

HUMAN CAPITAL, STRATEGIC DEVELOPMENT AND ECONOMIC GROWTH IN ROMANIA: AN INTEGRATED PERSPECTIVE, 2020–2025

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ABSTRACT: *This paper examines the interaction between human capital, strategic development and economic growth in Romania during 2020–2025, a period marked by the COVID-19 shock, post-pandemic recovery, high inflation, accelerated EU-funded investment and renewed pressure to modernise education and skills. The study adopts an integrated economic perspective in which human capital is treated not only as educational attainment but as a productive asset whose contribution depends on labour-market utilisation, continuous skill renewal, digital capabilities and the institutional capacity to connect education with investment and innovation. The empirical component combines official Eurostat indicators, European Commission monitoring data and national and European policy evidence. Romania recorded a rapid rebound after the 2020 contraction, but the recovery coexisted with structural weaknesses: tertiary attainment among 25–34 year-olds was 23.2% in 2024 compared with 44.1% in the EU; adult participation in learning remained substantially below the EU benchmark; basic digital skills were weak; and the employment rate of the 20–64 population reached 69.0% in 2025 compared with 76.1% in the EU. The employment rate of recent graduates was 72.7% in 2025. The evidence suggests that the principal constraint is not the absence of investment alone, but the incomplete conversion of education, skills and labour supply into productive capacity. The paper argues that Romania’s strategic-development model should integrate human-capital objectives with investment policy, regional development, digitalisation and labour-market institutions. Because the national annual sample contains only six observations, the analysis is deliberately descriptive and mechanism-based rather than presenting an underidentified causal growth regression. The contribution lies in combining growth, education, employment and strategic-policy evidence into a coherent framework for assessing Romania’s capacity to transform investment into sustainable productivity gains.*

Keywords: *Human Capital; Economic Growth; Strategic Development; Employment; Tertiary Education; Lifelong Learning; Digital Skills; Romania*

JEL Classification: *I25; J24; O15; O47; O52.*

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1. INTRODUCTION

Human capital is one of the central mechanisms through which education, labour-market institutions and technological change affect long-run economic performance. Physical investment can expand productive capacity, but its returns depend on the ability of workers and organisations to operate new technologies, reorganise production and generate innovation. For economies engaged in convergence, this complementarity is especially important. Catch-up growth can initially rely on capital deepening, foreign investment and the reallocation of labour toward more productive activities; sustaining convergence requires progressively stronger domestic capabilities, higher skills and more effective diffusion of knowledge.

Romania offers a particularly relevant case. The 2020–2025 interval combines several shocks and policy transitions that make the relationship between skills and growth unusually visible. The pandemic produced a sharp disruption in 2020, followed by a strong rebound. The subsequent period brought an energy-price shock, elevated inflation, tighter financing conditions and geopolitical uncertainty. At the same time, the Recovery and Resilience Facility and EU cohesion policy expanded the resources available for infrastructure, digitalisation, education and institutional reform. These developments created an environment in which the quantity of investment and the economy's capacity to absorb investment became equally important.

The human-capital indicators reveal a less favourable picture than headline convergence. According to the European Commission's Education and Training Monitor 2025, only 23.2% of Romanians aged 25–34 had tertiary education in 2024, compared with 44.1% in the EU. Early leaving from education and training remained high at 16.8%, while adult participation in learning, although improving, remained far below the EU level. Digital capability is another constraint: only 27.7% of people aged 16–74 had at least basic digital skills in 2023, compared with 55.6% in the EU (European Commission, 2025a). These indicators matter economically because they influence technology adoption, occupational mobility, productivity and the speed at which firms can respond to structural change.

The labour market provides a second layer of evidence. Romania's employment rate for persons aged 20–64 reached 69.0% in 2025, compared with 76.1% for the EU. The employment rate of recent graduates was 72.7%, also below the EU aggregate. Such gaps imply that the effective stock of human capital is determined by both formation and utilisation. A qualification generates economic returns only when it is matched to productive employment; similarly, investment in digital infrastructure yields smaller productivity gains when firms and workers lack complementary skills.

Against this background, the article addresses four questions. How did Romania's macroeconomic performance evolve during 2020–2025? What do education, training, digital-skill and employment indicators reveal about the quality and utilisation of human capital? Through which channels can strategic public investment strengthen or weaken the human-capital–growth relationship? Finally, which policy priorities follow from an integrated interpretation of the evidence? The objective is not to claim causality from six annual observations, but to develop an empirically disciplined diagnosis that can support subsequent regional panel research.

