How Does Sustainable Energy System, Creativity, and Green Finance affect Environment Efficiency and Sustainable Economic Growth: Evidence from Highest Emitting Economies

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ABSTRACT

In present times, sustainability is to be demanded to attain high economic growth in longer run. Thus, countries are obliged to scrutinize the factors which balance the economic growth and prove to be efficient indicator of environment. This study, knowing the significance of such indicators, the study formulates a framework in which a role of sustainable energy system, creativity, and green finance on the environmental efficiency and sustainable economic development intends to be examined in the context of high carbon emission economies such as Iran, Canada, China, Indonesia, India, Japan, Saudi Arabia, United States, Russia, and South Korea. In order to tackle the abovementioned issue, the study used the data extracted from world development indicators (WDI) covering the period from 2010 to 2020. The study employed Random fixed model to test the proposed hypotheses. Obtained results expose that sustainable energy systems, creativity and green finance share negative association with carbon emissions, hence, revealing this point that the indicators are useful to increase sustainable economic development and environmental efficiency. Thereby, in order to achieve sustainable economic growth, governments are liable to implement policies with a long-term approach. The outcomes are also helpful for the upcoming researchers and regulators while formulating the policies about environmental efficiency.

Keywords: Sustainable Energy System, Creativity, Sustainable Economic Development, Green Finance, Carbon Emissions
JEL Classifications: Q01, F65, O13, O44, P28, Q56

1. INTRODUCTION

Internationally, rapid environmental changes and global warming have become critical strategic issues. Environmental changes and global warming both have raised concerns about the Earth's increase in atmospheric temperature. Natural phenomena and human causes, including production and commercial activities, play a role in increasing global temperatures. Changes in the Atmosphere are mainly caused by an increase in "greenhouse" gases like CO_2 emission. The focus of our study is on the economies of developing countries like Iran, Canada, China, Indonesia, India, Saudi Arabia, South Korea, the United States, Japan, and

Russia. The population and economy of these countries have caused major problems for economists and many environmental issues (Baloch et al., 2021; Chien et al., 2021a; Hussain et al., 2021; Li et al., 2022). That's why, in the coming few years, they should find the best combination of climate damage reduction and economic growth. The best way to achieve this objective is to gain environmental efficiency.

Environmental efficiency is a well-known indicator of how economically sustainable the economy is. In cities or countries with high environmental efficiency, the same investment will produce less environmental pollution compared to low environmental

efficiency and environmental pollution. If the decision-making department (DMU) is more environmentally efficient, it can provide the best environmental and economic returns from a variety of factors. Environmental resources will be used more efficiently for an efficient DMU. Environmental efficiency shows the economic situation of the country (Chien et al., 2021b). This environmental efficiency can be attained by controlling the amount of CO_2 emission from economic activities in a country. This issue is being popular among researchers and academics. Our study aims at analyzing the factors like renewable energy production and consumption, creativity, and green finance, which can be helpful in controlling the amount of CO_2 and achieving high environmental efficiency (Li et al., 2021).

The use of energy in economic activities is the major source of CO_2 and other pollutants. The choice of energy resources affects the amount of CO_2 from commercial activities. The production and consumption of non-renewable energy resources like oil, natural gas, coal, and nuclear energy are the major sources of CO_2 emissions. At the same time, the production and consumption of renewable energy sources like wind power, solar energy, hydro energy, tidal power, geothermal power, and biomass energy do not cause a large amount of CO_2 but absorbs the heat from the atmosphere. After the choice of energy resources, creativity is also a very significant factor that could be helpful to control the emission of contaminating factors and enhancing environmental efficiency (Kot et al., 2021; Kubenka, 2020). The thinking, imagination, ideas, and efforts of the employees determine their decision-making and business performance. The creative employees have good observation skills (Cerisola, 2018; Zhao et al., 2021a), novel thinking, and the ability to solve the problems; thus, they can better handle the issue if getting the same economic progress with minimum CO_2 emission (Hussain et al., 2020; Zhao et al., 2021b). The coupling of green concept while formulating financial policies motivates the organizations to overcome the negative environmental impacts.

