sustainability

MDPI

Article

Sustainable Development—A Path to a Better Future

Carmen Elena Stoenoiu

Faculty of Electrical Engineering, Technical University of Cluj-Napoca, 400027 Cluj-Napoca, Romania; carmen.stoenoiu@emd.utcluj.ro

Abstract: The need for sustainable development is a common concern for many countries, and the level reached by each country validates the efforts made and the effects of their associated well-being. In this study, an analysis of the indicators included in SDG-9 was performed, indicators that aim to achieve sustainable industrialization, increase research and innovation, and create a resilient infrastructure. The analysis used nine indicators that measure the situation of eight Eastern European countries during 2013–2019 to signal improvements or deteriorations in situations. The study used three working hypotheses that were verified and presented the evolution of countries in the aforementioned years. The results obtained led to the ranking of the countries by evaluating their economies from the perspective of the effects obtained by the method of sustainable development, thus categorizing the countries into ones with real, moderate, and low progress.

Keywords: sustainable development; resilient infrastructure; inclusive and sustainable industrialization; stimulating innovation

check for updates

Citation: Stoenoiu, C.E. Sustainable Development—A Path to a Better Future. *Sustainability* **2022**, *14*, 9192. https://doi.org/10.3390/su14159192

Academic Editors: Hubert Paluš, Jan Parobek, Andreja Pirc Barčić and Branko Glavonjic

Received: 28 June 2022
Accepted: 23 July 2022
Published: 27 July 2022

1. Introduction

Accelerating the pace of life and globalization has led to the need for cooperation between countries on common environmental and sustainable development issues [1], which led to the joint actions of several states on sustainability issues [2]. In 2015, the United Nations Statistical Commission (UNSC) developed a global framework of indicators called IAEG-SDGs (Inter-agency and Expert Group on SDG Indicators). Subsequently, Agenda 2030 highlighted that the objectives and targets of the SDGs are integrated and indivisible, and, thus, balance the dimensions of sustainability: economic, social, and environmental development. This accentuates the fact that actions are for people, the planet, and prosperity [3]. The global effort to build a sustainable future is desirable in order to create progressive improvements and well-being among the population in line with the rationalization and conservation of the resource ecosystem [4,5].

For the progressive improvement of economies, the advancement of industrialization has become one of the existing steps in almost all countries. With the rise of industrialization, encouraging innovation and resilient infrastructure are considered the pillars of achieving a sustainable industry [6,7]. Therefore, the concern of all countries is interconnecting these aspects (innovation, infrastructure, and industry), in order to achieve the objectives specified by the UN. According to SDG-9, each country should strive to create economies with inclusive and sustainable industries in which innovation is facilitated and there is a resilient and sustainable infrastructure [3]. These approaches are thought to enable future economies to increase competitiveness, facilitate new jobs (and, thus, higher incomes), and lead to the rational use of resources. Furthermore, the advantage of new technologies will affect social welfare and progress on a national level [4,5,8].

Analyzing the Fourth Industrial Revolution of the 21st century, it was observed that, while it had benefits, it has also brought about a negative impact on the environment, as observed in climate change, industrial emissions, and greenhouse gases. Studies show that uncontrolled industrial development risks violating the principles of sustainable industrial development [9]. This can then require the involvement of organizations, businesses, and stakeholders, as well as the reinterpretation of their actions [10]. The economy, energy, and the environment (3E) are inextricably linked [11]. Disasters that threaten economic sustainability, human society, and the stability of the 3E system frequently occur due to the impact of climate change [12]. Therefore, the relationship between economic development and climate change needs to be analyzed [13], as challenges and opportunities coexist in this process [14,15]. On the other hand, governments and international organizations around the world are committed to increasing industrial sustainability and reducing resource use [16]. The industrial sector is becoming the engine of low carbon initiatives, both economically and managerially [17], causing cooperation between the private and public sectors [18]. Thus, sustainable development brings to the fore the problem of sustainable industrialization by reducing greenhouse gas (GHG) emissions. This can be implemented if there are solutions for resources and technologies [19,20], the industrial sector being a large consumer of energy and dependent on fossil fuels [21]. Energy policy instruments designed to support sustainable development are diverse: green certificates [22], food tariffs [23,24], carbon taxes [25,26], public funding [27], imposed standards [28], and direct control [29]. These are mentioned in the literature as incentives or courses of action for transition. On the other hand, the UN supports the need for sustainable development, emphasizing the need to increase energy efficiency and the use of clean and green technologies in economies [3]. It is believed that, over time, competitive and sustainable industries will be able to bring economic growth through better value chains, a circular economy, and renewable energy [2,3,28,30]. The relevance of sustainable development is provided by the benefits it creates: industry increases productivity, new jobs appear, and incomes are generated. This will contribute to the eradication of poverty and the creation of opportunities for social inclusion [3,31,32]. Subsequently, the development of industry allows for the growth of added value [30,33] and the improvement of science, technology, and innovation [34–36] by encouraging and contributing to new investments in skills and education [7], thus providing resources for further development. According to studies, the role of the industry seems to be major, aiding economic and social development, the creation of consumption and production patterns, and environmental protection [31,37].

Supporting research and innovation is another desirable approach, and studies in the literature show that the development of research and innovation will produce new forms of practice and social organization in economies [38,39], as well as new or improved products and business processes [40,41].

In many countries, research and innovation is usually carried out through personal efforts due to a low interest in the economic environment. Regardless, these activities are recognized by most researchers as vital for innovations [42,43]. Research and innovation funding through public–private partnerships can create conditions for sustainable growth of innovation [44]. States can create domestic policies that stimulate research and innovation activity through direct or indirect funding instruments [45,46].

Another important step in the development of economies is the existence of a permissive infrastructure. Though the need to modernize infrastructure arises as progress is made, it must be closely linked to environmental policies [47]. The existence of global decision-making structures helps one understand the complexity of the problems that, according to specialists, can only be solved through joint actions aimed at the national integration of cross-border telecommunications, transport, or industrial projects [47–50]. Thus, each state needs to find a balance between legislation, public–private initiatives, and consumer options so that economies become sustainable. Reduced or nonexistent access to infrastructure (transport, energy, ICT) is considered an impediment to development, diversification, and growth [51]. The development of infrastructure through transport options (road, rail, river, sea, or air) occurs in terms of sustainability, economic efficiency, safety, and environmental impact, all contributing to the development of the economy. Concerning domestic and international connectivity, infrastructure contributes to the creation or attraction of investment opportunities, economic development and improvement, and the achievement of global interconnectivity [52–54].

