Green economy performance and sustainable development achievement: empirical evidence from Saudi Arabia

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Abstract
As a pillar of United Nations, the Kingdom of Saudi Arabia pursues to greener its economy and achieve the Sustainable Development Goals of the 2030 Agenda. The green economy represents a catalyst for sustainable development in its three dimensions -economic, social and environmental- aiming to improve human well-being and social equity and reduce environmental risks. However, the relevant previous studies lacked the role of green economy on sustainable development for the Saudi Arabia. For this purpose, this paper aims to explore how green is the kingdom and analyze its performance toward sustainable development from 2015 to 2020. To do so, we adopt the EEPSE Green Economy Index that combines educational, economic, political, societal and environmental indicators associated with the pillars of the Quintuple Helix Innovation Model. In this study, this index is composed of 42 indicators related to the green economy and the sustainable development. The empirical results suggest that the Saudi Arabia witnessed a significant progress of EEPSE GEI score. In addition, the findings support that the performance of the kingdom regarding the green economy is affected after the COVID-19 crisis. Thus, the paper provides original visions for policy makers to encourage the transition to green economy which constitutes the main locomotive to attain the economic, social and environment sustainability for the kingdom.

Keywords Green economy · Sustainable development · EEPSE Green Economy Index · Quintuple Helix innovation model
1 Introduction

The environmental degradation and pollution besides the rapid spread of COVID-19 crisis across countries in the world have disrupted the livelihoods and undermined the well-being. The recovery from these crises becomes the major challenge for communities. In fact, Governments need new ways to enhance the resilience of economies and societies and sustain the environmental quality. “Green” stimulus was one of the several proposals for pandemic alternative that helps the economy recovering and facilitates it transition to a cleaner and more sustainable path (Chen et al., 2020). Correspondingly, there is an urgent need to integrate climate and development strategies providing green, resilient, and inclusive development (Alsmadi & Alzoubi, 2022; Bowen & Hepburn, 2014; Mikhno et al., 2021; World Bank Group, 2021). These strategies may develop a new economy with green growth and sustainable development based on digitization and technologies, cross-sectorial efforts and systemic innovation adding an effective policy that is reflected in Sustainable Development Goals (SDGs) of United Nations’ 2030 Agenda (Adamowicz, 2022; Dissanayake et al., 2021; Fouquet, 2019; Khoshnava et al., 2019; Mealy & Teytelboym, 2020; Merino-Saum et al., 2018). The SDGs were officially adopted in September 2015 by the United Nations General Assembly (UNGA) with 17 goals and 169 targets responding development in its three dimensions economic, social and environmental (United Nations, 2015).

The United Nations Environment Program (UNEP) defines the green economy as “one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities. In its simplest expression, a green economy can be thought of as one which is low carbon, resource efficient and socially inclusive.” (UNEP, 2011). In December 2019, since the beginning of the coronavirus pandemic, the European Commission underpin their economic and social model. This latter set the European Green Deal that is a new growth strategy dealing with sustainability in its three dimensions in the Recovery Plan for Europe (Commission et al., 2019).

In the same way, the Kingdom of Saudi Arabia (KSA) seeks to realize the sustainable development goals, especially that it characterized with economic development and continuous population growth coupled with the rapid urbanization. To do so, the KSA needs more than a traditional economy, an economy which goes in line with the achievement of the SDGs of the 2030 Agenda. The ‘Vision 2030’ program based on three pillars a vibrant society, a thriving economy and an ambitious nation represents a departure of Saudi Arabia to a novel economy and society however it is a significant challenge that need new efforts to balance between economic growth and sustainable development. Indeed, to accomplish this program, several series of policies and strategies are necessary to be developed based on a framework for the implantation of environmental and economic sustainability and promoting social well-being. To realize these policies, the government launches several projects and initiatives such as the Saudi Green Initiative, NEOM project and Saudi MADE program (Kingdom of Saudi Arabia, 2016; A Sustainable Saudi Vision–Vision 2030).

