



## DIGITAL TRANSFORMATION, SKILL MISMATCHES, AND EMPLOYMENT OUTCOMES IN TRANSITION ECONOMIES

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### ABSTRACT

**Background:** Digital transformation has become a systemic driver of economic restructuring, reshaping innovation systems, labour markets, and skill demand worldwide. In transition economies, employment and productivity effects of digitalization remain uneven due to persistent skill mismatches, weak innovation ecosystems, and misalignment between education systems and labour market needs. **Objectives:** The paper aims to examine how digital transformation affects employment outcomes in a transition economy by analysing the role of digital skills and education job alignment as key mediating factors. It seeks to explain why the benefits of digitalization remain unevenly distributed across sectors and worker groups despite rising educational attainment. **Methods/Approach:** The study employs a quantitative, cross-sectional research design based on primary survey data collected from 150 employed individuals across multiple sectors. Descriptive statistics and binary logistic regression are used to assess the relationship between digital skill proficiency, perceived labour market barriers, and career advancement outcomes within an innovation systems framework. The results indicate that insufficient digital skills constitute a significant barrier to career advancement regardless of formal education level. Higher digital skill proficiency substantially reduces the likelihood of experiencing career constraints, while the perceived benefits of digitalization are concentrated in technology-intensive sectors, revealing pronounced structural and sectoral heterogeneity. **Conclusions:** The findings confirm that digital transformation delivers inclusive labour market outcomes only when supported by adequate human capital and well-functioning innovation systems. Strengthening digital skills development, lifelong learning, education and labour market alignment is essential for ensuring that digitalization translates into sustainable employment growth and innovation-driven competitiveness in transition economies.

**Keywords:** Digital transformation, Human Capital, Innovation, Employment, Labour Market

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### INTRODUCTION

Labour productivity is a fundamental driver of long-term economic performance and overall welfare, and its growth is increasingly shaped by technological change. While classical and neoclassical growth theories traditionally emphasize capital accumulation as the main source of productivity improvements, modern endogenous growth theory highlights technological progress, knowledge accumulation, and innovation as central engines of sustained productivity growth. In this context, the adoption and effective integration of digital technologies in production and workplace processes directly enhance efficiency and workforce output.



Productivity growth, therefore, is not an automatic outcome of economic activity but emerges from deliberate investments in human capital, skills development, and research and innovation capacity, which together enable economies to leverage technology for improved competitiveness, higher value creation, and more dynamic labour market outcomes.

The spread of digital technologies, including cloud computing, big data analytics, artificial intelligence, and digital platforms, has increased productivity growth, fostered innovation, and altered traditional supply and demand relationships for production factors. As a result, digital transformation represents not merely the adoption of new technologies, but a systemic transition toward a knowledge-based economy in which information, data, and intellectual capital increasingly replace physical capital as the primary drivers of economic growth (Bertani et al., 2020; Oloyede et al., 2023).

Innovation performance, as reflected in the Global Innovation Index, captures the combined effects of institutional quality, human capital, infrastructure, market conditions, and knowledge creation. For transition economies like Georgia, these factors are especially important. Weaknesses in research systems, digital skills, and venture funding can limit the effective use of advanced technologies. Understanding these factors helps explain how digital transformation can boost productivity, strengthen competitiveness, and shape labor market outcomes in a technology-driven global economy.

National economic progress increasingly depends on the quality of human capital, the effectiveness of education and training systems, and the availability of highly skilled and adaptable labour. These factors enhance the ability of the economy, enabling firms to adopt, and create new technologies, thereby strengthening competitiveness and fostering structural transformation (Cohen & Levinthal, 1990). Well-developed human capital also improves labor allocation across sectors and enhances a country's attractiveness to domestic and foreign investment, reinforcing positive feedback loops between innovation, productivity, and employment.

Historically, each major technological revolution has profoundly influenced labour markets. While short-run employment effects have often included job displacement, long-run outcomes have generally involved job creation and structural upgrading (Kolade & Owoseni)). The digital revolution, however, differs from previous waves of technological change in both its speed and scope. Digital technologies increasingly substitute routine and manual tasks while complementing analytical, creative, and problem-solving activities, resulting in complex and heterogeneous employment effects across countries, sectors, and skill groups (Autor et al., 2003).

Labour market outcomes are increasingly shaped by the interaction between individual skill profiles, institutional frameworks, and sectoral characteristics. While formal education remains an important determinant of employability, it does not necessarily ensure the acquisition of applied digital competencies required in contemporary work environments. As a result, insufficient digital skills may act as a binding constraint, limiting career advancement opportunities, reducing labour market mobility, and constraining the broader economic benefits of digital transformation.



This study provides a quantitative empirical analysis of the impact of digital transformation on labour market outcomes in Georgia. The primary objective is to examine how individual-level digital skill endowment influences perceived labour market barriers, particularly in relation to career advancement. In addition, the study assesses the degree of alignment between formal education and job requirements in the context of increasing digitalization and explores how the adoption of digital technologies affects employees' perceptions of work flexibility, task efficiency, and job quality.