Completing the existing studies, this study's novelty is found in the analysis of countries from another perspective, using its own mathematical model that allows the classification of countries by progress. The research was conducted on eight countries that have had different economic evolutions despite starting from the same socioeconomic model of governance (about 30 years ago). The importance is provided by the fact that these former communist countries evolved differently, and it is conclusively the subject of analysis.

The main hypotheses of this study are: (1) All countries have begun to promote inclusive and sustainable industrialization, and there is a rise in this approach in each country; (2) research and innovation is a condition of progress, and countries have created circumstances for its development; and (3) all countries make efforts for the development of infrastructure due to the economic and social benefits they generate.

The purpose of this study is to test the proposed hypotheses using a mathematical model that will allow for the classification of countries by results, placing them in areas of progress (high, moderate, or low). To verify the hypotheses, the following analyses were performed: (1) of the indicators that make up SDG-9 on the global level, (2) of the share held by each country at an individual level, and (3) of the result obtained for each country from the perspective of the three directions mentioned below.

2. Materials and Methods

In this study, an analysis was performed based on data provided by the Eurostat database for the years 2013–2019 [55]. The information was collected from 8 Eastern European countries: Bulgaria (BG), Czech Republic (CZ), Estonia (EE), Lithuania (LT), Hungary (HU), Poland (PL), Romania (RO), and Slovakia (SK). These countries started from the same model of socioeconomic governance and later developed private economies.

The indicators in SDG-9, "Industry, Innovation, and Infrastructure", are GDERDS (gross domestic expenditure on R&D by sector), RDPS (R&D personnel by sector), PAEPO (patent applications to the European Patent Office), SBTTPT (share of buses and trains in total passenger transport), SRIWTFT (share of rail and inland waterways in total freight transport), TEAS (tertiary educational attainment by sex), AEII (air emission intensity from industry), ACOEKNPC (average CO_2 emissions per km from new passenger cars) and HICTA (high-speed internet coverage, by type of area).

The indicators in SDG-9 were studied according to 3 directions: (1) promoting inclusive and sustainable industrialization (SI), (2) stimulating research and innovation (RI), and (3) building a resilient infrastructure (I), as presented in Table 1.

Table 1. Indicators according to SDG-9.

No.	Abv.	Directions	Unit	Indicator Explanations
1	TEAS	1	%	share of the population aged 25–34 who successfully graduated from tertiary education.
2	ACOEKNPC	1	number	average carbon dioxide emissions per km of new cars in a given year.
3	HICTA	1	%	share of households with a very high-capacity fixed network connection [1].
4	GDERDS	2	%	gross domestic expenditure on R&D as a percentage of gross domestic product.
5	RDPS	2	%	share of existing R&D staff.
6	PAEPO	2	number	the number of patent applications for an invention filed with the European Patent Office, whether or not they are granted.
7	SBTTPT	3	%	share of public transport modes [2] in the total performance of inland passenger transport expressed in passengers/kilometers.
8	SRIWTFT	3	%	share of rail and inland waterway transport in total inland freight transport expressed in tons/kilometers.
9	AEII	3	grams per euro, chain-linked volumes	the intensity of fine particulate emissions (PM 2.5) in the production sector.

[1] Electronic communication networks consisting of fiber optic elements, at least up to the distribution point at the service location, or having similar network performance in terms of available bandwidth. [2] Buses, including coaches, trolleybuses, and trains.

This study permits the measurement of the level registered by each country; comparisons in time at the level of each country, but also between countries; and the measurement of the difference between the value of each indicator and the average value at the level of each indicator.

The mathematical model created starts by transforming the data into weights (indices) at the level of each objective and of each country so that they can be expressed in the same unit of measurement and can be centralized. To calculate the value of the indices related to each indicator, the starting point was the value related to 2019 for each country, which was divided by the amount obtained per indicator by all countries, according to Equation (1).

$$I_n = \frac{C_i}{\sum_{i=1}^{8} C_i} \quad (1)$$

where n is the name of the indicator under study (n = 1 ÷ 9, according to Table 1), c is the indicator value for each country, and i is the name of the country under study (i = 1–8).

Subsequently, the centralized values related to the 3 directions were obtained: sustainable industrialization (SI), research and innovation (RI), and infrastructure (I) according to Equations (2)–(4).

$$I_{SI} = I_1 - I_2 + I_3 \quad (2)$$

$$I_{RI} = I_4 + I_5 + I_6 \quad (3)$$

$$I_I = I_7 + I_8 - I_9 \quad (4)$$

The values related to indicators I_2 and I_9 (Table 1) were taken with the minus sign because these indicators influence in opposite directions; the aim is to minimize at the level of each country.

For the analysis to be as conclusive as possible, the data obtained by summing the indicators in the 3 directions were multiplied by the index obtained for each country as follows: competitiveness [56], innovations [57], and infrastructure [58], according to Table 2.

Table 2. The situation of the countries according to the indices.

Index/Country	BG	CZ	EE	LT	HU	PL	RO	SK
α (%)	64.9	70.9	70.9	68.4	65.1	68.9	64.4	66.8
β (%)	40.35	49.43	49.97	41.46	44.51	41.31	36.76	42.05
γ (%)	86.7	95.2	60.3	74.2	92.4	95.3	91.3	88.6

The value obtained in each direction was multiplied by the value corresponding to the score obtained for each country from Table 2 according to Equations (5)–(7).

$$\overline{I_{SI}} = I_{SI} \times \alpha \quad (5)$$

$$\overline{I_{RI}} = I_{RI} \times \beta \quad (6)$$

$$\overline{I_I} = I_I \times \gamma \quad (7)$$

where α is the global competitiveness index, β is the global innovations index, and γ is the global quality infrastructure index.

The adjustment of data through indices allowed us to obtain values with a higher weight given the competitiveness needed to have sustainable industrialization, the innovations needed for innovation research, and infrastructure through quality according to indices in the literature [56–58].

By summing the values obtained in the three directions, the total value assigned to each country (I_T) was obtained, which permits a ranking of the countries studied according to Equation (8).

$$I_T = \overline{I_{SI}} + \overline{I_{RI}} + \overline{I_I} \quad (8)$$

This total value for each country is a composite indicator that better defines the country's level by cumulating the results obtained from SDG-9 with the score obtained for each country in terms of studies by international organizations [56–58]. After obtaining the composite indicators, the countries were grouped by levels of progress (high, moderate, or low) when the difference between one country and the next exceeded 8 units.