In the past four decades, the size of the world economy has tripled. Therefore, the issue of sustainable development has become the focus of discussion. A country's development policy needs to emphasize the realization of economic efficiency while at the same time improving energy efficiency and saving energy. In 2018, global energy consumption surpassed 157,063.77 TWh. Conferring to forecasts, by the end of 2050, the Earth's energy demand level may reach 50%, although most of it will occur in developing countries in Asia. The distribution of energy supply will increase by 0.6% annually by fossil fuels (coal increases by 0.4% and natural gas consumption increases by 1.1% annually 46). Although the output of renewable energy has increased beginning 1.06 TW to 2.18 48 TW in the past nine years (2008-2017), there will be a considerable increase (3.1% per year) of renewable energy. Especially China has developed rapidly, but its atmospheric security is much worse than other developed international cities. Therefore, the development of eco-cities from 2010 to 2020 will be a great success. Beijing should focus on ecosystems inside and outside the city. This is a big challenge for Beijing. Environmental measurement is important in any sustainable economy and in any environmentally efficient city.

Countries and cities with an efficient environment for efficient production and resource elements can produce efficiently, with less harm to the environment. Environmental resources will decrease in that city. Therefore, every country must build an ecosystem to succeed (Abdul Hamid et al., 2020; Tabeikyna et al., 2021).

In order to achieve the study objectives, the paper is classified into several parts. 2nd part deals with the influences of renewable energy production and consumption, creativity, and green finance on the amount of CO_2 and achieving high environmental efficiency in light of past arguments of authors. The 3rd part describes the process of how an empirical analysis about the understudy constructs has been acquired, analyzed, and results have been set. Finally, these results are approved through discussion of past studies, and proper conclusions and implications of the study are given.

2. LITERATURE REVIEW

The green economy is a systematic financial activity designed to ensure the best possible environmental impact. It is a multi-member field, including human entrepreneurs, producers, shareholders, and lenders. Raw green bonds for sale will soon reach USD2.36 trillion, providing environmentally friendly products and services to companies (Ainou et al., 2022). These companies are promoting new technologies that support the low-carbon dependence on the use of alternatives. The European Central Bank is a major contributor to the green economy, with three major green bond issuers being the US, France, and PRC (The People's Republic of China). It provides a variety of funds, credit mechanisms, and investments used to fund the construction of green projects or to mitigate the impact on the climate of common projects. Green funding plays a significant share in the United Nations as it delivers its specific objective of sustainable development (Apostoaie and Bilan et al., 2020; Wei et al., 2021). The UN Environment Team is already working in partnership with civil society and the private sector in an effort to align global financial systems with a sustainable development plan. Helping countries reorganize their regulatory framework-so that green borrowing can be a habitat, for example-and helping to regulate public sector planning in an environmentally friendly manner is one of the United Nations' ongoing activities. Fulfillment of clean energy sources can be brought about by the right combination of planning approval, strategic priorities, and access to capital. These projects can be put to good use to make them a more attractive option than, for example, gasoline power infrastructure (Ali et al., 2022; Bierwiaczonek et al., 2020).

Projects that fall under the green umbrella, such as renewable energy, energy efficiency, green innovation, and green finance, reduce waste management and control, environmental conservation, round economic systems, and sustainable use of natural and land deposits. There are several rules that define what constitutes green finance. The green finance must meet the level of expenditure incurred, must be evaluated according to a different function, ensure proper management of any revenue received and provide detailed reporting (Al Mamun et al., 2021; Li et al., 2021; Lan et al., 2021). At present, the European Central Bank controls about 20% of all green euro debt, although it started buying corporate bonds some time ago in 2016; this shows that the bank views this as a

process to make its green agenda. At the national level, major banks make plans for green investment as a priority. Sweden's Riksbank has already begun stripping mineral-based assets, selling bonds to another market. The green conversion can be assisted by financial institutions in three ways. First, they are instrumental in developing new ways to finance sustainable development: They take their voluntary commitment to mitigate climate risks and carbon offenses for potential investment when making investment decisions using carbon "prices." Second, financial institutions generally have a different goal of playing in the organization and in delivering individual and organizational funds for green investment through the establishment of creative tools like green bonds. In conclusion, financial institutions are commissioned to form a green financial union with a view to improving global financial governance by worrying about sustainable development (Bai et al., 2022; Liu et al., 2021; Sharma, 2020).

