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Assessment of the Results and Methodology of the Sustainable Development Index for Spanish Cities

Javier García López [1,2,3,*], Raffaele Sisto [1,2,3], Javier Benayas [4], Álvaro de Juanes [2,5], Julio Lumbreras [6] and Carlos Mataix [3]

1 Department of Organizational Engineering, Business Administration and Statistics, Escuela Técnica Superior de Ingenieros Industriales, Universidad Politécnica de Madrid, 28006 Madrid, Spain; industriales@upm.es
2 Smart & City Solutions SL, Calle Blasco de Garay 61, 28015 Madrid, Spain; info@smartandcity.com
3 Centro de Innovación en Tecnología para el Desarrollo Humano, Universidad Politécnica de Madrid (itdUPM), 28040 Madrid, Spain; itd@upm.es
4 Department of Ecology, Autonomous University of Madrid, 28049 Madrid, Spain; javier.benayas@uam.es
5 School of Economics and Business Administration, University of Alicante, c. San Vicente del Raspeig s/n, Building 31, 03690 San Vicente del Raspeig, Spain
6 Harvard Kennedy School, 79 John F. Kennedy St., Cambridge, MA 02138, USA; julio.lumbreras@hks.harvard.edu
* Correspondence: javier.garcialope@alumnos.upm.es

Abstract: In 2017, the United Nations adopted a global Sustainable Development Goals (SDG) indicator framework, calling on member countries to collect complementary national and regional indicators. Cities are crucial to channelling efforts towards sustainability through the use of these indicators. They provide an integrated approach to the city situation monitoring sustainability. However, more research is needed to understand how to adapt the goals, targets and indicators to specific municipal contexts. In 2020, the Spanish Sustainable Development Solutions Network launched the 2nd edition of the Spanish Cities Index. A set of 106 indicators allows for monitoring the implementation of the SDGs at the local level for Spanish cities. The objective is to perform a statistical audit to evaluate the consistency of the indicators and the impact of modelling assumptions on the result. The methodology used is an adaptation of the Handbook on Constructing Composite Indicator prepared by the European Commission. The indicator system is well balanced and covers the essential areas of the Sustainable Development Goals. The Spanish ranking is robust enough among the alternatives evaluated. However, some improvements are possible in the selection of indicators, e.g., removing redundant indicators and regional data. Finally, it is recommended to weigh goals based on municipal responsibility to adjust the results to the Spanish municipal context.

Keywords: sustainable development goals; SDG; 2030 Agenda; evaluation; indicators

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1. Introduction

Based on the experience of the Millennium Development Goals (MDGs) [1,2], in 2015, the UN adopted the 2030 Agenda for Sustainable Development and its 17 Sustainable Development Goals (SDGs). They aim to guide the achievement of sustainable development [3] and are rank highly on the agenda of most countries in the world. The SDGs comprise 17 goals that cover different aspects of sustainable development under a holistic approach. These objectives, in turn, are further specified in 169 goals.

The evaluation and monitoring of sustainability through indicators are considered effective ways to condense the complex system dynamics, starting from a manageable amount of information used to evaluate the progress against the declared results [4].

Solid metrics and indicators are a practical sustainability measurement tool to assess progress and ensure achievement [5,6]. In 2017, the UN adopted a global framework of 247 indicators to assess progress in meeting the SDGs [7]. In this framework, member countries are asked to compile complementary national and regional indicators. The implementation and success of this universal agenda require all levels of administration, the academic environment, civil society and the private sector [8,9]. In addition, each country is left free to establish its implementation strategies. Governments must be able to tailor targets and their indicators to fit national contexts and priorities. In this way, countries show their benchmarks against which they can evaluate their performance and help measure their progress.

In addition, these metrics should serve as a management tool for all the parties involved to carry out the necessary transformations to achieve the targets of the SDGs in 2030. For example, one of the first steps that countries must take is to establish voluntary monitoring evaluations of the progress made in each of the 17 SDGs [9]. The UN High-Level Political Forum plays a central role in monitoring progress globally [10].

It is estimated that more than two-thirds of the world's population will reside in urban areas by 2050, adding another 2.5 billion people to the current 4 billion urban residents [11]. Meeting the basic needs of growing urban populations while ensuring the integrity of their ecosystems, addressing climate change, and promoting economic productivity and social inclusion are the main challenges facing the cities of our time. They are considered places of critical importance for understanding and solving sustainability problems [12,13]. They are the primary consumers of energy [14], the largest generators of waste [14], and they produce the majority of global greenhouse gas emissions [15].

Urban planning decisions will play a critical role in achieving the SDGs [16]. In this sense, UN-Habitat has also developed an action framework of indicators specifically to assess the sustainability of cities [17]. This document examines the extent to which UN indicators will help cities assess their efforts to achieve results towards their sustainability. However, it does not provide either a policy roadmap for action or a data or policy monitoring system [18].

The recognition of the role of municipalities and local governments in facilitating sustainable development has led to a specific goal dedicated to cities and communities [19]. However, there are urban issues among the other 16 goals [20–22], and many cities already have their own sustainability goals. In particular, SDG 11 relates to sustainable and resilient cities and human settlements; given rapid urbanization, cities are generally recognized as key actors to implement the entire SDG agenda [17,19] successfully. It has thus become increasingly important to monitor their performance [23]. As urban systems are complex, a common way to simplify monitoring is by using indicators and their metrics [24]. Although they have been using indicators for a long time, it is only in the last few decades that an attempt has been made to compile sustainability indicators into sets that reflect the many different aspects required to assess their performance [25]. In this sense, the SDG indicators offer the possibility of a more balanced and integrated approach for monitoring urban sustainability [26,27].

To help countries in the annual balance of SDG progress, the Sustainable Development Solutions Network (SDSN) has been conducting yearly evaluations since 2016 through indices and dashboards of the Sustainable Development Goals [28]. Its evaluation report for countries, the SDG Index, presents a composite index that analyzes the 17 SDGs of the 2030 Agenda with 85 indicators. In its latest edition in 2020, it has included the analysis of 193 countries [29]. Likewise, the SDSN promotes evaluation reports and dashboards through its national and regional chapters evaluating progress in achieving the 2030 Agenda by measuring a series of indicators. It is an unofficial monitoring tool whose objective is to complement official efforts to monitor the 2030 Agenda implementation.

Table 1 shows the evaluation reports promoted by the SDSN and their distribution of indicators at the national, regional and local levels. SDSN reports distribute the aggregated indicators across the 17 SDGs to help countries and cities assess their degree of achievement and level of progress directly with the 2030 global political agenda [3].

Table 1. Number of indicators per goals in the reports developed by SDSN. (N = National; C = City).

SDSN Report	Spatial Scope	SDG 1	SDG 2	SDG 3	SDG 4	SDG 5	SDG 6	SDG 7	SDG 8	SDG 9	SDG 10	SDG 11	SDG 12	SDG 13	SDG 14	SDG 15	SDG 16	SDG 17
[30]	N	4	6	18	3	7	4	4	5	6	1	4	6	4	7	4	9	5
[31]	N	3	7	16	5	7	4	4	6	7	2	4	3	4	6	5	9	4
[32]	N	3	6	18	4	7	5	4	5	6	2	4	5	4	5	4	10	5
[33]	N	3	7	16	6	8	7	5	8	6	1	2	8	4	4	3	14	3
[34]	N	4	5	20	9	6	6	3	8	9	3	7	5	4	4	6	11	3
[35]	N	3	6	20	9	6	6	3	8	9	3	7	6	3	6	6	10	3
[28]	N	2	6	11	6	5	3	4	6	7	3	3	3	2	5	3	7	3
[36]	N	3	6	15	5	5	4	4	6	9	3	3	8	4	5	5	9	5
[37]	N	3	6	17	8	5	6	4	6	11	3	4	8	5	6	5	9	5
[38]	N	3	8	17	9	6	7	4	7	10	3	4	7	5	4	5	10	5
[29]	N	3	8	17	9	6	7	4	7	10	3	4	7	4	5	5	10	6
[39]	N	7	7	14	6	7	4	5	8	8	6	5	6	9	0	4	7	0
[40]	C	2	2	5	7	2	3	1	3	1	1	3	2	1	0	2	2	2
[41]	C	2	2	5	6	3	3	2	3	1	2	7	2	2	0	2	2	2
[42]	C	3	3	12	5	6	3	5	5	5	6	10	4	3	4	3	5	3
[43]	C	3	3	7	4	2	2	2	3	2	3	10	1	1	0	2	3	1
[44]	C	3	2	8	4	3	1	1	4	2	3	7	1	1	0	2	2	0
[45]	C	5	3	7	4	3	3	3	3	3	5	5	3	3	0	3	4	0
[46]	C	2	1	6	7	3	2	1	3	6	1	10	4	1	0	4	5	0
[47]	C	4	4	9	6	4	3	4	7	5	3	3	0	3	0	2	3	2
[48]	C	2	5	19	21	5	5	1	6	2	6	3	2	2	1	1	4	2
[49]	C	5	5	13	6	5	6	4	8	6	6	11	5	4	5	4	9	4
Average		3.21	4.95	13.11	6.11	5.11	4.21	3.32	5.47	6.21	2.84	5.42	4.68	3.37	3.21	3.84	7.26	2.89

A significant imbalance in each goal's number is observed by analyzing the distribution of indicators in these international and national reports. On the one hand, SDG 3 and SDG 16 have the highest number of indicators, followed by SDG 4 and SDG 9. On the other hand, SDG 10 and SDG 17 have the least number of indicators. In addition, significant differences can be observed between the distribution of indicators by SDG for country-level reports versus city-level reports. There are fewer indicators for each SDG compared to country-level reports due to the difficulties in finding data [13,50].

In the particular case of Spain, the *Red Española para el Desarrollo Sostenible* (REDS-SDSN) presented in 2020 the second edition of the Spanish Cities Report (SCR) [49] where more than 100 cities are evaluated and which is the object of analysis of this article. The study includes all the Spanish cities with more than 80,000 inhabitants and the regional capitals, covering over 50% of the total population in Spain. For this purpose, all the indicators selected were identified considering the national context and data availability of the official statistical sources.

The SCR maintains alignment with the global SDG framework similar to the SDSN's methodology for the SDG index. In this way, as with the countries, it is intended to help local Spanish entities to diagnose and evaluate their progress in each of the 17 SDGs. It presents a selection of aggregated indicators in the 17 objectives to link them with the 2030 Agenda. It has followed a rigorous selection and validation process run by representatives of the academic environment. It has also had the support of local entities and the Spanish Federation of Municipalities and Provinces. This report has become the benchmark for monitoring the progress of the objectives in the cities in the Spanish context.

In its latest edition of 2020, 106 indicators have been selected starting from the previous edition indicator set and following the SDSN methodology [51]. The indicators have been selected based on relevance, statistical adequacy, timeliness, quality and percentage of coverage. In addition, there has been a validation by experts for each SDG and a final public consultation to validate and rule out their suitability. These are essential aspects that contributed to increasing the transparency of the SCR.