The contribution is threefold. First, the paper treats human capital as a multidimensional productive asset rather than equating it with years of schooling. Second, it links the human-capital diagnosis to strategic development, understood as the coordination of investment, education, innovation, digitalisation and labour-market policy. Third, it explicitly distinguishes descriptive evidence from causal inference. This distinction is important for applied economic research because a small annual sample can easily produce unstable coefficients that appear more precise than the underlying information permits.

2. THEORETICAL FRAMEWORK AND LITERATURE

Human-capital theory conceptualises education and training as investment because they raise the productive capacity of individuals and can generate returns over the working life (Becker, 1964). In aggregate growth models, human capital can affect output through several mechanisms: it raises worker productivity directly, facilitates the adoption of existing technologies, improves allocative efficiency and increases the capacity to generate new knowledge. Lucas (1988) emphasises the accumulation of human capital as a source of sustained growth, while Romer (1990) places knowledge and innovation at the centre of endogenous technological change.

The empirical literature has progressively moved beyond simple measures of schooling quantity. Hanushek and Woessmann (2015) show that cognitive skills are more closely related to long-run growth than years of schooling alone. This distinction is particularly relevant for Romania because formal attainment and effective competencies do not necessarily move together. A rise in enrolment may expand the nominal stock of education, yet weak foundational skills, high dropout or poor labour-market matching can limit the productivity effect.

A useful analytical distinction is therefore between human-capital formation, quality and utilisation. Formation refers to participation and attainment in education and training. Quality concerns the competencies acquired, including foundational, technical and digital skills. Utilisation captures whether those competencies are employed in productive activities. Economic growth depends on the interaction among all three dimensions. A country may expand higher education while losing skilled workers through migration, or may produce graduates whose fields of study do not match labour demand. In both cases, measured educational investment overstates the human capital effectively available to domestic production.

Strategic development is defined here as the coordinated use of public policy and investment to alter the economy's productive structure and long-term capabilities. This differs from a narrow interpretation of strategy as a collection of planning documents. An economically meaningful strategy links resources to measurable mechanisms: infrastructure lowers transaction costs; education increases skill supply; research and innovation improve technological capabilities; digitalisation raises information-processing capacity; and labour-market institutions influence the allocation of workers across firms and regions.

The complementarity between physical and human capital is central. A transport corridor can improve market access, but firms require managerial and technical capacity to exploit new opportunities. Digital public services can reduce administrative costs, but their benefits depend on citizens' and firms' ability to use them. Advanced manufacturing equipment raises potential productivity only if technicians, engineers and operators can integrate it into production. Strategic development therefore concerns not only the volume of expenditure but the sequencing and complementarity of investments.

For Romania, this perspective is especially relevant because the Recovery and Resilience Plan and cohesion-policy instruments mobilise substantial resources for infrastructure, digital transformation, education and the green transition. The 2025 Digital Decade country report notes a national roadmap containing 98 measures with a budget of EUR 3.6 billion, while also identifying persistent weaknesses in R&D, SME innovation, emerging-technology adoption and basic digital skills (European Commission, 2025c). The policy challenge is thus one of absorption in a broad economic sense: not simply spending funds, but converting them into durable productive capabilities.

Digitalisation strengthens the case for treating human capital as a dynamic rather than fixed stock. Technology changes task content, creates new occupations and alters the skills required within existing occupations. Workers therefore need not only initial qualifications but the capacity to learn repeatedly over the life cycle. Basic digital skills increasingly function as

general-purpose competencies analogous to literacy and numeracy, because they affect access to information, public services, training and a widening range of jobs.

Romania combines strengths and weaknesses in this area. The Education and Training Monitor reports that 30.9% of tertiary students were enrolled in STEM fields in 2023, above the EU share of 26.9% and close to the proposed EU-level target of 32%. Yet less than one third of the population aged 16–74 possessed at least basic digital skills in 2023. This coexistence suggests a distributional problem: advanced skills exist in parts of the education system and economy, while broad digital capability remains weak. A growth strategy focused only on high-end ICT talent may therefore leave a large productivity gap in traditional firms, public administration and less-skilled occupations.

The issue is reinforced by retention. The Digital Decade assessment recognises Romania's relatively strong supply of ICT graduates but identifies difficulty in retaining talent domestically. From a growth perspective, emigration changes the return to public and private investment in education. Mobility can generate remittances, networks and knowledge circulation, but persistent net losses of skilled workers reduce the domestic stock available for innovation, management and public services. Policies aimed at skill formation therefore need to be analysed jointly with wages, career opportunities, research ecosystems and institutional quality.

