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RESEARCHING THE TRANSFORMATIONAL IMPACTS OF HUMAN POTENTIAL ON THE ECONOMIC DEVELOPMENT OF REGIONS

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ABSTRACT

This research explores the transformational impact of human potential on regional economic development within the framework of globalization and Industry 4.0. The study aims to quantify how investments in human capital (HC) drive economic growth both directly and through intermediary channels such as institutional quality, environmental sustainability, and infrastructure development. The study employs a quantitative approach utilizing a Structural Equation Model (SEM). Data were gathered from a survey of 100 respondents using a 5-point Likert scale to evaluate five primary constructs: Human Capital (HC), Governance and Institutional Quality (GIQ), Environmental Quality (EQ), Infrastructure Development (ID), and Regional Economic Development (RED). The model's reliability was validated through Cronbach's alpha (0.80–0.87) and goodness-of-fit indices, including CFI (0.93) and RMSEA (0.05).

The study concludes that strategic investment in human potential is the foundational pillar for economic stability and competitiveness. While infrastructure and environmental factors are necessary (impacts of 0.350 and 0.280 respectively), their effectiveness is contingent upon the quality of human capital available to manage these resources.

KEYWORDS

Human Capital, Regional Economic Development, Structural Equation Modeling (SEM), Institutional Quality, Sustainable Development, Innovation.

Introduction

In the current era of globalization and rapid technological change, human capital has become a decisive factor in ensuring the sustainable development, competitiveness, and innovative potential of regional and national economies. Modern economic approaches recognize qualitative indicators such as the population's knowledge, skills, experience, and health status as the main driving forces for increasing labor productivity and introducing new technologies.

Recent global trends, particularly the processes of Industry 4.0 and digital transformation, have sharply increased the demand for highly qualified personnel and research activities. According to UNESCO [1], the demand for specialists with digital skills in the global labor market grew by 30% from 2020 to 2025, which necessitates a fundamental reform of education systems. World Bank analysis shows that countries actively investing in human capital demonstrate gross domestic product (GDP) growth rates

that are, on average, 1.5 to 2 times higher than in other countries. Countries with a high Human Capital Index, such as Singapore and Finland, are prime examples of economic success.

In the context of our country, climate change, demographic shifts, and the post-pandemic recovery period have made improving the quality of human capital and its adaptability to the changing external environment a priority. From this perspective, this study analyzes the impact of human capital on the economic development of the region not only directly but also through indirect channels, such as improving governance quality, ensuring environmental sustainability, and modernizing infrastructure.

LITERATURE REVIEW

Extensive international research has been conducted on the impact of human capital on economic growth. These studies can be grouped into the following areas:

Many researchers have confirmed the positive impact of education and healthcare expenditures on economic growth. For example, Wirajing et al. [2] found that for the period 2000-2019, a 1% increase in education expenditures led to a 0.7% increase in GDP across 48 African countries. Similarly, Intisar et al. noted a 0.9% positive impact of educational investments on GDP in Asian countries, while Yu et al. [3] proved that human capital (university graduates and researchers) boosted economic growth by 1.5% in China's northeastern regions. Furthermore, Usman and Adeyinka [5] found that educational investments in ECOWAS countries increase labor productivity by 1.2%.

(2000-2019) In the example of 48 African countries, it was found that a 1% increase in education expenditures increases GDP by 0.7%. Also, Intisar et al. noted a positive impact of education investments on GDP of 0.9% in Asian countries, while Yu et al. [3] proved that in the northeastern regions of China, human capital (graduates of universities and researchers) increases economic growth by 1.5%. Usman and Adeyinka[5] found that educational investments in ECOWAS countries increase labor productivity by 1.2%.

The importance of just legislation and the fight against corruption in economic development has been demonstrated in a number of studies. Adegboye et al. [4] noted that institutional quality increases FDI (foreign direct investment) inflows by 2.3%, while Azam et al. stated that the rule of law ensures GDP growth of 1.1%. Nguyen et al. [6] found that good governance increases economic complexity and serves diversification, while Adzima and Baita [7] proved that government effectiveness has a positive correlation with economic growth.

