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The Impact of Sustainable Development Indicators on Human Development: The Case of Saudi Economy (1990-2020)

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Abstract

The present study aims to investigate the impact of sustainable development indicators on the human development index in the context of Saudi Arabia. For this purpose, the study employed time data for the period 1990-2020. An ordinary least squares (OLS) model was employed to check this relationship. The results show that life expectancy at birth and expected years of schooling have a negative and significant impact on the human development index. On the other hand, gross domestic product per capita has an insignificant impact on the human development index. On the other hand mean year of schooling and CO2 significantly impact the human development index. The study with these findings highlighted the critical role of sustainable development indicators in improving the human development Index. Based on empirical outcomes, the policy prescriptions discussed for relevant authorities to invest in green technologies and education to increase Saudi Arabia population life quality.

Keywords: Sustainable Development, Human Development Index, Saudi Arabia, CO_2 Emission.

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Introduction

Human development index (HDI) has become a basic foundation for evaluating economic progress, emphasizing people's wellbeing rather than just wealth accumulation (UNDP 1990). The concept was introduced by economist Ul Haq (1995), who introduced the HDI, which indicates the prominence of people the chance to live long, healthy, and satisfying lives. Its key elements, including life expectancy, education, and general well-being, have been used to understand human development over time (Papavlassopulos and Keppler 2023). Although economic progress is necessary, social inequality can result from emphasizing exclusively on financial success instead of improving the lives of individuals (Stiglitz, Sen and Fitoussi 2009). Human development is getting a lot of consideration in the extant literature, which aims to enhance healthcare, education, and general quality of life (Alazemi 2022). However, issues like environmental sustainability, health care advancements, and educational accessibility remain crucial in determining the long-term results of human development (Leal Filho et al. 2019). To report these issues, it is essential to connect sustainable development indicators with policies that improve people's lives, ensuring a balanced and inclusive future (Al-Shamsi, Abyad and Rafii 2022).

Human development is based on sustainable development, which guarantees a stable method to social advancement, economic growth, and environmental sustainability (Singh 2024). Its main goal is to enhance people's well-being by implementing long-term plans that support access to high-quality education, economic stability, and a healthy environment (Estes and Sirgy 2019). Since sustainable development programs provide opportunities for better living conditions, healthcare, and education, nations that successfully implement these policies generally achieve higher levels of human development (Alkire, Kanagaratnam and Suppa 2021). Nevertheless, accomplishing human development requires a deeper understanding of key indicators, including GDP per capita (GDPP), life expectancy at birth (EXPL), expected years of schooling (EXYRS), mean years of schooling (MYRS), and CO_2 emissions. According to Al-Sukkar (2023), these elements work together to decide the extent to which sustainable development enhances human well-being. Therefore, the study focused on testing the influence of these indicators on human development.

From the above sustainable indicators, GDP per capita (GDPP) contributes significantly to human development by increasing income levels, job opportunities, and access to basic services (Fadare 2023). Governments could allocate more funds to infrastructure, healthcare, and education when GDP per capita is higher, which directly improves human well-being (Sen 1999). However, the impact of economic growth on human advancement can be limited by income inequality and resource misallocation, thus, it is not a guarantee of equitable development on itself (Kabeer and Natali 2013). Consequently, the association between GDP per capita and advancements in health, education, and living standards is strengthened when a strong economic foundation is combined with effective governance (Guisan 2021). Equally, EXPL, which reflects living conditions, disease prevention, and the quality of healthcare, increases the HDI (Miladinov 2020). An increase in life expectancy is a sign of better public health programs, better healthcare systems, and easier access to medical facilities (Woolf and Schoomaker 2019). Moreover, increased life expectancy boosts worker productivity, which promotes social progress and economic stability (Olanrewaju 2021). As a result, prioritizing healthcare development is important for maintaining both human well-being and long-term economic prosperity (Dyakova et al. 2017).

