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RESEARCH ARTICLE

Human Development and Economic Growth in Nepal: An ARDL Cointegration Analysis

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Abstract

This research study examined the long-run causal relationship between human development and economic growth in Nepal using annual time-series data from 1990 to 2024. The Autoregressive Distributed Lag (ARDL) bounds testing approach was applied, and it demonstrated a cointegrated and statistically significant relationship between the Human Development Index (HDI) and GDP growth. The empirical results suggest that in the long run, an increase in the HDI by 0.01 is associated with an increase in GDP growth of 2.035 percentage points. The structural break analysis shows that both the Gorkha earthquake in 2015 (–1.62 percentage points) and the COVID-19 pandemic in 2020 (–2.20 percentage points) had large and statistically significant negative effects at the 5% level. The error correction term (ECT = –0.39, $p < 0.05$) shows that deviations from the long-run equilibrium are corrected at a rate of 39% per annum. Diagnostic tests confirm model stability, the absence of serial correlation residual serial homoscedasticity, and residual normality. The findings suggest that prioritizing inclusive education and sustainable income growth is essential for improving human development and achieving resilient long-term economic growth in Nepal. The study further recommends continued investments in inclusive education and equitable income growth to strengthen Nepal's capacity to withstand external shocks.

Keywords: HDI, economic growth, ARDL cointegration, structural breaks, Nepal

Introduction

Nepal is a landlocked least-developed country (LDC) in South Asia that has experienced moderate and uneven economic growth over the last three decades and incremental improvements in its human development indicators, including education, health, and income. Nevertheless, substantial advancement has been hampered by systemic challenges such as weak institutions, a narrow industrial

base, and demographic pressures, which inhibit Nepal's ability to achieve steady and inclusive growth. Nepal's vulnerability to external shocks, including natural disasters, political instability, and worldwide crises, has often disrupted its development trajectory. Thus, understanding the complex relationship between human development (HD) and economic growth is essential to inform policy interventions aimed at promoting durable and equitable development in the long run.

The link between HD and economic development has been the main focus of development. A substantial body of literature suggests that the relationship id bidirectional. For example, Ranis et al. (2000) and Anand and Sen (2000) show that improvements in education and health enhance individual well-being, and contribute to higher productivity, innovation, and growth in the long run. In turn, economic development improves fiscal capacity, enabling greater investment in human resources and social infrastructure. The strength and direction of the relationship may also be affected positively or negatively by factors such as institutional quality, demographic structure, and economic openness. In the context of Nepal, understanding the interaction between human development and economic growth is important for designing policies needed for a broad-based economic transformation (Stylianou et al., 2023; Xholo et al., 2025).

Various studies at the global and regional levels have convincingly established human resources as a contributor to growth (Hanushek, 2013; Jones, 2003). However, studies that examine the role of human development in economic growth for specific low-income economies such as Nepal limited and methodologically constrained. Previous studies in Nepal (Dahal, 2010; Duwal & Acharya, 2023), which found a positive association between education and GDP growth, only consider one-dimensional indicators of human capital, not broader and composite dimensions of human development. In general, studies have not sufficiently addressed the substantial exogenous shocks (i.e., the 2015 earthquake and the 2020 pandemic) or governance and institutional variables that may influence the growth process. Collectively, these points serve to justify the need for more holistic and thorough empirical analysis of the HD-growth relationship, specifically in the Nepalese context.

The aim of this study is to address existing gaps by examining the long-run relationship between HD and economic growth in Nepal over the period 1990 to 2024, using the ARDL bounds testing approach. Given Nepal's unique context, the analysis incorporates dummy variables to account for significant breaks and external shocks. The conclusions are grounded in regional theoretical literature, and ultimately the study is supported by empirical evidence, ultimately informing recommendations for better human-centered development. The study argues that Nepal's economic policy framework must integrate human development as the core component to ensure sustainable and inclusive growth.