The researchers of this article are also coauthors of the SCR. To continue with the research process, they have considered it necessary to evaluate and analyze the results obtained in greater depth. The main objective is to assess the robustness of the results and methodology of the Sustainable Development Index for the Spanish Cities. This could identify improvements for future editions by studying the impact of different alternatives in the calculation methodology and selecting indicators. For this, the methodology used by Joint Research Center (JRC) of the European Commission's Competence Center for the audit of the SDG index in 2019 [52] has been taken as a reference. In addition, based on the results obtained, the following complementary objectives are pursued: (i) consolidate its system of city indicators, (ii) analyze the results of different alternatives and (iii) validate their reliability.

This article does not intend to question the conceptual relevance of the indicator system. The aim is to analytically and objectively identify its main features and the improvement options that could be implemented based on the results obtained in its database.

2. Materials and Methods

In 2019, the SDSN requested an audit of the 2019 SDG Index from the Joint Research Center (JRC) of the European Commission's Competence Center on Composite Indicators and Scoreboards (COIN) [52]. This statistical audit focuses on two main issues: the statistical coherence of the structure of indicators and the impact of crucial modelling assumptions on the SDG Index ranking. This analysis was carried out in three stages: (i) Descriptive statistics of the data and data analysis to detect missing values and potential outliers; (ii) Multilevel analysis testing the statistical coherence of the structure and correlations between indicators and each SDG Index; (iii) Analysis of the index robustness and testing of the impact of crucial modelling assumptions on the SDG Index ranking. The JRC report also supplemented the country rankings of the SDG index with confidence intervals to better understand their robustness to the calculation method.

This JRC analysis has been taken by the authors as a methodological reference to achieve the objectives of this research, but applied to the SCR. This is possible because both reports use the SDSN methodology [51]. However, the Monte Carlo experiment was not performed to investigate the impact of varying the assumptions. Instead, to evaluate the effect of the weighting assumption, the survey published in the SCR report has been used. Thus, the analysis presented in this article follows these steps:

1. Description and analysis of the indicators
   The objective is to identify potentially problematic indicators that could bias the overall index results. The authors used the same JRC rule to analyze the distributions [52]. An indicator should be considered for mathematical treatment if it has an absolute skewness more significant than 2.0 and a kurtosis greater than 3.5. In those cases, further analysis of their data distribution would be developed [53]. The formula for skewness is referred to as the Fisher-Pearson coefficient of skewness:

$$G1 = \frac{\sqrt{N(N1-1)}}{N-2}\frac{\sum_{i=1}^{N}\left(\frac{\left(Yi-\overline{Y}\right)^{3}}{N}\right)}{s^{3}}, \quad (1)$$

   The authors use the following definition of kurtosis:

$$kurtosis = \frac{\sum_{i=1}^{N}\left(\frac{\left(Yi-\overline{Y}\right)^{4}}{N}\right)}{s^{4}} - 3, \quad (2)$$

2. Alternatives for calculating the index, assumptions
   These methodological alternatives are collected in the assumptions listed below. The analysis results are intended to demonstrate how the choice of indicators and the

methodology affect the position of cities in the ranking. The selection of indicators and their targets can be considered two central points for defining the SDGs' performance metric [54]. This proves the sensitivity of rankings by comparing an Initial set (I_s) versus an Alternative set (A_s) of the SCR indicators. The assumptions raised in this study are the following:

i. Aggregation: arithmetic mean and geometric mean
The geometric mean is usually used to aggregate heterogeneous variables and when the focus of the analysis is on percentage changes rather than absolute changes. For example, this method is used in the Human Development Index [55]. Its three-dimensional aggregation method for the arithmetic mean was changed to the geometric mean in 2010. Compared with the geometric mean, the arithmetic average has the advantage of the simplicity of interpretation: an index score between 0 and 100 reflects the average initial placement of the country between worst and best on the average of the 17 goals [51]. The study proposes the calculation of geometric mean for the Alternative set (A_s).

ii. Weighting of the SDGs
The method for aggregating and weighting different variables into a single index can profoundly impact the overall ranking [56]. In the Initial set (I_s), each indicator was weighted equally. As a result, the relative weight of each indicator in a goal was inversely proportional to the number of indicators considered under that goal [51]. Different weightings of individual SDGs can have important implications on a city's performance and relative ranking in the composite index [57]. For this reason, the authors propose to use for the Alternative set (A_s) as the expert weight approach at the goal level [51], taking advantage of the survey on municipal competencies carried out by sustainability experts and members of local Spanish entities included in the report.

iii. Reduction of the indicator set
To evaluate the statistical consistency of SCR indicators, a cross-sectional analysis is employed. The correspondence between the SCR index and real-world phenomena needs to be analyzed because correlations do not necessarily represent the real influence of the individual indicators on the phenomenon being measured [58]. The correlation aims to quantify the strength of the link joining two different indicators or goals [59]. Non-parametric correlation methods are commonly applied to those pairs of variables whose distribution is unknown a priori. This is the case of Spearman's analysis [60]. In contrast to Pearson's, the most commonly used correlation coefficient, Spearman's does not assume normally distributed and same-scaled variables [61]. This is why Pearson's rank has been used in several disciplines and previous studies [62,63]. The authors propose using the cross-correlation analysis to preliminary address the extent to which the data supports the conceptual framework [51]. The 1% significance level is used to determine whether the correlation between two variables is statistically significant [58]. To optimize and reduce the number of indicators, the Alternative set (A_s) will not include the correlated ones.

3. Analysis of the impact of assumptions:

iv. Principal component analysis
Principal Component Analysis (PCA) is commonly used to assign weights to individual variables correlated and measured by a common underlying factor. In addition, PCA reduces the effects of multicollinearity by using a subset of the principal components in the model [51]. To analyze the impact of the previous assumptions using the Alternative set, the authors propose to use principal component analysis (PCA) to summarize each goal and interactions in the SCR. Applying PCA allows mapping trends, synergies and trade-offs at

the level of goals for all SDGs while using all available information on each indicator [64].

v. Analysis of the variation of positions
This analysis aims to evaluate the shifts in the positions between the Initial set (I_s) and the Alternative set (A_s). Cities shifts under three positions cannot be considered significant, whereas differences of 10 places can show a meaningful difference [52]. The variation in the rankings, considering the previous assumptions, allows us to identify which cities show a particular sensitivity to changes.

3. Results

3.1. Description and Analysis of the Indicators

The SCR identifies a total of 106 indicators based on the ones from the 2018 edition. Of these indicators 84% (89 out of 106) have data at the municipal level, 47% (49 out of 106) are new to this edition or present improvements in their level of detail, and 60% (64 out of 106) have just been updated. The quality and reliability of the data stand out because they all come from official National and European statistical repositories or research centers and non-governmental organizations of recognized prestige. Data provided individually by the entities evaluated have not been accepted in the SCR to guarantee comparability and reliability. A full list of indicators can be found in Table A1 Appendix A.

The distribution of indicators for each SDG is balanced compared to other similar reports, as shown in Table 1. SDG 3 and SDG 11 with 13 and 11 indicators, respectively, stand out for their significantly higher number of indicators, while SDG 7, SDG 13, SDG 15 and SDG 17 hit a minimum of four. In general, data coverage for the indicators included in the index is suitable for all SDGs and all cities observed. In the particular case of the cities of the Basque Country region, some of the economic data is not available. SDG 14 is a particular case since the cities without coastal areas have no indicators for this goal.

Regarding the dataset provided, no specific issues have been found. Data did not require imputation for the index calculation because the selection of indicators already excluded those not reaching at least 80% coverage. Complete data can be found in Appendix B.

The SDSN methodology identifies the sustainability thresholds for each indicator based on the explicit/implicit goals of the SDGs, scientific goals or the average performance of the best actors and the specific criterion of the goal expert. At the same time, to eliminate the effect of extreme values and facilitate the comparability of results, the report authors have limited the data to the lower 2.5 percentile as the minimum value for normalization. The details of the specific values used on the maximum/minimum values and the chosen thresholds are described in Annex I of the SCR [49]. Indicator values are normalized using the minimum/maximum method from the dataset of all cities for any given indicator. The normalized value is then transformed into a value ranging from 0 to 100, which is directly comparable with the rest of the indicators. In other words, the city with the highest value of the raw data obtains a score of 100, while the lowest value will have a score of 0. This normalization operation guarantees that all the variables are ascending and, therefore, the highest values indicate positive performance in achieving each goal. It also eliminates outliers at both ends of the distribution because those cities that exceed the average of the best or worst values are assigned the same score, as recommended by the OECD manual for constructing composite indicators [58]. This improves their understanding and facilitates the communication of results.

The methodology used by JRC [52] for the SDG index analyzes skewness and kurtosis to assess the data distribution's shape and identify potentially problematic indicators. The rule applied by the JRC is that an indicator is valid for treatment if it has an absolute skewness greater than 2.0 and a kurtosis more significant than 3.5.

Table A2 in Appendix B shows potentially problematic indicators: 6 indicators with abnormal distributions (2b, 2c, 9d, 11h, 11i and 17a) and 11 indicators with negative skewness (7d, 8h, 10f, 11c, 11d, 12d, 13a, 14b, 16a, 16i and 17d). As well as JRC, the authors applied different techniques to improve the distributions, such as logarithmic transformations, and their scatter plots have been analyzed in detail, but no significant improvements were observed. Finally, it has been decided to keep them in the calculation set due to their alignment with the official UN indicators [65] and to guarantee a minimum number of indicators per goal.

However, 16.04% (17 out of 106) of the indicators come from data at the provincial or regional level (see Appendix B). These indicators could alter the results because they do not reflect the particular reality of each city but rather a regional average. In the cities analyzed, several cities are very different from each other. Some of them are in single-province regions or with high depopulation rates. Some other cities belong to large metropolitan areas highly populated. Only 9 of the 17 SDGs present indicators with regional data, and there are never more than two indicators per goal. Therefore, its impact on the SCR index is relevant but limited.

3.2. Alternatives for Calculating the Index, Assumptions

3.2.1. Aggregation: Arithmetic vs. Geometric Average

In the SCR, according to the SDSN methodology, the arithmetic average has been used as a two-stage aggregation method, at the indicator level for each goal and the goal level for the general index. An alternative aggregation method is proposed based on the geometric instead of the arithmetic mean to limit compensation between very different values in various areas of sustainable development [51]. Table 2 shows the position shifts in the SCR index obtained by changing from arithmetic to geometric average across SDG scores.

Table 2. Position shifts in the SCR Index. Alternative aggregation.