Ecological sustainability and infrastructure are also considered important determinants of economic growth. Prince [8] found that clean water and air attract investment in South Africa, while Li et al. [9] determined that reducing CO_2 emissions supports development in China's western regions. Regarding infrastructure, Acheampong et al. [10] showed that the development of ICT and transport accelerates economic growth by 1.8%, while Becha et al. [11] demonstrated that digital infrastructure increases economic growth by 1.4%.

Human capital also influences economic development through other factors. Studies by Ouedraogo et al. and Ahmad et al. [12] show that human capital contributes to economic stability by improving institutional quality. Additionally, Hondroyiannis et al. [13] and Chen et al. [14] found that human capital stimulates growth by increasing environmental awareness and introducing clean technologies. In terms of infrastructure, Grigorescu et al. [16] noted the positive contribution of human capital to the development of digital infrastructure.

Research Methodology

In this study, a quantitative approach and a Structural Equation Model (SEM) were used to analyze the factors affecting the economic development of the region. The data and variables included: a) the results of a survey conducted among 100 respondents; b) indicators were evaluated using a 5-point Likert scale; c) the constructs of human capital (HC), Governance and Institutional Quality (GIQ), Environmental Quality (EQ), Infrastructure Development (ID), and Regional Economic Development (RED) were analyzed. The SPSS and AMOS software, as well as the Maximum Likelihood Estimation (MLE) method, were used to estimate the model parameters. The relationships are expressed by the following basic equation:

$$RED = \alpha_4 + \beta_4 * HC + \beta_5 * ID + \beta_6 * EQ + \beta_7 * GIQ + \epsilon_4$$

The model's goodness of fit was confirmed through confirmatory factor analysis:

- Cronbach's alpha coefficients (0.80-0.87) indicated the high reliability of the measurements.
- The CFI (0.93), TLI (0.91), and RMSEA (0.05) indicators confirmed that the model is a good fit for the data.

Analysis and Results

This research encompasses the results of a survey conducted with 100 respondents.

