Towards a Framework for Evaluating Sustainable Society Index

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ABSTRACT

The Sustainable Society Index describes social progress along three dimensions: human, environmental and economic. Being a composite indicator, its aim is to be a comprehensive and quantitative measure of sustainability and a quality of life of a nation. The objective of this paper is to offer a new approach to a framework for objective evaluation of the SSI. To this end we have improved the SSI by implementing a statistical I-distance method that synthesizes several indicators into one quantitative indicator. The applied I-distance method offers the possibility to obtain an optimal set of variables for future revisions of the Sustainable Society Index. In addition, the differences in ranks between countries have been discussed. We hope that our results may initiate further studies concerning the framework of the Sustainable Society Index.

Keywords*: Sustainable Society Index, I-distance, Ranking of countries, Sustainable development, Country's welfare*
JEL CODE: *Q01, Q50, C01, C10*

1. INTRODUCTION

Since the 1992 United Nations Conference on Environment and Development in Rio de Janeiro, the limitations of Gross Domestic Product (GDP) as a measure of *sustainable development* have been frequently elaborated (Davidson, 2000; Pissourios, 2013; Cameron et al., 2013). Therefore, many different frameworks for evaluating socio-economic development and welfare of countries have been introduced (Cracolici et al., 2010), with majority of them concerned with economic indicators (UNDP, 2008). As a counterpart of economic growth philosophy, the concept of sustainable progress was introduced in 1980's. It was defined by the Brundtland report as *"development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs"* (WCED, 1987; Petrovic et al.,

2011). Social and ecological factors as well as economic ones must be taken into account for defining *sustainable development* (IUCN, UNEP and WWF, 1980). Over the past decades there has been considerable interest in analyzing the relationship between economic growth and environmental impact (Wang et al., 2013).

During the World Summit on Sustainable Development in 2002 (UN, 2002) sustainability was formalized on three pillars – social, environmental and economic. Economic sustainability, as economists see it, is focused on various kinds of "capital" (man-made, natural, human, social) that should be sustained (World Bank, 2006). *Sustainable development* is fundamentally perceived as the use of renewable natural resources in a manner that does not eliminate or degrade them or otherwise diminish their usefulness for future generations. Furthermore, it requires a sufficiently slow-rate of depletion of non-renewable energy resources to ensure the high probability of an orderly social transition to renewable ones. A specific definition of a social dimension of *sustainable development* is a less clear-cut (Martin, 2001). Understandably, the diversity of economic, social and cultural conditions in individual countries makes development of a uniform definition of social sustainability very difficult. Black defined social sustainability as *"the extent to which social values, social identities, social relationships and social institutions can continue into the future" (Black, 2004)*. It is precisely the social "pillar" of sustainable development that is probably the most important and critical for long-term survival of human civilizations as shown in Jared Diamond's insightful study of the past (and contemporary) societies (Diamond, 2005). Last of the "three pillars" concept, the environment, has not been closely scrutinized as the previous two pillars. According to Goodland, environmental sustainability *"seeks to improve human welfare by protecting the sources of raw materials used for human needs and ensuring that the sinks for human wastes are not exceeded, in order to prevent harm to humans" (Goodland, 1995)*. He also identifies environmental sustainability as a set of constraints on the four major activities regulating the scales of the human economic subsystem: *"the use of renewable and nonrenewable resources on the source side, and pollution and waste assimilation on the sink side"*.

Given the above mentioned it can be concluded that the problem of sustainability is multi-dimensional. Besides being formalized on three pillars, sustainability is more than a mere aggregation of the indicators because it encompasses their interlinkages (Singh et al., 2012). Also, the indicator should be able to serve as a benchmarking instrument, to show trends in time and set targets. Accordingly, there is a need for indicators that could cover the linkages between the environmental and the other two dimensions of sustainability

(Moldan et al., 2004). To this end composite indicators have been used to measure sustainability.

