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Integrating Environmental, Social, and Economic Dimensions to Monitor Sustainability in the G20 Countries

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Abstract: Several regions have struggled to define and implement strategic priorities to ensure resource supply security and environmental, economic, and social sustainability. The circular economy is gaining more and more importance as one of the forms of transition towards a sustainable future that integrates, in a balanced way, economic performance, social inclusion, and environmental resilience, for the benefit of current and future generations. In light of the challenges of solving or avoiding future problems, the G20 bloc created proposals and action plans to support the transition towards a more circular economic model while at the same time fostering discussions on the implementation of the 2030 Agenda for Sustainable Development. Therefore, the main objective of this study is to monitor and compare the performance of 19 countries in the G20 bloc (the 20th member is the European Union) from 2000 to 2020 to assess their progress toward environmental, economic, and social sustainability supported by the CE principles. To achieve this objective, the five sectors sustainability model was used and was supported by goal programming as a multicriteria analysis tool generating a synthetic sustainability indicator to assist decision making. The results showed that the countries with the best overall sustainable performance (environmental, economic, and social) in 2020 were Canada (which also occupied the best position in 2000), Australia, Italy, the United Kingdom, and the United States, while Argentina, South Africa, India, Indonesia, and China showed lower sustainability. The results can serve as a reference for decision making by stakeholders in designing policies and incentives to encourage the adoption of the circular economy and boost economic development without compromising welfare or the environment.

Keywords: circular economy; 5SEnSU model; regional sustainability; multi-criteria indicator

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1. Introduction

Circular economy (CE) has been promoted in recent years as a new way to achieve sustainability in the long term as it seeks to dissociate economic development from the use of natural resources, providing a series of economic, social, and environmental benefits. As circularity is related to sustainability [1], the discourse has attracted the attention of the sustainable development community globally. It has become one of this field's most popular research areas [2–4]. Although the two concepts do not necessarily share the same objectives [5], as the possibilities of CE application increase, so does its relationship with sustainability [6], by spreading solutions for continuous economic development with minimal exploitation of the environment and the integrity of natural ecosystems [7]. Thus, while many studies have focused on analyzing CE as an important part of the sustainability solution [8], others report that the transition towards a sustainable economic system requires the balanced and simultaneous consideration of economic, environmental, technological, and social aspects [9].

In any case, efforts have been made to promote CE as a tool to improve the utilization of limited resources within the socioeconomic system [10] and to enhance environmental quality, economic prosperity, and social equity to achieve sustainable development [11]. However, despite the potential benefits of implementing CE, Blum [12] showed that circular practices do not always contribute to sustainability since the fact that materials circulate does not necessarily mean less resource use.

In this way, CE has been considered as a possible route to dissociate economic growth from resource consumption and influence global sustainability [13], becoming a central piece of public policy formulation in the European Union and Asia [14,15]. In this context, the G20 countries are also encouraging the development of circular practices that make production and consumption more sustainable at an individual and institutional level [16]. In the quest to achieve a more sustainable economy, Japan presented CE as a priority at the summit of member countries in 2019 [17]. As G20 represents more than 80% of global consumption of materials, fuels, and food [18], a multi-regional analysis that unites theoretical objectives and practical strategies for CE implementation is vital to assess sustainable development.

Within this scenario, several initiatives have been proposed to measure, evaluate, and compare entities' progress toward CE at different levels, especially those linked to the micro-level [19]. For Bassi and Dias [20], this is because some studies on CE remain focused on industry regardless of whether circular practices are applied or not, with a predominant focus on economic benefits [6]. As the ultimate goal of CE is sustainability [21], some authors emphasize that circularity should not be focused only on production [22] but on the system as a whole to obtain a clear view of the environmental impacts from a long-term perspective.

As CE is a hierarchical system with economic agents at its center [22], most indicators used to assess circularity do not fully contemplate a socio-environmental perspective [23]. Thus, despite various initiatives to measure circularity, few have an integrative focus, simultaneously measuring the environmental, economic, and social dimensions [24]. This investigation intends to mitigate this gap by presenting a holistic and multidimensional approach to measuring the performance of 19 countries (called from here G19) of the G20 bloc. It uses a set of social, economic, and environmental data and implements the five sectors sustainability model (5SEnSU) to generate a single sustainability indicator, thus allowing for the ordering and direct confrontation of these countries.

The main objective of this research is to monitor and compare the performance of the G19 countries in the period 2000–2020 to assess their progress toward environmental, economic, and social sustainability. Unified comparisons are made between countries over the years, identifying the leading nations and those particularly lagging and providing insights into which practices may contribute to overcoming economic development challenges, conservation nature, and social equity. Furthermore, as CE practices are relevant for the implementation of some Sustainable Development Goals (SDGs) [25], with interdependence with SDG 6 [26], strong links with the SDGs 7, 8, 9, 11, 12, and 13 [27], and a deep influence on SDG 14, 15, and 17 [28], different actions, including national policies and programs, should be prioritized to promote the sustainability approach.

In addition to presenting the theme and relevance of the research, the study has three more sections. The methods and action strategies adopted to assess the effectiveness of the study are explained in Section 2. The analysis and discussion of the environmental, social, and economic macro indicators generated by the 5SEnSU model follow in Section 3. Finally, the article concludes by indicating actions to be prioritized, aiming at a more sustainable environment.

2. Materials and Methods

The G20 comprises the 7 wealthiest and most influential countries in the world (Canada, France, Germany, Italy, Japan, United Kingdom, and United States,) and 12 emerging countries (Argentina, Australia, Brazil, China, India, Indonesia, Mexico, Russia, Saudi Arabia, South Africa, South Korea, and Turkey), in addition to the European Union. As the EU is an economic block with a complex political, economic, and social situation, only individual economies are considered in this study, that is, 19 countries. Another reason for assessing only 19 countries is that France, Germany, Italy, and the United Kingdom (as of 2020) belong to the EU and the G20, causing data duplication.