Aggregation Method Shifts in the Index	Number of Cities	Percentage of Cities
0	25	24.27%
1	27	26.21%
2	22	21.36%
3	7	6.80%
4	11	10.68%
5	5	4.85%
6	1	0.97%
7	1	0.97%
8	2	1.94%
9	0	0.00%
>10	2	1.94%

The two methods yield results that are almost the same and thus a nearly identical ranking. The volatility between ranks is minimal. These differences are due to the geometric average, which, unlike the arithmetic mean, penalizes significantly poor scores on specific goals. The maximum shift in positions is 10 and only occurs in two cities in the Madrid metropolitan area (1.94% of the total). Most cities, 74 out of 103 (71.84% of the total), change from zero to two positions. The cities that are most affected by the change in the aggregation method have their location in the metropolitan areas of Madrid, Catalonia, Basque Country and Andalusia.

3.2.2. Weighting of the SDGs

The SDSN reports are calculated without using any type of weighting because all targets and SDGs are equally crucial for the 2030 Agenda by definition. Only the number of indicators per SDG skews their representativeness. However, assigning the same weight to the indicators and targets does not necessarily guarantee an equal contribution of the indicators or targets to the index results [58,66]. For example, the 13 indicators from SDG 3 and the 11 indicators from SDG 11 have less weight in the overall aggregation than the 4 indicators from SDG 7, SDG13, SDG 15 and SDG 17 (see Table 1). In conclusion, the greater the number of indicators per SDG, the less relative weight than other SDG indicators with a lower number.

The SCR [49] publishes an assessment of municipal competencies carried out by sustainability experts and members of local Spanish entities. The authors propose these results to create alternative weighting coefficients for normalizing the assessment values. These vary from 1.5 for the best result to 0.5 for the worst (Table A3 in Appendix C) to properly analyze their impact.

Table 3 shows the shifts in the position of the cities in the SCR index using this alternative weighting method. Of the total cities, 37.86% only change a maximum of two positions. Most cities, 59 out of 103 (57.28% of the total), change a maximum of four positions. The most affected cities by the alternative weighting method are sparsely populated southern cities of the peninsula and do not belong to any metropolitan area. However, unlike the application of the alternative aggregation method, this method significantly affects all cities and alters the results of the SCR index.

Table 3. Position shifts in the SCR Index. Alternative weighting.

Weighting Method Shifts in the Index	Number of Cities	Percentage of Cities
0	7	6.80%
1	12	11.65%
2	20	19.42%
3	7	6.80%
4	13	12.62%
5	6	5.83%
6	3	2.91%
7	8	7.77%
8	9	8.74%
9	5	4.85%
>10	13	12.62%

3.2.3. Reduction of the Set of Indicators

The methodology proposed by the JRC [52] and the SDSN methodological paper [51] performs a correlation analysis to evaluate the statistical coherence of the SCR, aiming to reduce the set of indicators initially proposed. Determining the relationship and degree of dependency between the quantitative variables in the report evaluates the extent to which the data supports the index's conceptual framework. The analysis of the correlations (both positive and negative) between indicators makes it possible to identify redundancies, avoid an overvaluation of the same event, and, finally, reduce the model's complexity. The authors have analyzed the correlations of the indicators (with their SDG and with the general index) and the correlations of the SDGs (with each other and with the general index).

Table A4 in Appendix C shows the correlations between indicators with their respective SDG general index. Ideally, each indicator should correlate positively with its SDG and with the overall index. A significance level of 1% has been taken to determine if the correlation between two variables is statistically significant.

Indicators 4e and 11i (in red) show negative correlations with their SDG, but their coefficients are very low and not significant. These results are similar or even better than those obtained by the JRC analysis for the SDG Index in 2019. Only two indicators (1e—poverty line, and 13d—covenant of mayors) present a Pearson correlation coefficient higher than 0.92. It makes sense because they are of particular relevance to the achievement of the SDG. Furthermore, 21 of the 106 indicators present correlation coefficients higher than 0.70 and an acceptable significance level. Values greater than 0.70 are desirable as they imply that the index captures at least 50% ($\approx 0.70 \times 0.70$) of the variation in the underlying goals and vice versa [52]. In total, eight of the SDGs present two or more indicators with correlation values greater than 0.70, only three SDGs present a single indicator, and six of the SDGs do not show any indicator with a correlation value greater than 0.70. This finding suggests that the selection of the indicators has been adequate because there is a low redundancy in the results [66].

Regarding the correlation with the general index, on the one hand, 20 negative correlations have been identified. They all have a very low correlation coefficient (<0.5), and only indicators 8g and 10d present acceptable levels of significance (<0.01). On the other hand, 10 indicators are identified with a positive correlation with a Pearson coefficient (>0.5) and an acceptable level of significance (<0.01). Therefore, SDG 1, SDG 4 and SDG 17 present a higher number of indicators with a better positive correlation, which corresponds to the highest scores in the city index. On the contrary, SDG 3 and SDG 13 present indicators with negative correlations and the worst scores of the cities that top the index.

Table A5 in Appendix C presents the Pearson coefficients of the 17 SDGs regarding the correlations at the SDG level. All of them correlate positively with the overall index. In addition, SDG 1, SDG 7, SDG 16 and SDG 17 show high positive and significant correlations with the index. Cities well positioned on these SDGs rank equally well in the SCR index. Furthermore, most of them (12 out of 17) present an excellent significance (<0.01). On the contrary, SDG 3 and SDG 14, with very low correlation coefficients, are identified as the worst-ranked cities in the SCR overall index.

Regarding the correlations between the Goals, only three of them have been identified with a high Pearson correlation coefficient (>0.50) and an acceptable level of significance (<0.01): (SDG 1 vs. SDG 4, SDG 7 vs. SDG 16, SDG 12 vs. SDG 17). Moreover, SDG 3 presents several negative correlations with other SDGs, but none have an acceptable significance level (<0.01). SDG 14 shows negative correlations with SDG 1 and SDG 4 with a low coefficient but a high significance level. Similarly, SDG 17 shows negative correlations with SDG 2 and SDG 14 with a low correlation coefficient but a high significance level.

Pearson correlation coefficients greater than 0.70 and significant values under 0.01 have been identified regarding the correlations between the indicators themselves. It shows a very high significant correlation which may suggest redundancy. The main values of the Pearson correlation analysis are summarized in Table A6 in Appendix C. Only a negative correlation has been identified between indicators 15a and 11j. The rest of the significant correlations are positive. To obtain a reduced set of indicators, those highly correlated with each other have been further analyzed to remove them [52]. Finally, the indicators removed for a reduced set are: 1d, 1e, 3f, 4d, 5a, 6e, 8e, 10a, 10f, 11d and 16h.

3.3. Analysis of the Impact of Assumptions

Based on the precedent results, variations in the methodology for calculating the SCR index can be proposed to evaluate their impact within a range of improvement alternatives. The objective is to quantify the uncertainty based on the difference in the position of the cities considered in the SCR index in each result. Table 4 shows three particular assumptions that have been identified in this uncertainty analysis. They are alternatives for the construction of the SCR index and can be easily investigated.

Table 4. Conceptual assumptions framework for the SCR Index.

Assumption	Alternatives for I_s/A_s
1. Aggregation method (SDG level)	Arithmetic average/Geometric average
2. Weighting method (SDG level)	SDG equal valuation/SDG valuation by experts
3. Indicator set	Complete set/Reduced set

According to the SDSN methodology, the arithmetic average has been used as an aggregation method in two stages in the SCR report: at the indicator level for each goal and the goal level for the overall index. In Section 3.2.1, the change in the aggregation method by geometric instead of arithmetic mean has been analyzed. It concludes that it does not significantly impact, so it has been ruled out as a suitable alternative for this study.

Consequently, the improvement alternatives to be analyzed are using a weighting method for the SDGs and using a reduction method for the indicators. Their impact analysis is carried out by comparing the initial set (I_s) of the SCR and the new alternative set (A_s) resulting from applying these alternatives. The evaluation of their results is carried out with two approaches: principal components analysis and an analysis of variation of positions in the index of cities.

3.3.1. Principal Component Analysis

Principal Component Analysis (PCA) aims to assess the extent to which statistical approaches confirm the conceptual framework [67]. It explores the correlation of all indicators simultaneously, highlighting, if present, some common trends that describe a common concept among the indicators [68,69]. The objective is to transform a set of original variables into a new set of variables that are a linear combination of the original ones, called Principal Components. These components or factors are unrelated to each other and successively explain most of the total variance. Ideally, it is expected to have one principal component explaining at least 70–80% of the total variance to claim a single latent phenomenon behind the data. As shown in Table A7 in Appendix C, this is not the case for the SCR Index. The results identify that six principal components explain almost 70% of the variance.

Eighty-two indicators are available for each city in the sample and seventeen intermediate indices referring to each SDGs and the overall index. Based on the 17 variables, a reduction of dimensions is carried out through a PCA. Table A6 shows the PCA results for I_s and A_s. The eigenvalues represent the amount of variance explained by each factor; therefore, the higher the eigenvalue, the more variance each factor explains. The Kaiser–Guttman rule [70] has been used in this study due to its strict scale. It suggests keeping those factors with eigenvalues greater than 1.0. It would hold a total of six factors that would represent 66.94% of the explained variance. On the other hand, in A_s, the number of factors becomes seven, with an explained variance of 71.08%. In addition, the total explained variance and the distribution between the same factors increase, being more uniform among the seven factors of I_s concerning those of A_s.

Consequently, the modification of indicators from one set to another has increased the sample's representativeness, at least in those latent relationships within the dataset.

In addition, Table A8 in Appendix C shows the rotated component matrix for both sets. They differ considerably concerning the composition of their factors, and none of these components exhibit a clear or logical arrangement concerning the subject discussed. Figure A1 in Appendix C shows a heterogeneous disposition to the issue analyzed. For factor 1, a group of SDG 12, SDG 16, SDG 17, SDG 4 and SDG 7 was analyzed versus an opposing group consisting of SDG 14 and SDG 10 (as suggested by negative correlations). For factor 2, ODS 1 is diametrically opposite to ODS14 and ODS15.

Consequently, it is necessary to visualize the composition of the intermediate indices and analyze them individually as has been done as a whole. Table A9 in Appendix C shows the analysis of the main components of the indicators that comprise each SDG. Factors indicate the number of factors generated by Factor Analysis; indicators indicate the number of indicators collected in the database for each SDG; % Variance is the total percentage of variance explained by these factors. The last column shows the variance difference explained within the alternatives.

Accordingly, 14 of the 17 SDGs contain a total explained variance more significant than 60%, exhibiting high representativeness and assessing the subject to be observed. This is reduced in A_s where the number of SDGs with a total explained variance above 60% is reduced to five. The elimination of indicators in several SDGs has a severely negative impact. However, the cases that remain above the established criterion, i.e., SDGs 2, 3, 4, 8 and 11 that maintain a total explained variance above 60%, manage to describe and monitor the central theme of each of the goals. Therefore, the analytical loss of reducing an average of two indicators for each group of indicators per SDG does not compensate or enrich the analysis in some of them. As can be observed, up to 34% of the analytical information losses for some SDGs do not interact well with reducing indicators.