All institutional investors should state how their investment policy addresses environmental, social and administrative issues in their annual report and disclose how they go into carbon dioxide. Regulatory authorities should be aware of environmental threats. Monetary policies such as Basel III and Solvency II should be different in terms of economic recovery requirements and green investment funds. While targets for climate change and sustainability can be achieved, it will largely depend on the decision of these members to move forward in further green economic development (Nawaz et al., 2021; Vveinhardt and Sroka, 2021). Larger banks should assess the effects of environmental degradation, the effects of climate change, and the lack of resources on prices and inflation. In addition, they must incorporate environmental effects into their central bank reporting to ensure financial stability. Cross-learning can also be successfully developed locally, positioned at a national level, or at a development finance institution. Green structures can also be incorporated in such an institution well as other necessary green policy measures such as project evaluation, reporting, and monitoring, which will give greater confidence to global investors (Bilan et al., 2020; He et al., 2021).

It is argued that green financing grabs the complete attention of world due to the benefits which have been casted on various sector of economy. These benefits are encouraging economies to focus more attention towards the development of this type of financing. Prior literature clearly attenuates that economic growth of countries can be enhance by employing various opportunities that prolongs the sustainable economic development. In this regard, multiple finance sources support economies to construct strong measures in order to sustain country' economy (Tu et al., 2021; Chien, 2022d), but amongst all green finance wins the credit. Various authors postulates that in order to establish economic growth measure, it is imperative to have proper sustainability in financial contribution due to their prominent significance. Studies widely proclaims that there exist financial indicators that may add valuable addition to economy, however, green finance development is the most effective one. The reason being its consideration of social and other factors that are required to be integrated with economic growth sustainability (Chien et al., 2022c; Mallick and Rahman, 2020). Also, it is observed that blemished infrastructure induces

predominant effect on economy, however, inclusiveness of other factors alters the relationship in significant manner, hence, offer safe environment.

From literature, it can be speculated that socially responsible economies efficiently manage green investments in order to build socio-environment and economic growth (Chien, 2022a; Gajjar, 2020). Various investment tactics from the literature can make this conclusion that they are proved to be significant for emerging economies as such economies strive for tentacle economic growth (Chien et al., 2022b; Zhuang et al., 2021). All in all, it is quite clear that green finance helps various economies to secure sustainability in their economic growth (Haroon et al., 2021).

Renewable energy is most often taken as clean energy. It is produced from natural resources or processes which are spontaneous and can be replenished. RE sources are wind power, solar energy, hydro energy, tidal power, geothermal power, and biomass. The consumption of RE does not cause an increase in the amount of CO_2 as, during the consumption of RE, no harmful substances are released. So, using renewable energy large amount of products and services can be produced without causing pollution spreading. Empirical research was conducted by Nawaz et al. (2021) and Cheba et al. (2020) to show the importance of choice pf energy in getting environmental efficiencies. This study implies that when the business organization has the tendency to use energy resources which are replenished or renewed, its operations, including production of goods or services, do not emit pollutants like CO_2 emission; thus, with the effective choice of energy resources, the organizations can produce more products having good quality within the same inputs. The literary workout of Sadiq et al. (2021) proves a positive influence of renewable energy consumption on environmental efficiency. This workout posits that the firms which have the tendency to use renewable energy to run different sorts of machinery or logistics, there are minimum chances of wastes, toxic substances, and CO_2 emission. There is the healthy work environment, minimum loss in the form of wastes, and lower costs. Thus, the firms have the capacity to generate more production at a minimum cost even without affecting the environmental requirements of the customers or general public.