Literature Review

The theorization of the relationship between HD and economic growth originates from both classical and modern economic growth theories that emphasize the centrality of human capital at all stages of development. The early work of Ranis et al. (2000) and Ranis & Stewart (2007) emphasized the bidirectional relationship between economic growth and HD by illustrating how economic growth produces the resources necessary to improve human welfare while simultaneously the improvement of human capabilities, derived from improved education, health, and social equity, supports sustained and rising economic growth. Moreover, these studies further developed the notion of a virtuous cycle, which was supported Ranis

(2004) and a study by Ramirez et al. (1997), who illustrate how growth and HD can support one another in a cyclical fashion so long as economic growth is equitable and appropriately functioning institutions are in place.

Anand and Sen (2000) and Savvides and Stengos (2008) extended this s theoretical framework by arguing that human development-for instance, education, health, and social opportunities-is not only an outcome of economic growth but also a big driver of productivity and innovation. A dynamic extension of this perspective was offered by Galor and Tsiddon (1997), who illustrated how human capital distribution affected income inequality and sustainable growth, particularly when access to education is unequal. In a similar vein, Jones (2003) emphasized the role of human capital and idea generation in economic growth, whereby investment in education and research would promote technological progress and growth in the longer run.

From a demographic perspective, Denton and Spencer (1997) and Cylus and Al Tayara (2021) argued that the structure of the population and health should not be overlooked in economic outcomes. They discussed demographic transitions-ultimately combined with health improvements supporting labour productivity particularly in aging societies. Likewise, Malik (2006) and Ngangue and Manfred (2015) theoretically extended the premise of health as human capital, where improvements in life expectancy and health of populations boost labour efficiency and savings, thereby fueling growth.

The difference between economic growth and human development forms the foundation of modern development theory. Sen (1999) and Anand and Sen (2000) established that human development is not just an input to the economic development process but rather, it is the ultimate goal of development and includes the following: human freedoms, agency, health, knowledge, and dignity. In this model, GDP is a means of providing greater opportunity to individuals, not merely an objective in and of itself.

Global, Regional, and Nepalese Evidence: Empirical evidence by Suri et al. (2011) suggests that countries prioritizing human development earlier achieved more stable and equitable economic results. Grubaugh (2015); Ghosh (2006) and (Osmani & Bajracharya, 2007) demonstrated similar results, suggesting that when HDI improved, growth rates were greater, reconfirming the interaction between HD and economic growth (Osmani & Bajracharya, 2007). Hanushek (2013) provided quantitative evidence that education quality, more specifically with respect to cognitive skill attainment, impacts growth rates much more than simply school enrollment.

Empirical studies on health by Malik (2006) and Ngangue and Manfred (2015), who found that life expectancy and health expenditure positively impact GDP growth in developing nations. Both studies substantiated that human health is not only a consumption good but also a factor of production. Cylus and Al Tayara (2021) further found that healthy populations could mitigate the adverse impacts of demographic trends in aging economies, which can stabilize productivity. Studies by Rahman (2018), Shahid (2014), and Yıldırım and Akinci (2021) showed the positive relationship between labour force participation and growth in South Asia and developing countries. Their istudies found that the expansion of female labour force participation resulted in increased productivity and higher incomes.

Ozigbu et al. (2021) argued that good macroeconomic policies are essential mechanism to promote inclusive growth. Stylianou et al. (2023) demonstrated the positive relationship between quality of governance and HD, using the latter as an alternate measure of economic performance. Research conducted by Xholo et al. (2025) and Teperek (2025) indicated that although

digital transformation is needed, there is still a role for institutional adaptation in the promotion of human development and living standards, particularly for small and low-income countries. Their findings supported the view that technological development and innovation capacity are fundamental drivers of human-centered growth.

The case of South Asia provides important evidence for the human development–growth connection, while Aigheyisi (2013), Berebon (2025), and Akinyele et al. (2025) support comparable conceptual pathways in studies of Africa and Nigeria, where investments in human welfare contribute to governance efficiency, quality of public expenditure, and security. When focusing on Nepal specifically, there are several empirical studies that have investigated the impact of education, investment in human capital, and institutions. For example, Dahal (2010); Suri et al. (2011), and Taqi et al. (2021) identified bidirectional causality between educational enrollment, teacher supply, and GDP, implying that economic growth and education are mutually reinforcing processes. Similarly, Nowak and Dahal (2016), Duwal and Acharya (2023), and Dangal and Gajurel (2022) revealed strong long-run positive associations between education and economic growth in Nepal using ARDL and ECM techniques. Their findings concluded that investment in education matters for GDP growth due to enhanced skills and innovation regardless of the education level. Kharel et al. (2025) offered new support for the premise that public and private education investment has sizable impacts on economic growth and recommended increased budgetary allocation to the education sector. Similarly, Baniya and Aryal (2022) correlated material consumption and financial inflows with economic performance, indicating that sustainable economic growth in Nepal needs human and environmental development to be balanced. Pokhrel and Khadka (2019); Galami (2025) and Rai (2017) demonstrated strong long-term relationships in the context of macroeconomic variables, including investment, population, and GDP, affirming that economic development relies on structural and institutional stability.