Looking individually at the rotated component matrices of each of the SDGs, it is possible to observe groupings that explain different aspects within each goal. SDGs 3, 4, 8 and 11 are worthy of analysis because they obtain high total explained variances, and they present exciting relationships within their matrix:

SDG 3 is a goal with a large number of indicators and factors. Table A10 in Appendix C shows the rotated component matrix, filtering out those relationships equal to or greater than 0.3 in absolute value. Values represented only in one factor, being absolute relationships with their associated factor, are highlighted in bold. It can be observed that these relationships coincide with the most robust relationships in the matrix (except one existing in indicator n_sdg03_alcohol) and have a positive relationship with the measurement of SDG 3.

Figure A2 in Appendix C represents a rotated space component graph for SDG 4. It visually shows the type of relationship that the indicators that make up the SDG maintain with the calculated factors. It can be seen that there are two types of indicators or aspects within the SDG itself. Thus, factor 1, which contains most of the variance, is highly related to education expenditure per capita, an explicit effort that transversally influences the SDG. On the other hand, those outcome indicators that would give us a picture of the situation in the territory are grouped in factor 2, suggesting that they are different dimensions to be considered but not contrary or exclusive.

The analysis of SDG 8 (Table A11 in Appendix C) shows a first factor that explains 24.41% of the variance and represents a positive dimension for the SDG. Their indicators that have high relationships connect with the economic progress and productivity of the territories. In contrast, factor 2, which explains 23.06% of the total variance, is the one that represents the negative weighting of the SDG. These are the variables that have an inverse influence on the goal's progress, all referring to the unemployment data.

Finally, Table A12 in Appendix C presents the analysis of SDG 11. It does not exhibit explicit specializations or differentiated aspects within each factor and groups the variables that measure air quality in the same factor, which provides logic to the composition of this factor but does not present a valuable interpretation within the analysis.

3.3.2. Index Position Shifts Analysis

Table 5 summarizes the changes in the position of the cities in the SCR index between I_s and A_s. Appendix C includes the complete list of cities and the index score for each variation of the calculation.

Table 5. Position shifts in the SCR Index. All alternatives included.

Shifts in the index I_s to A_s	Number of Cities	Percentage of Cities
0 to 5	17	16.50%
6 to 10	25	24.27%
11 to 15	36	34.5%
16 to 20	10	9.71%
>21	15	14.56%

It can be observed that 34.95% of cities (36 out of 103) change between 11 to 15 positions in the SCR index. Additionally, 24.27% (25 out of 103) change from 6 to 10 positions, 16.50% (17 out of 103) change from 0 to 5, 9.71% (10 out of 103) change from 16 to 20 positions and 14.56% change more than 21 positions.

The first three cities of the initial index (I_s) (Vitoria-Gasteiz, Zaragoza and Logroño) and the alternative index (A_s) maintain their positions. Similarly, the first five and the last five positions remain stable and do not change more than three positions between the different calculation alternatives. Table A13 shows the top 10 positions of cities on each calculation alternative. Table A14 shows the bottom 10 positions of cities on each calculation alternative. The full list of results is in Table A15 in Appendix C.

4. Final Conclusions and Discussions

The SCR, like the SDG Index, proposes a one-of-a-kind composite measure to track the progress of the SDGs at the city level. A deep understanding of their underlying components and the relationships between them must accompany the results. The effort of cities, strategic territories for their contribution to the national socioeconomic and environmental performance [25], is essential to achieve compliance with the SDGs since the municipal level is closest to the daily lives of people and companies. Therefore, the adaptation of its policies to the 2030 Agenda and the measurement of its progress is urgent and necessary for the country's progress towards meeting the SDGs.

The SCR ranking is robust enough among the alternatives evaluated based on the previous evaluation of the results and the methodology. The sensitivity analyses performed confirm that the uncertainty is manageable. For this reason, it can be concluded that the system of city indicators is consolidated. However, according to [71], many indicator initiatives are driven by the availability of relevant and reliable data [72–74]. The limitation in the data availability conditions the use of the appropriate indicators [75]. In the case of SCR, the sets of indicators are biased and incomplete to measure sustainability. This situation jeopardizes the reliability of the results. Therefore, developing further scientific research and expanding the data collection at the city level is necessary. It is also hopeful that, as the availability of data increases to measure some of the goals, implicit weighting would be reduced across goals.

Regarding selecting indicators, two aspects should be improved to reduce the complexity of the evaluation system. On the one hand, redundancy between collinear indicators should be avoided because it is equivalent to double-counting the same urban phenomenon. This target seems to have been accomplished for the SCR. However, the indicators selected for the SCR should be positively correlated with each of the objectives they represent. The results in this aspect are slightly better than those obtained by the JRC analysis for the global SDG Index. These suggest that there is little redundancy in the indicators' data, and their selection has been correct because they measure different aspects of the city. Therefore, its representativeness is adequate and, from a statistical point of view, with low levels of uncertainty.

On the other hand, whenever possible, regional data should be omitted [50]. By repeating the data of cities in the same province, the singularities of each city are neglected. There are single regions with high depopulation in the cities considered, and others belong to large, highly populated metropolitan areas. In this way, very different city realities are mixed due to the chosen population and representativeness bias. In addition, the results of very different realities are simplified, and their comparability is difficult. It would be advisable to carry out specific analyses by regions or similar urban areas to deepen and broaden the results. Furthermore, it would be desirable to use compliance thresholds based on other criteria for selecting and grouping cities to complement the SCR. For instance, in addition to the number of inhabitants and representativeness, economic biases or population density could be used to make groupings between equals and improve comparability [76,77].

Regarding the calculation methodology, it can be concluded that the use of an alternative aggregation method from the geometric mean instead of the arithmetic does not significantly affect the index positions [51]. However, using an alternative weighting method has been shown to affect index positions significantly. The first and last positions of the index are not affected by this change in the weighting method, but the rest of the intermediate positions are. There is no specific pattern of cities that are more sensitive to this change. Further investigation would be necessary considering other variables.

The SCR index is based on the 2030 Agenda for Sustainable Development adopted by all UN member states and rigorously follows the same structure of 17 goals. The indicator system is well balanced and covers the essential areas of the SDGs. However, as it is a framework designed at the country level, its application in cities requires an adaptation process. Therefore, indicators must adjust to the competence frameworks distributed among the different administrative levels and eminently urban phenomena. According to [78], this recent research contributes to a strong grounding for the successfully implementation of the SDGs in Spain at both the national and city levels. Corroborating with previous research, our findings show that no SDG can individually make a country evolve and comply with the 2030 Agenda but working with the SDGs as a whole can create a virtuous cycle of SDG progress. Once the datasets and indicators are consolidated and improved, it would be advisable to investigate the synergies and trade-offs between the results at the country level and the results of their main cities.

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Appendix A

Table A1. Full list of indicators included in the 2020 SCR.

Goal	Id	Indicator	Description	Scale
		SDG 1—No poverty		
1	1a	sdg01_2020ratio	20:20 ratio. Income inequality metric	Municipal
1	1b	sdg01_gastosocial	Social Welfare spending per capita	Municipal
1	1c	sdg01_pobreza	Population with income per consumption unit below 40%	Municipal
1	1d	sdg01_pobrezamenores	Child poverty rate	Municipal
1	1e	sdg01_riesgopobreza	Risk of poverty rate	Municipal
		SDG 2—Zero hunger		
2	2a	sdg02_agricultura	Organic farming rate	Provincial
2	2b	sdg02_consumo	Food consumption prices index	Provincial
2	2c	sdg02_empagri	Employment rate in agriculture and fishery	Municipal
2	2d	sdg02_expagrariasurbano	Agricultural and Forestry Operations	Municipal
2	2e	sdg02_supcultivos	Share of land of agricultural areas	Municipal
		SDG 3—Good Health and well-being		
3	3a	sdg03_adfertility	Adolescent fertility rate	Municipal
3	3b	sdg03_alcohol	Alcohol and drugs death rate	Municipal
3	3c	sdg03_gripe	Infectious disease of the respiratory system death rate	Municipal
3	3d	sdg03_hepatitis	Viral hepatitis-related deaths rate	Municipal
3	3e	sdg03_infantil	Infant mortality	Municipal
3	3f	sdg03_ncd	Non-communicable diseases death rate	Municipal
3	3g	sdg03_prematuras	Premature mortality (under 65 years)	Municipal
3	3h	sdg03_suicidios	Suicide death rate	Municipal
3	3i	sdg03_trafico	Road traffic death rate	Municipal

Table A1. *Cont.*

Goal	Id	Indicator	Description	Scale
3	3j	sdg03_tuberculosis	Tuberculosis death rate	Municipal
3	3k	sdg03_tumores	Respiratory system tumours death rate	Municipal
3	3l	sdg03_vida	Life expectancy	Municipal
3	3m	sdg03_vih	HIV and AIDS death rate	Municipal
		SDG 4—Quality education		
4	4a	sdg04_estudiantes	Students enrolled in higher education	Municipal
4	4b	sdg04_gastoedu	Education spending per capita	Municipal
4	4c	sdg04_guarderia	Children 0–4 in day care or school	Municipal
4	4d	sdg04_isced012	Adults with primary education (ISCED level 0,1–2)	Municipal
4	4e	sdg04_isced34	Adults with secondary education (ISCED level 3–4)	Municipal
4	4f	sdg04_isced56	Adults with higher education (ISCED level 5–8)	Municipal
		SDG 5—Gender equality		
5	5a	sdg05_brechapension	Gender subsidy gap	Provincial
5	5b	sdg05_brechasalarial	Gender salary gap	Provincial
5	5c	sdg05_delitossex	Violence and sexual exploitation rate	Municipal
5	5d	sdg05_denuncias	Gender violence rate	Municipal
5	5e	sdg05_paridad	Seats held by women in municipal governments	Municipal
		SDG 6—Clean water and sanitation		
6	6a	sdg06_balanceagua	Balance in budgets for water service	Municipal
6	6b	sdg06_canon	Fee for water supply and sanitation rate	Municipal
6	6c	sdg06_esfuerzo	Financial exertion for water supply	Municipal
6	6d	sdg06_litros	Volume of water distributed per day	Municipal
6	6e	sdg06_precioabasteci	Water supply price	Provincial
6	6f	sdg06_preciosaneamiento	Water sanitation price	Provincial
		SDG 7—Affordable and clean energy		
7	7a	sdg07_eficiencia	Reduction in spending on street lighting since 2012	Municipal
7	7b	sdg07_facturaelectr	Impact of electricity costs on average household income	Municipal
7	7c	sdg07_renovable	Renewable energy rate	Provincial
7	7d	sdg07_suministro	Power supply quality index	Provincial
		SDG 8—Decent work and economic growth		
8	8a	sdg08_accidentes	Accidents at Work	Provincial
8	8b	sdg08_desempleo	Unemployment rate	Municipal
8	8c	sdg08_desempleocovid	Impact of COVID-19 on unemployment rate	Municipal
8	8d	sdg08_desempleojovenes	Youth unemployment rate	Municipal
8	8e	sdg08_desempleolarga	Long term unemployed	Provincial
8	8f	sdg08_diversidad	Sector-dependency job index	Municipal
8	8g	sdg08_pibcapitamun	GDP annual growth rate	Municipal
8	8h	sdg08_productividad	Annual productivity growth rate	Municipal
		SDG 9—Industry, Innovation and Infrastructure		
9	9a	sdg09_3g4g	3G and 4G networks access index	Provincial
9	9b	sdg09_bandaancha	Broadband penetration rate	Provincial
9	9c	sdg09_empindus	Employees in Industry rate	Municipal
9	9d	sdg09_gastoidi	R&D spending per capita	Municipal
9	9e	sdg09_patentes	Patent applications local rate	Municipal
9	9f	sdg09_sueloactecon	Land area planned for economic activities	Municipal
		SDG 10—Reduced inequality		
10	10a	sdg10_mediana	Population under poverty line	Municipal
10	10b	sdg10_discapacitados	People with disabilities in labor market	Provincial
10	10c	sdg10_extranjeros	Foreign employment rate	Provincial
10	10d	sdg10_igini	Gini index	Municipal
10	10e	sdg10_indicedependencia	Child and elderly dependency ratio	Municipal
10	10f	sdg10_top1	Top 1%. Income inequality metric	Municipal