3. Results and Discussion

3.1. The Evolution of the Global Level Indicators

Table 3 shows the values of the indicators for 2019, the average, and the difference resulting from the evolution of each country. This analysis is important because Agenda 2030 specifies that SDG-9 was created to recognize technological progress and innovation. The purpose is to see whether sustainable solutions to social, economic, and environmental challenges have been found and whether improvement took place. This encourages innovation by improving scientific research and technological development and by improving the technological capabilities of industrial actors.

Table 3. Analysis of the variability of the indicators.

Indicator	Year/Country	BG	CZ	EE	LT	HU	PL	RO	SK
	2019	32.70	32.60	42.80	55.20	30.60	43.50	25.50	39.20
1	Aver.	32.23	31.77	41.80	54.17	31.03	43.10	25.16	33.67
	Diff.	*0.01*	*0.03*	*0.02*	*0.02*	*−0.01*	*0.01*	*0.01*	*0.16*
	2019	130.20	128.70	130.10	132.00	129.70	130.40	124.30	130.40
2	Aver.	130.97	127.50	136.33	131.40	129.44	130.56	124.81	129.04
	Diff.	*−0.01*	*0.01*	*−0.05*	*0.00*	*0.00*	*0.00*	*0.00*	*0.01*
	2019	42.00	29.30	57.40	61.00	42.60	60.30	68.10	45.50
3	Aver.	34.04	21.30	49.41	53.37	27.77	20.76	60.34	38.11
	Diff.	*0.23*	*0.38*	*0.16*	*0.14*	*0.53*	*1.91*	*0.13*	*0.19*
	2019	0.83	1.93	1.63	0.99	1.48	1.32	0.48	0.83
4	Aver.	0.78	1.86	1.46	0.96	1.36	1.05	0.46	0.89
	Diff.	*0.06*	*0.04*	*0.12*	*0.04*	*0.08*	*0.26*	*0.04*	*−0.06*
	2019	0.81	1.51	0.96	0.92	1.20	0.99	0.39	0.76
5	Aver.	0.70	1.32	0.90	0.81	0.92	0.76	0.40	0.67
	Diff.	0.15	0.14	0.07	0.13	0.30	0.30	−0.02	0.14
	2019	5.02	19.02	36.17	10.38	9.93	12.20	2.06	7.70
6	Aver.	4.18	18.59	32.82	10.03	10.63	12.19	1.92	7.36
	Diff.	0.20	0.02	0.10	0.04	−0.07	0.00	0.07	0.05
	2019	15.30	26.20	19.90	9.40	28.40	19.30	21.10	26.20
7	Aver.	16.09	26.57	19.70	9.87	30.77	21.19	21.56	24.59
	Diff.	−0.05	−0.01	0.01	−0.05	−0.08	−0.09	−0.02	0.07
	2019	52.90	26.20	42.00	67.40	31.50	24.00	55.00	34.50
8	Aver.	45.56	27.17	49.54	66.80	34.57	25.49	58.46	38.74
	Diff.	0.16	−0.04	−0.15	0.01	−0.09	−0.06	−0.06	−0.11
	2019	0.31	0.03	0.42	0.04	0.09	0.31	0.24	0.06
9	Aver.	0.32	0.07	0.95	0.08	0.09	0.40	0.33	0.11
	Diff.	−0.03	−0.55	−0.56	−0.53	−0.05	−0.23	−0.26	−0.45

1—Gross domestic expenditure on R&D by sector; 2—R&D personnel by sector; 3—patent applications to the European Patent Office; 4—share of buses and trains in total passenger transport; 5—share of rail and inland waterways in total freight transport; 6—tertiary educational attainment by sex; 7—air emission intensity from industry; 8—average CO_2 emissions per km from new passenger cars; 9—high-speed internet coverage, by type of area. Aver.—average; Diff.—the difference between 2019 and average.

From the data presented in Table 3, it can be seen that the values in 2019 are above average for most indicator countries (1—except HU, 2–3, 4—except SK, 5—except RO, 6—except HU, 7—except EE, 8—except BG and LT), which is a positive evolution. Lower values in 2019 compared to the average (2013–2019) can be seen in the following countries: BG (SBTTPT, SRIWTFT, TEAS), CZ (SBTTPT, SRIWTFT), EE (SRIWTFT), LT (SBTTPT), HU (PAEPO, SBTTPT, SRIWTFT), PL (SBTTPT, SRIWTFT), RO (RDPS, SBTTPT, SRIWTFT), and SK (GDERDS, SRIWTFT). This shows a worsening of the situation.

Decreasing values were also found in the 'air emission intensity from industry' indicator, the only exception being HU, where the situation remained at the same level in 2019 compared to the average. According to the 'average CO_2 emissions per km from new passenger cars' indicator, although the values should decrease in all countries as a result of CO_2 emission reduction requirements, it can be observed that there was an increase in values in 2019 in four countries (CZ, LT, HU, and SK), which reveals the lack of a positive change in these countries.

The analysis in Table 3 shows that, for the 'tertiary educational attainment by sex' indicator, LT (55.2) is in the first place, followed by PL (43.5) and EE (42.8). A high level of variability is found in SK (0.16).

For the 'average CO_2 emissions per km from new passenger cars' indicator, the lowest level is in RO (124.3), CZ (128.7), and HU (129.7). The highest level of variability is recorded in EE (−0.05), followed by BG (−0.01).

For the 'high-speed internet coverage, by type of area' indicator, the highest level in 2019 is RO (68.10), followed by LT (61) and PL (60.30). The highest level of variability is found in PL (1.91).

The 'gross domestic expenditure on R&D by sector' indicator registered the highest value in 2019 in CZ (1.93), followed by EE (1.63) and HU (1.48). However, if one takes into account the difference between 2019 and the 7-year average, one will find that the highest level of variability was obtained in PL (0.26), followed by EE (0.12) and HU (0.08).

For the 'R&D personnel by sector' indicator, CZ is in first place (1.51), followed by HU (1.2) and PL (0.99). The highest level of variability is found in HU (0.3) and PL (0.3), followed by BG (0.15).

For the 'patent applications to the European Patent Office' indicator, EE is in first place (36.17), followed by CZ (19.02) and PL (12.2). A high level of variability is found in BG (0.2) and EE (0.1).

For the 'share of buses and trains in total passenger transport' indicator, the highest levels are in HU (28.4), CZ (26.2), and SK (26.2). The highest level of variability is recorded in SK (0.07).

