



Foresight of Education and Empowerment of Rural Human Capital in Iran in the Era of Digital Transformation

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Abstract

Purpose- This study aimed to conduct foresight of education and empowerment of rural human capital in Iran in the era of digital transformation and to identify the key factors shaping the future of this field and the alternative scenarios that may emerge from different combinations of future conditions.

Design/methodology/approach- The study adopted a foresight approach and employed scenario planning based on the Global Business Network (GBN) approach, with Martin's foresight model serving as the overall framework. Data were collected through documentary studies and semi-structured interviews with 25 experts from academic, executive and policy-making, technology and digital transformation, and rural development fields. The collected data were analyzed using qualitative content analysis, and the identified factors, trends, opportunities, challenges, and driving forces were organized into six dimensions: sociocultural, technological, economic, environmental, political, and intellectual-philosophical.

Findings- The findings showed that the 38 identified key factors could be grouped into six major driving forces: social and cultural acceptance of digital transformation in rural areas; development of rural digital education technology and infrastructure; economic support and financial sustainability of rural education and empowerment; governance and policy coherence for rural digital transformation; flexibility and redefinition of the rural skills and human capital system; and equity and inclusion in rural education and digital transformation. The combination of the two key uncertainties resulted in four alternative scenarios: Smart Villages, Empowered People; Bright Lights, Dark Homes; Ready Hands, Distant Tools; and A Land Left Behind by Change.

Research limitations/implications- The study focuses on the future of education and empowerment of rural human capital in Iran and relies on documentary evidence and expert judgments. Therefore, the identified scenarios should be interpreted as alternative and plausible futures rather than predictions of a single predetermined future.

Originality/value- This study develops a foresight-based framework for examining the future of rural human capital education and empowerment in the context of digital transformation. The findings emphasize that technological development alone is insufficient for sustainable empowerment and that technological and infrastructural capacity should be considered in interaction with social and cultural readiness, economic support, governance, skills-system flexibility, and equity and inclusion.

Keywords- Foresight; Rural Human Capital; Digital Transformation; Empowerment; Rural Education.

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How to cite this article:

Azizi Shamami, M., & Tajari, M. (2026). Foresight of education and empowerment of rural human capital in Iran in the era of digital transformation. *Journal of Research & Rural Planning*, 15(4), 99-121.

<http://dx.doi.org/10.22067/jrpp.v15i4.2610-1188>

Date:

Received: 21-09-2026

Revised: 11-10-2026

Accepted: 13-10-2026

Available Online: 13-10-2026

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1. Introduction

The rapid advancement of digital technologies in recent decades has fundamentally transformed the nature of economic, social, and human development (Aflalo et al., 2026). The expansion of the Internet, artificial intelligence, digital platforms, the Internet of Things, and smart technologies is not merely associated with changes in communication tools or increased access to information; rather, it is reshaping patterns of production, employment, learning, service delivery, and social interaction (Muduli & Choudhury, 2026). In this context, digital transformation has become one of the major forces shaping the future of societies. Technological change is rapidly altering the structure of skills demand (Kazemiyeh et al., 2026), while the integration of technical and digital skills with cognitive and social skills is increasingly important for accessing or transitioning toward new employment opportunities (Sun & Ch'ng, 2026). Accordingly, digital transformation has expanded into diverse domains, including business (Kraus et al., 2021), public services (Ulas, 2019), and sustainable development (Rogelj et al., 2021). The implications of digital transformation are particularly important in rural areas. Although digital technologies have expanded considerably in urban settings, their potential in rural communities remains insufficiently realized (Bhattarai, 2021). Rural areas are commonly characterized by geographical dispersion, distance from urban centers, limited access to educational and specialized services, restricted employment opportunities, and difficulties in accessing broader markets (Shyian et al., 2023). These conditions can constrain the development of rural communities. Digital transformation, however, has the potential to reduce some of these structural and geographical constraints by expanding access to education, information, services, markets, and employment opportunities (Yuan et al., 2025). Digital technologies can enable rural residents to access educational resources, specialized knowledge, public services, broader markets, and wider communication networks without complete dependence on physical mobility (Li et al., 2022). They can also strengthen the utilization of human-resource capacities in rural settings (Utechenko, 2020). Similarly, access to online markets, e-commerce, digital financial services, smart

agriculture, and modern business-management tools can create opportunities for increasing productivity, diversifying economic activities, and generating new sources of income in rural areas (Mayer et al., 2018; Demchenko et al., 2023).

Nevertheless, access to technology and communication infrastructure alone does not guarantee sustainable rural development. The developmental effects of technology depend substantially on individuals' knowledge and skills and on the social and cultural readiness of communities to accept technological change (Golovina et al., 2021). Therefore, digital transformation in rural areas is closely interconnected with education, skills development, empowerment, and human-capital development. Rural human capital is particularly important because the ability of rural communities to adapt to technological, economic, social, and environmental changes depends on the knowledge, skills, competencies, experience, and capabilities of their members. Investment in education and empowerment can contribute not only to the development of individual capabilities but also to productivity, employment, entrepreneurship, innovation, and social participation (Lin & Peng, 2025).

International research suggests that rural digital transformation is no longer merely a matter of expanding communications infrastructure; rather, it is a multidimensional process shaped by the interaction of technology, human capital, economic capacity, local governance, and social equity. A 2024 report by the Food and Agriculture Organization of the United Nations emphasizes that, alongside its development opportunities, digital transformation may reproduce or exacerbate existing digital divides when disadvantaged groups are not adequately considered (Hernandez et al., 2024). China provides an example of the links between rural digital-development policies and economic and institutional development. Research on digital villages in China highlights the roles of talent and human capital, financial capital, governance systems, and development planning, suggesting that technological expansion is more likely to contribute to sustainable rural development when accompanied by human-capital development, financing, and institutional capacity (Liu et al., 2024). In India and other developing countries, digital inclusion and the conversion of

technological access into the actual capacity to use technology are also important concerns. Accordingly, access to the Internet should be distinguished from digital skills and the ability to use technology for learning, employment, and economic activity. In Europe, particularly in the Balkan region, urban-rural connectivity gaps and the need for targeted investment in less-advantaged areas have also received attention (Emerllahu & Bogataj, 2024).

Despite these developments, an important research gap remains. Existing studies have addressed different dimensions of digital transformation, rural development, digital skills, human capital, and empowerment; however, these dimensions have often been examined separately. Limited attention has been given to the simultaneous interaction of technological, social and cultural, economic, political, environmental, and intellectual factors in shaping the future of rural human capital education and empowerment. The literature cited in the present study also indicates that rural contexts have received comparatively limited attention in research on human-resource empowerment and digital transformation (Hrustek, 2020; Kraus et al., 2021; Deja et al., 2021). Moreover, the rapid pace of technological change means that the skills required by labor markets are continuously evolving. The World Economic Forum's *Future of Jobs Report 2025* emphasizes the growing importance of artificial intelligence and technological literacy alongside creative thinking, flexibility, resilience, and lifelong learning, suggesting that human-resource education should increasingly prepare individuals for multiple possible futures rather than only for existing occupations (*Future of Jobs Report*, 2025).

This challenge is particularly significant in Iran. Available evidence indicates a persistent urban-rural gap in Internet access and Internet use. In 2021, approximately 69.2% of rural households in Iran had access to the Internet compared with 82.5% of urban households, while Internet use was reported at 65.7% among rural populations compared with 82.6% in urban areas (International Telecommunication Union, 2021). Although the available rural-urban disaggregation cited here is for 2021, complementary ITU figures for 2024 indicate that 85.3% of Iran's population used the Internet and that population coverage by at least LTE/WiMAX reached 94.2% (International Telecommunication

Union, 2021; Ahmadi & Jahansoozi, 2026). Thus, the future of rural digital transformation in Iran cannot be understood solely in terms of communication coverage. The quality of access, effective use, digital skills, and the ability to convert digital access into educational, economic, and social opportunities are equally important (Anabestani & Rahimi, 2026; Kazemiyeh et al., 2026). The uneven distribution of advanced digital skills further reinforces the significance of this issue, particularly because the urban-rural gap may be substantially larger for advanced digital skills than for basic digital skills (International Telecommunication Union, 2025). At the same time, rural areas in Iran face limitations in educational opportunities, diversified labor markets, specialized services, and knowledge resources, while a considerable proportion of rural economic activity remains dependent on agriculture, natural resources, and small and local businesses (Azizi & Tajari, 2026c; Liu et al., 2023). Digital transformation can reduce some of these limitations by facilitating access to new markets, distance education, digital financial and administrative services, specialized information, smart agriculture, and emerging forms of employment (Anabestani et al., 2023). However, without sufficient human capacity and digital skills, technological access may not result in effective utilization and may even contribute to the persistence of inequalities between more- and less-advantaged groups and areas (Ye & Yang, 2020).