Table A1. *Cont.*

Goal	Id	Indicator	Description	Scale
		SDG 11—Sustainable cities and communities		
11	11a	sdg11_no2	NO_2 concentration. Air Quality indicator	Municipal
11	11b	sdg11_o3	Ozone concentration. Air Quality indicator	Municipal
11	11c	sdg11_pm10	PM10 concentration. Air Quality indicator	Municipal
11	11d	sdg11_pm10dias	Days that exceed PM10 limits	Municipal
11	11e	sdg11_pm10media	PM10 annual average	Municipal
11	11f	sdg11_preciovivienda	Housing access index	Municipal
11	11g	sdg11_residencias	Nursing home places	Provincial
11	11h	sdg11_resiliencia	Urban resilience index	Municipal
11	11i	sdg11_suptrans	Access to public transport index	Municipal
11	11j	sdg11_viviendaprotegida	Access to protected housing	Provincial
11	11k	sdg11_vulnerables	Urban vulnerability index	Municipal
		SDG 12—Responsible consumption and production		
12	12a	sdg12_envases	Plastic recycling and packaging rate	Municipal
12	12b	sdg12_impropios	Improper waste rate	Municipal
12	12c	sdg12_papel	Paper recycling rate	Municipal
12	12d	sdg12_turismo	Sustainable tourism	Municipal
12	12e	sdg12_vidrio	Glass recycling rate	Municipal
		SDG 13—Climate action		
13	13a	sdg13_CO2buildings	Buildings and industry CO_2 emissions per capita	Municipal
13	13b	sdg13_CO2capita	CO_2 emissions per capita	Municipal
13	13c	sdg13_CO2transport	Transportation CO_2 emissions per capita	Municipal
13	13d	sdg13_medicion	Covenant of mayors for climate and energy network	Municipal
		SDG 14—Life below water		
14	14a	sdg14_banderaazul	Blue flags index for coastal areas	Municipal
14	14b	sdg14_calidad	Bathing sites with excellent water quality	Municipal
14	14c	sdg14_costamun	Land built on the coastal strip of the first 500 m	Municipal
14	14d	sdg14_dpmt	Protected public land–maritime domain	Municipal
14	14e	sdg14_habitatsmun	Coastal and marine protected natural habitats	Municipal
		SDG 15—Life on land		
15	15a	sdg15_cobartificial	Territory and habitat diversity. Artificial cover	Municipal
15	15b	sdg15_enp	Protection of Natural Areas	Municipal
15	15c	sdg15_zonaforestal	Forest areas	Municipal
15	15d	sdg15_zonasverdes	Tree Cover Density	Municipal
		SDG 16—Peace, justice and strong institutions		
16	16a	sdg16_blanqueo	Drug traffic crime rate	Municipal
16	16b	sdg16_criminalidad	Crime rate	Municipal
16	16c	sdg16_homicidios	Murders and violent deaths	Municipal
16	16d	sdg16_participa	Voter turnout in municipal elections	Municipal
16	16e	sdg16_participacion	Citizen participation and collaboration index	Municipal
16	16f	sdg16_solidez	Strength and autonomy of the municipal institution	Municipal
16	16g	sdg16_transparencia	Municipal transparency index	Municipal
16	16h	sdg16_transparenciaeco	Economic and financial transparency index	Municipal
16	16i	sdg16_violencia	Violence against children (under 13 years)	Provincial
		SDG 17—Partnership for the goals		
17	17a	sdg17_coop	Cooperation and development projects	Municipal
17	17b	sdg17_opendata	Open data index	Municipal
17	17c	sdg17_redes	National networks to achieve the SDGs	Municipal
17	17d	sdg17_zonasblancas	White NGA areas	Municipal

Appendix B

Table A2. Complete statistics of the indicators for the 2020 SCR.

Goal	Indicator	Number of Cities	Missing Data (%)	Mean	Skewness	Kurtosis	Deviation	Variance
1	1a	98	4.85	13.32	1.44	1.27	18.1	327.55
1	1b	101	1.94	22.8	1.6	3.23	19.91	396.25
1	1c	98	4.85	50.72	−1.04	0.56	18.44	340.08
1	1d	98	4.85	40.38	−0.24	0.27	16.9	285.75
1	1e	98	4,85	43.54	−0.64	−0.28	18.36	336.94
2	2a	103	0	54.01	−0.2	−0.54	25.21	635.29
2	2b	94	8.74	13.1	2.84	8.52	20.41	416.69
2	2c	103	0	11.58	2.94	9.32	19.62	384.77
2	2d	103	0	37.71	0.44	−0.85	29.36	861.83
3	3a	103	0	56.08	0.1	0.05	22.92	525.29
3	3b	103	0	79.61	−1.23	1.04	24.91	620.35
3	3c	103	0	58.62	−0.4	−0.34	24.76	612.91
3	3d	103	0	71.14	−1.08	0.78	25.09	629.3
3	3e	94	8.74	67.42	−0.94	0.54	21.85	477.43
3	3f	103	0	60.5	−0.28	−0.48	24.25	588.1
3	3g	103	0	56.98	−0.19	−0.8	26.08	680.26
3	3h	103	0	50.7	0.17	−0.55	22.97	527.68
3	3i	102	0.97	98.71	−1.57	2.49	1.16	1.34
3	3j	103	0	76.63	−1.22	0.95	26.42	698.21
3	3k	103	0	57.3	−0.23	−0.66	25.97	674.5
3	3l	103	0	90.34	−0.16	−0.4	4.58	20.98
3	3m	103	0	67.04	−0.52	−0.7	29.32	859.45
4	4a	92	10.68	27.24	1.2	1.87	22.78	518.9
4	4b	101	1.94	41.91	0.71	−0.62	30.33	919.66
4	4c	94	8.74	29.63	0.68	1.96	14.39	207.02
4	4d	89	13.59	35.84	0.34	0.55	17.09	292.18
4	4e	94	8.74	85.23	−0.27	−0.42	10.41	108.41
4	4f	94	8.74	49.04	0.3	0.2	19.39	375.97
5	5a	98	4.85	26.77	−0.1	0.14	10.19	103.84
5	5b	98	4.85	24.23	0.5	−0.44	15.43	237.98
5	5c	103	0	45.36	−0.48	−0.19	18.18	330.47
5	5d	97	5.83	54.59	−0.9	0.23	21.17	448.17
5	5e	103	0	84.73	−1.02	1.21	15.02	225.51
6	6a	72	30.1	79.41	−1.6	1.88	27.2	739.7
6	6b	77	25.24	82.76	−1.53	1.59	25.81	666.34
6	6c	79	23.3	68.93	−0.72	0.02	22.09	488.12
6	6d	95	7.77	67.82	−1.01	1.42	21.7	470.73
6	6e	77	25.24	62.39	−0.92	0.11	27.71	768.05
6	6f	77	25.24	59.84	−0.38	−0.27	24.64	607.23
7	7a	87	15.53	46.59	−0.42	0.25	22.81	520.27
7	7b	103	0	47.9	−0.1	0.3	21.67	469.46
7	7c	103	0	35.72	1.02	−0.28	28.9	835.08
7	7d	103	0	70.82	−1.72	6.17	15.83	250.6
8	8a	103	0	63.83	−0.39	−0.77	26.41	697.39
8	8b	89	13.59	48.88	−0.53	−0.66	24.32	591.4
8	8c	103	0	55.9	−1.01	2.05	17.88	319.67
8	8d	103	0	39.95	−0.66	1.14	14.28	203.96
8	8e	103	0	68.87	−1.18	0.87	23.6	556.74
8	8f	94	8.74	72.62	−1.59	2.29	23.68	560.74
8	8g	103	0	65.17	−0.44	0.54	23.16	536.35
8	8h	103	0	81.86	−2.42	6.62	19.8	391.92
9	9a	103	0	24.44	1.78	3.12	21.93	481.03
9	9b	103	0	44.52	0.58	−1.02	32.53	1058.11
9	9c	94	8.74	37.18	0.76	−0.29	26.2	686.43
9	9d	101	1.94	12.26	2.28	5.16	20.05	402
9	9e	103	0	23.75	1.25	1.21	23.21	538.58

