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INNOVATIVE CALCULATION MODEL FOR EVALUATING REGIONAL SUSTAINABLE DEVELOPMENT

Abstract: *The sustainable development of organizations, of all types and sizes, is currently enforced and regulated by internal and international normative acts. The impact of their development is directly felt by local, regional, national or global communities. The purpose of the paper is to investigate and measure this impact on the sustainable development in three major areas: economic, social and environmental, by selecting representative indicators. Following the conducted research, the authors propose a calculation model of a composite index for the evaluation of regional sustainable development. The flexibility of the indicator selection system and the building of the composite index will allow simulations of the development of local communities, depending on the development factors considered as a priority in the central and local policies at that time. This solution is supported by the results of a statistical analysis in Romania, in which the authors used data from 2007-2017 for 8 development regions.*

Keywords*: regional sustainable development, calculation model for evaluating regional sustainable development, composite index.*

JEL Classification:E17, F63, P25, R11, R12, R13

1.Introduction

The globalization of the business environment and retail markets have posed great challenges for the management of organizations, which must ensure not only their development, but also increased competitiveness in a dynamic and highly diversified market. Hence the economic growth, determined by the development of the organizations and the increasing demand for products, implies an increasing consumption of resources, a marked deterioration of the limited natural resources and even of the living conditions (water, air, Earth), the deterioration of the environment with the vulnerability of the entire communities simultaneously. As a result, many researchers, economists, specialists and politicians have signaled these side-effects since 1972 through international (UN)

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or European bodies (European Commission, European Council), which defined the concept of sustainable development and enforced regulations for the development of local organizations and communities.Therefore, sustainable development is defined by the Brundtland Report (WCED, 1987) as “the development that meets the needs of the present, without compromising the ability of future generations to meet their own needs,” and they must urgently lead to change the behavior of all organizations and communities regarding the environment and to eliminate disparities in accessing resources. Laws, directives and regulations have been drafted on a global, European, national or local level, establishing obligations for all organizations in their development and economic growth, aimed at their sustainable development, through measures to protect the resources, the environment and the local communities.

Furthermore, it is no longer sufficient for one company to be viable and competitive on the market compared to the others, as it must ensure its own sustainable development and contribute to the sustainable development of the local community and the environment in which it operates, through concrete measures of social responsibility and environmental protection.Thus, taking account of the requirements of sustainable development of organizations, it is imperatively needed that scholars evaluate the effect of their development on the sustainable development of the society, the local communities and the environment.Therefore, this paper aims to develop a composite index for the evaluation of regional sustainable development in Romania. The rest of the study is organized as follows. The next section reviews earlier studies concerning regional sustainable development measures. The second section is dedicated to research methodology. The fourth section reveals the empirical outcomes, whereas the fifth section is focused on robustness analysis. The final section concludes the research and provide policy implications.

2. Prior studies on measuring regional sustainable development

Regional sustainable development is a dynamic concept and is carried out by all entities operating in a geographical space (environment, resources, infrastructure) and within the local communities belonging to a certain area (city, county, national or international development area). Under such circumstances, the regions can be very different, both in terms of the degree of economic development, given by the number, structure and specificity of the active companies and the specificity of the environment (relief, infrastructure, plant crops, forests, etc.), and in terms of the development of society, the structure by age and its education level, the customs, culture, and religion of these communities. This aspect gives a complex character to the development regions, which influences decisively not only the sustainable development of all organizations, but also of the regions as a whole.

Practically, at the UN level, the matter of sustainable development of an organization has long been pursued, defined and analyzed by specialists, being

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identified three major dimensions of its activity: economic, social and environmental and measures have been established for their implementation (United Nations, The Sustainable Development Goals 2030 Agenda). Similarly, a series of analyses, conferences, meetings of the decision-makers worldwide took place, which established strategies for the sustainable development of some very important activities, through their effects, in the sustainable development of the global society: climate change, transport (United Nations,2019), energy and waste. Within the European Union, a series of concrete actions and activities took place to stimulate the sustainable development of organizations, which involve definite measures of development and economic growth meeting the requirements for the protection of the resources, the environment and the local communities. Consequently, it was elaborated the Financing Plan for Sustainable Growth (Communication from the European Commission to the European Parliament, 2018) and the Sustainable Development Strategy in Europe. Romania responded promptly, by developing and implementing the national strategic programs for sustainable development.

Under the current pressure of environmental destruction along with the technological development and economic growth, the scientists and politicians have begun to seek solutions to ensure sustainable development, both at the level of organizations, society and communities in different geographical areas. The concept of sustainable development was defined in different ways, then it evolved and led to concrete measures, such as: “understanding the interdependencies between economy, society and environment”; the achievement, on a territorial level, of “an equitable distribution of resources and opportunities for the present and future generation”, as well as the limited capacity of natural resources (Jovovic et al, 2017).Therefore, the economic development, the increase of production and services must be achieved with the concomitant limitation of the impact on the environment, the natural resources and the reduction of harmful emissions.In response to the calls of the Brundtl and Commission and, later, to those included in the Agenda 21numerous systems of indicators were developed by experts, economists, researchers to measure the impact of the sustainable development effort of organizations on local communities and environment. This practically means measuring regional sustainable development (Pinter et al, 2008), which has been difficult to quantify because the various systems of indicators are more and more complex and critical.

