Research Article

Green management practices for a sustainable future

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ABSTRACT

Global environmental changes have stimulated thinking about organizational leadership as a major factor for current and upcoming financial growth in the green economy. As per Pakistan climate and weather, the solar technology is well suited for our region. Solar radiations are mostly used as a source of renewable energy with the direct use of it for generation of electricity or heating. However, the Pakistan government has set the target to shift its 30% energy consumption on renewable energy which is currently being generated from fossil fuels. Therefore, the present study explores that the green management practices in terms of renewable energy, which are applied in sugar industries, are they truly reviving the economic and social environment which makes a difference in reducing the carbon emission in environment and get rid of pollution.

1. INTRODUCTION

Modern global changes have stimulated thinking about organizational leadership as a major factor for current and upcoming financial growth in the green economy. A committed leader is required to implement policies and strategies that can lead towards environmentally sustainable practices in their factories (Subramanian & Suresh, 2023). World energy demand is increasing at an annual rate of 2% over the outlook period. Gas demand increases more than that for oil in the OECD regions. Consumption of gas almost gets double over the outlook period, increasing from 1810 Mtoe in 1995 to 3460 Mtoe by 2020. Meanwhile, in the same duration of time, most of the plants will reach the end of their operational life span leading to an overall decrease level of nuclear power in the region. Outside the OECD, growth could be higher, with nuclear power increasing in Asia and in the transition economies (Ayhan et al., 2024). Pakistan requires to reduce greenhouse gas emissions from the industrial zone. The energy security, air pollution, and acid rain are the dominant catalysts for renewable energy development. It is an increasingly compulsory factor to reduce the emissions of gases. Climate change became a key policy driver for renewable energy due to high oil prices and current green management crises in Pakistan.

As per Pakistan climate and weather, the solar technology is well suited for our region. Solar radiations are mostly used as a source of renewable energy with the direct use of it for generation of electricity or heating. According to World Bank, Pakistan's current electricity demand would be achieved by just using 0.071% of country's area. However, Pakistan has just 1500 Megawatts installed capacity of renewable energy which is equal to 3% of total generation. With exceeding the air pollution due the carbon emissions, solar energy is the best way to keep balance in green management and reducing the emissions. The study has helped provide the evidential foundation for the government's alternative and renewable energy policy 2019, and the indicative generation capacity expansion plan (IGCEP 2047) submitted by NTDC to NEPRA in this year. It confirms that Pakistan has set the target to increase its renewable energy mix to 30% by 2030 (Butt & Singh, 2023). Thus, the aim of this study is to examine how carbon emission can be reduced by green management practices to make energy economy and social environment sustainable.

1.1. BACKGROUND OF PROBLEM

Climate has been changing since the beginning of creation, the growth rate of carbon dioxide emission has been increased over the past 30 years (Owusu & Asumadu-Sarkodie, 2016). Around 1.4 ppm/year before the 1995 and 2 ppm/year till now. Globally, fossil fuel uses increased to dominate energy supply, leading to sudden growth in CO_2 emissions since the 1850. By the end of 2010, it is confirmed that fossil fuels consumption accounted for the global anthropogenic greenhouse gas emission, after concentrations brought up to over 390 ppm/year, around 39% (Owusu & Asumadu-Sarkodie, 2016).

Pakistan is an agriculture based country, food industries is trending on enhancement gradually. One of largest sector is sugar industry, they have their own power plant which emits a lot of carbon gases. CEOs are starting to recognize that issues such as climate change, carbon emissions, and impacts on natural resources concern society. Industries running on fossil fuel in Pakistan has produced 217 million metric tons of CO_2 emissions in 2020. This was the third consecutive year that CO_2 emissions is increasing in Pakistan, it was 217 $MtCO_2$ in 2018 as well.