To achieve these objectives, primary data were collected through a structured survey administered to employees across multiple sectors of the Georgian economy in 2025. The sample was designed to capture heterogeneity in age, education level, and sectoral affiliation, enabling meaningful comparisons between technology-intensive and traditional industries. Participation was voluntary and anonymous, ensuring response reliability and minimizing potential bias. The final dataset consists of 150 valid observations, providing a sufficient basis for both descriptive and econometric analysis in an exploratory research context.

By linking individual-level perceptions with structural labour market dynamics, this study contributes to the broader literature on digital transformation in transition economies. It provides micro-level evidence on the relationship between digital skills, perceived labour market barriers, and employment outcomes, offering insights into skill-related frictions and their implications for human capital development and policy design.

## LITERATURE REVIEW

### Theoretical background

As digital technologies continue to develop rapidly, a shift is taking place from the automation- and digitalization-focused model of Industry 4.0 toward Industry 5.0. While Industry 4.0 mainly emphasizes efficiency and technological advancement, Industry 5.0 introduces a more human-centered perspective. It highlights the importance of combining human creativity, judgment, and problem-solving with advanced digital technologies. In this context, collaboration between humans and AI is seen as an important factor for organizational innovation and adaptability, rather than focusing only on machine efficiency (Faraj et al., 2018; Vassilakopoulou et al., 2023).

In this evolving context, a comprehensive understanding of the components of digital transformation, their national-level impacts, and the associated opportunities and gaps is crucial for evaluating a country's capacity to leverage technological change effectively. However, existing studies often provide an incomplete consideration of the complex interdependencies among these factors. Recent research proposes a multi-layered, socio-technical conceptualization that integrates technological infrastructure, institutional readiness, and human capital development, providing a more holistic framework to evaluate digital transformation potential (Wang et al., 2024; Mabotha & Ngcamu, 2025). This represents a methodological advance by moving beyond single-level analyses toward multi-level frameworks that capture national, organizational, and individual effects simultaneously (Farias-Gaytan et al., 2023). Empirical evidence from the Industrial and Technological Revolutions clearly demonstrates that these transformations have profoundly alter labour



market structures. Recent studies confirm that digital transformation accelerates job polarization, shifting demand toward cognitive, analytical, and digital competencies, while routine middle-skill occupations are increasingly automated or restructured (Mhlanga, 2024; Wang et al., 2024). This conceptual insight emphasizes the reciprocal relationship between technological adoption and workforce skill requirements, highlighting human capital as a central factor in organizational and economic performance (Gelashvili, 2018; Mhlanga, 2024; Bedianashvili et al., 2024).

Digital transformation has also emerged as a key driver of organizational sustainability, flexibility, and operational efficiency. Digital technologies enable environmentally conscious practices, reduce resource consumption, and promote energy efficiency, contributing to long-term resilience (Bindeeba et al., 2025; El Khatib & Al-Sadi, 2023). Moreover, the integration of advanced analytics, AI, IoT, and blockchain enhances supply chain visibility, coordination, and resilience, which represents both a conceptual and methodological innovation, as performance outcomes can now be systematically measured through empirical metrics (Kim et al., 2024; Lee et al., 2024; Al Tera et al., 2024).

Digital transformation is essential for achieving societal sustainability, as it promotes the development of digital business models that generate shared value while addressing environmental and social challenges (Pappas et al., 2023).

Moreover, digitalization fosters flexibility by allowing organizations to rapidly adapt to changing market conditions, reconfigure workflows and implement remote or hybrid working arrangements. As a result, firms can respond more efficiently to demand fluctuations and evolving customer needs (Cosa & Toreli, 2024).

Digital ecosystems and interconnected platforms increase flexibility by enabling organizations to collaborate with external partners, access distributed knowledge, and integrate resources across organizational boundaries (Nambisan et al., 2019).

From a human resource perspective, digital transformation supports flexible work practices by facilitating continuous communication, virtual collaboration, and decentralized decision-making structures, which contribute to more adaptive and responsive organizations (Bondarouk & Brewster, 2016).

In addition, digitalization improves operational efficiency by automating routine tasks, optimizing supply chains, and facilitating data-driven decision-making. These changes reduce costs, increase productivity, and enable organizations to allocate resources more effectively toward strategic initiatives (Tia et al., 2023).

Empirical research demonstrates that integrating smart technology into digital supply chains mediates the relationship between digitalization and operational outcomes, with improved decision quality and productivity as key outcomes of this integration (Lee et al., 2024).