Not only does the choice of energy consumption for energy purposes both at the domestic and commercial level affect the CO_2 and environmental efficiency, but also the production of different sorts of energy resources can be influencing. According to the views of Shair et al. (2021), there are fewer chances of CO_2 emissions in areas where renewable energy resources such as biomass energy, wind power, solar power, hydropower, and geothermal power are used to meet the energy needs of commercial enterprises and business organizations can reduce the negative environmental impacts of the economic activities they engage in. Therefore, the organization has high environmental efficiency. The study was conducted by the Sun et al. (2020), which identifies the impacts of both renewable and non-renewable energy sources on business sustainability through environmental efficiency. This study elaborates that RE sources do not emit any toxic gases or chemicals, but they can absorb carbon and heat from the air, resulting in CO_2 emissions. As a result, the generation of renewable

energy resources enhances environmental quality, natural resource availability, and human health, all of which contribute to increased productivity compares both the renewable and non-renewable energy resources in order to show the significance of renewable energy in achieving high environmental efficiency. These energy sources help to maintain climatic balance and environmental quality by not emitting harmful gases like CO_2. Good quality products and services may be produced in greater quantities with the right resources and healthy staff.

As businesses work in a highly competitive world, therefore, innovation is essential for success. Creativity is defined as the ability to originate great ideas, question conventional thinking, devise novel solutions, and create new opportunities from challenges (Kaufman, 2018; Liu et al., 2022b; Lu et al., 2020). Elements such Curiosity, innovative mindset, fast analysis, ingenuity, and the exploitation of available opportunities are all useful creative talents for dealing with the CO_2 and environmental degradation problems. The creative skills of organizational personnel lead the organization towards environmental efficiency. Zafar et al. (2019), argue that Employees that are innovative do not rely on traditional methods of producing. They examine the flaws in outdated manufacturing processes that could result in pollutants such as CO_2 emissions and environmental damage, and they work to enhance production methods that emit the least amount of CO_2. As a result, employee innovation can help to prevent environmental damage. So, productivity can be accelerated with improved quality. According to the study of Adedoyin et al. (2020), employees that are innovative may quickly solve environmental issues because they have the ability to identify energy inefficiencies in technology used in business operations, which can raise CO_2 and SO_2 emissions and disrupt the climatic equilibrium. The innovative staff not only identify the technology's energy inefficiency but also understand how to make environmentally-friendly changes to the technology in order to cut CO_2 emissions. Wu et al. (2021), state that CO_2 emissions and other pollutants have been found to be reduced in firms where employees have creative knowledge or abilities and the chance to present their ideas before administration and can implement those innovative ideas. Novelty, creativity, and value addition are prevalent in these firms, and problems that affect reputation of company, are identified and attempted to be resolved regularly. As a result, changes are made to raw materials, technology, the quality of human resources, and industrial procedures. The firm's environmental performance improves as a result of this change.

To discuss it further, creative economy possesses knowledge intensive properties and derives from individual talent and creativity, hence creating a positive and significant impact on building inclusive societies. Also, it appears to be critical to citizen's shared sense of cultural elements that helps in strengthening social cohesion. Discussing it with economic benefits, creativity plays a central role in sustainable development, hence, provides major contribution to SD agenda 2030 (Kamarudin et al., 2021; Khattak et al., 2021). In this regard, creativity offers an inclusive social development and motivates people to own their responsibilities as it promotes continuous progress and innovation towards sustainability (Lan et al., 2022; Liu et al., 2022a; Soini

and Dessein, 2016). Discussing it further, creative initiatives and economic activity are somewhat paradoxical and mutually exclusive. It reflects on different approaches and policies that helps in gaining sustainability. Thereby, bridging the relationship of creativity and sustainable economic development is still an important view, even though it has overlooked by scholars (Fanea-Ivanovici, 2018). The reason is adding more evidences provides a deeper insight which help policy makers to understand the background and extracts potential benefits of creative industries. Also, scholars admit that creativity is helpful in promoting inclusive social progress and sustainable growth.

