JEEPO, 8(1), 66-74.

Journal of Energy & Environmental Policy Options

Integrating Green Finance, Economic Complexity, and Renewable Energy for Sustainable Development in Asia

Razan Al-Masri[a]
Mehmed Ibrahim[b]

Abstract

The primary aim of this research is to conduct a comprehensive examination of the existing theoretical and empirical frameworks concerning green finance, renewable energy, and the economic complexity index, focusing on their roles as central determinants of sustainable development in Asian countries from 1990 to 2023. The study starts with a detailed overview of the pertinent issues, setting the stage for a deeper investigation. It methodically reviews and discusses the relevant literature, extracting key theoretical and empirical insights that contribute significantly to the understanding of these complex relationships. This paper also introduces several dynamic dimensions for future research, aiming to expand and enrich the academic discourse surrounding these topics. It explores the impact of green finance, the economic complexity index, and renewable energy on fostering sustainable development within these nations, attempting to unravel the complex interactions between these factors. The research aims to provide actionable insights that could aid policymakers and stakeholders in enhancing sustainability initiatives. Furthermore, this study makes a significant contribution to the fields of green finance, economic complexity, and sustainable development. It does so by critically analyzing and synthesizing the existing body of knowledge, thereby offering a more integrated perspective that could inform future policies and practices. This comprehensive approach helps bridge gaps in the current literature and suggests pathways through which Asian countries can achieve sustainable development goals effectively.

Keywords: *Green Finance, Renewable Energy, Sustainable Development*
JEL Codes: *Q01, Q56, O44, G23*

Received: 14 January 2025
Revised: 14 March 2025
Accepted: 22 March 2025
Published: 30 March 2025

Citation:
Al-Masri, R. & Ibrahim, M. (2025). Integrating Green Finance, Economic Complexity, and Renewable Energy for Sustainable Development in Asia. *Journal of Energy and Environmental Policy Options*, 8(1), 66-74.

1. INTRODUCTION

The concept of sustainable development, first articulated in the 1987 report Our Common Future, emphasized the necessity of meeting present needs without compromising the ability of future generations to meet their own (Parveen et al., 2024; Amin et al., 2024; Sadia et al., 2024). This principle underlines the ongoing global challenge of balancing economic growth with environmental preservation, especially given the high levels of emissions associated with modern economic activities. The link between economic progress and environmental sustainability has become a pivotal area of focus, with significant attention on the impacts of rapid industrialization and heavy reliance on nonrenewable energy sources, which contribute to increased solid waste and climate change (Ahmad, 2018; Huang et al., 2024; Rabbia & Arshad, 2024; Audi et al., 2025). To address these pressing issues, there is a critical push towards adopting a circular economy framework aimed at reducing carbon emissions by 45% by 2030 and achieving carbon neutrality by 2050 (Zubair et al., 2024). The adverse impacts of climate change affect individuals, industries, and the environment in numerous ways, prompting the need for strategic policies and sustainable practices that mitigate environmental degradation (Sheikh & Ahmad, 2020; Masri & Wimanda, 2024; Song et al., 2024; Saeed et al., 2024; Amjad & Marc, 2016; Ali et al., 2021; Ali et al., 2022).

Green finance (GF) plays a crucial role in promoting economic sustainability by channeling financial resources towards environmentally sustainable projects. Incorporating Environmental, Social, and Governance (ESG) criteria into investment decisions, green finance facilitates the allocation of capital to initiatives that focus on mitigating climate change and achieving

[a] Abu Dhabi School of Management: Abu Dhabi, United Arab Emirates, r.masri@adsm.ac.ae
[b] Othman Yeop Abdullah Graduate School of Business, Universiti Utara Malaysia, Sintok, Malaysia

broader sustainable development goals (Singh & Kumar, 2023; Wang & Manopimode, 2023). According to the International Finance Corporation (IFC), green finance is defined as investments that produce ecological benefits and promote a balance between economic growth and environmental quality enhancement (Kosyak & Popov, 2020; Iqbal & Asif, 2022; Saeed et al., 2024). The significance of green finance was underscored during the One Planet Summit in November 2023, where the Network for Greening the Financial System—a group of central banks and financial regulators—highlighted the necessity of integrating climate risk considerations into global financial stability frameworks. Green finance not only supports small and medium-sized enterprises by facilitating access to advanced technologies that improve environmental sustainability but also backs projects focusing on renewable energy and clean technologies, which have minimal environmental impacts and contribute to sustainable economic growth (Khan & Hassan, 2019; Bakht, 2020; Roussel & Audi, 2024). Furthermore, green finance is instrumental in mobilizing capital for climate adaptation efforts, offering financial instruments such as green bonds and green loans. These tools support infrastructure and development projects that advance sustainability (Ahmad & Ali, 2024; Amjad et al., 2021), highlighting its pivotal role in transitioning toward a sustainable economic model.

Renewable energy, derived from natural sources that replenish themselves over short periods, is fundamental to achieving environmental sustainability and spurring sustainable economic growth. It encompasses energy from solar, wind, hydro, and other sustainable sources, playing a pivotal role in reducing carbon emissions, combating climate change, and promoting environmental conservation. Furthermore, renewable energy initiatives drive economic growth and create employment opportunities within the green economy sector, contributing to a more sustainable future (Shahid, 2024; Maqsood et al., 2023). The importance of renewable energy is highlighted in the United Nations' Sustainable Development Goal 7 (SDG 7), which aims to ensure universal access to affordable, reliable, sustainable, and modern energy by 2030. This goal not only emphasizes the shift towards renewable energy but also underscores the need for energy efficiency and the expansion of infrastructure and technology for clean energy in all countries. Achieving SDG 7 is crucial for mitigating environmental impact, reducing energy poverty, and promoting sustainable industrialization and economic growth. Renewable energy's role extends beyond environmental benefits; it also has significant social and economic impacts. By reducing dependence on imported fuels, it can enhance national energy security and reduce energy costs. Additionally, the renewable energy sector demands a diverse range of skills and labor, contributing to job creation in manufacturing, installation, maintenance, and operational roles. This economic stimulation is vital for developing nations, where renewable energy can be a driver of industrial development and help in alleviating poverty by providing energy access to remote and underserved regions (William & Adam, 2018; Denial, 2023; Wang & Li, 2024).