The uncertainty surrounding future technological developments further strengthens the need for a foresight perspective. It is difficult to determine with certainty which technologies will have the greatest influence on rural economies, which occupations will be transformed, which skills will become more important, or how deeply artificial intelligence and other advanced technologies will penetrate rural activities. These technological developments also interact with demographic change, climate change, economic policies, global market developments, and changing patterns of employment and consumption. Consequently, linear and exclusively predictive approaches are insufficient for addressing the future of rural education and human-capital empowerment. Foresight makes it possible to identify major trends, driving forces, uncertainties, and their interactions and to examine a set of alternative futures rather than assuming a single predetermined future.

Accordingly, the present study was conducted to identify the major factors and driving forces shaping the future of education and empowerment of rural human capital in Iran in the era of digital transformation and to develop alternative scenarios based on the interaction of key uncertainties. The study seeks to answer the following question: What are the most important factors influencing the future of education and empowerment of rural human capital in Iran in the era of digital transformation, and what scenarios may emerge from alternative combinations of these conditions? The originality of the study lies in integrating the educational and empowerment dimensions of rural human capital with the multidimensional context of digital transformation and examining their possible futures through a systematic foresight and scenario-planning approach. Rather than considering digital transformation merely as an issue of infrastructure or technological access, the study examines the interaction of human, social, cultural, technological, economic, political, environmental, and intellectual dimensions and uses this integrated perspective to construct alternative futures for rural human-capital development in Iran.

2. Research Theoretical Literature

2.1 Rural Human Capital, Education, and Empowerment

Rural human capital refers to the combination of knowledge, skills, competencies, experiences, cognitive abilities, professional capacities, and social capabilities embodied in individuals and groups living in rural areas (Moradbakhsh, Hashemi & Pourahmad, 2026). These capabilities enable rural residents to participate more effectively in economic, social, cultural, and environmental activities and to contribute to the rural development process (Karmaker & Cvetković, 2025). From the perspective of human-capital theory, education and skills development represent forms of investment that enhance individual productivity and expand the capacity to participate in economic and social activities (Hanushek & Woessmann, 2020). In rural contexts, human-capital development is particularly relevant because the capacity to exploit local resources, adopt innovations, acquire new skills, establish economic activities, and adapt to environmental change contributes significantly to the development trajectory of rural communities (Joshi, 2019; White, 2021; Liu et al., 2023; Sun et al., 2023; Kosasih & Sulaiman, 2024).

Empowerment extends this perspective by emphasizing the development of individuals' and communities' capacity to understand change, make effective use of opportunities, participate in decision-making, and act upon their own development conditions. In the context of digital transformation, empowerment can no longer be limited to increasing educational attainment or transferring existing occupational skills. Instead, it encompasses continuous learning, adaptation, creative use of technology, entrepreneurship, access to broader markets, participation in the digital economy, and adaptation to technological and environmental changes (Prastiwi et al., 2025; Wang et al., 2023; Ma et al., 2023; Nalikan & Rozikin, 2025; Qudsi & Nurhayati, 2023; Franciskovic-Ingunza et al., 2023; Li et al., 2025; Gong et al., 2025). Consequently, rural human-capital empowerment in the digital era requires a shift from episodic and conventional education toward lifelong, flexible, skill-oriented, technology-supported learning.

2.2 Digital Transformation and the Digital Divide

Digital transformation extends beyond the digitization of existing tools and services. It involves changes in processes, structures, learning practices, employment patterns, service delivery, and relationships between people and technology. In rural areas, the realization of digital transformation is shaped by a broad combination of social, cultural, technological, economic, environmental, political, and intellectual conditions.

Digital divide theory provides an important theoretical basis for understanding these differences. The digital divide does not refer only to physical access to Internet infrastructure and digital devices; it also encompasses differences in the quality of access, digital skills, patterns of use, and the ability to convert technological access into meaningful educational, economic, and social benefits (Azizi & Tajari, 2026a; Ye & Yang, 2020). This perspective is particularly important in rural settings because infrastructure expansion without simultaneous development of human capabilities may not generate the expected developmental outcomes.

The diffusion of innovation perspective also helps explain the social adoption of digital technologies. According to this perspective, the acceptance and diffusion of innovation depend not only on the availability of technology but also on its perceived

usefulness, compatibility with existing values and needs, opportunities for experimentation, and the social conditions surrounding adoption. In rural communities, therefore, digital transformation is influenced by the extent to which technologies are perceived as useful, understandable, compatible with local conditions, and accessible to different social groups (Abad et al., 2026).

2.3 Social Systems and Economic Growth Perspectives

The social-systems perspective emphasizes that social phenomena should be understood as interconnected components rather than isolated variables. From this standpoint, digital transformation in rural communities emerges from interactions among technological infrastructure, social acceptance, cultural values, institutions, economic resources, patterns of learning, and local structures (Amanollahnejad et al., 2026). This perspective supports the need for a multidimensional analysis of rural digital transformation because changes in one component may generate consequences in other components.

Economic growth theory provides another relevant perspective. Digital technologies may affect rural economic growth through improvements in productivity, market access, innovation, entrepreneurship, employment, and human-capital development (Kosasih & Sulaiman, 2024). However, such outcomes depend on complementary conditions, including appropriate infrastructure, sufficient skills, supportive institutions, and access to financial resources. Thus, digital transformation should not be regarded as an independent technological input but as part of a broader development system in which human and institutional capacities shape the extent to which technological opportunities can be realized.

2.4 Foresight and Scenario Planning

The future of rural human-capital education and empowerment is inherently uncertain because technological, economic, social, environmental, and political changes interact continuously. From a foresight perspective, the future is not regarded as a single predetermined state; rather, multiple alternative futures may emerge through the interaction of driving forces, trends, and uncertainties. This perspective provides a foundation for moving beyond conventional prediction toward systematic exploration of plausible futures.

Scenario planning is particularly relevant in this context because it enables researchers and decision-makers to identify major driving forces, determine critical uncertainties, and combine their alternative states to construct coherent and plausible future scenarios. In the present study, the Global Business Network (GBN) approach is used as the basis for scenario development, while Martin's foresight model provides the broader framework for organizing the foresight process. Within this framework, the identification of major environmental forces, key factors, driving forces, and critical uncertainties provides the analytical foundation for developing alternative scenarios.

2.5 Empirical Research on Digital Transformation and Rural Human Capital

Previous empirical research has addressed several dimensions relevant to the present study. Research on digital transformation has highlighted the importance of technological infrastructure, digital access, and the geographical dimension of digital development (Yakimova & Streltsova, 2020; Bhattarai, 2021). Other studies have emphasized the role of digital technologies in improving access to education, information, public services, markets, and employment opportunities in rural areas (Li et al., 2022; Anabestani et al., 2023; Yuan et al., 2025). Research has also documented the potential contribution of e-commerce, digital financial services, smart agriculture, and digital business tools to productivity and income diversification in rural communities (Mayer et al., 2018).

A second group of studies has focused on human capital, skills, and empowerment. These studies indicate that rural development is influenced by residents' ability to acquire new competencies, adapt to changing economic conditions, adopt innovation, and participate in emerging economic activities (White, 2021; Sun et al., 2023; Karmaker & Cvetković, 2025). Recent research has further emphasized continuous learning, technological adaptability, entrepreneurship, and digital participation as increasingly important components of human-capital development in changing environments (Ma et al., 2023; Nalikan & Rozikin, 2025; Li et al., 2025).

A third body of research has examined inequalities associated with digital transformation. These studies show that digital inequality may persist even when basic technological access improves because differences in digital skills, quality of access,

affordability, and the capacity to derive benefits from technology remain significant (Ye & Yang, 2020). Research focusing on rural areas has therefore increasingly emphasized the importance of combining infrastructure development with human-capital development and social inclusion.

