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Green Technology and Sustainable Development: Assessment and Green Growth Frameworks

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Abstract: The aim of this study is to investigate the characteristics of a sustainable development assessment methodology being designed in the context of green technology. The methodology in question is based on indicators from the Sustainable Development Goals Index (SGDI), specifically in its ecological component. These indicators underlie an Averaging Sustainable Development Index (ASDI) and a Normalized Sustainable Development Index (NSDI). The resultant methodology was applied to 20 countries from the SDGI ranking. According to the research results, the intensive activity of the brown industries in the United Arab Emirates, Kazakhstan, the United States, Korea, and Russia resulted in significant carbon dioxide emissions. Switzerland, Kazakhstan, and Russia had high scores on sustainable management of water and sanitation. Russia was the only developed country to have an ASDI higher than its SDGI and its gap between NSDI and ASDI indexes was not significant, indicating a positive trend in greentech development. The reason why NSDI was increasingly different from SDGI was that countries leading the socio-economic rankings had higher consumption of energy and resources, and a much greater environmental footprint than those countries that consumed less. The originality of this study is that it identifies gaps between NSDI and ASDI values, which indicate that conditions for greentech adoption in most developing countries are unfavorable.

Keywords: green economy; green technology; innovation; investment; sustainable development index

1. Introduction

In the light of growing global problems such as climate change, population growth, environmental pollution, and inefficient use and depletion of natural resources, countries need to employ technologies and approaches towards economic activity that are environmentally less harmful and that preserve resources. Sustainable development is associated with less environmental damage and is driven by comprehensive and all-encompassing policies, both international and of single countries that take into account the needs of future generations. Among these policies, several suggest employing green technologies.

Threats such as the exhaustion of natural resources, climate change due to overpopulation, and the accelerating economic growth of new industrial countries (South Korea, Singapore, India, Malaysia, Turkey, Iran, the Philippines, etc.) associated with negative environmental impacts are widely recognized. They necessitate the adaption of new approaches to economic growth and development that would focus more on additional sources of growth to minimize the use of natural resources and improve the living conditions of the population [1].

The Europe 2020 strategy for smart, sustainable, and inclusive growth distinguishes the following major factors that contribute to the strengthening of the economy: smart growth (developing an economy based on knowledge and innovation); sustainable growth (promoting a more resource-efficient, greener, and more competitive economy); and inclusive growth (fostering a high-employment economy delivering social and territorial cohesion). This strategy has specially developed sections devoted to the smart use of resources and energy sources in Europe, to the economic transition towards a hydrocarbon-non-intensive scenario, and to the advantages of utilizing renewable energy sources and modernizing the transport sector [2]. Although its scope of application is wide enough, encompassing actions from the improvement of energy efficiency to the reduction of emissions, the strategy failed to cover the full range of green sectors.

According to the OECD report entitled "Towards Green Growth," policymakers should follow the concept of green growth. The economy needs to be flexible, dynamic, and efficient when using resources and imposing a mutual effect on the environment for its preservation. Innovation and investment are seen as drivers for the green technology development [3]. A development forecast is based on a common scenario (increasing productivity, innovation, and technology) that additionally brings an extra range of ecological advantages. Indirectly-mentioned threats such as climate change, the loss of biodiversity, and food shortages undermine the promotion of growth. The social pillar of sustainable development and green growth is also disregarded.

It is green technology that stimulates sustainable development, which means identifying environmentally-friendly sources of growth, developing new environmentally-friendly industries, and creating jobs and technologies [4]. To achieve green growth, it is necessary to intensify investments and innovations that represent a foundation of sustainable development and open new economic opportunities [5]. Thus, the promotion of green economy requires thorough research on the conditions of its formation, system-forming factors, and its impact on national sustainable development. Parties that are interested in green economic development include business (which focuses on economic benefits), the authorities (which set environmental goals of sustainable development), and the public (which represents the interests of a social community) [6].

To achieve goals of sustainable development, innovations are needed [7]. The processes of green knowledge management play a special role in sustainable development, more specifically the creation, acquisition, exchange, and use of knowledge, as well as its impact on green technologies, eco-innovations, and the socio-economic dimension of sustainable development [8,9]. Sustainable innovation allows the company to keep up with technology. The sustainable green innovations are aimed at the generation of high-quality innovative products that can reduce environmental footprint. As long as environmental issues arise, the importance of sustainable green innovations will be widely recognized [10]. The compliance with environmental standards is the strongest predictor in the structural model, representing the impact of variable environmental factors, i.e., innovations, on the environmental situation. Market orientation and technologies were proven to drive environmental performance, imposing a positive impact on the latter. The eco-innovation values enable companies to confront challenges inflicted by competitors in the market [11]. The increased investment in environmental and social information disclosure in corporations facilitates operational development [12].