Sugar industry has a high energy consumption industry. It is unable for industries to fulfil their energy needs by national grid due to high energy cost in Pakistan. They have their own gas power plants, which is able to fulfill energy consumption needs but unfortunately it emits carbon emission in surrounding and pollute the environment. If we compare our environmental circumstances from 1980s, it is thoroughly changed. It is because we just had worked in the economic sector to improve the economy of Pakistan and sacrificed the environmental sector. The quality of air for city of east was recorded as 296 which makes it the most polluted city in the world (Naqvi et al., 2023). Pakistan being an agriculture country, Sugar sector has a more importance and on trending in Pakistan. About 30% of total anthropogenic emission of greenhouse gases such as methane and nitrous oxide are from sugar industry, fertilizers, livestock production and rice sectors (Bashir et al., 2023). Since the past some years, Pakistan has been focusing on the betterment of environment.

1.2. RESEARCH OBJECTIVE

1. To check the green management practices (Sugar industry) on environmental quality.
2. To explore the impact of renewable energy (Solar & Wind) (Sugar industries) on environmental quality.

1.3. RESEARCH QUESTIONS

1. How energy consumption and natural resource effect on environmental quality?
2. How renewable energy (Solar, Wind, Tidal, and Hydro) reduces carbon footprint in environment?

1.4. SCOPE OF STUDY

This study targets the industrial sector of Pakistan by determining the prevalence of carbon emission and greenhouse gases in the leading sector of Sugar industries. The scope of this study was to carry out an environmental performance assessment of carbon footprints in the industries of Pakistan. The sugar industry is targeted to explore the reality of renewable energy for reducing the carbon footprint, water wastage level, and its impact on the environmental quality. It would decrease the usage of fossil fuels and natural resources that impacts on social environment and economy of country as well.

2. LITERATURE REVIEW

In study on the relationship between the renewable energy with environment and human development, the author investigated act of energy in environment and human development in EU countries till 2008 by using regression analysis (Aydin et al., 2024). Renewable energy's consumption was also included in the energy variable (The human Development Relies on Energy, Panel Data Evidence). The study concludes that there was a constructive relationship between renewable energy with environment and human development. In another study (Danish et al., 2018), the author investigated relationship between the consumption of renewable energy and economic growth in Pakistan in the period from 1992 to 2014 (Khan et al., 2024). Two-stage least square method was applied in this study. The study showed the renewable energy discourage the human development in Pakistan, it did not improve development process of humans and environment. Economic growth has negative diminishing effect on human development index and environmental factors improves human development process in Pakistan.

In his study, Al-Sarihi and Bello (2019), the author investigated the relationship between the socio-economic development and renewable energy in countries of Africa. The study concluded that socio-economic activities could be promoted by renewable energy when they are used in its full capacity and properly. In another study, the Spanish developmental model of sustainability was evaluated for the time period of 1980-2010 using the method of co-integration. In that model, the investigation was done on relationship between renewable and nonrenewable energy resources, pollution and development of economy. For growth and the human capital GDP was used and for development social development

index was used. The results which were obtained were also compared to Germany, United Kingdom and Italy. At the end it was concluded that use of renewable energy has a positive impact on development and growth.

In another study, Cerqueira et al. (2021), investigated the relationship between renewable energy, economic development, and environmental pollution in 28 OECD countries in the period from 2004 to 2015. They observed that the use of renewable energy showed the prediction of the sustainable development levels of countries in addition to the physical and human capital. In a similar study (Zhu, 2023), Author investigated the effect of the non-renewable and renewable energy on sustainable development in 73 developing countries and 40 developed countries in the time period from 1990 to 2014 by using OLS, system GMM, and 2SLS methods. The study proved that renewable energy had a great positive effect on sustainable development in the developing and developed countries.

This research question observed the relationship between consumption of renewable energy and social and economic indicators in 21 African countries for the time period of 1990-2013 by using panel data analysis (Ergun et al., 2019). As a result, the authors concluded that in the countries having high human development index and GDP, share of renewable energy is low. In a recent study (Cerqueira et al., 2021), four factors–human development, renewable energy, carbon dioxide emissions, and recycling – were analyzed in structural model. Here, the authors conclude that both renewable energy and recycling contribute to human development of the OECD countries. Another study conducted on a single country's energy consumption, growth of economy, sustainability of environment, and the human development index in Pakistan in time frame of 1990 to 2015. There, it was also proved that on human development renewable energy had positive impact (Omri & Belaïd, 2021).