In this regard, this paper aims to examine how green is the KSA and how it performs to achieve sustainable development during the period 2015–2020 using a novel economic index adopted from EEPSE Green Economy Index (EEPSE GEI). This index is based on the Quintuple Helix Innovation Model (QHIM) which shows the importance of the relationship among the economic actors; education, industry, government, society and environment. Each system is connecting with the other functioning as spiral that generates a national, regional and global impact (Rybalkin et al., 2021). This index system
technique combined with the QHIM serves as analytical tools for pursuing SDGs (Franc & Karadžija, 2019; König et al., 2020). Additionally, it represents a powerful decision-making tool, proven by the international organization such as the United Nations and UNESCO (Baguma et al., 2016; Millard, 2018) allowing to frame research and policies to build resilient infrastructures, promote inclusive and sustainable industrialization, and foster innovation.

Our theoretical and empirical contributions in this paper are twofold. First, most of the contemporary research has been focused on the renewable energy consumption–environment nexus without admitting how green economy can close the gap between economic activity and sustainable development in Saudi Arabia. As far as we are concerned, to our knowledge, there is very few studies that have examined the combination of the two main frameworks of the green economy and sustainable development in Saudi Arabia (AlArjani et al., 2021; Albanawi, 2015; Alwakid et al., 2020). Second, from an empirical side and compared to existing studies, this paper adopts a novel index system technique that assesses the performance of green economic development and reflect the sustainable development goals achievement for the case of Saudi Arabia.

The remainder of this manuscript is organized as follows: The literature on the importance of the green economy and sustainable development was reviewed in section two. In section three, the methodology, data sources and variables used in this study are displayed. In section four, the finding of this research was reported. The last section drew the conclusion and proposed some policy implication.

2 Literature review

The need to develop of a new economy, new policy growth and new economic measurement become a necessity for economies to attain the SDGs established by the United Nations. In fact, the 2030 Agenda for sustainable development represents an action plan for the economists, politicians, society, and the planet, which seeks sustainable development in its three dimensions, economic, social and environmental (Khoshnava et al., 2019). Green economy is estimated as a catalyzer to this new economic program as it aims to improve the efficiency of resource use, ensure the ecosystem resilience and enhance the social equity (Brears, 2018).

In 1989, the concept of green economy was established for the first time in the Blueprint for a Green Economy report prepared for the United Kingdom Government by a group of economists in the field (Pearce et al., 1989). In 2008, the UNEP developed the Green Economy Initiative to support investment in green sectors and encourage greening specific area (UNEP, 2008). In 2012, the UNGA convened UN Conference on Sustainable Development Rio +20, in which they consider green economy a tool to achieve sustainable development (United Nations, 2012). The green economy term and concepts related to it like green growth and sustainable development have progressed from its appearance until now (Dogaru, 2021).

Existing literature reviews on green economy and sustainability during the past years have prioritized qualitative research method to present new concepts, tool and approach related to this field (Capasso et al., 2019; Diyar et al., 2014; Loiseau et al., 2016; Merino-Saum et al., 2020).
In a recent research, Capasso et al. (2019) show that more than 113 scientific articles focused on innovation, environmental and economic issues for 2010–2016 period using the approach of evidence-informed review methodology, explored that green economy needs new competence in the private and public sectors as well as developing green technologies is crucial to realize green growth. Most important, the quality and the relevance of physical resources, skills, technology, markets, institutions and policies can be not only drivers for green growth but also barriers. In the same trend, Zhironkin and Cehlár (2022) confirm that a true transition to green economy requires production and consumption saturation of green technologies coupled with a sustainable development of all industries. D’Amato and Korhonen (2021) applied the Natural Step Framework in their research to detect the contribution of the circular economy, bioeconomy and green economy for achieving global sustainability goals. They approve that the complementarity between the three narratives is crucial to provide important plans for sustainability transformations post-COVID-19 as well as there is a necessity for more universal systems and integrative research work on potentially sustainability narratives. Capabilities to advance the green economy and the reorientation of the existing economic structure to an environmentally friendly one is not an easy task for countries. In the same line, Ali et al. (2021) applied the Strengths, Weaknesses, Opportunities, and Threats (SWOT) analytical tool to explore strengths, weaknesses, opportunities, and threats of Ghana’s efforts to be greener. Results show that despite the implementation of different policies and strategies regarding the green economy, Ghana still suffer from inadequate long-term policies, inadequate funding for technologies innovations and weak institutions. The intensive use of capital and the lack of control over the destruction of natural capital represent other factors that can threat the environment and delay the progress to the green economy.