In this framework, organizations value employees who can leverage digital tools, analyse data, and engage in problem-solving. Thus, a strong positive correlation emerges between workers' qualifications, their digital competencies, and their labour market outcomes. Conversely, workers lacking up-to-date digital skills suffer higher unemployment and lower reemployment probabilities in modern economies. As a result, organizational performance becomes increasingly dependent on the effective integration of digital technologies with human



capital. Labour demand increasingly favours cognitive, analytical, and digital competencies, reinforcing the importance of human capital quality in contemporary economic development. Within this context, the role of employees shifts from executing routine functions to performing more complex, analytical, and problem-solving tasks. Consequently, organizations place growing value on workers who are capable of using digital tools, interpreting data, and adapting to technologically mediated workflows. Empirical evidence consistently demonstrates a strong positive relationship between workers' educational attainment, digital competencies, and labour market outcomes, including higher employability, wage premiums, and career mobility. In contrast, individuals who lack up-to-date digital skills face elevated risks of unemployment, longer job search durations, and lower probabilities of successful re-employment in increasingly technology-intensive labour markets.

Digital skill shortages are not limited to low-educated workers. Studies reveal that even highly educated individuals face barriers due to insufficient applied digital competencies. For example, research on IT labour markets shows that advanced digital skills significantly increase wage expectations and employability, while their absence constrains career opportunities regardless of education level (Shakina et al., 2024). This indicates that digital skills operate as a transversal competence across all education levels.

Against this backdrop, the digitalization process has fundamentally altered employer demand for skills. Analytical thinking, digital literacy, and the ability to interact with advanced technologies have become core requirements across a wide range of occupations, rather than niche competencies limited to the ICT sector. As digital technologies diffuse across industries, demand for specialized roles in information technology, data analysis, and related fields has expanded rapidly. This shift reflects deeper structural transformations within the economy, whereby traditional job functions are progressively automated or redefined, while new positions emerge that require advanced technical expertise and digital proficiency. Consequently, employers increasingly prioritize candidates who possess not only domain-specific knowledge but also the capacity to effectively navigate, adapt to, and leverage digital tools and platforms in dynamic work environments.

Theoretical and empirical research, as well as recent literature, indicate that individuals with higher qualifications are more likely to possess complementary skills in digital technologies and artificial intelligence, which positively impacts their wages and employment prospects. Conversely, individuals with lower digital skills face reduced probabilities of reemployment in the labour market, increasing their vulnerability and exacerbating inequality (Kristal & Cohen, 2016).

Within this context, the successful adoption of digital transformation largely depends on the extent to which workforce skills are aligned with evolving labour market requirements, as technological change has reshaped the overall structure of skill demand. This alignment is further facilitated by the relatively well-established institutional, economic, and social foundations of the labour market (Kakulia & Tkemaladze, 2023). Empirical evidence further suggests that current employer demand is predominantly focused on competencies related to information and data literacy, problem-solving skills, and digital content creation.

Based on these insights, the following hypotheses are proposed:



H1: Adoption of digital technologies and process automation enhances work flexibility, accelerates task completion, improves the quality of output, and reduces human error in organizational processes.

H2: Lack of digital skills constitutes a significant barrier to career advancement.

### **Innovation Capacity and Digital Indicators: International Context**

Technological advancement constitutes a fundamental driver of accelerated post-industrial development, reshaping production processes, economic structures, business models, and social relations (Papava, 2019). In this context, digital transformation extends beyond the simple diffusion of advanced technologies and represents a systemic shift toward a knowledge-based economy in which information, data, and intellectual capital increasingly replace physical capital as the primary factors of production. This transformation alters the mechanisms through which value is created, accumulated, and distributed across economies.

The contemporary business environment is characterized by rapid technological change, heightened uncertainty, and intensified global competition. Under such conditions, firms are required to manage projects efficiently, respond swiftly to external shocks, mitigate operational risks, and achieve strategic objectives in volatile markets. These dynamics have direct implications for labour markets, as employers increasingly emphasize workforce flexibility, digital proficiency, and continuous skill upgrading. Consequently, labour markets are transitioning toward employment models that prioritize digital competencies, adaptability, and, in some cases, non-standard forms of work, reflecting structural changes in the organization of production and employment.

Within this broader context, innovation capacity has emerged as a critical determinant of economic resilience, productivity growth, and long-term development. Innovation enhances firms' competitive advantage and strengthens national economies by enabling technological upgrading, diversification, and structural transformation. A widely used framework for assessing national innovation performance is the Global Innovation Index (GII), developed by the World Intellectual Property Organization (WIPO). Since its introduction in 2007, the GII has become a central reference point in global innovation analysis and economic policymaking, providing internationally comparable evidence on the functioning of national innovation systems (World Intellectual Property Organization, 2025).

The GII adopts a multidimensional approach to innovation, encompassing institutional quality, human capital and research, infrastructure, market and business sophistication, and knowledge and creative outputs. Based on more than 80 indicators drawn from international public and private data sources, the Index annually ranks over 130 economies, capturing the complex and systemic nature of innovation ecosystems and enabling cross-country comparison over time.

According to the Global Innovation Index 2025, the world's leading innovation performers include Switzerland, Sweden, the United States, the Republic of Korea, and Singapore (Table 1).