As global awareness and technological advancements increase, renewable energy becomes more viable and less costly, making it an increasingly attractive option for meeting the world's energy needs sustainably. Governments, businesses, and communities worldwide recognize the strategic benefits of renewable energy and are investing in its development to meet the environmental challenges of our time while fostering economic growth and social inclusion. Achieving global energy access by 2030 requires expediting electrification efforts, increasing investments in renewable energy, enhancing energy efficiency, and establishing supportive policies and regulatory frameworks. Many developing nations are actively working to expand renewable energy adoption and improve fossil fuel efficiency to provide sustainable and affordable energy solutions for all (Luna & Luna, 2018; Yan & Sriboonchitta, 2024). However, transitioning from conventional energy sources to renewable alternatives presents several challenges, including high implementation costs, the need for advanced technology, technical expertise, and financial constraints (Abro et al., 2024; Clain & Horodnic, 2023; Ashiq et al., 2023; Sharma & Das, 2024; Marc & Amjad, 2017; Audi & Ali, 2023). The Economic Complexity Index (ECI) serves as a measure of economic progress and reflects the level of skills and knowledge required for producing exported goods (Radas, 2023; Tabassum et al., 2023; Zahra et al., 2023; Truan & Can, 2024). The link between economic complexity and sustainable development is deeply interconnected. By fostering innovation, enhancing productivity, and generating employment opportunities, ECI contributes to overall development. A more complex economy is better equipped to adapt to global technological transformations. This research aims to delve into the interplay between green finance, renewable energy, economic complexity, and sustainable development in the Association of Southeast Asian Nations (ASEAN) region. ASEAN, with its ten rapidly growing member states—Brunei, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Vietnam—faces unique environmental vulnerabilities due to its traditional reliance on conventional energy sources. Despite the economic slowdown caused by the COVID-19 pandemic, ASEAN continues to be a region of strategic importance with a collective GDP of approximately $3.63 trillion. This represents 7.2% of the global GDP as of 2023, with the region contributing significantly to global economic growth over the past decade (World Economics, 2023).

The concept of economic complexity, which involves a diverse array of knowledge-intensive and technologically advanced industries, is critical for understanding sustainable development within ASEAN. While economic complexity can drive growth and technological advancement, it may also increase resource consumption, pollution, and environmental degradation if not managed properly. The challenge lies in balancing economic complexity with environmental stewardship to ensure sustainable development. As countries enhance their economic complexity index, there is typically an increase in research and development activities, skill development, and the adoption of green technologies and eco-friendly production methods (Urban & Radas, 2021; Li et al., 2022; Javaid et al., 2023; Shahzadi et al., 2023; Audi & Yu, 2024).

To mitigate the environmental impacts of activities driven by high economic complexity, ASEAN countries are increasingly leveraging technological advancements to optimize their economic structures (Dawood et al., 2023; Marc & Amjad, 2023;

Audi et al., 2020). This strategic approach is pivotal in transitioning towards more sustainable energy systems and reducing the environmental footprint of economic activities. This study will thoroughly review the literature to examine the dynamics among green finance, renewable energy, and economic complexity in fostering sustainable development within ASEAN. Through a comprehensive theoretical and empirical literature review, this paper will analyze the influence of these factors in shaping the region's approach to sustainable development. The aim is to contribute to the formulation of informed policies and strategies that align economic growth with environmental sustainability, emphasizing the need for integrated solutions to meet the Sustainable Development Goals (SDGs).

2. LITERATURE REVIEW

This section examines existing theoretical and empirical literature on sustainable development to offer practical solutions for addressing potential economic challenges associated with sustainability. The primary objective of this comprehensive literature review is to develop well-founded perspectives, identify gaps in the current body of knowledge, and bridge these gaps by contributing new insights to the field. The concept of economic growth has been shaped by various schools of thought over the years. Central to the discussion is the neoclassical growth theory, which was pioneered by Solow and Swan in 1956, emphasizing the critical roles of capital, labor, and technology in driving economic expansion. This theory particularly highlights the pivotal role of technology; nations that effectively implement policies and tools to advance technological capabilities are likely to achieve substantial economic growth. In the context of green economic growth, sustainable finance instruments such as green finance are instrumental in facilitating the transfer of green technologies and attracting capital for environmentally friendly projects, positioning green finance as a crucial element in achieving sustainable economic growth.

The impact of green finance on sustainability has been extensively studied across various geographic contexts using a range of time frames and econometric techniques. For example, studies by Ur Rahman and Bakar (2019) and Chaudhary et al. (2023) evaluated the effects of indicators like foreign direct investment (FDI), domestic credit, and bank credit to the private sector on environmental outcomes such as CO_2 emissions, energy usage, natural resource depletion, and greenhouse gas emissions across 40 European countries. These studies found that while green finance generally helps reduce environmental degradation, FDI may adversely affect environmental indicators. Further research by Zhao et al. (2023) on G7 countries supports the view that green finance significantly aids in sustainable environmental development and the mitigation of environmental damage. Additional studies, including those by Ur Rahman and Bakar (2018), Zulfiqar et al. (2022), and Marc et al. (2024), have examined the relationship between green finance, renewable energy usage, and CO_2 emissions within ASEAN economies, demonstrating the effectiveness of green finance in reducing environmental pollution. Rahman et al. (2022) highlighted the role of green finance in enhancing energy efficiency in Chinese cities, showing that it effectively curbs energy consumption. Moreover, research by Shahid et al. (2022) utilizing annual data from China found that green finance significantly drives sustainable growth, supporting economic sustainability and efforts toward carbon neutrality. Studies in Brazil and across 46 countries further corroborate the positive impact of green finance on environmental quality and its significant role in reducing CO_2 emissions. The vital role of renewable energy in promoting environmental sustainability and driving long-term economic growth has also been well-documented. For instance, Awan et al. (2023) analyzed data from the G7 from 1990 to 2020, exploring how renewable energy consumption and research and development (R&D) investments affect sustainability. Their findings suggest that renewable energy and R&D investments, while beneficial, also present challenges to traditional fossil fuel consumption and alter energy dynamics within these nations. An extensive examination of OECD countries from 1990 to 2019 showed that while fossil fuels and economic growth tend to increase carbon emissions, the adoption of renewable energy sources has a significant negative correlation with carbon emissions, thereby enhancing sustainable development in these regions.