The ecological issues regarding the sustainable development are described and modelled in (Manea, Titan et al, 2016). By applying the logistic regression, the authors have predicted the chances of some tree species to develop in a certain geographical area, depending on cartographic characteristics such as: altitude, aspect, slope and others. In a notable article, Harris (2010) gave a general overview of the regional development models that have been mentioned in the literature in the past 40 years, emphasizing the special importance of intangible factors, such as education, knowledge, and their impact on economic growth.

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The problems in China due to overcrowding in big cities, traffic jams, noise, and lack of adequate housing, even the limited use of resources, determined specialists to develop a system of indicators to measure the sustainable development of different regions (Liang et al, 2017). Their aim was to develop appropriate policies to eliminate the mentioned effects, above all, the overcrowding, by encouraging the population to settle in other development regions which can ensure a better standard of living. Moreover, in China, since it faces a rapid process of urbanization and industrialization which affects the lives of communities tremendously, another group of researchers developed a system of 52 indicators for measuring urban sustainable development, regarding economic growth, efficiency, construction, environment protection, social progress and population well-being (Li et al, 2009).

Furthermore, the specialists investigated and built specific indicators for the sustainable development of cities in China (Yin et al, 2014; Tan and Lu, 2016; Yanget al, 2016), proposing various concrete development policies.

(Salvati and Carlucci, 2014) built an indicator composed of 99 variables for measuring regional sustainable development in a highly developed but polarized country like Italy. The analysis was performed and then verified in a number of competitive and disadvantaged regions in Italy, and the results showed that they could be used for the implementation of regional sustainable development policies in countries which have significant differences in terms of economic, social and environmental development. In Poland, a handful of researchers (Kocmanova and Docekalova, 2012) defined indicators to measure the economic performance of the companies in the production sector and designed these indicators in relation to the environmental, social and corporate governance indicators, so that the sustainable development of companies could be ensured.

Other studies examined, in regional sustainable development, the relation between the economic development of the regions and the use of natural capital, local natural resources (Hou et al, 2019), and a long-term causal relationship in both directions. Thus, regional economic development is dependent on the existence of natural resources and their consumption, and the excessive consumption of resources will in turn limit long-term development. The results of the study showed that natural resources and their limitation were under-analyzed in economic growth models.

Analyzing the state of the art in the field of sustainable regional development, researchers proposed, based on a survey conducted in 17 cities in Shandong Province, China, an integrated indicator for measuring the level of sustainable development, which includes 4 subsystems: economy, society, resources and environment (Yifei et al., 2019). Using a three-layer neural network, the authors selected the AHP (Analytic Hierarchy Process with Entropy Correction) method to calculate the overall scores of the development levels corresponding to the 4 subsystems for the analyzed cities.(Popovic et al,2018) noticed the lack of quantitative indicators of social sustainability, thereby they studied the problem

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and proposed a set of 31 quantitative indicators of social sustainability that would allow the evaluation of the entire supply chain. Furthermore, other experts'approach was to analyze the field of energy, more precisely the sustainability of this extremely important field for the development of the society and the protection of the environment, the proper handling of the waste and the gradual conservation of the environment (Satyroet al, 2017). In the study of (Latif et al, 2017), an interactive model was developed, based on the users' responses, which then determined the sustainability index of the sector. Kilkis S. (2016) built a composite indicator on the sustainable development of energy, water and environmental systems (SDEWES) in the same field, for 12 cities in southeastern Europe, with 7 dimensions and 35 main indicators. The SDEWES indicator is useful for learning, collaboration and interaction between cities to ensure a more sustainable future. The problem of evaluating the sustainable development of a region is very complex, because the economic, environmental and social factors interact and condition each other, being strongly influenced by the specificity of the region.

3. Research methodology

3.1. Data description and sample selection

The study of scientific publications in the field of evaluation of regional sustainable development has shown that there is no single and universally valid instrument for its measurement. Under such circumstances, starting from the interdependence between sustainable regional development and its subsystems: economic, social and environmental, proven scientifically through a series of studies, analyses and developed models (Jovovic et al, 2017), we propose and experiment a flexible calculation model of a composite index of regional sustainable development. It uses the most important indicators (characteristics) for measuring sustainable development in the three subsystems, recognized and within the reach of the interested decision makers. The system of selected indicators and the model of evaluation will be demonstrated practically and tested by conducting empirical research for 8 development regions in Romania.The methodology of selecting the indicators and evaluating sustainable regional development through a flexible composite index offers a new perspective and a new calculation model for evaluating regional sustainable development in general. Generally speaking, the selected indicators can be grouped into a chosen number of subsystems.