Human capital contributes to growth only when labour is mobilised and allocated efficiently. Low employment among working-age adults reduces the effective labour input, while skill mismatch lowers productivity within employment. Demographic decline intensifies these mechanisms because a shrinking working-age population increases the economic cost of inactivity and skill underutilisation. The Education and Training Monitor cites projections of a substantial long-term contraction in Romania's working-age population, strengthening the case for higher participation, lifelong learning and productivity growth.

Regional disparities further complicate the national picture. Bucharest–Ilfov concentrates high-productivity services, headquarters, universities and advanced employment, whereas several other regions face lower incomes, weaker urban networks and greater outmigration. National averages therefore combine very different human-capital ecosystems. Access to universities, training providers, digital infrastructure, employers and transport shapes the return to education locally. This is one reason why a future extension of the present study should move from six national annual observations to a NUTS 2 panel, where territorial heterogeneity can be modelled explicitly.

3. DATA AND METHODOLOGY

The empirical window covers 2020–2025. The starting point captures the pandemic shock and creates a consistent frame for analysing recovery and structural adjustment. The study draws primarily on Eurostat national accounts and Labour Force Survey indicators, supplemented by the European Commission's Education and Training Monitor and Digital Decade reporting. These sources were selected because they provide harmonised definitions and allow Romania to be interpreted against EU benchmarks.

The core economic outcome is real GDP growth, complemented by nominal GDP to illustrate the scale of the economy. Human-capital utilisation is represented by the employment rate of persons aged 20–64 and the employment rate of recent graduates. Formation and renewal are captured through tertiary educational attainment among 25–34 year-olds, early leaving from education and training, adult participation in learning, STEM enrolment and digital skills. These indicators do not exhaust the concept of human capital, but together they capture quantity, quality, renewal and utilisation more effectively than a single education variable.

The paper uses descriptive time-series comparison, benchmark analysis and mechanism-based interpretation. Changes over time are examined alongside the EU aggregate

where comparable data are available. The approach is intentionally conservative. With only six annual observations, a multiple regression of GDP growth on several human-capital indicators would have almost no degrees of freedom, would be highly sensitive to the pandemic observation and would not separate common macroeconomic shocks from structural effects. Reporting such coefficients as evidence of a stable relationship would be misleading.

Instead, the study evaluates whether observed patterns are consistent with mechanisms established in the economic literature. For example, weak tertiary attainment is interpreted as a constraint on the supply of advanced skills, not as proof that a specific percentage-point increase would mechanically raise GDP by a given amount. Similarly, low adult-learning participation is linked to adjustment capacity, while low graduate employment is treated as evidence of incomplete labour-market absorption. This approach preserves empirical discipline while allowing the available evidence to inform strategic policy analysis.

Table 1. Human-capital dimensions, indicators and economic interpretation

Dimension	Indicator	Economic interpretation	Main source
Growth	Real GDP growth	Short-run output dynamics and recovery	Eurostat national accounts
Labour utilisation	Employment rate, 20–64	Use of working-age labour resources	Eurostat LFS
Education stock	Tertiary attainment, 25–34	Supply of advanced formal qualifications	Eurostat / EC Monitor
Transition	Recent graduate employment	Education-to-work absorption	Eurostat
Skill renewal	Adult participation in learning	Capacity for reskilling and adaptation	Eurostat / EC Monitor
Digital capital	At least basic digital skills	Capacity to use digital technologies broadly	Digital Decade / Eurostat
Specialisation	STEM share of tertiary students	Pipeline for technical and scientific skills	EC Monitor / Eurostat

Source: Authors' synthesis based on Eurostat, European Commission – Education and Training Monitor 2025, and the statistical indicators discussed in the article (including edat_lfse_04 and edat_lfse_24).

Interpretation follows three rules. First, levels and trends are separated: a country may improve while remaining far from the EU benchmark. Second, educational inputs are not equated automatically with productive outcomes; employment and skill use matter. Third, 2025 values are included only where official releases provide them. Where the most recent comparable structural indicator refers to 2023 or 2024, that reference year is stated explicitly rather than extrapolating a value for 2025.

The principal limitation is the small national time dimension. The period is also dominated by unusual shocks, including the pandemic, energy-price increases and high inflation. These factors make simple correlations especially difficult to interpret. Labour Force Survey series may contain methodological breaks, while education indicators often change slowly and are published with different reference years. Consequently, the study should be read as an integrated empirical diagnosis rather than a causal estimate of the return to human capital.

A stronger econometric extension would construct an eight-region NUTS 2 panel for 2020–2025, generating up to 48 region-year observations. A panel specification could relate regional GDP per capita or productivity growth to tertiary attainment, employment, training proxies, R&D or digitalisation controls, with regional and year fixed effects. Such a design would exploit cross-regional variation while controlling for common national shocks. The

present article provides the conceptual foundation and identifies the indicators that should enter that extension.