Furthermore, education with MYRS and EXYRS has a significant impact on societal advancement and individual skills (UNESCO 2023). Traditionally, education improves human development by raising social

awareness and enabling people to make significant contributions to society (Grant 2017). Although Saudi Arabia has achieved great progress in increasing educational access and enhancing learning outcomes but issues with quality and skill development remain (Allmnakrah and Evers 2020). Therefore, the role of education in encouraging human development can be further strengthened by funding modern educational systems, online learning environments, and career training initiatives (Ali 2020). In other words, human development is greatly influenced by environmental sustainability, especially CO2 emissions, which have an impact on public health and climate conditions (Ofremu et al. 2024). Although economic growth and industrialization promote prosperity, they frequently result in higher carbon emissions, which threaten human health and environmental stability over a longer period. Consequently, ensuring long-term ecological balance and human well-being requires the implementation of green energy policies, reducing emissions, and encouraging sustainable urban growth (Zhang, Zhang and Xie 2024). These previous studies emphasized testing the influence of sustainable development indicators on human development.

With the significance of previous studies' relationship, prior studies still have various gaps that need to be addressed in the current study. Firstly, extant studies were mainly focused on how economic, social, and environmental factors affect human development separately, with little focus on how these components function together in a comprehensive framework (Mensah 2019; Rogers 2020; Newman and Newman 2022). Consequently, by combining important sustainable development metrics, GDP per capita, life expectancy, years of education, and CO2 emissions into a single model contributed to increase previous model's strength. Secondly, previous studies have mostly examined developed economies, which has left little understanding about the function of sustainable development indicators in Saudi Arabia developing nation (Hickel 2020; Andini and Boer 2025). Thirdly, while prior research has examined direct relationships, it has not given much consideration to the interconnected impacts of sustainable development indicators on human development (Mahmoodi and Dahmardeh Ghaleno 2025; Jie and Lan 2024). Therefore, this study fills the gap by examining how multiple sustainability factors interact to shape human well-being.

Study results hold significant practical implications for policymakers, economists, and sustainability researchers, particularly in Saudi Arabia and other developing economies. By demonstrating the combined effect of sustainable development indicators on human development, this study shows the essential for integrated policy frameworks that create balance in the economic, social and environmental sustainability. Furthermore, the findings emphasized that importance of sustainable human development in Saudi Arabia, mitigate environmental risk and strengthen the foundations of inclusive development. Additionally, the findings enable policy makers to make informed decisions to achieve 2030 vision objective. The second section discussed theoretical and empirical literature. The third section enclosed the research methodology, outlining research design, research approach and data analysis techniques etc. The fourth section discussed data analysis and results. Lastly, the fifth section involves discussion where each finding supported by previous studies.

Literature Review and Hypothesis Development

GDP Per Capita and Human Development Index

Economic growth (EG) provides resources that are crucial for sustained improvements in human development. According to Alkire, Kanagaratnam and Suppa (2021) increase in economic growth (measured by GDP per capita) lead to improvement in the living standards of workforce, contributing to human development index (HDI). Similarly, prior literature indicated that GDP per capita promote better living

standard in countries where governments allocate funds to public welfare projects (Llena-Nozal, Martin and Murtin 2019; Sabir and Qamar 2019; Elshahawany and Elazhary 2024). Moreover, Aminda et al. (2024) reported that GDP per capita raise opportunities of employment and reduce poverty level of a country, thus contribute significantly to the HDI. Correspondingly, Kousar et al. (2023) proved that high GDP per capita enable countries to allocate more funds to healthcare and education sectors, in turn increases educational attainment and life expectancy. Correspondingly, Managi et al. (2024) described that countries must adopt policies that ensure inclusive economic growth to maximize the impact of economic indicators such as GDP per capita on the human development index. In addition, Almutairi (2024) discussed that Saudi Arabia as oil enriched nation face high fluctuations in GDP due to global energy markets influence long-term human development outcomes. In the contrary, some studies argued that economic growth (measured by GDP per capita) alone is not sufficient for human development, as income inequality, social and environmental concerns can limit the equitable distribution of benefits (Henderson and Loreau 2023; Hariram et al. 2023; Androniceanu, Kinnunen and Georgescu 2021). These empirical studies debated that a country's GDP per capita can improve human development, and hence the following hypothesis proposed below,