The empirical literature also indicates that technological change is reshaping labor-market skill requirements. The *Future of Jobs Report 2025* highlights the increasing significance of artificial intelligence, technological literacy, creative thinking, flexibility, resilience, and lifelong learning. This evidence supports the argument that future-oriented education must prepare individuals not only for current occupational requirements but also for changing and emerging forms of work.

Taken together, the theoretical and empirical literature indicates that rural human-capital development in the digital era is a multidimensional phenomenon. Technological infrastructure, social and cultural acceptance, economic support, policy and governance, skills-system flexibility, and equity and inclusion are interconnected rather than independent factors. At the same time, the reviewed literature is largely concerned with individual dimensions of this problem, while relatively limited attention has been devoted to integrating these dimensions within a foresight framework and exploring how their alternative states may generate different futures for rural human-capital education and empowerment. This gap provides the theoretical and empirical basis for the present scenario-based foresight study in Iran.

3. Research Methodology

The present study was conducted as an interdisciplinary study using a foresight approach and scenario planning as its main methodological tool. The scenario planning process was based on the Global Business Network (GBN) approach, in which scenarios are created through the identification of key uncertainties. The time horizon considered for the foresight process should be sufficiently long to allow major changes in the external environment to emerge, but not so long that the resulting futures become implausible or unmanageable. To structure the foresight process, Martin's foresight model (1995) was employed as an overall framework, and the stages of scenario development were defined within this framework. The stages of scenario development are described

below. The foresight horizon was set at Iranian calendar year 1415 (approximately 2036-2037) to examine medium- and long-term trends in digital transformation and their potential implications for rural human-capital education, skills development, and empowerment. The scenarios are not deterministic predictions; rather, they present coherent alternative images of plausible futures that can inform strategic decision-making, educational policy, and flexible rural-development planning.

3.1 Step 1: Environmental Scanning

The first step involved environmental scanning to identify the future of education and empowerment of rural human capital in Iran in the era of digital transformation. At this stage, the STEEP framework, consisting of sociocultural, technological, economic, environmental, and political factors, is commonly employed. However, because philosophical perspectives and patterns of thinking can influence educational futures, intellectual and philosophical factors were also added to the framework, resulting in the STEEP-I framework.

Data were collected through document review and semi-structured interviews with 25 purposively selected key experts (Table 1). Participants were purposively selected on the basis of their experience, expertise, and familiarity with different dimensions of rural human-capital education and empowerment in the era of digital transformation. They included academic experts, executive managers and policy-makers, technology and digital-transformation specialists, and rural activists and facilitators, allowing the topic to be examined from academic, policy, technological, and implementation perspectives. However, expertise in rural development is not equivalent to direct representation of the lived experiences of all rural groups. Therefore, the interviews and Delphi process primarily reflect participants' expert judgments about the driving forces and uncertainties shaping the future of rural education and empowerment; they should not be interpreted as directly representing the views of all rural stakeholders. The documentary-study population consisted of documents and studies related to major future trends and their effects on education and empowerment of rural human capital in the era of digital transformation (Table 2).

Table 1. Distribution of the Research Experts

Area of expertise	Inclusion criteria	Female	Male
Academic experts	At least 5 years of relevant research or teaching experience	3	4
Executive and policy-making experts	Relevant executive or managerial experience; direct experience in policy-making, planning, or implementation of projects related to rural areas, education, skills development, or digital transformation; familiarity with issues and challenges of rural areas	1	5
Technology and digital transformation specialists	Relevant academic qualification or substantial specialized experience; at least 5 years of professional experience in technology or digital transformation; experience in projects related to digitalization and digital education	2	4
Rural activists and facilitators (entrepreneurs and business owners)	At least a master's degree and experience in using educational technologies	3	3

Table 2. Search Specifications and the Process of Selecting and Screening Research Documents

Component	Description
Search databases	Google Scholar, Scopus, Web of Science, ERIC, and Iranian scientific databases, including the Jihad Daneshgahi Scientific Information Database, Magiran, and Noormags (2020–2026)
Persian keywords	Digital transformation, rural human capital, rural education, rural empowerment, rural digital skills
English keywords	Digital Transformation, Rural Human Capital, Rural Education, Rural Empowerment, Rural Digital Skills
Sources examined	Research articles, scientific reports, and relevant policy and higher-level official documents
Document selection criteria	Documents directly related to foresight, digital transformation, education and empowerment, rural human capital, and digital skills, preferably published during 2020–2026
Document exclusion criteria	Duplicate documents, studies without direct relevance to the research topic, sources without full text, non-scientific materials, and sources without clear scientific or organizational credibility were excluded
Screening process	Duplicate documents were removed; the titles and abstracts of the sources were then reviewed for relevance; the full texts of eligible documents were examined; and finally, documents directly related to the research objectives were selected for qualitative content analysis
Document analysis method	First, concepts and themes related to education, empowerment, rural human capital, digital transformation, digital skills, driving forces, challenges, opportunities, and future trends were extracted. The themes were then organized into main and subcategories and used to identify trends, drivers of change, influential factors, and key uncertainties

Regarding the semi-structured interview process, the main interview questions were designed around four areas: (1) In your view, what are the most important trends and changes that currently and in the future affect education and empowerment of rural human capital in the era of digital transformation? (2) In your opinion, what factors and forces may contribute to the expansion or limitation of this field? (3) What opportunities and challenges do you anticipate in the education and empowerment of rural human capital in the era of digital transformation? (4) In your view, what factors can contribute to achieving a desirable state of education and empowerment of rural human capital in Iran in the era of digital transformation?

Follow-up questions were also asked, where appropriate, to deepen and clarify the experts' perspectives. Each interview lasted an average of 25 minutes, and interviews continued until sufficient informational adequacy and appropriate coverage of the dimensions under study were achieved. The interview content was recorded, transcribed, and prepared for analysis after obtaining participants' consent. The interview data were analyzed using qualitative content analysis. To enhance the credibility of the analysis, the coding process was reviewed and re-examined. A portion of the extracted codes and categories was provided to experts to assess their consistency with the interview content and research objectives. In addition, the coding and categorization processes

were reviewed in stages to ensure consistency between the codes and the initial data and to prevent unrelated interpretations.

3.2 Step 2: Identification of Key Forces

The data obtained from the documentary study were coded, and the interviews were analyzed using

qualitative content analysis. The resulting codes were then merged, leading to the identification of 96 initial key variables or factors. These factors, which could potentially influence education and empowerment of rural human capital in Iran in the era of digital transformation, were organized into six dimensions, as presented in Table 3.

Table 3. Key Dimensions, Factors, and Illustrative Interview Evidence

Dimension	Key factors	Illustrative interview excerpts
Sociocultural factors	Rural demographic changes; migration and loss of human capital; aging of the rural population; retention and presence of rural youth; rural social participation and cohesion; social networks and local communication; attitudes toward and acceptance of education; attitudes toward and acceptance of technology and innovation; cultural readiness for digital transformation; digital literacy of rural households; digital generational gap; participation and role of rural women; participation and access of disadvantaged groups; educational and digital equity; cultural and ethnic diversity; motivation and culture of lifelong learning; rural entrepreneurial culture; changes in rural lifestyles; changes in rural employment patterns; rural cultural capital; local learning networks and environments	Interviewee 2: "Acceptance of digital education in villages depends on families' attitudes and their familiarity with technology." Interviewee 16: "If training is not aligned with local culture and the needs of rural youth and women, participation declines."
Technological	Rural communication infrastructure and access; access to and affordability of digital equipment and services; quality of communication services; digital education infrastructure and models; artificial intelligence; educational technologies; access to and quality of digital educational content; rural digital services and platforms; information literacy; cybersecurity and digital trust; localization and adaptation of technology to rural needs; low-cost technologies; electrification and sustainability of energy required for technology; digital divide; speed of technological change; updating and adaptation of technological infrastructure; access to technical support services	Interviewee 7: "Weak Internet connectivity and the cost of digital equipment limit many rural residents' access to online education." Interviewee 11: "Developing user-friendly platforms and educational content tailored to rural conditions can improve the effectiveness of digital learning."
Economic	Economic capacity and purchasing power of rural households; cost of rural education; investment in digital infrastructure and technology development; financing and investment in rural education; private-sector investment; access to financial resources and facilities for rural businesses; diversity of employment opportunities; rural entrepreneurship; development of knowledge-based rural economy and businesses; access to national and global markets; productivity and economic returns of education and human capital; return on digital investment; economic	Interviewee 2: "The cost of attending courses and purchasing digital equipment is a major obstacle for low-income rural households." Interviewee 19: "Continuity of educational programs depends on sustainable financing and private-sector participation."