Formed in 1999, the G20 is the main forum for discussing the international regulatory framework with a significant impact on economic development and global sustainability. At the global level, G20 countries are responsible for approximately 77.1% of the economy [29], generate 85% of the global GDP, 75% of trade, account for 80% of global carbon emissions [30], and generate approximately two-thirds of plastic waste [31].

Due to their global representation, in 2020 the G19 countries directed US$ 3.7 trillion to sectors that significantly impact carbon emissions and the environment and proposed more than 70 sustainable policy actions at the national or subnational level [30]. These actions highlight the G19 importance of coordinating activities for the 3 sustainability dimensions and playing a leadership role in facilitating the implementation of the SDGs both nationally and internationally, although it also faces serious challenges. However, there are still issues to overcome, despite the various actions and attempts to develop action-based assessments that promote sustainable development that addresses economic, social, and environmental issues in different countries and at multiple levels.

Considering the essential need to maintain natural resources and capital stocks that cannot be replaced by any other form of manufactured capital [32], and to analyze the status of CE practices and policy initiatives by national governments to meet the SDGs, annual data covering the period 2000–2020 for the G19 countries were selected. The choice of the selected data (Figure 1) was dictated mainly by the availability of reliable data strongly connected with sustainable development, considering the idea of strong sustainability [33,34], in which a preserved environment is capable of maintaining a healthy society and a prosperous economy [35].

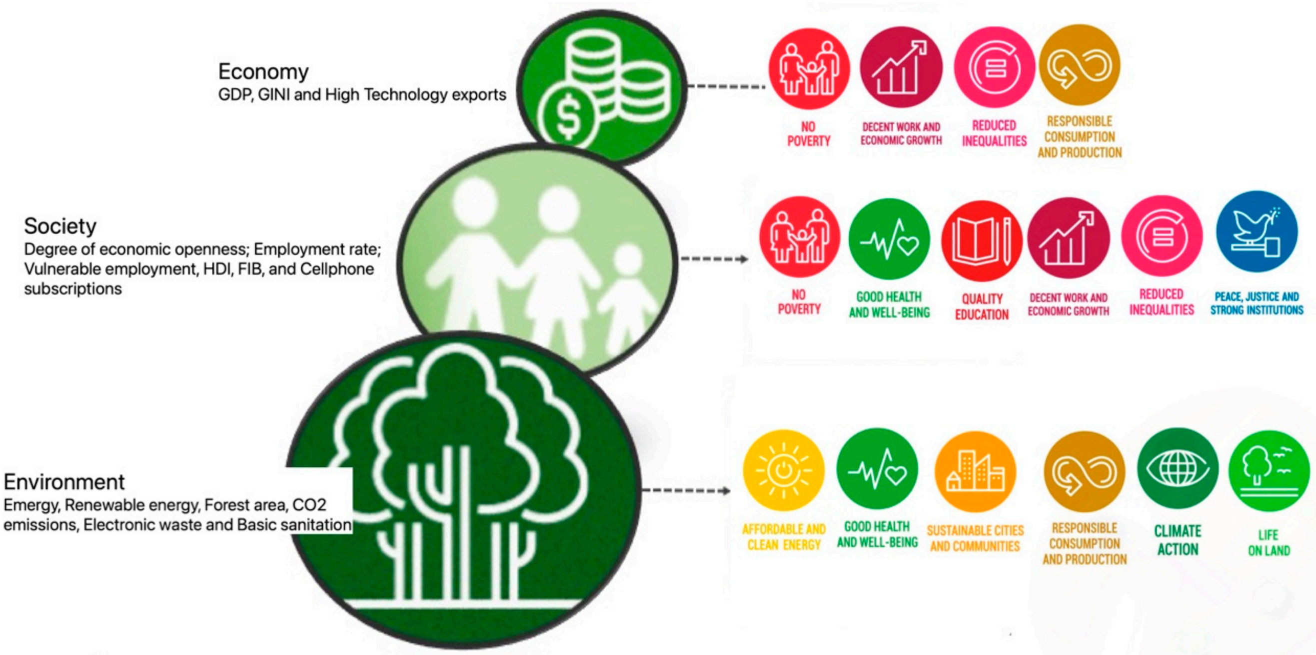

Figure 1. The connections of the indicators used in this study are based on the holistic view of CE and SDGs. The environment forms the general basis of human activities, followed by society, organized according to normative definitions. Finally, the economy provides goods and services to society and must operate within environmental restrictions.

To project a CE contributing to sustainability, selected variables for the developed and developing economies of the G19 countries were evaluated using the 5SEnSU model (Figure 2), which considers 5 sectors with assigned functions [36]. The model uses goal programming that combines different measurement units into a single measure, the synthetic indicator of systems sustainability (SISS) [37]. The SISS values reflect how close each country's entire set of indicators is to the established targets, and the higher the SISS, the further they are from achieving sustainability [38]. Detailed calculation procedures are described in Giannetti [36] and Garcia [37] and are also available in Appendix A, while the results related to the present study are presented in the Supplementary Material.