In line with SDGs of the 2030 Agenda, several research discussions interested to clarify quantitatively the importance of these goals for the nations’ transition toward green economy. The SDGs index launched in 2015 is one of the best tools that presents information on countries’ performance regarding the SDGs. The overall index indicates the country’s position compared to the best possible score across all SDGs. In the sustainable development report of 2021, a significant decline in the average SDG index caused by the COVID-19 pandemic. This crisis has a direct impact on the three sustainable development’s dimensions that call countries to take actions to create economic recovery and achieve the SDGs (Sachs et al., 2021). Merino-Saum et al. (2018), determine the relationship between SDGs and Natural Resources using 494 green economy indicators derived from 12 different frameworks concentrating on green economy and green growth. Strong interlinkages with different intensities were interpreted as well as all SDGs are related to at least one Natural Resources in the green economy indicators perception. Basing on global “green” economy index, results shows that hydrocarbon-exporting countries presents the lowest level of the rating, which inquires new level of management from public and private sectors (Prudnikova, 2020). For instance, countries with greater environmental patenting rates, lower CO2 emissions, and efficient stringent environmental policies are more capable to the transition toward the green world. This ranking is based on data-driven approach to analyze green production capabilities across countries between 1994 and 2014 (Mealy & Teytelboym, 2020). In further research, dynamic indicators of green growth and green investments indicate that Russia have recorded a significant growth of green investments and it remains behind the leading countries of the world between 2000 and 2018 (Tarkhanova et al., 2020). Recently, Petrushenko and Grunwaldt (2021) outlines the importance of sustainable development at the local level with the example of Kyiv city in Ukraine during the period 2017–2019. To do so, they applied the QHIM. Findings show that the city and the country
in whole can mark a real transition to achieve the SDGs only with the accelerating in the transformation of the projects’ structure that ensures the development of economic, social and environmental aspects. To know the relationships between the variables affecting SDGs and support decision-making in Latin American countries, the QHIM was integrated using 20 indicators related to the SDGs. The QHIM findings indicate the importance of harmony between the five systems of the model (Barcellos-Paula et al., 2021). Using the same model (QHIM), Lavrinenko et al. (2019) tried to evaluate the sustainable development and the importance of the green economy in the European Union (EU) countries for the period 2016–2017. The authors confirmed the positive role of “green economy” in the sustainable development in the EU countries. Kasztelan (2021) also demonstrates the importance of the implementation of green economy in the EU countries between 2000 and 2018 through a synthetic evaluation index composed of 27 indicators. The findings indicate a slowdown in the greening processes due to lack of energy efficiency, low resource productivity rate and social exclusion. However, China represents a good example of realizing a significant green growth and improving its sustainable development. Ecological civilization and social progress besides economic development and innovations are the main factors promoting the green economic growth according to a comprehensive index system of green economy introduced by Lin and Zhou (2022). Another new index presented by Usubiaga-Liaño and Ekins (2021) is the Strong Environmental Sustainability Index based on the Environmental Sustainability Gap framework. This index is composed of 21 indicators in which each of them is related to the functions of natural capital. The main findings show that the functions of natural capital decreased in 28 European countries representing weak performance in indicators related to pollution and the health ecosystem.