Dimension	Key factors	Illustrative interview excerpts
	incentives for education; knowledge-based economy; financial sustainability of educational programs	
Environmental	Climate change and rising temperatures; natural disasters; degradation and erosion of natural resources; decline in agricultural productivity; changes in agricultural production patterns; food security; economic resilience to crises; environmental and climate education and literacy; education for sustainable development; smart agriculture; green technologies; renewable energy; water-use efficiency; waste management; biodiversity; adaptation to climate change; resilient infrastructure	Interviewee 3: "Climate change and water scarcity mean that farmers need training in new, environmentally adapted practices." Interviewee 14: "Training in modern agricultural technologies can help reduce water consumption and increase rural resilience."
Political	Rural development, education, and skills-development policies; digital transformation policies; artificial intelligence and the digital economy; digital governance; rural governance; policy stability; long-term planning and policy foresight; stakeholder and private-sector participation in policy-making; decentralization and the role of local institutions in rural governance; technology laws and regulations; regional, educational, and digital equity; support for disadvantaged groups; policy monitoring and evaluation; policy enforcement; educational human resource management	Interviewee 5: "Frequent changes in policies and managers prevent some rural educational programs from continuing." Interviewee 10: "Coordination between government and local institutions is essential for developing digital infrastructure and skills."
Intellectual and philosophical	Foresight and mental readiness for the future of education; systems thinking; critical thinking; social and digital responsibility; equity and equality of technological and learning opportunities; localization of knowledge; human-technology relationship; rural identity; acceptance of changes in occupational roles; redefinition of the concept of skills and competencies; redefinition of the concepts of human capital, education, and empowerment	Interviewee 1: "In the future, skills development will not be limited to learning one occupation; the ability to adapt to technological change will also matter." Interviewee 16: "Rather than viewing technology only as a tool, the relationship between people, local knowledge, and technology should be considered in empowering rural residents."

3.3 Step 3: Extraction of Driving Forces

Driving forces are fundamental forces that operate as causes underlying other variables and have the potential to generate major changes. Driving forces have three characteristics: high influence, high uncertainty, and relative independence.

To determine the driving forces affecting education and empowerment of rural human capital in the era of digital transformation, the key factors identified in the previous stage were incorporated into a Delphi questionnaire. Following the identification of factors affecting the future of education and empowerment of rural human capital through document review and semi-structured interviews, an initial list of factors was extracted, and the Delphi

questionnaire was developed after coding and categorization.

In the questionnaire, the identified factors were presented as specific items, and the experts were asked to assess the importance and uncertainty of each factor in shaping the future of education and empowerment of rural human capital in the era of digital transformation. A five-point Likert scale (strongly disagree, disagree, neither agree nor disagree, agree, and strongly agree) was used to assess the factors.

The content validity of the questionnaire was assessed using expert judgment. The initial questionnaire was provided to subject-matter experts, who were asked to assess the appropriateness, clarity, and relevance of each

factor to the research topic. Items considered ambiguous or conceptually overlapping were revised, merged, or removed based on expert feedback. Following these revisions, the final version of the questionnaire was prepared for the first Delphi round.

In the first Delphi round, the factors identified in the qualitative stage were provided to 20 experts, and each factor was assessed in terms of importance and uncertainty. After collecting the questionnaires, descriptive indicators and the level of expert agreement were calculated for each factor. Factors that did not reach an acceptable level of importance and agreement according to the predetermined criteria were removed from the list, while factors with ambiguity or conceptual overlap were revised

or merged where necessary. As a result, 53 factors remained from the 96 initial factors for examination in the second Delphi round.

In the second Delphi round, the list of 53 remaining factors, together with the results of the first round, was provided to the same group of experts so that they could reconsider their assessments with knowledge of the group's overall views. After analyzing the results of the second round, the factors were classified based on two criteria: importance and uncertainty. Expert consensus was defined as achieving an acceptable level of agreement in the evaluation of each factor. Finally, 38 factors with high importance and high uncertainty were selected as key factors for continuing the foresight process and developing the scenarios (Table 4).

Table 4. Mean Importance Scores for the 38 Key Factors (Second Delphi Round)

Mean importance score	Key factor	No.	Mean importance score	Key factor	No.
4.55	Policies on digital transformation, artificial intelligence, and the digital economy	20	4.60	Attitudes toward and acceptance of technology and innovation	1
4.60	Digital governance	21	4.55	Cultural readiness for digital transformation	2
4.30	Rural governance	22	4.50	Digital literacy of rural households	3
4.40	Long-term planning and policy foresight	23	4.20	Generational digital divide	4
4.20	Policy stability	24	4.45	Participation and access for disadvantaged groups	5
4.35	Policy implementation guarantees	25	4.75	Rural communication infrastructure and access	6
4.50	Redefining the concepts of skills and competencies	26	4.65	Quality of communication services	7
4.20	Acceptance of changes in occupational roles	27	4.70	Infrastructure and models for digital education	8
4.40	Foresight and mental readiness for the future of education	28	4.30	Artificial intelligence	9
4.30	Systems thinking	29	4.45	Educational technologies	10
4.45	Critical thinking	30	4.50	Access to and quality of digital educational content	11
4.25	The relationship between humans and technology	31	4.35	Updating and adaptation of technology infrastructure	12
4.50	Redefining the concepts of human capital, education, and empowerment	32	4.50	Financing and investment in rural education	13
4.60	Educational and digital equity	33	4.60	Investment in digital infrastructure and technology development	14
4.55	Regional, educational, and digital equity	34	4.15	Private-sector investment	15

Mean importance score	Key factor	No.	Mean importance score	Key factor	No.
4.45	Support for disadvantaged groups	35	4.20	Financial resources and business loans for rural enterprises	16
4.40	Participation and access for disadvantaged groups	36	4.55	Financial sustainability of educational programs	17
4.30	Decentralization and the role of local institutions	37	4.10	Economic incentives for education	18
4.35	Stakeholder and private-sector participation in policy-making	38	4.45	Rural development, education, and skills-training policies	19

Content Validity Index (CVI) was also used to assess the content validity of the questionnaire. To calculate the CVI, experts were asked to indicate the relevance of each item using a four-point scale: 1 = not relevant; 2 = requires major revision; 3 = relevant but requires revision; and 4 = highly relevant. The number of experts selecting options 3 and 4 was divided by the total number of experts. If the resulting value was less than 0.70, the item was rejected; values between 0.70 and 0.79 required revision; and values greater than 0.79 were

considered acceptable. In the present study, all items obtained values above 0.70.

Ultimately, the matrix provided a useful and concise clustering of the factors influencing the phenomenon under study, through which 38 key factors with high influence and uncertainty were selected. These factors were grouped according to shared concepts and underlying causes, forming six major categories or driving forces, which are presented in Table 5 along with their alternative states.

