ISSN Print: 2394-7500
ISSN Online: 2394-5869
Impact Factor (RJIF): 8.4
IJAR 2024; 10(5): 371-376
www.allresearchjournal.com
Received: 23-04-2024
Accepted: 26-05-2024

Marwati
Research Scholar, Sunrise University, Alwar, Rajasthan, India

Dr. Manju Lata
Professor, Sunrise University, Alwar, Rajasthan, India

Corresponding Author:
Marwati
Research Scholar, Sunrise University, Alwar, Rajasthan, India

Study the relationship between energy consumption and economic growth in India

Marwati and Dr. Manju Lata

Abstract
This study looks at the connection between economic growth and environmental sustainability, with a focus on the potential negative consequences of fast economic expansion on the environment. The relationship between GDP growth and power consumption is investigated using the Granger causality model. Data series of GDP and power consumption were determined to be non-stationary at its level and stationery at 1st difference, according to this research. Integral of order one, or I(1), is applied to both series. Electricity consumption and GDP do not seem to have any long-term connection. Our findings provide important new information for those fighting for sustainable development and reducing the environmental impacts of economic expansion.

Keywords: Economic development, economics, energy, consumption and GDP

Introduction
Powering a nation's economy and playing a pivotal role in its progress, energy is essential. On a global scale, it is acknowledged as a key component of personal and economic development. Of all the booming industries that affect other parts of the economy, the energy sector is the most pervasive and important one. Included in the category of essential infrastructure is this particular sector. There has been a tremendous strain on resources due to the skyrocketing demand for electricity. In order for an economy to function, energy must be readily available. A country's economic growth is correlated with the availability of reliable energy sources. In order to fulfil energy demands, the Indian economy encounters enormous obstacles.

To forecast energy needs, one looks at the historical correlation between GDP growth and total primary energy use. There seems to be a two-way causation between energy consumption and economic growth, as shown by the connection between the two. Production, economic growth, and living standards are all enhanced by increased energy use. There will be an increase in energy usage as a result of all these signals of development. In addition, several sustainability issues, such as global warming, depletion of natural resources, and both internal and external air pollution, are significantly impacted by energy use and production (Ruijven 2008) [16]. Improving a country's efficiency and production via the use of energy has become the primary role of any nation's economic growth. In India, energy consumption has skyrocketed due to widespread industry, increased urbanisation, and a growing population.

Energy consumption and economic growth: a link that economists are very interested in understanding. Since energy is seen as a key component of economic development for any country, studying the correlation between energy consumption and GDP growth has been a popular pursuit (Pokharel 2006) [17]. Even if the exact direction of the connection isn't always obvious, energy consumption and economic development are inextricably linked. Put simply, the relationship between economic development and energy is not quite evident.

Consumption, or the use of energy, is the primary driver of economic expansion. The political ramifications of this causal direction are substantial. Using Granger causality approaches, this empirical research seeks to identify the region of relationship between India's total primary energy consumption and economic development.

Rising energy consumption is a global trend, driven mostly by the world's two most populous emerging nations, India and China. They are among the world's top 10 energy users.

The energy consumption of houses, transportation, farms, and factories is directly correlated to the global population, and the rate of population expansion is significantly impacting this figure. According to the International Energy Agency (2017), emerging nations will account for 70% of the increase in energy demand by 2030, which is a 53% increase.

Literature Review

Munier, Nolberto. (2015) [1]. Briefly analyses the existing dichotomy between these two notions while planning the future of a city. We must use our resources, but we must do so in a way that future generations may enjoy them, as this study argues that these two seemingly conflicting principles can be reconciled.

Anwarya, Winda. (2022) [2]. This study looks at the connection between economic growth and environmental sustainability, with a focus on the potential negative consequences of fast economic expansion on the environment. To examine how environmental protection expenditure moderates the relationship between GDP per capita and carbon emissions per capita, we employed descriptive statistics, trend analysis, correlation analysis, regression analysis, hypothesis testing, sensitivity analysis, and robustness checks on cross-sectional data from a number of nations. Spending on environmental protections mitigates the association between GDP per capita and carbon emissions, according to our findings. These findings highlight the need for nations going through fast economic growth to encourage ecologically sustainable development strategies and increase expenditure on environmental protection. Important new information is provided by our study for anyone striving to promote sustainable development and reduce the environmental costs of economic expansion.