Table A2. *Cont.*

Goal	Indicator	Number of Cities	Missing Data (%)	Mean	Skewness	Kurtosis	Deviation	Variance
9	9f	95	7.77	32.61	1.07	−0.11	31.89	1016.87
10	10a	103	0	32.83	1.26	2.41	18.85	355.25
10	10b	103	0	30.47	0.53	1.69	17.66	311.88
10	10e	98	4.85	55.33	−0.15	0.02	20.43	417.2
10	10d	103	0	43.57	0.52	0.39	21.84	477.2
10	10e	98	4.85	62.43	−0.86	0.04	25.05	627.39
10	10f	98	4.85	78.17	−2.09	6.07	18.06	326.22
11	11a	94	8.74	61.48	−0.5	−0.46	24.44	597.29
11	11b	90	12.62	50.9	0.09	−1.03	26.95	726.34
11	11c	92	10.68	86.86	−2.87	11.18	16.26	264.35
11	11d	38	63.11	83.43	−2.84	8.41	20.53	421.44
11	11e	92	10.68	50.03	−0.36	−0.11	12.05	145.26
11	11f	103	0	68.44	−1.22	1.46	22.45	504.1
11	11g	103	0	48.99	0.25	−0.64	25.86	668.82
11	11h	84	18.45	9.11	3.43	12.93	17.23	296.8
11	11i	103	0	21.74	1.98	4.85	19.66	386.44
11	11j	103	0	34.68	0.51	−0.7	24.69	609.64
11	11k	98	4.85	79.59	−1.93	3.49	22.51	506.89
12	12a	103	0	38.77	0.76	−0.03	23.8	566.67
12	12b	100	2.91	42.36	0.46	1.05	20.45	418.03
12	12c	103	0	34.59	0.78	0.28	23.31	543.24
12	12d	63	38.83	91.96	−4.45	24.85	14.71	216.42
12	12e	103	0	32.94	1.14	1.25	22.18	491.75
13	13a	58	43.69	76.55	−2.44	7.78	14.05	197.49
13	13b	62	39.81	54.64	−0.24	−0.31	15	224.95
13	13c	58	43.69	58.81	−0.38	0.32	18.05	325.79
13	13d	103	0	57.93	−0.33	−1.42	39.6	1567.79
14	14a	45	56.31	41.18	0.17	−1.26	34.52	1191.4
14	14b	46	55.34	92.96	−3.5	13.39	19.22	369.6
14	14c	43	58.25	50.08	−0.02	−1.13	30.35	921.03
14	14d	47	54.37	17.81	1.53	2.45	22.92	525.21
14	14e	43	58.25	26.55	1.11	0	31.46	989.43
15	15a	103	0	67.09	−0.72	−0.2	26.17	684.94
15	15b	103	0	11.34	1.87	2.61	18.09	327.34
15	15c	103	0	38.52	0.45	−0.42	25.45	647.68
15	15d	103	0	26.84	1.7	2.93	22.41	502.19
16	16a	103	0	82.61	−3.1	12.81	16.04	257.27
16	16b	103	0	44.33	−0.81	0.31	16.83	283.39
16	16c	103	0	74.87	−1.17	0.63	28.83	831.13
16	16d	103	0	52.45	−0.35	−0.36	24.08	579.73
16	16e	103	0	52.84	−0.61	−0.21	25.89	670.35
16	16f	101	1.94	52.97	−0.51	0.13	22.4	501.66
16	16g	103	0	50.84	−0.97	0.5	22.38	500.78
16	16h	103	0	56.96	−0.5	−0.66	29.88	892.78
16	16i	85	17.48	50.82	−1.96	6.31	12.33	152.08
17	17a	103	0	13.98	2.19	4.37	23.22	539
17	17b	103	0	32.52	0.76	−1.41	46.29	2142.59
17	17c	103	0	41.05	0.42	−0.32	23.71	562.08
17	17d	103	0	86.58	−2.25	4.68	22.66	513.64

Appendix C

Table A3. Normalized values used in the alternative weighting.

Goal	Assessment Value	Normalized Value
1	2.08	1.09
2	1.80	0.94
3	1.72	0.89
4	1.54	0.80
5	2.29	1.20
6	2.80	1.47
7	1.76	0.91
8	1.95	1.02
9	1.97	1.03
10	2.28	1.19
11	2.85	1.50
12	2.29	1.20
13	2.18	1.14
14	0.99	0.50
15	1.38	0.71
16	2.18	1.14
17	2.35	1.23

Table A4. Correlations between the indicators, their respective goal and the overall index. Numbers represent the Pearson correlation coefficients between each indicator and the corresponding goal and between each indicator and the overall index. Correlations that are not significant at the significance level of $\alpha = 0.01$ are in grey. Very high correlations (i.e., Pearson correlation coefficients greater than 0.70) are bolded and negative correlations highlighted in red.

	Respective SDG		General Index	
Id	**Coefficients**	**Indicator**	**Coefficients**	**Indicator**
1a	0.51	0.00	0.01	0.92
1b	0.27	0.01	0.04	0.70
1c	**0.90**	0.00	0.66	0.00
1d	**0.87**	0.00	0.64	0.00
1e	**0.92**	0.00	0.65	0.00
2a	0.39	0.00	0.04	0.63
2b	0.43	0.00	0.05	0.65
2c	0.66	0.00	0.02	0.83
2d	**0.78**	0.00	0.16	0.11
2e	**0.76**	0.00	0.12	0.25
3a	0.28	0.00	0.03	0.80
3b	0.46	0.00	0.10	0.32
3c	**0.72**	0.00	−0.07	0.49
3d	0.58	0.00	0.05	0.59
3e	0.09	0.40	0.10	0.36
3f	**0.90**	0.00	−0.10	0.32
3g	**0.92**	0.00	0.01	0.96
3h	0.56	0.00	−0.01	0.93
3i	0.10	0.31	0.07	0.46
3j	0.56	0.00	−0.11	0.26
3k	**0.88**	0.00	−0.06	0.56
3l	0.23	0.02	0.51	0.00
3m	0.67	0.00	0.07	0.45
4a	0.58	0.00	0.29	0.01
4b	0.49	0.00	0.14	0.18
4c	0.62	0.00	0.22	0.03
4d	**0.83**	0.00	0.53	0.00

Table A4. *Cont.*

	Respective SDG		General Index	
Id	**Coefficients**	**Indicator**	**Coefficients**	**Indicator**
4e	−0.05	0.65	−0.06	0.56
4f	**0.82**	0.00	0.53	0.00
5a	0.42	0.00	−0.01	0.95
5b	0.38	0.00	−0.10	0.32
5c	0.46	0.00	0.26	0.01
5d	0.58	0.00	0.28	0.01
5e	0.51	0.00	0.19	0.05
6a	0.49	0.00	−0.01	0.91
6b	0.35	0.00	0.06	0.58
6c	0.67	0.00	0.41	0.00
6d	0.46	0.00	0.11	0.29
6e	0.53	0.00	0.41	0.00
6f	0.18	0.12	−0.02	0.85
7a	0.40	0.00	0.18	0.09
7b	0.48	0.00	0.43	0.00
7c	0.58	0.00	0.23	0.02
7d	0.63	0.00	0.39	0.00
8a	0.64	0.00	0.25	0.01
8b	0.61	0.00	0.48	0.00
8c	0.21	0.03	0.19	0.05
8d	0.26	0.01	0.12	0.21
8e	0.61	0.00	0.46	0.00
8f	0.37	0.00	−0.03	0.75
8g	0.23	0.02	−0.26	0.01
8h	0.48	0.00	0.15	0.14
9a	0.06	0.53	0.22	0.03
9b	0.38	0.00	0.03	0.77
9c	0.56	0.00	0.22	0.03
9d	0.23	0.02	−0.22	0.03
9e	0.33	0.00	0.35	0.00
9f	0.52	0.00	0.01	0.90
10a	0.41	0.00	0.12	0.21
10b	0.50	0.00	0.21	0.03
10e	**0.82**	0.00	0.07	0.52
10d	0.14	0.17	−0.26	0.01
10e	0.54	0.00	0.66	0.00
10f	0.53	0.00	−0.07	0.47
11a	0.37	0.00	−0.05	0.63
11b	0.35	0.00	0.13	0.23
11c	0.40	0.00	0.33	0.00
11d	0.35	0.03	0.24	0.15
11e	0.36	0.00	0.38	0.00
11f	0.44	0.00	0.20	0.05
11g	0.18	0.06	−0.15	0.14
11h	0.17	0.12	0.15	0.19
11i	−0.004	0.97	0.01	0.94
11j	0.30	0.00	0.15	0.12
11k	0.24	0.02	0.09	0.40
12a	0.60	0.00	0.33	0.00
12b	0.37	0.00	0.14	0.16
12c	**0.74**	0.00	0.46	0.00
12d	0.11	0.37	0.38	0.00
12e	0.70	0.00	0.11	0.27
13a	0.59	0.00	−0.12	0.37
13b	**0.77**	0.00	0.17	0.18
13c	0.65	0.00	0.35	0.01
13d	**0.95**	0.00	0.30	0.00

Table A4. *Cont.*

	Respective SDG		General Index	
Id	**Coefficients**	**Indicator**	**Coefficients**	**Indicator**
14a	0.56	0.00	−0.19	0.21
14b	0.61	0.00	−0.13	0.38
14c	0.70	0.00	0.21	0.19
14d	0.61	0.00	0.08	0.60
14e	**0.84**	0.00	0.25	0.11
15a	**0.72**	0.00	0.13	0.20
15b	0.48	0.00	0.03	0.74
15c	**0.78**	0.00	0.09	0.37
15d	0.51	0.00	0.17	0.09
16a	0.48	0.00	0.49	0.00
16b	0.35	0.00	0.27	0.01
16c	0.52	0.00	0.44	0.00
16d	0.53	0.00	0.55	0.00
16e	0.68	0.00	0.25	0.01
16f	0.36	0.00	0.09	0.36
16g	**0.72**	0.00	0.21	0.03
16h	0.66	0.00	0.18	0.06
16i	0.64	0.00	0.43	0.00
17a	0.67	0.00	0.51	0.00
17b	**0.82**	0.00	0.38	0.00
17c	**0.72**	0.00	0.56	0.00
17d	0.48	0.00	0.14	0.16

Table A5. Correlations between the goals and the overall index. Numbers represent the Pearson correlation coefficients between the SDG goals and the overall index. Significant correlations greater than 0.01 are in grey. High positive correlations are highlighted in green and negative in red.