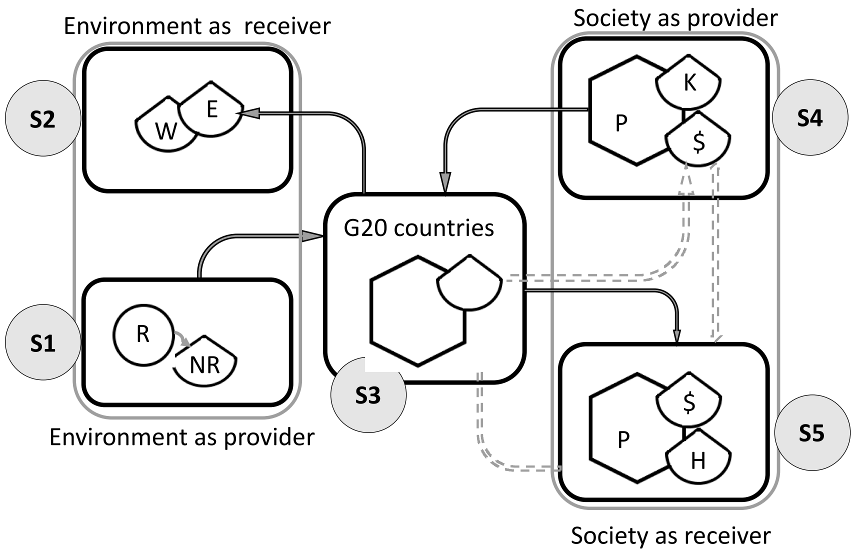

Figure 2. Schematic representation of the 5SEnSU model. W: waste and sanitation; E: emissions; R and NR: renewable and non-renewable resources; P: people; K: knowledge; and H: happiness. Straight lines refer to material and energy flows and white arrows refer to currency exchange.

Due to the complexity inherent in analyzing 19 different countries, several indicators proposed in the literature do not cover all technical, economic, environmental, business, and social aspects [39], making it necessary to use multicriteria approaches to assess sustainability in an integrated manner. Other authors [40,41] have used multicriteria decision-making (MCDM) methods to simultaneously assess performance and sustainability. However, some of these methods have specific fields of application and therefore do not fully capture environmental, social, and economic aspects in a comprehensive way.

Under the strong sustainability perspective, the 5SEnSU model shows the relationships between humans and the natural environment, considering that all production systems, whether natural or man-made, are part of a larger, complex, and integrated system [36]. The 5 sectors of the model contemplate (1) the environment as a resource provider; (2) the environment as a waste receiver; (3) economic aspects of the G19; (4) the society as a supplier of materials and labor; and (5) the society as a receiver of the system outcomes.

As data quality is critical to producing meaningful results, 15 indicators (3 per sector) extracted from data-rich environments were selected to feed the 5SEnSU model. Indicators are represented by the letter K, followed by a number indicating the sector and a second number denoting the indicator for a given sector (for example, K11 refers to sector 1 and the indicator "Energy"; K21 represents sector 2 and the indicator "Degree of Economic Openness", and so on).

As CE actions support various international development agendas on poverty eradication, natural resource conservation, economic development, sustainable cities, sustainable consumption, and production, among others [28], the following section presents in detail the environmental, economic, and social indicators used to feed the 5SEnSU model.

2.1. Environmental Indicators Used in Sectors 1 and 2

The indicators chosen for sector 1 (environment as a provider of resources) were total emergy per capita (U, K11), consumption of renewable energy (% of total consumption, K12), and % of forest area, K13. Emergy analysis (K11) builds on performance measurements with donor-side assessment approaches and can provide insights into environmentally sustainable circularity [42]. Socioeconomic development depends on the use of non-renewable local resources, which leads to an increase in the environmental burden [43]; thus, the value of this indicator should be minimized to improve the sustainability of the G19.

The second indicator for sector 1, renewable energy consumption (K12), is the share of renewable energy in total final energy consumption. In a closed-loop framework, the CE should strengthen the concept of converting waste materials into energy, reducing waste and resource use [44]. In an optimistic CE scenario, the closed-loop would eliminate waste, provide renewable energy, and protect the environment [45,46]. To increase the trend toward renewable sources, the objective is to maximize the values of this indicator.

The third indicator of sector 1 (K13), % of forest area, is made up of trees at least 5 m tall, natural or planted, productive or not, located in rural and urban areas, and excludes those belonging to agricultural production systems and/or agroforestry systems, given that deforestation is one of the leading causes of biodiversity loss [47]. CE offers several opportunities for countries and regions to reduce the forest area net loss significantly [48], and the objective is to maximize the values of this indicator.

In sector 2 (environment as a receiver of waste and emissions), the chosen indicators were CO_2 emissions (t/capta year, K21) that arise from the burning of fossil fuels, the manufacture of cement, the carbon dioxide produced during the consumption of solid, liquid, and gaseous fuels, and the burning of gas. Despite CE solutions not always resulting in emission reductions [49], minimizing this indicator is fundamental for sustainability by increasing the implementation of green energy projects to mitigate CO_2 emissions [50] and reduce GHG emissions.

Electronic waste (kg per capita/year) is the second indicator for sector 2 (K22) to be minimized. For Islam [51], the rapid technological revolution, combined with the growing consumer demand for high-tech products, has triggered unprecedented levels of consumption of electrical and electronic equipment. The management of this waste has become the main priority of all developed nations and those in development [52].

Finally, indicator K23, people using safely managed sanitation services (% of the population), refers to improved sanitation facilities that are not shared with other households and where excrement is safely disposed of on-site or transported and treated outside the local facility. As sanitation is fundamental for human development and is directly related to environmental performance and economic aspects [53], the objective is to maximize the value of this indicator.

2.2. Economic Indicators Used in Sector 3

The indicator GDP per capita (K31) is expressed in current international dollars, converted by the purchasing power parity (PPP) conversion factor. Applying the CE concept in some countries promises to increase GDP and reduce the use of natural resources, ensuring greater environmental protection [54]. Furthermore, some efforts have been made to measure social equity through GDP [55], so the goal is to maximize the value of this indicator to improve the economic performance of the G19. The second indicator for sector 3 is the GINI coefficient (K32), which measures the extent to which income distribution within an economy deviates from a perfectly equal distribution, where 0 represents perfect equality and 100 implies complete inequality. A reduction in inequality is among the SDGs [56] and the objective is to maximize the value of this indicator.