Ullah et al. (2023) examined the relationship between natural resources and CO_2 emissions and found that excessive reliance on natural resources intensifies environmental degradation. However, the adoption of renewable energy, structural economic transformations, the expansion of green finance initiatives, and advancements in technology serve as crucial moderating factors in mitigating environmental harm. Moreover, the economic recession triggered by the COVID-19 pandemic resulted in a significant decline in the global demand for energy, leading to a drop in natural resource prices. This downturn adversely affected the financial viability of renewable energy projects, causing a decline in both public and private sector investments in clean energy solutions. Consequently, the lack of financial support slowed down progress in renewable energy initiatives, making it challenging for many countries to transition toward a sustainable energy model. Similarly, research conducted by Khawaja (2021) investigated how the integration of renewable energy and green finance contributes to the expansion of the tourism industry, ultimately fostering sustainable economic development. The findings of this study revealed that renewable energy deployment, green financial mechanisms, and technological advancements collectively exert a significant positive impact on the tourism sector. Furthermore, the study suggested that as tourism activities increase, there is a notable decline in health-related costs and carbon emissions. The moderating effect of renewable energy and green finance was found to be instrumental in accelerating tourism growth, which, in turn, strengthened economic development through employment generation and increased revenue streams.

Bakar (2019) conducted a detailed examination of the challenges associated with incorporating renewable energy into the mining industry and its implications for achieving the Sustainable Development Goals (SDGs). The study emphasized that integrating renewable energy within mining operations offers several advantages, including job creation, environmental

pollution reduction, knowledge expansion in the sector, and the establishment of a circular economy. These factors collectively contribute to improved sustainability indicators and enhance long-term environmental and economic resilience. Despite these benefits, the study identified a critical challenge: a lack of awareness regarding the advantages of renewable energy, which hinders its widespread adoption across various industries. Addressing this gap through targeted awareness campaigns, policy incentives, and financial support mechanisms is essential to promote the large-scale adoption of renewable energy technologies. Additionally, a long-term study analyzing the impact of renewable and non-renewable energy sources on sustainable development in South Asia, covering the period from 1995 to 2019, found that both energy sources have played a pivotal role in driving economic and environmental sustainability in the region. The findings suggest that while non-renewable energy sources continue to meet significant energy demands, the increasing reliance on renewable energy offers promising prospects for reducing environmental degradation and promoting economic resilience. As South Asian economies continue to evolve, the integration of green finance, technological advancements, and policy-driven renewable energy initiatives will be key to ensuring long-term sustainability and meeting the growing energy demands of the region.

The Economic Complexity Index (ECI) is a modern environmental paradigm that assesses economic advancement while also identifying the skills and knowledge necessary for producing exported goods. It serves as a key indicator of a nation's ability to diversify its economy and integrate innovation-driven production processes. According to Ghazia, (2022), environmental degradation is expected to decline as the ECI of a host economy improves. This is primarily due to the fact that a rise in ECI fosters increased participation in research and development activities, leading to skill enhancement and the introduction of green technologies and environmentally sustainable production methods. By encouraging innovation, ECI not only supports economic growth but also aids in transitioning toward more sustainable industrial practices. Hafiza et al. (2022) conducted an empirical study across 28 OECD countries to examine the role of economic complexity and renewable energy in mitigating environmental degradation. Their findings indicate that economies with higher ECI levels are better equipped to implement renewable energy solutions and adopt sustainable development practices. The study suggests that the interplay between economic complexity and renewable energy contributes to reducing environmental pollution while simultaneously supporting long-term economic resilience. Similarly, Shahzadi, Ali et al. (2023) analyzed the impact of economic complexity on China's green development efficiency. Their study concluded that an increase in ECI has a positive influence on the promotion of sustainable development across various Chinese provinces. As ECI grows, it drives advancements in clean energy adoption, green technological innovation, and environmentally responsible industrial expansion. This not only strengthens China's overall economic performance but also reinforces its commitment to sustainable growth strategies. By investing in research and development, enhancing technical skills, and promoting green technology, nations can leverage ECI to strike a balance between economic progress and environmental stewardship. As economies continue to evolve, integrating economic complexity with sustainable policies will be key to ensuring long-term ecological and economic well-being.

3. SHAPING SUSTAINABLE DEVELOPMENT GOALS

Green finance is instrumental in driving sustainable development by fostering the adoption of eco-friendly practices and tackling the challenges of climate change. This financial paradigm includes diverse instruments like green bonds, green loans, and investments aimed at renewable energy and energy efficiency projects. By channeling capital towards sustainable ventures, green finance not only curbs environmental degradation but also bolsters economic resilience by weaving sustainability into development strategies. The impact of green finance extends significantly across several Sustainable Development Goals (SDGs), enhancing its pivotal role in global sustainability efforts. For example, it underpins SDG 7, Affordable and Clean Energy, through its support for renewable energy projects that replace traditional, polluting energy sources. It advances SDG 9, Industry, Innovation, and Infrastructure, by promoting industrial innovations that are environmentally friendly and technologically advanced. Additionally, it contributes to SDG 12, Responsible Consumption and Production, by fostering efficient and sustainable resource use. Moreover, green finance is critical for SDG 13, Climate Action, as it finances initiatives that reduce greenhouse gas emissions and enhance climate resilience. It supports SDG 15, Life on Land, by funding biodiversity conservation and reforestation efforts, vital for ecological balance. Lastly, SDG 17, Partnerships for the Goals, is strengthened by green finance through its role in catalyzing collaborations among governments, the private sector, and financial institutions to spur sustainable economic growth.