**Table 1.** GII 2025 rankings 2025

Country	Over all GII Rank	Institutions	Human Capital and research	Infrastructure	Market sophistication	Business Sophistication	Knowledge and technology outputs	Creative output
Switzerland	1	3	6	5	3	5	2	1
Sweden	2	12	3	4	9	2	4	2
United States of America	3	16	13	32	1	1	3	5
Republic of Korea	4	20	1	7	5	4	9	4
Singapore	5	1	2	19	6	3	7	15

*Source:* Author's own compilation based on WIPO 2025 result

The data reveals a significant correlation between institutional stability and innovation output. These top-ranked economies are all high-income countries, underscoring the strong empirical association between innovation performance, institutional quality, human Capital and research, market and business position, infrastructure, and creative development level. Innovation acts as a key engine of growth by enhancing productivity, accelerating technological progress, and reinforcing international competitiveness.

Switzerland dominates the Output side, ranking 1st in both Knowledge/Technology and Creative outputs. World-class research institutions such as ETH Zurich and EPFL, together with globally competitive firms, reinforce Switzerland’s capacity to generate and commercialize knowledge. Rather than extensive direct state intervention, public policy focuses on creating favorable framework conditions that stimulate private-sector innovation and international collaboration. Sweden, while 2nd overall, leads the world in Infrastructure and Business Sophistication, indicating a seamless integration between high-tech physical assets and private-sector innovation capacity. The USA maintains its lead in Market Sophistication, driven by the depth of its venture capital ecosystems and financial scale. Innovation hubs such as Silicon Valley exemplify a market-driven model centered on entrepreneurship, venture capital, and competition. Government intervention remains relatively limited, with innovation largely driven by private-sector initiative, supported by strong financial markets. Beyond institutions, Korea’s 2nd place in Human Capital and Research underscores its massive investment in STEM education and high-density researcher populations. For Singapore, despite a lower institutional ranking relative to its peers, it compensates through hyper-efficiency in market and creative outputs, suggesting a highly streamlined, results-oriented regulatory environment.

Georgia ranked 56th among 139 economies in the Global Innovation Index 2025, indicating moderate innovation performance relative to global benchmarks. An examination of selected GII indicators between 2023 and 2024 reveals heterogeneous innovation dynamics. Scientific publications declined marginally by 0.6%, while research and development expenditures increased by 16.2%, signalling a stronger financial commitment to innovation (Table 2).



**Table 2.** Deviation of key GII Performance Indicators in Georgia (2023-2024)

Scientific publications	R&D investments	Venture capital deal numbers	International patent filings	Safe sanitation	Connectivity
▼ -0.6 %	▲ 16.2 %	▼ -57.1%	▲ 133.3%	▲ 1%	▲ 4%

Source: Author's own compilation based on WIPO 2024 result

At the same time, venture capital deal numbers decreased sharply by 57.1%, pointing to a contraction in private investment activity, whereas international patent filings increased by 133.3%, reflecting growth in formalized innovation outputs. Indicators related to enabling conditions showed more modest improvements, with safe sanitation increasing by 1% and digital connectivity by 4%. These divergent trends highlight the multidimensional nature of innovation processes, in which knowledge production, financing mechanisms, and entrepreneurial activity may evolve along different trajectories. The coexistence of rising R&D expenditure and patent activity alongside declining venture capital flows suggests a potential structural reorientation of the innovation ecosystem, characterized by a stronger role of public and institutional actors and greater volatility in private-sector investment.

From an innovation systems perspective, digital transformation is not an isolated technological process but a systemic phenomenon shaped by interactions between firms, educational institutions, labor market policies, and governance structures. In transition economies, weaknesses in these systems often limit the capacity to absorb and effectively utilize digital technologies. As a result, digital adoption may coexist with low productivity gains and persistent employment frictions.

Empirical studies provide mixed evidence on the employment effects of digitalization. While some research finds positive effects on job creation and productivity, others highlight displacement risks and growing inequalities. Recent contributions emphasize the central role of digital skills as a mediating factor. Workers possessing adequate digital competencies are more likely to benefit from technological change through higher employability, flexibility, and career mobility.

## METHODOLOGY

This study aims to empirically examine how digital transformation reshapes labour market outcomes in a transition economy context. The research objectives are fourfold.

First, the study seeks to assess the relationship between individual level digital skill endowment and perceived labour market constraints, particularly the extent to which insufficient digital skills are identified as a barrier to career advancement and employment opportunities.

Second, the research aims to analyse the degree of alignment between formal education and job requirements in the context of digital transformation, identifying the prevalence of education job mismatch and its association with digital skill gaps across sectors.



Third, the study investigates how the level of digitalization of work processes influences employees' perceptions of job quality, work flexibility, and task composition, thereby capturing the organizational implications of digital adoption from the employee perspective.

Fourth, the paper contributes to the broader literature on digital transformation and labour markets in transition economies by providing micro level empirical evidence on skill related frictions. In doing so, it seeks to inform policy discussions on human capital development, digital skills upgrading, and the alignment of education and labour market institutions necessary for inclusive and productivity enhancing digital transformation.