The third indicator used in sector 3 (K33) was % high technology exports (manufactured exports), which are products with a high R&D intensity, such as computers, pharmaceuticals, scientific instruments, and electrical machines. Currently, there is a great expectation that Industry 4.0 technologies will enable better results in circular practices through high-tech strategies, blockchain technology, and eco-environmental performance [57]. This scenario is raising concerns and forcing countries, companies, and civil society to rethink their competitiveness, innovation strategies, and innovation capacity [58]. As a result, high technology production and exports favor competitiveness and innovation and lead countries to foster their growth in the future. Maximizing this indicator strengthens the idea of the transition towards a resilient CE that will lead to sustainable economic behavior.

2.3. Social Indicators Used in Sectors 4 and 5

Considering society as a supplier of materials and labor (sector 4) and a recipient of goods and services (sector 5), the indicators chosen for these sectors not only belong to the category of "Social and World Development Indicators" published by the World Bank but are also considered the institutional and social predispositions necessary for social transition towards a CE. Despite the predominant focus of most CE-related approaches being on the environmental and economic dimensions [24], the first indicator of sector 4 (K41), the degree (or index) of economic openness, is calculated by summing the export and imports values of goods and services divided by the GDP and reveals the dependence and influence of international trade on the activities within the country. Maximizing the values of this indicator potentially describes how much the production and consumption activities within a country and abroad [59] contribute to public objectives as suggested by the CE, such as reducing dependence on materials, competitiveness, and the creation of domestic jobs.

The second indicator for sector 4 (K42) is the employment rate, which reflects the proportion of the economically active population aged 15 or over who provide labor for producing goods and services. Considering that CE is based on the principle of maintaining synergy and balance between social, economic, and environmental dimensions [60] through a more sustainable economic model that induces positive changes in the labor market with the creation of green jobs at the national, regional, and municipal levels [61], the objective is to maximize the values of this indicator to strengthen the idea of economic development. Indicator K43, vulnerable employment (% of total employment), describes the behavior and working conditions in a given region, with a high proportion of informal workers indicating poor socio-economic development. Schroeder [25] argues that CE practices can potentially directly contribute to SDG 8 (decent work and economic growth); thus, minimizing the values of this indicator means that workers in a country have greater social protection and are less vulnerable to poverty.

In sector 5 (society receiving the system outcomes), the indicator chosen was the human development index (HDI, K51), which is a summarized measure of the average performance in key dimensions of human development that varies between 0 (low human development) and 1 (very high human development). The CE model must have explicit links with socioeconomic elements of the transformation from linear to circular economic models combined with human development [62]. The K52 indicator (gross domestic happiness, GNH) complements traditional measures to measure the development of a nation. Among the issues analyzed by the GNH are human well-being and the depletion of natural resources. Within the CE discourse, innovative solutions are presented for the society of the future [63]. It also considers common issues between circularity and sustainability, such as the focus on international equity [64], quality improvement of people's lives, sustainable well-being, and happiness for all [65].

Finally, the indicator K52, mobile cellphone subscriptions (per 100 people), directly influences the generation of electronic waste, although CE models provide mechanisms to extend the useful life of the equipment [66]. Cellphone electronic waste circulates through several processes [67] and contains many different components and materials, which makes the recycling process difficult. This leads to "unwanted cell phones" [68], raising questions about the ability of a CE to close material and product cycles and prevent primary production [69]. Therefore, the objective is to minimize the values of this indicator.

Table 1 summarizes the 15 indicators chosen to feed the 5SEnSU model, their objectives (maximize or minimize), and the goals for each indicator.

Table 1. Indicators, their objectives, and targets defined to feed the 5SEnSU model to assess the sustainability of the G19.

Sector	Indicators	Objective	Goal
1	K_{11}—Total emergy per capta (U).	MIN	$\mathrm{Min}K_{11} + \sigma(K_{11})$
	K_{12}—% of renewable energy consumption	MAX	$\overline{K_{12}} + \sigma(K_{12})$
	K_{13}—% forest area	MAX	$\overline{K_{13}} + \sigma(K_{13})$
2	K_{21}—CO_2 emission (t/capta year)	MIN	$\mathrm{Min}K_{21} + \sigma(K_{21})$
	K_{22}—Electronic waste (kg/capta year)	MIN	$\mathrm{Min}K_{22} + \sigma(K_{22})$
	K_{23}—% of the population with sanitation services	MAX	100% of the population
3	K_{31}—GDP PPP per capta (USD)	MAX	$\overline{K_{31}} + \sigma(K_{31})$
	K_{32}—GINI coefficient	MIN	$\mathrm{Min}K_{32} + \sigma(K_{32})$
	K_{33}—High technology exports (% of manufactured exports)	MAX	$\overline{K_{32}} + \sigma(K_{32})$
4	K_{41}—Degree of economic openness	MAX	$\overline{K_{41}} + \sigma(K_{41})$
	K_{42}—Employment rate	MAX	$\overline{K_{42}} + \sigma(K_{42})$
	K_{43}—Vulnerable employment (% of total employment)	MIN	$\mathrm{Min}K_{43} + \sigma(K_{43})$
5	K_{51}—Human development index—HDI	MAX	0.80
	K_{52}—Gross national happiness—GNH	MAX	7.81
	K_{53}—Mobile cellphone subscriptions (per 100 people)	MIN	100

The time series data used to feed the 5SEnSU model cover the 3 dimensions of sustainability (environmental, economic, and social) and were taken from international bases: K11 was extracted from the National Environmental Accounting Database (NEAD) (www.emergy-nead.com); K12, K13, K21, K22, K23, K31, K32, K33, K41, K42, K43, and K53 were taken from the open source World Development Indicators published by the World Bank; K51, data on human development, were obtained from the Human Development Report of the United Nations Development Program (UNDP); and the indicators to feed K52, gross national happiness (GNH), were taken from the world happiness report (world happiness. report). However, although international databases are data-rich environments, there is no information for some periods. To update the time series variables, the autofill feature in the Microsoft Excel® program was used to fill cells with data that follow a pattern or that are based on data from other cells (the "goal programming" applied in this study is available in the Supplementary Materials in an Excel® file).