Hypothesis 1 For each indicator taken into account, there is an *X* value specific to each development region or the analyzed geographical area (country, region, county) for each unit of time (year, semester, month and day).However, these indicators are expressed in different units of measurement (percentages, number of persons, millions of lei) and have very different values as order of size (units, thousands, millions, etc.), thus being difficult to compare. To make them comparable, our model proposes to assign points, for each value in the data series,

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calculated by the algorithm of the model, in the range of numbers from 1 to 100 (Soltănel, 2011).
We make the following notations:
R = the number of development regions considered
r = region *r*, *r = 1, ... R*
T = the number of years (units of time) taken into account
t = year *t, t = 1, ... T*
S = the number of subsystems of indicators of the same type
s = subsystem *s, s = 1, ... S*
Ls = the number of indicators (characteristics) within sub-item *s, s = 1, ... S*
ls = the indicator from subsystem *s*, with *s = 1, .. S*; *ls = 1, .. Ls*;
X (ls, r, t) = the value of indicator *ls*, from region *r*, year *ts = 1, .. S*; *ls = 1, .. Ls*; *r = 1, .. R; t = 1, .. T*
PX (ls, r, t) = the score corresponding to the value *X (ls, r, t);*
I (r, t, s) = the composite index values for region *r*, year *t*, subsystem of indicators *s*.
I (r, t) = the composite index values for region *r*, year *t*.
I (t) = the values of the composite index for general for year *t*.
Hypothesis 2 For each indicator (from the list of *L* indicators grouped into *S* subsystems, each with *Ls* indicators), which has associated *X* values of the same type, we consider that the maximum scattering field of the characteristic values is the range [*Xmin*, *Xmax*], which is delimited lower than the lowest value *Xmin* and higher than the highest value *Xmax*, of all the *X* values of the indicator for all regions and all years.The comparison of values can be reduced by comparing the position of each *X* value within the range [*Xmin*, *Xmax*] associated with the respective indicator. This position is given by the value *X-Xmin* (see Fig. 1).

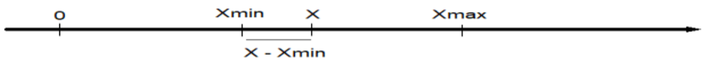

Figure1.Representation of the values associated with an indicator in the range[Xmin, Xmax]

For the indicator *ls* in the subsystem of indicators, the "Absolute amplitude of variation - *A (ls)*" will be calculated as the difference between the maximum value (*Xmax*) and the minimum value (*Xmin*) of the indicator:

A (ls) = Xmax-Xmin (1)

A (ls) has the unit of measurement of the values of each indicator and, therefore, cannot be used to compare the series of values expressed in different units of measurement corresponding to other indicators. For each value of the indicator *ls*, the corresponding score will then be calculated by the formula:

(*X-Xmin*) / *A (ls)* (2)

The Report (2) has a subunit value .Under such circumstances, the model will allow us to determine a composite index of sustainable development at the subsystem level analyzed within each region, a composite index at the level of each

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region and a general composite index of development for all the regions considered in our study.

3.2.Description of the model

In the context of the working hypotheses presented above, we propose a method of granting a unitary *PX* score with values in the range *[1,100]*, for each *X* value of an indicator, which allows comparison and synthesis, as follows:

a) We define:

- for $s=1:S$; $l_s=1:L_s$; the maximum value of the indicator l_s in the subsystem *s* between all indicator values for the regions $r=1:R$ and time s$t=1:T$; is:
  $Xmax(l_s) = max(X(l_s,r,t)\ r=1:R;\ t=1:T)$ (3)
- for $s=1:S$; $l_s=1:L_s$; the minimum value of the indicator $l_s$in the subsystem *s* between all indicator values for the regions $r=1: R$ and times $t=1:T$; is:
  $Xmin(l_s) = min(X(l_s,r,t)\ r=1:R;\ t=1:T)$ (4)
- fors$=1:S$; $l_s=1:L_s$; The Amplitude of the l_s indicator values in the subsystem of indicators *s* is:
  $A(l_s)= Xmax(l_s) - Xmin(l_s)$ (5)

Points are given in the range *1-100*, calculated as percentages of the values associated with an indicator against the amplitude of variation of the values *A (ls)*.

b) For indicators whose growth is beneficial to sustainable development, so in the same sense as the synthesis indicator:

The calculation formula for the score given to the value of indicator $X(l_s, r, t)\ l_s$ in the subsystem of indicators *s*, region *r*, year *t* is:

- $PXmin(l_s) =1$; (6)
- $PXmax(l_s) =100$; (7)
- The score for any other value of the indicator will be calculated by the formula

$$PX(ls,r,t) = \frac{X(ls,r,t)-Xmin(ls)}{A(ls)} * 100 \text{ for } Xmin(ls) < X(ls,r,t) < Xmax(ls) \qquad (8)$$

c) For the indicators whose growth is opposed to the sense of the synthesis indicator (showing a negative development situation, for example *General mortality rate*):

- $PXmin(l_s) =100$; (9)
- $PXmax(l_s) =1$; (10)
- The score for any other value of the indicator will be calculated by the formula:

$$PX(ls,r,t) = 100 - \frac{X(ls,r,t)-Xmin(ls)}{A(ls)} * 100 \text{ for } Xmin(ls) < X(ls,r,t < Xmax(ls) \qquad (11)$$