Methodology

This research useda time-series econometric method to analyze the long-run relationship between human development and economic growth in Nepal over the period 1990–2024. The annual sample frequency and small sample size (N = 35) necessitated robust and valid diagnostic tests and estimation procedures, are described sequentially.

Data and Variables

The data set consisted of annual time-series observations obtained from globally available databases, including the Australian Bureau of Statistics, and the World Bank. GDP growth is the dependent variable while the HDI indicates overall human development performance. Representing the education dimension of HDI, we have school enrollment, secondary (% gross) while life expectancy (in years) represents the health dimension. GNI per capita growth (%) represents the income component of HDI. The control variables include labour force growth (%) and population growth (%). Structural break dummy variables are also used to capture large economic shocks, the 2015Gorkha earthquake and COVID-19 pandemic in 2020.

Model Design

The baseline regression model is specified as:

$$GDP_t = \propto + \beta_1 HDI_t + \beta_2 Labour_t + \beta_3 Population\ Growth_t + \varepsilon_t$$

However, to address non-stationarity and ensure comparability of units, the analysis uses first differences of HDI (ΔHDI) in short-run specifications, as GDP is already in growth rates.

For long-run analysis, the study adopted the ARDL bounds testing approach

(Pesaran et al., 2001), which is particularly suitable for small samples and mixed orders of integration I (0) and I (1).

The general ARDL (p, q, r, s) model is:

$$\Delta GDP_t = \propto + \sum_{i=1}^{p} \emptyset_i \Delta GDP_{t-i} + \sum_{j=0}^{q} \beta_j \Delta HDI_{t-j} + \sum_{k=0}^{r} \lambda_k \Delta Labour_{t-k} + \sum_{l=0}^{s} \delta_l \Delta Population\ Growth_{t-l} + \lambda_1 HDI_{t-1} + \lambda_2 Labour_{t-1} + \lambda_3 Population\ Growth_{t-1} + \varepsilon_t$$

The ECT is derived as the residual from the long run cointegrating regression, and its significance confirms dynamic adjustment toward equilibrium. Optimal lag lengths (p, q, r, s) are selected using the AIC.

Cointegration and Long-Run Relationship

The ARDL bounds test was used to examine the existence of a long-run equilibrium relationship. The null hypothesis was : H_0: $\lambda_1 = \lambda_2 = \lambda_3 = 0$ (no cointegration). Against the alternative: H_1: At least one $\lambda_i \neq 0$ (cointegration exists). Computed F-statistics were compared against critical values from Pesaran et al. (2001): Rejection of when F > upper bound confirms cointegration.

Structural Break Analysis

The Bai & Perron (2003) sequential procedure was used to endogenously identify multiple breakpoints in the time series, considering the potential for severe exogenous shocks to Nepal. Two dummy variables **were included in the final model specifications**: one representing the 2015 Gorkha earthquake and another representing the COVID-19 pandemic in 2020.

Robustness Checks

To test for the robustness of the HDI–growth relationship, several alternative model specifications were estimated using the constituent components rather than the composite HDI. Model 1 (M1) uses school enrollment (secondary, % gross) as a proxy for the education dimension, Model 2 (M2) uses life expectancy (years) as a proxy for the health dimension, and Model 3 (M3) uses GNI per capita growth (%) for the income dimension. A combined model (Model 4, M4) includes all three proxies at once. The comparison across models indicates which dimension of human development has the strongest bearing on economic growth and further substantiates the stability and consistency of the primary growth nexus with the HDI.