For the 'share of rail and inland waterways in total freight transport' indicator, the highest levels are in LT (67.4), RO (55), and BG (52.9). The highest level of variability is recorded in BG (0.16), followed by LT (0.01).

For the 'air emission intensity from industry' indicator, CZ is in first place again (0.03), followed by LT (0.04) and SK (0.06). The highest level of variability is found in EE (−0.56), close to that of CZ (−0.55).

3.2. Comparative Analysis at the Individual Level

Figure 1a–i show the indicators within SDG-9 for 2019 and the percentage obtained by each country. The analysis conducted in 2019 is important because it displays the share of each country in total, highlights the countries that support sustainable development after observing good results, and helps one understand why there are differences in welfare in some countries.

From the analysis of Figure 1a, for the 'tertiary educational attainment by sex' indicator, LT has the highest value (18.27%). For this indicator, RO has the lowest level compared to the other countries studied (8.44%), which reveals that the share of the population aged 25–34 that completed tertiary studies is at a lower level.

From Figure 1b, for the 'average CO_2 emissions per km from new passenger cars' indicator, it can be seen that the country with the best value is RO (12%), followed by CZ (12.43%) and HU (12.52%). Slightly higher values for this indicator are recorded in LT (12.74%).

From Figure 1c, the 'high-speed internet coverage, by type of area' indicator shows that the best value is recorded for RO (16.77%), followed by LT (15.02%) and PL (14.84%). The weakest values, due to a low share of households with a fixed connection to a very high-capacity network, are found in CZ (7.21%), BG (10.34%, and HU (10.49%).

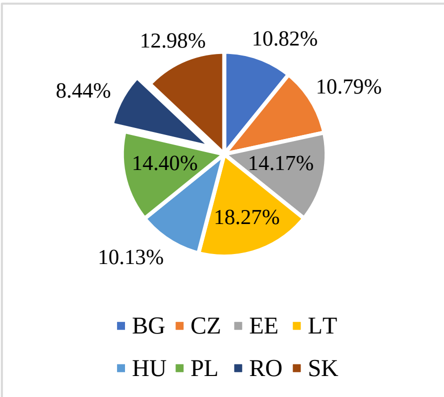
The first three indicators in Figure 1a–c show the evolution of countries through the prism of the first direction, that of sustainable industrialization. These indicators show, on one hand, the differences between countries in the performances obtained in 2019 (TEAS, LT; ACOEKNPC, RO; and HICTA, RO) and, on the other hand, the progress registered when compared to the 7-year average.

In Figure 1d, the values obtained for the 'gross domestic expenditure on R&D by sector' indicator place CZ (20.34%) at the highest level of performance in 2019, followed by EE (17.18%) and HU (15.6%). The percentage recorded for RO (5.06%) for this indicator shows the existence of the lowest level of gross domestic expenditure on research and development as a percentage of gross domestic product.

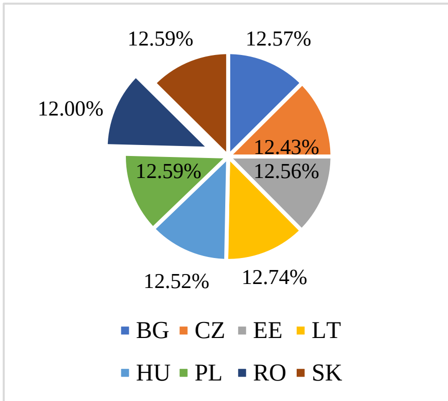
Analyzing Figure 1e, for the 'R&D personnel by sector' indicator, in 2019, CZ (19.96%) is in first place, followed by HU (15.96%) and PL (13.17%). Furthermore, for this indicator, RO (5.18%) is in last place because of a low level in the share of R&D personnel.

From Figure 1f, one can see that, for the 'patent applications to the European Patent Office' indicator, the country with the highest level is EE (35.29%), followed by CZ (18.56%) and then PL (11.9%). The value registered for RO (2.01%) ranks it last due to the low number of patent protection applications filed with the European Patent Office.

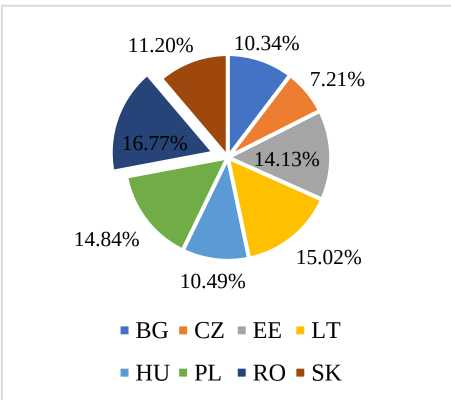
The three indicators presented in Figure 1d–f allow for the measurement of one of the directions of research—innovation. The development efforts in this direction are mostly seen in countries such as CZ and EE because of stimulation through funding and results measured by patent protection applications, which may lead to new forms of practice and social organization, as well as new premises that consider future approaches for the creation of new or improved products and business processes.



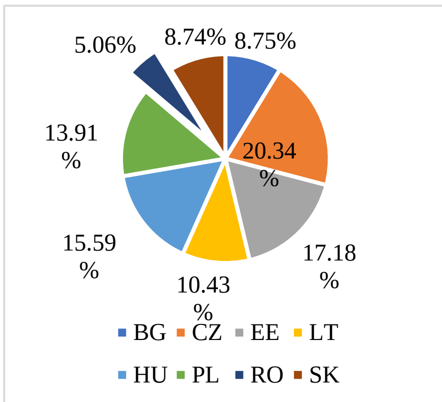
(**a**)



(**b**)



(**c**)



(**d**)