For the calculation of the values of the synthetic composite index we define:

- The value of the composite index *I (r, s, t)* in the region *r*, year *t*, for the subsystem *s* is the simple average of the points corresponding to each region for the considered subsystem

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$I(r,t,s) = \frac{1}{Ls} * \sum_{i=1}^{Ls} PX\ (i,r,t)$ (12)

- The value of the composite index *I (r, t)* for the region *r* (including all subsystems) at a considered time *t* (year)

$I(r,t) = \frac{1}{S} * \sum_{i=1}^{S} I(r,s,t)$ (13)

- The value of the general composite index *I (t)* at time *t* (for all regions)

$I(t) = \frac{1}{R} * \sum_{r=1}^{R} I(r,t)$ (14)

We noted that, if the indicators are subdivided into several indicators, each data series belonging to the sub-indicators is scored and then integrated into a single one, which will participate together with the other indicators in the calculation of the composite index of regional development. We believe that the built model is very flexible. First of all, the model allows us to take into consideration, at one point, those indicators of sustainable development considered as a priority and more important within the *S* subsystems taken into account by the local, regional or central decision-makers. Within the model, we considered the share equal to *1* for the three subsystems of regional sustainable development. However, we consider that the party, who implements the model at a given moment, can intervene and can change the share of the 3 groups of indicators, depending on the priority given at the time of measurement and the importance of each subsystem at that time. For example, the higher share for the resource subsystem and the environmental subsystem shows that these two subsystems are more important in China than the other two subsystems (Hou et al, 2019). Likewise, when they want to eliminate the major discrepancies between the regions, the uniform access to resources, the decision makers can decide, at a given moment, that the *environment* subsystem is a priority and, consequently, they will give it a higher share than to the others in the calculation model.

4. Empirical findings

4.1. Preliminary assessment of the model

We checked the validity of the model for the 8 development regions in Romania, which are varied in terms of competitiveness, distribution and access to natural resources, infrastructure, economic and scientific development level. Thus, without considering that this is the only or the best selection of indicators, we chose 26 indicators from the list of indicators defined for sustainable development at regional level in Romania and we grouped them into three subsystems (economic, social and environmental) to be included in the calculation model of the composite index, according to Table 1. By applying the presented model for the calculation of the regional sustainable development index in Romania, for 8 development regions, starting from the annual values of the selected indicators, in the period 2007-2017, we have:number of regions R = 8, time expressed in years T = 11, number of subsystems S = 3, number of indicators selected in: the subsystem 1 - L1 = 11, the subsystem 2 - L2 = 8, the subsystem 3 - L3 = 7.

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Table1. The indicators selected to be included in the calculation model of the composite index

Subsystem	Indicators of sustainable development	Variables
1: Economic development	Economically active population – total thou. persons	X1_1
	Employment rate by working - total (%)	X1_2
	Number of companies active in industry, trade and other services	X1_3
	Gross Domestic Product (GDP) per capita (Euro)	X1_4
	Job vacancy rate (%)	X1_5
	Existent tourist accommodation capacity (no.)	X1_6
	Length of modernized town streets (km)	X1_7
	Share of people according to the level of education in number of adults between 25 and 64 years	X1_8
	Share of people with higher education level in number of adults between 25 and 64 years	X1_8a
	Share of people with average level of education in number of adults between 25 and 64 years	X1_8b
	Share of people with a low level of education in number of adults between 25 and 64 years	X1_8c
	Turnover of companies active in industry, trade and other services	X1_9
2: Social	Average monthly nominal gross earnings (Lei)	X2_1
	General mortality rate(no of deceased people from 1000 inhabitants)	X2_2
	ILO unemployment rate – overall (%)	X2_3
	Number of hospital beds per 1000 inhabitants	X2_4
	Number of doctors per 1000 inhabitants	X2_5
	Total average monthly wages by household (Lei)	X2_6
	Total average consumption expenditure by household (lei)	X2_7
	Drinking water installation capacity (m^3/day)	X2_8
3: Environment and Resources	The volume of water distributed (thousands m^3/year)	X3_1
	Population connected to wastewater treatment plants-pers	X3_2
	Waste water discharged(thousands m^3/year)	X3_3
	Investments of environmental protection (thousands of lei)	X3_4
	Forest annual fallings	X3_5
	Local public transportation(passengers transport)	X3_6
	Length of public roads	X3_7

Source: http://www.insse.ro/cms/files/IDDT2012/index_IDDT.htm (the authors' processing)