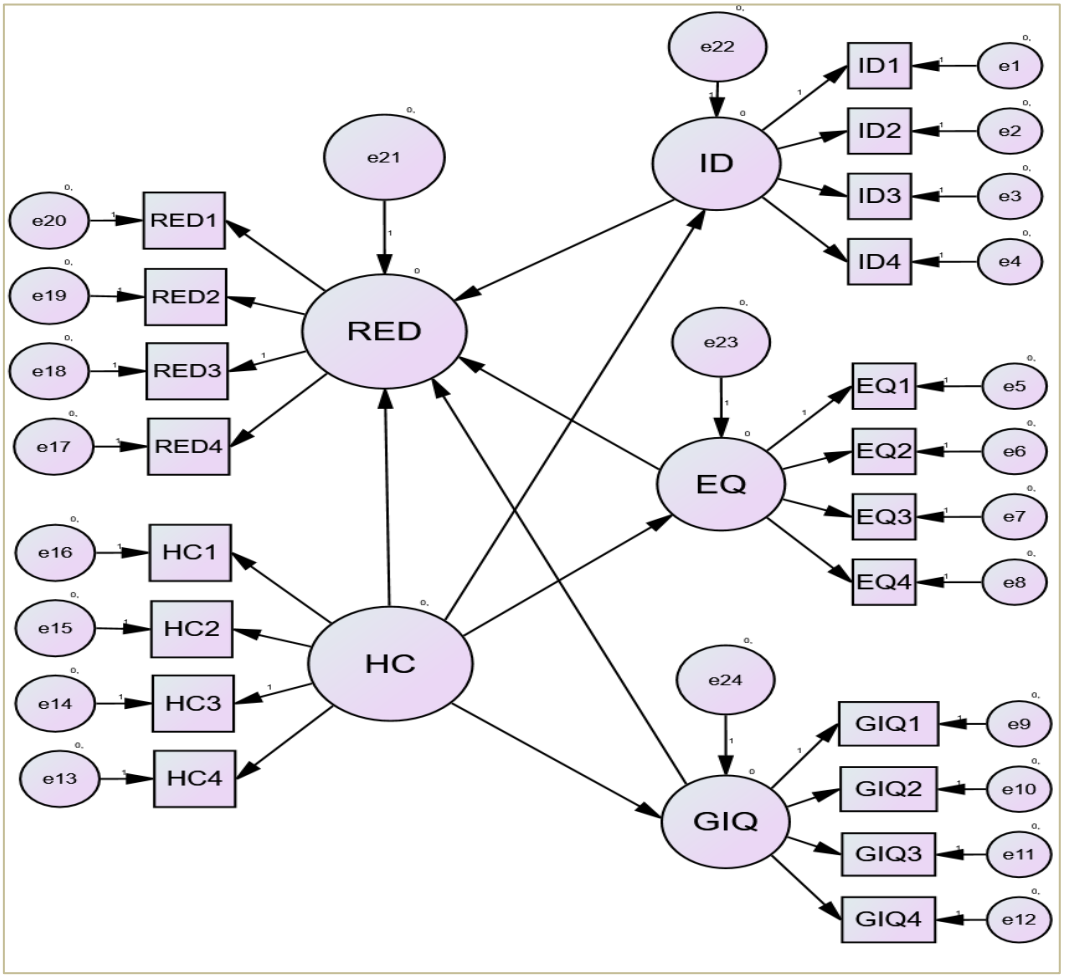

Figure 1. The conceptual framework of the SEM model

Based on the hypotheses above, the conceptual framework of the SEM model we aim to construct is illustrated in the figure below (Figure 1).

Indicators related to Human Capital (HC), Governance and Institutional Quality (GIQ), Environmental Quality (EQ), Infrastructure Development (ID), and Regional Economic Development (RED) were assessed by each respondent on a Likert scale ranging from 1 (very low) to 5 (very high). The following variables were analyzed:

— HC (Human Capital): HC_1-HC_4 (4 indicators);
— GIQ (Governance and Institutional Quality): GIQ_1-GIQ_4 (4 indicators);
— EQ (Environmental Quality): EQ_1-EQ_4 (4 indicators);
— ID (Infrastructure Development): ID_1-ID_4 (4 indicators);
— RED (Regional Economic Development): RED_1-RED_4 (4 indicators).

The Structural Equation Model (SEM) in this study is estimated using the Maximum Likelihood Estimation (MLE) method. The model includes the following equations:

$$ID = \alpha_1 + \beta_1 * HC + \epsilon_1 (1)$$

$$EQ = \alpha_2 + \beta_2 * HC + \epsilon_2 (2)$$

$$GIQ = \alpha_3 + \beta_3 * HC + \epsilon_3 (3)$$

$$RED = \alpha_4 + \beta_4 * HC + \beta_5 * ID + \beta_6 * EQ + \beta_7 * GIQ + \epsilon_4 \quad (4)$$

$\alpha_1, \alpha_2, \alpha_3, \alpha_4 - \beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7 - \epsilon_1, \epsilon_2, \epsilon_3, \epsilon_4$ —where: is the intercept, are the coefficients representing the direct effect, and is the error term.

Descriptive statistics are used to summarize the general characteristics (mean, standard deviation, maximum and minimum values) of the variables mentioned above (Table 1).

Table 1. Descriptive statistics of latent variables and their constituent indicators[1]

Latent Variables	Number of Indicators	Mean	Standard Deviation	Max Value	Min Value
HC	4	3.685	0.897	5	1
GIQ	4	3.763	0.935	5	1
EQ	4	3.551	0.954	5	1
ID	4	3.534	1.013	5	1
RED	4	3.789	0.912	5	1

The descriptive statistics in Table 1 show that the mean values of the variables for all constructs range from 3.0 to 4.5, which indicates that the respondents' overall ratings are at an average to above-average level. The standard deviations range from 0.8 to 1.2, indicating a moderate dispersion of responses. In the next stage, a Confirmatory Factor Analysis (CFA) is conducted to test the measurement model of the latent variables. This involves assessing the factor loading of each indicator on its respective latent variable and the overall fit indices of the model.

[1] created by the author

The results of the model adequacy are typically evaluated using Cronbach's Alpha, the Chi-square test, the Comparative Fit Index (CFI), the Tucker-Lewis Index (TLI), the Root Mean Square Error of Approximation (RMSEA), and the Standardized Root Mean Square Residual (SRMR). The following table presents the values of the indicators that represent the adequacy of the model (Table 2).