According to *KEI (2005), "Indicators and composite indicators are increasingly recognized as a useful tool for policy making and public communication in conveying information on countries' performance in fields such as environment, economy, society, or technological development"*. According to *Meadows (1998) "Indicators arise from values (we measure what we care about), and they create values (we care about what we measure)"*. Another definition states that a composite index is a combination of multiple sources of information measured in or off a system in order to provide a summary of the system that itself is not directly measurable (Dobbie & Dail, 2013).

There is a strong political desire for the comprehensive assessment of changes in economic, environmental, and social (including institutional) conditions: an issue that cannot be clearly measured and difficult to improve (Böhringer and Jochem, 2006). The construction of a composite index is a dynamic process, which may be roughly simplified in three steps. In the first theoretical step, experts are often involved to select the most representative underlying variables (Yuan et al., 2003; Esty et al., 2005). The second step (operational step) involves data collection and handling. Once the variables are normalized, the resulting variables could be aggregated into an overall index by an aggregating method. Then, in the final step, the collected data are aggregated leading to a composite index.

Many of the sustainability composite indicators fail to meet fundamental scientific requirements. There are three central issues to be addressed. Firstly, in selecting input variables one should be conscious that the themes determine a thematic aggregation method, and the units determine a technical aggregation method. Secondly, as there are no general rules for normalization of these variables and their weighting these procedures should be treated in a transparent way, with a great reserve, and be subject to comprehensive sensitivity analysis. Thirdly, commensurability of input variables should be assured (Ebert and Welsch, 2004).

Bearing this in mind our paper will try to address several topics. Firstly, we will point out the significance of socio-economic composite indicators and how they are constructed. Secondly, we will review the *Sustainable Society Index* which has been developed since 2006 with the aim to be a comprehensive and quantitate method to measure and monitor the health of coupled human-environmental systems at national level worldwide.

In search of an adequate set of indicators to measure the level of sustainability of a country, the main existing indexes have been examined.

However, the conclusion appears to be that none of them seem to fit the needs completely. The main shortcomings are a limited definition of sustainability, a lack of transparency, and absence of regular updates. For this reason, a new index — the *Sustainable Society Index (SSI)* — was developed in 2006. It aims at describing social progress along all the three pillars – human (social), economic and environmental. Since then the SSI has been refined methodologically in order to arrive at an index that is both conceptually and statistically sound (Saisana, Philipapas, 2012). Sustainable Society Foundations was released for the fourth time in 2012, having undergone a revision by the Joint Research Centre. The latest update concerns the used aggregation method which has been changed from arithmetic to geometric mean. The SSI integrates the most important aspects of sustainability and the quality of life of a nation in a simple and transparent way. Consisted of 21 indicators, grouped into 8 categories, three Wellbeing dimensions, it is based upon the definition of the Brundtland Commission, measuring and summarizing the complex concepts underlying a sustainable society.

The paper is organized as follows: Section 2 focuses on the methodology used to perform the analysis. Section 3 features the comparative analysis of the latest SSI rankings based on the revised methodology (Saisana and Philipapas, 2012) and the *I-distance* method applied on the 2012 database. The final section of the paper underlines conclusions of the paper.

2. METHODOLOGY

Subjectivity in creating composite indicators may affect the measurements to a great extent. In order to overcome this problem the *I-distance* method can be used. It was originally defined by Ivanovic (Ivanovic, 1977) who devised this method to rank countries according to the level of development based on several indicators, where the main issue was how to use all of them in order to calculate a single synthetic indicator which will afterwards represent the rank.

The *I-distance* measurement is based on calculating the mutual distances between the entities being processed, whereupon they are compared to one another so as to create a rank (Seke et al., 2013). It is necessary to fix one entity as a reference in the observed set using the *I-distance* methodology. The ranking of entities in the set is based on the calculated distance from the referent entity (Jovanovic at al., 2012).