Table 5. Driving Forces Affecting Education and Empowerment of Rural Human Capital in the Era of Digital Transformation

No	Key factors	Driving forces	Alternative states
1	1. Attitudes toward and acceptance of technology and innovation; 2. Cultural readiness for digital transformation; 3. Digital literacy of rural households; 4. Digital generational gap; 5. Participation and access of disadvantaged groups	Social and cultural acceptance of digital transformation in rural areas	1. High acceptance and readiness 2. Resistance and low readiness
2	1. Rural communication infrastructure and access; 2. Quality of communication services; 3. Digital education infrastructure and models; 4. Artificial intelligence; 5. Educational technologies; 6. Access to and quality of digital educational content; 7. Updating and adaptation of technological infrastructure	Development of rural digital education technology and infrastructure	1. Rapid and inclusive technological development 2. Slow and unequal technological development
3	1. Financing and investment in rural education; 2. Investment in digital infrastructure and technology development; 3. Private-sector investment; 4. Access to financial resources and facilities for rural businesses; 5. Financial sustainability of educational programs; 6. Economic incentives for education	Economic support and financial sustainability of rural education and empowerment	1. Extensive and sustainable investment and financial support 2. Limited and unstable investment and financial support
4	1. Rural development, education, and skills-development policies; 2. Digital transformation policies, artificial intelligence, and the digital economy; 3. Digital governance; 4. Rural governance; 5. Long-term planning and policy foresight; 6. Policy stability; 7. Policy enforcement	Governance and policy coherence for rural digital transformation	1. Integrated, stable, and future-oriented policy-making 2. Fragmented, unstable, and short-term policy-making

No	Key factors	Driving forces	Alternative states
5	1. Redefinition of the concept of skills and competencies; 2. Acceptance of changes in occupational roles; 3. Foresight and mental readiness for the future of education; 4. Systems thinking; 5. Critical thinking; 6. Human–technology relationship; 7. Redefinition of the concepts of human capital, education, and empowerment	Flexibility and redefinition of the rural skills and human capital system	1. Dynamic, future-oriented, and adaptive skills system 2. Static, traditional, and inflexible skills system
6	1. Educational and digital equity; 2. Regional, educational, and digital equity; 3. Support for disadvantaged groups; 4. Participation and access of disadvantaged groups; 5. Decentralization and the role of local institutions; 6. Stakeholder and private-sector participation in policy-making	Equity and inclusion in rural education and digital transformation	1. Equitable and inclusive access 2. Unequal and concentrated access

3.4 Step 4: Identification of Key Uncertainties

In scenario planning using the Global Business Network approach, uncertainties are selected from among the driving forces based on expert judgments. At this stage, the list of driving forces was provided to the experts so that they could rate them according to two criteria: degree of influence (importance) and uncertainty (ambiguity). The ratings were made using a three-point scale (1, 0.5, and 0.1), and the final score for each factor was calculated by multiplying its influence score by its uncertainty score.

Accordingly, the two driving forces with the highest scores—social and cultural acceptance of digital

transformation in rural areas and development of rural digital education technology and infrastructure—were identified as the key uncertainties for scenario generation (Table 6).

Each selected uncertainty consisted of two alternative states that, when combined with one another, formed the logic of the scenarios. Social and cultural acceptance of digital transformation in rural areas comprised two alternative states: high acceptance and readiness, and resistance and low readiness. Development of rural digital education technology and infrastructure also comprised two alternative states: rapid and inclusive technological development, and slow and unequal technological development.

Table 6. Ranking of the Driving Forces

No	Driving forces	Importance score	Uncertainty score	Final score
1	Social and cultural acceptance of digital transformation in rural areas	0.89	0.82	0.73
2	Development of rural digital education technology and infrastructure	0.93	0.76	0.71
3	Economic support and financial sustainability of rural education and empowerment	0.86	0.71	0.61
4	Governance and policy coherence for rural digital transformation	0.81	0.68	0.55
5	Flexibility and redefinition of the rural skills and human capital system	0.84	0.61	0.51
6	Equity and inclusion in rural education and digital transformation	0.79	0.57	0.45

3.5 Step 5: Scenario Development

After identifying the key uncertainties, a 2×2 scenario matrix was constructed based on their alternative states. Before writing the scenarios, the overall narrative structure needs to be determined. Three common narrative structures in this regard are winners and losers, challenge and response, and

evolution. In the present study, the challenge-and-response structure was employed. In this structure, conditions are depicted in which the outcomes of actions taken by groups and individuals in response to challenges constitute the basis of the story. These narrative structures reflect the key factors and important trends identified through interviews and

documentary studies in the scenarios and contribute to enriching them. Scenario titles should also be creative and evocative of their overall nature. For this purpose, titles inspired by philosophical concepts were used to name the scenarios.

After establishing the logic and overall structure of the scenarios, the narrative of each scenario was developed. Finally, the scenarios were reviewed and refined based on the criteria of internal consistency, plausibility, challenge, and relevance.

It should also be noted that, in qualitative research, the criterion of credibility concerns not merely the results but also the process through which the results are reached and derived. In this study, peer review and respondent validation were used to examine credibility and ensure meaningful convergence among findings derived from multiple sources.

4. Research Findings

Table 7. Alternative Scenarios for Education and Empowerment of Rural Human Capital in the Era of Digital Transformation

Social and cultural acceptance of digital transformation	Development of rural digital education technology and infrastructure	Scenario
High acceptance and readiness	Rapid and inclusive technological development	Scenario 1: Smart Villages, Empowered People
Low acceptance / resistance and low readiness	Rapid and inclusive technological development	Scenario 2: Bright Lights, Dark Homes
High acceptance and readiness	Slow and unequal technological development	Scenario 3: Ready Hands, Distant Tools
Low acceptance / resistance and low readiness	Slow and unequal technological development	Scenario 4: A Land Left Behind by Change

4.1 Scenario 1: Smart Villages, Empowered People

In this scenario, digital transformation in rural areas occurs simultaneously with rapid and inclusive development of technology and infrastructure, along with high social and cultural acceptance and readiness. In such a future, digital technology gradually moves from being a peripheral tool to becoming an integral part of everyday life and the rural development process, while access to the Internet, digital services, educational platforms, and emerging technologies expands across rural areas. Reduced access costs, improved communication quality and coverage, and the development of infrastructure suited to the geographical conditions of rural areas enable residents to make greater use of educational, informational, and economic opportunities.

In this context, social acceptance of technology also increases in parallel with infrastructural development. Rural households, different social

Based on the results of environmental scanning, documentary analysis, expert interviews, and the Delphi process, six major driving forces affecting the future of education and empowerment of rural human capital were identified. Among these driving forces, social and cultural acceptance of digital transformation in rural areas and development of rural digital education technology and infrastructure were identified as the two key uncertainties with the highest levels of importance and uncertainty. The combination of the alternative states of these two uncertainties formed the future scenario space and resulted in four distinct futures for education and empowerment of rural human capital in Iran in the era of digital transformation. The four alternative scenarios are presented in Table 7, and the general framework of each scenario is described below.

groups, and different generations perceive technology not as a threat to their way of life but as a tool for expanding opportunities for learning, employment, and social participation. The expansion of digital literacy and the emergence of a culture of lifelong learning create the conditions for creative and purposeful use of technology. Consequently, the gap between access to technology and the ability to benefit from it is reduced, while the human capacities of rural areas to adapt to economic and social changes are strengthened.

In such an environment, education and empowerment also move away from limited and episodic models and become continuous, flexible processes aligned with environmental changes. Digital skills, critical thinking, problem-solving, entrepreneurship, information literacy, and the ability to adapt to new technologies become increasingly important. The concept of rural human capital is also redefined in this scenario, such that

indigenous knowledge and professional and experiential skills are combined with digital knowledge and the ability to use technology.

At the same time, technological development is accompanied by transformations in the economic structure of rural areas. Access to broader markets, e-commerce, digital financial services, smart agriculture, knowledge-based businesses, and new occupations creates more diverse opportunities for the economic utilization of human capital. Consequently, education is no longer merely a means of increasing individual knowledge but becomes one of the core elements of increasing productivity, diversifying the rural economy, and creating new income-generating opportunities.

Under these conditions, governance also moves toward integrated, future-oriented, and participatory policy-making, and efforts are made to align digital development with the social, economic, and environmental requirements of rural areas. Attention to educational and digital equity, support for disadvantaged groups, and participation of local institutions and the private sector prevent technological development from contributing to widening existing gaps. Therefore, in this scenario, digital transformation not only changes rural infrastructure but also strengthens human capabilities, expands learning and employment opportunities, and contributes to the emergence of a dynamic and future-adaptive rural human capital.

4.2 Scenario 2: Bright Lights, Dark Homes

In this scenario, technology and digital infrastructure develop at an appropriate speed and scale, but social and cultural acceptance of digital transformation remains low. From a technical perspective, many rural areas have access to the Internet, equipment, platforms, and new technologies; however, the availability of infrastructure does not necessarily imply its effective use. Technology has entered the rural environment, but part of the population continues to show caution or resistance toward the changes resulting from it.

Under these conditions, the main gap is no longer between the presence or absence of technology, but between access, acceptance, and effective use. Some households and social groups may have access to digital tools and services, but because of low digital literacy, concerns about the consequences of technology, weak digital trust, or generational differences, they may not fully utilize

the available capacities. As a result, technological investments do not necessarily translate to the same extent into educational, economic, and social opportunities.