H_1: *There is significant impact of GDP per Capita on human development index.*

Life expectancy at birth and the Human Development Index

Moreover, despite economic indicators, social indicators also influence the human development index (HDI). Fahmiyah and Ningrum (2023) life expectancy shows that the overall health conditions significantly increase the HDI. Furthermore, UNDP (2022) asserted that as a core component of HDI, higher life expectancy implies better medical facilities, improved nutrition, low mortality rate, promoting improved societal wellbeing. Moreover, several empirical studies suggest that increased life expectancy at birth raises economic productivity by increasing the workforce and improving human capital formation, thus improving HDI outcomes. For instance, Duwal and Paudel (2024) discovered that countries having high life expectancy may experience higher advancement in social progress, driving economic growth and promoting human capital formation. Similarly, Peng et al. (2021) point out that countries with higher life expectancy at birth lead to advanced healthcare sector, improved living standards and stronger economies, foster long life expectancy that ultimately positively affects HDI. In contrary, several researches reported that the impact of life expectancy at birth on human development depends upon numerous factors including economic disparities, environmental sustainability and healthcare disparities (Chen et al. 2021; Zhang and Wu 2022; Jin et al. 2020). In the same vein, Ulici (2020) claimed that healthcare disparities among nations leads to deviation in human development index scores. Consequently, restrict the likelihood of improvement in life expectancy at birth. Additionally, World Bank (2024) declared that effective healthcare policies maximize the benefits derived from higher life expectancy. Regardless of these obstacles, countries those invest more in education, healthcare and social welfare projects succeed in reaching higher HDI ranking. Based on the empirical findings, the hypothesis formulated as follows:

H_2: *There is a significant impact of life expectancy at birth and Human Development Index.*

Expected years of schooling and Human Development Index

Further, expected years of schooling represents education dimension of HDI enhance workforce social mobility, economic opportunities and skills. An empirical study by Widodo et al. (2025) concluded that

there is positive and significant impact of expected years of schooling and HDI. Moreover, UNDP (2022) reported that high expected years of schooling not only associated with high literacy but also enhance productivity of workforce and boost EG. At the same time, Ali, Nasution and Arif (2024) by extending existing body of knowledge empirically proved that high level of literacy improve human development index by reducing poverty and encouraging innovation. Similarly, Hakim (2024) explored that in terms of expected years of schooling impact on HDI there are variations across nation and need to do further research is needed in different contexts. In contrary, disparities persist as in emerging economies where expected years of schooling is at least 3 years fewer than global average, limits human capital growth as per Égert, De la Maisonneuve and Turner (2022). Furthermore, Dominic et al. (2017) examined that the extent to which expected years of schooling impact HDI depends on education quality, gender inequality and accessibility to healthcare. Similarly, World Bank (2024) declared that countries should heavily invest in comprehensive educational policies and high education increases years of schooling influence on sustainable human development. Mutually, these findings affirmed that expected years of schooling contribute significantly to the HDI outcomes, emphasizing the critical role of educational policies and investments in promoting human capital formation and study has following research hypothesis,

H_3: *There is significant impact of expected years of schooling on human development index.*

Mean years of schooling and human development index

Furthermore, a similar trend found with mean year of schooling, another crucial component of HDI that measures an average number of schooling years of countries adults' population aged 25 and older. It actually reflects accumulated education achievement and workforce excellence (Kim and Park 2020). Furthermore, several cross sectional studies of Septiawan, Handajani and Martini (2018) and Herrero, Martínez and Villar (2019) consistently found significant positive association between mean years of schooling (MYS) and HDI, indicating that countries having high MYS tend to exhibit a high level of human development. Moreover, Indrawati and Kuncoro (2021) claimed that human capital investment by means of education strengthens the workforce and promotes productivity. Additionally, Luy et al. (2019) conducted research in the context of Italy, Denmark and USA, proving that improved healthcare, such as low infant mortality rate, tends to increase life expectancy, is mostly observed in populations having high mean years of schooling. Similarly, research conducted by Halisçelik and Soytas (2019) found that high educational achievement, measured by mean years of education, significantly reduces poverty, thus impacting HDI. Additionally, Guijarro-Garvi et al. (2022) further confirmed the relationship by providing empirical evidence that higher mean years of schooling improve the education index, which in turn positively enhances HDI. However, Gutiérrez-Martínez, Saifuddin and Haq (2021) argued that factors such as income inequality and gender stereotypes prevailing across different economies limit the benefits of mean years of schooling on the human development index. Therefore, investigating the role of mean years of schooling in shaping the HDI is crucial, as education is critical not only to enhance human capabilities but also to provide accessibility to better economic opportunities, and the study has research hypothesis,