2.1 HYPOTHESES

H1: The level of knowledge about green management practices increases confidence in alternative / renewable energy sources.

H2: The level of knowledge about renewable energy sources and management affects the energy management skills in one's own household, as well as the costs.

2.2 OPERATIONAL FRAMEWORK

Renewable energy and green management practices have a valuable relationship with the dependent variable (Chavez, 2020). Renewable energy refers to eco-friendly energy resources. Unlike fuels of fossil, retrieval of other sources of renewable energy are not environmentally harmful. Different types of technologies are being used in harvesting the renewable energy of the Earth and it makes no negative impression to the environment (Fu & Zhang, 2017). The schematic diagram is used for illustrating the relationship between these variables. The model represents an increase in renewable energy sources in terms of green management practice leads to reduce damaging effect of environmental quality. There is a constructive impact of any form of renewable energy on reducing the carbon footprints in the environment.
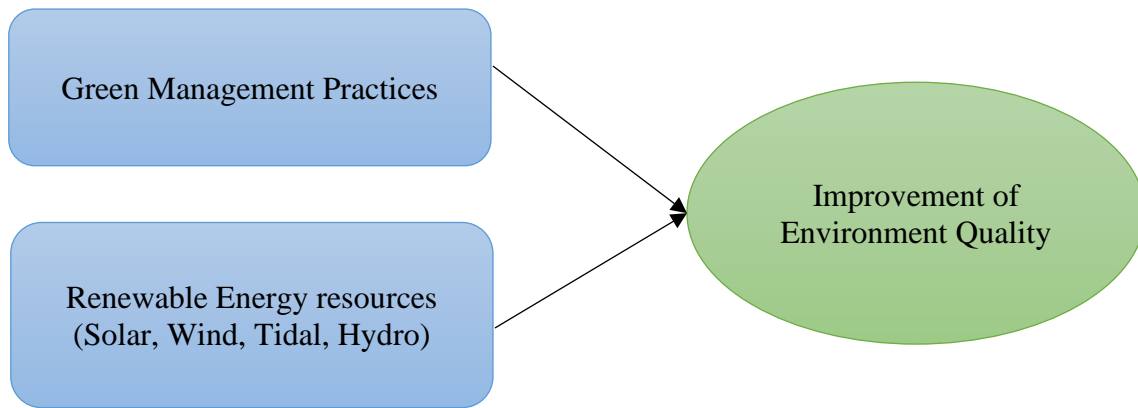
Fig. 1. Operational Framework

3. RESEARCH METHODOLOGY

This study chooses a quantitative research methodology to target the carbon footprints drawn from the Sugar industries in Pakistan. This study targets the industrial sector of Pakistan by determining the prevalence of carbon emission and greenhouse gases in the leading sector of Sugar industries. The sugar industry is targeted to explore the reality of renewable energy for reducing the carbon footprint, water wastage level, and its impact on the environmental quality. It would decrease the usage of fossil fuels and natural resources that impacts on social environment and economy of country as well.

Pakistan comes in a most air polluted countries in the air index. Pakistan needs to be worked on green management to improve quality of green environment. A quantitative survey is more useful in stating the responses of green management practices in numerical form. A primary survey is used for collecting the response of renewable energy about green environment.

3.1 VARIABLES

3.1.1. Independent variable:

Green management practices are independent variable. Green management is a paradigm that includes improving environment awareness, using energy resources and eco-friendly technologies. It may include measures such as introducing methods of recycling and initiatives of waste reduction, by using sustainable supplier and production chains, increasing the usage of renewable and sustainable energy, reducing pollution , reducing the carbon footprint with green initiatives, programs of tree plantation and working with environmental charities on partnership basis (Tan, 2009).