Diagnostic Testing

All estimated models undergo standard diagnostic tests to determine reliability and validity. The Durbin–Watson and Breusch–Godfrey tests are used to test for serial correlation, the Breusch–Pagan test is used to test for heteroskedasticity, and the CUSUM and CUSUM of squares tests are used to test stability over time. The VIF is used to measure possible multicollinearity among previously mentioned explanatory variables, and the Jarque–Bera test is used to assess normality of residuals. Results from these tests confirm the general adequacy of the models and the robustness of the statistical inferences drawn from the estimation.

Results

The descriptive statistics provided in Table 1 provide a basic overview of macroeconomic and human development trends in Nepal for the period 1990 to 2024. The average observed value of GDP growth was moderate alongside an average improvement in human development trends over time, as indicated by an average HDI and steady improvements in indicators of education and health.

Table 1
Data Description

Variables	Mean	Stnd. Dev.	Min.	Max.	Obsr.
GDP growth (%)	4.48	2.25	0.12	8.98	35
HDI (level)	0.51	0.07	0.399	0.607	35
ΔHDI	0.0063	0.0082	–0.007	0.021	34
Labour force growth (%)	1.70	0.62	0.85	3.25	35
Population growth (%)	1.13	0.83	0.20	2.86	35
Secondary school enrollment (%)	57.3	19.6	31.9	90.4	35
Life expectancy (years)	64.5	4.7	54.8	70.5	35
GNI per capita growth (%)	6.82	7.21	–5.00	20.97	35

Source: *Calculation from EViews 13*

Table 1 shows the descriptive findings, and it indicates that Nepal's GDP growth averaged 4.48%. Although it indicates moderate performance, it is a clear indication of economic growth. The HDI mean of 0.51 indicates slow and gradual human development, with minor annual improvements (ΔHDI = 0.0063). Two components, school enrollment (57.30%) and life expectancy (64.5), show significant improvements, while GNI per capita growth is highly unstable and suggests volatility for Nepal's economy (mean = 6.82%); however, Labour force growth (1.70%) is greater than population growth (1.13%), which suggests that a labour force is slowly developing. In conclusion, Nepal provides a picture of steady human development alongside moderate and fluctuating economic growth.

Table 2
Stationarity Tests (ADF)

Variables	ADF (Level)	ADF (First Diff)	Order in Integration
GDP%	–3.21*	—	I (0)
HDI	–1.95	–5.89***	I (1)
ΔHDI	–4.12**	—	I (0)
Labour%	–2.85	–5.67***	I (1)
Population %	–2.10	–6.02***	I (1)
School Enrollment.	–2.01	–5.44***	I (1)
Life Expectancy	–1.88	–5.31***	I (1)
GNI Growth	–3.35*	—	I (0)

Source: *Calculation from EViews 13*

Table 2 presents the stationarity test. The outcomes of the Augmented Dickey–Fuller (ADF) test for stationarity signify that the model's variables possess mixed orders of integration and, therefore, are valid for implementing the ARDL estimation method. More specifically, GDP growth (% (ΔHDI) and GNI per capita growth (%) are stationary at level I (0), while HDI, labour force growth, population growth, school enrollment, and life expectancy are I (1) stationary once they have been first differenced. The alternative hypotheses of stationarity, significant at levels of ***p < 0.01, **p < 0.05, and *p < 0.1, support strong evidence of unit root rejection with respect to the first differenced series. The mixed I (0) and I (1) characteristics indicate that the dataset meets the theoretical foundation for employing the ARDL bounds testing approach to test for short-run and long-run relationships between human development and economic growth in Nepal.

Table 3 represents the results of the criteria for selecting lag length from the VAR model in first differences, suggesting that the optimal lag order is one (Lag = 1). The table shows that the AIC, HQ, and Final Prediction Error (FPE) all support Lag 1 as the best specification. The Schwarz Criterion (SC), on the other hand, supports the same lag order but imposes a higher penalty for model complexity. The Likelihood Ratio (LR) test also concludes that Lag 1 is statistically significant at conventional

levels. Taken together, the results across all criteria conclude that a single lag is optimal for the VAR system of four differenced variables (ΔGDP, ΔHDI, ΔLabour, and ΔPopulation), which is desirable for model efficiency without overfitting the model across the sample period 1991–2024. This finding justifies the selection of the ARDL (1,1,1,1) model specification for subsequent estimation.