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The eight development regions in Romania are:1. North - West; 2. Center; 3. North - East; 4. South - East; 5. South - Muntenia; 6. Bucharest - Ilfov; 7. South - West Oltenia; 8. West. We used a set of 24 indicators for the 8 development regions in Romania (see Table 1) to build the model. The model uses 26 data series (2007-2017), corresponding to the 24 sustainable development indicators considered. The indicator *X1_8* is centralized from three sub-indicators (*X1_8a*, *X1_8b* and *X1_8c*), so basically, we have 26 data series for the 24 indicators. The data used are public and were taken from the database of the National Institute of Statistics of Romania, for the 8 development regions, in the period 2007-2017 and then we centralized and processed the data according to our needs. One can notice there are great inequalities in the development and economic growth of the development regions. Analyzing the values of the composite index for the 8 development regions of Romania, we have found that Bucharest-Ilfov is the region with the best sustainable development, having the highest value of the indexes obtained in all 3 subsystems. By analyzing and comparing the values of these indexes for each indicator (criterion) taken into account, for all the regions or only a part of them, one can identify the regions that achieve a sustainable development progress, evidenced by the values of the indexes calculated for a time span of 11 years (2007-2017).If we look through the lens of sustainable development, these developmental inequalities manifest themselves as a priority in one or the other subsystems considered. Thus, in some regions there are energy consuming entities with a strong industrial pollution, in others aggressive environmental degradation through massive deforestation and the destruction of natural resources whereas the people with a very different level of education and culture in the 8 regions, are less informed and interested in environmental and social problems.

4.2. Evaluating regional sustainable development

By applying the calculation algorithm for the implementation of the proposed model, we obtained the following values of the evaluation ranking for 8 development regions in Romania, corresponding to the 3 subsystems: *Economic, Social* and *Environmental* (see Table 2).

Table 2. The obtained evaluation results

I	DEN IND	Re	200	200	200	201	201	201	201	201	201	201	201
X	ECONOMIC	1	**38**	**37**	**32**	**30**	**32**	**36**	**39**	**41**	**44**	**46**	**50**
X	SOCIAL	1	**30**	**37**	**35**	**34**	**41**	**40**	**42**	**43**	**43**	**48**	**53**
X	ENVIRONMENTAL	1	**35**	**38**	**38**	**38**	**38**	**35**	**35**	**36**	**37**	**36**	**37**
	Average	**1**	**34**	**37**	**35**	**34**	**37**	**37**	**39**	**40**	**41**	**43**	**47**
X	ECONOMIC	2	**40**	**40**	**34**	**30**	**31**	**34**	**36**	**38**	**40**	**44**	**47**
X	SOCIAL	2	**36**	**31**	**30**	**29**	**32**	**32**	**35**	**34**	**38**	**45**	**52**
X	ENVIRONMENTAL	2	**28**	**30**	**28**	**30**	**29**	**29**	**29**	**33**	**37**	**32**	**34**
	Average	**2**	**35**	**34**	**31**	**30**	**31**	**32**	**33**	**35**	**38**	**40**	**44**
X	ECONOMIC	3	**43**	**42**	**36**	**34**	**33**	**33**	**34**	**36**	**40**	**41**	**43**
X	SOCIAL	3	**26**	**32**	**31**	**29**	**35**	**32**	**33**	**33**	**31**	**35**	**41**
X	ENVIRONMENTAL	3	**28**	**29**	**31**	**28**	**30**	**27**	**26**	**28**	**30**	**28**	**27**

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	Average	3	32	34	33	30	33	31	31	32	34	35	37
X	ECONOMIC	4	40	39	35	33	31	34	34	35	38	39	40
X	SOCIAL	4	25	31	32	28	30	26	27	25	28	32	38
X	ENVIRONMENTAL	4	48	53	47	47	50	52	44	43	44	39	41
	Average	4	38	41	38	36	37	37	35	34	37	37	40
X	ECONOMIC	5	39	38	33	31	27	29	32	35	37	39	42
X	SOCIAL	5	13	20	20	19	16	16	18	18	17	21	29
X	ENVIRONMENTAL	5	39	41	48	42	43	40	37	40	39	40	38
		5	30	33	34	31	29	28	29	31	31	33	36
X	ECONOMIC	6	51	49	47	46	47	48	58	62	68	72	76
X	SOCIAL	6	53	63	65	65	67	63	65	67	72	78	85
X	ENVIRONMENTAL	6	60	56	52	52	54	46	55	55	52	44	45
	Average	6	55	56	55	54	56	52	59	61	64	65	69
X	ECONOMIC	7	24	24	20	18	18	20	19	21	17	18	24
X	SOCIAL	7	18	23	23	22	27	26	27	26	22	27	34
X	ENVIRONMENTAL	7	30	31	34	38	34	30	35	36	44	33	34
	Average	7	24	26	26	26	26	25	27	28	28	26	31
X	ECONOMIC	8	34	33	28	25	25	25	28	32	36	38	40
X	SOCIAL	8	29	34	35	35	41	41	42	42	40	46	49
X	ENVIRONMENTAL	8	29	31	30	30	32	31	28	29	31	31	30
	Average	8	31	33	31	30	33	32	33	34	36	38	40

Source: our processing

Analyzing the values in Table 2 we found that region 6,*Bucharest – Ilfov*, is the most developed not only for each of the three subsystems, but also for the average composite index of sustainable development calculated. A graphical representation shows how the 8 regions are compared to the composite index in Romania (the average in Romania). If most of them have the average value calculated around the average value per country, region 6 (Bucharest - Ilfov) has much higher values than the average, showing a much higher development, while region 7 (South-West Oltenia) has low values which are below the average values per country, denoting for instance a weak sustainable development, well below the average per country. These values show that the disparities between the regions are tremendous and the underdeveloped regions must be supported by concrete policies of development, stimulation and support elaborated by the local and central decision makers. The evolution of the graph of the composite index for regional development between 2007 and 2017 is presented in Fig. 2.