4. ECONOMIC DYNAMICS IN ROMANIA, 2020–2025

Romania's growth path over 2020–2025 was highly non-linear. The pandemic produced a contraction in 2020, followed by a strong reopening-driven rebound. Subsequent growth moderated as inflation accelerated, household purchasing power came under pressure and external demand weakened. By 2025, the European Commission assessed real growth at a modest rate relative to the immediate post-pandemic recovery. The sequence matters because human-capital indicators evolve more slowly than cyclical GDP, making it inappropriate to infer structural improvement from a short-lived rebound.

Nominal GDP expanded much faster than real output during the period because price increases were substantial. This distinction is important in strategic-development analysis. Rising nominal fiscal resources can create the appearance of rapidly expanding capacity, but real investment costs, wages and procurement prices also increase. Evaluation should therefore focus on real output, productivity and physical or service outcomes rather than nominal expenditure alone.

The labour market proved more resilient than the output shock might have suggested, but Romania continued to display a sizeable employment gap relative to the EU. In 2025 the employment rate of persons aged 20–64 was 69.0%, compared with 76.1% in the EU. This gap represents more than a social indicator. It implies foregone labour input and tax revenue, while increasing the burden of demographic ageing on the employed population. Raising participation can therefore support growth even before changes in educational attainment affect the workforce.

Gender differences are particularly relevant. Lower female employment can reflect childcare constraints, care responsibilities, local labour-market opportunities, transport accessibility and institutional design. These barriers interact with human capital: education produces lower aggregate returns when qualified individuals cannot participate fully in employment. Policies that expand childcare, flexible work and transport connectivity can therefore function as human-capital policies even though they are not classified as education expenditure.

Romania's strategic-development challenge is increasingly to convert investment into productivity. Public infrastructure can crowd in private investment by improving connectivity and reducing costs, while EU-funded digital and green projects can accelerate capital renewal. Yet the productivity effect depends on project selection, implementation quality and complementary capabilities in firms and public institutions. Shortages of engineers, technicians, project managers, health professionals or skilled construction workers can delay projects and raise costs.

This creates a two-way relationship between investment and human capital. Investment raises demand for skills and can increase wages and learning opportunities. At the same time, the available skill base determines which projects can be implemented domestically and how much value is retained in the economy. Where specialised labour is scarce, investment may increase imports of services or equipment without generating equivalent domestic knowledge accumulation. Strategic planning should therefore anticipate occupational demand rather than treating training as a separate policy stream.

5. HUMAN CAPITAL FORMATION AND UTILISATION

Tertiary attainment is one of the clearest structural weaknesses. In 2024, 23.2% of Romanians aged 25–34 had completed tertiary education, compared with 44.1% in the EU. The

gap is unusually large and cannot be explained by a single cohort. The Education and Training Monitor shows that the Romanian rate was 25.5% in 2015, indicating that the country did not converge toward the EU benchmark over the decade. High early leaving, unequal access, university dropout and migration all contribute to the outcome (European Commission, 2025a).

The economic effect is not simply a shortage of graduates in general. Modern growth increasingly depends on occupational mixes that combine advanced technical, managerial, health, education and professional skills. A low tertiary-attainment rate narrows the pool from which firms and public institutions recruit for such roles. It can also constrain the diffusion of technology because adoption often requires employees capable of adapting systems to local processes rather than merely operating standard equipment.

At the same time, policy should avoid interpreting expansion of university enrolment as an objective independent of quality and relevance. Completion, field of study, practical experience and labour-market outcomes matter. The introduction of dual higher-education pathways is potentially significant because it creates a stronger institutional bridge between universities and employers. The Monitor reports expansion of dual bachelor and master programmes during the 2024/2025 and 2025/2026 academic years. Their economic value will depend on scale, employer participation and whether programmes reach regions outside the strongest university centres.

The human-capital pipeline is affected well before tertiary education. Early leaving from education and training remained 16.8% in 2024, compared with 9.4% in the EU. High early leaving reduces the pool eligible for tertiary study and increases the probability of low-skilled employment or inactivity. It also makes later reskilling more difficult because adult training builds on foundational literacy, numeracy and learning capacity.

Learning outcomes reinforce this concern. The Education and Training Monitor reports high shares of low achievement among Romanian students in reading, mathematics and science. These deficits have long-term economic consequences because they affect not only future university participation but also the capacity to learn in vocational settings, use digital tools and respond to workplace change. Improving basic skills is therefore not merely an education-sector objective; it is part of productivity policy.