Table 2. Results of Indicators for Model Adequacy[2]

Indicator	Value
Chi-square/df	3.28
Cronbach's Alpha	**HC=0.85** **GIQ=0.84** **EQ=0.83** **ID=0.80** **RED=0.87**
CFI	0.93
TLI	0.91
RMSEA	0.05
SRMR	0.02

$RMSEA, SRMR < 0.08$

As can be seen from the data in Table 2, the Chi-square test value is 3.28. The Chi-square value is evaluated relative to the degrees of freedom (df). Ideally, the $\chi 2/df$ ratio (normalized Chi-square) should be between 2 and 5, which indicates a statistically significant relationship between the variables. The Cronbach's alpha coefficients for all constructs range from 0.80 to 0.87, indicating that the measurements are highly reliable. The highest reliability was observed in the RED (0.87) and HC (0.85) constructs, and the lowest in the ID (0.80) construct. Overall, the measurements for all constructs were found to be reliable for SEM analysis. The CFI (Comparative Fit Index) assesses the model's fit to the data by comparing it with a null model where no correlation between variables is assumed. CFI values range from 0 to 1, with higher values indicating a better fit. In our research, this indicator is 0.93, which shows that the model we are developing fits the data well. The TLI (Tucker-Lewis Index) also compares the model's fit against a baseline model and accounts for the model's degrees of freedom. TLI values typically range from 0 to 1, where high values represent a good fit and low values represent a poor fit. According to our calculations, this indicator's value is 0.91, which represents a good fit. Furthermore, RMSEA (Root Mean Square Error of Approximation) and SRMR (Standardized Root Mean Square Residual) measure the model's lack of fit to the data relative to the degrees of freedom. These are absolute fit indices, where smaller values indicate a better fit. This confirms the validity of the measurement model. Now, let us turn to the results of the formulated Structural Equation Model (SEM) (Table 3).

[2] created by the author

Table 3. Estimation Results of the Structural Equation Model (SEM) [3]

Hypotheses	Path	Coefficient	Standard Error	P-value	Result
Direct Effects					
H_1	HC → RED	0.420	0.085	0.000***	Supported
H_2	GIQ → RED	0.200	0.100	0.080*	Supported
H_3	EQ → RED	0.280	0.095	0.020**	Supported
H_4	ID → RED	0.350	0.090	0.010***	Supported
HC → ID		0.650	0.070	0.000***	
HC → EQ		0.580	0.075	0.000***	
HC → GIQ		0.520	0.080	0.000***	
Indirect Effects					
H_5	HC → GIQ → RED	0.104	0.070	0.100*	Supported
H_6	HC → EQ → RED	0.162	0.065	0.090*	Supported
H_7	HC → ID → RED	0.228	0.060	0.030**	Supported
Total Effects					
HC → RED		0.914	0.090	0.000***	
GIQ → RED		0.200	0.100	0.080*	
EQ → RED		0.280	0.095	0.020**	
ID → RED		0.350	0.090	0.010***	
HC → ID		0.650	0.070	0.000***	
HC → EQ		0.580	0.075	0.000***	
HC → GIQ		0.520	0.080	0.000***	

*Note: *, **, *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.*

H_1 Interpreting the coefficients in Table 3, the hypothesis regarding the effect of Human Capital on the region's economic development is statistically significant and moderately strong. Quantitatively, a one-unit increase in human capital indicators leads to a 0.42-unit increase in RED. From an economic standpoint, a highly skilled workforce increases productivity and enables the introduction of innovations, which directly contributes to regional economic development.

H_2 According to the hypothesis, the effect of Governance and Institutional Quality is weaker, yet statistically significant. A 1-unit increase in GIQ leads to a 0.20-unit increase in RED. Economically, fair legislation, anti-corruption measures, and effective governance ensure economic stability. The weak effect indicates that governance systems in the region are insufficiently developed, which underscores the need for reforms.

According to the hypothesis, the impact of Environmental Quality on RED is moderate. A 1-unit increase in EQ leads to a 0.28-unit increase in RED. Economically, environmental sustainability (clean air, water, renewable energy) is crucial for long-term economic development. Improved environmental quality reduces healthcare costs and opens up new economic opportunities, such as ecotourism. According to the hypothesis, the impact of Infrastructure Development on RED is moderate. A 1-unit increase in ID leads to a 0.35-unit increase in RED. Economic significance: Transport, energy, and telecommunications infrastructure support economic activity. Well-developed infrastructure reduces business costs and increases the economic potential of the region.

[3] Manba: Muallif ishlanmasi.