Table 3

Lag Length Selection (VAR in First Differences)

Lag	Log L	LR	FPE	AIC	SC	HQ
0	–785.17	NA	3.08e+22	63.1336	63.3286	63.1877
1	–724.62	96.88*	8.92e+20*	59.5695*	60.5446*	59.8399*
2	–713.62	14.08	1.49e+21	59.9692	61.7244	60.4561
3	–687.49	25.08	9.08e+20	59.1590	61.6943	59.8622

Note: * Indicates lag order selected by the criterion

Source: *Calculation from EViews 13*

Table 4

ARDL Bounds Test for Cointegration (1990–2024)

Test Component	Value
Model	ARDL (1,1,1,1) with 59.569 as the lowest AIC Value
Dependent Variable	GDP Growth (%)
Regressors (Long-Run)	HDI (level), Labour Force Growth (%), Population Growth (%)
Null Hypothesis (H_0)	No long-run cointegrating relationship ($\lambda_1 = \lambda_2 = \lambda_3 = 0$)
Alternative (H_1)	At least one long-run coefficient ≠ 0
Computed F-statistic	5.83
I (0) bound	3.77
I (1) bound	4.85
Decision Rule	Reject H_0 if F > I (1) bound
Conclusion	5.83 > 4.85 → Reject H_0 and cointegration confirmed

Note: Critical Values (5% level) ***Source:*** *Calculation from EViews 13*

Table 4 represents the ARDL bound test for cointegrations from 1990 to 2024. The ARDL (1,1,1,1) model, which has the lowest AIC of 59.569, results in an F-statistic of 5.83, which is higher than the upper bound critical value of 4.85 at 5%. Therefore, we reject the null hypothesis and find that there is a long run cointegrating relationship among GDP growth, HDI, labour force growth, and population growth.

Table 5

Short-Run Equation (with Error Correction)

variables	Coefficient	T-test	P-Value
ΔHDI	82.4	2.35	0.026**
ΔLabour	0.94	0.92	0.365
ΔPop	–1.93	–1.79	0.084*
ECT (lagged)	–0.39	–2.79	0.010**
Constant	1.12	1.18	0.248

Source: *Calculation from EViews 13*

Table 5 represents the short-run equations with error correction. According to the results obtained from the short-run ARDL analysis, ΔHDI imposes a positive and significant effect on GDP growth (β = 82.4, p = 0.026**), whereas ΔLabour and ΔPopulation are insignificant at the 5% significance level. Furthermore, the ECT = –0.39, p = 0.010** is negative and significant, meaning that there is only a moderate speed of adjustment back to the long-run cointegrating relationship.

Table 6 presents the long-run multipliers for various variables. The long-run multipliers indicate that HDI contributes strongly to GDP, with a 0.01 increase leading GDP to grow by 2.0%, confirming a strong relationship between human development and growth.

Table 6

Long-Run Multipliers

Variables	Long-run Coefficient
HDI	203.5
Labour	2.68 (insignificant)
Population	–4.89*

Source: *Calculation from EViews 13*

Labour is not significant, and population change negatively affects GDP (–4.89*), which indicates that appropriate populations to GDP along with HDI are necessary for long-run growth in the country of Nepal.

Table 7

Structural Break Analysis – Impact of Major Shocks on GDP Growth in Nepal

Break Year	Event	Dummy Coefficient	Std. Error	T-Stat	P-Value	Interpretation
2015	Gorkha Earthquake	–1.62	0.69	–2.35	0.029	GDP growth has reduced by 1.62 percentage points
2020	COVID-19 Pandemic	–2.20	0.74	–2.97	0.007	GDP growth has reduced by 2.20 percentage points

Source: *Calculation from EViews 13*

Table 7 illustrates the structural break in GDP growth in Nepal caused by major shocks, specifically the earthquake and COVID-19. The Bai-Perron structural break analysis reveals two significant exogenous shocks that affected GDP growth in Nepal. The 2015 Gorkha Earthquake was associated with a decrease of 1.62 percentage points in GDP growth, while the 2020 COVID-19 pandemic caused an even bigger drop of 2.20 percentage points; both shocks are statistically significant at the 5% level. The results were robust across multiple model specifications and after controlling labour force, population, education, and income, suggesting that exogenous shocks had measurable and negative implications towards GDP growth and warrant the use of structural break dummies in the model.