For a selected set of variables $X^T = (X_1, X_2, ...X_k)$ chosen to characterize the entities, the I-distance between the two entities $e_r = (x_{1r}, x_{2r}, ...x_{kr})$ and $e_s = (x_{1s}, x_{2s}, ...x_{ks})$ is defined as

$$D(r,s)=\sum_{i=1}^{k}\frac{\left|d_i\left(r,s\right)\right|}{\sigma_i}\prod_{j=1}^{i-1}\left(1-r_{ji.12\ldots j-1}\right) \quad (1)$$

where $d_i(r,s)$ is the distance between the values of variable X_i for e_r and e_s e.g. the discriminate effect.

$$d_i\left(r,s\right)=x_{ir}-x_{is} \qquad i\in\{1,\ldots k\} \quad (2)$$

σ_i the standard deviation of X_i, and $r_{ji.12\ldots j-1}$ is a partial coefficient of the correlation between X_i and X_j, $\left(j<i\right)$ (Radojicic et al., 2012).

To overcome the problem of negative coefficient of partial correlation, which can occur when it is not possible to achieve the same direction of variables, it is a suitable to use the square I-distance (Jeremic et al., 2013). It is given as:

$$D^2\left(r,s\right)=\sum_{i=1}^{k}\frac{d_i^2\left(r,s\right)}{\sigma_i^2}\prod_{j=1}^{i-1}\left(1-r_{ji.12\ldots j-1}^2\right) \quad (3)$$

3. RESULTS OF THE ANALYSIS

Within the aim of the paper to provide an appropriate framework for evaluating countries' sustainability, we applied the *I-distance* method on 151 countries and compared it to the official SSI rankings. The input data was obtained from the official 2012 SSI database. Table 1 contains 21 variables that enter the SSI framework, which are divided into eight categories and three wellbeing dimensions. This framework aims at picturing the global landscape of societies in regard to their sustainability level.

Human, Environmental and Economic indicators for countries' wellbeing

Table no. 1

Wellbeing dimensions	Categories	Indicators
Human Wellbeing	Basic Needs	Sufficient Food
		Sufficient Drink
		Safe Sanitation
	Health	Healthy Life
		Clean Air
		Clean Water
	Personal & Social Development	Education
		Gender Equality
		Income Distribution
		Good Governance
Environmental Wellbeing	Nature & Environment	Air Quality
		Biodiversity
	Natural Resources	Renewable Water Resources
		Consumption
	Climate & Energy	Renewable Energy
		Greenhouse Gases
Economic Wellbeing	Transition	Organic Farming
		Genuine Savings
	Economy	Gross Domestic Product
		Employment
		Public Debt

Source: Table used from Saisana, M., Philippas (2012) , Sustainable Society Index (SSI): Taking societies' pulse along social, environmental and economic issues, Publications Office the European Union, Luxembourg, pp. 17

The above variables have been chosen in an iterative process during the framework revision carried out by Joint Research Centre and the SSI team in order to achieve a conceptual and statistical coherence and arrive at SSI components that are relatively balanced (Saisana, Philipapas, 2012). We have applied the proposed *I-distance* method on the first ten officially ranked countries in 2012. Table 2 shows the results of the I-distance method, square I-distance value, I-distance ranks and official SSI ranks. According to the I-distance method Norway and Sweden top the list.

The results of the I-distance method, square I-distance value, I-distance ranks and official SSI ranks for year 2012

Table no. 2

Country	I^2 - distance	I^2 - rank	SSI - rank
Norway	110.90	1	5
Sweden	107.95	2	2
Switzerland	107.02	3	1
Finland	103.77	4	8
Austria	100.04	5	3
New Zealand	94.50	6	11
Denmark	91.47	7	34
Luxembourg	91.04	8	27
Iceland	90.53	9	92
Netherlands	89.90	10	44

Table 2 shows that Sweden and Switzerland remained in the top three countries regardless the method applied. Countries among the top 10 by the official SSI ranking that are not in the same rank after applying the I-distance method are: Latvia (4), Costa Rica (6), Slovenia (7), Slovak Republic (9), Sri Lanka (10). They are replaced by New Zealand (6), Denmark (7), Luxembourg (8), Iceland (9) and the Netherlands (10). Several countries have significantly improved their ranking, with Iceland and the Netherlands leading the way.