3. Results and Discussion

Results are divided into evaluating the sustainability performance of the G19 countries and providing a rank of the countries according to their performance.

3.1. G19 Performance According to the Synthetic Indicator of System Sustainability

The assessment of the G19 sustainability performance for the years 2000 to 2020, represented by the SISS values and considering the indicators, targets, and objectives chosen to feed the 5SenSU model, is presented in Figure 3. The G20 countries are formulating and implementing strategies CE to achieve some SDGs [16] and most countries in the group share commonalities.

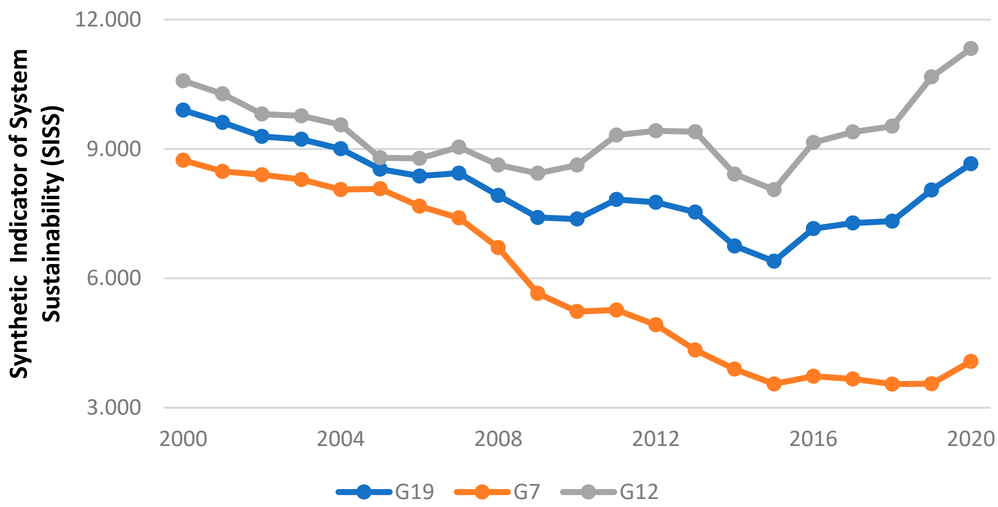

Figure 3. Synthetic indicator of systems sustainability (SISS) for G19, G7, and G12 from 2000 to 2020. Lower values indicate that the group is closer to the sustainability goals.

Figure 3 reflects the actions taken from 2000 to 2020 by multiple parties (G19, G7, and G11) involved in the CE transition. The improvements between 2000 and 2015 reflect policies adopted by the countries. From a general analysis, it is clear that G7 presented better initiatives to strengthen sustainability, which is perceived by the lower SISS in the analyzed period. With the founding of the Resource Efficiency Alliance, G7 strengthened and promoted measures to protect natural resources and improve resource efficiency [70]. Although the G19 is seen as the leading group of the world's major economies seeking to develop global policies to address environmental, economic, and social challenges, G12 members often lack the capacity to manage their environmental problems and are unable to take advantage of the emerging CE opportunities [71].

Despite all the efforts towards sustainability, there has been a continuous expansion of resource use and consumption, resulting in ever-increasing amounts of waste and the accompanying environmental impacts [72], as seen in the increase in the SISS of the G19 from 2015. Aiming to reverse this situation, the G19 committed to rethink the policies of subsidies for the use of fossil fuels [5] and to increase the renewable energy matrix, replacing high-impact materials [18]. From 2008, G7 shows a decreasing trend in the SISS, which represents better sustainability on the part of the countries that make up the group. Despite the rapid economic development achieved by the G19 over the last two decades [73], growing income disparity and environmental deterioration have affected the sustainability of G12, and radical changes toward promoting a more circular economy are essential for sustainable development.

To analyze the main aspects of sustainability over the years examined and to verify the win–win situation in terms of macroeconomic, social, and environmental benefits, Figure 4 provides insights into possible tradeoffs that occurred in the period.

Despite the CE gaining evidence in terms of environmental management and the need for a gradual transition towards a more sustainable economic development [74], the analysis carried out (Figure 4) highlighted that in the G19 countries, environmental quality was maintained or improved over the analyzed period through economic development. While the economic SISS (sector 3) was reduced in the period, from approximately 3.11 in 2000 to 0.68 in 2020, the social SISS (sectors 4 and 5) remained stable (1.31 in 2000 and 1.08 in 2020) and the environmental SISS (sectors 1 and 2) increased the most, from 2.10 in 2000 to 2.91 in 2020, which shows that economic growth and maintenance of social conditions came at the expense of the environment.

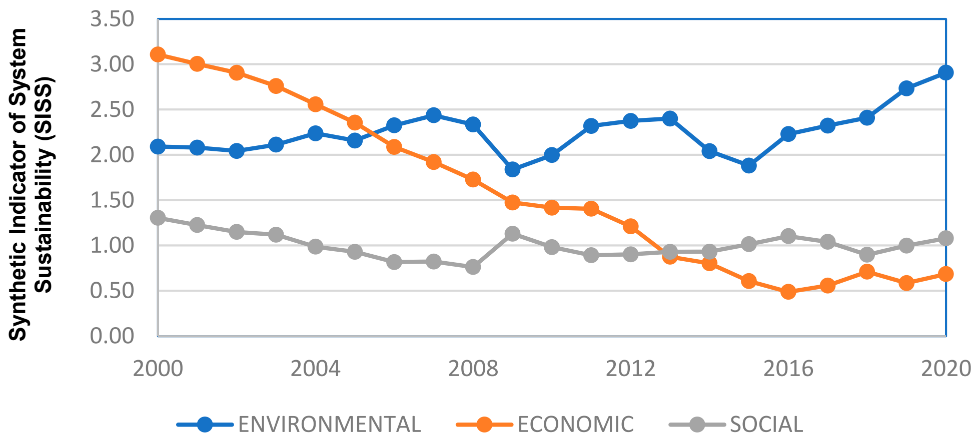

Figure 4. Synthetic indicator of systems sustainability by sector. Environmental SISS shows the average for sectors 1 and 2; economic shows the SISS of sector 3; and social corresponds to the average SISS from sectors 4 and 5 for the G19 from 2000 to 2020. Lower values indicate that the group is closer to the sustainability goals.