SDG		Index	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Index	Pearson’s corr.	1.00																	
	Significance coef.																		
Goal 1	Pearson’s corr.	0.54	1.00																
	Significance coef.	0.00																	
Goal 2	Pearson’s corr.	0.12	−0.21	1.00															
	Significance coef.	0.25	0.04																
Goal 3	Pearson’s corr.	0.01	0.01	−0.15	1.00														
	Significance coef.	0.91	0.93	0.14															
Goal 4	Pearson’s corr.	0.47	0.58	−0.23	−0.14	1.00													
	Significance coef.	0.00	0.00	0.02	0.17														
Goal 5	Pearson’s corr.	0.35	0.13	0.09	−0.21	0.09	1.00												
	Significance coef.	0.00	0.20	0.38	0.04	0.38													
Goal 6	Pearson’s corr.	0.27	0.16	0.10	0.01	−0.01	0.19	1.00											
	Significance coef.	0.01	0.12	0.31	0.95	0.91	0.05												
Goal 7	Pearson’s corr.	0.58	0.43	−0.02	−0.16	0.42	0.34	0.31	1.00										
	Significance coef.	0.00	0.00	0.87	0.10	0.00	0.00	0.00											
Goal 8	Pearson’s corr.	0.38	0.42	−0.15	0.04	0.19	−0.05	0.24	0.31	1.00									
	Significance coef.	0.00	0.00	0.14	0.70	0.05	0.60	0.01	0.00										
Goal 9	Pearson’s corr.	0.31	0.38	0.04	0.26	0.10	−0.06	0.05	0.11	0.26	1.00								
	Significance coef.	0.00	0.00	0.68	0.01	0.31	0.57	0.58	0.27	0.01									
Goal 10	Pearson’s corr.	0.19	0.47	0.20	0.07	−0.02	−0.01	0.09	0.14	0.23	0.34	1.00							
	Significance coef.	0.05	0.00	0.05	0.51	0.88	0.90	0.36	0.17	0.02	0.00								
Goal 11	Pearson’s corr.	0.29	−0.02	0.36	−0.16	0.06	0.12	0.11	0.10	−0.13	−0.07	0.11	1.00						
	Significance coef.	0.00	0.85	0.00	0.10	0.55	0.22	0.29	0.31	0.18	0.48	0.25							
Goal 12	Pearson’s corr.	0.47	0.26	−0.11	−0.14	0.39	0.12	−0.16	0.31	0.05	0.10	−0.18	−0.12	1.00					
	Significance coef.	0.00	0.01	0.28	0.15	0.00	0.25	0.10	0.00	0.65	0.29	0.06	0.21						
Goal 13	Pearson’s corr.	0.37	−0.01	−0.24	−0.01	0.05	0.04	−0.17	−0.18	0.04	−0.01	−0.19	0.10	0.16	1.00				
	Significance coef.	0.00	0.89	0.01	0.91	0.65	0.68	0.09	0.07	0.69	0.93	0.06	0.33	0.11					
Goal 14	Pearson’s corr.	0.08	−0.38	0.28	0.04	−0.30	0.02	0.05	−0.14	−0.22	−0.16	0.04	0.27	−0.21	0.05	1.00			
	Significance coef.	0.43	0.00	0.00	0.68	0.00	0.81	0.61	0.17	0.03	0.10	0.66	0.01	0.03	0.62				
Goal 15	Pearson’s corr.	0.17	−0.21	0.24	−0.19	−0.10	0.27	−0.13	0.18	−0.22	−0.20	−0.10	0.12	0.03	−0.02	0.31	1.00		
	Significance coef.	0.09	0.03	0.01	0.06	0.31	0.01	0.18	0.07	0.03	0.04	0.32	0.25	0.74	0.81	0.00			
Goal 16	Pearson’s corr.	0.57	0.31	0.12	−0.14	0.35	0.23	0.25	0.56	0.37	0.03	−0.01	−0.01	0.30	−0.12	−0.03	0.13	1.00	
	Significance coef.	0.00	0.00	0.24	0.17	0.00	0.02	0.01	0.00	0.00	0.74	0.94	0.90	0.00	0.21	0.78	0.20		
Goal 17	Pearson’s corr.	0.56	0.32	−0.26	−0.04	0.42	0.03	0.04	0.28	0.22	0.06	−0.22	0.08	0.53	0.32	−0.30	−0.17	0.30	1.00
	Significance coef.	0.00	0.00	0.01	0.70	0.00	0.75	0.66	0.00	0.02	0.54	0.03	0.44	0.00	0.00	0.00	0.08	0.00	

Table A6. Summary of main correlations between the indicators.

Indicators Id	Pearson Coef.	Indicators Id	Pearson Coef.	Indicators Id	Pearson Coef.	Indicators Id	Pearson Coef.
15a/11j	−0.78	16h/1e	0.89	3g/3d	0.77	7b/1d	0.74
10a/1e	0.99	8b/8e	0.81	3m/1d	0.77	7b/1c	0.74
10a/1c	0.99	16d/3m	0.81	6e/6a	0.77	8c/1d	0.74
1c/1e	0.98	10d/1a	0.8	16d/1d	0.77	3m/1e	0.73
1c/1d	0.97	16h/16e	0.8	16d/10a	0.77	4g/1d	0.73
10a/1d	0.96	16g/16h	0.79	16d/1e	0.76	8c/1e	0.73
1d/1c	0.95	4d/1d	0.78	16g/1e	0.76	10f/10d	0.73
4d/4g	0.95	5a/5b	0.78	3m/1c	0.75	8e/3m	0.71
3g/3l	0.92	8c/1c	0.78	10a/3m	0.75	11c/11d	0.71
3h/3i	0.91	8b/3m	0.78	10a/8b	0.75	16a/1c	0.71
3h/3g	0.91	16d/1c	0.78	4d/1c	0.74	4d/1c	0.69

Table A7. Total explained variance for I_s and A_s.

Component	Initial Set (I_s)			Alternative Set (A_s)		
	Eigenvalue	% Variance	% Accumulated	Eigenvalue	% Variance	% Accumulated
1	3.634	21.37	21.37	3.183	18.72	18.72
2	2.238	13.16	34.54	2.234	13.14	18.72
3	2.068	12.16	46.70	1.854	10.90	31.86
4	1.280	7.53	54.23	1.442	8.48	42.77
5	1.147	6.74	60.98	1.151	6.77	51.25
6	1.013	5.95	66.93	1.131	6.65	58.02
7	0.904	5.31	72.25	1.088	6.40	64.67
8	0.852	5.01	77.20	0.870	5.12	71.07
9	0.756	4.44	81.71	0.751	4.42	76.19
10	0.553	3.25	84.96	0.623	3.66	80.61
11	0.548	3.22	88.18	0.551	3.24	84.28
12	0.484	2.85	91.03	0.545	3.20	87.52
13	0.435	2.55	93.59	0.477	2.80	90.73
14	0.324	1.90	95.50	0.316	1.85	93.53
15	0.320	1.88	97.38	0.287	1.68	95.39
16	0.256	1.50	98.89	0.270	1.59	97.08
17	0.188	1.10	100	0.225	1.32	98.67

Table A8. Rotated Component Matrix for I_s and A_s.

SDG	Initial Set (I_s)				Alternative Set (A_s)			
	1	2	3	4	1	2	3	4
1		0.787				−0.674	0.471	
2	0.698							
3								
4	−0.309	0.442		0.385	0.567	−0.363		
5			0.616				0.742	
6								0.708
7		0.310	0.678		0.420		0.371	
8		0.330						0.763
9		0.590					0.336	
10		0.771		−0.332			0.565	0.392
11	0.734						0.308	
12	−0.426		0.470	0.452	0.797			−0.304
13				0.765				
14	0.698				−0.317	0.731		
15	0.308		0.648			0.697		
16			0.652		0.603			0.497
17				0.770	0.721			

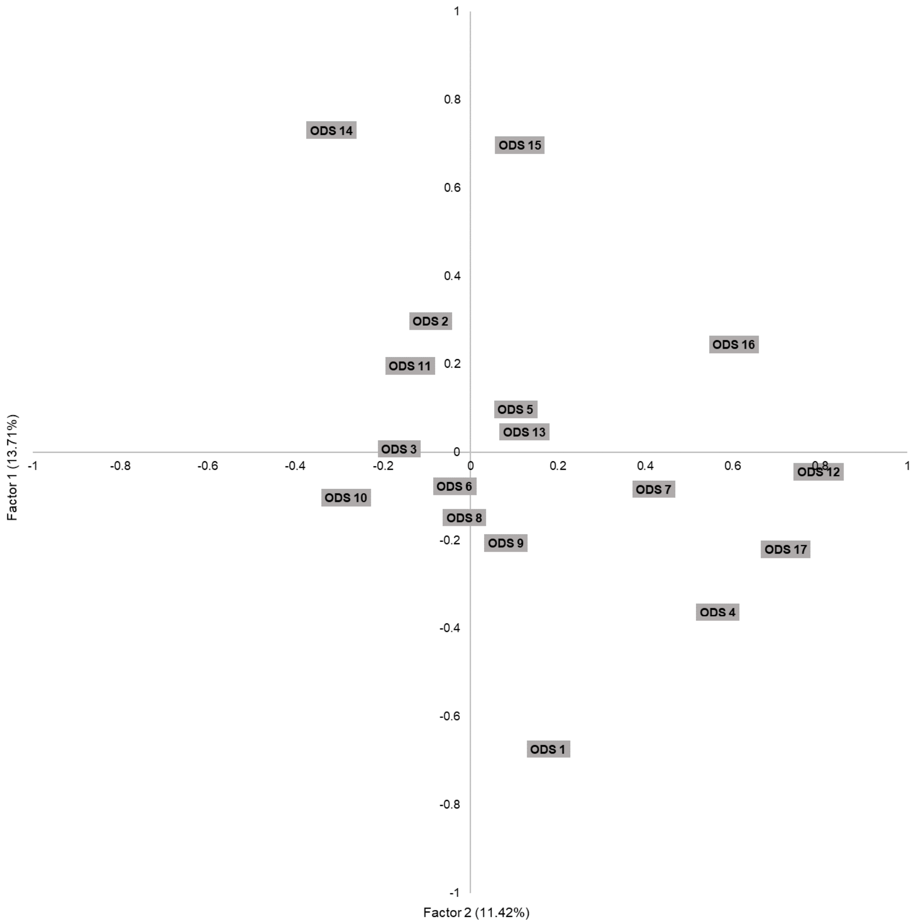

Figure A1. Factor map of the 17 goals of the SCR Index for A_s.

Table A9. Total explained variance of the intermediate indices. In bold values with total explained variance above 60%.

SDG	Initial Set (I_s)			Alternative Set (A_s)			Variance Difference
	Factors	Indicators	% Variance	Factors	Indicators	% Variance	
1	1	5	**60.75**	1	3	43.82	−27.87
2	2	5	**64.00**	1	3	63.56	−0.69
3	4	13	**66.49**	4	12	**64.48**	−3.02
4	2	6	**66.95**	2	5	**65.84**	−1.66
5	2	5	**64.43**	1	3	46.63	−27.63
6	3	6	**69.82**	2	4	55.27	−20.84
7	2	4	**61.97**	1	2	50.58	−18.38
8	3	8	**63.90**	3	6	**68.04**	6.48
9	3	6	**69.03**	2	4	59.89	−13.24
10	3	6	**77.13**	1	3	50.82	−34.11
11	4	11	**61.56**	3	8	**61.49**	−0.11
12	2	5	**67.04**				
13	2	4	**66.83**				
14	1	5	44.54				
15	1	4	41.13				
16	3	9	**69.50**	2	7	57.81	−16.82
17	1	4	48.49				

Table A10. Rotated component matrix for SDG 3. In bold values greater than 0.700.