This study adopts a quantitative, cross sectional research design to examine the relationship between digital transformation, workforce skills, and labour market outcomes in Georgia. Primary data were collected through a structured survey administered to employees across diverse sectors of the Georgian economy in 2025. The survey approach was selected to capture individual level perceptions of digital skills, education-job alignment, and the perceived impact of digital technologies on employment conditions, which are not fully observable through administrative or secondary data sources.

The questionnaire was distributed online using a standardized format to ensure consistency across respondents. Participation was voluntary and anonymous, reducing the risk of response bias and encouraging honest reporting. Before full deployment, the survey instrument was pilot-tested on a small sample to ensure clarity, internal coherence, and relevance of questions. Based on this pilot phase, minor adjustments were made to improve question wording and response options.

After data cleaning, excluding incomplete and inconsistent the final sample consisted of N=150 valid observations, which is sufficient for descriptive analysis and regression-based inference in exploratory labor market research.

The sample covers a broad cross-section of the labour force in terms of age, education, and sectoral affiliation. Respondents represent multiple age cohorts, with the largest share concentrated in the economically active prime-age group (26-35 years). Educational attainment is relatively high, with the majority of respondents holding at least a bachelor's degree, reflecting Georgia's broader pattern of high formal educational participation. Sectoral representation includes finance, education, information technology, public administration, healthcare, manufacturing, and other service activities, allowing for meaningful comparison across technology-intensive and traditional sectors.

Although the sample is not fully representative of the national labour force, it captures substantial heterogeneity in employment conditions and digital exposure, which is appropriate for analysing skill mismatches and perceived barriers related to digital transformation.

The questionnaire was structured into several thematic blocks covering demographic characteristics, education and employment profiles, digital skill endowment, training pathways, and perceptions of digital transformation. Key variables were operationalized as follows:



**Digital Skill Level:** Respondents self-assessed their overall digital competence on a five-point Likert scale (1 = very low, 5 = very high). In addition, respondents evaluated their proficiency across specific domains, including data analysis, programming, digital marketing, cybersecurity, artificial intelligence/machine learning, cloud technologies, and digital project management. This multidimensional approach allows for a more nuanced understanding of digital capability beyond a single aggregate indicator.

**Education Job Match:** Measured using a categorical variable indicating whether the respondent's formal education fully matches, partially matches, or does not match the requirements of their current job. For regression analysis, this variable was transformed into a binary indicator capturing the presence or absence of perceived mismatch.

**Digital Skill Barrier:** A binary variable indicating whether respondents perceive insufficient digital skills as a barrier to career advancement or job search. This variable serves as the primary dependent variable in testing Hypothesis 2.

**Digitalization of Work Process:** Respondents rated the extent to which their current job processes are digitalized on a five-point scale. This variable captures firm-level digital adoption as experienced by employees.

**Impact of Digital Technologies:** Perceived effects of digital technologies on work flexibility, job quality, and task composition were measured using Likert-scale items.

Additional variables include participation in professional training, sources of skill acquisition (formal education, workplace training, self-learning, certification programs), adaptability to new technologies, and attitudes toward future digital skill development.

The empirical analysis proceeded in several stages.

First, descriptive statistics were computed to summarize sample characteristics, sectoral distribution, digital skill levels, and perceived labor market outcomes. These statistics provide an overview of structural patterns and highlight potential mismatches between education, skills, and employment.

Second, cross-tabulations were used to explore associations between digital skill levels, education-job match, sector of employment, and perceptions of digital barriers. This step allowed for preliminary identification of heterogeneity across groups.

Third, to formally test Hypothesis 2, a binary logistic regression model was estimated, where the dependent variable is whether a respondent reports lack of digital skills as a barrier to career advancement. The key explanatory variable is Digital Skill Level, with controls for education level and field of employment. Logistic regression is appropriate given the dichotomous nature of the dependent variable and allows for interpretation in terms of odds ratios.

To assess Hypothesis 1, the analysis focuses on comparing average perceived impacts of digital technologies on job flexibility and work quality across sectors and skill levels. Although causal inference is limited by the cross-sectional design, this approach provides insight into whether digitalization is associated with improved organizational outcomes at the employee level.



## RESULTS

The survey sample provides a detailed snapshot of digitally exposed segments of Georgia’s labor market. The majority of respondents were aged 26–35, representing the core economically active population most directly affected by digital transformation (Table 3).

**Table 3.** Age Distribution of Survey Respondents (%)

Age range	Respondent %
18-25	6.8%
26-35	50.8%
36-45	22.0%
46-55	16.1%
56+	4.3%

Source: own research

Educational attainment among respondents was relatively high, with approximately 83% holding at least a bachelor’s or master’s degree, consistent with Georgia’s broader pattern of elevated formal educational participation (Table 4).

Sectoral affiliation was heterogeneous, encompassing services, education, finance, manufacturing, ICT, and public administration. This diversity enables comparisons between technology-intensive and traditional sectors and strengthens the analytical relevance of the sample for assessing digital skill mismatches across employment contexts.

Education job alignment varied substantially by education level. Among respondents with bachelor’s, master’s, and PhD degrees, 35%, 38%, and 52% respectively, reported that their education was well aligned with job requirements. In contrast, only around 29% of respondents with a vocational degree perceived a strong match between education and job tasks.