Figure 1. *Cont.*

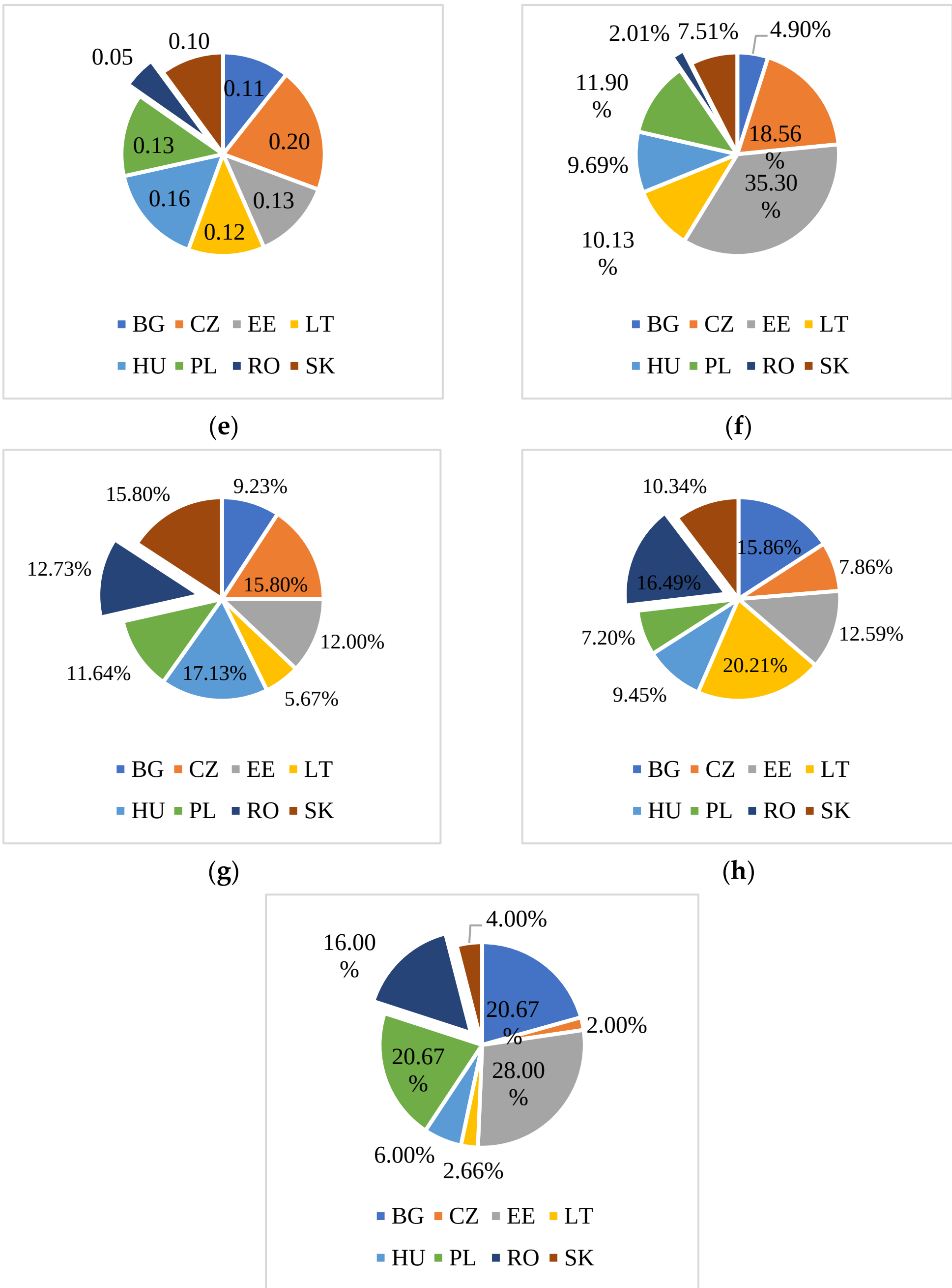


Figure 1. The situation for each country at the level of the studied indicators: (**a**) TEAS, (**b**) ACOEKNPC, (**c**) HICTA, (**d**) GDERDS, (**e**) RDPS, (**f**) PAEPO, (**g**) SBTTPT, (**h**) SRIWTFT, and (**i**) AEII.

In Figure 1g, for the 'share of buses and trains in total passenger transport' indicator, HU has the best value (17.13%), followed by CZ and SK, both having an equal value of 15.8%. LT is the country that registers the lowest value for this indicator, at 5.67%, which tells us that the share of public transport modes in the total performance of domestic passenger transport is lower.

In Figure 1h, for the 'share of rail and inland waterways in total freight transport' indicator, LT (21.21%) has the highest value, followed by RO (16.49%) and BG (15.86). For this indicator, CZ is the country with the lowest value due to the existence of a smaller share of rail transport and inland waterways in the total domestic freight transport.

In Figure 1i, for the 'air emission intensity from industry' indicator, the countries with the highest levels are CZ (2%), LT (2.67%), and SK (4%). For this indicator, which measures the intensity of fine particulate emissions (PM 2.5) in the production sector, one can see that EE (28%) is the country with the highest level of pollution, followed by BG and PL, which have the same level of 20.67%.

The three indicators presented in Figure 1g–i measure the third direction, which defines the performance of each country through the development of infrastructure and helps us understand the extent to which each country has a positive evolution as a result of efforts made toward sustainable development.

3.3. Analysis from the Perspective of the Three Directions

Table 4 presents the countries' situations centralized on the three directions corresponding to SDG-9: building resilient infrastructure, promoting inclusive and sustainable industrialization, and stimulating innovation. This represents the final analysis of SDG-9 (Table 4) and shows that SDG-9 can be tracked at the country level and the evolution can be identified by comparing 2013 with 2019.

Table 4. The situation registered according to the three directions.

Country	Sustainable Industrialization		Research and Innovation		Infrastructure		Total		Overall Rank	
	2013	2019	2013	2019	2013	2019	2013	2019	2013	2019
BG	0.08	0.09	0.2	0.24	0.11	0.04	0.39	0.37	VIII	VIII
CZ	0.04	0.06	0.59	0.59	0.2	0.22	0.83	0.87	I	I
EE	0.2	0.16	0.72	0.65	−0.2	−0.03	0.68	0.78	IV	II
LT	0.26	0.21	0.33	0.33	0.2	0.23	0.80	0.77	II	III
HU	0.07	0.08	0.43	0.41	0.26	0.21	0.77	0.7	III	IV
PL	0.04	0.17	0.32	0.39	0.08	−0.02	0.44	0.54	VII	VI
RO	0.2	0.13	0.14	0.12	0.17	0.13	0.51	0.38	VI	VII
SK	0.11	0.12	0.27	0.26	0.2	0.22	0.58	0.6	V	V

From the analysis in Table 4, one can see that, in 2019, in total, the first four positions with respect to SDG-9 are: CZ (which keeps its position), EE (which moved from fourth place to second place), LT (which reached 2019 in second place), and HU (which passed from third place to fourth place). It can also be observed that, in 2019, CZ evolved, registering a higher advance than in 2013 compared to the evolution of the other countries. There is a decrease in the results obtained in 2019 compared to 2013 for RO (−0.13), HU (−0.07), and BG (−0.02), which reveals that the situation has worsened, with these countries not being able to support the previously accumulated achievements.