Sustainable green technologies add much to a sustainable society while promoting environmental protection and economic development. Upon that, special attention should be paid to both determinants of sustainable green technology invention and differences between their development priorities [13].

Nevertheless, not only do the cumulative efforts of participants within the leader–follower supply chain with sustainable eco-innovations influence the creation of sustainable green innovations but also the equity among these participants. The latter posed major challenges for all participants within the supply chain, such as imbalances in supply and demand, environmental damage, and job distribution [14]. The current policy focuses on limiting the consumption of harmful products [15], on improving the effectiveness of supply chains in enterprises [16], and on integrating green human resource management (HRM) to companies. In this way, green employee behavior and green values will acquire a mediating role in reducing the environmental footprint [17].

Any country geared towards green growth first needs to solve a range of financing-related issues. Therefore, the current framework for sustainable development expands to place a financial component in line with the accepted environmental, social, and economic components [8]. Today, green finance can be regarded as (1) a component of the financial framework for sustainable development [18] and (2) a process of financing diverse activities including those conducive to sustainable development [19]. Multiple decision-making models such as quantitative and qualitative economic analysis, environmental impact assessment, and sustainable development assessment can enable new angles and approaches to promote green growth and improve sustainability [20].

In the environmental context, the sustainable development assessment involves the following key indicators:

1. Environmental Sustainability Index (ESI). This index includes 76 variables integrated into 21 indicators of environmental sustainability. These indicators embrace natural resource endowments, the environmental management efforts of the country, past and present pollution levels, the country's capacity to improve environmental efficiency, etc. [21].
2. Environmental Performance Index (EPI). The EPI index consists of 16 indicators that measure progress towards environmental sustainability. These indicators include child mortality (deaths per 1000 children 1–14 years old); air pollution ($\mu g/m^3$); access to drinking water (%); regional ozone; nitrate level in drinking water (mg/l); water consumption; wilderness protection; timber harvest rate (%); agricultural subsidies; overfishing; renewable energy; energy efficiency; and carbon dioxide emissions per GDP [22,23].

So far, a hybrid mathematical approach has been developed to prioritize the most effective variables among green economy and sustainable development indicators (23 criteria). This methodology is known as DEMATEL or Decision-Making Trial and Evaluation Laboratory. It is designed to examine interconnections between multiple criteria to collect the most effective variables (12 criteria) based on the three pillars (economic, environmental, and social) of sustainable development [24].

A system of criteria for green innovation risk identification in the manufacturing industry under the global value chain has been created. Three methods were applied to identify the green innovation risks of manufacturing under the global value chain. From the perspective of the green innovation process, four risks were classified: green R&D risk, green manufacturing risk, green marketing risk, and green service risk [25]. Given these risks, one should take into account the behavior of indicators and how they change at the time of development fluctuations [26].

There are studies that assess countries with different levels of sustainable development to identify priority areas and to draw recommendations for policymakers to improve green technologies in terms of effectiveness [27]. These studies may present a variety of global indexes and provide an opportunity to compare the sustainability directions of different countries. The construction of Sustainable Development Goals Indexes (SDGIs) is based on top-down approaches [28]. Significant similarities (above 95%) between SDGI and results obtained with the artificial neural network were determined [29]. An integrated Wellbeing Global Index (WeGIx) was proposed to assess the quality of life of communities at the global level. WeGIx includes a set of forty-three variables aimed at diagnosing global progress towards achieving the SDGs [30]. The indicators of sustainability are considered as analytical tools. However, the integration of micro, meso, and macro agents plays an important role, since the macro-level SDG can only be achieved through the actions of micro and meso agents. Their actions require a methodologically sound approach to assessment in order to avoid low-impact decisions [31].