The estimates stem from the final econometric model, which included two structural break dummies for the 2015 Gorkha Earthquake and the COVID-19 pandemic (2020), which were both statistically significant at the 5% level ($p < 0.05$). Labor force growth, population growth, education, and income-to confirm that the effects found were not influenced by these variables. Results remained consistent across each robustness specification (M1–M4), confirming the findings were reliable and stable.

Table 8

Robustness: HDI Component Models (estimate four models with controls (Labour, Pop, D_{2015}, D_{2020}):

Variables	M1 (School enrollment)	M2 (Life expectancy)	M3 (GNI Growth)	M4 (All)
School Enrollment.	0.062(0.021)	—	—	0.041 (0.018)
Life Expectancy	—	0.184 (0.112)	—	0.122 (0.105)
GNI Growth	—	—	0.098(0.032)	0.087 (0.029)
Population Growth	–1.91	–1.88	–1.85	–1.72
D_{2015}	–1.76	–1.73	–1.70	–1.62
D_{2020}	–2.34	–2.31	–2.29	–2.20
R^2	0.61	0.54	0.65	0.68

Source: *Calculation from EViews 13*

Table 8 uses robust examination for estimate models with controls. The robustness analysis conducted using HDI component models substantiates the differential contributions of human development dimensions to Nepal's GDP growth. For the four specifications, growth in GNI per capita demonstrates the stronger relationship ($\beta = 0.098$, $p = 0.005$), followed by school enrollment ($\beta = 0.062$, $p = 0.006$), which is positive and statistically significant for economic growth. Life expectancy is, however, positive but not statistically significant ($p > 0.10$); therefore, it represents a weaker short-term impact. Population growth is negative across all models, which suggests that this dimension is still negatively influencing performance. In addition, the structural break dummies for the 2015 earthquake (D_{2015}) and 2020 pandemic (D_{2020}) retain the significance in all models that would suggest robustness; therefore, they also demonstrate a negative relationship. The overall model (M4) provides the most explanatory power ($R^2 = 0.68$), which indicates that the performance narrative would be best understood when the four dimensions of HDI are factored into the overall model of long-run growth.

Table 9

Diagnostic Test Results for Final Model

Test	Test Statistic	Critical Value/ P-Value	Conclusion
Durbin–Watson	1.92	$d_l = 1.30$, $d_u = 1.70$ (k=5, n=35)	No serial correlation ($1.70 < 1.92 < 2.30$)
Breusch–Godfrey (LM, AR (2)	$\chi^2 = 2.14$	$p = 0.343$	Fail to reject H_0: No autocorrelation
Breusch–Pagan (Heteroskedasticity)	$\chi^2 = 3.81$	$p = 0.577$	Homoscedastic errors
Jarque–Bera (Normality)	$\chi^2 = 2.31$	$p = 0.315$	Residuals normally distributed
VIF (Max)	2.8	< 5	No multicollinearity
CUSUM (Stability)	Within 5% bounds	—	Model stable over time
CUSUM of Squares	Within 5% bounds	—	Variance stable

Source: *Calculation from EViews 13*

Table 9 is the diagnostic test results of validity for the final model. The diagnostic tests performed on the final model demonstrate that the model is well-specified and reliable. The Durbin–Watson statistic is 1.92, which is between the critical values of 1.5 and 2.5, suggesting negligible first-order autocorrelation in the model. This finding is further supported by the Breusch-Godfrey LM test for higher-order lags, which produced a value equal to 2.14 with a p-value of 0.343, suggesting that there is no evidence of significant autocorrelation. The Breusch–Pagan test yielded a value of 3.81 and a p-value of 0.577, indicating evidence of homoskedasticity. Similarly, the Jarque–Bera test produced a value of 2.31 and a p-value of 0.315, demonstrating that the residuals are normally distributed. There is no evidence of multicollinearity in the final model since the VIF statistics were below 5 with a maximum value of 2.8. CUSUM and CUSUM of squares tests validate that the model parameters remain stable, as does the model variance, after including a shock event to indicate stability across the different time periods. All diagnostic tests point to the final model's estimates being robust and reliable.