Initial education cannot provide all the skills required over a working life. The pace of technological and organisational change makes adult learning a central component of modern human capital. Romania has improved from a very low base, but participation remains insufficient. The Education and Training Monitor reports an increase in adult participation in learning from 5.8% in 2016 to 19.1% in 2022 under the Adult Education Survey measure, compared with 39.5% in the EU. The gap is especially relevant for people outside the labour market, residents of rural areas and adults with low educational attainment.

The economic mechanism is straightforward. When workers can reskill, firms can reorganise production without relying entirely on new cohorts or external recruitment. This reduces adjustment costs and makes investment more complementary with the existing workforce. Conversely, weak adult learning can create bottlenecks: vacancies coexist with unemployment or inactivity because the skill profiles do not match. In a shrinking labour force, such mismatches become increasingly expensive.

Romania's adult-learning strategies for 2024–2027 and 2024–2030, together with ESF+-supported upskilling programmes, provide an institutional framework for improvement. The challenge is to link participation to measurable labour-market outcomes. Training volume alone is not sufficient. Evaluation should examine completion, certification, employment transitions, wage progression and employer-reported skill use.

Digital skills reveal one of the sharpest gaps between infrastructure and human capability. Romania has comparatively strong fixed connectivity, yet the 2025 Digital Decade assessment continues to identify basic digital skills as a major weakness. In 2023, 27.7% of individuals aged 16–74 had at least basic digital skills, against 55.6% in the EU. More recent

Eurostat evidence shows that in 2025 only 53.3% of Romanian 16–24 year-olds had at least basic digital skills, one of only two EU countries below 60% for this age group.

This matters for productivity because digital technologies are general-purpose tools. Their value depends on complementary organisational changes and user capability. A firm can purchase software, cloud services or automated equipment, but productivity gains remain limited if employees cannot integrate these tools into workflows. The same applies to public-sector digitalisation: online services reduce administrative costs only when users can access them effectively and institutions redesign processes rather than merely digitising existing paperwork.

The coexistence of low broad-based digital skills with a relatively high STEM enrolment share suggests that Romania's challenge is not simply to produce more elite technical specialists. It is also to diffuse functional digital capability across the workforce. This requires differentiated interventions: advanced programmes for ICT and engineering, applied digital training for SMEs and occupations undergoing transformation, and foundational digital inclusion for groups with low participation.

The employment rate of recent graduates is a useful indicator of whether educational investment is translated into labour-market utilisation. Eurostat reported a rate of 72.7% for Romania in 2025, below the EU level. The indicator is affected by the business cycle and composition of graduates, but it nevertheless signals friction between education and employment. Such friction can arise from skill mismatch, geographic immobility, limited work experience, wage expectations or insufficient demand in particular fields.

From a strategic perspective, the transition can be improved through work-based learning, internships, dual programmes, career guidance and stronger employer involvement in curriculum design. These mechanisms reduce information asymmetry on both sides of the market. Students learn which competencies employers value, while firms obtain earlier information about potential recruits. The objective is not to subordinate education entirely to immediate vacancies, but to reduce avoidable mismatch while preserving transferable skills.

6. STRATEGIC DEVELOPMENT AND THE HUMAN-CAPITAL-GROWTH NEXUS

Romania's access to EU financing creates an opportunity to accelerate convergence, but it also raises the importance of complementary human capital. Recovery and resilience investments in digitalisation, energy, transport, health and education generate demand for specialised skills during implementation and for operational skills after completion. If these capabilities are scarce, projects may face delays, cost escalation or dependence on external expertise. Human-capital planning should therefore be integrated into investment programming from the design stage.

A useful policy principle is to associate major investment programmes with a skill map. For each investment area, authorities can identify occupations likely to experience increased demand, existing training capacity, regional shortages and the time required to produce additional workers. Such mapping can inform vocational places, university programmes, adult-learning subsidies and mobility support. It also creates a measurable link between strategic planning and labour-market outcomes.

Human capital affects growth not only through labour productivity but through absorptive capacity: the ability of firms and institutions to identify, adopt and adapt external knowledge. This is especially important for a convergence economy where imported technologies and foreign direct investment can be major sources of productivity improvement. Engineers, researchers, managers and technically skilled workers help translate external technology into local routines and supplier capabilities.

The 2025 Digital Decade report identifies persistent R&D gaps and weak innovation among SMEs and start-ups. These weaknesses imply that policy should connect research institutions, universities and firms more effectively. Public R&D expenditure alone cannot guarantee innovation if firms lack skilled personnel or incentives to collaborate. Conversely, producing researchers without attractive domestic opportunities can intensify emigration. The ecosystem perspective therefore complements the traditional human-capital focus on individual education.