Renewable energy resources such as Solar, Wind, Tidal, and Hydro are independent variables. They are operated by natural resources, takes no input like fossil fuels or furnace oil which causes emissions. Therefore, they make good impact on environment to make it healthy and qualitative. This is a diversifying energy supply which reduces dependence on imported fuels. Renewable energy sector also improves economic development and exposed opportunities in manufacturing, installation, and services sectors (Gunawan et al., 2020).

3.1.2. Dependent variable:

Environmental quality is dependent variable which refer to greenhouse gases emits from industries, caused a polluted environment due to harmful gases CO_2, which influenced by independent variables of green management practices via renewable energy. Productivity represents the level of efficiency which allows green management practices to meet the task of improving quality of environment. Improved productivity is a high level of efficiency that reduces the carbon footprint by green management practices to complete the aim. Low productivity refers the less benefit of renewable energy impact on environmental quality.

4. RESULTS

Table 1. The data gathered for some sample set before adopting of renewable energy source (Solar).

Sr. No.	Industry Name	Current Capacity of Bagasse Plant (MW)	Energy Units Produced MWh/hour	CO_2 Emission ton/year	Water Level Wastage gallon/year
1	Ashraf Sugar Mills	15	12	257	17,990,000
2	Kashmir Sugar Mills	8	6.4	199	13,930,000
3	Ittefaq Sugar Mills	6	4.8	158	11,060,000

Table 2. The resulted of CO_2 emission reduction shows in below table by renewable energy source (Solar).

Sr. No.	Industry Name	Current capacity of Bagasse Plant (MW)	Energy units produced MWh/hour	CO_2 Emission ton/year	Water level wastage gallon/year	Solar energy capacity (MW)	CO_2 reduction by Solar ton/year
1	Ashraf Sugar Mills	15	12 MWh	257	17,990,000	7	136
2	Kashmir Sugar Mills	8	6.4 MWh	199	13,930,000	3	61
3	Ittefaq Sugar Mills	6	4.8 MWh	158	11,060,000	2	39

The results indicated that Ashraf sugar mills is able to reduce its 53% CO_2 emission, Kashmir sugar mills reduces 26%, and Ittefaq sugar mills reduces 25% of their carbon footprints. The water wastage level reduces to; for Ashraf sugar mills it is around 9 million gallon/year, for Kashmir sugar mills around 3.6 million gallon/year, and for Ittefaq sugar mills it is around 2.8 million gallon/year wastage saved. The result study are on current based on survey findings conducted by sample of Ashraf sugar industries. Survey findings shows that huge capacity were a bagasse plant such as 15 MW while renewable energy (Solar) had a low installed capacity of 7 MW. According to frequency table 37% energy sharing is done by renewable energy sources which makes impact on 53% CO_2 emission reduction by Ashraf sugar mills.

Table 3. Frequency distribution table

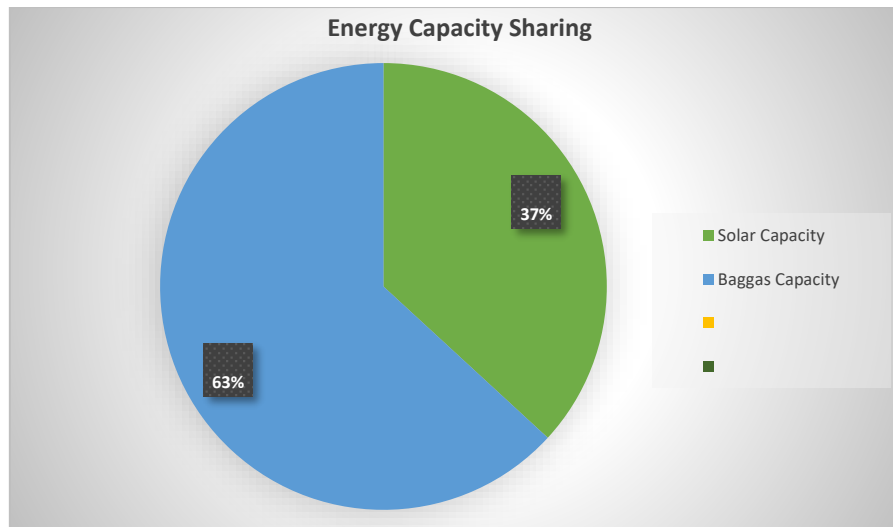| Capacity	Frequency	%	Valid %	Cumulative %
Baggas Capacity (MW)	12	63	63	100
Solar Capacity (MW)	7	37	37	100
Total (MW)	19	100	100	

Fig. 2. Frequency distribution graph

4.1. REGRESSION ANALYSIS

Regression analysis is estimated to find out the variance and their relationships. The result shows the independent variables such as green management practices and renewable energy resources has a significant relationship with dependent variable (environmental quality).