H_4: *There is a significant impact of mean years of schooling on human development index.*

CO_2 Emissions per Capita and Human Development Index

While considering social factors to realize the benefits of education on the HDI, consideration of

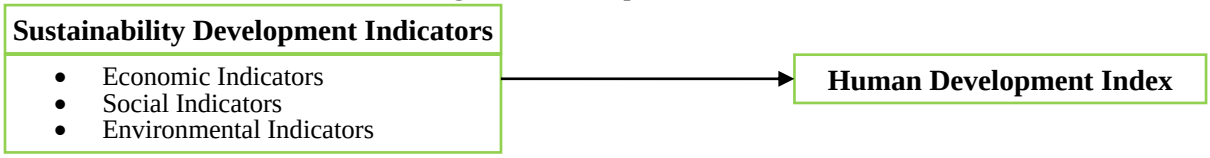
environmental in human development is also crucial. Khosravi et al. (2024) asserted that CO_2 emissions per capita have a significant contribution to the HDI, as industrialization and energy consumption drive social progress and economic growth. Furthermore, Akbar et al. (2021) stated that a high level of CO_2 emission is often associated with increased economic activities, better living standards, and improved infrastructure, leading to an enhanced human development index rating. In the same vein, empirical studies have reported that industrialized countries with high CO_2 emissions management significantly improve HDI (Guo et al. 2024; Hao 2022). Correspondingly, Schröder, Lemille and Desmond (2020) highlighted that most industrialized nations develop job opportunities and promote economic activities, indirectly contributing to human development indicators. Similarly Sun and Wang (2021) emphasized that in the context of resource-rich economies, high CO_2 emission not necessarily promote human development as policy framework and wealth distribution plays a vital role. Therefore, the mixed literature of CO_2 emissions makes it a critical indicator that needs to be addressed in the context of Saudi Arabia, and hence the study has the following hypothesis below,

H5: *There is a significant impact of carbon dioxide emission on Human Development Index.*

Theoretical Framework

The association between sustainable development indicators and human development supported various theories in the extant literature. From those theories, the capability approach shows that development should evaluated not just by economic growth but also by the expansion of people's capacities, which enables them to live happy, healthy, and educated lives. This is also provided an integral foundation through highlighting the significance of expanding people choice after providing better education and economic opportunities (Wang and Chen 2022). In this perspective, funding for improved living conditions, healthcare, and education, GDP per capita (GDPP) promotes human development (Wang and Chen 2022). Individual skills are directly impacted by education indicators like mean years of schooling (MYRS) and expected years of schooling (EXYRS), which promote societal advancement and better well-being (Kuzminov, Sorokin and Froumin 2019). Human development depends on a society's overall health and standard of life, which is further reflected in life expectancy at birth (Aburto et al. 2020). According to Wei, Rahim and Wang (2022), increasing CO_2 emissions, however, threaten sustainable human development by deteriorating public health and environmental quality. Research framework align with capability approach, which emphasizes that economic, social, and environmental issues influence human development and that balanced policies are necessary to guarantee sustainable advancement. In order to examine how sustainable development indicators collectively contribute to human development in Saudi Arabia, this study employs the Capability Approach as underpinning theory. Based on the theory, researchers formulated the research framework below in Figure 1.

Figure 1: Conceptual Framework.



Data and Methodology

Research aimed to experimentally investigate how sustainable development indicators influence human development index (HDI) in the Saudi economy. A quantitative research approach was employed. Over the

years 1990–2020 time series information was gathered from official Saudi sources. Table 1 displays descriptions of the five sustainable development indicators. The Ordinary Least Squares (ARMA) method was employed to quantify the impact of sustainable development factors on the HDI.

The research model equation that the study seeks to evaluate is presented in Equation 1.

HDI=f (model variables) (1)

The model variables and the related SDIs are presented in Table 1.