By mobilizing financial resources and encouraging investments in green initiatives, green finance serves as a dynamic force in steering economies towards sustainability. Its strategic investment in renewable energy and energy-efficient solutions promotes a departure from fossil fuel dependence, thereby diminishing carbon footprints and enhancing long-term environmental and economic stability. Additionally, the integration of green finance into national and global policy frameworks enhances the effectiveness of sustainability initiatives, ensuring that economic progress aligns with environmental responsibility. Overall, green finance serves as a catalyst for achieving the SDGs by bridging the gap between economic development and ecological preservation. Its ability to direct capital toward environmentally sustainable ventures makes it a fundamental component of global sustainability efforts. As more countries and organizations recognize the importance of green financial mechanisms, the potential for large-scale positive environmental and economic transformation continues to grow.

3.1. ROLE OF RENEWABLE ENERGY

Energy is a fundamental component of daily life, influencing various aspects of society, including social equity, economic development, and environmental sustainability. It plays a critical role in multiple sectors such as education, healthcare, business, national security, food production, and employment generation. As the global demand for energy escalates, the need for a sustainable, efficient, and environmentally friendly energy supply becomes increasingly critical for long-term development. While fossil fuels have long been the dominant source of energy, renewable resources now stand as the most viable and sustainable alternatives. However, transitioning to a balanced energy mix requires overcoming inefficiencies in traditional fuel usage while enhancing the production and distribution of clean energy sources (Naz et al., 2022). A strategic integration of renewable energy technologies can ensure a dependable and sustainable energy supply, providing consistent access to clean energy solutions. Renewable energy is intrinsically linked with Sustainable Development Goal (SDG) 7, which advocates for affordable and clean energy for everyone. As the global population grows rapidly, the corresponding increase in energy demand highlights the critical need for substantial investments in renewable energy sources. Key steps toward achieving SDG 7 include improving energy efficiency, increasing productivity, and expanding universal access to clean energy. These initiatives are essential for fostering sustainable development and mitigating environmental impacts, positioning renewable energy at the forefront of efforts to meet global energy needs sustainably.

The broad adoption of renewable energy not only aligns with Sustainable Development Goal 7 (SDG 7) but also significantly supports the achievement of various other SDGs, both directly and indirectly. For instance, Good Health and Well-being (SDG 3) is directly impacted by the transition to clean energy, which significantly reduces air pollution and decreases the incidence of respiratory diseases linked to the combustion of fossil fuels. Additionally, renewable energy enhances healthcare delivery by ensuring a reliable electricity supply to medical facilities, which is crucial for patient care and overall public health outcomes. Moreover, the integration of renewable energy technologies plays a crucial role in fostering economic growth and industrialization, thus positively affecting Decent Work and Economic Growth (SDG 8) and Industry, Innovation, and Infrastructure (SDG 9). The deployment of renewable energy not only creates numerous job opportunities in the green energy sector but also encourages innovation and technological advancements essential for modern, sustainable industrial processes. Furthermore, the expansion of clean energy solutions contributes to environmental sustainability goals, such as Climate Action (SDG 13) and Sustainable Cities and Communities (SDG 11). By promoting sustainable urban development and minimizing carbon footprints, renewable energy helps cities become more sustainable and climate-resilient. These multifaceted benefits of renewable energy underscore its pivotal role in not only advancing global energy goals but also in promoting comprehensive sustainable development across multiple sectors and communities. Renewable energy is a cornerstone of sustainable development, directly supporting SDG 7 while simultaneously contributing to various other SDGs. Its adoption is essential for ensuring energy security, promoting environmental stewardship, and fostering inclusive economic growth. As global energy demands continue to rise, prioritizing renewable energy investments and optimizing energy efficiency will be crucial in driving long-term sustainability and achieving global development objectives.

3.2. ROLE OF ECONOMIC COMPLEXITY INDEX

The Economic Complexity Index serves as a key indicator for assessing the diversity and sophistication of an economy's productive structure. It evaluates the range of goods an economy exports and the level of expertise required to manufacture these goods. The Economic Complexity Index is widely utilized to analyze an economy's industrial capabilities, technological advancements, and its ability to compete in global markets. As discussed in the previous section, extensive literature suggests that the Economic Complexity Index is strongly correlated with economic growth and development. More complex economies tend to have greater adaptability to shifting economic conditions and can capitalize on emerging opportunities more effectively. Their ability to produce a diverse range of sophisticated goods enhances competitiveness and facilitates innovation-driven progress. Additionally, these economies demonstrate higher resilience against external shocks, such as natural disasters, financial crises, and geopolitical instability. Their diversified production structures allow for flexibility in resource allocation, mitigating economic disruptions and ensuring sustained growth. Beyond its direct impact on economic development, the Economic Complexity Index plays a crucial role in achieving the Sustainable Development Goals. The Sustainable Development Goals, consisting of seventeen ambitious global objectives, aim to eradicate poverty, protect the environment, and ensure that all individuals have access to fundamental necessities for a decent standard of living. A highly complex economy contributes to these goals in several ways. First, it fosters job creation and income generation, which are essential for reducing poverty levels outlined in the first Sustainable Development Goal, No Poverty. The expansion of high-value industries and skill-intensive sectors provides employment opportunities and strengthens social mobility.