National averages conceal large territorial differences in educational opportunity, employment structure and migration. A place-based approach recognises that the same intervention can have different returns across regions. In a metropolitan region with universities and dense labour markets, support for research collaboration may generate strong spillovers. In a rural or shrinking region, basic transport, school access, digital connectivity and vocational training may be more binding constraints.

Regional policy should also account for mobility. Supporting education in lagging regions does not automatically increase local human capital if graduates relocate permanently to Bucharest or abroad. Retention requires complementary job creation, housing, public services and career prospects. At the same time, policies should not attempt to prevent mobility; rather, they should make more Romanian regions viable locations for skilled work and investment.

Table 2. Integrated strategic-development framework linking human capital to economic performance

Strategic area	Human-capital mechanism	Economic channel	Suggested monitoring indicator
Higher education	Advanced skill formation	Innovation, management, professional services	Tertiary attainment; completion; graduate employment
VET / dual education	Occupation-specific skills	Industrial upgrading and faster matching	Work-based learning; placement rate
Adult learning	Reskilling and upskilling	Adaptation to technology and sectoral change	Participation; certification; wage/employment transition
Digitalisation	Broad digital capability	Technology adoption and lower transaction costs	Basic/advanced digital skills; SME adoption
R&D and innovation	Knowledge creation/absorption	Productivity and new products/processes	Researchers; business R&D; collaboration
Labour participation	Mobilisation of existing skills	Higher effective labour supply	Employment by sex/age/region
Regional policy	Retention and local matching	Reduced territorial productivity gaps	Graduate retention; regional employment/productivity

Source: Authors' conceptual synthesis based on the literature reviewed in the article and on European Commission and Eurostat monitoring frameworks for education, skills, employment, digitalisation and regional development.

The framework emphasises that policy success should be evaluated along a chain from inputs to outcomes. Spending is an input, training completion is an intermediate output, employment or productivity improvement is an outcome. Confusing these levels can lead to

optimistic assessments based on absorption rates without evidence that productive capacity has changed.

7. INTEGRATED EMPIRICAL DISCUSSION

The evidence from 2020–2025 supports a differentiated interpretation of Romania’s convergence. The economy recovered from the pandemic and continued to expand, but several human-capital indicators remained structurally weak. This does not imply that human capital made no contribution to growth. Rather, it suggests that growth can proceed for a period through capital accumulation, consumption, EU transfers, sectoral reallocation and foreign investment even when education and skill indicators lag. The policy question is whether such a model can sustain productivity convergence as demographic pressures intensify.

The tertiary-attainment gap is particularly important because it has not narrowed over the longer comparison period. At the same time, the relatively high share of STEM students demonstrates that the structure of Romanian higher education contains areas of strength. The strategic task is therefore twofold: broaden participation and completion while preserving quality and strengthening fields linked to technological transformation.

The integrated evidence suggests that human capital should be viewed as a potential constraint on the marginal return to investment. When investment accelerates simultaneously across infrastructure, energy, health and digital projects, demand for scarce skills rises across sectors. Wage increases can attract workers and stimulate training, but adjustment takes time. If supply is inelastic, projects compete for the same engineers, technicians and managers, potentially reducing implementation speed.

This mechanism helps explain why strategic coordination matters. Education policy operates with long lags, whereas investment programmes often have fixed implementation deadlines. Anticipating skill needs can reduce this mismatch. Short-cycle adult training and mobility measures can respond faster than university programmes, while long-term reform must strengthen foundational and tertiary education for future cohorts.

Human capital is not productive in isolation from institutions. Wage-setting, public-sector recruitment, procurement, research funding, firm competition and management quality influence where skills are allocated and how intensively they are used. A highly educated worker in a poorly organised institution may contribute less to productivity than a moderately educated worker in a firm with strong management and technology. This is why education reform should be complemented by improvements in institutional capacity and business dynamism.

Incentives also shape migration. Romania participates in an integrated European labour market in which skilled workers can move relatively easily. Retention cannot rely solely on appeals to remain in the country. It depends on expected wages, career progression, research opportunities, public services and confidence in institutions. Policies that improve these conditions increase the domestic return to education without restricting mobility.

8. POLICY IMPLICATIONS

The first priority is to increase the proportion of young adults who successfully complete high-quality tertiary education. Measures should target the transition from upper-secondary education, financial barriers for disadvantaged students, first-year dropout and completion. Scholarships and access programmes are most useful when combined with academic support and monitoring of progression. Expansion should be evaluated by completion and graduate outcomes rather than enrolment alone.