Table 1: Classification of Sustainability Indicators and Abbreviations (Explanatory Variables).

Sustainable Development Pillars	Main Indicators
Economic Indicators	GDP Per Capita (GDPPt)
Social Indicators	Life expectancy at birth (EXPLt: females and males) Expected years of schooling (EXYRSt) Mean years of schooling (MYRSt)
Environmental Indicators	CO_2 emissions per capita (CO2t)

The Empirical Model

Equation 2 reflects the empirical model to determine of the study as follows:

$$HDI_t = \beta_0 + \beta_1 GDPP_t + \beta_2 EXPL_t + \beta_3 EXYRS_t + \beta_4 MYRS_t + \beta_5 CO2_t + \varepsilon_t \quad (2)$$

Where:

The variable HDIt is the Human Development Index (HDI), and t is the time interval from 1990 to 2020. The constant is represented by β0, while the coefficients of the variables (GDPP, EXPL, EXYS, MYRS, and CO2) are β1 to β5. Lastly, the error term is represented by εt. The independent variables in Table 2 indicate the sustainable development indicators. Equation (3) below describes the architecture of the model once all variables are converted to the natural log:

$$LnHDI_t = \beta_0 + \beta_1 LnGDPP_t + \beta_2 LnEXPL_t + \beta_3 LnEXYRS_t + \beta_4 LnMYRS_t + \beta_5 LnCO2_t + \varepsilon_t \quad (3)$$

During the study period, Saudi Arabia's human development index showed a decreasing marginal return, which was supported by the natural log of all variables.

Results and Discussion

Descriptive Statistics and Correlation Analysis

Firstly, Table 2 represents variables descriptive results. The following variables' values (means) are displayed: mean years of schooling (8.82), GDPP (14087.06), CO2 (13.350), expected years of schooling (14.258), life expectancy at birth (72.71), and HDI (0.780), in that order. The standard deviation quantifies the degree of variability present in a sample's data concerning the mean. The HDI appears to be the least unpredictable variable, having the lowest standard deviation (.0629). The GDP per capita seems to be the variable with the biggest standard deviation (6338.926). Furthermore, according to the descriptive statistics of the chosen variables, the Jarque-Bera test is not significant for any of the variables encompassed in the study, suggesting that all of the chosen are normally distributed.

Table 2: Summary of Descriptive Statistics of All Variables.

	CO2	EXPL	EXYRS	GDPP	HDI	MYRS
Mean	13.35095	72.71787	14.25806	14087.06	0.780355	8.823333
Median	12.92310	73.26900	14.30000	13463.00	0.780000	9.150000
Maximum	17.25779	76.07000	17.10000	23879.00	0.873000	11.30000
Minimum	10.70952	67.72400	10.80000	7169.000	0.688000	6.200000
Std. Dev	.2.090844	2.680102	1.955807	6338.926	0.062964	1.374819
Skewness	0.393655	-0.336993	-0.021621	0.291998	0.057314	-0.251556
Kurtosis	1.738586	1.762301	1.694038	1.446613	1.554027	2.012612
Jarque-Bera	2.855905	2.565451	2.205401	3.557330	2.717639	1.535072
Probability	0.239799	0.277281	0.331973	0.168863	0.256964	0.464155
Sum	413.8795	2254.254	442.0000	436699.0	24.19100	264.7000
Sum Sq. Dev	131.1489	215.4883	114.7555	1.21E+09 0	.118933	054.81367
Observations	31	31	31	31	31	30

Unit Root Test

A unit root test was showed in order to specify the influence of different explanatory variables on human development prior to doing the (ARMA) estimates. If the p-value and the critical value of the test statistic are both less than 0.05 which shown data is stationary. Table 3 displays the outcomes of the unit root test. The ADF test findings indicate that there is no unit root for any of the selected variables. Consequently, the models agree with the independence assumption that forms their basis.

Table 3: Unit Root Tests (ADF constant with Intercept).