Table 4. Regression Table

Model		Un-standardized Co-efficient		StandardizedCoefficients	t	Sig.
		B	**E**	**β**		
1	(Constant)	1.76	1.02		2.67	.003
	Green Management Practice	.321	.201	.321	1.81	.003
	Renewable Energy resource	.201	.143	.180	1.314	.002

Table 5. Coefficient of determination

Model	R	R²	Adjusted R²
1	.791	.758	.741

The value of R² is 0.756 which means 75.8% of the variation in the statistics is shown by the dependent variable (Summary). The R² is above 75%, which means the variation in the dependent variable (environmental quality) is described by the independent variables (green management practices and renewable energy resources). The value of the adjusted R² is 0.741 which represents the positive relationship between the dependent and the independent variables. The value of R ranges between 0-1. The greater value indicates a positive and strong relationship between the variables.

Table 6. Variance analysis

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4.89	4	.892	1.250	.000
	Residual	33.518	47	.662		
	Total	37.728	51			

Predictors: (Constant): Green management practices, Renewable energy resources
Dependent Variable: Environmental quality

5. CONCLUSION

This study focused on examining the impact of green management practices by applying renewable energy solution in the targeted Sugar industries in Pakistan. Data were obtained by surveying Ashraf sugar industries and Kashmir sugar industries who have installed renewable energy (Solar) solution. They survey result proved that renewable energy only gives a partial solution to the problem of reducing greenhouse gas emissions whilst meeting energy needs in future and reduces their carbon footprint to 45%. Moreover, for economy perspective, chairman of Pakistan Association stated that renewable energy made more opportunities about business for the betterment of green economy of Pakistan.

5.1 LIMITATIONS

There are some limitations of this study as only the solar power is feasible for industries other than Wind, Tidal and hydro energy. It was difficult to gather the actual and resulted data for other renewable sources such as Wind, Hydro and Tidal energy. Sugar industrial sector is very large in Pakistan so limitations of funds prevented to conduct this research at a large scale.

6. FUTURE RECOMMENDATIONS

There is an intimate connected between renewable energy and sustainable future. Sources of renewable energy are being replenished by natural means, which makes those sources the most sustainable alternative in nature. While fossil fuels naturally come to an end, abundant resources like Solar, Wind, tidal & Hydro restored fast or even exist limitless. The investigation found that Solar and Wind could play an important role in the future for betterment of the environment quality. But there is need to investigate the potential of offshore-wind, biomass, and ocean thermal energy. Their research and development program in terms of exploration, production and usage of renewable energy are urgently needed.

Author Contributions:

The authors have significantly contributed to advancing knowledge in the intersection of renewable energy, green management practices, and environmental quality within Pakistan's sugar industry. By conducting a thorough literature review and formulating clear research objectives, they have provided valuable insights into the potential impact of implementing renewable energy solutions on carbon emission reduction and environmental sustainability in industrial settings. Through the development of an operational framework and the selection of a quantitative research methodology, the authors have laid a solid foundation for empirically investigating the relationship between these variables. Their analysis of data collected from sugar mills demonstrates the tangible benefits of adopting renewable energy sources, such as solar power, in terms of reducing CO_2 emissions and water wastage. This research not only sheds light on the environmental challenges faced by the sugar industry but also offers practical solutions for mitigating carbon footprints and promoting sustainable practices. Overall, their work contributes to a deeper understanding of the role that renewable energy and green management can play in fostering environmental stewardship and economic development within Pakistan's industrial sector.

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