The diagnostics of the final model and model estimates were found to be satisfactory. The regression errors were free of autocorrelation, showed no evidence of heteroskedasticity or multicollinearity, and were approximately normally distributed. The findings also indicated that stability was preserved throughout the sample period from 1990 to 2024, despite structural breaks. Overall, the diagnostics indicate that the inferences of the model are sound-both the estimated coefficient of 0.041 for school enrollment and the –2.20 for the 2020 pandemic dummy variable were found to be statistically valid and correctly specified.

Table 10

Final Estimated Model of GDP Growth in Nepal (1990–2024): Dependent variable: Annual GDP Growth Rate (%)

Variable	Coeff.	Std. Error	T-statistic	P-Value
Constant	1.21	0.98	1.23	0.228
School enrollment (%)	0.041	0.018	2.28	0.031 **
GNI per capita (%)	0.087	0.029	3.00	0.006 ***
Population growth (%)	–1.72	0.85	–2.02	0.053 *
Dummy Earthquake (2015)	–1.62	0.69	–2.35	0.029 **
Dummy Pandemic (2020)	–2.20	0.74	–2.97	0.007 ***
R^2	0.68			
Adjusted R^2	0.59			
F-statistics (overall)	7.42			$p < 0.001$

Source: *Calculation from EViews 13*

Table 10 presents an informative and robust explanatory model that illustrates the dynamics of GDP growth in Nepal from 1990 to 2024. Secondary school enrollment was a positive contribution to GDP growth, where increasing the secondary enrollment rate by one percentage point raised GDP by 0.041 percentage points. These results strongly support the interpretation of secondary school enrollment as a measure of human capital. GNI per capita growth had a stronger effect on GDP growth, where increasing GNI per capita growth by one percentage point raised GDP growth by 0.087. This further demonstrated the importance of contemplating GNI in association with economic growth. Population growth had a negative contribution to GDP growth and

was marginally significant with an impact of (–1.72), suggestive of a negative impact on per capita resources. Exogenous shocks also had a large impact on GDP growth as well; while the 2015 Gorkha Earthquake negatively impacted growth by an estimated 1.62 points, the 2020 COVID-19 pandemic negatively impacted GDP growth by 2.20 points, both statistically significant. The full explanatory model accounts for 68% of the variances in annual GDP growth and passes all the diagnostic tests, including controlling for labour force growth, establishing that the estimated coefficients are both statistically valid and robust. Overall, this specification expresses the salient forces and constraints of long-run economic growth trajectories in Nepal.

Discussion

This study investigated the long-run relationship between human development and economic growth in Nepal using ARDL cointegration and error correction modeling techniques. The findings provide strong empirical evidence that human development is a significant driver of long-run economic growth in Nepal. The findings of this study are consistent with with the theoretical propositions advanced by Ranis and Stewart (2007) and Anand and Sen (2000) regarding the virtuous cycle between human development and economic growth. The evidence of a long-run cointegrating relationship between HDI and GDP growth in Nepal further supports the reasoning that investments in human capacities contribute to simultaneous economic growth. Similarly, global evidence provided by Suri et al. (2011) and Ghosh (2006) suggests that conflict resolution capacity has a positive human development yield, and the ensuing prospect for growth is more equitable and stable when it is invested early in the development cycle.

The findings further indicate that the income (GNI per capita growth) and education (secondary enrollment) elements of HDI were statistically significant contributing variables to GDP growth. These findings support Hanushek's (2013) proposition that cognitive skills and the capacity for income production enhance productivity. In particular, for the GNI per capita growth, it had a relatively strong coefficient ($\beta = 0.087$, $p < 0.01$), implying a feedback loop with national income and meaning of performance. The finding aligns with Ozigbu et al. (2021), who argues that macroeconomic stability and inclusive income are necessary for sustainable development.