Furthermore, economies with greater complexity are more likely to prioritize research and development, driving technological advancements that contribute to environmental sustainability. Innovation in clean energy, waste management, and resource efficiency supports the Sustainable Development Goal of Affordable and Clean Energy, as well as the Sustainable Development Goal of Climate Action, by promoting low-carbon technologies and sustainable industrial practices. A knowledge-based economy also fosters the Sustainable Development Goal of Quality Education by encouraging investment in scientific research, leading to advancements in healthcare, energy efficiency, and environmental conservation. Additionally, economic complexity contributes to sustainable industrialization and infrastructure development, supporting the Sustainable Development Goal of Industry, Innovation, and Infrastructure by facilitating technological diffusion and fostering industrial upgrading. The ability of complex economies to integrate sustainable production processes also aligns with the Sustainable Development Goal of Responsible Consumption and Production by promoting eco-friendly manufacturing and reducing

environmental degradation. The implications of the Economic Complexity Index on achieving the Sustainable Development Goals are significant. Economies with higher complexity are better equipped to drive sustainable growth, foster resilience, and innovate solutions to global challenges. Their ability to adapt, invest in technological progress, and create employment opportunities positions them as key contributors to achieving economic, social, and environmental sustainability. As countries strive toward the Sustainable Development Goals, fostering economic complexity through industrial diversification, human capital development, and technological advancements will be essential in ensuring long-term prosperity and sustainability.

4. METHODOLOGY

In this study, a systematic literature review approach was adopted, following the principles outlined by previous scholars, including Shahid (2024), to compile and critically examine the most recent and relevant literature. This method ensures a structured and transparent approach to synthesizing existing research, identifying key themes, and evaluating the progress made in the field. For a comprehensive and in-depth analysis, a critical review was conducted to extract and analyze major key points from previous studies. These key aspects include the primary focus of the research, bibliographic details, research philosophy, as discussed by Saeed et al. (2024), key findings, methodological approaches, definitions of sustainable development, green finance, renewable energy, and the Economic Complexity Index within their respective domains. Additionally, the review considered the research context, geographical location of the studies, theoretical and practical perspectives, along with their conclusions and reported limitations. To ensure a relevant and up-to-date analysis, this study focused on research published between the years 2020 and 2023. Journal articles included in the review were sourced from Scopus-indexed journals, which serve as a reliable benchmark for high-quality academic publications in the domains of sustainable development, green finance, renewable energy, and the Economic Complexity Index. The selection process for relevant studies was conducted systematically. Initially, a broad search for relevant literature was performed, followed by a more refined selection process to identify the most pertinent studies. The researcher gathered articles from various well-recognized academic sources, including economics journals listed in Clarivate Analytics, particularly those included in The Master Journal List (2020) and the Journal Citation Reports. Additional sources included comprehensive academic databases such as Business Source Premier by EBSCO and Scopus, which provide extensive coverage of scholarly publications. Furthermore, Google Scholar was used to access a wide range of academic articles published in different journals across multiple disciplines.

To maintain the relevance and rigor of the literature review, a well-defined selection criterion was established. Studies that did not focus on green finance or the Economic Complexity Index were omitted. Additionally, non-empirical or non-conceptual works were excluded from the review. These included books, commentaries, summaries of conference proceedings, abstracts and keywords-only publications, executive abstracts, editorials, literature reviews, and newspaper or magazine articles. To determine the relevance of each selected study, the researcher thoroughly examined the title, abstract, and, where necessary, the methodology section of the paper. This step ensured that only studies that directly contributed to the research themes were included in the review. By adopting this rigorous selection process, the study ensures that the literature review provides a comprehensive, high-quality analysis of the existing body of knowledge in the fields of sustainable development, green finance, renewable energy, and economic complexity.

5. CONCLUSIONS

After a thorough review of the existing literature, it is evident that green finance and renewable energy are pivotal in steering the economies of the Association of Southeast Asian Nations (ASEAN) towards sustainable development. This study finds that green finance significantly enhances sustainability. This impact can be attributed to the commitment of financial institutions to integrate environmental considerations into their policies, which not only boosts economic performance but also improves environmental quality. Green finance empowers the productive sector by providing access to environmentally friendly technologies, which enhances traditional production processes, boosting economic output while reducing environmental damage. Furthermore, renewable energy plays a crucial role in long-term sustainable development by diminishing reliance on fossil fuels and fostering cleaner energy transitions. Conversely, the Economic Complexity Index (ECI) seems to exert an insignificant impact on sustainability in these economies, possibly due to the need for more time to improve their productive capacities and knowledge bases to effectively bolster sustainability efforts. Given that economic complexity is intertwined with industrial sophistication and technological advancement, transitioning towards sustainable development may necessitate additional structural transformations and enhanced investments in research and development. This study aimed to synthesize insights from the existing literature while making distinct contributions to the topic. Its primary goal was to provide a comprehensive understanding of the research surrounding green finance and the Economic Complexity Index concerning sustainable development. In conclusion, this research enriches the ongoing discourse on sustainability by exploring the asymmetric impacts of green finance and the Economic Complexity Index on green growth within the dynamic and diverse region of ASEAN. The findings underscore that propelling these economies towards a sustainable future requires a holistic approach that melds strategies of green finance with those of economic complexity. Given the varied economic structures and stages of development among ASEAN member states, the noted asymmetry in effects highlights the need for tailored strategies. The differences across these economies underscore the importance of adaptable policy frameworks that are sensitive to the unique characteristics of each country within the region. Thus, achieving sustainable development in

ASEAN necessitates a collaborative effort that aligns green finance, renewable energy adoption, and economic complexity while ensuring that policies are suitably adapted to the specific conditions of each nation.

REFERENCES

Abro, A. A., Abubakar, M., Shahid, T. A., & Fatima, U. (2024). Does Volatility Spillover among Sectors Varies from Normal to Turbulent Periods ? Evidence from Pakistan Stock Exchange. *Pakistan Journal of Humanities and Social Sciences Volume*, *12*(02), 1174–1187.

