

THE INFLUENCE OF HUMAN CAPITAL AND ECONOMIC GROWTH ON CARBON EMISSIONS AND RENEWABLE ENERGY UTILIZATION IN INDONESIA

Meinarti Puspaningtyas, Muhammad Nur Sholeh Juniawan

STIE Jaya Negara Tamansiswa Malang

ABSTRACT

This study attempts to examine the relationship between human capital, economic growth, the impact of carbon emissions, and the adoption of renewable energy in Indonesia. The research data is taken from secondary data from the World Bank covering the period from 2004 to 2020. The variables analyzed include Health, GDP Growth, Carbon Emissions, and Renewable Energy, using vector autoregressive analysis to obtain an overview of the impact of carbon emissions and renewable energy utilization. The results show that there is a negative correlation between health and carbon emissions, which indicates that increasing human capital through better health has the potential to increase carbon emissions. Improved human health usually implies increased economic productivity and technological infrastructure, which ultimately increases the use of energy resources and the potential for increasing carbon emissions. On the other hand, increased economic growth provides an impetus for more efficient and environmentally friendly technologies. As the economy grows, more resources and investment are available to develop renewable energy, which can reduce dependence on fossil fuels that significantly contribute to increasing carbon emissions in Indonesia. Therefore, policymakers are considering sustainable development techniques to reduce carbon emissions while promoting economic growth and human resource development.

Keywords : Health, GDP Growth, Carbon Emissions, Renewable Energy.

INTRODUCTION

The combined skills, knowledge, and abilities of a society are known as human capital, and they are widely recognized as key contributors to economic progress (Abbas et al., 2024). When countries invest in education, health, and workforce development, they increase the productivity and innovation capacity of their citizens. Such investments not only benefit individuals by providing them with better skills and knowledge, but also benefit the country as a whole by creating a more competent and efficient workforce (Oliinyk et al., 2021). The drive for economic expansion often results in increased carbon emissions, which exacerbate environmental degradation and climate change. Large volumes of carbon emissions are generated by intensive economic activities, such as infrastructure development, industrial output, and the use of fossil fuels, which damage the atmosphere and impact the global climate system (Raihan et al., 2022). These negative impacts create significant challenges for environmental sustainability and the quality of human life in the future. Countries need to adopt development strategies that focus not only on increasing income and production but also consider the environmental impacts of their economic activities (Zhang et al., 2022).

The adoption of renewable energy, clean technologies, and policies that promote energy efficiency are essential steps to achieve this balance (Hoang & Nguyen, 2021). Countries can reduce their dependence on carbon-rich fossil fuels and their carbon

footprint by encouraging the use of renewable energy sources such as wind and solar (Usman & Radulascu, 2022). Furthermore, promoting environmentally friendly behavior and fostering a culture of sustainability also relies heavily on public education and environmental awareness (Uralovich et al., 2023). Inclusive and ecologically responsible economic growth will be strongly reinforced through investments in sustainable human capital. Countries can build a brighter future through the advancement of sustainable practices and knowledge (Hajian & Kashani, 2021).

Investing in human capital is crucial for creating a competent and highly competitive workforce (Adriani & Yustini, 2021). Quality education and training not only enhance individual skills but also foster innovation and creativity that can generate new solutions to economic and social challenges (Abulibdeh, Zaidan, & Abulibdeh, 2024). Furthermore, good health enables individuals to contribute maximally to economic activities and increases overall productivity. In this context, quality education includes access to up-to-date information, technology, and skills development relevant to industry and labor market needs (Li, 2022). Effective training also plays a crucial role in honing practical skills and preparing individuals to face the challenges of an evolving workforce. Investing in human capital also involves attention to public health. Comprehensive health programs, including access to affordable and quality healthcare, good nutrition, and a safe work environment, are crucial for improving workforce well-being and productivity (Wu et al., 2021).

Investments in education and training can stimulate creativity and innovation, which can lead to new solutions to a variety of challenging social and economic problems (Schröer, 2021). The creation of new technologies has the potential to lower costs, increase manufacturing efficiency, and create jobs. Furthermore, innovative social solutions, such as community empowerment programs and entrepreneurship initiatives, can help reduce economic disparities and improve community well-being (Abiddin, Ibrahim, Abdul Aziz, 2022). Investing in human capital is a holistic and long-term strategy for achieving sustainable and inclusive economic growth. Improving individual knowledge and health helps countries create a workforce that is adaptive, innovative, and competitive in the global market. Therefore, collaboration between the public and private sectors, as well as educational institutions, is crucial in fostering an environment that encourages the growth of superior human capital (Indrawati & Kuncoro, 2021).