Consistent with Hypothesis 2, approximately 78% of respondents reported that insufficient digital skills had hindered their career advancement. This perception was strongly stratified by self-assessed digital skill level. Among respondents with the lowest digital skill ratings (1-2 on a five-point scale), more than 85% reported experiencing digital skill related barriers, compared to only about 15% among those rating their skills at the highest level (5).

**Table 4.** Respondent characteristics by education level

Education level	Count	% of Sample	% of respondents facing barriers in the labor market due to digital shortage
Bachelor’s	64	43%	65%
Master’s	61	41%	62%
PhD	14	9%	48%
Vocational	11	7%	71%

Source: own research

To assess the integration of digital competencies within the educational system, respondents were asked to indicate the extent to which digital technologies were incorporated into their study programs. Education represents the primary mechanism through which labor market-relevant skills are developed, making this



assessment critical. The results indicate that most respondents reported minimal or partial integration of digital technologies into their curricula. Only 7% of respondents noted substantial or full integration, highlighting the limited inclusion of digital components within the education system.

A modest positive association between age and perceived barriers was observed, although this effect was not statistically significant.

**Table.5.** Logistic Regression Results: Effect of Digital Skill Proficiency on Perceived Career Barriers

Predictor	Coefficient – $\beta$	Std. Error	z-value	p-value
Digital Skill Level	-0.95	0.22	-4.32	<0.001
Constant	3.21	0.62	5.18	<0.001

Source: own research

Regarding Hypothesis 1, 75% of respondents strongly agreed (ratings of 4 or 5) that digital tools had improve work flexibility and/or output quality. However, sectoral differences were pronounced. Respondents in ICT and technology-oriented services reported significantly higher benefits from digitalization, while those in traditional sectors such as education, manufacturing, and public administration reported substantially lower perceived impacts. Key barriers to professional development were identified as lack of time, insufficient financial resources, and limited employer support.

The logistic regression results provide strong empirical support for the central role of digital skills in shaping labor market outcomes. As shown in Table 5, the coefficient on Digital Skill Level is negative and highly statistically significant ( $\beta = -0.95$ ;  $z = -4.32$ ), indicating a robust inverse relationship between digital skill proficiency and the likelihood of reporting a digital skill-related barrier to career advancement.

Substantively, the magnitude of the estimated coefficient suggests a large effect. Holding other factors constant, a one-unit increase in self-assessed digital skill level substantially reduces the log odds of perceiving insufficient digital skills as a barrier. In practical terms, a one-unit increase in the five-point digital skill scale reduces the odds of experiencing a digital skill barrier by approximately 61% ( $\exp(-0.95) \approx 0.39$ ), holding other factors constant. This result highlights digital competence as a decisive form of human capital in the contemporary labour market, with tangible implications for individual career trajectories.

The constant term ( $\beta = 3.21$ ;  $z = 5.16$ ) indicates that workers with very low digital proficiency face a high baseline likelihood of encountering digital skill-related constraints in their careers.

## DISCUSSION

The results reveal deep structural and skills-related mismatches in Georgia’s labour market, with digital competencies emerging as a central determinant of employment outcomes. While formal educational attainment among respondents is relatively high, education alone does not ensure effective skill utilization or protection against digital skill shortages.



Respondents aged 26-35 made up the majority of the sample, which is advantageous for this study as this age group typically exhibits the highest labor market participation, economic activity, and motivation. Their prominent presence ensures that the findings reflect the perspectives of a workforce most actively engaged in work processes and most capable of adapting to digital transformation, providing meaningful insight into skill requirements and employment outcomes in a technology-driven economy.

The sectoral diversity allows for meaningful comparisons between technology-intensive and traditional industries, enhancing the analytical value of the sample in assessing digital skill gaps across different employment contexts. The study found that overall levels of digitalization among employees remain low across all sectors, although technology-focused sectors exhibit relatively higher digital adoption compared to traditional industries. Nevertheless, self-assessments on the Likert scale indicate that employees generally rate their digital skills as low to moderate. For several advanced technologies, such as artificial intelligence, robotics, data analytics, and cybersecurity, respondents often possess only a basic understanding or, in some cases, are familiar merely with the terminology rather than practical application, highlighting a generally low level of digital competence.

The coexistence of relatively strong education job alignment among bachelor's and master's degree holders and persistent digital skill barriers highlights a critical limitation of traditional education pathways. Formal credentials do not automatically translate into applied digital competencies aligned with evolving workplace requirements. This finding reinforces the argument that digital skills constitute a distinct dimension of human capital, operating independently of formal education levels.,

Workers with vocational education appear particularly vulnerable. Their low education job alignment combined with the highest incidence of digital skill barriers, suggests a cumulative disadvantage in adapting to technological change. While vocational pathways may facilitate labour market entry, they often fail to provide transferable digital skills necessary for career progression in an innovation-driven economy.