Ahmad, K. (2018). Addressing Demographic Challenges: Strategies for Sustainable Economic Growth in Pakistan. *Journal of Business and Economic Options*, *1*(4), 120-130.

Ahmed, J., & Alvi, A. A. (2024). Balancing Economic Growth and Environmental Sustainability in Developing Countries: The Role of Financial Innovation. *Journal of Energy and Environmental Policy Options*, *7*(4), 9-19.

Ali, A., Audi, M., Bibi, C., & Roussel, Y. (2021). The Impact of Gender Inequality and Environmental Degradation on Human Well-being in the Case of Pakistan: A Time Series Analysis. *International Journal of Economics and Financial Issues*, *11*(2), 92-99.

Ali, A., Audi, M., Senturk, I., & Roussel, Y. (2022). Do Sectoral Growth Promote CO2 Emissions in Pakistan? Time Series Analysis in Presence of Structural Break. *International Journal of Energy Economics and Policy*, *12*(2), 410-425.

Amin, N., Rahman, S. U., Khalid, S., & Idress, S. (2024). How Does Tourism, Trade Openness and Green Energy Influence CO2 emissions? Evidence from ASEAN Countries. *Bulletin of Business and Economics*, *13*(2), 71–79.

Amjad, A., & Marc, A. (2016). The Impact of Income Inequality, Environmental Degradation and Globalization on Life Expectancy in Pakistan: An Empirical Analysis. *International Journal of Economics and Empirical Research*, 4 (4), 182-193.

Amjad, A., Audi, M., & Roussel, Y. (2021). Natural Resources Depletion, Renewable Energy Consumption and Environmental Degradation: A Comparative Analysis of Developed and Developing World. *International Journal of Energy Economics and Policy*, *11*(3), 251-260.

Arshad, S., Joseph, S., Rahman, S. U., Idress, S., & Shahid, T. A. (2024). Decarbonizing the Future: A Critical Review of Green Energy, Financial Inclusion and Trade Openness on CO2 Emissions. *Bulletin of Business and Economics*, *13*(2), 160–163.

Ashiq, S., Ali, A., & Siddique, H. M. A. (2023). Impact of Innovation on CO2 Emissions in South Asian Countries. *Bulletin of Business and Economics (BBE)*, *12*(2), 201-211.

Audi, M. & Ali, A. (2023). Unveiling the Role of Business Freedom to Determine Environmental Degradation in Developing countries. *International Journal of Energy Economics and Policy*, 13(5), 157-164.

Audi, M., & Yu, H. (2024). Strategic Value Creation Through Corporate Social Responsibility Adoption for Sustainable Financial Performance. *Journal of Policy Options*, *7*(4), 14-21.

Audi, M., Ali, A., & Kassem, M. (2020). Greenhouse Gases: A Review of Losses and Benefits. *International Journal of Energy Economics and Policy*, *10*(1), 403.

Audi, M., Poulin, M., Ahmad, K., & Ali, A. (2025). Modeling Disaggregate Globalization to Carbon Emissions in BRICS: A Panel Quantile Regression Analysis. *Sustainability*, *17*(6), 2638.

Awan, A., Rahman, S. U., Ali, M., & Zafar, M. (2023). Institutional Performance and Tourism Arrival Nexus in BRICS Countries: Evidence from Nonlinear ARDL Cointegration Approach. *IRASD Journal of Economics*, *5*(1), 784–796.

Bakar, S. U. R. and N. A. (2019). Fdi and Manufacturing Growth: Bound Test and ARDL Approach. *International Journal of Research in Social …*, *9*(5), 36–61.

Bakht, Z. (2020). The nexus between economic growth, energy consumption, and environmental pollution in Bangladesh. *Journal of Energy and Environmental Policy Options*, *3*(1), 1-8.

Calin, A., & Horodnic, I. (2023). Determinants of CO2 Emissions and the Role of Renewable Energy in Romania. *Journal of Energy and Environmental Policy Options*, *6*(1), 8-15.

Chaudhary, S., Nasir, N., Ur Rahman, S., & Masood Sheikh, S. (2023). Impact of Work Load and Stress in Call Center Employees: Evidence from Call Center Employees. *Pakistan Journal of Humanities and Social Sciences*, *11*(1), 160–171.

Dawood, M., Rehman, S. ur, Majeed, U., & Idress, S. (2023). Contribution the Effect of Corporate Governance on Firm Performance in Pakistan. *Review of Education, Administration & Law*, *6*(1), 51–62.

Denial, A. (2023). The Role of Innovative Renewable Energy Technologies in Advancing Energy Access in Developing Countries. *Journal of Energy and Environmental Policy Options*, *6*(2), 23-28.

Ghazia Khoula, S. ur R. and S. I. (2022). Does Foreign Direct Investment Promote Economic Growth : Evidence from Pakistan Based ARDL to Cointegration Approach Email : ghazia.khoula@superior.edu.pk. *Journal of Contemporary Macroeconomic Issues*, *3*(1), 54–63.

Hafiza, N. S., Manzoor, M., Fatima, K., & Sheikh, S. M. (2022). Motives of Customer ' S E -Loyalty Towards E-Banking Services : a Study in Pakistan. *PalArch's Journal of Archaeology of Egypt / Egyptology*, *19*(3), 1599–1620.

Huang, Y., Rahman, S. U., Meo, M. S., Ali, M. S. E., & Khan, S. (2024). Revisiting the environmental Kuznets curve: assessing the impact of climate policy uncertainty in the Belt and Road Initiative. *Environmental Science and Pollution*

Research, *31*(7), 10579–10593.

Iqbal, M., & Asif, M. (2022). Diversifying Energy Resources for Economic Development in Pakistan. *Journal of Energy and Environmental Policy Options*, *5*(4), 11-20.