El Chami, Daniel. (2021) [3]. "Sustainable" is a buzzword in every media outlet, but it's also a marketing cliche that may be exploited unethically for "greenwashing" or for profit-driven goals. Because of this misunderstanding, writers often use the terms "sustainable development" and "economic growth" interchangeably, which is counterproductive to efforts to make the world a better place. Sustainable development and economic growth are discussed in this study, along with the ways in which GRI 100-the sustainability report focusing on management, governance, and social disclosures-could promote economic growth. Nevertheless, the report suggests a shift from profit maximisation to optimization as a means to achieve a sustainable model of economic development. The document concludes by urging more study in this area in order to bring about a long-term change in our society.

Paech, Niko. (2013) [5]. A paradigm of prosperity predicated on expansion and reliance on consumption has shown to be inadequate in light of the continuing climate, resource, and financial challenges. The ecological decoupling of monetary-based economic development is not going to happen anytime soon. Because of rising demand, "rebound effects" in a developing economy nullify any gains made in dematerialization or ecologization. Moreover, a significant conclusion from the so-called Science of Happiness is that, at a certain point, more money or material possessions do not add to one's subjective happiness. Now is the moment to assess the situation: Consider postgrowth economics as an alternative to broad "business-as-usual" practices; it has the potential to be sustainable over the long run, but on a smaller scale.

Hirai, Tadashi. (2022) [7]. The evolution of the development discourse is profoundly political. Despite a range of innovations, the situation remains much the same, and has led over time to the dominance of the economic growth model. Whilst academic/ideological vigor, policy relevance and institutional support, together with intellectual independence, are essential; too radical an alternative approach would be dismissed by mainstream opinion, either by design or neglect. To survive and to remain influential, any alternative requires the mainstream to engage with it for political feasibility. The development discourse has thus evolved through a delicate balancing act, acknowledging a need for a cautiously optimistic outlook. By tracing changes in two approaches to development (basic needs and human development) and in two global development goals (millennium development goals and sustainable development goals) through their selection and use of indicators, this article explores both the explicit and the implicit power of the mainstream in the past and present alternatives.

The relationship between total energy consumption and economic growth in India

Finding out whether the data is stationary is the first step in analyzing this aim. The researcher has used the Augmented Dickey Fuller (ADF) test to assess this. The Dickey Fuller test could have an autocorrelation issue. The Augmented Dickey Fuller (ADF) test is a sophisticated tool that Dickey Fuller created to address the problem of autocorrelation. In this part, we try to prove that there is a unit root between total primary energy use and economic growth by analyzing the data. A correlation between India's total primary energy consumption and GDP growth has been the subject of some investigation. The variables cannot be steady or have a unit root; this is a necessary condition for establishing the null hypothesis (Ho). There is no change in the values of the alternative hypothesis variables (H1).

Testing the Stationarity of Variables: Augmented Dickey Fuller (ADF) Test for GDP and Total Primary Energy Consumption

The research employs the Augmented Dickey Fuller (ADF) unit root test to determine whether the variables are stationary before computing the linkages. The stationary status of the variables in time series data and their levels may be confirmed using this test. When it comes to data analysis, the two most suitable tests are the Autoregressive Distributed Lag (ARDL) and the Granger Causality Test. When other variables are accurately predicted, data in one variable is satisfied; in contrast, the Autoregressive Distributed Lag (ARDL) models are time-saving tools for estimating various variables; and the Granger causality test defines the presence of such a relationship. For testing stationary, this test has seen extensive use.

The co-integration test does not care whether the variables are steady; all of them are considered. For time series data, the following tests were utilised: Dickey and Fuller (DF), Augmented Dickey Fuller (ADF), and Phillips and Perron (PP). Utilising the Augmented Dickey Fuller (ADF) unit root test, the researcher has investigated the potential for a

unit root relationship between total primary energy consumption and the rate of economic growth, in order to determine if each variable is stationary. Because all of the variables have unit roots, we may state that this is a unit root null hypothesis.