Rapid economic growth is often accompanied by negative consequences, such as increased carbon emissions (Yang, Hao, & Feng, 2021). Industrial activity, transportation, and large-scale infrastructure development can generate significant amounts of carbon emissions (Acheampong et al., 2022). The combustion of fossil fuels such as coal, oil, and natural gas releases carbon emissions into the atmosphere, which trap heat and contribute to climate change and global warming. This process also worsens air quality, which can cause major human health problems, including heart and respiratory problems (Kumar et al., 2023). Furthermore, increased carbon emissions due to climate change can alter global weather patterns, resulting in more frequent and severe extreme weather events, including floods, droughts, and storms (Abbas et al., 2022). These changes can damage ecosystems, threaten biodiversity, and disrupt human life (Muluneh, 2021).

This phenomenon poses significant challenges to environmental sustainability and requires effective strategies to mitigate its negative impacts. Efforts to reduce carbon emissions can be implemented in various ways, such as increasing energy efficiency, using renewable energy, and implementing clean technologies (Habiba, Xinbang, &

Anwar, 2022). Countries need to collaborate in developing and implementing stringent environmental policies and promoting technological innovation to reduce carbon footprints (Wang et al., 2022). Countries need to implement environmentally friendly practices in every aspect of economic development (Sadiq et al., 2022). This also includes the use of renewable energy, energy efficiency, and clean technologies that can reduce carbon emissions without sacrificing economic growth. Thus, investment in human capital and the implementation of sustainable practices can go hand in hand to achieve inclusive and environmentally friendly economic prosperity (Du et al., 2022). Renewable energy has emerged as a crucial component of this balance. Renewable energy sources, such as solar, wind, and hydroelectric power, offer the potential to reduce carbon emissions while supporting sustainable economic growth (Raihan et al., 2022). As countries shift to renewable energy, they can reduce the environmental impact of their development and create new opportunities for economic progress (Mohsin et al., 2021).

The renewable energy industry has created numerous new jobs, from technology research and development to the installation and maintenance of renewable energy systems (Strielkowski et al., 2021). Innovation in renewable energy technology drives intensive research, resulting in numerous discoveries and improvements that increase the efficiency and effectiveness of renewable energy sources (Zhu et al., 2021). Engineers, scientists, and technicians collaborate to design and develop more advanced and sustainable energy solutions. Furthermore, the installation and maintenance of renewable energy infrastructure requires a skilled workforce, creating numerous new job opportunities in the construction and technical services sectors (Ram et al., 2022). Investment in renewable energy infrastructure also drives the growth of related sectors, such as manufacturing, construction, and services. The manufacturing industry benefits from the production of renewable energy equipment such as solar panels, wind turbines, and energy storage batteries (Usman et al., 2024). The development and installation of this infrastructure also stimulates demand in the construction sector, creating jobs for construction workers, architects, and civil engineers. Furthermore, related service sectors, such as energy consulting, project planning, and system maintenance, are also growing along with the increasing adoption of renewable energy. Beyond its economic benefits, renewable energy also contributes to energy security. By reducing dependence on fossil fuel imports, countries can increase their energy independence and mitigate the risk of global energy price fluctuations (Berdysheva & Ikonnikova, 2021).

Dependence on fossil fuels often makes countries vulnerable to energy price volatility in international markets and political instability in oil-producing countries (Dalheimer, Herwartz, & Lange, 2021). The transition to renewable energy is a crucial step towards sustainable development (Potrč et al., 2021). By utilizing clean and abundant natural resources, countries can reduce carbon emissions, protect the environment, and create new economic opportunities. Furthermore, renewable energy also helps conserve non-renewable natural resources and mitigates the negative impacts of overexploitation (Xiong et al., 2023). Thus, the transition to renewable energy not only contributes to environmental protection but also supports sustainable economic growth. Therefore, it is crucial for the government, the private sector, and the community to continue supporting and accelerating the adoption of renewable energy as part of their development strategies (Aleluia et al., 2022). This study aims to analyze the relationship between human capital, economic growth, the impact of carbon emissions, and renewable energy utilization in Indonesia.