If one analyzes the results in terms of the three directions, it is clear that CZ does not occupy the first place in any of the directions, neither in 2013 nor in 2019. In 2019, the best results for promoting inclusive and sustainable industrialization were achieved by LT, PL, and EE. For research innovation in 2019, the best position is occupied by EE, followed by CZ and HU, and in infrastructure, the first position belongs to LT, followed by CZ/SK and HU.

The results obtained for the countries studied (Table 4) are also important due to the links that SDG-9 has with the other SDGs [59]. If one examines the first direction, one can see the associations between industrialization and job creation (SDG-8); sustainable livelihoods (SDG-11); innovation, technology development, and skills (SDG-9); or food security (SDG-2). The second direction (research and innovation) produces chain effects on SDG-7 (energy), SDG-2 (food), SDG-6 (water), and SDG-11 (housing). The third direction (infrastructure) affects objectives such as rural poverty (SDG-1), food security (SDG-2), the capacity of rural economies to integrate young people (SDG-8), rural–urban depression (SDG-11), etc. Therefore, the role played by infrastructure development is becoming increasingly strong in the global context.

Table 5 presents the situation of the countries, obtained by multiplying the values in Table 4 with indices associated with each direction within SDG-9 (according to the data in Table 2) from the year 2019.

Table 5. The situation was recorded by adjusting the data by indices.

Country	Sustainable Industrialization	Research and Innovation	Infrastructure	Total	Level of Progress
CZ	4.25	29.16	20.94	54.36	I
LT	14.36	13.68	17.07	45.11	
HU	5.21	18.25	19.40	42.86	II
EE	11.34	32.48	−1.81	42.02	
SK	8.02	10.93	19.49	38.44	
PL	11.71	16.11	−1.91	25.92	
RO	8.37	4.41	11.87	24.65	III
BG	5.84	9.68	3.47	18.99	

From the analysis in Table 5, it can be seen that, in 2019, the best result was obtained by CZ, followed by LT, HU, EE, and SK. At a fairly long distance, there are PL, RO, and BG. This reveals that the advance registered by CZ (54.36) shows the best growth within SDG-9, and CZ is thus included in the first category as a country with high progress. A second category, that of countries with moderate progress, is formed by countries like LT, HU, EE, and SK (45.11–38.44. Lastly, the third category includes PL, RO, and BG (25.92–18.99) as countries with low progress.

4. Summary and Conclusions

The study includes the analysis of indicators of SDG-9 (Industry, Innovation, and Infrastructure), tracking the performance of each country and highlighting the current level of improvement or relapse. From this study, it can be seen that there are countries that recorded increasing results in 2019 compared to 2013 (CZ, EE, and PL), countries that stalled (SK, BG), and countries that deteriorated (LT, HU, and RO). It can also be seen that there are countries where the results are lower (RO, PL, and BG). This decline is due to either unsustainable industrialization (RO), low results in research and innovation (EE, HU, RO, and SK), or infrastructure (BG, HU, PL, and RO). For the verification of hypothesis 1, it was found that the growth of sustainable industrialization occurred only in PL, CZ, SK, BG, and HU, for which the hypothesis was validated. The following countries are exceptions: LT, RO, and EE have seen a decrease. Hypothesis 2 was verified in countries such as PL and BG, where there was an increase, and it is not verified for EE, HU, RO, and SK, where there was a decrease or stalling (CZ and LT). In hypothesis 3, the countries in which infrastructure made progress are LT, CZ, and SK, where the hypothesis was verified, and the countries in which the results decreased were BG, HU, PL, and RO, where the situation worsened compared to 2013.

At the level of the directions mentioned by SDG-9, it can be seen that, in the first direction (sustainable industrialization), LT is in first place (both in 2019 and in 2013), and in the second direction (research and innovation), EE is in first place (both in 2019 and in 2013). In the third direction (infrastructure) LT (2019) and HU (2013) lead. Although CZ is not in the leading position in any direction, overall, it has the highest SDG-9 value recorded, ranking first. Thus, the gap obtained for CZ with respect to SDG-9 makes this country distance itself from others due to registered development and shows that its efforts have produced better results in the same time frame. EE is the country that moved from fourth place in 2013 to second place in 2019, following the improvement of the values in the third direction of SDG-9 (infrastructure). LT moved from second place (2013) to third place (2019) due to low values in the direction of research and innovation. As a result, this country may have problems in the future in terms of sustainable innovation and adapting to the future.

The poor performance of some countries (RO, BG, EE, and PL) in infrastructure is quite alarming, as this decline will slow down progress.

This study also shows that low or high results should be interpreted in terms of the influences of chain effects on other SDGs, as other authors have noted.

Although the economic conditions, levels of development, and growth potentials are different for each of the countries studied, it can be seen that the classification made for the stage of sustainable development in 'industry, innovation, and infrastructure' allowed them to fall into three specific categories: high, moderate, or low progress. This classification into specific categories provides an image of the long-term results, thus explaining the possible differences between the countries in terms of prosperity.

There are several limitations in the implemented approach, some of which may be further investigated in the future. Firstly, the model investigates only the situation related to SDG-9, and the research could be extended to other SDGs. A possible extension would be to investigate how countries have made progress on each SDG and the overall sustainable development objectives. Secondly, the paper analyzes the data without being able to associate the value differences between countries with the socioeconomic or political conditions that allowed these changes, this being impossible due to the existence of several variables, and this issue should be investigated further.

Funding: This research received funding for open access publishing from the author's employer, the Technical University of Cluj-Napoca.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The author declares no conflict of interest. The funder had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