Economic growth and total primary energy consumption were measured using the ADF. Table 1 below displays the results of the ADF unit root test for GDP and total primary energy consumption.

Table 1: Augmented Dickey Fuller (ADF) Results for GDP and Total Primary Energy Consumption

Variables	Statistics		Critical Value	Statistics		Critical Value
	With Intercept		1 per cent 2 per cent 3 per cent	With Trend and Intercept		1 per cent 2 per cent 3 per cent
	t-Value	p-Value		t-Value	p-Value	
Level form						
GDP	4.5179 (3)	1.000	-3.711457* -2.981038* -2.629906*	1.0667 (3)	.9999	-4.356068 -3.595026 -3.233456
Total	3.919906*** (3)	1.000	-3.711457 -2.981038 -2.629906	2.288124*** (3)	1.000	-4.356068 -3.595026 -3.233456
Difference form						
GDP	4.185105*** (3)	.0019*** *	-3.724070 -2.986225 -2.632604			-4.374307 -3.603202 -3.238054
Total	10.10264*** (3)	.0001*** *	-3.724070 -2.986225* -2.632606*			-4.374307 -3.603202* -3.238054*

***Source*:** Author's estimation considering E-views. On the basis of critical value, ***, **, * represents the refusal of null hypothesis of unit root at 1%, 5% and 10% stages of consequence respectively. Number in the bracket denotes Lag Length.

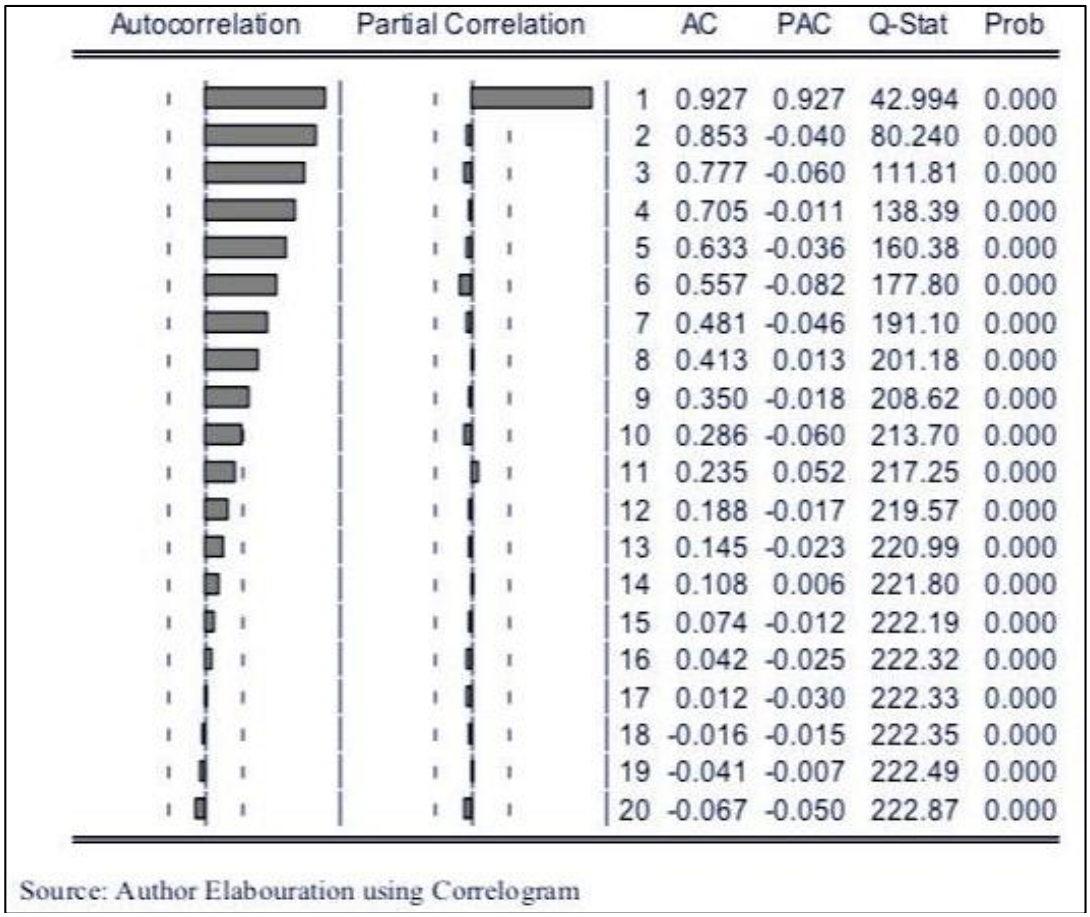
The study's author has used two different models using the Augmented Dickey Fuller (ADF) test statistics. You may think of them as intercept, trend, and intercept. Level and first differenced series have these data. In table 1, we can see the level and difference forms of total primary energy consumption and economic growth, respectively. Total primary energy consumption and gross domestic product (GDP) do not have a unit root, as seen in the table. The absolute values of its t-statistics at level and first difference indicate that it is stationary. To start, at the 1%, 5%, and 10% levels of significance, the t-value of GDP (economic growth) is 4.5179, which is more than the critical value.