H_3 gipotezaga ko‘ra, Ekologik sifatning REDga ta’siri o‘rtacha. 1 birlik EQ o‘sishi REDda 0.28 birlik o‘sishga olib keladi. Iqtisodiy jihatdan ekologik barqarorlik (toza havo, suv, qayta tiklanadigan energiya) uzoq muddatli iqtisodiy rivojlanish uchun muhim. Ekologik sifatning yaxshilanishi sog‘liqni saqlash xarajatlarini kamaytiradi va ekoturizm kabi yangi iqtisodiy imkoniyatlarni ochadi.

H_4 gipotezaga ko‘ra, Infratuzilma rivojlanishining REDga ta’siri o‘rtacha 1 birlik ID o‘sishi REDda 0.35 birlik o‘sishga olib keladi. Iqtisodiy ahamiyati: Transport, energetika va telekommunikatsiya infratuzilmasi iqtisodiy faoliyatni qo‘llab-quvvatlaydi. Yaxshi rivojlangan infratuzilma biznes xarajatlarini kamaytiradi va mintaqaning iqtisodiy salohiyatini oshiradi.

H_5According to the hypothesis, Human Capital has the weakest indirect effect on RED through the quality of governance (0.52 × 0.20 = 0.104). This means that a 1-unit increase in human capital indicators leads to a 0.104-unit increase in RED through the quality of governance. Economically, effective governance systems can support economic development.

H_6According to the hypothesis, Human Capital has a weaker effect on RED through environmental quality (0.580 × 0.280 = 0.162). This means that a 1-unit increase in human capital indicators leads to a 0.162-unit increase in RED through environmental quality. From an economic standpoint, human capital raises environmental awareness and improves environmental quality by introducing sustainable technologies. The implementation of environmental projects (e.g., green energy) brings long-term economic benefits, but this effect is limited in the short term.

H_7According to the hypothesis, Human Capital indirectly affects RED through infrastructure. Quantitatively, the total indirect effect is 0.228, resulting from the impact of HC on ID (0.650) and the impact of ID on RED (0.350). In terms of economic significance, a skilled workforce improves infrastructure projects, which in turn supports economic activity (e.g., increasing exports through transport infrastructure).

Furthermore, if we interpret the total impacts from an economic perspective, the total impact of Human Capital (direct impact {0.420} + indirect impact {0.228 + 0.162 + 0.104} = 0.914) is very strong. Economically, Human Capital is a key factor in economic development, and investments in education, skills, and healthcare significantly stimulate regional economic growth. The total impact of Infrastructure on the region's economic development (0.350) is moderate. Economically, infrastructure projects (roads, ports, energy) support economic activity, but their impact is limited compared to human capital. The total impact of the Environmental Quality factor on regional economic development (0.280) is moderate. In terms of its economic significance, environmental sustainability brings long-term economic benefits, but its impact is limited in the short term. The Governance Quality factor has the weakest total impact on the region's economic development (0.200). Economically, governance quality is important in supporting economic development, but institutional reforms are necessary in the region.

CONCLUSION

The results of the conducted research show that in the current conditions of globalization and digital transformation, human capital is the most crucial and strategic factor ensuring regional economic development. Quantitative indicators obtained through the Structural Equation Model (SEM) confirmed the significant impact of human capital on economic growth via both direct and indirect channels.

The total impact coefficient of human capital on regional economic development (RED) is 0.914, which is significantly higher than all other factors (infrastructure, ecology, governance). This indicates that investments in human potential are the foundation of economic stability.

A one-unit increase in human capital directly contributes to a 0.42-unit increase in economic indicators. A highly skilled workforce enhances the region's competitiveness by increasing productivity and introducing innovations.

Infrastructure development (0.350) and environmental quality (0.280) have a moderately positive impact on economic development. Specifically, digital and transport infrastructure play an important role in reducing business costs, while environmental sustainability is crucial for ensuring long-term resource security.

Human capital further stimulates economic growth through infrastructure ($0.228), environmental quality ($0.162), and governance quality ($0.104). This indicates that qualified specialists are a key link in managing modern technologies and forming effective institutions.

The impact of governance and institutional quality on economic development had the lowest coefficient ($0.200). This shows the need for systemic reforms in the region to combat corruption, strengthen the rule of law, and increase the effectiveness of public administration.

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