Based on the SISS values, a dependence between the environmental and economic dimensions is perceived, especially from 2006 onwards, which links the current development model to the exploitation of the environment and the indiscriminate use of materials and energy to maintain stable social conditions. For Sverko Grdic [54], this is because economic efficiency is often linked to negative environmental impact since high production growth, low unemployment, and price stability, in theory, would not collide with environmental protection. Busu [75] investigated the relationship between CE and economic development and found that economic factors are the basis of the circular development model (at the European level), so it is important to simultaneously investigate economic development and the environmental impacts caused by this development. However, Ghisellini [10] claim that CE can be used as an approach aimed at more efficient waste management, and this challenges current models of economic development and does not privilege the interaction between economic processes and the environment, although some countries present significant achievements in circularizing their economic model to achieve better sustainability [54]. When investigating the economic development linked to CE, it is noted that the sustainable consumption of resources that can lead to improved environmental quality [76] is still a point to be reached.

When the environmental and social perspectives are analyzed from the multidimensional sustainability perspective the fragility of the current economic model is clear, as the environmental SISS is higher than the social SISS throughout the analyzed period. In terms of the value of the environmental SISS, from 2015 onwards the indicator showed a growing trend which affected environmental sustainability, while the social SISS increased from 2018. Across the period, the social dimension stood out over the environmental one, which may mean that social well-being is not as strongly linked to environmental degradation as economic growth [23]. From another perspective, Geissdoerfer [1] argues that socioeconomic effects simplify the environmental dimension since problems such as loss of biodiversity, water, air, and soil pollution, resource depletion, and excessive land use are side effects of the relationships between ecological and economic systems. As long as society as a whole does not change its lifestyles and attitudes towards production and consumption to face the challenges posed by environmental degradation, climate change, and unexpected events [77], CE will clearly prioritize the economic system that benefits materials for the environment [55].

Although social and environmental dimensions share important principles within sustainability, such as increasing resource efficiency and extending product life cycles [2], meeting social needs [78], and stimulating the creation of new policies that improve people's lives [79], paths and goals to achieve sustainable development have yet to be created [15].

The social sustainability indicated by its SISS presented better results than the economic one until 2008. Despite the assumption that a transition towards a CE will create economic prosperity and social equity [11], the results show that social aspects were only peripherally and sporadically integrated into the circular model. For Mies and Gold [24], to achieve a genuinely sustainable alternative it is essential that social actions are more present in the economic system.

3.2. G19 Ranking Using the Synthetic Indicator of System Sustainability

Aiming to empirically evaluate sustainable practices from economic, social, and environmental aspects in the G19 countries, the 5SEnSU model provided a composite indicator that made it possible to create a ranking of the more sustainable countries according to their SISS. For Becker [80], rankings are a simple tool that provides a summarized picture of complex and multidimensional phenomena to analyze and compare the most varied performances. With this, it was possible to directly monitor, order, and compare the behavior of the G19 over the years, based on multiple criteria to highlight the best environmental, economic, and social approaches to achieving sustainable development.

As shown in Table 2, the country with the best SISS performance both in 2000 and in 2020 was Canada, while the country with the highest SISS in 2000 was India. In 2020, this position was occupied by China (which in 2000 occupied the penultimate position). South Africa, Argentina, and Indonesia were the nations that dropped more posts in the analyzed period, going from the third, fifth, and eighth positions, respectively, in 2000 to the sixteenth, fifteenth, and eighteenth positions in 2020. On the other hand, the United Kingdom and Italy were the economies that climbed ranks, moving from fourteenth and eleventh place, respectively, in 2000 to fourth and third place in 2020. Canada, France, and Brazil did not change their positions over the years. The ranking presented in Figure 4 also allowed is to identify the group of the eight most sustainable countries according to their SISS: Canada, Australia, Italy, United Kingdom, United States, France, Mexico, and Japan in 2020. As can be seen, some countries considered the most advanced and developed economies in the world were left out of the sustainable G7 (according to the SISS of these nations), as was the case for Italy, Japan, and Russia in 2000 (Russia also did not enter the sustainable G7 in 2020).

For Velenturf [81], the unbridled exploitation of natural resources brought well-being to many people in some countries. However, this situation accelerated waste production. This scenario has led some nations to adopt the circular approach in isolation in recent years, and these efforts still need to be improved to promote sustainable practices in their territories [82]. In a world with limited resources, the adoption of circular measures can generate several positive impacts on the economy and on the environmental pressures of nations through redesigning processes and the cycling of materials, even with limitations inherent to the social dimension [78].

As CE gains increasing importance in the transition towards a sustainable future in its three dimensions, quantifying and comparing levels of sustainability in each dimension allows for the identification of shortcomings and immediate requirements to improve overall sustainability [37]. Thus, Table 1 presents in detail the levels of sustainability established according to the SISS in the environmental, economic, and social sectors, their position in the ranking both for the year 2000 and for 2020, and the variation in position between these two periods.