Sustainability indicators are discussed in many studies. For example, the rationale of the SDGs and the conceptual parameters of their indicators are reviewed, covering certain fundamental aspects such as uncertainty, irreversibility, and criteria for defining critical points [32]. Studies on the contextualization of global objectives at the national level regarding urban development have revealed that the SDG baselines and indicators were not used to the full extent [33]. Particular attention was paid to the development of SDG regional indexes to achieve more limited ultimate goals. Based on the composite index (SDGI) the expediency of its application for the assessment of the implementation of the Action Plan to 2030 was studied [34]. A multi-disciplinary approach is needed to develop indicators of sustainable development. The aim of this study is to investigate the characteristics of a sustainable development assessment methodology being designed in the context of green technology. The methodological proposal is projected to be useful in identifying gaps in the implicit values between indicators and thus in contributing to the acquisition of real results, which are necessary for assessing the potential for green technology development. The level of sustainable development is determined in accordance with a specially designed strategy by using certain sets of indicators. The sets of indicators may not only differ, but also indicate real results. Therefore, this study seeks to compare different systems of indicators with the proposed methodological approach.

The key tasks to achieve the aim of the study are as follows: (1) to explore the link between national development and CO_2 emissions; (2) to identify differences between sustainable development indicators accepted in different countries; (3) to establish a connection between environmental development and the overall sustainable development. Furthermore, the study assesses indicators underlying the Normalized Sustainability Index (NSDI). The assessment methodology for sustainable development was found to be dependent on the market conditions.

2. Materials and Methods

Figure 1 presents the methodological framework used in this study. It is based on a Sustainable Development Goals Index (SDGI) consisting of 17 sustainable development goals: SDG 1 (no poverty), SDG 2 (zero hunger), SDG 3 (good health and well-being), SDG 4 (quality education), SDG 5 (gender equality), SDG 6 (clean water and sanitation), SDG 7 (affordable and clean energy), SDG 8 (decent work and economic growth), SDG 9 (industry, innovation and infrastructure), SDG 10 (reduced inequalities), SDG 11 (sustainable cities and communities), SDG 12 (responsible consumption and production), SDG 13 (climate action), SDG 14 (life below water), SDG 15 (life on land), SDG 16 (peace, justice, and strong institutions), and SDG 17 (partnerships for the goals) [35].

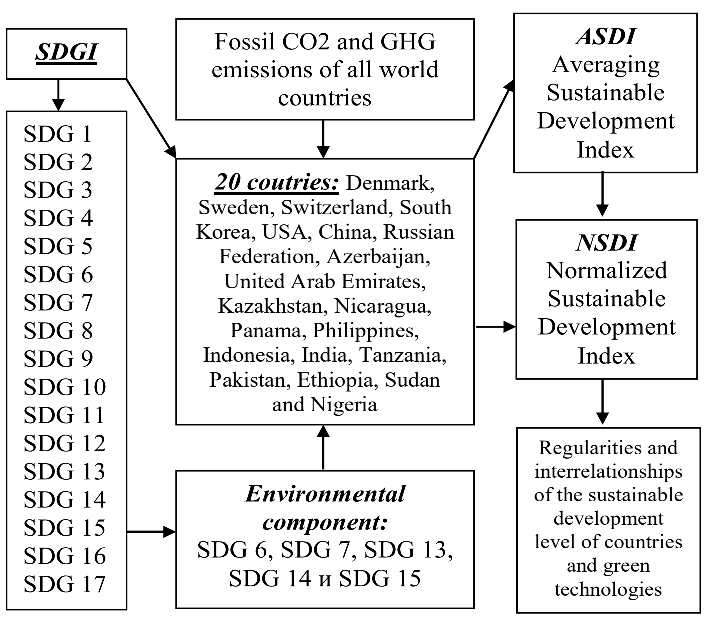

Figure 1. A graphical representation of the process of assessing the relationship between sustainable development and green technology (developed by the authors).

From among all SDGs, a set of goals was selected that is related to environmental sustainability: SDG 6, SDG 7, SDG 13, SDG 14, and SDG 15. This set was next incorporated into a novel methodological approach towards assessment alongside the general averaging (ASDI—Averaging Sustainable Development Index) and normalized (NSDI—Normalized Sustainable Development Index) indexes. The relative weight of the overall index varied depending on the number of indicators assigned to one of the key components of sustainable development.

Given that each index has different units and values, all units were normalized to a range from 0 to 1, where 0 is the least stable goal and 1 is the most stable goal for each country. Equation (1) is a simple expression used to normalize each index.

$$Index_J = \frac{I}{n}\sum_{i=1}^{n} I_{Nij} = \frac{I}{n}\sum_{i=1}^{n}\left(\frac{I_{ij} - I_{ij_{min}}}{I_{ij_{max}} - I_{ij_{min}}}\right) \tag{1}$$

I represents the sustainability index found for a specific goal; and *N* represents the normalized value; *i* indicates the type of the index; *j* represents the country, and *n* represents the number of indicators. In this study, five indicators were used (SDG 6, SDG 7, SDG 13, SDG 14, and SDG 15), therefore n = 5.