In the context of the KSA, few researches concentrate to explore the relationship among green economy and SDGs with quantitative approach (AlArjani et al., 2021; Albanawi, 2015; Alwakid et al., 2020). In fact, Albanawi (2015) examines the main barriers, strategies and opportunities of KSA sustainable development and greener infrastructure through the analysis of journal articles and available literature statistics and data from government. The study concludes that there is a need to the implement of greener projects and environmental initiative. Nevertheless, Alwakid et al. (2020) are interested to explore the development of green entrepreneurship through the analysis of the relationships between cultural characteristics and environmentally friendly entrepreneurship during the period 2015–2018. These relationships are tested using 84 observations from 21 cities analyzed with regression models. Results verify that the level of green entrepreneurial activity across cities in the KSA increases with specific cultural characteristics, such as environmental actions and environmental consciousness.

In a different study, AlArjani et al. (2021) represent the first study applying mathematical model through the row geometric mean method to quantify the achievement level toward the SDGs. The model covers three goals linked to the gross domestic product, sustainable energy consumption and employment capacity. The study confirms that the KSA achieves only 57% of studied goals that requires more effort in advancing resources in alternative energy sources, including renewable energy. Alwakid et al. (2021) approve that green entrepreneurial activity increases all the sustainable development components during the period 2012–2017 through the data collected from the General Authority for Statistics from 13 Saudi Arabian cities.

This review exposes different studies that addressed the use of indicators related to the green economy and the SDGs achievement, but no existing index considers the relationships among the three dimensions of sustainable development (social, economic and environmental) with a particular focus on the green economy and sustainable development of
KSA. Thus, the purpose research is to carry out new evaluation to explore the development sustainability and how green is the KSA during the period 2015–2020.

3 Methodology

3.1 Introduction of Quintuple Helix innovation model and SDGs

To analyze green economy trend and sustainable development in the KSA, we adopt the EEPSE GEI introduced in 2021 by Rybalkin et al. (2021). This index combines educational, economic, political, societal, and environmental indicators that is inspired from the QHIM. This latter represents a reference for many organizations like the United Nations and the European Union in their guidelines and handbooks production (König et al., 2020). Also, in the United Nation Report, Baguma et al. (2016) approve that the QHIM provides all knowledge needed to bring all the SDGs comprising environmental sustainability. The helix model developed through the economic and society needs and progress that seeks to describe the dynamic relation among the actors of a society. The double helix model is the first helix model that includes a linear linkage between academia and entrepreneurs (Gibbons et al., 1994). The development of information and communication technologies leads to the necessity to add new helix which establish knowledge and innovation in society, namely government developing the triple helix model. This model is an innovation spiral model that explains the importance of innovation among the three strands and aligns the educational system with the needs of labor market (Etzkowitz & Leydesdorff, 2000). The Quadruple Helix is introduced due to the rapid progress of knowledge society. The fourth element added to the first three mentioned is media-based and culture-based public (Carayannis & Campbell, 2009). Later, significant challenges and crises in the world, especially pollution and environment degradation were the most important factors for the introduction of the QHIM. The fifth added dimension called environment highlights the sociological transformations and the natural environment significance. The natural environment in the QHIM aims to generate new green technologies as well as preserve the humanity (Barcellos-Paula et al., 2021; Carayannis & Campbell, 2010; Franc & Karadžija, 2019).

In the QHIM, each system presents a knowledge helix that functions as a spiral connecting with the other systems. This connection creates knowledge as an output of one system which represents an input for the other systems of the QHIM. Figure 1 describes this continuous circulation of knowledge within the five systems which stimulates knowledge, sustainability development and innovations creation besides it makes all systems affect each other (Carayannis et al., 2012).

For instance, the first system of QHIM is -education- that represents the human capital development. The second system -economic- emphasis the economic capital, while the third system -political system- focus on political and legal capital. The fourth system -societal- describes information and social capital, which are basic element of innovation participant. The last system -environment- represents the fundamental factor to realize greener economy and sustainable development.

The SDGs represent the action plan for achieving sustainable development in the world, but the challenge for the countries is how to operationalize and realize these goals. To achieve the SGDs all stakeholders such as, industries, civil society and academia must work together (Sachs et al., 2019). The KSA launched different initiatives and strategies responding to the SDGs starting from the introduction of Vision 2030 by HRH the Crown Prince Mohammed
bin Salman in 2016 down to the launch of The Saudi Green Initiative and The Middle East Green Initiative in 2021.