Before we continue with the comparison of rankings and reasons for the differences in them, we should analyze a correlation between the official SSI ranking, the ranking obtained by applying arithmetic mean on the 2012 database, and the I-distance ranking. We carried out the Spearman's correlation test on these rankings to determinate whether there is a correlation and whether it is positive or negative.

As expected, the correlation between the 2012 SSI official and 2012 SSI arithmetic ranks is very strong ($r=0.835$, $p<0.01$). What makes the difference between them is the fact that the arithmetic mean approach does not penalize more uneven performance of countries, whilst the geometric does. Geometric mean is far better in representing the improvements of indicators, while the arithmetic mean compensates a good performance in one indicator by a poor performance in another indicator (Saisana and Philippas, 2012). The correlation important for this paper is the correlation between the 2012 SSI official and I-distance ranks, which is strong ($r=0.666$, $p<0.01$).

The SSI official methodology takes into account all three Wellbeing

dimensions equally, while same do not apply to the *I-distance* method. Implicitly, SSI official methodology provides equal weight to all three wellbeing dimensions which could easily be challenged. The countries to top the list in official ranks have had a similar level of all three Wellbeing dimensions, while other countries performed well in the Economic, but at the expense of the Environmental Wellbeing. This inverted shaped relationship is named Kuznets curve (Kuznets, 1955), which is seen in most developing nations who still have economic growth corresponding to a degradation of environmental wellbeing.

We already pointed out that the *I-distance* approach proposed here, besides providing the ranking list of countries, can also explore in-depth significance of each observed indicator and its contribution to the final rank. By applying our method, we are able to point out crucial indicators of countries' sustainability and determine their significance. Thus, the dataset was further examined and correlation coefficients of each indicator with the I-distance value were determined. The crucial indicators which correlate highly ($r>0.6$) with the I-distance values are given in Table 3.

The correlation between I^2-distance and input indicators

Table no. 3

Indicators	r
Good Governance	0.851
Gross Domestic Product	0.760
Healthy Life	0.738
Gender Equality	0.734
Education	0.718
Organic Farming	0.692
Clean Water	0.667
Clean Air	0.615
Sufficient to Drink	0.606

The correlation coefficients between the *I-distance* and initial indicators demonstrate which indicators are important in analyzing a country's socio-economic and environmental development (Milenkovic et al., 2014). (Un)surprisingly the most important indicator for measuring countries' welfare is Good Governance with $r=0.851$ ($p<0.01$), followed by GDP $r=0.760$ ($p<0.01$) and Healthy Life $r=0.738$ ($p<0.01$). Countries that improved their ranks have significantly better scores in these indicators. The fact that more than 50% of top 10 countries are from northern Europe can be explained by

the Scandinavian welfare model that has been in practice in these countries since the beginning of their development in 1960's and 1970's. At the core of this welfare model stands the principle of universalism and broad public participation in various areas of economic and social life, which is intended to promote an equality of the highest standards rather than an equality of minimum needs (Magnussen, Vrangbaek et Saltman, 2009). Since in the Scandinavian model the state has a crucial role as a supplier of social service, it follows that the model leaves relatively high support for low-wage groups (Torben, 2004). Nordic health care systems are intrinsically related to the development of the welfare state, building on the same principles of universalism and equity. Central features have traditionally been an egalitarian ideology, promoting equal access to health services, low levels of cost sharing and high levels of tax-based financing to realize this ideology, public ownership of hospitals and decentralized responsibility for managing the services (Magnussen, Vrangbaek et al., 2009).

Luxembourg entered the top 10 nations in the list according to the I-distance method. These results are in compliance with previous studies which emphasized Luxembourg's welfare and economic openness as the goals other countries should try to achieve (Koster, 2013). In particular, its GDP per capita is the highest in the EU and numerous researchers emphasize its importance as a driving force of socioeconomic development while still taking into account renewable energy and sustainable development aspects wherein Luxembourg excels (Djuran et al., 2013).