3. RESEARCH METHODS

This study examines the role of renewable energy production and consumption, creativity, and green finance on the environmental efficiency and sustainable economic growth among high carbon emission producing countries such as Iran, Canada, China, Indonesia, India, Japan, Saudi Arabia, United States, Russia, and South Korea. This study extracted the data from WDI from 2010 to 2020. This study has used random and fixed models to test the connection. The following equation is developed by using the present study variables.

$$CO2_{it} = \alpha_0 + \beta_1 REC_{it} + \beta_2 REP_{it} + \beta_3 CR_{it} + \beta_4 GF_{it} + e_{it} \quad (1)$$

$$EG_{it} = \alpha_0 + \beta_1 REC_{it} + \beta_2 REP_{it} + \beta_3 CR_{it} + \beta_4 GF_{it} + e_{it} \quad (2)$$

Where;
CO_2 = Carbon Emission
EG = Economic Growth
i = Country
t = Time Period
REC = Renewable Energy Consumption
REP = Renewable Energy Production
CR = Creativity
GF = Green Finance.

The current study has adopted carbon emission as the dependent variable and measured it as carbon dioxide damages (% of GNI). In order to measure sustainable economic development which is another dependent variable of study is measured by GDP growth. In addition, this research has also used four predictors such as renewable energy production and measured as the renewable energy output (% of total electricity output), renewable energy consumption and measured as the renewable energy consumption (% of total electricity consumption), creativity that is measured as the research and development expenditures (% of GDP) and green finance and measured as the green credit. Table 1 highlights the measurements of the constructs.

Firstly, descriptive statistics have been executed by the research that to reveal the data properties. The study also employed correlation method to evaluate either the relation among constructs is strong or vice versa. Thirdly, the current study has used the variance inflation factor (VIF) that shows the multicollinearity among the constructs.

Table 1: Measurements of variables

S#	Constructs	Measurements
01	CO_2 emissions	CO_2 damages (% of GNI)
02		GDP growth
03	REP	Renewable energy output (% of total electricity output)
04	REC	REC (% of total electricity consumption)
05	Creativity	R and D (% of GDP)
06	GF	GC provided by the financial sector (% of GDP)

REC: Renewable energy consumption, REP: Renewable energy production, GF: Green finance

Table 2: Descriptive statistics

Variable	Obs	Mean	SD	Min	Max
CO_2	110	1.790	0.408	1.028	2.733
EG	110	1.891	0.387	1.045	3.722
REC	110	0.145	0.130	0.105	0.593
REP	110	0.630	0.354	0.367	0.828
CR	110	5.537	0.406	4.099	6.346
GF	110	2.562	2.722	1.941	5.893

REC: Renewable energy consumption, REP: Renewable energy production, CR: Creativity, GF: Green finance

Table 3: Correlations matrix

Variables	CO_2	EG	REC	REP	CR	GF
(1) CO_2	1.000					
(2) EG	0.542	1.000				
(3) REC	−0.200	0.412	1.000			
(4) REP	−0.161	0.239	0.412	1.000		
(5) CR	−0.055	0.391	0.355	0.612	1.000	
(6) GF	−0.267	0.443	0.560	0.489	0.241	1.000

REC: Renewable energy consumption, REP: Renewable energy production, CR: Creativity, GF: Green finance

The random-effect model (REM) is used to test after taking decision through Hausman text in order to evaluate the nexus among the constructs. REM has the possibility of estimating "shrunken residuals" and also the possibility of accounting for "differential school effectiveness" through the use of random coefficients models (Gujarati and Porter, 2003). The REM equations are given as under:

$$Y_{it} = \beta_1 + \beta_2 X_{2it} + \beta_3 X_{3it} + \beta_4 X_{4it} + \varepsilon_i + u_{it} \quad (3)$$

$$Y_{it} = \beta_1 + \beta_2 X_{2it} + \beta_3 X_{3it} + \beta_4 X_{4it} + w_{it} \quad (4)$$

The REM equation with this study variables is given as below:

$$CO2_{it} = \beta_1 + \beta_2 REP_{it} + \beta_3 REC_{it} + \beta_4 CR_{it} + \beta_5 GF_{it} + w_{it} \quad (5)$$

$$EG_{it} = \beta_1 + \beta_2 REP_{it} + \beta_3 REC_{it} + \beta_4 CR_{it} + \beta_5 GF_{it} + w_{it} \quad (6)$$

4. EMPIRICAL RESULTS

Firstly, descriptive statistics have been executed by the research that shows the minimum and maximum values along with standard deviation and mean values. It can be seen that CO_2 average value is 1.790 followed by REC 0.145, REP 0.630. In addition, the average value of creativity is 5.537, while the average value of green finance and EG is 2.562 and 1.891 respectively. Table 2 shows the descriptive in detail.

