndex's five-component architecture reflects the multi-dimensional nature of digital competence in a way that single-indicator measures (e.g., internet penetration) cannot. By weighting technical proficiency most heavily (25%) while capturing adaptive learning (15%), critical security behaviour (20%), and lifelong learning disposition (20%), the index aligns with the DigComp

2.2 competence areas (Vuorikari et al., 2022) while adding operability for HR decision-making at the organisational level.

Second, the identification of a 0.30% of GDP reskilling threshold provides a normative anchor for fiscal policy that is currently absent from Azerbaijan's digital economy strategy documents. The 2024 expenditure level (approximately 0.22% of GDP) implies that the country is operating below its productivity frontier. Closing this gap requires not merely increasing the quantum of investment but redirecting it from infrastructure toward human capital — a rebalancing from the current 75:25 infrastructure-to-skills allocation.

Third, the Baku–region competence gap documented in Table 3 confirms that digital inequality in Azerbaijan has a pronounced spatial dimension, consistent with patterns observed in comparable middle-income economies (Dewan & Riggins, 2005; ITU, 2023). Region-tailored policy packages — mobile learning platforms, regional skill hubs, and differentiated subsidy schemes — are necessary complements to nationally uniform programmes.

Fourth, the employer-reported shift to skills-based hiring (68% of firms) mirrors trends documented globally (World Economic Forum, 2023; Jesuthasan & Boudreau, 2022) and strengthens the case for K-digiIndex's application as a standardised recruitment KPI. Integration of K-digiIndex into the national qualification framework and public procurement requirements could accelerate this transition.

6. Conclusion

This paper introduced K-digiIndex, a composite, nationally calibrated instrument for measuring individual digital competence within the context of Azerbaijan's digital economy transition. Built on a 31-item standardised assessment covering five evidence-based competence dimensions and validated through an empirical study of 2,000 respondents and 500 employer interviews, the index provides a replicable, low-cost diagnostic tool applicable at individual, organisational, and policy levels.

The study's principal empirical contributions are: (i) the mapping of significant regional (Baku vs. provincial) and sectoral (ICT/finance vs. construction) digital competence disparities; (ii) the confirmation that employer hiring preferences have shifted decisively toward skills-based criteria; and (iii) the identification of a 0.30% of GDP reskilling investment threshold above which the GDP multiplier rises to 3.4 — providing a data-driven basis for budget allocation decisions.

Limitations include the cross-sectional nature of the survey, which prevents causal inference regarding competence-productivity relationships, and the self-reported basis of the K-digiIndex questionnaire, which is susceptible to social-desirability bias. Future research should apply the instrument longitudinally and triangulate self-assessments with performance-based tasks to improve criterion validity.

The K-digiIndex framework is available for adaptation by other transition economies facing analogous digital human capital measurement challenges. Its modular design allows component weights to be recalibrated to reflect country-specific labour market priorities without altering the underlying measurement logic.

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