Indicators	1	2	3	4
n_sdg03_adfertility		**0.794**		
n_sdg03_alcohol	0.432			
n_sdg03_gripe	0.668		−0.308	0.365
n_sdg03_hepatitis	0.672		0.323	
n_sdg03_infantil			**0.703**	
n_sdg03_prematuras	**0.891**			
n_sdg03_suicidios	0.403	0.486		
n_sdg03_trafico				**0.839**
n_sdg03_tuberculosis	0.339	0.441	−0.383	0.404
n_sdg03_tumores	**0.883**			
n_sdg03_vida		0.595	0.594	
n_sdg03_vih	**0.811**			

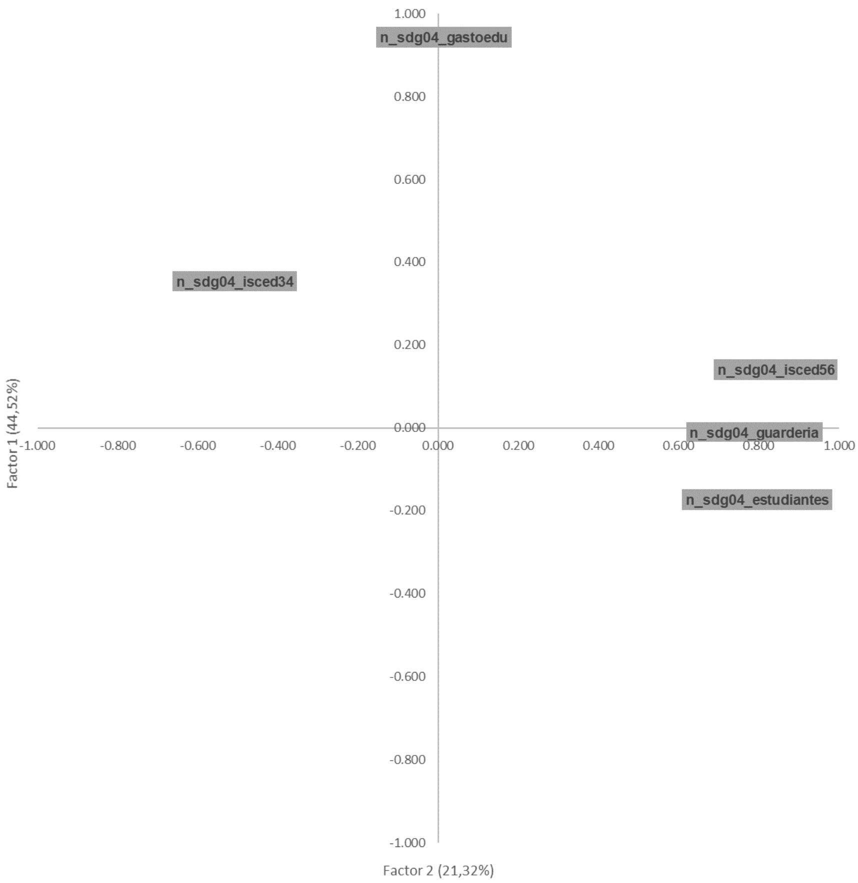

Figure A2. Rotated space component for SDG4.

Table A11. Rotated component matrix for SDG 8. In bold values greater than 0.700.

Indicators	1	2	3
n_sdg08_desempleo		**0.762**	
n_sdg08_desempleocovid			**0.833**
n_sdg08_desempleojovenes		**0.761**	
n_sdg08_diversidad	**0.710**	−0.327	
n_sdg08_pibcapitamun	0.454		−0.663
n_sdg08_productividad	**0.821**		

Table A12. Rotated component matrix for SDG 11. In bold values greater than 0.700.

Indicators	1	2	3
n_sdg11_no2	**0.76**		
n_sdg11_o3			**−0.77**
n_sdg11_pm10		**0.88**	
n_sdg11_pm10media		**0.85**	
n_sdg11_preciovivienda	0.64		
n_sdg11_resiliencia	0.59		0.49
n_sdg11_suptrans	**−0.79**		
n_sdg11_vulnerables			0.55

Appendix C

Table A13. Top 10 positions of cities on each calculation alternative.

Position	Initial Set (I_s)		Alternative Set (A_s)	
	City	Index Score	City	Index Score
1	Vitoria-Gasteiz	61.05	Vitoria-Gasteiz	68.33
2	Zaragoza	58.72	Zaragoza	66.60
3	Logroño	57.23	Logroño	63.60
4	Soria	56.15	Getafe	62.53
5	Getafe	55.04	Soria	61.31
6	Lleida	53.47	Burgos	60.90
7	Palencia	53.47	Rivas-Vaciamadrid	60.73
8	Cáceres	53.46	Palencia	60.72
9	Madrid	53.36	Cáceres	59.98
10	Donostia-San Sebastián	53.19	Móstoles	59.93

Table A14. Bottom 10 positions of cities on each calculation alternative.

Position	Initial Set (I_s)		Alternative Set (A_s)	
	City	Index Score	City	Index Score
1	Barakaldo	41.11	Teruel	45.13
2	Arona	41.03	Barakaldo	44.69
3	Talavera de la Reina	40.60	Melilla	44.63
4	Melilla	40.47	Vélez-Málaga	42.74
5	Marbella	39.86	Arona	42.06
6	Vélez-Málaga	39.82	El Ejido	41.85
7	El Ejido	38.67	Marbella	41.19
8	Fuengirola	38.07	Ceuta	40.35
9	Ceuta	35.75	Fuengirola	40.04
10	Torrevieja	35.50	Torrevieja	36.60

Table A15. Full list of cities and index score on each calculation variation.

	Initial Set (I_s)		Alternative Set (A_s)		
City	Position	Index Score	Position	Index Score	Shifts
Albacete	44	48.96	31	56.61	13
Alcalá de Henares	28	50.95	22	58.09	6
Alcobendas	27	51.06	25	57.83	2
Alcorcón	20	51.72	14	59.08	6
Algeciras	85	43.34	91	45.68	−6
Alicante	64	46.47	78	48.62	−14
Almería	83	43.56	86	47.12	−3
Arona	95	41.03	98	42.06	−3
Ávila	24	51.51	26	57.23	−2
Avilés	89	42.69	81	48.38	8

Table A15. *Cont.*

	Initial Set (I_s)		Alternative Set (A_s)		
City	**Position**	**Index Score**	**Position**	**Index Score**	**Shifts**
Badajoz	59	47.29	62	51.77	−3
Badalona	77	44.35	66	51.27	11
Barakaldo	94	41.11	95	44.69	−1
Barcelona	23	51.63	23	57.88	0
Bilbao	43	49.10	41	54.87	2
Burgos	15	52.63	6	60.90	9
Cáceres	8	53.46	9	59.98	−1
Cádiz	58	47.30	47	53.53	11
Cartagena	52	47.82	56	52.13	−4
Castellón de la Planta	53	47.64	49	53.22	4
Ceuta	102	35.75	101	40.35	1
Chiclana de la Frontera	61	46.83	80	48.46	−19
Ciudad Real	66	46.22	55	52.64	11
Córdoba	22	51.67	19	58.66	3
Cornellá de Llobregat	42	49.23	16	58.90	26
Coslada	88	42.93	75	49.02	13
Cuenca	16	52.02	44	54.38	−28
Donostia-San Sebastián	10	53.19	45	54.05	−35
Dos Hermanas	90	42.45	88	46.78	2
El Ejido	100	38.67	99	41.85	1
El Puerto de Santa María	51	47.92	67	51.23	−16
Elche	46	48.57	58	51.92	−12
Fuengirola	101	38.07	102	40.04	−1
Fuenlabrada	49	48.24	34	56.14	15
Getafe	5	55.04	4	62.53	1
Gijón	14	52.63	18	58.70	−4
Girona	12	53.06	12	59.23	0
Granada	65	46.31	65	51.30	0
Guadalajara	38	49.85	28	56.82	10
L’Hospitalet de Llobregat	93	41.81	83	48.18	10
Huelva	80	44.15	84	47.45	−4
Huesca	26	51.33	35	56.01	−9
Jaén	62	46.55	46	53.66	16
Jerez de la Frontera	79	44.23	82	48.28	−3
A Coruña	39	49.72	43	54.63	−4
Las Palmas de GC	68	45.47	59	51.82	9
Las Rozas de Madrid	36	49.89	40	55.14	−4
Leganés	70	45.04	64	51.54	6
León	35	50.09	30	56.72	5
Lleida	6	53.47	17	58.82	−11
Logroño	3	57.23	3	63.60	0
Lorca	13	52.76	13	59.09	0
Lugo	31	50.62	52	52.87	−21
Madrid	9	53.36	11	59.77	−2
Málaga	54	47.63	51	53.01	3
Marbella	98	39.86	100	41.19	−2
Mataró	72	44.85	74	49.36	−2
Melilla	97	40.47	96	44.63	1
Mérida	75	44.66	87	46.90	−12
Mijas	69	45.45	90	46.62	−21
Móstoles	17	51.88	10	59.93	7
Murcia	60	46.92	63	51.66	−3
Ourense	57	47.34	71	50.09	−14
Oviedo	41	49.49	32	56.61	9
Palencia	7	53.47	8	60.72	−1
Palma de Mallorca	71	44.87	85	47.30	−14
Pamplona	25	51.40	38	55.50	−13

Table A15. *Cont.*

	Initial Set (I_s)		Alternative Set (A_s)		
City	**Position**	**Index Score**	**Position**	**Index Score**	**Shifts**
Parla	78	44.31	68	50.89	10
Pontevedra	67	45.68	77	48.93	−10
Pozuelo de Alarcón	29	50.90	37	55.55	−8
Reus	81	44.05	70	50.53	11
Rivas-Vaciamadrid	11	53.08	7	60.73	4
Roquetas de Mar	92	41.98	93	45.23	−1
Sabadell	40	49.61	15	59.08	25
Salamanca	55	47.60	48	53.46	7
San Boi de Llobregat	56	47.48	29	56.82	27
San Cristobal La Laguna	50	48.04	61	51.78	−11
Sant Cugat del Vallès	18	51.76	21	58.12	−3
San Fernando	47	48.40	57	52.10	−10
San Sebastián de los Reyes	63	46.51	54	52.75	9
Santa Coloma de Gramenet	87	43.05	76	48.97	11
Santa Cruz de Tenerife	32	50.35	39	55.49	−7
Santander	21	51.68	27	57.21	−6
Santiago de Compostela	37	49.85	33	56.36	4
Segovia	76	44.62	73	49.52	3
Sevilla	82	43.81	79	48.61	3
Soria	4	56.15	5	61.31	−1
Talavera de la Reina	96	40.60	89	46.75	7
Tarragona	48	48.38	50	53.14	−2
Terrasa	30	50.79	20	58.53	10
Telde	91	42.39	92	45.43	−1
Teruel	86	43.06	94	45.13	−8
Toledo	84	43.49	69	50.68	15
Torrejón de Ardoz	74	44.69	60	51.78	14
Torrent	45	48.92	36	55.67	9
Torrevieja	103	35.50	103	36.60	0
Valencia	34	50.10	53	52.85	−19
Valladolid	19	51.75	24	57.86	−5
Vélez-Málaga	99	39.82	97	42.74	2
Vigo	33	50.27	42	54.73	−9
Vitoria-Gasteiz	1	61.05	1	68.33	0
Zamora	73	44.82	72	49.61	1
Zaragoza	2	58.72	2	66.60	0

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