In the field of education and empowerment, technology creates new possibilities, but the culture of learning and technology use has not developed in parallel. Digital programs and content are available, but their use may focus more on access to information than on generating changes in learning and empowerment patterns. Under these conditions, lifelong learning and the development of new skills encounter cultural and attitudinal barriers, and part of the investment in educational infrastructure becomes disconnected from the actual capacity of society to benefit from it.

This situation can also be reflected in the rural labor market and economy. Although digital tools provide opportunities to enter new markets and establish innovative businesses, low social acceptance can slow the emergence of such activities. Therefore, the main issue in this scenario is not a lack of technology but the conversion of existing technology into real human and economic capacity. In such a future, policies focused solely on developing equipment and infrastructure cannot adequately respond to rural needs. Enhancing digital literacy, social trust, the culture of learning, participation of different groups, and readiness to accept change becomes as important as technological development itself. Otherwise, rural areas may become digitally equipped in appearance and infrastructure, while a substantial portion of their human capacity remains outside this process. This condition is represented by the title Bright Lights, Dark Homes.

4.3 Scenario 3: Ready Hands, Distant Tools

In this scenario, unlike the previous one, social and cultural acceptance of digital transformation is high, but technological and infrastructural development proceeds slowly and unevenly. Rural communities have greater readiness to learn about and use technology, and residents, particularly younger generations, recognize the opportunities created by digital transformation for education, employment, and economic activities. However, the necessary facilities to translate this readiness into action are not available in all areas.

Under these conditions, demand for digital education and skills increases, but infrastructural capacity to respond to this demand is limited.

Differences in Internet quality and coverage, the cost of equipment and services, unequal access to educational platforms and content, and inadequate technical support prevent the opportunities created by social readiness from being realized equally across rural areas. Consequently, the digital divide is attributable less to social resistance than to differences in access to facilities and infrastructure. In this future, rural human capital has substantial potential in terms of motivation and readiness for change, but the lack of adequate tools prevents this potential from being fully realized. Individuals may be willing to acquire new skills, use digital markets, or establish new businesses, but limitations in connectivity, equipment, services, and financial resources reduce the possibility of realizing these capabilities. As a result, a gap emerges between readiness for change and the practical ability to implement change.

This situation is also reflected in the rural economy. Greater awareness of opportunities associated with e-commerce, digital financial services, smart agriculture, and new businesses increases potential demand for participation in the digital economy, but infrastructural weaknesses hinder the balanced expansion of such activities. Consequently, some areas or groups with better infrastructure benefit more rapidly from emerging opportunities, while more disadvantaged areas face a greater risk of falling further behind.

From this perspective, the central challenge in this scenario is to create a bridge between human readiness and technological capacity. The social and cultural capital required to accept transformation exists, but development policies need to combine this readiness with sustained investment in infrastructure, reduced access costs, expanded digital services, financial support, and infrastructure suited to the needs of rural areas. Otherwise, a society that is ready for change will not be able to fully benefit from digital transformation because the necessary tools are unavailable.

4.4 Scenario 4: A Land Left Behind by Change

In this scenario, the development of digital technology and infrastructure is slow and unequal, while social and cultural acceptance of digital transformation also remains low. This situation combines two fundamental constraints that reinforce one another. On the one hand, weak infrastructure, access costs, low service quality, and regional inequality restrict digital opportunities; on

the other hand, low social readiness and acceptance reduce effective demand for and use of technology. Under such conditions, digital transformation cannot become an inclusive component of the rural development process, and education and empowerment remain largely dependent on traditional models and existing skills. New learning opportunities become available only in limited and fragmented forms, while a culture of lifelong learning and the redefinition of skills fail to develop at the necessary pace. Consequently, the gap between the skills required by the future economy and the existing capabilities of rural human capital widens.

The continuation of this situation can have broader consequences for rural human capital. Limited educational and new employment opportunities, particularly for young people, may reduce the attractiveness of remaining in rural areas and create conditions for the departure of some of the active and educated workforce. Conversely, the decline in human capital can further weaken the capacity of rural areas to adopt technology, establish new businesses, and participate in the digital economy, thereby creating a cycle of human and technological underdevelopment.

In this scenario, the rural economy also faces greater constraints. Limited access to new markets, financial services, and economic information, together with restricted investment and private-sector activity, reduces the potential for diversification of the rural economy. At the same time, low social demand for technology and weak infrastructure reduce incentives for further investment, potentially creating a cycle of low demand, low investment, and limited opportunities. Simultaneously, educational and digital inequalities intensify, and groups and areas that were initially less advantaged become even more distant from the opportunities created by digital transformation. Under such circumstances, short-term and fragmented policies cannot by themselves change the existing trajectory. An integrated approach is required that links infrastructure development with enhanced digital literacy, strengthened social acceptance, skills redefinition, support for disadvantaged groups, and strengthening the capacity of local institutions.

Therefore, A Land Left Behind by Change represents a future in which the simultaneous weakness of technology and social readiness limits

the ability to benefit from the potential of digital transformation and increases the distance between rural areas and emerging economic, educational, and social trends. In this context, the issue is not merely technological lag but also the risk of continuing and reproducing human, economic, and educational gaps.

Economic and environmental factors should also be considered as contextual conditions affecting the empowerment of rural human capital. From an environmental perspective, climate change, water scarcity, and changes in rural production conditions may alter the skills required and increase the importance of training in resource management, smart agriculture, and adaptation to environmental risks. From an economic perspective, the financial sustainability of education, household affordability, investment in digital infrastructure, and the capacity to create employment aligned with new skills affect the extent to which rural residents can benefit from digital transformation. Thus, access to technology and social acceptance alone are not sufficient to achieve the desirable scenario; positive outcomes depend on the links among education, financing, economic opportunities, and the capacity to adapt to environmental conditions. To improve the policy usefulness of the scenarios, the following indicators are proposed for future monitoring: employment rates among trained individuals, labor productivity, the urban-rural skills gap, completion rates for digital-education courses, net migration among the working-age population, the financial sustainability of educational programs, and the uptake of climate-adaptive skills. These indicators can be used to monitor future developments and compare the trajectories associated with the scenarios. Given the foresight nature of the study, the expected direction of change in these indicators can be discussed in relation to each scenario; however, determining target values or making reliable quantitative projections would require baseline data and additional analysis.

5. Discussion and Conclusion

The findings of the study showed that the future of education and empowerment of rural human capital in Iran in the era of digital transformation is not the result of the influence of a single factor or merely technological development; rather, it is shaped by the interaction of a set of social, cultural, technological, economic, political, and intellectual factors. Among the identified driving forces, social

and cultural acceptance of digital transformation in rural areas and development of rural digital education technology and infrastructure had the highest levels of importance and uncertainty and were therefore identified as the two key uncertainties. The significance of this finding lies in the fact that the future of digital transformation in rural areas cannot be explained solely by the level of access to technology. Instead, the way rural communities interact with technology and their readiness to accept and effectively use technological changes, together with infrastructural capacity, will determine future trajectories.

From the perspective of digital divide theory, the digital divide is not limited to the absence of physical access to technology; it also encompasses differences in the ability to use technology effectively, digital skills, quality of access, and the ability to transform access into real opportunities (Azizi & Tajari, 2026b). Accordingly, a village may have a relatively favorable communication infrastructure, but if households lack sufficient digital literacy or have negative attitudes toward technology, the actual potential of digital transformation may not be realized. This is why the Bright Lights, Dark Homes scenario demonstrates that infrastructure development, without the necessary social and cultural capacity, does not necessarily result in the empowerment of human capital. Conversely, the Ready Hands, Distant Tools scenario shows that the existence of social and cultural readiness, without appropriate infrastructure, cannot lead to the full realization of digital opportunities. In this situation, demand and motivation for learning and using technology exist, but limitations in connectivity quality, access to equipment, digital content, services, and financial resources reduce the possibility of transforming this readiness into actual capacity.

Therefore, the findings indicate a reciprocal relationship between social capacity and technological capacity. Digital development can contribute to human capital empowerment when both the ability to use and the opportunity to use technology are simultaneously available. This finding can also be explained through the logic of diffusion of innovation theory. Technology adoption in a society is not merely a function of the existence of an innovation; it also depends on individuals' perceptions of its usefulness, its compatibility with existing values and needs, opportunities for

experimentation and learning, and the social conditions of adoption. In rural communities, where social, cultural, and economic structures have particular characteristics, technology becomes a transformative force when it is connected to living conditions, real needs, and local capacities. Therefore, low social acceptance in the Bright Lights, Dark Homes scenario can be interpreted as an indication of a gap between technological supply and the social context of technology use. Under such conditions, even advanced technologies may fail to produce the expected effects in education and empowerment.