References

1. Government of Romania (GR). *National Strategy for Sustainable Development of Romania 2030*; Paideia: Bucharest, Romania, 2018; pp. 1–109. Available online: https://www.edu.ro/sites/default/files/Strategia-nationala-pentru-dezvoltarea-durabila-a-Rom%C3%A2niei-2030.pdf (accessed on 22 March 2022).
2. Brundtland, G.H. Report of the World Commission on Environment and Development–Our Common Future. 1987, pp. 1–374. Available online: https://digitallibrary.un.org/record/139811 (accessed on 22 March 2022).
3. United Nations General Assembly. *Transforming our world: The 2030 Agenda for Sustainable Development*; United Nations General Assembly: New York, NY, USA, 2015; pp. 1–35. Available online: https://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1 (accessed on 22 March 2022).
4. Aghion, P.; Boulanger, J.; Cohen, E. Rethinking Industrial Policy. Bruegel Policy Brief. 2011. Available online: https://ideas.repec.org/p/bre/polbrf/566.html (accessed on 26 March 2022).
5. Lin, J.Y. *New Structural Economics—A Framework to Rethinking Development and Policy*; The World Bank: Washington, DC, USA, 2012; pp. 1–371. Available online: https://openknowledge.worldbank.org/bitstream/handle/10986/2232/663930PUB0EPI00nomics09780821389553.pdf?sequence=1&isAllowed=y (accessed on 27 March 2022).
6. Rodrik, D. *Industrial Development: Some Stylized Facts and Policy Directions. Industrial Development for the 21st Century*; Part 1.1; U.N. Department of Economic and Social Affairs, Division for Sustainable Development: New York, NY, USA, 2007; pp. 7–28. Available online: https://www.un.org/esa/sustdev/publications/industrial_development/full_report.pdf (accessed on 11 February 2022).
7. Arrow, K.J. The Economic Implications of Learning by Doing. *Rev. Econ. Stud.* **1962**, *29*, 155–173. [CrossRef]
8. Diao, X.; McMillan, M.; Rodrik, D. *The Recent Growth Boom in Developing Economies: A Structural Change Perspective*; NBER Working Paper; National Bureau of Economic Research: Cambridge, MA, USA, 2017; p. 23132. Available online: https://www.nber.org/system/files/working_papers/w23132/w23132.pdf (accessed on 30 March 2022).
9. Lamichhane, S.; Eğilmez, G.; Gedik, R.; Bhutta, M.K.S.; Erenay, B. Benchmarking OECD countries' sustainable development performance: A goal-specific principal component analysis approach. *J. Clean. Prod.* **2021**, *287*, 125040. [CrossRef]
10. Velenturf, P.M.; Purnell, P. Principles for a sustainable circular economy. *Sust. Prod. Consum.* **2021**, *27*, 1437. [CrossRef]
11. Suo, C.; Li, Y.; Mei, H.; Lv, J.; Sun, J.; Nie, S. Towards sustainability for China's energy system through developing an energy-climate-water nexus model. *Renew. Sustain. Energy Rev.* **2021**, *135*, 110394. [CrossRef]

12. Yin, Z.; Hu, Y.; Jenkins, K.; He, Y.; Forstenhäusler, N.; Warren, R.; Yang, L.; Jenkins, R.; Guan, D. Assessing the economic impacts of future fluvial flooding in six countries under climate change and socio-economic development. *Clim. Chang.* **2021**, *166*, 38. [CrossRef]
13. Copiello, S.; Grillenzoni, C. Economic development and climate change. Which is the cause and which the effect? *Energy Rep.* **2020**, *6*, 49. [CrossRef]
14. Liobikienė, G.; Butkus, M. The challenges and opportunities of climate change policy under different stages of economic development. *Sci. Total Environ.* **2018**, *642*, 999–1007. [CrossRef]
15. Hertzberg, M.; Siddons, A.; Schreuder, H. Role of greenhouse gases in climate change. *Energy Environ.* **2017**, *28*, 530–539. [CrossRef]
16. Martinho, V.J.P.D. Insights into circular economy indicators: Emphasizing dimensions of sustainability. *Environ. Sustain. Indic.* **2021**, *10*, 100119. [CrossRef]
17. Ghisellini, P.; Cialani, C.; Ulgiati, S. A Review on Circular Economy: The Expected Transition to a Balanced Interplay of Environmental and Economic Systems. *J. Clean. Prod.* **2016**, *114*, 11–32. [CrossRef]
18. Kocmanová, A.; Dočekalová, M.P.; Simanavičienė, Ž. Corporate sustainability measurement and assessment of Czech manufacturing companies using a composite indicator. *Eng. Econ.* **2017**, *28*, 88–100. [CrossRef]
19. Fouquet, R.; Pearson, P.J. Past and prospective energy transitions: Insights from history. *Energy Policy* **2012**, *50*, 1–7. [CrossRef]
20. O'Connor, P. *Energy Transitions*; Pardee House: Boston, MA, USA, 2010; p. 12. Available online: https://www.bu.edu/pardee/files/2010/11/12-PP-Nov2010.pdf (accessed on 25 March 2022).
21. International Energy Agency (IEA). *World Energy Balances: An Overview*, 2019th ed.; International Energy Agency (IEA): Paris, France, 2019; pp. 1–23. Available online: https://iea.blob.core.windows.net/assets/8bd626f1-a403-4b14-964f-f8d0f61e0677/World_Energy_Balances_2019_Overview.pdf (accessed on 15 March 2022).
22. Johnstone, N.; Haščič, I.; Popp, D. Renewable Energy Policies and Technological Innovation: Evidence Based on Patent Counts. *Environ. Resour. Econ.* **2010**, *45*, 133–155. [CrossRef]
23. Marques, A.C.; Fuinhas, J.A. Are public policies towards renewables successful? Evidence from European countries. *Renew. Energy* **2012**, *44*, 109. [CrossRef]
24. Kilinc-Ata, N. The evaluation of renewable energy policies across EU countries and US states: An econometric approach. *Energy Sustain. Dev.* **2016**, *31*, 83–90. [CrossRef]
25. Bruvoll, A.; Larsen, B.M. Greenhouse gas emissions in Norway: Do carbon taxes work? *Energy Pol.* **2004**, *32*, 493. [CrossRef]
26. Elliott, J.; Foster, I.; Kortum, S.; Munson, T.; Cervantes, F.P.; Weisbach, D. Trade and Carbon Taxes. *Am. Econ. Rev.* **2010**, *100*, 465–469. [CrossRef]
27. Mazzucato, M.; Semieniuk, G. Public financing of innovation: New questions. *Oxf. Rev. Econ. Policy* **2017**, *33*, 24–48. [CrossRef]
28. Pfeiffer, B.; Mulder, P. Explaining the diffusion of renewable energy technology in developing countries. *Energy Econ.* **2013**, *40*, 285–296. [CrossRef]
29. OECD. *The Role of Nuclear Energy in a Low-Carbon Energy Future*; OECD Publishing: Paris, France, 2012; pp. 1–96. [CrossRef]
30. Szirmai, A. Industrialization as an engine of growth in developing countries 1950–2005. *Struct. Chang. Econ. Dyn.* **2012**, *23*, 406. [CrossRef]
31. Cooper, D. *The Lima Declaration on Biodiversity and Climate Change: Contributions from Science to Policy for Sustainable Development*; Secretariat of the Convention on Biological Diversity: Montreal, QC, Canada, 2017; pp. 1–153. Available online: https://www.cbd.int/doc/publications/cbd-ts-89-en.pdf (accessed on 10 April 2022).
32. Ayele, B.Y.; Megento, T.L.; Habetemariam, K.Y. The governance and management of green spaces in Addis Ababa, Ethiopia. *Heliyon* **2022**, *8*, e09413. [CrossRef] [PubMed]
33. Yao, Y. The relationship between China's export-led growth and its double transition of demographic change and industrialization. *Asian Econ. Pap.* **2011**, *10*, 52–76. [CrossRef]
34. Szirmai, A.; Verspagen, B. Manufacturing and economic growth in developing countries, 1950–2005. *Struct. Chang. Econ. Dyn.* **2015**, *34*, 46–59. [CrossRef]
35. Wood, Adrian, Variation in Structural Change Around the World, 1985–2015: Patterns, Causes and Implications. WIDER Work. Paper. 2017. Available online: https://www.wider.unu.edu/sites/default/files/wp2017-34.pdf (accessed on 12 March 2022).
36. Szopik-Depczyńska, K.; Kędzierska-Szczepaniak, A.; Szczepaniak, K.; Cheba, K.; Gajda, W.; Ioppolo, G. Innovation in sustainable development: An investigation of the EU context using 2030 agenda indicators. *Land Use Policy* **2018**, *79*, 251–262. [CrossRef]
37. Martorano, B.; Park, D.; Sanfilippo, M. Catching-up, structural transformation, and inequality: Industry-level evidence from Asia. *Ind. Corp. Chang.* **2016**, *26*, 555–570. [CrossRef]
38. Wang, Q.; Zhang, F. Does increasing investment in research and development promote economic growth decoupling from carbon emission growth? An empirical analysis of BRICS countries. *J. Clean. Prod.* **2020**, *252*, 119853. [CrossRef]
39. Becker, B. Public R&D policies and private R&D investment: A survey of the empirical evidence. *J. Econ. Surv.* **2015**, *29*, 917–942. [CrossRef]
40. Shao, X.; Zhong, Y.; Li, Y.; Altuntaş, M. Does environmental and renewable energy R&D help to achieve carbon neutrality target? A case of the US economy. *J. Environ. Manag.* **2021**, *296*, 113229. [CrossRef]
41. Umar, M.; Ji, X.; Kirikkaleli, D.; Xu, Q. COP21 Roadmap: Do innovation, financial development, and transportation infrastructure matter for environmental sustainability in China? *J. Environ. Manag.* **2020**, *271*, 111026. [CrossRef]