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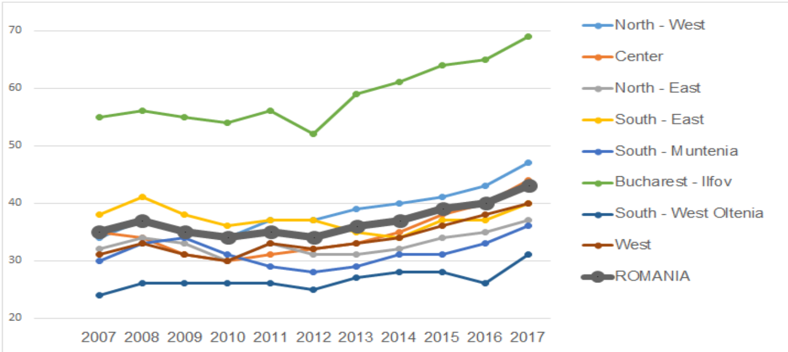

Figure 2. Evolution of the composite index of development in 8 development regions at national level

The dotted line for Romania represents the value of the composite index of sustainable development at the country level. We noted that 6 regions have values close to those calculated at the level of Romania. The South-West Oltenia region has values well below the average in the country or in the other regions, showing a declining sustainable development, which means that effective measures are needed to stimulate economic, social and environmental development. One can also see that the region 6 has the values of the regional development index which are far superior to all the others, showing that it has an increased sustainable development, thus becoming very attractive for both investors and high-skilled human resources. Analyzing the graphs for the evolution of the regional development index calculated at the level of each subsystem (economic, social and environmental) we found interesting aspects. The evolution of the index calculated for the economic subsystem related to the 8 development regions is presented in Fig. 3.

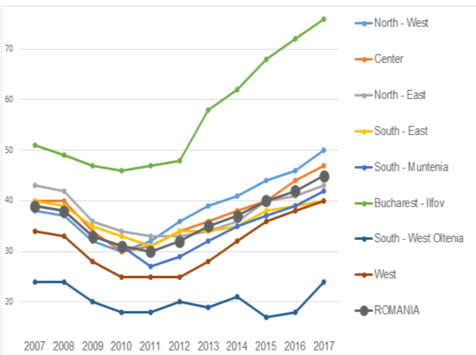

Fig. 3. Evolution of the development index for the economic subsystem in 8 development regions

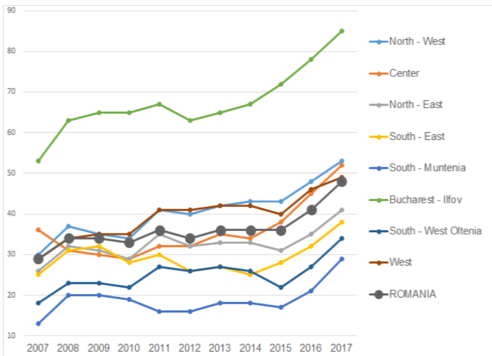

Fig. 4. Evolution of the development index for the social subsystem in 8 regions

We observe the economic subsystem highlights the same South-West Oltenia region which lags far behind regarding the level of development, while the same

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Bucharest-Ilfov region is highly developed, being well above the index values of the other regions. The graph for the development index of the social subsystem (Fig. 4) highlights the same trend, which may mean that the social development follows, naturally, the economic development of each region. A strongly developed region has a direct impact on the earnings of the members of the community, on the expenses borne by the households, on the health status of the population, on the mortality rate, etc.

The graph of the index development for the environmental subsystem (Fig. 5) shows a completely different situation. Thus, there were no such great differences between the values of these indexes, due to the different situation of geographical location, natural resources, concerns and concrete results regarding the protection of these resources. This analysis must be corroborated with the values calculated for each subsystem at the level of the 8 development regions (see Table 2).

The values of this index have dropped considerably in recent years in the North-East region, which shows the lowest level of sustainable development of the environment and where, as a matter of fact, massive deforestation took place. The Bucharest-Ilfov and South-East regions (which encompass the Romanian Black Sea coast) are the best from the point of view of sustainable development of the environment.

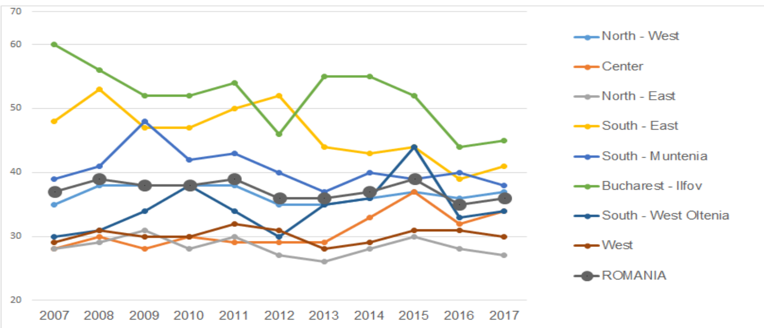

Figure 5. Evolution of the development index for the environmental subsystem in 8 development regions

It can be observed that, once the model is created and the composite indexes are calculated at the level of the 3 subsystems and then integrated for all regions, detailed analyses of the existing situation can be made for each indicator considered (criterion), for each region or group of regions, to motivate the intervention of the decision makers in stimulating or correcting them.