Secondly, this study also used the matrix of correlation that shows the relations among the constructs. The results indicated that REC, REP, creativity, and green finance have a negative association with carbon emission. Whereas in case of economic growth, all the constructs follow same directional path due to positive sign. This indicates that when REC, REP, CR and GF increase, an increment can be seen in EG as well. Table 3 shows the correlation matrix.

Thirdly, the current study has used the variance inflation factor (VIF) that shows the multicollinearity among the constructs. The values of VIF are lower than five that exposed no multicollinearity. Table 4 shows the VIF.

Hausman test was conducted to check which model is appropriate and should be accepted to test the proposed hypotheses. For the selection of model null and alternative hypotheses were formed.

Table 4: VIF

	VIF	1/VIF
REC	1.086	0.921
GF	1.085	0.922
CR	1.078	0.928
REP	1.070	0.935
Mean VIF	1.080	

REC: Renewable energy consumption, REP: Renewable energy production, CR: Creativity, GF: Green finance

Ho: Random Effect model is appropriate

If the significance value or P > 0.05, Random model will be used.

Ha: Fixed Effect model is appropriate

If the significance value or P < 0.05, fixed model will be used.

It can be seen in Tables 5 and 6 that P-values are more than 5% (0.05) which on the basis of our hypothesis indicates that null hypotheses cannot be rejected. Thereby, random effect model is appropriate and should be accepted for regression analysis.

4.1. Random Effect Model
Random effect method was performed to check the statistical significance of construct path coefficients by means of beta coefficient and P-values. The estimation results from EViews software are shown in Table 7a and 7b. According to results, the statistics of REC and CO_2 shows the significant and negative relationship as the P = 0.000 (P < 0.05) and beta coefficient is negative. Table 7a further depicts that the relationship of REP. CR and GF with CO_2 is significant and negative as the P < 0.05 with positive beta coefficient. In addition, 57.1% of variations in the carbon emission are due to the understudy constructs.

REM findings have also exposed that renewable energy output, renewable energy production, creativity, and green finance are positively associated with economic growth. In addition, 54.7%

Table 5: Hausman test (CO_2)

Test summary	Chi-square	Chi-square	Prob.
Cross-section random	5.123	2	0.772

Table 6: Hausman test (EG)

Test summary	Chi-square	Chi-square	Prob.
Cross-section random	1.635	2	0.4414

Table 7a: Random effect model (CO_2)

CO_2	Beta	S.D.	t-value	P-value	L.L.	U.L.	Sig
REC	−1.709	0.372	−4.60	0.000	−2.971	−0.446	***
REP	−0.681	0.179	−3.81	0.000	−3.035	−0.326	***
CR	−0.231	0.162	−1.43	0.042	−2.191	−0.454	***
GF	−0.106	0.004	−26.50	0.000	−5.002	−0.013	***
Constant	4.868	1.230	3.96	0.000	2.426	7.310	***
R-square	0.571		obs			110	
F-test	8.940		Prob >F			0.00	

REC: Renewable energy consumption, REP: Renewable energy production, CR: Creativity, GF: Green finance

Table 7b: Random effect model (EG)

EG	Beta	SD	t-value	P-value	L.L.	U.L.	Sig
REC	1.718	0.262	5.70	0.000	2.881	0.356	***
REP	0.472	0.268	3.92	0.000	3.125	0.316	***
CR	0.432	0.281	2.52	0.042	2.172	0.464	***
GF	0.216	0.104	6.50	0.000	6.012	0.022	***
Constant	4.877	1.330	3.96	0.000	2.426	7.220	***
Overall r-squared	0.547		Number of obs			110	
Chi-square	31.695		Prob >Chi2			0.000	
R-squared within	0.467		R-squared between			0.358	

REC: Renewable energy consumption, REP: Renewable energy production, CR: Creativity, GF: Green finance

of variation in economic growth happens because of the chosen constructs. Table 7b shows the REM.