Adult learning should become a mainstream labour-market instrument rather than a marginal education activity. Funding can be targeted toward occupations affected by

digitalisation, green investment and demographic shortages. Employer co-design is important, but public policy should preserve portability of skills so that training does not bind workers to a single firm. Micro-credentials and recognition of prior learning can lower participation costs when quality assurance is credible.

Romania's high-end ICT strengths will not automatically digitalise the wider economy. Policy should distinguish between specialist ICT skills and general digital competence. SMEs need accessible support for adoption, managers need the ability to redesign processes, and employees in non-ICT occupations need applied training. Schools should integrate digital competence across subjects rather than treating it as an isolated technical module.

Given demographic constraints, activating existing human capital is as important as creating new skills. Childcare, transport, flexible work arrangements and targeted activation can raise participation among groups with lower employment rates. Career guidance and labour-market information should use vacancy and wage data to help students and workers make informed choices. Better matching raises output without requiring immediate increases in the working-age population.

Major public investments should include explicit assessments of regional skill requirements. Managing authorities can coordinate with universities, vocational schools, employers and employment services to identify bottlenecks before procurement and construction peak. Regional monitoring should track whether funded projects generate local employment, supplier development and skill formation rather than only physical outputs.

A stronger evidence architecture is necessary for strategic management. Romania should monitor a compact dashboard linking education, skills, labour utilisation and productivity. Indicators should be available by region, age, sex and educational level where possible. Administrative data can complement surveys by tracking transitions from education to employment and participation in publicly funded training. Evaluation should distinguish correlation from causal impact and should publish methodologies transparently.

9. LIMITATIONS AND RESEARCH AGENDA

The analysis has several limitations. First, the 2020–2025 national time series is too short for credible multivariate causal estimation. Second, structural indicators are not all available for the same reference year; some 2025 outcomes coexist with education or digital-skill measures referring to 2023 or 2024. Third, aggregate indicators conceal variation in quality. Tertiary attainment does not measure field-specific competence, and participation in training does not establish that useful skills were acquired. Fourth, national averages hide substantial regional disparities and migration flows.

These limitations point directly to a research agenda. A regional panel should combine NUTS 2 GDP per capita and employment with tertiary attainment, demographic structure, R&D, digitalisation and investment indicators. Fixed effects can control for persistent regional characteristics, while year effects capture common shocks. Where policy programmes have staggered implementation, quasi-experimental designs may become possible. Firm-level research could examine whether training, management quality and digital adoption jointly predict productivity, while linked education-employment data could assess graduate matching and retention.

A second extension concerns the measurement of human-capital quality. Future work should incorporate standardised skill assessments, occupation-level shortages and wage returns where comparable data permit. This would help distinguish between insufficient educational quantity and weak conversion of formal qualifications into productive competencies. The distinction is central for designing policy: the remedy for low attainment is different from the remedy for low quality or poor matching.

10. STATISTICAL SYNTHESIS AND TESTABLE PROPOSITIONS

Taken together, the indicators describe a development model in which macroeconomic convergence has advanced faster than several dimensions of human-capital convergence. This distinction is analytically important. GDP can rise because the capital stock expands, labour moves from low- to higher-productivity activities, domestic demand grows or external financing supports investment. Human-capital indicators, by contrast, reflect slower institutional and demographic processes. The coexistence of growth with weak education and skill outcomes is therefore not contradictory; it indicates that the sources of recent growth may not be identical to the capabilities required to sustain growth over a longer horizon.

The most persistent signal is the low tertiary-attainment rate. At 23.2% among 25–34 year-olds in 2024, Romania stood far below the EU average of 44.1%. This gap is reinforced by early leaving from education and training, which remained 16.8% compared with 9.4% in the EU. The two indicators should be interpreted jointly: a narrow pipeline into higher education limits the future stock of advanced skills, while high dropout within tertiary education further reduces completion. Policy that focuses exclusively on university capacity therefore addresses only one part of the chain.

Adult learning provides a second signal. The improvement recorded in recent years shows that participation can respond to policy and funding, but the level remains insufficient relative to the speed of technological change. This weakness has immediate economic relevance because the workers who will constitute most of the 2030 labour force are already beyond initial education. Improvements in schools and universities are essential, but they cannot by themselves reskill existing workers in sectors affected by automation, digitalisation, energy transition or changing trade patterns.

Digital skills sharpen the same diagnosis. Romania combines good connectivity and a meaningful pipeline of STEM students with low basic digital capability across the population. The policy implication is not to choose between advanced and basic skills. Both are complementary. A small group of highly trained specialists can create and implement sophisticated systems, but broad productivity gains require managers, employees, consumers and public servants who can use digital tools confidently. Diffusion, rather than technological availability alone, is the relevant economic mechanism.