Table 2. Synthetic indicator of system sustainability (SISS), rankings for each sector, and sustainability level. The SISS values highlighted in green refer to the 1st to 6th positions, yellow from 7th to 13th, and red from 14th to 19th.

Final Ranked Country	Sector 1	Sector 2	Sector 3	Sector 4	Sector 5	SISS Value 2000	Sector 1	Sector 2	Sector 3	Sector 4	Sector 5	SISS Value 2020
Canada	2.01	1.41	1.99	0.15	0.01	5.58	0.01	0.78	0.31	1.14	0.00	2.24
United States	3.19	1.41	1.92	1.24	0.01	7.77	0.65	0.09	1.61	1.02	0.31	3.67
South Africa	0.00	3.04	2.16	1.70	1.06	7.96	4.87	3.66	1.11	0.68	3.59	13.91
Australia	0.68	2.40	4.14	1.00	0.01	8.22	0.61	1.29	0.00	0.00	0.38	2.29
Argentina	0.32	2.70	2.37	2.77	0.20	8.36	6.09	3.90	1.46	1.20	1.06	13.71
France	2.41	2.16	3.01	1.02	0.01	8.61	0.25	1.07	0.70	1.20	0.57	3.80
Germany	3.93	0.77	2.58	1.49	0.00	8.76	4.83	0.14	0.50	0.47	1.41	7.36
Indonesia	0.02	3.57	2.83	1.32	1.24	8.97	6.69	4.27	1.73	2.32	1.96	16.97
Mexico	0.28	4.11	2.07	2.05	0.58	9.09	1.97	2.16	0.20	0.00	0.10	4.42
Brazil	0.47	3.21	2.84	1.89	0.73	9.15	2.46	3.72	1.18	0.00	0.17	7.53
Italy	4.10	1.39	2.30	1.58	0.00	9.36	0.67	0.21	0.00	0.19	1.42	2.49
Japan	2.13	1.58	1.66	4.63	0.01	10.01	1.38	1.09	0.39	0.55	2.71	6.13
Saudi Arabia	1.41	3.14	1.81	3.82	0.37	10.54	3.74	3.75	2.45	2.02	1.21	13.17
United Kingdom	6.08	1.70	2.57	0.71	0.00	11.07	0.00	0.10	0.03	1.87	0.82	2.82
South Korea	3.73	1.22	3.47	3.60	0.00	12.03	5.62	0.98	0.00	1.28	1.88	9.77
Turkey	0.37	2.05	6.05	3.00	0.88	12.36	6.30	3.13	0.00	0.00	0.00	9.43
Russia	0.13	2.23	6.64	2.97	0.50	12.47	3.29	2.32	1.30	1.06	3.18	11.15
China	0.85	4.35	4.12	2.99	1.33	13.64	9.16	7.22	0.02	1.95	1.07	19.41
India	0.25	4.67	4.52	2.80	1.92	14.16	6.14	5.84	0.00	1.32	0.86	14.17

Canada had the lowest SISS in 2000 and 2020 in the 5SEnSU global indicator, in addition to improving by 10 positions in sector 1 and 7 in sector 5, maintaining the same position in sector 2. For Liu [83], one of the main reasons for the country's good performance is that the Canadian industrial base and population are small compared to the country's area, which makes it easier to find solutions to respond to resource conservation and environmental protection pressures. However, despite Canada occupying the first place in the 5SEnSU global indicator in 2000 and 2020, the country lost 5 positions in sector 3 and 10 positions in sector 4, and although recycling has been practiced in the country since the end of the 1980s, the CE implementation remains dispersed and lacks a higher level of commitment from policymakers [84].

The United States dropped by 3 positions in the analyzed period and, despite improving by 10 positions in sector 1 and 3 positions in sectors 2 and 5, the country declined by 14 positions in sector 3 and 4 positions in sector 4. The concern with managing natural resources resulted in a structural change in sustainability initiatives [85], and the possible generation of US$ 4.5 trillion in US GDP by 2030 [86] made a CE increasingly essential.

South Africa and Argentina maintained the same position in sectors 2 and 5, respectively; however, in all other sectors there was a loss of positions, mainly in sector 1, where South Africa fell by 12 positions and South America by 9 positions. Other countries that also lost several positions in the sustainability ranking include Indonesia (15 in sector 1, 1 in sector 2, 7 in sector 3, and 12 in sector 4) and China (9 in sector 1, 1 in sector 2, and 2 in sector 4). Per capita income and income distribution is a critical factor that significantly affects environmental quality in developing countries of the G19 [73].

This situation is evident when verifying in Figure 4 that developing countries such as South Africa, Argentina, Indonesia, Mexico, Brazil, Turkey, Russia, China, and India lost positions mainly in sector 1 and sector 2. In contrast, Canada, the United States, Australia, France, Germany, Italy, Japan, the United Kingdom, and South Korea had less environmental degradation and improved their position in the ranking of sector 1. In the same line, it was verified that Australia, France, Italy, United Kingdom, South Korea, Turkey, Russia, China, and India improved their performance in relation to economic sustainability (sector 3), with emphasis on Turkey which rose by 17 positions in this sector, while the United States, Japan, and Saudi Arabia fell further in the ranking.

Studying the sustainability of the textile industry, [87] found that in the G19, China, the United States, and Russia were the largest emitters of organic pollutants in water, while Saudi Arabia and Argentina were the smallest. Cabernard [18] found that in 2015, half of global greenhouse gas emissions in the G19 came from the extraction and processing of metals and building materials in China and India.

In the G19, most BRICS countries, i.e., China, India, and South Africa, did not achieve good results in the sustainability ranking, despite China investing approximately 3 to 5% of its GDP in the development of industries related to sustainable technologies [88]. Even though China exercises leadership in the implementation of sustainable development policies, the country is one of the largest consumers of resources and sources of greenhouse gas emissions [54], which may partly explain the country's position in the last places in the sustainability ranking generated by 5SEnSU.