Notably, even among PhD holders, nearly half report digital skill-related barriers. This underscores the transversal nature of digital competencies and indicates that advanced academic training does not guarantee proficiency in applied digital tools relevant to modern work environments.

According to the majority of respondents, the most pronounced changes in their respective fields are driven by automation and the emergence of new specializations, indicating that digital transformation primarily triggers structural shifts.

Respondents identified the main opportunities of the digital economy as increased work flexibility, faster task execution, enhanced innovation, and improved job quality. At the same time, they emphasized key challenges, including low education quality, skill shortages, and the risk of job displacement. These findings reflect a dual perception of digital transformation: while it is widely recognized as a driver of progress and new opportunities, it simultaneously creates a more competitive, skills-oriented labour market in which the ability to adapt becomes crucial.



This duality is further supported by the empirical evidence, which indicates that the adoption of digital Technology-intensive industries demonstrates higher levels of digital adoption and, consequently, experience stronger productivity-enhancing effects, whereas traditional sectors lag in both adoption and outcomes.

From an innovation systems perspective, such uneven diffusion can be explained by structural differences in firms' absorptive capacity, access to technological infrastructure, and their integration into knowledge and innovation networks. As a result, the productivity gains from digital transformation are not determined solely by the presence of new technologies, but also by the broader institutional and organizational context that enables their effective implementation.

The logistic regression results provide strong empirical support for Hypothesis 2. The magnitude and statistical significance of the digital skill coefficient demonstrate that digital competence substantially reduces the likelihood of encountering career advancement barriers. Expressed in odds ratios, each additional point on the digital skill scale reduces the odds of facing such barriers by approximately 61%, highlighting the decisive role of digital skills in shaping labour market trajectories.

The research reveals that workers with very low digital skills face a high baseline probability of encountering skill-related constraints, even in the absence of other influencing factors. This finding reflects a broader structural context characterized by limited digital skill diffusion and pervasive skill mismatches across sectors. It emphasizes that digital skill deficits represent a binding constraint for a large share of the workforce, potentially limiting both individual career progression and overall labor market efficiency.

Analysis of additional comments and recommendations highlights systemic challenges and areas for improvement:

- Lack of practical components in education - graduates often possess theoretical knowledge but minimal practical skills, with few laboratory exercises or hands-on tasks, requiring employers to retrain staff.
- Suboptimal curriculum structure - an excess of non-core subjects in technical programs reduces the effective use of time and resources, suggesting the need to revise curricula to increase professionally oriented training.
- Need for international experience sharing - respondents emphasized learning from developed countries' experiences to improve digital education and skills development policies.
- Strengthening public and private sector roles - institutional support for digital skills promotion and development is insufficient. Respondents highlighted the need for information campaigns and programs to raise awareness and promote participation.

From a policy perspective, these results suggest that formal education alone is insufficient to address digital skill gaps. Targeted interventions, such as digital upskilling programs, continuous learning initiatives, and accessible training opportunities, are essential to improve workforce adaptability and inclusivity. Additionally, sector-specific approaches may be required to ensure that both traditional and technology-intensive sectors benefit from the productivity-enhancing potential of digital transformation. Overall, the findings point to the need for coordinated strategies combining education, workforce development, and technological adoption to



strengthen labor market outcomes and support sustainable economic growth. The high and significant constant term reflects a broader structural context in which digital skill shortages are widespread, even after accounting for education and sector. This finding aligns with international evidence identifying skill gaps as a primary obstacle to technological adoption and inclusive growth.

Overall, the findings suggest that expanding formal education alone is insufficient to address labour market mismatches. Targeted digital upskilling policies, continuous learning frameworks, and improved access to time and cost-efficient training opportunities are essential to ensure that the benefits of digital transformation are broadly shared and to enhance labour market mobility in Georgia.

## CONCLUSION

By synthesizing innovation metrics with granular workforce insights, this investigation has elucidated the systemic reconfiguration of labour market dynamics through an integrated perspective that links digitalization, innovation capacity, and human capital alignment, with a particular focus on transition economies. Building on innovation systems theory, skill-biased technological change, and labour market economics, the paper sought to clarify how digital technologies reshape skill demand, employment structures, and organizational performance, and why these effects remain uneven across sectors and worker groups.

Several core findings emerge from the theoretical and empirical analysis. First, digital transformation operates as a fundamentally systemic process rather than a purely technological one. While digital technologies offer significant potential for productivity growth, flexibility, and innovation, their labour market effects are mediated by the quality of human capital, the responsiveness of education and training systems, and the overall coherence of national innovation systems. Where these complementary factors are weak or poorly aligned, the benefits of digitalization remain partial and uneven.

Second, the results confirm that digital transformation systematically alters the structure of labour demand. Consistent with the literature on routine-biased and skill-biased technological change, demand is shifting away from routine, standardized, and physically intensive tasks toward cognitive, analytical, and digital competencies. This transformation increases the complementarity between digital technologies and advanced skills, while reducing the relative demand for low-skilled and routine labour. As a result, labour markets increasingly reward workers who possess digital literacy, problem-solving capacity, and adaptability, while penalizing those whose skills are outdated or poorly matched to new technological requirements.