The SDGs framework and the Helix models are commanding tools for educating and progressing societies despite their different logics. Thus, the helix models afford conceptual frames centered on the linkage and the relation among academia, economy, government, civil society and the environment, while the SDGs provide practical plan actions and very specific targets in different domains like politics, social economic, environment and education (König et al., 2020). However, there is a need of new measure that response to the combination of both frameworks.

The purpose of emerging a new composite measure is to formulate an instrument for researchers and policy makers to assess how green is the country in our case the KSA and how it progresses to achieve development sustainability presented by the SDGs.

A composite indicator is established using 42 indicators of green economy and indicators related to SDGs covering the five dimensions of the QHIM. The index inspired from the results of the study of (Rybalkin et al., 2021) cannot be a single indictor but a composite index due to the multidimensional process. However, it is easily interpreted by any user.

### 3.2 Selection of indicators

The QHIM has proved it efficiency as an inter-disciplinary and trans-disciplinary framework. It examines the synergies between society, ecology and economy and represents the perfect model that can be used to assess the transition to the green economy and achievement of the sustainable development. From the perspective of the QHIM, 42 specific
indicators associated to the green economy and the SDGs are selected. The indicators are grouped on five systems: education, economic, civil societal, government and environment ("Appendix"). Some indicators differ from those of EEPSE GEI in Rybalkin et al. (2021) research due to the missing data for the KSA. However, other indicators are chosen in line with the indicators of SDGs. The data are collected from different online databases like the World Bank Indicators and OECD Statistics.

For instance, the study covers annual data over the period of 2015–2020 for the KSA indicators. The selected period was chosen for two main reasons. Firstly, the year 2015 represents the date of launching the SDGs plan action. Secondly, since 2019 the COVID-19 pandemic appeared and upsets the economic, social and environmental features all over the world, which is crucial to educate how this pandemic has impacted the performance of the KSA.

3.3 The construction of the index

The construction of the final EEPSE GEI requires three steps. The first step consists on dimensionless standardization to make all indicators comparable. The next step is the standardization of indicators which a very important since the indicators are expressed in different units in the sub-dimensions. In EEPSE GEI, the normalization was carried out according to the method of Z-score. To observe them better, we use the transition to T-score by the formula

\[ T = (Z \times 10) + 50. \]

Then, all the systems corresponding to the QHIM are attained as arithmetic means of the corresponding indicators. Finally, the general indicator EEPSE GEI is estimated as the arithmetic mean of the values of five systems.

4 Results and discussion

This section presents and discusses the empirical findings of this study. The application of the QHIM in the EEPSE GEI affords qualified and accessible indicators from official sources which put decision-making more certain. With the QHIM it is possible to identify in the one hand the effect of each helix and its links with the SDGs and in the another hand the performance of the country globally toward green economy and sustainable development (Barcellos-Paula et al., 2021; Bonnet et al., 2021; Janoušková et al., 2018). Table 1 defines the EEPSE GEI results of the KSA according to its most recent data indicators. A significant progress of EEPSE GEI score of this country was proved from 47.70 to 51.12 among the 2015 to 2020 period. Comparing our findings to the results of the study of Rybalkin et al. (2021) which are taken as basis, the KSA can be considered within the countries with high score since 2017. Despite the result confirming that this first is performing well in overall indicators related to the green economy and sustainable development, the study pinpointed opportunities for improvement in all systems. In fact, the KSA reaches a EEPSE GEI score equal to 51.12 in 2020 which is close to the Estonia’s score (51.07). The lowest value of EEPSE GEI score was in 2016 with a score equaling 47.32 due to the weak performance of economic and environmental system. The weak performance of the economic system is affected by decreased oil price in 2016 and the slowdown of the Gross Domestic Product while the weakness of the environmental system is affected essentially by a high per capita energy-related CO₂ emissions (Burck et al., 2016; World Bank Group, 2016). Yet, the EEPSE GEI score increases with 9.76% between 2016 and 2017 remarking the best
performance of the KSA thanks to environment system performance. Indeed, in 2017, the environment system has recorded the strongest results among all systems during the six years with a score equaling 55.55. This progress can be a result of the effort of the KSA regarding environmental dimension with the announcement of the National Renewable Energy Program in 2017 that seeks to diversify local energy sources and reduce carbon dioxide emissions and the launch of the National Environment Strategy in 2018 (Saudi Green Initiative, 2022). Though, we can observe an important decrease in the performance of the fifth system in the last two years which reflects the impact of the COVID-19 crisis on the environment sustainability and the failure of renewable energy in advancing the economy and protecting the environment (AlArjani et al., 2021; Kahia et al., 2021). In this point, the KSA still needs some improvements such importing more environmentally friendly technologies, encouraging renewable energy projects and encouraging the use of effective energy technologies not only for industries but also for consumers to meet the industrial and domestic energy demand.