42. Holt, J.; Skali, A.; Thomson, R. The additionality of R&D tax policy: Quasi-experimental evidence. *Technovation* **2021**, *107*, 102293. [CrossRef]
43. Ganda, F. The impact of innovation and technology investments on carbon emissions in selected organizations for economic co-operation and development countries. *J. Clean. Prod.* **2019**, *217*, 469. [CrossRef]
44. Wiesenthal, T.; Leduc, G.; Haegeman, K.; Schwarz, H.-G. Bottom-up estimation of industrial and public R&D investment by technology in support of policy-making: The case of selected low-carbon energy technologies. *Res. Policy* **2012**, *41*, 116–131. [CrossRef]
45. Wang, T.; Libaers, D.; Park, H.D. The Paradox of Openness: How Product and Patenting Experience Affect R&D Sourcing in China? *J. Prod. Innov. Manag.* **2017**, *34*, 250–268. [CrossRef]
46. Mazzucato, M. Mission-oriented innovation policies: Challenges and opportunities. *Ind. Corp. Chang.* **2018**, *27*, 803–815. [CrossRef]
47. Khan, A.; Chenggang, Y.; Bano, S.; Hussain, J. The empirical relationship between environmental degradation, economic growth, and social well-being in Belt and Road Initiative countries. *Environ. Sci. Pollut. Res.* **2020**, *27*, 30800–30814. [CrossRef] [PubMed]
48. Khan, A.; Chenggang, Y.; Hussain, J.; Bano, S.; Nawaz, A. Natural resources, tourism development, and energy-growth-CO_2 emission nexus: A simultaneity modeling analysis of BRI countries. *Resour. Policy* **2020**, *68*, 101751. [CrossRef]
49. Narain, D.; Maron, M.; Teo, H.C.; Hussey, K.; Lechner, A.M. Best-practice biodiversity safeguards for Belt and Road Initiative's financiers. *Nat. Sustain.* **2020**, *3*, 650–657. [CrossRef]
50. Hussain, J.; Khan, A.; Zhou, K. The impact of natural resource depletion on energy use and CO_2 emission in Belt & Road Initiative countries: A cross-country analysis. *Energy* **2020**, *199*, 117409. [CrossRef]
51. Yin, W. Integrating Sustainable Development Goals into the Belt and Road Initiative: Would It Be a New Model for Green and Sustainable Investment? *Sustainability* **2019**, *11*, 6991. [CrossRef]
52. Alonso, A.; Monzón, A.; Cascajo, R. Comparative analysis of passenger transport sustainability in European cities. *Ecol. Indic.* **2015**, *48*, 578–592. [CrossRef]
53. Haghshenas, H.; Vaziri, M. Urban sustainable transportation indicators for global comparison. *Ecol. Indic.* **2012**, *15*, 115–121. [CrossRef]
54. Zhou, J. Sustainable transportation in the US: A review of proposals, policies, and programs since 2000. *Front. Arch. Res.* **2012**, *1*, 150–165. [CrossRef]
55. Available online: https://ec.europa.eu/eurostat/data/database (accessed on 5 March 2022).
56. Schwab, K.; Zahidi, S. *The Global Competitiveness: How Countries are Performing on the Road to Recovery*; World Economic Forum: Geneva, Switzerland, 2020; pp. 81–83. Available online: https://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2020.pdf (accessed on 10 May 2022).
57. Cornell University; INSEAD; The World Intellectual Property Organization. *Global Innovation Index 2019: Creating Healthy Lives–The Future of Medical Innovation*, 12th ed.; World Intellectual Property Organization: Geneva, Switzerland, 2019; pp. 1–400.
58. Harmes-Liedtke, U.; Oteiza, J.J. Global Quality Infrastructure Index Report 2020. 2021, pp. 1–53. Available online: https://www.researchgate.net/publication/350589103_GLOBAL_QUALITY_INFRASTRUCTURE_INDEX_REPORT_2020_TITLE_Global_Quality_Infrastructure_Index_Report_2020 (accessed on 25 May 2022).
59. Available online: https://sustainabledevelopment.un.org/content/documents/14363SDG9format-revOD.pdf (accessed on 20 March 2022).