ASDI was also normalized to the range from 0 to 1 by the following expression:

$$Index_{NJ} = \frac{I_j - I_{j_{min}}}{I_{j_{max}} - I_{j_{min}}} \tag{2}$$

where Index N is the Normalized Sustainable Development Index (NSDI).

The deviation between each normalized index and NSDI was calculated by the following formula:

$$\overline{D_\iota} = \frac{I}{m}\sum_{j=\mathrm{I}}^{n}\left|\left(I - \frac{I_{Nij}}{I_{\mathrm{Nj}}}\right)\right| \tag{3}$$

where $\overline{D}$ means deviation.

A total of 20 countries of the SDG index were selected to determine the level of sustainable development. These countries include: Denmark (85.2), Sweden (85), Switzerland (78.8), South Korea (78.3), USA (74.5), China (73.2), Russian Federation (70.9), Azerbaijan (70.5), United Arab Emirates (69.7), Kazakhstan (68.7), Nicaragua (67.9), Panama (66.3), Philippines (64.9), Indonesia (64.2), India (61.1), Tanzania (55.8), Pakistan (55.6), Ethiopia (53.2), Sudan (51.4), and Nigeria (46.4) [35]. The sample embraces countries with scores ranging from very high to low in order to identify patterns and correlations between the country's level of sustainable development and the green technologies. The location of the country was also considered.

3. Results

All countries, regardless of their access to natural resources and geopolitical position, face challenges while moving towards sustainability, e.g., the exhaustion of natural resources and climate change. In environmental sustainability analysis, carbon dioxide emissions are among the most important indicators (Figure 2).

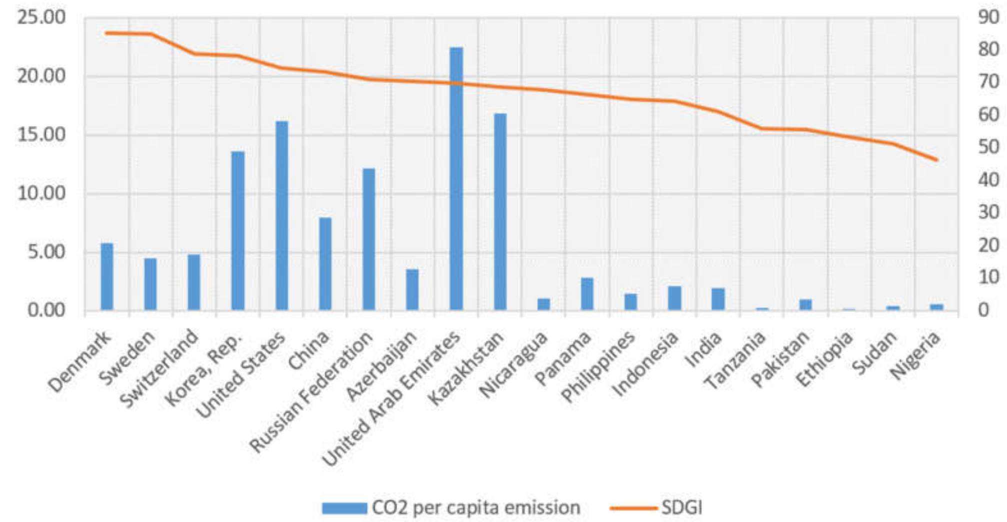

Figure 2. CO_2 per capita emission and Sustainable Development Goals Index in 2019, developed by the authors based on data from [36].

Despite the promotion of environmental policies in the United Arab Emirates, Kazakhstan, the US, Korea, and Russia, carbon dioxide emissions in these countries may be considered significant as compared to other countries under study. These emissions come from multiple oil and gas and mining industries. Meanwhile, countries with lower levels of sustainable development, i.e., island countries, have lower carbon dioxide emissions. This dependence can be explained by the fact that these countries are not industrially developed and do not have significant natural resources to extract, etc.

After six years of steady decreases at the average annual rate of 0.6%, carbon dioxide emissions in Russia increased by 3.5% (60 million tonnes of CO_2) in 2018 to reach about 1.7 million tonnes, while GDP grew 2.3% compared to 2017. With a share in global CO_2 emissions of 4.6% in 2018, Russia is the fifth largest emitter after China, the United States and India. The growth of CO_2 emissions in 2018 is mainly due to an increase in the consumption of coal, natural gas, and oil by 4.9%, 5.4%, and 0.5%, respectively. Russian per capita emissions of 12.1 tonnes CO_2 per cap per year are higher than those in China (53%) and 25% lower than those in the United States [36].