Irfan, A., Azam, A., & Shahid, T. A. (2023). Terrorism and Social Politics : How the Increase of Terrorism Impacts the Socio-Terrorism and Social Politics : How the Increase of Terrorism Impacts the Socio-Political Thoughts of the Pakistani Public. *International Journal of Research in Econoics & Commerce*, *4*(1), 21–30.

Javaid, Z., Noor, Q., Iftikhar, H., Haris, M., Rahman, S. U., & Ali, M. (2023). Assessing Mediating Role of Environment Knowledge Between Green Resource Management and Sustainable Performance, Under Moderating Effects of Green Self-Efficacy. *Central European Management Journal*, *31*(2), 352–368.

Khan, M. N., & Hassan, T. (2019). Balancing economic growth and environmental sustainability through energy consumption in Pakistan. *Journal of Energy and Environmental Policy Options*, *2*(4), 109-116.

Khawaja Hisham Ul Hassan, S. M. S. and S.-R. (2021). Analyzing the Link between Distributed Leadership and Teachers' Self-Efficacy Beliefs at Secondary School Level. *Annals of Social Sciences and Perspective*, *2*(2), 287–298.

Kosyak, A., & Popov, S. (2020). Analyzing Consumer Preferences for Green Products and Environmental Impact. *Journal of Energy and Environmental Policy Options*, *3*(4), 134-140.

Li, D., Bai, Y., Yu, P., Meo, M. S., Anees, A., & Rahman, S. U. (2022). Does institutional quality matter for environmental sustainability? *Frontiers in Environmental Science*, *10*(July), 1–12.

Luna, A., & Luna, G. (2018). Exploring Investment Dynamics in Renewable Energy for Low-Carbon Economies through a Global Comparative Analysis. *Journal of Energy and Environmental Policy Options*, *1*(3), 73-79.

Maqsood, N., Shahid, T. A., Amir, H., & Kanwal Bilal. (2023). Symmetric impact of Trade, exchange rate, and inflation rate on Stock Market in Pakistan: New evidence from Macroeconomic variables. *Bulletin of Business and Economics*, *12*(3), 903–911.

Marc, A. & Amjad, A. (2017). Environmental Degradation, Energy consumption, Population Density and Economic Development in Lebanon: A time series Analysis (1971-2014). *Journal of International Finance and Economics*, 17(1), 7-20.

Marc, A., & Amjad, A. (2023). The role of environmental conditions and purchasing power parity in determining quality of life among big Asian cities. *International Journal of Energy Economics and Policy*, *13*(3), 292-305.

Marc, A., Poulin, M., & Ali, A. (2024). Environmental impact of business freedom and renewable energy: a global perspective. *International Journal of Energy Economics and Policy*, *14*(3), 672-683.

Masri, R., & Wimanda, E. (2024). The Role of Green Supply Chain Management in Corporate Sustainability Performance. *Journal of Energy and Environmental Policy Options*, *7*(2), 1-9.

Minhas, A. S., Maqsood, N., Shahid, T. A., & Rehman, A. U. (2024). Investment Performance in Green Finance: Assessing the Impact of Environmental Social and Governance Integration. *IRASD Journal of Economics*, *6*(1), 27–44.

Naz, N., Gulab, F., & Aslam, M. (2022). The Socio-Cultural Factors Influence On Women's Ability To Become Social Entrepreneurs. *Competitive Social Sciences Research Journal (CSSRJ)*, *3*(2), 42–52.

Nazik Maqsood, T. A. S. and A. U. R. (2024). The Impact of Dividend and Tax Avoidance on Earning Management of Companies. *Bulletin of Business and Economics*, *13*(April), 256–272.

Parveen, S., Hanif, A., Rahman, D. S. U., & Sheikh, D. S. M. (2024). Examining the Effect of Foreign Direct Investment and Exports on Stock Market Performance: Evidence from India Based Bound Testing to Cointegration ARDL Approach. *Bulletin of Business and Economics*, *12*(4), 700–707.

Qureshi, ghaziaKhoulaQureshi G. K., Zaman, mWaheed M. W. U., Rahman, saifUrRahman S. U., & Shahzadi, hafizaNabilaShahzadi H. N. (2022). Legal Insights of Crypto-currency Market and State of Crypto-currency in Pakistan. *Superior Law Review*, *2*(1), 77–104.

Rabbia Syed, Sehrish Arshad, S. U. R. and S. M. S. (2024). An Overview of Foreign Direct Investment and Green Growth in OIC Countries. *Pakistan Journal of Humanities and Social Sciences*, *2*(1), 8826.

Radas, A. (2023). Inclusive business models as drivers of sustainable growth and social progress. *Journal of Policy Options*, *6*(3), 9-14.

Rahman, S. ur, Chaudhry, I. S., Meo, M. S., Sheikh, S. M., & Idrees, S. (2022). Asymmetric effect of FDI and public expenditure on population health: new evidence from Pakistan based on non-linear ARDL. *Environmental Science and Pollution Research*, *29*(16), 23871–23886.

Rahman, S., & Bakar, N. A. (2019). *Long Run Relationship between Domestic Private Investment and Manufacturing Sector of Pakistan : An Application of Bounds Testing Cointegration Saif ur Rahman Nor ' Aznin Abu Bakar Sa ... Long Run Relationship between Domestic Private Investment and Manuf*. *39*(August), 739–749.

Roussel, Y., & Audi, M. (2024). Exploring the Nexus of Economic Expansion, Tourist Inflows, and Environmental Sustainability in Europe.

Sadia Bint Raza, Sheikh, S. M., & Rahman, S. U. (2024). The Mediating Role of Agency Cost between Corporate Governance and Financial Performance: Evidence from Pakistan Stock Exchange. *IRASD Journal of Economics*, *6*(1), 144–163.

Saif Ur Rahman, Salyha Zulfiqar Ali Shah, S. M. B. and F. N. J. (n.d.). Impact of Resource Rents and Institutional Quality on Economic Growth : An Approach of Panel Threshold Analysis. *Competitive Educational Research Journal*, *3*(2),

195–208.