Variables	1%	5%	10%	T-statistics	Prob.
HDI	-4.309824	-3.574244	-3.221728	-6.027331	0.0002
GDPP	-4.296729	-3.566379	-3.218382	-5.078247	0.0015
EXPL	-4.296729	-3.568379	-3.218382	-4.617750	0.0000
EXYRS.	-4.309824	-3.574244	-3.221728	-4.293336	0.0104
MYRS.	-4.296729	-3.568379	-3.218382	-7.266456	0.0000
CO_2 PP	-4.309824	-3.574244	-3.221728	-9.223997	0.0000

Selection of Optimal Lags

In the third section in Table, the optimal lag order selection criteria (AIC, SC, LR, and FPE) indicate that lag 1 is the best choice for model estimation, as shown in Table 4. The lowest values for AIC (-29.36747), SC (-27.36917), and FPE (7.57e-21) at lag 1 confirm its superiority. Therefore, the model will be estimated using lag 1 to ensure optimal forecasting accuracy.

Table 4: Optimal Lags Selection.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	299.2772	NA	3.22e-17	-20.94837	-20.66290	-20.86110
1	453.1446	230.8011*	7.57e-21*	-29.36747*	-27.36917*	-28.75657*
2	488.9282	38.33959	1.14e-20	-29.35202	-25.64088	-28.21748 *

Post Estimation Tests

Serial Correlation Test

Reviews offer multiple ways to test for serial correlation to control whether the model's specification

displays an autocorrelation problem. Among the well-known tests is the Breusch-Godfrey LM test. The absence of serial correlation is the null hypothesis. Table 6 demonstrates that the observed R-squared has a fair likelihood of being more than 0.05. According to both statistics, serial correlation is absent from the model. Consequently, this shows that there is no correlations.

Table 6: Serial Correlation Test.

F-statistic	**2.177130**	**Prob. F (2,21)**	**0.1383**
Obs*R-squared	4.980369	Prob. Chi-Square (2)	0.0829

Heteroscedasticity Test

The OLS (ARMA) calculations are trustworthy when disturbances have zero mean, constant variance, and no association. In time series problems, correlations between disturbances are commonly seen. This study also employed the Breusch-Pagan and Koenker tests to determine whether heteroscedasticity, an uneven dispersion of residuals or error components, was present. Table 7 displays R-squared (1.99) probobility, which is more than 0.05 and acceptable. Therefore, the null hypothesis that there is no homoscedasticity is not ruled out. Thus, we may conclude that there is no issue with the heteroscedasticity of the regression model.

Table 7: The Homoscedasticity Test.

F-statistic	**0.340435**	**Prob. F (5,23)**	**0.8830**
Observed*R-squared	1.998328	Prob. Chi-Square (5)	0.8494
SS Scaled explained	2.876748	Prob. Chi-Square (5)	0.7190

OLS (ARMA) Estimates

Fourthly, Table 5 highlights the results of the OLS (ARMA) regression analysis. The p-values and t-ratios show that all other explanatory variables, save GDPP, are significant at the 5% significance level, based on the estimations. GDPP insignificantly influences HDI, which rejects the hypothesis. While life expectancy significantly negatively influences the HDI, which supports hypothesis. In contrast, several years of education have had a significant impact on HDI, which supports the study hypothesis. Additionally, CO2 significantly influences HDI, which supports proposed hypothesis. The overall model results show that R R-squared value is 92 %, which shows the overall model fitness of the model.

Table 5: OLS Estimates.

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob**
LOG (EXPL)	0.270400	-0.067933	-3.980363	0.0005
LOG (EXYRS)	-0.445790	0.135831	-3.281940	0.0030
LOG (GDPP)	0.044679	0.038078	1.173350	0.2517
LOG (MYRS)	0.472899	0.127646	3.704761	0.0011
LOG (CO2)	0.251114	0.091965	2.730531	0.0114
R-squared	0.924596			
Adjusted R-squared	0.912531			

Discussion

The study objective was to test the impact of sustainable development indicators i.e. economic, social and environmental indicators on the human development index in the context of Saudi Arabia. The study

selected OLS (ARMA) model to conduct analysis. OLS (ARMA) finding shows that life expectancy at birth (EXPL) is significantly and positively influence on human development index (HDI) in Saudi Arabia. The findings emphasize that improvement in life expectancy at birth reduces mortality rate, leading to higher HDI, confirming the critical role of public health in promoting human development. Furthermore, it highlights that a healthier population exhibits higher productivity, access to education and improved overall wellbeing, contributing significantly to the national development. The current study finding supported by the opinions of Freeman et al. (2020) and Swargiary (2024) asserted that high life expectancy at birth is highly associated with socioeconomic consequences because investment in healthcare reduces mortality rate. It promotes the development of more productive nations, contributing significantly to gross national income (GNI). Based upon the above discussion, Saudi Arabia should heavily invest in healthcare that reduces mortality rate at birth thus contributing to high standard of living and promoting economic growth.