At the beginning of 2019, the Green New Deal project was introduced in the United States, aimed at the transition from fossil fuels to renewable energy. This legislation package is expected to help overcome the climate crisis and build a new model of the economy based on energy decarbonization and transition to renewable energy. It provides for the reconstruction of transport infrastructure, the promotion of electric vehicle production, the modernization of all existing buildings to reach higher energy efficiency, and for the replacement of fossil fuels. Green New Deal calls for the reduction of greenhouse gas emissions from agriculture and healthy food production; for the creation of new jobs, and for strengthening social guarantees for workers (including medical care, paid leave, etc.). To incorporate Green New Deal proposals, the country has to gradually reduce those segments of the economy that generate carbon dioxide emissions, especially the oil, gas, and coal sectors. To do so, the government can raise taxes for oil and coal companies and regulate their activities.

To assess the efficiency of sustainable environmental development, it is necessary to link carbon emissions to GDP in the countries under study (Figure 3).

The countries emitting the most carbon dioxide are highly developed countries with a powerful industrial complex, as well as oil-exporting countries. South Korea was among the first countries to announce their intention to incorporate the green growth goals into their national strategies. Its National Strategy for Green Growth (2009-2050) provides a comprehensive long-term approach to green growth that aims to create eco-friendly engines for economic growth, improve the quality of life of the population, and mitigate climate change. To implement this strategy, a Framework Act on

Low-Carbon Green Growth was adopted in 2010, according to which a part of the annual GDP is allocated for green development programs and projects. The bulk of this investment goes into renewable energy projects, energy-efficient construction, and waste management. The enactment of the Act is expected to promote employment in the green sectors of the economy, increase budget receipts, enhance energy security, and most importantly, reduce CO_2 emissions.

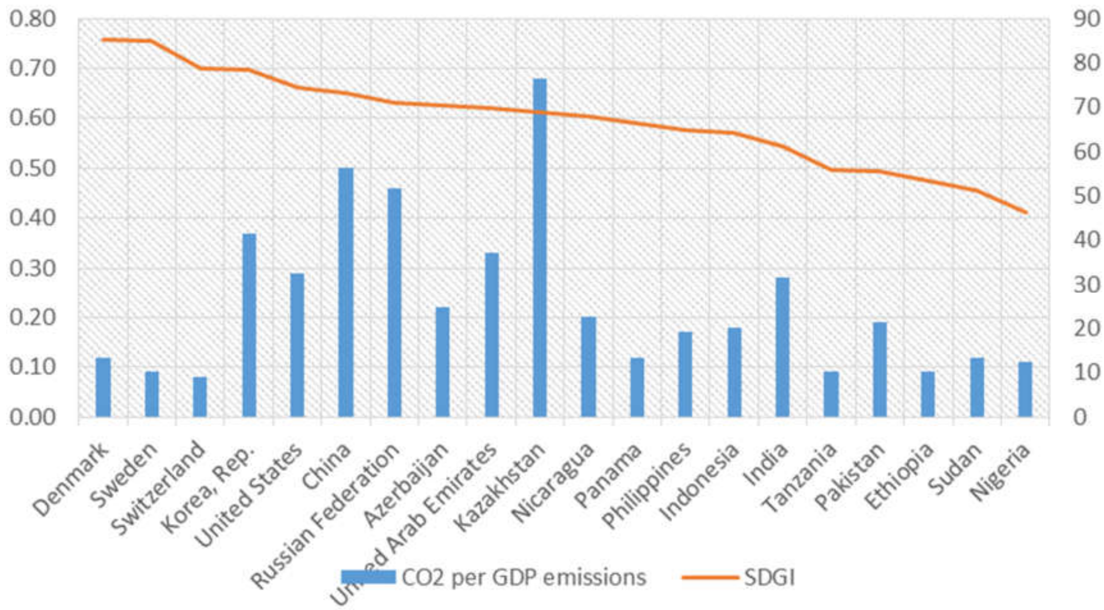

Figure 3. Metric tonnes of per capita CO_2 emitted per GDP Sustainable Development Goals Index in 2019, developed by the authors on the basis of data from [36].

Regarding Eastern Europe, the Caucasus, and Central Asia (EECCA), their policies are greening as well. For instance, Kazakhstan has approved a long-term program for the transition to a green economy and ensured that this program will be followed. Less-developed countries have established low-carbon development strategies and/or national action plans for energy efficiency.