Shahid, A. U., Ghaffar, M., Rahman, S. U., Ali, M., Aslam Baig, M., Idrees, S., & Baig, M. A. (2022). Exploring The Impact Of Total Quality Management Mediation Between Green Supply Chain Method And Performance-Palarch's. *Journal Of Archaeology Of Egypt/Egyptology*, *19*(4), 1252–1270.

Shahid, T. A. (2024). *Effect of Public Investment on Health Population : A Review of BRICS Countries*. *6*(1), 1–9.

Shahid, T. A., Zafar, M., & Minhas, A. S. (2023). Testing the Economic Theory of Crime in case of Pakistan. *UCP Journal of Business Perspectives*, *1*(2), 73–86.

Shahzadi, H. N., Ali, M., Ghafoor, R. K., & Rahman, S. U. (2023). Does Innovation and Foreign Direct Investment Affect Renewable Energy Consumption? Evidence from Developing Countries. *Pakistan Journal of Humanities and Social Sciences*, *11*(2), 908–916.

Sharma, R., & Das, V. (2024). A Review of Sustainable Agriculture and Renewable Energy Pathways for Reducing Environmental Degradation. *Journal of Energy and Environmental Policy Options*, *7*(3), 14-22.

Sheikh, U. Q., & Ahmad, H. K. (2020). Exploring the nexus of foreign aid, energy production, human capital, and income inequality in Pakistan: A time series analysis. *Journal of Business and Economic Options*, *3*(1), 18-25.

Shen, Y., Ur Rahman, S., Hafiza, N. S., Meo, M. S., & Ali, M. S. E. (2024). Does green investment affect environment pollution: Evidence from asymmetric ARDL approach? *PLoS ONE*, *19*(4 April), 1–25.

Singh, U., & Kumar, K. (2023). Exploring the Interconnection Between Anthropogenic Activities and Greenhouse Gas Emissions: An Empirical Study. *Journal of Energy and Environmental Policy Options*, *6*(4), 43-53.

Song, M., Anees, A., Rahman, S. U., & Ali, M. S. E. (2024). Technology transfer for green investments: exploring how technology transfer through foreign direct investments can contribute to sustainable practices and reduced environmental impact in OIC economies. *Environmental Science and Pollution Research*, *31*(6), 8812–8827.

Tabassum, N., Rahman, S. U., Zafar, M., & Ghaffar, M. (2023). Institutional Quality, Employment, Trade Openness on Environment (Co2) Nexus From Top Co2 Producing Countries; Panel ARDL Approach. *Review of Education, Administration & Law*, *6*(2), 211–225.

Tanveer Ahmad Shahid, Amna Shafiq Minhas, I. U. R. and A. U. R. (2023). Impact of Human Development Index on Economics Growth: Evidence from Asian Countries. *Article in International Journal of Innovative Science and Research Technology*, *8*(2).

Turan, F., & Can, S. (2024). Innovation as a Driver of Growth in the Context of Circular Economy and Green Management. *Journal of Policy Options*, *7*(4), 1-13.

Ullah, S., Ur Rahman, S., & Rehman, C. A. (2023). Public Investment, Technological Innovations, and Environmental Degradation: Asymmetric ARDL Approach. *Pakistan Journal of Humanities and Social Sciences*, *11*(2), 730–741.

Ur Rahman, S., & Bakar, N. A. (2018). A Review of Foreign Direct Investment and Manufacturing Sector of Pakistan. *Pakistan Journal of Humanities and Social Sciences*, *6*(4), 582–599.

Ur Rahman, S., & Bakar, N. A. (2019). Manufacturing sector in Pakistan: A Comprehensive Review for the Future Growth and Development. *Pakistan Journal of Humanities and Social Sciences*, *7*(1), 77–91.

Urban, D., & Radas, S. (2021). Managing Cruise Tourism for Sustainable Development in Dubrovnik: Revisited. *Journal of Policy Options*, *4*(4), 1-8.

Wang, J., & Li, J. (2024). Green Innovation and Economic Growth Balancing Development and Environmental Protection. *Journal of Energy and Environmental Policy Options*, *7*(3), 1-13.

Wang, Z., & Manopimoke, P. (2023). Exploring the Interplay Between Supply Chain Dynamics and Organizational Culture in Green Practices Adoption: A Study of Thailand's Hospitality Sector. *Journal of Energy and Environmental Policy Options*, *6*(4), 21-32.

William, C., & Adam, A. (2018). Sustainable Power Choices: An Analysis of CO2 Mitigation and Renewable Energy in USA. *Journal of Energy and Environmental Policy Options*, *1*(3), 54-59.

Yan, S., & Sriboonchitta, S. (2024). Governance, Renewable Energy, and Urbanization: Drivers of Environmental Outcomes in Asia. *Journal of Energy and Environmental Policy Options*, *7*(4), 42-51.

Zahra, A., Nasir, N., Rahman, S. U., & Idress, S. (2023). Impact of Exchange Rate, and Foreign Direct Investment on External Debt: Evidence from Pakistan Using ARDL Cointegration Approach. *IRASD Journal of Economics*, *5*(1), 709–719.

Zhao, J., Rahman, S. ur, Afshan, S., Ali, M. S. E., Ashfaq, H., & Idrees, S. (2023). Green investment, institutional quality, and environmental performance: evidence from G-7 countries using panel NARDL approach. *Environmental Science and Pollution Research*, *30*(45), 100845–100860.

Zubair, S., Rahman, S. U., Sheikh, S. M., & Zafar, M. (2024). A Review of Green Innovation and Environmental Performance in BRICS Nations. *Pakistan Journal of Humanities and Social Sciences*, *12*(1), 444–449.

Zulfiqar, M., Ansar, S., Ali, M., Hassan, K. H. U., & ... (2022). The Role of Social Economic Resources Towards Entrepreneurial Intentions. *PalArch's Journal of …*, *19*(1), 2219–2253.