The findings also showed that the concept of rural human capital needs to be redefined under conditions of digital transformation. Traditional human capital models place greater emphasis on knowledge, educational attainment, and skills related to existing activities, whereas in a rapidly changing digital environment, the capacity for continuous learning, adaptability, digital literacy, critical thinking, problem-solving, entrepreneurship, and creative use of technology becomes increasingly important. The identification of flexibility and redefinition of the rural skills and human capital system as a driving force indicates that the main issue is not merely the transfer of new skills, but a change in the definition of what it means to be empowered in the rural society of the future.

This issue is also important from the perspective of human capital theory. If education is viewed as an investment to increase individual and social capabilities, digital transformation changes both the scope and nature of this investment. Education is no longer intended only to increase productivity in existing occupations; it should also prepare individuals for reskilling, occupational change, creation of new activities, and adaptation to economic and environmental transformations. From this perspective, the empowerment of rural human capital should move away from limited and short-term training toward the development of sustainable capabilities for continuous learning and adaptation. Another important finding concerns the position of economic and governance factors alongside the two key uncertainties. Although these two driving forces were not ultimately selected as the main axes of scenario development, their scores indicated that economic support and financial sustainability of rural education and empowerment and governance and policy coherence for rural digital transformation

are influential factors in shaping future pathways. This finding shows that digital development is not merely a technological process and that its realization requires an appropriate economic and institutional environment. Infrastructure, education, digital services, and empowerment programs all depend on financial resources, policy stability, institutional coordination, and implementation capacity.

From this perspective, the scenarios developed in the study should not be regarded as four completely separate conditions, but rather as four different pathways of interaction between society and technology. In Smart Villages, Empowered People, synergy between social readiness and infrastructure development enables technology to become a real opportunity for enhancing human capital. In Bright Lights, Dark Homes, technological capacity advances beyond social capacity, and consequently part of the available technological resources remains underutilized. In Ready Hands, Distant Tools, social capacity advances beyond technological capacity, and the main problem is the inability to transform readiness into real opportunities. Finally, A Land Left Behind by Change represents a condition in which weaknesses in both dimensions reinforce one another, increasing the likelihood of reproducing digital and human underdevelopment.

This pattern highlights the importance of a systems approach to rural development. From a systems perspective, change in one component can produce consequences in other components. For example, digital infrastructure development can increase access to education and markets, but its effects are limited when skills and social acceptance are absent. Conversely, increased skills and willingness to use technology, without adequate access, may not lead to the realization of expected opportunities. Therefore, education, technology, the economy, culture, and governance cannot be considered separately in rural policy-making.

The findings also indicate that equity and inclusion should be regarded as fundamental considerations in the future of digital education and empowerment. Uneven infrastructure development can increase disparities between rural areas and even among different groups within the same rural community. In this context, the issue is not merely whether individuals have access to the Internet; the quality of access, ability to use technology, cost of

equipment and services, learning opportunities, and the capacity to transform digital skills into economic opportunities are also important. Therefore, if digital transformation proceeds without consideration of regional and social differences, it may create new forms of inequality rather than reduce existing inequalities.

Likewise, the future of rural human capital education and empowerment cannot be considered independently of environmental and climatic developments. Climate change, declining natural resources, and changes in production patterns alter the skills required by rural residents. Under such conditions, future human capital should possess not only digital skills but also the capacity to adapt to environmental changes, use smart technologies, improve resource efficiency, and engage in sustainable economic activities. Therefore, the relationship between digital transformation and the green transition can represent an important dimension of the future of rural empowerment.

Based on the findings of the study and the four scenarios developed for the future of rural human capital education and empowerment in the era of digital transformation, it is suggested that policy-making in this field move beyond a purely technological approach and pursue infrastructure development and human capacity development simultaneously. Since social and cultural acceptance of digital transformation and the development of rural digital education technology and infrastructure were identified as the two key uncertainties, digital development programs should not only expand access to the Internet and digital equipment but also focus on enhancing digital literacy, increasing social readiness, strengthening trust, and developing a culture of lifelong learning.

Furthermore, in view of the driving force of flexibility and redefinition of the rural skills and human capital system, education and empowerment should move from the transfer of fixed and short-term skills toward the development of continuous learning capabilities, reskilling, technological adaptation, and skills aligned with future occupations. In this regard, linking digital education with real economic opportunities—including entrepreneurship, e-commerce, digital financial services, smart agriculture, and knowledge-based businesses—can create conditions for converting acquired skills into employment and income opportunities.

Given the importance of economic support and financial sustainability, investment in digital infrastructure and empowerment programs should move beyond short-term and project-based arrangements and be supported by sustainable financing mechanisms. Attention to equity and inclusion is also essential because differences in economic, geographical, generational, and social conditions may cause the benefits of digital transformation to be distributed unequally. Therefore, targeted support for disadvantaged areas and groups, together with simultaneous attention to access, affordability, connectivity quality, and the ability to use technology, should be incorporated into policy-making.

Moreover, given the role of governance and policy coherence, coordination among education, technology, employment, economic, and rural development policies is necessary. The use of foresight-oriented approaches and continuous monitoring of technological trends can also help reduce short-term and reactive decision-making. Alongside these measures, the participation of local institutions, the private sector, rural organizations, and rural residents themselves in designing and implementing digital transformation programs can improve the alignment of programs with the actual needs and capacities of different rural areas.

Given the presence of environmental factors among the influential variables, it is also recommended that future education and empowerment programs include skills related to smart agriculture, resource management, water and energy efficiency, green technologies, and adaptation to climate change.

Finally, like any foresight study, the present research has several limitations. First, the scenarios developed were based on expert judgments and perceptions and therefore do not represent deterministic predictions of the future. Rather, they constitute coherent images of possible futures based on the knowledge and assessments of experts at the time of the study. Second, although efforts were made to select experts with experience in academic, policy-making, technological, and rural-activity domains, the sample was selected purposively and therefore did not directly reflect the perspectives of all stakeholders, particularly the broad population of rural residents and different social groups. Third, the rapid pace of technological change, particularly in artificial intelligence, digital platforms, and smart technologies, means that some of the identified

trends and uncertainties may change over time. Therefore, the scenarios presented require periodic review and updating. Fourth, the predominantly qualitative nature of the study meant that the consequences of each scenario were not measured quantitatively in terms of indicators such as employment, income, productivity, or human capital levels, but rather the study focused primarily on explaining possible future pathways. In addition, the complexity of interactions among social, technological, economic, environmental, and political factors means that some long-term feedback effects cannot be fully captured within the present scenario framework.

Accordingly, future studies are recommended to employ mixed methods, quantitative modeling, system dynamics, and regional studies to examine the consequences of each scenario in greater detail. Finally, given the changing economic, policy, and technological conditions, the findings of this study should be considered as a framework for thinking

about the future and increasing preparedness for different possible futures, rather than as a deterministic prediction of a specific situation. Therefore, continuous revision of the scenarios based on new data and the participation of diverse stakeholders can help maintain their validity and usefulness in planning and policy-making processes.

Acknowledgments

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Authors' contributions

The authors equally contributed to the preparation of this article.