Likewise, expected years of schooling negatively and significantly influence human development index. The study findings demonstrate that solely relying on expected years of schooling does not certainly contribute to HDI, emphasizing the critical role of educational quality in influencing human development. Furthermore, it emphasizes that inefficiencies in the educational system need to be addressed. Moreover, this finding is important for Saudi Arabia as it suggests that government educational reforms not only focus on years children spend in school but also improve quality as well as the relevance of the provided education. This finding is in line with the views of Gaol et al. (2024) and Sharaienko (2021) concluded that the influence of expected years of schooling on the human development index is mainly determined by education quality and its relevance to the economy. Correspondingly, this finding is also consistent with the view of Montenegro and Shenai (2019), who claimed that expected years of schooling, along with quality education, can contribute to higher productivity and innovation, which are key determinants of EG. Collectively, these empirical findings by ensuring a responsive education system as per the needs of the labor market suggest that Saudi Arabia can build a more skilled and knowledge-intensive workforce and contribute heavily in HDI.

Moreover, the findings further highlight that GDP per capita shows a positive and insignificant influence on HDI. This finding emphasized that despite its positive impact GDP is not a significant contributor human development index. Furthermore, the insignificant finding confirmed that economic growth alone may not be enough to enhance HDI outcomes, and other indicators like education and healthcare are crucial to realize the full potential of economic growth. Although GDP per capita improves gross national income but it does not improve the living standards without better access to education, healthcare and social services. The findings align with the studies of Jansen et al. (2024) and Kalimeris et al. (2020), who claimed that GDP is merely a limited measure of wellbeing, which is never designed to be but economic growth as a whole should be viewed as a mean to accomplish human development goals. Additionally, Mandegar and Olsson (2023) found the same view that the relationship between GDP per capita and HDI is weak and insignificant, indicating that an increase in GDP per capita does not cause significant variations in human development. Based on above discussion, Saudi Arabia should focus and invest on other factors such as social welfare and education along with economic growth for promoting sustained human development.

Further, the finding shows a positive and significant impact of mean years of schooling (MYRS) and human development index (HDI) in Saudi Arabia. The result indicated that education dimension is crucial as high mean years of schooling (MYRS) increases human development index rating. Moreover, it confirmed that education is essential for sustainable economic growth and human development as it encourages the development of knowledge intensive and productive workforce. Therefore, a country can increase human

capital by increasing both the accessibility of education and quality to boost economic growth. This finding is supported by the previous studies of Angrist et al. (2021); Mughal and Baig (2024), which illustrated that a high level of education (measured by mean years of schooling) is closely associated with overall economic and human development. Similarly, the finding is in line with the view of Karimi Alavijeh et al. (2024), who examined that high mean years of schooling play a critical role in empowering individuals, creating job opportunities, and enhancing societal wellbeing, thus significantly contributing to the human development index (HDI). Based upon the discussion, it confirmed that education accessibility, quality not only enhance national development by promoting innovation, social progress, but innovation also yield long-term economic growth, thereby increasing Saudi Arabia's human development.