Research methods

This study will attempt to examine and analyze the relationship between human capital, economic growth, the impact of carbon emissions, and renewable energy utilization in Indonesia. The data for this study are secondary data from the World Bank covering the period 2004 to 2020. The variables used are health, GDP growth, carbon emissions, and renewable energy. Autoregressive vector analysis is used to obtain an overview of the impact of carbon emissions and renewable energy utilization. Systematically as follows:

$$\begin{aligned}
 HLT_t &= b_0 + b_1GDP_t + \beta_2EMC_t + b_3RNE_t + \text{and}_t && \text{intellect 1} \\
 GDP_t &= b_0 + b_1EMC_t + b_2RNE_t + b_3HLT_t + e_t && \text{intellect 2} \\
 EMC_t &= b_0 + b_1RNE_t + b_2HLT_t + b_3GDP_t + e_t && \text{intellect 3} \\
 RNE_t &= b_0 + b_1HLT_t + b_2GDP_t + b_3EMC_t + \text{and}_t && \text{intellect 4}
 \end{aligned}$$

Information:

- HLT = Health
- GDP = GDP per capita
- EMC = CO2 emissions
- RNE = Renewable Energy
- b = the magnitude of the causal influence
- and = Error term

The Vector Error Correction Model (VECM) is a subset of VAR, a statistical analysis technique that models dynamic relationships between variables over time. Stationarity testing is necessary to ensure that the data is free from trends or seasonal patterns that could affect the analysis results, using the Augmented Dickey-Fuller (ADF) test. Optimal lags are determined using information criteria such as the Akaike Information Criterion (AIC) or the Schwarz Bayesian Criterion (SBC). Once the optimal lags are determined, the VAR model can be estimated by incorporating the lags of the analyzed variables, and then the VECM is applied for further analysis. The Granger causality test is used to determine whether one variable can predict another. Impulse Response Function (IRF) analysis shows how changes in one variable affect other variables in the short and long term. Finally, Variance Decomposition (VD) analyzes the proportion of variability in each variable explained by shocks to other variables, providing in-depth insight into the dynamic relationships among the analyzed variables.

$$H_0: \alpha=0$$

$$H_1: \alpha \neq 0$$

Results and Discussion

In vector testing, the first test performed in data preparation for stationarity at the same level is the stationarity test via ADF, as explained in Table 2.

Table 2. ADF Stationary Testing

Variables	Unit Root	Statistics for the Augmented Dickey Fuller	Probability	Description
Health (HLT)	Level	-0.999777	0.7197	No Stationary
	First Different	-4.383495	0.0057	Stationary
GDP growth	Level	-0.014290	0.9437	No Stationary
	First Different	-4.303187	0.0003	Stationary

CO2 Emissions (EMC)	Level	-1.535944	0.4904	No Stationary
	First Different	-4.014129	0.0098	Stationary
Renewable Energy (RNE)	Level	-0.335476	0.8990	Stationary
	First Different	-3.131005	0.0473	Stationary

The results of the stationarity test using the ADF model, as shown in Table 2, indicate that the research variables are at the same level. Next, the lag criteria were measured based on Table 3.

Table 3. Lag Length Criteria (Optimum Lag)

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-20.92660	THAT	0.000265	3.115826	3.308973	3.125716
1	23.29560	60.80552*	8.49e-06*	-0.411949*	0.553786*	-0.362496*

The optimum lag indicated by the Lag Length Criteria model in Table 3 is one lag, so the lag used in this study is one lag. The cointegration test is intended to confirm the use of the analysis model described in Table 4.

Table 4. Cointegration Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.962722	80.34838	47.85613	0.0000
At most 1 *	0.673962	31.00793	29.79707	0.0361
At most 2	0.526637	14.19680	15.49471	0.0777
At most 3	0.180090	2.978406	3.841466	0.0844

Table 4 describes the results of the cointegration test, which indicates the presence of cointegration, thus allowing for testing the VECM model. The results of the VECM test are explained in Table 5 as follows.