5. DISCUSSION

The study results have shown the positive relationship between REC with environmental efficiency. These results mean that as the consumption of RE in different economic activities like business operations, production of goods and services, and marketing enables the organization to reduce the wastes and greenhouse gas like CO_2 emission, the organization can have more quality production in minimum resources and the environmental quality can be protected. The past study of (2017; Waheed et al., 2018) supports these results. This study analyses how much the consumption of renewable energy resources can be beneficial to a business organization and the country's environment. This study posits that the tendency of the organization to use energy resources that can be replenished or renewed minimizes the emission of harmful gases like CO_2, toxic chemicals, and contaminated wastes. Thus, it reduces total costs, enhances marketing and productivity of goods in minimum resources. Thus, renewable energy consumption enhances environmental efficiency. Findings are also approved by Boontome et al. (2017), that declares that

the use of renewable energy resources like biogas or biofuel does not cause the emission of CO_2; it saves the natural environment, the quality of natural resources, and the health of living beings. These resources and living beings are used as material or human resources in the business process. The high quality of physical and human resources gives high-quality production in more quantity and minimum cost. These results are also approved by the previous study of Bailera et al. (2017), which shows that renewable energy consumption enhances environmental efficiency on the part of business organizations. Like non-renewable energy, renewable energy (biogas and biofuel) consumption does not release carbon dioxide and not only offers healthy environment to the general public but gives a healthy work environment to organizational personnel who can work more effectively and thus, gives more production with better quality.

The results of the study have also represented that renewable energy production has a positive association with environmental efficiency. The areas where there is a tendency to produce renewable energy resources for meeting energy needs of commercial enterprises, there are fewer chances of CO_2 emission, and the business organizations can reduce the negative environmental impacts of economic activities which they operate. Findings show consistency with the evidences of Marcantonini and Valero (2017), that articulates that REP is a safe production as it do not exhibit harmful substances. Infact, it has the tendency to consume carbon and heat from air, hence, mitigate harmful carbon emissions. Thus, the production of renewable energy resources improves the environmental quality, natural resources, and the health of living beings which contribute to an increase in productivity. These findings are consistent with Nathaniel and Iheonu (2019), which also shows the significance of RE production in getting environmental efficiency in comparison with the production of non-RE sources. RE resources maintain the balance of climate and sustain environmental quality, thus, with quality resources and a healthy workforce, good quality products and services can be produced in more quantity.

Creativity is proved to have positive association with environmental efficiency. Findings are similar with Usman et al. (2021), that proclaims that when the organizational personnel has the capability to address the issue differently, to generate new ideas on the basis of analysis, and apply these ideas in practice while undertaking the business processes, can have the ability to solve the environmental issues like CO_2 emission. Thus, they can give eco-logical production in minimum resources or cost. Current evidences are also similar to the past study of and He et al. (2021) and Mehmood and Mansoor (2021), that explains business creativity as an ability which offers newness to the system. The proposed innovation could be in multiple facets such as any modification, inventions or sort of value addition to the existing systems and processes. The study exposes that creativity in any form gives leverage to institutions to get rid of environmental issues while performing business activities. The study results have also shown that green finance is in a positive association with environmental efficiency. These results are approved by the workout of Le et al. (2020) that shows the greater significance of green finance in

order to combat carbon emission related issues with the aim to increase environmental efficiency. The study discusses that finances related to green agenda are helpful for enterprises to exploit eco-friendly resources as their application mitigates carbon emission challenges. The reduction of CO_2 emission and improved quality enhance environmental efficiency. Findings are supported by Ren et al. (2020) due to consistent evidences, which further claims that contrary to conventional finances techniques, it is reported to face less emission challenges where organizations made investment in green projects. These overall increases their environmental efficiency as well, hence, ensure long term sustainability.