5. Robustness investigation

We obtained and presented the values for the index of sustainable development at the level of regions in Romania for the period 2007-2017. We continue the analysis by verifying the relation between the values of this index and the gross domestic product at the level of regions and country. The analysis can be

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extended to other economic indicators, such as economic activities, population number, etc. For this we also assign points from 1 to 100 to regional GDP values (Eurostat database, 2020), using the same algorithm and verify the existence of relations through simple regression models. The results obtained by assigning the points are presented in table 3.

Table3. Score obtained for GDP by regions in the period 2007-2017

No	Region	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
1	1	14	18	12	12	12	14	16	19	22	26	31
2	2	14	17	12	12	13	14	16	17	20	24	29
3	3	11	15	10	10	9	10	13	14	16	19	24
4	4	11	14	9	10	12	12	17	18	19	20	25
5	5	16	22	17	15	19	16	20	25	25	28	33
6	6	52	71	53	54	62	64	72	76	86	90	100
7	7	2	5	1	1	1	2	3	3	6	7	10
8	8	8	12	7	8	9	8	10	11	14	17	21
	Romania	16	22	15	15	17	17	21	23	26	29	34

Source: our processing

We have observed that the Bucharest-Ilfov region, which includes the capital of the country, is well above the level of all the other regions, and shows a higher development. For a better accuracy of the graph for the other regions, we made the graph for the other 7 regions, as presented in fig. 6.

It shows that the South-West Oltenia region has the least development from this point of view. We continue with a series of analyses - the starting point is that the measures taken with the general development of an area (region, country) should influence the sustainable development of that area.

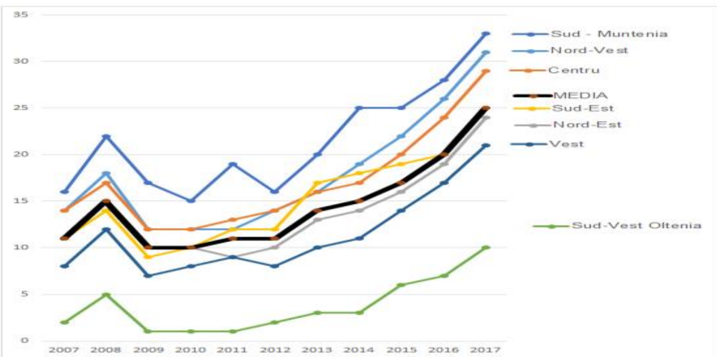

Figure6. Regional GDP evolution during 2007-2017, except the 6th region (B-IF)

We consider GDP as an indicator of general development at country and region level.

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At country level, the linear regression model by which we check the correlation between the score obtained for all regions for the sustainable development index (*X1*) and for GDP (*X2*) is:

$X1 = c + X2$(15)

where *X1* is the dependent variable and *X2* is the independent variable.

According to the method of assigning points, *X2* is the average of the points assigned for the GDP of each region and year. The values of the obtained parameters are presented in Table 4.

Table4. Processing results using Eviews 7.0

Dependent Variable: X1

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	27.36965	0.673787	40.62065	0.0000
X2	0.442272	0.030379	14.55826	0.0000
R-squared	0.959265	Mean dependent var		36.81818
Adjusted R-squared	0.954739	S.D. dependent var		2.821992
S.E. of regression	0.600365	Akaike info criterion		1.980409
Sum squared resid	3.243948	Schwarz criterion		2.052754
Log likelihood	-8.892251	F-statistic		211.9429
Durbin-Watson stat	1.507471	Prob(F-statistic)		0.000000

Source: our processing

The model is valid and shows that regional development depends on the regional GDP. Continuing the analysis of the correlation through simple linear regression models between the components of sustainable development (economic, social, and environmental) and GDP we obtained the results below. We consider that the economic development of each region is in close correlation with the general development, reflected by the GDP. At country level, the social component of sustainable development depends on GDP, with a high probability, according to Table 5. The linear regression model is:

$X1M2 = C + X2M$(16)

where:*X1M2* is the social component of the social development index, *X2M* is score the corresponding to GDP at country level.