Note that different countries focus on specific dimensions of sustainable development when composing a system of sustainable development indicators such as economic, environmental, social, institutional, etc. Apart from these sets, countries may use composite or integrated indicators. Countries that do not yet have a sustainable development strategy but are moving towards it also have their methodological approaches to sustainable development assessment. Studies are being conducted to determine indicators of sustainable development and design a measurement system that would take into account the specificity of each country's development path. When comparing sets of indicators applied in EECCA countries, one can find similarities and significant differences. These sets may have similar names but the metadata during evaluation will differ significantly. Thus, it is impossible to compare them without thoroughly exploring each indicator of sustainable development. The diversity of assessment methods and measurement frequency also pose a challenge when measuring the level of sustainable development. The use of a single specific indicator cannot provide complete information about the level of sustainable development of a particular country. Therefore, an all-encompassing characterization with a general system of diverse indicators is needed.

Given the importance and impact of environmental sustainability, it is necessary to study interconnections between its growth and the overall level of sustainable development in the country. For doing so, the indicators of green technology development were separated from the overall index of sustainable development, i.e., SDG 6 (providing availability and sustainable management of water and sanitation), SDG 7 (ensuring access to affordable, reliable, sustainable and modern energy), SDG

13 (taking action to combat climate change and its impacts), SDG 14 (conserving and sustainably using the oceans, seas, and marine resources for sustainable development), and SDG 15 (protecting, restoring, and promoting sustainable use of terrestrial ecosystems, sustainably managing forests, combating desertification, halting and reversing land degradation, and halting biodiversity loss) (Figure 4).

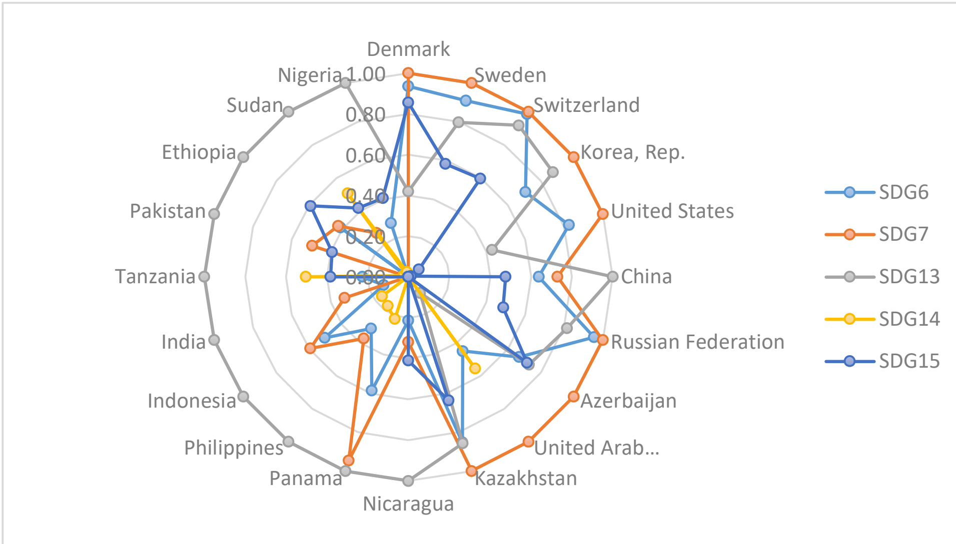

Figure 4. Greentech efficiency by Sustainable Development Goals in 2019, developed by the authors on the basis of data from [35].

Countries that are economically more developed demonstrate better sustainable management of water supply and sanitation as well as higher access to sustainable energy, while less-developed countries are better at climate actions. The majority of countries under study had small progress towards SDG 14.

For higher assessment accuracy, countries were ranked in accordance with their NSDI values (Figure 5). The ranking framework took into account the Averaging Sustainable Development Index and the Sustainable Development Goals Index.