The t-value for total primary energy consumption is also statistically significant at the 1%, 5%, and 10% levels of significance, with an intercept of 4.5179. The variables become stationary with an intercept in the difference form, however, and at the 5% level of significance, the p-value for GDP is.0019 and for total primary energy consumption it is.0001. In order to consider the variable stationary, the researcher has drawn the conclusion that the series is either stationary or does not have a unit root at the level and first difference form.

Determining the ideal lag length is the next stage. When the SBC and AIC criteria are applied, the ideal lag duration becomes apparent. Using the SBC and AIC values of the Vector Autoregressive (VAR) model computed for various combinations of lag length, this approach applies the model.

Unit Root Results of Variables + Unit Root Results for Total Primary Energy Consumption and GDP: Using Correlogram

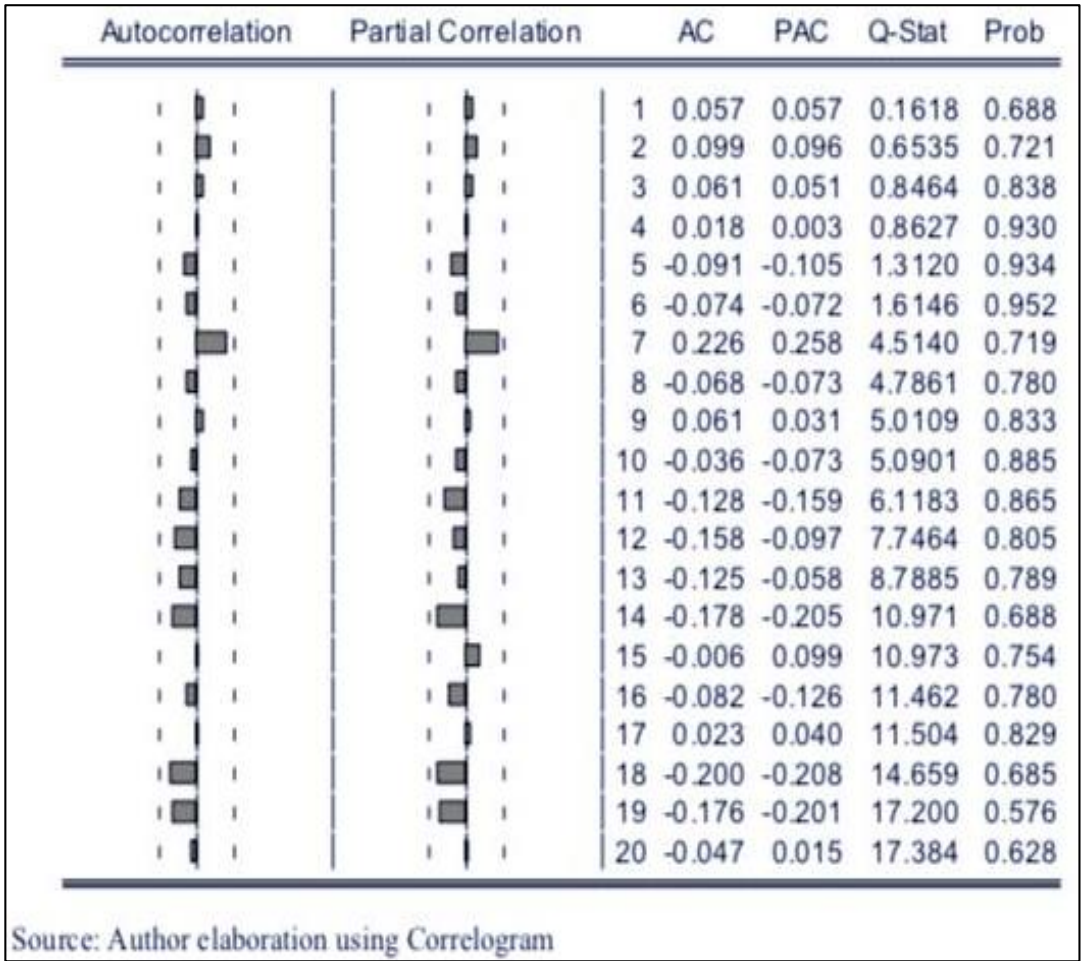
The plot of the Autocorrelation Function (ACF) is called a correlogram. It is a visual representation of a temporal correlation route in data. Both the data range and the sample chosen cover the years 1970-2016. There are a total of 47 observations. Finding out whether GDP data is stationary is the key question. Researchers have a lot of options when it comes to time series models that make use of the stationarity variable. Examples include the Granger causality test, the Vector Error Correction Model, and the Vector Autoregressive (VAR). All of these activities may be accomplished with the help of the Q statistics and the correlogram.