Table 5. VECM Test

	D(HLT)	D(GDP)	D(EMC)	D(RNE)
D(HLT(-1))	0.120860	2.454875	0.062095	-9.194557
	(0.70086)	(7.40437)	(0.02347)	(5.22426)
	[0.17245]	[0.33154]	[2.64535]	[-1.75997]
D(GDP(-1))	-0.055138	-0.231276	-0.009921	2.125488
	(0.15282)	(1.61445)	(0.00512)	(1.13910)
	[-0.36081]	[-0.14325]	[-1.93847]	[1.86594]
D(EMC(-1))	-4.324087	-46.22494	0.286615	-127.8462
	(9.96990)	(105.329)	(0.33391)	(74.3164)
	[-0.43371]	[-0.43886]	[0.85836]	[-1.72030]
D(RNE(-1))	-0.049363	-0.191410	-0.001452	-0.097796
	(0.06015)	(0.63548)	(0.00201)	(0.44838)
	[-0.82063]	[-0.30120]	[-0.72051]	[-0.21811]

C	-0.031185	-1.056035	-0.007202	-1.368711
	(0.13540)	(1.43044)	(0.00453)	(1.00927)
	[-0.23032]	[-0.73826]	[-1.58822]	[-1.35614]

The results of the VECM test are explained in Table 5, interestingly, where human capital has a significant correlation with carbon emissions. Based on the results above, health (HLT) has a significant positive effect on carbon emissions (EMC) with a t-statistic value of [2.64535] against the influence coefficient value (0.02347). This explains that increasing human capital through health has the potential to increase carbon emissions. Improving human health will certainly increase economic productivity, thereby increasing the use of energy resources, which has the potential to increase carbon emissions. In addition, economic productivity is also characterized by an increase in health-supporting infrastructure, which will certainly increase the consumption of technology and resources, thereby significantly increasing carbon emissions (EMC).

Economic growth (GDP) has a negative effect on carbon emissions (EMC), as evidenced by the t-statistic value [-1.93847] compared to the coefficient value (0.00512). This result explains that economic growth will reduce carbon emissions. In addition, economic growth (GDP) also has a significant positive effect on the utilization of renewable resources (NR) with a t-statistic value of [1.86594] which affects the coefficient value (1.13910). This explains that along with increasing economic growth, the utilization of renewable resources will also increase. Increased economic growth will provide an impetus for environmentally friendly and efficient resource technologies. In addition, when the economy grows, resources and investment will be available to develop renewable resources. This will reduce dependence on fuels that contribute significantly to increasing carbon emissions in Indonesia. These results support the research hypothesis..

Table 6. Granger Causality Test

Null Hypothesis :	Obs	F-statistic	Prob
GDP does not Granger Cause HLT	15	0.98909	0.4056
HLT does not Granger Cause GDP		0.29242	0.7526
EMC does not Granger Cause HLT	15	0.84579	0.4578
HLT does not Granger Cause EMC		3.77806	0.0600
RNE does not Granger Cause HLT	15	4.26148	0.0459
HLT does not Granger Cause RNE		0.09657	0.9088
EMC does not Granger Cause GDP	15	0.30864	0.7412
GDP does not Granger Cause EMC		0.98680	0.4063
RNE does not Granger Cause GDP	15	2.35839	0.1449
GDP does not Granger Cause RNE		0.08718	0.9172
RNE does not Granger Cause EMC	15	3.04453	0.0928
EMC does not Granger Cause RNE		4.59750	0.0384

The Granger test results in Table 6 indicate that there is only a one-way reciprocal relationship between renewable resources (RNE) and carbon emissions (EMC) with a probability value of 0.0384. To strengthen the relationship between variables in each period, it can be measured using the impulse response as explained in Figure 1.