The results of each system were analyzed according to its importance in the EEPSE GEI. Considering the importance of the five systems of the index, the political factor represents the most important determinant in the index then education system. The civil society is in the third place, while the environment takes the fourth place, and the economy system has the least important role (Rybalkin et al., 2021). Indeed, the political system score of the KSA raises significantly since 2015 and represents the best value among the other systems in 2020 with 54.09 score which is almost the same score of France (54.06). This result indicates that political system has an important effect on green economy and sustainable development in 2020 and support the economy to recover from the COVID-19 pandemic. Thanks to the establishment of Vision 2030 infrastructure that provides to the KSA an important prospect for implanting the SDGs into the existing governance system and records this strong value (Toward Saudi Arabia’s Sustainable Tomorrow, 2018). Similarly, the education system performs strongly on sustainable development according to the findings, especially in 2020 thanks to the supportive national strategy for continuing education quality in the pandemic among the online education and the encouragement of research and development. This academic system is the only system that witnessed a continuous rise over the study period which verifies the good pathway of the KSA to achieve the SDG4 (Quality Education) (United Nations, 2018).

Table 1: The performance scores evolution across all the EEPSE GEI systems for Saudi Arabia

|            | Quality of education system | Economic aspects | Political system | Civil society | Natural environment | EEPSE GEI |
|------------|-----------------------------|------------------|------------------|--------------|---------------------|-----------|
| 2015       | 46.66                       | 54.70            | 47.26            | 44.92        | 44.98               | 47.70     |
| 2016       | 47.77                       | 48.85            | 46.98            | 50.76        | 42.26               | 47.32     |
| 2017       | 50.23                       | 50.39            | 49.72            | 55.08        | 54.25               | 51.94     |
| 2018       | 50.33                       | 49.19            | 48.83            | 49.78        | 55.55               | 50.74     |
| 2019       | 51.99                       | 47.14            | 53.12            | 49.78        | 53.88               | 51.18     |
| 2020       | **53.02**                   | 49.73            | **54.09**        | 49.67        | 49.08               | 51.12     |

*Source:* The authors' calculations in SPSS according to statistical data

The bold values indicated the best performance score among each system. However, the bold values of the last column revealed the evolution of EEPSE GEI score
Concerning the civil society system, it noticed a weak performance on sustainable development with an incessant decrease value since 2018, where the weakest value is given with a score equaling to 49.67 in 2020. This result can be associated with COVID-19 pandemic’s socio-economic impact since it directly impacted the healthcare sector and shut down the educational institute due to home quarantine. Therefore, the KSA has different potential for improvements by establishing National Strategy for Social Development which seeks to add financial resources, provide personal protection equipment to healthcare population, support online education, improve the internet service and introduce supportive labor market regulations targeting private sector which go in line with the SDG1 (No Poverty), SDG2 (Zero Hunger) and SDG3 (Good Health and Well-Being) (United Nations, 2020). At the same time, the economic capital system performed poorly toward the sustainable development, especially in 2019 with a score equal to 47.14. This could be attributed to the oil prices crisis in the world market coinciding with the health crisis and caused the shutdown of business around the globe for nearly one year as well as the weak consumption of renewable energy during the last six years. Far greater efforts are needed to achieve the SDGs for economies heavily reliant on oil such the KSA starting by diversifying the economy and localizing the oil and gas sector besides maximizing investing capabilities in different aspects to realize SDG7 (Affordable and Clean Energy), SDG9 (Industry, Innovation and Infrastructure), and SDG11 (Sustainable Cities and Communities).