Conflict of interest

The author declares no conflict of interest.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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آینده‌نگاری آموزش و توانمندسازی سرمایه انسانی روستایی ایران در عصر تحول دیجیتال

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چکیده مبسوط

۱. مقدمه

تحول دیجیتال در سال‌های اخیر، شیوه‌های آموزش، یادگیری و توانمندسازی سرمایه انسانی را به‌طور چشمگیری دگرگون کرده است. گسترش اینترنت، پلتفرم‌های آموزشی، هوش مصنوعی، فناوری‌های آموزشی و خدمات دیجیتال، فرصت‌های تازه‌ای برای ارتقای دانش، مهارت و قابلیت‌های افراد فراهم کرده است. این تحولات در نواحی روستایی از اهمیت بیشتری برخوردارند زیرا آموزش و توانمندسازی سرمایه انسانی می‌تواند در ارتقای قابلیت‌های اقتصادی و اجتماعی، تنوع‌بخشی به فرصت‌های شغلی، کاهش مهاجرت نیروی انسانی و تقویت ظرفیت‌های توسعه محلی نقش داشته باشد. پژوهش حاضر با هدف آینده‌نگاری آموزش و توانمندسازی سرمایه انسانی روستایی ایران در عصر تحول دیجیتال انجام شده و درصدد پاسخ به این پرسش است که مهم‌ترین عوامل مؤثر بر آینده این حوزه کدام‌اند و ترکیب وضعیت‌های مختلف چه سناریوهایی را شکل می‌دهد؟

۲. مبانی نظری تحقیق

سرمایه انسانی روستایی مجموعه‌ای از دانش، مهارت‌ها، قابلیت‌ها، تجربیات و ظرفیت‌های افراد ساکن در نواحی روستایی است که می‌تواند در فرآیند توسعه اقتصادی، اجتماعی و محیطی مورد استفاده قرار گیرد. آموزش و توانمندسازی، از مهم‌ترین سازوکارهای ارتقای این سرمایه محسوب می‌شوند و در عصر تحول دیجیتال، مفهوم آن‌ها نیز از آموزش‌های سنتی و محدود به آموزش مستمر، انعطاف‌پذیر، مهارت‌محور و مبتنی بر فناوری گسترش یافته است. تحول دیجیتال نیز فراتر از دیجیتالی‌کردن ابزارها، به تغییر در فرایندها، ساختارها، شیوه‌های یادگیری، الگوهای اشتغال و روابط میان انسان و فناوری اشاره دارد. در محیط روستایی، تحقق این تحول تحت تأثیر مجموعه‌ای از عوامل اجتماعی، فناورانه، اقتصادی، محیطی، سیاسی و فکری قرار می‌گیرد. از منظر آینده‌نگاری، آینده یک وضعیت از پیش تعیین‌شده

نیست، بلکه می‌تواند تحت تأثیر پیشران‌ها و عدم قطعیت‌های مختلف به مسیرهای متفاوتی حرکت کند. در این میان، برنامه‌ریزی سناریو امکان شناسایی و تصویرسازی آینده‌های بدیل را فراهم می‌کند.

۳. روش تحقیق

پژوهش حاضر از نظر رویکرد، آینده‌نگارانه و از نظر روش، مبتنی بر برنامه‌ریزی سناریو با رویکرد GBN است و مدل آینده‌نگاری مارتین به‌عنوان چارچوب کلی پژوهش مورد استفاده قرار گرفت. داده‌های مورد نیاز از طریق مطالعات اسنادی و مصاحبه‌های نیمه‌ساختاریافته با ۲۵ نفر از خبرگان حوزه‌های دانشگاهی، اجرایی و سیاست‌گذاری، فناوری و تحول دیجیتال و فعالان و تسهیلگران روستایی گردآوری شد. داده‌های حاصل با استفاده از تحلیل محتوای کیفی بررسی و عوامل، روندها، فرصت‌ها، چالش‌ها و نیروهای مؤثر استخراج و در شش بعد اجتماعی-فرهنگی، فناورانه، اقتصادی، محیطی، سیاسی و فکری-فلسفی سازمان‌دهی شدند. در نهایت عوامل شناسایی‌شده در قالب پرسشنامه دلفی در اختیار خبرگان قرار گرفت و اهمیت و میزان عدم قطعیت آن‌ها در دو دور ارزیابی شد. از میان ۹۶ عامل اولیه، ۵۳ عامل پس از دور نخست و ۳۸ عامل کلیدی پس از دور دوم شناسایی شد. سپس عوامل کلیدی بر اساس اشتراک مفهومی و علل زیربنایی در قالب شش پیشران اصلی سازمان‌دهی شدند. اهمیت و عدم قطعیت پیشران‌ها بررسی و با استفاده از حاصل ضرب این دو شاخص، عدم قطعیت‌های کلیدی تعیین شدند. در نهایت دو پیشران با بیشترین امتیاز، یعنی پذیرش اجتماعی و فرهنگی تحول دیجیتال و توسعه فناوری و زیرساخت‌های آموزش دیجیتال، به‌عنوان دو محور اصلی سناریونویسی انتخاب و با ترکیب وضعیت‌های بدیل آن‌ها، ماتریس ۲×۲ و چهار سناریوی آینده تدوین شد.

۴. یافته‌های تحقیق

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به توانمندسازی واقعی منجر شود و از سوی دیگر وجود جامعه‌ای آماده و پذیرای تغییر نیز بدون دسترسی عادلانه به زیرساخت‌ها و ابزارهای دیجیتال، به تحقق کامل ظرفیت‌های انسانی منجر نخواهد شد. بر این اساس روستاهای هوشمند، انسان‌های توانمند تصویری از آینده‌ای است که در آن توسعه فناوری با آمادگی انسانی و اجتماعی همراه شده است. در مقابل، سه سناریوی دیگر نشان‌دهنده پیامدهای احتمالی عدم توازن میان این دو محور هستند. بنابراین سیاست‌گذاری برای آینده مطلوب آموزش و توانمندسازی سرمایه انسانی روستایی نیازمند توجه هم‌زمان به توسعه زیرساخت‌های دیجیتال، ارتقای سواد و پذیرش دیجیتال، آموزش مهارت‌های جدید، تقویت یادگیری مادام‌العمر، حمایت از گروه‌های کم‌برخوردار و ایجاد سازوکارهای پایدار اقتصادی و نهادی است. در مجموع یافته‌ها تأکید می‌کند که تحول دیجیتال زمانی می‌تواند به توانمندسازی پایدار سرمایه انسانی روستایی منجر شود که فناوری، انسان، سیاست و عدالت در یک چارچوب یکپارچه و آینده‌نگر قرار گیرند.

کلید واژه‌ها: آینده‌نگاری، سرمایه انسانی روستایی؛ تحول دیجیتال؛ توانمندسازی؛ آموزش روستایی.

تشکر و قدردانی

مطالعه حاضر حامی مالی نداشته و حاصل فعالیت علمی نویسندگان است.

یافته‌های پژوهش نشان داد که ۳۸ عامل کلیدی شناسایی شده در قالب شش پیشران اصلی شامل پذیرش اجتماعی و فرهنگی تحول دیجیتال در روستا، توسعه فناوری و زیرساخت‌های آموزش دیجیتال روستایی، حمایت اقتصادی و پایداری مالی آموزش و توانمندسازی روستایی، حکمرانی و انسجام سیاستی تحول دیجیتال روستایی، انعطاف‌پذیری و بازتعریف نظام مهارت و سرمایه انسانی روستایی و عدالت و فراگیری در آموزش و تحول دیجیتال روستایی قابل دسته‌بندی هستند. که در نهایت چهار سناریوی متفاوت شامل: سناریوی اول: روستاهای هوشمند، انسان‌های توانمند، سناریوی دوم: چراغ‌های روشن، خانه‌های خاموش، سناریوی سوم: دست‌های آماده، ابزارهای دور و سناریوی چهارم: سرزمین جامانده از تغییر را شکل دادند.

۵. بحث و نتیجه‌گیری

نتایج پژوهش نشان می‌دهد که آینده آموزش و توانمندسازی سرمایه انسانی روستایی در عصر تحول دیجیتال، حاصل عملکرد منفرد فناوری نیست، بلکه از تعامل پیچیده میان ظرفیت فناوری و زیرساختی، آمادگی اجتماعی و فرهنگی، منابع اقتصادی، حکمرانی، نظام مهارت و عدالت و فراگیری شکل می‌گیرد. شناسایی پذیرش اجتماعی و فرهنگی و توسعه فناوری و زیرساخت به‌عنوان دو عدم‌قطعیت کلیدی نشان می‌دهد که برخورداری از فناوری بدون آمادگی اجتماعی نمی‌تواند

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How to cite this article:

Azizi Shamami, M., & Tajari, M. (2026). Foresight of education and empowerment of rural human capital in Iran in the era of digital transformation. *Journal of Research & Rural Planning*, 15(4), 99-121.

<http://dx.doi.org/10.22067/jrrp.v15i4.2610-1188>

Date:

Received: 21-09-2026

Revised: 11-10-2026

Accepted: 13-10-2026

Available Online: 13-10-2026