With this, it is clear that CE complements and supports a more sustainable economic model and that countries with successful circular initiatives, such as the G7 nations, have several stakeholders that work together to allow a circular flow of materials and related efficiency benefits [82]. For CE to really achieve its goals, disruptive changes, radical innovations [89], social support, and legislative and financial subsidies [90] are required, elements that are not always present in developing countries due to financial, structural, operational, attitudinal, and technological barriers, and this makes CE implementation slow in practice.

4. Conclusions

This work aimed to monitor and compare the performance of the G19 countries in the period 2000–2020, analyzing the environmental, social, and economic sectors of the 5SEnSU model to assess the progress of the main areas of impact of CE activities closely associated with the sustainable behavior of the system. The study indicated which points should be prioritized for actions towards a more sustainable environment, for example, in sector 1 of the 19 countries analyzed, 13 increased the SISS, 1 maintained it, and only 5 managed to improve the indicator, pointing to greater pressure on the natural environment. In sector 2 the situation is more encouraging, as 11 countries reduced the SISS while 8 increased it, indicating a reduction in emissions and waste generation. In sector 3, only Saudi Arabia had an increase in SISS; a similar situation occurred in Canada, France, Indonesia, and the United Kingdom in sector 4. In sector 5, Canada, Mexico, Brazil, Turkey, India, and China reduced their SISS, thus indicating an improvement in the standard of living in their societies.

The study made it possible to rank the sustainability of the G19 countries and it was found that in 2020, Canada, Australia, Italy, the United Kingdom, and the United States occupy the top five positions, indicating a superior performance in terms of development. Meanwhile, Argentina, South Africa, India, Indonesia, and China are outperformers. Although the rank of sustainability levels only considers the G19 countries, the study can be considered a cross-section of the situation in developed and developing countries and can thus provide more rational policy implications for national policymakers according to the environmental, economic, and economic structure of the society of each nation.

Future studies may consider evaluating other countries outside the G20, whether they are developed, emerging, or underdeveloped economies, as the 5SEnSU model provides a strong scientific basis to verify sustainability at any scale.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su15086502/s1, Supplementary Materials brings all raw data, organized in worksheets to calculate the SISS.

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Appendix A

As goal programming is one of the possible methods to be applied for multicriteria modeling, Refs. [36,37] adapted the traditional goal of programming for an analysis of the 5SEnSU model, assigning weights to the indicators to characterize their relative importance in the system. To show the unwanted deviations that affect the performance of the selected indicators and consider a decision problem in which there are goals, the main characteristics of the program modeling proposed by Ref. [36] for the 5SEnSU model are presented in the following equations:

$$ISG^{+}_{ijk} = \sum_{ijk} \frac{N^{+}_{ijk}}{W^{+}_{jk}.G^{+}_{jk}} + \sum_{ijk} \frac{P^{+}_{ijk}}{W^{+}_{jk}.G^{+}_{jk}} \forall i \in \{1, 2, \ldots, NE\} \forall j \in \{1, 2, \ldots, NS\} \forall k \in \{1, 2, \ldots, NI\} \quad \text{(A1)}$$

$$ISG^{+}_{ijk} = \sum_{ijk} \frac{N^{-}_{ijk}}{W^{-}_{jk}.G^{-}_{jk}} + \sum_{ijk} \frac{P^{-}_{ijk}}{W^{+}_{jk}.G^{-}_{jk}} \forall i \in \{1, 2, \ldots, NE\} \forall j \in \{1, 2, \ldots, NS\} \forall k \in \{1, 2, \ldots, NI\} \quad \text{(A2)}$$

where:

- ISG = Index of Sustainability Goal.
- N^{+}_{ijk}e N^{-}_{ijk} = positive and negative indicators for negative deviation variables, respectively.
- P^{+}_{ijk}e P^{-}_{ijk} = positive and negative indicators for the positive deviation variables, respectively.
- G^{+}_{jk}e G^{-}_{jk} = Goals (Goals for positive or negative indicators).
- W^{+}_{jk}e W^{-}_{jk} = Weight (weight of each indicator).
- *NE* = amount in systems (economic blocks).
- *NS* = amount in sectors (1 . . . 5).
- *NI*: amount in indicators per sector.
- *i*: rated systems (1 . . . *NE*).
- *j*: sectors for Model 5SEnSU (1 . . . 5).
- *k*: indicators each sector evaluated (1 . . . *NI*).

The result of Equations (A1) and (A2) provide the ISG that will indicate how far the indicator is from its target, considering the weight/punishment chosen for analysis [38], thus allowing the generation of the sector sustainability indicator (SSI). The sum of the differences between the positive (+) and negative (−) deviations for each sector of the 5SEnSU model are extracted from the result of Expression (A3):

$$SSI_{ij} = WS \sum_{ijk} \left(ISG^{+}_{ijk} - ISG^{-}_{ijk} \right) \{1, 2, \ldots, NE\} \forall j \in \{1, 2, \ldots, NS\} \forall k \in \{1, 2, \ldots, NI\} \quad \text{(A3)}$$

where:

WS (weight sector) is the weight established for each sector (normally equal to one), considering that the 5SEnSU model is based on the principle of achieving a balance between the five sectors [36,38]. After this step, with the result of adding the SSI of each sector extracted from Equation (A3), it is possible to find the sustainability synthetic indicator of the system (SSIS):

$$SSIS_{i} = \sum_{j}^{5} SSIS_{i} \{1, 2, \ldots, NE\} \forall j \in \{1, 2, \ldots, NS\} \forall k \in \{1, 2, \ldots, NI\} \quad \text{(A4)}$$

The SSIS represents the sustainability performance of the system, considering the relationship between the indicators [38] and the shorter distance to the established target. Therefore, the smaller the SSIS, the greater the sustainability of the system.

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