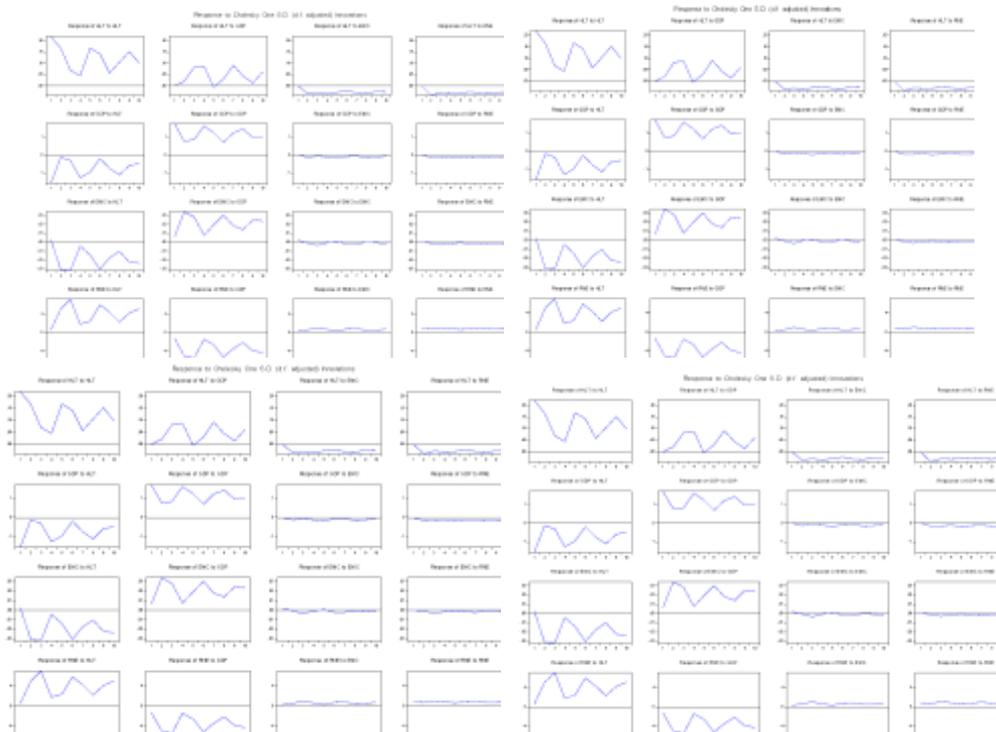


Figure 1. Impulse Response

Figure 1 above illustrates the changes in the response of the relationship between variables when a shock occurs to one of the variables. The Impulse Response graph shows that the response of the health variable (HLT) to the economic growth variable (GDP) fluctuates, with an increase occurring between the first and third periods. There is a fairly extreme decline in the fifth period, and then increases again in the following period. The response of the carbon emission variable (EMC) to economic growth (GDP) shows a significant increase in the second period and a decrease in the following period. This increase begins in the fifth period and fluctuates until the tenth period. The response of the renewable energy variable (RNE) to the health variable (HLT) is similar to the response of the previous variables, where there is a significant increase until the third period, followed by a decrease until the fifth period, and fluctuates until the tenth period. The response of the renewable energy variable (RNE) to the carbon emission variable (EMC) is stable until the tenth period.

Table 7. Uji Variance Decomposition

Period	S.E.	HLT	GDP	EMC	RNE
1	1.639537	11.90837	57.52816	4.960910	25.60256
2	7.365411	48.24299	48.67928	0.838760	2.238964
3	11.68632	55.74351	41.46475	1.152596	1.639144
4	11.95177	55.51506	41.01099	1.397739	2.076214
5	12.49496	54.65185	41.79721	1.366510	2.184428
6	14.81750	54.93528	41.98020	1.225771	1.858744
7	15.88131	55.34820	41.32208	1.359934	1.969780
8	16.20497	55.11725	41.34868	1.413332	2.120735
9	17.20727	54.84800	41.72589	1.359702	2.066403
10	18.47447	55.09104	41.52598	1.364847	2.018132

Table 7 above explains the relationship and contribution of the research variables in explaining their respective variability through the Variance Decomposition test. In the first period, the renewable energy (RNE) variable explained 25.6% of its variability, which decreased by 2.01% in the tenth period. The economic growth (GDP) variable contributed 57.52% in explaining the variability of the renewable energy (RNE) variable in the first period, which decreased by 41.52% in the tenth period. The health (HLT) variable contributed 11.9% in explaining the variability of the renewable energy (RNE) variable and increased to 55.09% in the tenth period. The carbon emission (EMC) variable contributed 4.96% in explaining the variability of renewable energy in the first period and decreased to 1.36% in the tenth period. This explains that the renewable energy (RNE) variable is important in explaining its own variability, although the percentage decreases in each period. Other variables, such as health and economic growth, contribute to explaining the variability of renewable energy with a significant percentage contribution.