Table5. Processing results using Eviews 7.0

Dependent Variable: X1M2

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	21.50535	2.821129	7.622960	0.0000
X2M	0.682728	0.127198	5.367441	0.0005
R-squared	0.761964	Mean dependent var		36.09091
Adjusted R-squared	0.735516	S.D. dependent var		4.887833
S.E. of regression	2.513717	Akaike info criterion		4.844368
Sum squared resid	56.86895	Schwarz criterion		4.916712
Log likelihood	-24.64402	F-statistic		28.80942
Durbin-Watson stat	1.046212	Prob(F-statistic)		0.000452

Source: our processing

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At regional level, the social component is closely correlated with the regional GDP for all the development regions, supporting once again the result obtained at the country level regarding the social component.
For the correlation model between the environmental component of sustainable development and the GDP the results show that there is no simple linear dependence relation. This can be interpreted as the result of the fact that the economic development of the regions does not directly influence the development of the indicators of the environmental component. The same result was also highlighted by the evaluation model of the sustainable development through the calculated composite index. This means that environmental policies must be a constant concern of the authorities responsible for protecting the environment and natural resources.

6. Concluding remarks and policy implications

We believe that our research provides specialists and especially practitioners, a new integrated model for evaluating regional sustainable development, which can support the development of regional sustainable development policies.
As a result, we believe that this index can be the basis of an in-depth analysis, based on real data that are easy to gather, for all stakeholders: decision makers, local or central authorities, policy makers, etc. They will be able to identify the tendency of composite indexes and their distribution by regions and years, indicators and subsystems, so as to establish the economic, social or environmental measures needed to stimulate sustainable regional development where appropriate.
In Europe, the overall aim is to minimize the existent gaps between its development regions. Under such circumstances, the regional development policy requires that Member States must promote real opportunities for all citizens, companies and entrepreneurs, all governments or local authorities, and the equitable development of all regions. This means reducing the disparities between regions and ensuring a social, economic and environmental development, basically to sustain the development of the whole European area. In Romania the regional development policy must follow the same principles. It must ensure, first and foremost, an internal economic growth, a sustainable development of production and services, an increase in the employment rate and its formation and training, ensuring a healthy and safety working environment at the same time. Furthermore, measures can be taken to protect the environment, water and forests, improve transportation infrastructure, develop new technologies in the fields of energy, waste, public transport, use of information and communication technologies for access to information systems in diagnosis and modern medical practice for health insurance (Ciocanel et al, 2017) and protection of local communities. Given the existence of international, European and national norms and legislation regarding the sustainable development of companies, they have committed themselves to sustainable development by integrating concrete requirements of environmental protection, social equity and economic well-being in their current activities, and by

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implementing the requirements for sustainable development. Last but not least, at the state level, there is a political desire to evaluate the factors that determine the current status of the companies, measure the progress made and contribute to the establishment of future development goals. Sustainable development indicators have thus been established as universal tools to measure the progress of regional, local sustainable development, to visualize and monitor sustainable development at continental scale (Shaker et al, 2014).The knowledge and promotion of experience in the field of measuring the sustainable regional development of some countries and regions, the exchange of best practices among them, are highly important, as they offer researchers and practitioners the opportunity to learn from each other (Jovovic et al, 2017).Indicator systems that provide the opportunity to track the progress of companies in fulfilling these responsibilities are effective tools for planning, operationalization and evaluation by all stakeholders, as well as communication tools at different levels of organization, up to the global level. (Pinter et al, 2008)

Such a simple model, correctly properly built and grounded, can be used to evaluate the sustainability of a particular region or country, to identify those necessary corrective measures at a given time. Diversified concerns of specialists from different countries of the world, have led to the creation and dissemination of several types of indicators calculated for the evaluation of sustainable development. If specialists in the field, theorists or practitioners from all countries worldwide know more methods to evaluate regional, local or national sustainable development, they will have the opportunity to develop coherent policies and concrete actions for the recovery of those underdeveloped areas/fields relevant for the sustainable development and the implementation of the Agenda 21 (Jovovic et al, 2017).We strongly believe that the composite index model of sustainable regional development built by us brings a new tool for measuring regional development for theorists and practitioners involved in measuring or, moreover, influencing it through concrete measures. These can be stimulating measures or special policies to increase some of the activities reported by the model as being deficient.

Thus, we consider that we contribute both to the theoretical research of the problem of sustainable regional development, as well as to the measurement practice and reaction of the decision-making factors to correct any abnormalities. They can be, first of all, the managers of the companies, who are well aware of their development compared to the local or central ones and can intervene in the strategic development of the company, through new economic development measures, investments for the development of modern technologies, which are efficient energetically and ecologically. Through research, innovation and innovative management (Gherghina et al,2020), companies can ensure besides their own development and sustainable territorial development, through the efficient use of resources, a sound specialization of human resources, social responsibility measures as well as environment and local community protection measures.

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Local or regional administrative authorities can use a simple and objective measurement tool to know their own and other regions' sustainable development index, and can act in support of measures that determine the stimulation of activities, the responsibility of companies in implementing social responsibility measures for the environment and the local community. Finally, policy makers, governors or MPs can use a tool for calculating and evaluating sustainable development at regional and national level and, by comparison, they can act to support, through economic, fiscal, education, culture, etc. the deficient regions or activities. Through education, they can change the attitude of communities towards the environment and even towards its members, thus promoting the economic, social and environmental sustainability.

Basically, this tool for evaluating regional sustainable development, proposed by us, differentiates itself from the existing tools known by the specialists in the field, since it offers a new calculation method, flexible and easy to use, especially useful in comparative analyses which are the basis of future decisions.

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