The descriptive findings can be translated into hypotheses for a subsequent NUTS 2 panel analysis. These propositions are not presented as results of the current six-year national dataset. They specify relationships that can be tested when harmonised regional observations are assembled.

H1: Regions with higher tertiary educational attainment are expected to exhibit higher labour productivity or GDP per capita, conditional on persistent regional characteristics and common annual shocks. The mechanism is a larger supply of advanced skills and greater capacity to adopt technology.

H2: Higher employment rates are expected to strengthen the relationship between educational attainment and regional output. This proposition reflects the distinction between human-capital stock and utilisation: education contributes less to local production when qualified people remain inactive, unemployed or migrate.

H3: Digital capability and innovation intensity are expected to complement formal education. The productivity association of tertiary attainment should be stronger in regions where firms and institutions use technology more intensively, because skilled labour has more opportunities to apply advanced competencies.

H4: The effect of strategic investment is expected to depend on the regional skill base. EU-funded or public capital expenditure may have larger medium-run productivity effects where complementary technical and managerial capabilities are available. Empirically, this can

be examined through interactions between investment intensity and predetermined human-capital indicators.

H5: Human-capital effects are expected to appear with lags. Education, training and institutional reform require time to influence occupational allocation, technology adoption and productivity. A regional panel should therefore compare contemporaneous relationships with one- and two-year lags rather than assuming instantaneous adjustment.

A feasible empirical extension would use the eight Romanian NUTS 2 development regions over the longest common period for which GDP, employment, education and innovation variables can be harmonised. The dependent variable could be real GDP per capita, labour productivity or their growth rates. Explanatory variables would include tertiary attainment, employment, adult-learning or training proxies, R&D intensity, digital indicators and investment. Region fixed effects would absorb persistent territorial characteristics, while year effects would capture shocks common to Romania, including inflation, national fiscal measures and EU-wide developments.

The preferred specification should remain parsimonious because eight regions provide a limited cross-section. Standard errors should account for within-region serial correlation where feasible, and results should be tested against alternative dependent variables and influential-region exclusions, particularly Bucharest–Ilfov. Because the capital region is structurally different from the rest of the country, reporting estimates with and without it would show whether national relationships are driven by a single high-income region.

Endogeneity must also be addressed cautiously. Higher-income regions may invest more in education and attract graduates, creating reverse causality between human capital and output. Fixed effects reduce bias from time-invariant differences but do not solve time-varying simultaneity. Lagged regressors can improve temporal ordering but are not, by themselves, causal instruments. Strong causal claims would require an exogenous reform, eligibility threshold, staggered programme implementation or another defensible source of quasi-experimental variation.

This proposed architecture gives the present descriptive study a clear empirical continuation. Rather than treating the 2020–2025 national evidence as sufficient for causal claims, it uses that evidence to identify economically meaningful variables, mechanisms and hypotheses. Such sequencing is preferable to estimating an overfitted national regression whose numerical precision would exceed the information contained in the data.

10. CONCLUSIONS

This article examined human capital, strategic development and economic growth in Romania during 2020–2025. The period demonstrates why short-run output recovery and long-run productive capacity should not be conflated. Romania recovered from the pandemic and continued its convergence process, yet several indicators of human-capital formation and utilisation remained weak relative to EU benchmarks. Tertiary attainment among young adults was only 23.2% in 2024, adult learning remained limited, basic digital skills were weak, the employment rate of working-age adults remained below the EU level and the transition of recent graduates into employment was incomplete.

The evidence also reveals important strengths. Romania retains a substantial STEM orientation in tertiary education, has strong connectivity infrastructure and benefits from unprecedented European investment resources. These assets create opportunities for faster technological upgrading. Their economic return, however, depends on whether skills are broadened, retained and effectively matched to productive employment. Human capital is therefore not a sectoral issue confined to education ministries; it is part of the infrastructure through which investment, innovation and regional development generate growth.

The central strategic implication is coordination. Physical investment should be accompanied by skill planning; higher education expansion should be assessed through completion and employment; digitalisation should include broad user capability; and regional development should address both skill formation and retention. In a context of demographic decline, Romania has less room to compensate for low participation or weak matching through labour-force expansion. Productivity and better utilisation of existing human capital become increasingly important.

Methodologically, the article deliberately avoids claiming causal effects from a six-year national sample. Its contribution is to assemble a coherent empirical diagnosis and specify the mechanisms that a stronger regional or microeconomic design should test. The next step is therefore not a mechanically longer national time-series regression, but a NUTS 2 panel and, where possible, linked administrative or firm-level evidence. Such work would allow Romania's strategic-development debate to move from measuring expenditure toward measuring the conversion of skills and investment into sustainable productivity gains.

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