Conclusion

Based on the research results, it can be concluded that human capital through health, economic growth, carbon emissions, and renewable energy are interrelated. Health has a negative correlation with carbon emissions. This explains that increasing human capital through health has the potential to increase carbon emissions. Improved human health will certainly increase economic productivity and technological infrastructure, thereby increasing the use of energy resources, which has the potential to increase carbon emissions. On the other hand, increased economic growth will provide an impetus for environmentally friendly and efficient resource technologies. As the economy grows, resources and investment will be available to develop renewable resources. This will reduce dependence on fossil fuels, which contribute significantly to increasing carbon emissions in Indonesia.

This research is expected to provide scientific insights into the relationship between human capital and health, economic growth, carbon emissions, and renewable energy. The limitations of this study are expected to enable more complex analytical exploration in future research, resulting in more comprehensive results. Thus, this study provides new insights into the relationships between variables and offers a strong foundation for decision-making.

Reference

- Abbas, A., Ekowati, D., Suhariadi, F., & Anwar, A. (2024). Human capital creation: a collective psychological, social, organizational and religious perspective. *Journal of Religion and Health*, 63(3), 2168-2200.
- Abbass, K., Qasim, M. Z., Song, H., Murshed, M., Mahmood, H., & Younis, I. (2022). A review of the global climate change impacts, adaptation, and sustainable mitigation measures. *Environmental Science and Pollution Research*, 29(28), 42539-42559.
- Abiddin, N. Z., Ibrahim, I., & Abdul Aziz, S. A. (2022). Non-governmental organisations (NGOs) and their part towards sustainable community development. *Sustainability*, 14(8), 4386.
- Abulibdeh, A., Zaidan, E., & Abulibdeh, R. (2024). Navigating the confluence of artificial intelligence and education for sustainable development in the era of

- industry 4.0: Challenges, opportunities, and ethical dimensions. *Journal of Cleaner Production*, 140527.
- Acheampong, A. O., Dzator, J., Dzator, M., & Salim, R. (2022). Unveiling the effect of transport infrastructure and technological innovation on economic growth, energy consumption and CO2 emissions. *Technological Forecasting and Social Change*, 182, 121843.
- Adriani, D., & Yustini, T. (2021). Anticipating the demographic bonus from the perspective of human capital in Indonesia. *International Journal of Research in Business and Social Science* (2147-4478), 10(6), 141-152.
- Aleluia, J., Tharakan, P., Chikkatur, A. P., Shrimali, G., & Chen, X. (2022). Accelerating a clean energy transition in Southeast Asia: Role of governments and public policy. *Renewable and Sustainable Energy Reviews*, 159, 112226.
- Berdysheva, S., & Ikonnikova, S. (2021). The energy transition and shifts in fossil fuel use: the study of international energy trade and energy security dynamics. *Energies*, 14(17), 5396.
- Du, Q., Wu, N., Zhang, F., Lei, Y., & Saeed, A. (2022). Impact of financial inclusion and human capital on environmental quality: evidence from emerging economies. *Environmental Science and Pollution Research*, 29(22), 33033-33045.
- Habiba, U. M. M. E., Xinbang, C., & Anwar, A. (2022). Do green technology innovations, financial development, and renewable energy use help to curb carbon emissions?. *Renewable Energy*, 193, 1082-1093.
- Hajian, M., & Kashani, S. J. (2021). Evolution of the concept of sustainability. From Brundtland Report to sustainable development goals. In *Sustainable resource management* (pp. 1-24). Elsevier.
- Hoang, A. T., & Nguyen, X. P. (2021). Integrating renewable sources into energy system for smart city as a sagacious strategy towards clean and sustainable process. *Journal of Cleaner Production*, 305, 127161.
- Kumar, P., Singh, A. B., Arora, T., Singh, S., & Singh, R. (2023). Critical review on emerging health effects associated with the indoor air quality and its sustainable management. *Science of The Total Environment*, 872, 162163.
- Li, L. (2022). Reskilling and upskilling the future-ready workforce for industry 4.0 and beyond. *Information Systems Frontiers*, 1-16.
- Mohsin, M., Kamran, H. W., Nawaz, M. A., Hussain, M. S., & Dahri, A. S. (2021). Assessing the impact of transition from nonrenewable to renewable energy consumption on economic growth-environmental nexus from developing Asian economies. *Journal of environmental management*, 284, 111999.
- Muluneh, M. G. (2021). Impact of climate change on biodiversity and food security: a global perspective—a review article. *Agriculture & Food Security*, 10(1), 1-25.
- Oliinyk, O., Bilan, Y., Mishchuk, H., Akimov, O., & Vasa, L. (2021). The impact of migration of highly skilled workers on the country's competitiveness and economic growth. *Montenegrin Journal of Economics*.
- Potrč, S., Čuček, L., Martin, M., & Kravanja, Z. (2021). Sustainable renewable energy supply networks optimization—The gradual transition to a renewable energy system within the European Union by 2050. *Renewable and Sustainable Energy Reviews*, 146, 111186.
- Raihan, A., Begum, R. A., Said, M. N. M., & Pereira, J. J. (2022). Relationship between economic growth, renewable energy use, technological innovation, and carbon

