



A differential multi-criteria analysis for the assessment of sustainability performance of European countries: Beyond country ranking



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ABSTRACT

Sustainable development as a concept that aims to enhance the quality of life without affecting environment has been in focus in European policies since the last decade of 20th century. The objectives of EU Sustainable Development Strategy (EU SDS) are grouped into ten thematic areas, where almost each theme has at least one headline and several operational sustainable development indicators (SDIs). A large number of SDIs is needed to evaluate all EU SDS goals, which imposes the use of multivariate data mining techniques. This paper presents an empirical study carried out to assess the sustainability performance of European countries using the differential multi criteria analysis (DMCA) technique. The PROMETHEE (Preference Ranking Organization MeTHod for Enrichment Evaluations) was applied on 38 headline and operational SDIs defined under the EU SDS. This DMCA was applied to 30 European countries over a 10-year period (2004–2014) with the aim to determine the theme specific, as well as, overall sustainability progress. The DMCA reveals that the majority of European countries have made progress in sustainability in the studied period, where Czech Republic, Germany, Hungary and Sweden, have enhanced their sustainability performance concerning all themes. There are only two countries, namely Greece and Ireland, which have not made overall progress in this period. Also, above the average progress has been made concerning social inclusion, sustainable transport, and climate change and energy, while in all other themes additional efforts should be made in order to ensure sustainable performance progress in future years. Although the progress in reducing uneven development between EU members has been made, after 2009 a positive trend can be observed only in a limited number of SDS themes.

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1. Introduction

Ecologically sustainable development is a major concern with regards to environmental protection and management (Ding, 2005). Since “one cannot manage what one cannot measure”, efforts have been made to define most suitable indicators and indexes for the evaluation of sustainability in various fields (Ding, 2005; O'Neill, 2015; Shokravi and Kurnia, 2014; Székely and Knirsch, 2005). Since the concept of sustainability is not univocally defined, and it is being influenced by regional or local specifics and issues, an objective measurement of sustainability is difficult to

achieve (Castellani and Sala, 2010), especially at the national or supranational level (e.g. European Union (EU)).

The EU Sustainable Development Strategy (EU SDS), which was renewed in 2006 (Council of the European Union, 2006), promotes environmental protection, social equity and cohesion, economic prosperity and sustainable development worldwide. In order to monitor all five dimensions of sustainable development, namely the economic, environmental and social advance along with good governance practices and the promotion of global partnership, the EU SDS objectives are evaluated using more than 130 sustainable development indicators (SDIs). Even if a small fraction of those indicators is used for an analysis of sustainable performance, their number imposes the use of multivariate data mining techniques.

A multi-criteria analysis (MCA) has attracted attention of decision makers for a long time and has been implemented in various

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fields for the search of sustainable solutions, e.g. integrated and sustainable solid waste management systems (Arikan et al., 2017) and sustainable energy management systems (Pohekar and Ramachandran, 2004). The PROMETHEE (Preference Ranking Organization Method for Enrichment Evaluations) is a non-parametric outranking MCA approach, widely used for decision making in the environmental and sustainability fields (Crnković et al., 2016; Deljanin et al., 2016; Herva and Roca, 2013; Oltean-Dumbrava et al., 2016). The main difference from other MCA methodologies is that PROMETHEE doesn't take into consideration only the importance of weight that shows the relationship level between criteria, but also considers the internal relation of each evaluation criterion (Arikan et al., 2017).

The aim of this paper is to present a PROMETHEE based differential multi-criteria approach for objective measurement and assessment of sustainability performance at the national (country) level. The paper is organized as follows: Section 2 briefly summarizes the SDIs contained in the EU SDS and gives a description of applied PROMETHEE method, Section 3 presents a differential MCA (DMCA) of these indicators for 30 countries and a 10-year period, while a discussion of the study's results is contained within Section 4. Section 5 draws some conclusions on the research presented.

2. Material and methods

2.1. Europe's sustainable indicators

The EU SDIs are grouped into ten thematic areas (Fig. 1), where each theme, except “good governance”, has at least one headline indicator which quantifies the overall objectives related to the key challenges of the particular theme. Operational indicators, which are related to the operational objectives of the EU SDS and represent the lead indicators in corresponding subthemes, are used at the second level. The third level (explanatory) indicators are breakdowns of higher level indicators, e.g. by gender or income group, and as such are related to actions described in the SDS or to other issues which are useful for analyzing progress towards the strategy's objectives. Contextual indicators, which are available for the limited number of themes (Fig. 1) provide valuable background information but they are difficult to interpret in a normative way (Eurostat, 2017). In total there are 134 indicators: 10 headline, 36 operational, 77 explanatory and 11 contextual indicators.

To facilitate efficient analysis of sustainable development progress, only headline and operational indicators are commonly used, which is the approach also applied in this study. The list of indicators used is presented in Table 1, along with covered themes and units. Themes “global partnership” and “good governance” are not included in the analysis because of the lack of suitable indicators. Also, because of the lack of data in the study period, the headline indicator (“Common bird index”) and one operational indicator (“Artificial land cover”) from Theme 8 (“Natural resources”) were not included in the analysis, while one operational indicator from Theme 5 (“Public health”) was replaced with corresponding explanatory indicators, namely “Index of production of toxic chemicals, by toxicity class” was replaced with “Urban population exposure to air pollution by particulate matter” and “Urban population exposure to air pollution by ozone”.

The selected indicators cover the wide range of natural, social and economic issues: biodiversity, fresh water resources, land use, climate change, resource use and waste, energy, transport and mobility, health, education, demography, public finance sustainability, monetary poverty and living conditions, access to labour market, employment, consumption and production patterns, innovation, competitiveness, eco-efficiency and economic development.

The analysis was performed using SDIs for 30 European countries, namely all EU28 members except Luxemburg, as well as for Iceland, Norway and Switzerland. Since 12 countries have become EU members after 2004, this analysis will describe the influence of EU environment on their sustainable development progress.

In the Eurostat database there was some missing data, mostly in the case of non-EU members, which were handled using data from other sources, but this was feasible only for limited number of cases. Since PROMETHEE can work with missing data, the analysis for particular country and particular theme was performed only if data was available for the majority of indicators that were included in the analysis. Therefore, for some countries and themes the analysis was not performed, i.e. Switzerland (T2 and T6), Croatia (T5), Greece (T5), Iceland (T8) and Malta (T5). As can be observed, SDIs related to “Public Health” (T5) were the least available.

2.2. PROMETHEE II

The PROMETHEE (Brans and Mareschal, 2005; Brans et al., 1986)

Theme	Headline Indicator	Operational indicators	Explanatory indicators	Contextual indicators
Socio-economic development	Real GDP per capita, growth rate and totals	5	12	/
Sustainable consumption and production	Resource productivity	3	14	2
Social inclusion	Persons at-risk-of-poverty or social exclusion	5	12	1
Demographic changes	Employment rate of older workers	4	3	5
Public health	Healthy life years and life expectancy at birth, by sex	2	7	/
Climate change and energy	Greenhouse gas emissions Primary energy consumption	3	7	/
Sustainable transport	Energy consumption of transport relative to GDP	4	6	1
Natural resources	Common bird index	4	5	/
Global partnership	Official development assistance as share of gross national income	3	9	1
Good governance	No headline indicator	3	2	1

Fig. 1. Themes and indicators defined in Europe's sustainable strategy (adopted from Eurostat).

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