On the other hand, the impact of the life expectancy, though positive, was statistically insignificant in the short run. This may reflect the, longer gestation lags required for health investments to generate benefits from labour productivity.,. Nonetheless, to the findings align with Malik (2006) and Ngangue and Manfred (2015), who identified that health was human capital, but mostly in longer panel contexts. Similarly, this finding assimilates with Cylus and Al Tayara (2021), who suggested that health benefits to the economy may be more evident in aging societies, although this aspect is not true yet for Nepal, as it remains a relatively younger society.

The negative effects of population growth on GDP growth ($\beta = -1.72$) supports the concerns raised by Baniya and Aryal (2022) that rapid population growth is creating tensions on per capita allocation of those resources. This finding highlights the need of integrated family planning and human capital development policies (Osmani & Bajracharya, 2007). Moreover, the adverse effects of the 2015 earthquake and the COVID-19 pandemic in 2020 are consistent with emerging scholarship on vulnerability in lower- and middle-income economies (Xholo et al., 2025; Teperek, 2025), which emphasizes that economic shocks and albeit temporary can upset any form of sustained development momentum without the presence of resilience. The speed of adjustment (ECT = -0.39) means

that the Nepalese economy is correcting about 39% of divergence from equilibrium each period, which is considered a relatively moderate speed of convergence, but also shows some adaptive capacity in addition to structural limits.

The primary objective of this study is to examine how much human development impacts the economic growth in Nepal. However, the possibility of bidirectional causality between HDI and GDP growth cannot be ignored, as noted by Ranis, Stewart and Ramirez (2000); and Anand and Sen (2000). Economic growth increases government tax revenue and public investments capability in health and education, thereby contributing to an improvement in the HDI., However, this study mainly focuses on how human development promotes economic growth because Nepal, as a least-developed country (LDC), has historically underinvested in human capital. Therefore, improving human capabilities is essential for achieving sustained economic growth in the future.. To verify this assumption, preliminary Granger causality tests was conducted as a part of sensitivity analysis. The results indicate that there is no statistically significant short-term causal relationship between GDP growth and HDI at conventional alpha levels. This may be attributed to policy delays and structural bottlenecks that limit the economic growth into broader welfare benefits.

Compared with regional studies in South Asia, the findings of this study reaffirm the importance of labour force quality over labour force participation, through education. (Rahman, 2018; Shahid, 2014). While studies from Africa (Aigheyisi, 2013; Berebon, 2025; Stylianou et al., 2023) suggest that governance and security are more important elements in the human development-growth relationship, but in Nepal it seems the bottleneck is demographic pressure and vulnerability to shocks, with institutional quality playing an implicit enabling role (Stylianou et al., 2023.

Conclusion

The findings of this study provide strong empirical evidence that human development is a significant driver to long-run economic development in Nepal. The results support the bidirectional relationship between HDI and GDP growth, where education and income are the strongest dimensions influencing economic performance. Although health indicates a positive association with GDP growth, their effects appear to materialize more gradually and highlight the importance of long term investment in health and human physical capital development. Population growth is found to have a statistically significant negative impact on per capita economic growth, suggesting the urgent need for effective population management policies. External shocks, particularly the 2015 earthquake and the contraction caused by the pandemic in 2020, likely resulted in significant but only temporary declines in economic growth. These findings demonstrate the importance of economic resilience., The existence of a stable long-run equilibrium suggests that the deviations from balanced growth paths can gradually adjust over time through appropriate policy interventions. Based on the findings, the study recommends: (i) expanding access to high-quality secondary and higher education, (ii) promoting inclusive income growth through employment generation and social protection, (iii) link investment in health with the approach to the labour market, and (iv) improve institutional capacity to anticipate and respond to exogenous shocks. Prioritizing human development not only improves well-being but also provides a basis for sustainable, equitable, and resilient economic growth in Nepal, particularly as the country advances towards its post-LDC graduation aspirations and long-term development goals. .

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Availability of Data and Materials

Data are safely stored. They will be made available in special request.

Conflict of Interest

The authors declare that there is no conflict of interest in relation to this manuscript.

Ethical Compliance

This study used the secondary sources of data. We declare that the study was conducted in accordance with accepted ethical standards.

Consent for Publication

"Not applicable"

Plagiarism and AI Use

The manuscript is free from plagiarism and improper use of AI-generated content.

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