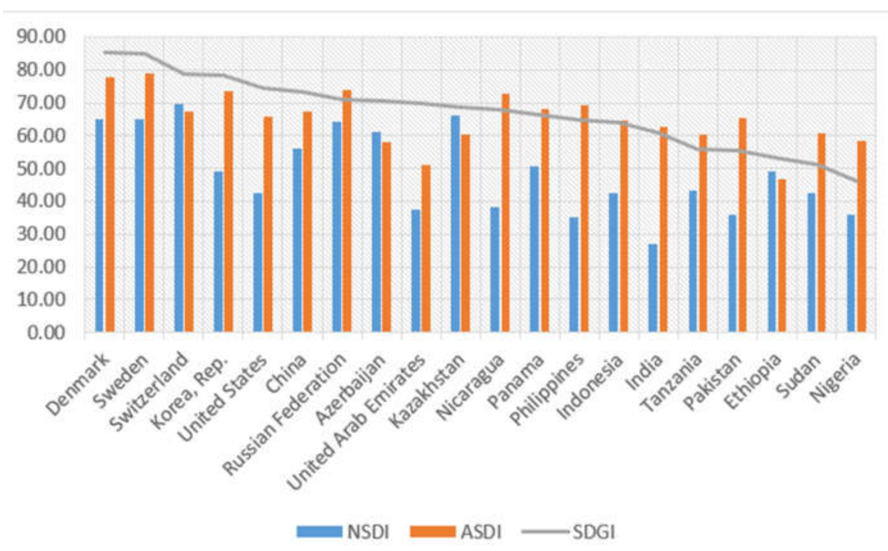

Figure 5. The efficiency of sustainable development in the context of green technology adoption in 2019, developed by the authors on the basis of data from [35].

The country with the highest NSDI score was Switzerland, followed by Kazakhstan, and Russia. Switzerland showed the greatest progress towards SDG6 and SDG7. Russia was the only developed country to have an ASDI higher than the overall level of sustainable development and its gap between NSDI and ASDI indexes was not significant, assuming a positive trend in greentech development.

The majority of less-developed countries had a significant gap between NSDI and ASDI values, indicating unfavorable conditions for greentech adoption. More specifically, it seems that green technologies were declared but not employed in production processes.

Initially, one may notice that there is no clear connection between the number of established indicators and ranking deviations when working with averaging indicators. More indicators do not necessarily mean better averaging, mainly due to differences in the weighing coefficients and relative importance of weighted indicators. The reason why NSDI was increasingly different from SDGI is that countries leading socio-economic rankings tend to consume more energy and resources and have a much greater environmental footprint than developing countries with lower resource consumption.

4. Discussion

The research results may be useful in designing environmental management policies that are aimed at implementing the principles of sustainable development [37]. The transition to sustainable economy requires a high-quality system of macro-indicators to assess a country's progress towards it [38]. Furthermore, the transition in question cannot be done without the corresponding global institutions that can influence countries that violate or ignore the guidelines for international cooperation. From this perspective, the proposed methodological approach is timely and in demand. However, there are problems that hinder the development of green economy such as:

- The lack of a cohesive approach to an effective green economy policy enshrined in the international documents so that all countries and business entities could follow it. Without an integrated approach to rely on, countries tend to perform actions that are contradictory [2]. In particular, these contradictions are manifested in the attempt of individual countries and transnational companies to front for their interests in the production of carbon-based energy carriers.
- The lack of an accurate measurement framework for the sustainable development. Among reasons that make this measurement difficult, researchers distinguish limited data about the diverse natural resources; insufficient political sustainability required to promote green industries or processes; and the need to improve institutional support for clean energy and green economy in general [24].
- Technological inertia manifested in the lack of manufacturing process flexibility [13]. More specifically, the fixed assets cannot be decommissioned promptly, limiting the performance of new clean industries.

The normalized NSDI index allows determining progress towards sustainability greatly facilitated by green technologies. Greentech expands the range of available options and potential strategies for achieving sustainable development goals such as clean water and sanitation, affordable and clean energy, climate action, and life below water and on land while reducing the costs of their implementation over time [14]. However, green technologies are not created, developed, or implemented on their own. Their progress depends on the market structure, demand, the ability of countries to introduce them, and most importantly, on government assistance (in particular, fiscal and financial support).

The proposed approach could be incorporated into a toolkit for assessing the effectiveness of green economy in the context of investment decision-making. A green economy today offers substantial and safe investment opportunities. It accounts for 6% of the global stock market (about 4 trillion US dollars) coming from the clean energy, energy efficiency, water supply, waste management, and so on. If a sustainable economy maintains its current course, it can hit about 90 trillion US dollars in green investments, reaching approximately 10% of the global market value by 2030 [35,36].