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.927	0.927	42.994	0.000
		2	0.853	-0.040	80.240	0.000
		3	0.777	-0.060	111.81	0.000
		4	0.705	-0.011	138.39	0.000
		5	0.633	-0.036	160.38	0.000
		6	0.557	-0.082	177.80	0.000
		7	0.481	-0.046	191.10	0.000
		8	0.413	0.013	201.18	0.000
		9	0.350	-0.018	208.62	0.000
		10	0.286	-0.060	213.70	0.000
		11	0.235	0.052	217.25	0.000
		12	0.188	-0.017	219.57	0.000
		13	0.145	-0.023	220.99	0.000
		14	0.108	0.006	221.80	0.000
		15	0.074	-0.012	222.19	0.000
		16	0.042	-0.025	222.32	0.000
		17	0.012	-0.030	222.33	0.000
		18	-0.016	-0.015	222.35	0.000
		19	-0.041	-0.007	222.49	0.000
		20	-0.067	-0.050	222.87	0.000

Source: Author Elabouration using Correlogram

Fig 1: GDP at level: using correlogram



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.057	0.057	0.1618	0.688
		2	0.099	0.096	0.6535	0.721
		3	0.061	0.051	0.8464	0.838
		4	0.018	0.003	0.8627	0.930
		5	-0.091	-0.105	1.3120	0.934
		6	-0.074	-0.072	1.6146	0.952
		7	0.226	0.258	4.5140	0.719
		8	-0.068	-0.073	4.7861	0.780
		9	0.061	0.031	5.0109	0.833
		10	-0.036	-0.073	5.0901	0.885
		11	-0.128	-0.159	6.1183	0.865
		12	-0.158	-0.097	7.7464	0.805
		13	-0.125	-0.058	8.7885	0.789
		14	-0.178	-0.205	10.971	0.688
		15	-0.006	0.099	10.973	0.754
		16	-0.082	-0.126	11.462	0.780
		17	0.023	0.040	11.504	0.829
		18	-0.200	-0.208	14.659	0.685
		19	-0.176	-0.201	17.200	0.576
		20	-0.047	0.015	17.384	0.628