- emission toward achieving Malaysia's Paris agreement. *Environment Systems and Decisions*, 42(4), 586-607.
- Raihan, A., Muhtasim, D. A., Khan, M. N. A., Pavel, M. I., & Faruk, O. (2022). Nexus between carbon emissions, economic growth, renewable energy use, and technological innovation towards achieving environmental sustainability in Bangladesh. *Cleaner Energy Systems*, 3, 100032.
- Ram, M., Osorio-Aravena, J. C., Aghahosseini, A., Bogdanov, D., & Breyer, C. (2022). Job creation during a climate compliant global energy transition across the power, heat, transport, and desalination sectors by 2050. *Energy*, 238, 121690.
- Sadiq, M., Amayri, M. A., Paramaiah, C., Mai, N. H., Ngo, T. Q., & Phan, T. T. H. (2022). How green finance and financial development promote green economic growth: deployment of clean energy sources in South Asia. *Environmental Science & Pollution Research*, 29(43).
- Schröer, A. (2021). Social innovation in education and social service organizations. Challenges, actors, and approaches to foster social innovation. In *Frontiers in Education* (Vol. 5, p. 555624). Frontiers Media SA.
- Strielkowski, W., Civiń, L., Tarkhanova, E., Tvaronavičienė, M., & Petrenko, Y. (2021). Renewable energy in the sustainable development of electrical power sector: A review. *Energies*, 14(24), 8240.
- Uralovich, K. S., Toshmamatovich, T. U., Kubayevich, K. F., Sapaev, I. B., Saylaubaevna, S. S., Beknazarova, Z. F., & Khurramov, A. (2023). A primary factor in sustainable development and environmental sustainability is environmental education. *Caspian Journal of Environmental Sciences*, 21(4), 965-975.
- Usman, M., & Radulescu, M. (2022). Examining the role of nuclear and renewable energy in reducing carbon footprint: does the role of technological innovation really create some difference?. *Science of The Total Environment*, 841, 156662.
- Wang, X., Khurshid, A., Qayyum, S., & Calin, A. C. (2022). The role of green innovations, environmental policies and carbon taxes in achieving the sustainable development goals of carbon neutrality. *Environmental Science and Pollution Research*, 1-15.
- Wu, A., Roemer, E. C., Kent, K. B., Ballard, D. W., & Goetzel, R. Z. (2021). Organizational best practices supporting mental health in the workplace. *Journal of occupational and environmental medicine*, 63(12), e925-e931.
- Xiong, Y., Guo, H., Nor, D. D. M. M., Song, A., & Dai, L. (2023). Mineral resources depletion, environmental degradation, and exploitation of natural resources: COVID-19 aftereffects. *Resources Policy*, 85, 103907.
- Yang, J., Hao, Y., & Feng, C. (2021). A race between economic growth and carbon emissions: What play important roles towards global low-carbon development?. *Energy Economics*, 100, 105327.
- Zhang, C., Khan, I., Dagar, V., Saeed, A., & Zafar, M. W. (2022). Environmental impact of information and communication technology: Unveiling the role of education in developing countries. *Technological Forecasting and Social Change*, 178, 121570.
- Zhu, L., Luo, J., Dong, Q., Zhao, Y., Wang, Y., & Wang, Y. (2021). Green technology innovation efficiency of energy-intensive industries in China from the perspective of shared resources: Dynamic change and improvement path. *Technological Forecasting and Social Change*, 170, 120890.