The identification of gaps between NSDI, ASDI, and SDGI values helps in finding real opportunities for green technology development. This process should take the impact of globalization on sustainable development and environmental policies into account. In China, for example, the twelfth Five-Year Plan shifted R&D priorities from renewable energy to pollution control and other sustainable green technologies [13,39,40]. However, the proposed approach limited by the baseline data, which allow for the macro-level assessment only. Considering that green and lean practices are becoming a critical approach for organizations in achieving sustainable development and improving organizational performance, it is reasonable to assess the lean and green impact on the overall outcome of the enterprise [31]. It is therefore appropriate to incorporate the proposed methodological approach into an integrated framework that promotes cross-sectoral integration, the use of local (regional) practices and knowledge, the promotion of stakeholder engagement and the empowerment of local organizations [41,42].

There is a need to use indicators for both general innovation capabilities and specific green technology capabilities including the normalized NSDI index. It is possible to expand the list of target countries to include their integration strategies and partnerships [7]. As most developing countries are at a very early stage of industrial development, a total leapfrogging to a greener industrial base is possible. This may affect the scores on NSDI, ASDI, and SDGI. Technical assistance and capacity-building support from multilateral banks and international development institutions will certainly play a decisive role in this regard [10]. Not only economic incentives are needed to switch to cleaner technologies but also a stronger action to promote job creation relative to environmental activities, which is essential for a full achievement of sustainable development goals [9].

The novelty of this study is that it offers a methodology for assessing sustainable development in the context of green technology enhancement while avoiding those errors that may emerge when using NSDI and ASDI indexes alone. This methodology facilitates the implementation of SDGs during transition to a green economy. In countries where the interests of companies operating in the brown economy are a priority, the transition to green technologies may result in the loss of income and jobs in the brown industries [43].

The future study can focus on factors affecting the acceleration of green technology adoption. These factors may be associated with the adaptive capacity to financial [8], social, economic, and cultural regulations, and with the availability of technological resources [6].

5. Conclusions

Countries emitting the most carbon dioxide are highly developed countries with a powerful industrial complex, as well as oil-exporting countries. In the United Arab Emirates, Kazakhstan, the US, Korea, and Russia, carbon dioxide emissions are higher than those in other countries under study. These emissions come from multiple oil, gas, and mining industries. Meanwhile, countries with lower levels of sustainable development, i.e., island countries, have less significant natural resources to extract and hence emit less carbon dioxide. Each country has its own characteristics originating from its development path, geographical location, and richness in natural resources. Therefore, greening scenarios may vary depending on the country.

Following the proposed methodological approach based on the Sustainable Development Goals Index (SDGI), in particular its environmental component, a connection between environmental development and the overall sustainable development was established. The ecology-related indicators underlay the Averaging Sustainable Development Index (ASDI) and the Normalized Sustainable Development Index (NSDI). Countries that are economically more developed show progress towards SDG 6 and SDG 7, while less-developed countries are better at climate actions. The majority of countries under study had small progress towards SDG 14. The country with the highest NSDI score was Switzerland, followed by Kazakhstan, and Russia. Switzerland showed the greatest progress towards sustainable management of water and sanitation, and towards sustainable energy. Russia was the only developed country to have an ASDI higher that SDGI and its gap between NSDI and ASDI indexes was not significant, assuming a positive trend in greentech development. The majority of less-developed countries had a significant gap between NSDI and ASDI values, indicating unfavorable conditions for greentech adoption.

The majority of less-developed countries had a significant gap between NSDI and ASDI values, indicating unfavorable conditions for greentech adoption. Initially, no clear connection between the number of averaging indicators and ranking deviations can be found. More indicators do not necessarily mean better averaging. The reason why NSDI was increasingly different from SDGI is that countries leading socio-economic rankings had higher consumption of energy and resources and a much greater environmental footprint than those countries that consumed less.

Strategies and legislative acts adopted by countries need to clearly interpret sustainable development in the context of green economy and follow the recognized international standards. Countries should continue to improve their national strategies to define a clear vision, specific goals, a sequence of actions and ways to fulfill their commitments.

Countries need clearly defined action programs and indicators to monitor sustainable development and green growth. The transition to green technologies should consolidate global trends in increasing well-being of people and their social equality while reducing environmental risks. The success of this course depends on countries' efforts to increase public investment and spending; introduce environmental taxes and approaches (that compensate for the insufficient impact of market institutions) to reduce the environmental footprint of industries; prohibit environmentally harmful subsidies; and improve the legal regulation framework for environmental protection.

A limitation of the proposed approach is the baseline data, which only allow for the macro-level assessment. The approach may be incorporated into a comprehensive framework that facilitates cross-sectoral integration, the use of local (regional) practices and knowledge, stakeholder engagement, and the empowerment of organizations.

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