Source: Author elaboration using Correlogram

Fig 2: GDP at first difference: using correlogram

Outcomes of Correlogram for GDP: At Level Form

A range of 1-20 delays have been chosen by the researcher. There is some autocorrelation, as shown by the relatively high Automatic Coefficient (AC). It is dwindling downhill slowly. Since this drops out over time, it's safe to assume that the data is not static. Not only that, but the Q-Statistics values are really high, well over zero. Therefore, GDP statistics do not remain static. However, p-values may still be used for verification by the researcher. Since all of the p-values are zero, the researcher is unable to rule out the possibility of null hypotheses. Thus, the variable is not considered to be stationary. The researcher used p-values and Q-statistics to confirm. Making a stationary variable is the subject at hand. The researcher has so made advantage of the initial distinction.

Outcomes of Correlogram for GDP: At First Difference Form

Thus, the number of delays did not vary for the first distinction. At this point, the correlogram looks entirely different. The Automatic Coefficient (AC) functions shrink in size in comparison to the level's form. Following the first disparity, the variable has attained stationary status. Due to the fact that almost no association exists anymore as all values have shrunk to very tiny levels. According to Q-statistics, the variable is now the primary determinant of GDP data. Compared to the level form, the p-values and accompanying probabilities for all twenty lags have become much larger. That is, 0.688 for the first delay and 0.721 for the subsequent one. Since the p-values are more than the 5% significance threshold, the null hypothesis was rejected and the alternative hypothesis was accepted by the researcher. The variable is stationary at its initial point of difference. To make the variables stationary, the researcher used first difference.

Examine the relationship between total energy consumption and economic growth In India

One method for predicting which variables in a time series will have a causal relationship is Granger Causality. The link between causes and effects is explained. If two series can be predicted using the data of one other, then we have Granger causality. We claim that one series does Granger cause another if we can anticipate one series using the lag values of another series.

The ever-changing energy industry has zeroed in on energy security as a means to stimulate economic expansion. It is important to highlight one outstanding aspect of India's energy security in this context. It has to do with the country's present energy security and its ability to sustainably expand economically. Accordingly, the following table displays the Granger causality test-derived link between GDP growth and total primary energy consumption.

Table 2: Causality between Energy Consumption and Economic Growth: Using Vector Autoregressive (var) Granger Causality/ Block Exogeneity Wald Tests

Dependent variable: D(TOTAL)			
Excluded	Chi-sq	Df	Prob.
D(GDP)	7.848001	3	0.0493**
All	7.848001	3	0.0493**
Dependent variable: D(GDP)			
Excluded	Chi-sq	Df	Prob.
D(TOTAL)	3.930494	3	0.2691
All	3.930494	3	0.2691

***Source*:** Author's Calculations

The effects of energy components on economic growth and economic growth on energy components

The Augmented Dickey Fuller (ADF) tests reveal that all of the variables are either zero-order integrated or stationary at first difference form. At the 1% level of significance, the F-statistic value (61.59788>6.02) is larger than the I (1) limit, so the null hypothesis about coal consumption is rejected according to the ARDL Bounds test findings. Because the F-statistic value (11.29547 > 6.02) is larger than the I(1) limit, even at the 1% level of significance, the null hypothesis is likewise rejected for petrol consumption. Therefore, the presence of long-run co-integration between coal and gas use was clarified using the Autoregressive Distributed Lag (ARDL) limits test. At the 10%, 5%, 2.5%, and 1% levels of significance, the F-statistic values were smaller than the I (0) and I (1) limits, hence the null hypothesis about oil consumption is not rejected. Thus, just the variables of oil consumption and GDP growth were subjected to the Granger Causality Test. Cooperation in the near term is shown via Granger causality. In table 3, you can see the results of the Granger Causality Test for oil use.