New Zealand, a country that moved up for 83 places, ranks above the OECD average in terms of health spending, with 10.3% of GDP spent on health in 2011. One of the key reasons New Zealand changed its rank so dramatically is not Healthy Life, but Good Governance indicator. Namely, its score on this indicator is 8.52 compared to the country which holds the same rank in the official SSI ranks with the score 6.22 (Costa Rica). Policy makers are increasingly attuned to social equity and welfare. Welfare reforms, besides education and training of youth at risk, have a goal to improve education, health, employment and social outcomes for large groups of Maori and other Pacific indigenous people in order to reduce social disparities (OECD Economic Survey, 2013).

The Netherlands found its place in the top 10 thanks to its high GDP (9.58) and Healthy Life (8.89) score. In 2006, the country's government introduced a structural health care reform. The reform can be seen as the realization of a long-standing political struggle to unite the health insurance fund and the voluntary private health insurance scheme. This reform gave results and health spending as a share of GDP in Netherlands was 11.9%

in 2011 (OECD Health Data, 2013). The European Commission predicts a growth rate of 1 per cent in 2014, which is a recovery from rate of -0.8 per cent in 2013 (European Commission, 2013). Although it had a negative growth rate in the previous year, the Netherlands was ranked 17th on the World list based on the GDP in millions of US Dollars (UN, 2012).

4. CONSLUSION

Since the Rio Earth Summit environmental and sustainable development indicators have proliferated. All that with the purpose of providing decision-makers with tools for assessing sustainability from global to local integrated nature–society systems in short- and long-term perspectives in order to assist them to determine which actions should or should not be taken in an attempt to make society sustainable (Kates et al., 2001). While composite indicators are usually used to present sustainability, they still have drawbacks such as subjectivity, due to the assumptions in estimating the measurement error in data, mechanism for including or excluding indicators in the index, transformation and/or trimming of indicators, normalization scheme, choice of imputation algorithm, choice of weights and choice of aggregation system (Pissourios, 2013). Although there are international efforts on measuring sustainability, only few of them have an integral approach which takes into account environmental, economic and social aspects (Singh et al., 2012). Amongst many, the *Sustainable Society Index* stands out as a simple instrument, based on a solid definition, which is used for assessing a country's present sustainability, as well as its distance to full sustainability (Van de Kerk, Manuel, 2007).

This paper covers an assessment of the *Sustainable Society Index* by applying the *I-distance* method to it. This methodology can easily integrate economic, social and environmental variables with different measurement units into one composite indicator (Isljamovic et al., 2014) which represents the rank. As the SSI synthesizes 21 social, economic and environmental indicators in eight categories, then to three wellbeing dimensions and finally to one single number, we suggest that I-distance method be applied not only to all indicators, but also to these categories in order to get a deeper insight of rankings of countries within a category. Not only does this approach enable *ranking of countries*, but it also allows for a better exploration of the differences between them. The results obtained by applying I-distance method to the official SSI 2012 database clearly demonstrate that Scandinavian and certain Western European countries lead the rank list due to their high level of living standard.

The difference in ranks between the SSI official and I-distance rankings can be explained by the fact that the SSI official rewards a balanced score in all three Wellbeing dimensions, in contrast to the I-distance method which rewards the countries with the higher score in the indicators which have greater significance. The reason the SSI official uses this kind of methodology is that *"the sustainability of the whole depends on mutual assistance and reciprocity among the parts"* (Moldan et al., 2011).

Indicators of sustainable development should be selected, revisited and refined based on the appropriate communities of interest (Singh et al., 2012). As the I-distance approach can identify crucial indicators for the ranking process, which means it can be used to reduce the number of indicators used to calculate a certain indicator (Milenkovic et al., 2014). This feature can be used to further reduce the number of indicators of the SSI, which was already done in 2012 when the index was revised by JRC (Saisana and Philippas, 2012).

We hope that our research will contribute to further improvements of the SSI, all with the purpose of creating a complete *"equilibrium between social, economic and environmental goals which is needed to reach a true index of sustainable development"* (Bravo, 2014).

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