5 Conclusion and policy implications

Several important indicators are introduced as a tool to analyze the green economy development and describe the extent of sustainable goals achievement. Thus, few scholars tried to make assessment of this interplay using multidimensional index (Barcellos-Paula et al., 2021; Bonnet et al., 2021; König et al., 2020; Lavrinenko et al., 2019; Rybalkin et al., 2021). The present paper examines how green is the KSA and how it performs toward the sustainable development realization. For the empirical purpose, our intention was to apply a novel system index composed of five systems reflecting the pillars of the QHIM which are education, economy, politics, society and environment which is proven as a powerful decision-making tool. The empirical finding indicates the unsteady performance of the Kingdom during the period 2015–2020. For the first three years, a constant increase in the EEPSE GEI score was observed. This progress is explained by the increase in the five systems’ performance during this period specifically the environment system performance with an increase of 23% from 2015 to 2018. Since 2019, the period of COVID-19 pandemic appearance, the EEPSE GEI score was declined. This result is attributed also to the significant descent of the environment system score. However, the political system performs strongly toward green economy and sustainable development achievement in the same period.

Despite the empirical results indicate that the KSA has a good performance toward the green economy and the attainment of the sustainable development, it has not yet reached its best performance and it still faces major challenges on environment protection, well-being enhancing, and economic diversifying. In addition, the SDGs Dashboard report of 2020 shows that the Kingdom is ranked 97th among 163 countries in terms of sustainable development goals achievement which confirms that the country needs to make further efforts concerning the sustainability in its three dimensions (United Nations, 2020). Concerning the economic dimension, the empirical findings show the feeble renewable
energy consumption, the weak sustainable competitiveness since the KSA is ranked the 108 among 180 countries and the lack of a coherent ecosystem process to support the innovation capabilities represent the major weaknesses (Schwab & Zahidi, 2020). Concerning the environment dimension, some factors participate to the environment degradation such the failure to reduce CO₂ and other greenhouse gas emissions, the absence of environmental regulations and the weak climate change performance, the lack of consumers’ awareness regarding environmental protection, the energy use are some important weaknesses. Regarding the social dimensions, the global average score for gender equality, including reproductive health, empowerment, and economic status, has decreased since 2019 (Khan et al., 2021).

Consequently, it is crucial that policy makers develop some technological, financial, and environmental policies. These policies can help take advantage of the strengths, especially that the KSA is a pioneer on launching and establishing strategies and initiatives that go in line with the SDGs achievement and green economy development such the Saudi Vision 2030 and the National Transformation Program serving as solutions to the weakness and threats. Thus, the KSA needs to act more powerfully in more than one direction. Firstly, further encouragement of research and development concerning innovation and green technologies is needed to achieve the SDG4 and further SDG9, especially that the education system score increases steadily from 46.66 in 2015 to 53.02 in 2020 reflecting the good path of the KSA toward the importance of the education in the building skills that are necessary for the labor market. It is imperative to boost green and renewable energy investments, reduce energy consumption in industries and implant green technologies besides set up more environmental regulation such applying a smart tax system which responds to the realizing of SDG7, SDG9 and SDG13 (Climate action). In addition, promote the consumer’s and users’ awareness of ecological protection is very important step to the Saudi Arabia’s transition to the green economy and realizing sustainable development serving the SDG3, SDG11 and SDG12 (Responsible consumption and production) achievements, after finding that the civil society system performs poorly regarding the green economy and the sustainable development during the period 2015–2020. In fact, the Kingdom starts the implementation of such strategies in launching the National Environment Strategy in 2018 and the updating of the National Urban Strategy 2030 in cooperation with the United Nations Development Program (A Sustainable Saudi Vision–Vision 2030). The decline of oil consumption due to the economic impacts of the COVID-19 health crisis, the climate change mitigation and the environment protection represent a big challenge for the KSA since it is rating highly insufficient (Saudi Arabia | Climate Action Tracker, 2021). This effect requires an urgent effort such Saudi Green Initiative 2021 to reduce the carbon emissions and realize the SDG13 that help to ameliorate the air quality and reduce the environment degradation. However, this strategy will take a long time to be fruitful aiming to reach net zero by 2060 (Saudi Green Initiative, 2022). In order to achieve SDG14 (Life below water) and SDG15 (Life on land), the KSA will launch different initiatives like Saudi Aquaculture Society, Desert Preservation Initiative in 2025 that aims to achieve 20% of protected land by 2030 noticing that it have just nearly 16% of land and sea under protection which is very neglected (Saudi Green Initiative, 2022). In short, the KSA is on the good path toward green economy and realizing the SDGs, but the implementation and the realization of the offered initiatives and strategies are very hard for all the economic actors and take a long time to be productive.