Additionally, the finding demonstrates the significant positive relationship between CO_2 emissions and the human development index in Saudi Arabia. This finding indicates that a country having higher CO_2 emissions tends to be more industrialized, often associated with an HDI, emphasizing the environmental challenges that come with rapid economic development. Although high carbon dioxide emission is a byproduct of industrialization but it does not necessarily bring sustainable development because environmental degradation challenges the long-term prosperity of a country. This finding is equally important for Saudi Arabia as it emphasizes the importance of a more balanced approach to economic development that simultaneously addresses both sustainability and human development, aligning with the 2030 vision. Yumashev et al. (2020) and Dong et al. (2019) same results demonstrated that in energy-intensive economies, CO_2 emissions and human development index increase simultaneously due to high-energy consumption in areas such as urban development, manufacturing, and transportation. Moreover, the findings are consistent with the opinion of Karimi Alavijeh et al. (2024), who declared that in developing economies, economic growth and industrial expansion lead to increased CO_2 emissions are also associated with improvements in human development indicators. Based upon the above discussion, Saudi Arabia should invest more in green technologies for balancing between economic growth and environmental sustainability, thus allowing it to main economic growth trajectory, assuring both long-term economic prosperity and more healthier sustainable environment.

Implication

The findings from the research constitute a major theoretical contribution to our understanding of the variables affecting the Human Development Index (HDI). By emphasizing the importance of health in human development and demonstrating how a healthier population is crucial to foster economic growth and development, the positive correlation between life expectancy and HDI incorporates to the body of existing literature. Moreover, the negative impact of expected years of schooling contributes to the theory that merely increasing the duration of education without improving its quality may not lead to better development outcomes. The study’s contribution to the theoretical framework is evident in its emphasis on the need for education reforms that align more closely with labor market demands. Furthermore, the insignificant relationship between GDP per capita and HDI contributes to the understanding that economic growth, while important is not the sole driver of human development, highlighting the need for a more holistic approach for education or other social services. Subsequently, the statistically significant association within HDI and CO2 emissions adds to the growing body of research on sustainable development and underscores the critical importance of integrating environmental factors into models of economic growth.

Furthermore, in practical implication perspective, the study gives strong insights that enable policymakers to devise healthcare, education and economic policies to boost economic development of Saudi Arabia. Life

expectancy positively influences human development index highlighting the importance of continuing investment in healthcare and preventive care, which can improve quality of life and productivity. The negative impact of expected years of schooling contributes to the need for a shift in focus from simply increasing schooling years to improving the quality and relevance of education, ensuring that it equips the workforce with the skills required by the evolving economy. The study's findings regarding GDP per capita highlight the need for economic growth that benefits all segments of society, with investments in healthcare, education, and social services being pivotal for improving human development outcomes. Finally, the positive relationship between CO_2 and HDI necessarily contributes to the adoption of sustainable development practices. Thus, urging Saudi Arabia to implement green technologies and develop energy efficient industries to separate economic growth from environmental degradation. These contributions collectively provide more actionable insights to promote a sustainable development that in turn influence human development index.

Conclusion and Future Directions

This study sought to empirically test the impact of a number of sustainable development indicators, namely, "GDP per capita (GDPP), Life Expectancy at Birth (EXPL), Expected Years of Schooling (EXYRS), Mean Years of Schooling (MYRS), and (CO2) emissions" on the human development index of the Saudi economy over the period 1990-2020. The Ordinary Least Squares (OLS) is employed as in econometric analysis. The results revealed that with the exception of GDPP, all four other explanatory variables are significant at 5% significance level. The variable (MYRS) indicates a large and significant contribution to the HDI. While both (EXPL) and (EXYRS) have a negative but significant impact on the HDI. Furthermore, the GDPP, and the (CO2) emissions show a negligible positive insignificant effect on economic growth. Finally, the value of R-squared implies that 92% of the HDI variations can be explained by the variations in the explanatory variables. The study recommends that a general strategic plan is necessary, but specific and integrated policies and strategies are required to improve the levels of the selected sustainable indicators and therefore advance human development in Saudi Arabia. Since those explanatory variables of (sustainable development indicators) have having their significant contribution to human development in the Saudi economy, it becomes vital to devote collective efforts to enhance those sustainable indicators. This can be achieved by designing a separate strategy for sustainable development and another for human development. An integrated sustainable development-human development strategy could be formulated. The research comprises with various limitations. Firstly, the study is limited to a country while ignoring other countries, which limits the study's generalizability. Hence, future study could be explored on other economies to increase the study's generalizability. Moreover, the current study did not add the moderating or mediating variable, which limited the model specification. Therefore, to handle this limitation, future research could add a moderating or mediating variable to increase the research model's strength.

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