Findings reveal that that green finance shares positive and significant relationship with economic growth. The findings are consistent with prior literature as studies postulate that financial stability brings the stability in economy. Also, with the focus on sustainable economic development goals, the relationship among green economics and green finances views as an interesting debate across the globe (Tan et al., 2021; Zhao et al., 2022). The reason is that scholars postulate that countries might able to achieve financial and economic growth while focusing on the prevention of environmental degradation. Environmental issues such as pollution, ecological imbalance are acknowledged as a global economic and political problems due to the close relation with social development and human survival (Da et al., 2019; Sadiq et al., 2022c). The study conducted by Wang and Zhi (2016) states that green finance is an essential element of sustainable economic development typically for two valid reasons; offers connection among financial development, environmental improvement and economic development and viewing as a novel financial pattern, it couples environmental and social protection with economic profits.

Findings reveal that that creativity has a positive and significant impact with economic dimension of sustainable development. The findings are somewhat consistent with economic and environmental dimension as studies evidently state that creativity plays a central role in sustainable development, hence, provides major contribution to SD agenda 2030 (Sadiq et al., 2022b). In this regard, creativity offers an inclusive social development and motivates people to own their responsibilities as it promotes continuous progress and innovation towards sustainability (Liu et al., 2022b; Sadiq et al., 2022a).

6. CONCLUSION

The present study has both theoretical as well as and empirical implications. This study has a great theoretical significance on account of its lot of contribution to the literature on environmental quality. This study focuses on three sorts of factors like REP, REC, creativity, and green finance and checks their influences on CO_2 emission and environmental efficiency on the part of economic enterprises. Prior to this study, the researchers and academics have paid attention to the influences of REP, REC, creativity, and green finance on CO_2 emission and environmental efficiency. But the past studies have discussed the influences of REP, REC, creativity,

and green finance on CO_2 emission and environmental efficiency under three different heads energy, creativity, and finance. Thus, the current study is a great contribution to the literature. Moreover, mostly the studies have addressed the issues of CO_2 emission and environmental efficiency and the related factors in on two studies. The address of the understudied issue in ten countries simultaneously saves an exceptional position for this study. But our study has a great empirical significance along with theoretical one as it gives way to the environmental regulators, economists, and government how they should formulate policies to enhance environmental efficiency. The study guides that environmental efficiency can be improved by reducing CO_2 emission through renewable energy consumption, renewable energy production, creativity, and green finance.

Iran, Canada, China, Indonesia, India, Saudi Arabia, South Korea, United States, Japan, and Russia are ten countries that produce CO_2 emissions in large amounts. For sustainable development, it is essential for the business enterprises to show high environmental efficiency, which is possible if it succeeds in controlling CO_2 emission as a result of its activities. That's why the current study was conducted with an aim to elaborate how much beneficial are renewable energy consumption, renewable energy production, creativity, and green finance in controlling CO_2 emission. This study collected quantitative data regarding the influences of REC, REP, creativity, and green finance on CO_2 emission and environmental efficiency in Iran, Canada, China, Indonesia, India, Saudi Arabia, South Korea, United States, Japan, and Russia. The empirical analysis helps extract the results. These results indicated that the use of energy resources that can be replenished or renewed reduces the emission of harmful gases like CO_2, toxic chemicals, and contaminated wastes. Thus, it reduces total costs, enhances marketing and productivity of goods in minimum resources. Thus, renewable energy consumption and production enhance environmental efficiency. The findings showed that the effective integration of green concepts informing the financial policies encourages eco-friendly projects, which reduces the negative impacts of economic activities on the environment. Thus, there is less emission of CO_2 and high environmental efficiency. The findings indicated that the creative skills of the organizational personnel enable them to reduce CO_2 emissions and enhance environmental efficiency.

Despite of several contribution, the study possesses some limitations as well. This study addressed only three factors like renewable energy production and consumption, creativity, and green finance. Many other factors like geographical characteristics, economic conditions, and government policies have deep impacts on environmental efficiency, but these factors have paid no attention here in this study. The upcoming scholars must ponder here and expand the scope of the study. Moreover, the empirical evidences are drawn from Iran, Canada, China, Indonesia, India, Saudi Arabia, South Korea, United States, Japan, and Russia for the period of 2010-2020. This makes the study less comprehensive and less valid. Thus, authors should expand the time period to have more validity of the study.

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