To conclude, promoting the transition to the green economy is vital to improve the economic, social, and environmental potential as well to ensure a sustainable future. Yet, to assure this transition, the cooperation between the government, academia, industry, society,
and nature which reflects the five systems of the Quintuple Helix Model become a requirement for all the economies.

Appendix

See Tables 2, 3, 4, 5, 6 and 7

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Data availability The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.
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Table 4  Political system indicators—political capital

| Variable | Meaning                                      | Unit     | Source     |
|----------|----------------------------------------------|----------|------------|
| G_1      | Climate change Performance Index             | Index    | CCPI       |
| G_2      | Intellectual property protection 1–7 (best)  | Score    | GCR        |
| G_3      | Environmental Performance Index              | 1–7 (best) | GII      |
| G_4      | Government effectiveness                      | Index    | GII        |
| G_5      | Information & communication technologies (ICTs) | Value    | GII        |
| G_6      | Environmental treaty ratification             | 0–27 (best) | TTCR   |
| G_7      | Stringency of environmental regulations       | 1–7 (Best) | TTCR    |
| G_8      | Enforcement of environmental regulations      | 1–7 (Best) | TTCR    |
| G_9      | GDP growth (annual %)                        | %        | WBI        |

CCPI: Climate Change Performance Index, GCR: Global Competitiveness Report, GII: Global Innovation Index, TTCR: The Travel & Tourism Competitiveness Report, WBI: World Bank Indicators

Table 5  Civil Society indicators—information capital

| Variable | Meaning                                      | Unit     | Source     |
|----------|----------------------------------------------|----------|------------|
| S_1      | Human development index                       | Score (0–1) | GE        |
| S_2      | Gross expenditure on R&D, % GDP              | %        | GII        |
| S_3      | Life expectancy                               | Value    | OECD       |
| S_4      | Social progress index                         | Index    | SPI        |
| S_5      | Human Capital Index (HCI) (scale 0–1)         | Score (0–1) | WBI   |
| S_6      | Individuals using Internet %                  | %        | WBI        |
| S_7      | Current health expenditure (% of GDP)         | %        | WBI        |
| S_8      | Females employed with advanced degrees, %    | %        | WBI        |

GE: the Global Economy, GII: Global Innovation Index, OECD: Organisation for Economic Cooperation and Development, SPI: Social Progress Index, WBI: World Bank Indicators

Table 6  Environment indicators—natural capital

| Variable | Meaning                                      | Unit     | Source     |
|----------|----------------------------------------------|----------|------------|
| E_1      | Ecological sustainability index              | Index    | GII        |
| E_2      | Environmental sustainability                 | 1–7 Best | TTCR       |
| E_3      | Baseline water stress                        | 5–0 (best) | TTCR |
| E_4      | Threatened species % total species           | %        | TTCR       |
| E_5      | Wastewater treatment %                       | %        | TTCR       |
| E_6      | Total natural resources rents                | % of GDP | WBI        |

GII: Global Innovation Index, TTCR: The Travel & Tourism Competitiveness Report, WBI: World Bank Indicators

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