Third, the empirical findings highlight the presence of pronounced skill mismatches and structural rigidities that constrain inclusive digital transformation. Although formal educational attainment among respondents is relatively high, a substantial share of workers report that insufficient digital skills constitute a major barrier to career advancement. The logistic regression results provide robust evidence that digital skill proficiency significantly reduces the likelihood of encountering such barriers, even after controlling for education level and sector of employment. This indicates that digital competencies function as an independent and increasingly decisive dimension of human capital in the contemporary labour market.



Fourth, the perceived productivity and flexibility gains from digitalization are highly uneven across sectors. Employees in ICT and technology-intensive services report significantly greater benefits from digital tools than those employed in traditional sectors such as education, manufacturing, and public administration. This pattern suggests that digital transformation remains concentrated in a narrow set of activities and has yet to diffuse broadly across the economy. Limited adoption of advanced digital systems among small and medium-sized enterprises, combined with skill shortages, appears to dampen aggregate productivity effects.

The findings underscore the critical role of innovation systems in shaping the labour market outcomes of digital transformation. Digital technologies generate the greatest economic and employment benefits when they are embedded in well-functioning innovation ecosystems characterized by strong linkages between firms, universities, training institutions, and policy frameworks. In such systems, continuous skill upgrading, knowledge transfer, and organizational learning enable firms to translate technological adoption into sustained productivity gains and high-quality employment.

Persistent weaknesses in university-industry collaboration, limited opportunities for lifelong learning, and insufficient emphasis on applied digital skills constrain the absorptive capacity of the economy. The coexistence of high wages and low employment in the information and communication sector illustrates this tension: while digital skills are highly valued and rewarded, their limited supply restricts sectoral expansion and broader spillovers to the rest of the economy. These dynamic risks reinforcing labour market segmentation, whereby a small group of highly skilled workers benefits disproportionately from digital transformation, while a large share of the workforce remains trapped in low-productivity, low-wage employment.

From a broader comparative perspective, these results are consistent with international evidence showing that countries with more adaptive education systems and stronger innovation institutions are better positioned to manage the employment effects of digitalization. In such economies, digital transformation tends to complement human labor, support job upgrading, and raise average wages, whereas in systems with weak skill formation and coordination failures, digitalization is more likely to generate substitution effects, inequality, and social tensions.

The analysis carries several important policy implications. First, digital transformation strategies should place human capital development at their core. Expanding access to digital infrastructure is necessary but not sufficient; equal priority must be given to developing functional, professional, and advanced digital skills across the workforce. This requires modernizing curricula, strengthening vocational and tertiary education in digital fields, and embedding digital competencies across non-ICT disciplines.

Second, lifelong learning and continuous reskilling must become central components of labour market policy. Given the rapid pace of technological change, initial education can no longer provide skills that remain relevant throughout an individual's career. Public-private partnerships, workplace-based training, modular certification programs, and incentives for firm-level training investment are essential for enabling workers to adapt to evolving skill requirements.



Third, reducing digital inequality should be a strategic priority. The urban-rural digital divide, disparities in access to training, and uneven diffusion of digital technologies across sectors risk exacerbating existing social and regional inequalities. Targeted interventions aimed at small and medium-sized enterprises, public sector organizations, and lagging regions can help broaden the diffusion of digital tools and spread productivity gains more evenly.

Fourth, innovation policy and labor market policy should be more closely integrated. Policies that support research and development, entrepreneurship, and digital innovation should be complemented by measures that facilitate labor mobility, protect workers during transitions, and ensure that productivity gains translate into improved job quality and wages. Such coordination is essential for balancing efficiency and equity in the digital economy.

In conclusion, digital transformation represents both a major opportunity and a significant challenge for contemporary labor markets. Its capacity to enhance productivity, innovation, and flexibility is undeniable, yet these benefits are neither automatic nor evenly distributed. The evidence presented in this study demonstrates that digital skills and innovation capacity are central determinants of whether digital transformation leads to inclusive growth or to deeper labour market segmentation.

For transition economies, the key challenge lies in transforming digitalization from a narrow, sector specific phenomenon into a broad-based development process. Achieving this objective requires coordinated investments in human capital, stronger innovation systems, and adaptive labour market institutions. Only through such an integrated approach can digital transformation serve as a foundation for sustainable economic development, high-quality employment, and social resilience in the digital age.

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Author have read and agreed to the published version of the manuscript.

**Declaration of Generative AI and AI-assisted technologies in the writing process:** During the preparation of this work the authors not used Generative AI or AI-assisted tools to create or alter images in manuscript.

### **Institutional Review Board Statement**

The study was conducted in accordance with the Declaration of Tbilisi and approved by the Institutional Review Board of Ivane Javakhishvili Tbilisi State University (N844/01-04/ 28.09.2023).

**Informed Consent Statement:** Informed consent was obtained from all study participants.

### **Data Availability Statement**

The data presented in this study are available on request from the corresponding author.



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