Table 3: Causality between Oil Consumption and Economic Growth: Using Vector Autoregressive (VAR) Granger Causality/ Block Exogeneity Wald Tests

VAR·Granger Causality/Block Exogeneity Wald Tests			
Dependent variable OIL			
Excluded	Chi-sq	df	Prob.
D(GDP)	.554696	2	.7578
All	.554696	2	.7578
Dependent variable: D(GDP)			
Excluded	Chi-sq	df	Prob.
D(OIL)	.372433	2	.8301
All	.372433	2	.8301

***Source*:** Author's calculations

Conclusion

Results for economic growth, unit root, co-integration, and Granger causality for energy components (coal, crude oil, and natural gas) and total primary energy consumption in this research, we looked at India to see how various types of energy affect GDP growth and how total primary energy consumption relates to GDP growth. From 1970-1971/22

until 2015-2016, time series data were gathered. Linear regression, the Augmented Dickey Fuller (ADF) test, the Granger Causality Test, and the co-integration test of the Vector Autoregressive (VAR) were some of the empirical models used to determine the connection. Total primary energy consumption is an important metric for measuring economic growth and development over the long term. We used the long-term version of Autoregressive Distributed Lag (ARDL) co-integration for our long-term analysis. Economic growth and total primary energy consumption are both in long term equilibrium, according to the researcher's findings.

References

1. Munier N. Economic growth vs. sustainable development; c2015.
2. Anwarya W. Exploring the Relationship between Economic Growth and Environmental Sustainability. Journal of Management and Administration Provision. 2022;2:26-36. DOI: 10.55885/jmap.v2i2.184.
3. El chami D. Sustainable Development and Economic Growth: A Reality or an Oxymoron? European Scientific Journal; c2021, 17(1). DOI: 10.19044/esj.2021.v17n41p1.
4. Dai L, Jia R, Wang X. Relationship between Economic Growth and Energy Consumption from the Perspective of Sustainable Development. Journal of Environmental and Public Health. 2022;2022:1-10. DOI: 10.1155/2022/6884273.
5. Paech N. Economic Growth and Sustainable Development. In: 10.1007/978-94-007-5712-7_3; c2013.
6. Meyer D, Masehla TM, Kot S. The relationship between economic growth and economic development: A regional assessment in South Africa. Journal of Advanced Research in Law and Economics. 2017;8:1377-1385. DOI: 10.14505/jarle.v8.4(26).38.
7. Hirai T. A balancing act between economic growth and sustainable development: Historical trajectory through the lens of development indicators. Sustainable Development. 2022;30. DOI: 10.1002/sd.2357.
8. Singh H, Singh A, Alam M, Agrawal V. Impact of Sustainable Development Goals on Economic Growth in Saudi Arabia: Role of Education and Training. Sustainability. 2022;14:1-26. DOI: 10.3390/su142114119.
9. Lal BS. Sustainable Tourism and Economic Growth in India - An Analysis. Journal of World Economy. 2024;3:34-42. DOI: 10.56397/JWE.2024.03.05.
10. Al-Taai S. Green economy and sustainable development. IOP Conference Series: Earth and Environmental Science. 2021;779:012007. DOI: 10.1088/1755-1315/779/1/012007.
11. Akhter Ali M, Kamraju M, Sonaji D. Economic Policies for Sustainable Development: Balancing Growth, Social Equity, and Environmental Protection. 03. 23-28.
12. Brad S, Mocan B, Brad E, Fulea M. Environmentally Sustainable Economic Growth. Amfiteatru Economic. 2016;18:446-460.
13. Bali Swain R. A Critical Analysis of the Sustainable Development Goals. In: 10.1007/978-3-319-63007-6_20; c2017.
14. Rout P, Verma A, Bhunia P, Surampalli R, Tyagi RD, Brar SK, *et al*. Introduction to Sustainability and Sustainable Development. In; c2020. DOI:10.1002/9781119434016.ch1
15. Lele S. Sustainable Development: A Critical Review. World Development. 1991;19:607-621. DOI: 10.1016/0305-750X(91)90197-P.
16. Van Ruijven B, Urban F, Benders RM, Moll HC, Van Der Sluijs JP, De Vries B, *et al*. Modeling energy and development: an evaluation of models and concepts. World Development. 2008 Dec 1;36(12):2801-21.
17. Pokharel S, Kulczycki A, Shakya S. School-based sex education in Western Nepal: uncomfortable for both teachers and students. Reproductive health matters. 2006 Jan 1;14(28):156-61.