IMPACT OF THE INFORMATION SOCIETY ON SUSTAINABLE DEVELOPMENT: GLOBAL AND REGIONAL ASPECTS

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ABSTRACT

The concept of sustainable ecological-social-economic development is considered proceeding from the condition of obligatory coordination of economic, ecological, and human dimensions in such a way that from one generation to the other, the quality and safety of life should not decrease, the environmental conditions should not worsen, and social progress should meet the needs of every person. An approach of system coordination and balancing of these three constituents is suggested.

Keywords: Sustainable development, Information society**,** Indicators, Databases**,** Index**,** Mathematical models

The problem that forms the subject of this study is based on the concept of sustainable development. This concept has become a continuation of the theory of **noosphere** formulated by the Russian academician Vladimir Vernadsky (1922) and French mathematician Edward Le Roy (1927). The **noosphere** may be seen as the "sphere of human thought" derived from the Greek word ("nous") meaning "mind" in the same manner as the terms "atmosphere" and "biosphere." In the original theory of Vernadsky, the noosphere is the third in a succession of phases of the Earth's evolution, after the geosphere (inanimate matter) and the biosphere (biological life). Therefore, the noosphere is the modern stage of the development of the biosphere connected with the emergence of the human being as an active factor that is beginning to greatly influence the further geological evolution of the planet.

The essence of the concept of sustainable development (fig. 1) is system coordination of economic, ecological, and human development in such a way that the *quality and safety of life* should not decrease from one generation to another. *The environmental conditions* should not worsen, and the *social progress should meet the needs of every person*.

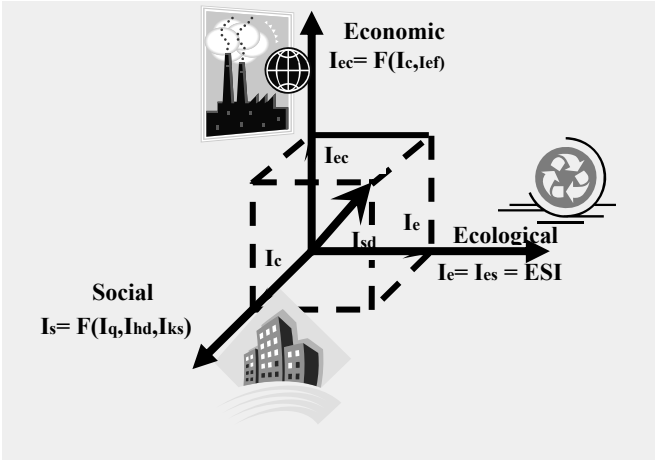

Figure 1. Global dimensions of sustainable development

In terms of the main criterion: "No decrease of quality and safety of human life" the question arises – how does the level of the information society development, as one of the products of human activities, influence sustainable development on the global and regional scale? To answer this question, first of all, it is necessary to introduce some measurement systems (metrics) for the sustainable development and information society.

The sustainable development measurement has been worked out by the introduction of the corresponding index (Isd) in (Fig. 2).

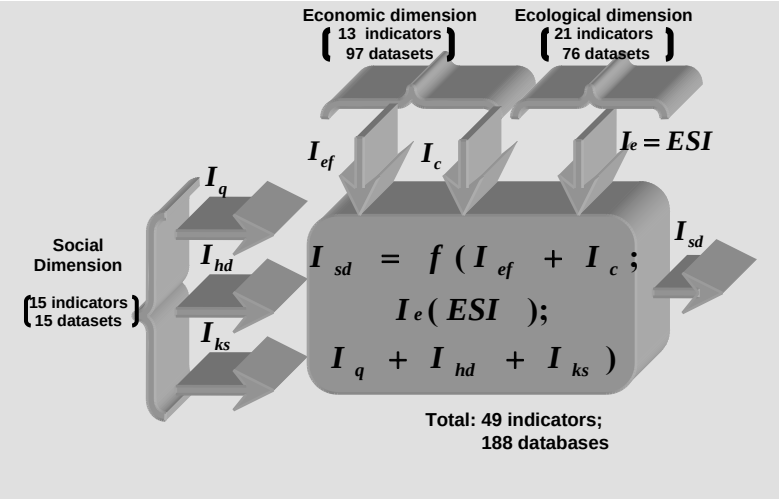

Figure2. Mathematical model of sustainable development (Model 1)

This index is determined by three dimensions: economic (Iec), ecological (Ie), and social (Is). In its turn, each of the indices (Iec), (Ie), (Is) is calculated by six global indices widely used in the international practice (Table 1).

Table 1.

Measure of sustainable development	Global index	Constituents (49 indicators, 188 datasets)	Source
Economic (Iec)	Ic-Growth competitiveness index	3 indicators, 47 sets of data	World Economic Forum (2006) [www.weforum.org]
	Ief – Economic freedom index	10 indicators, 50 sets of data	Heritage Foundation (2006) [www.heritage.org]
Ecological (Ie)	Ies – Environmental Sustainability Index	21 indicators, 76 sets of data	Yale University, USA (2006) [www.yale.edu/esi]
Social (Is)	Iq – Quality-of-life index	9 indicators	Economist Intelligence Unit (2006) [www.en.wikipedia.org]
	Ihd – Human development index	3 indicators	United Nation Development program (2005) [www.hdr.undp.org]
	Iks – Knowledge society index	3 indicators, 15 sets of data	UNDESA (2005) [UN, NE.04.C.1.2005]

On the basis of compositions of different indicators and datasets for these three dimensions, a mathematical model as a system of linear algebraic equations (Fig. 3) was developed for calculation of the sustainable development index (Isd).

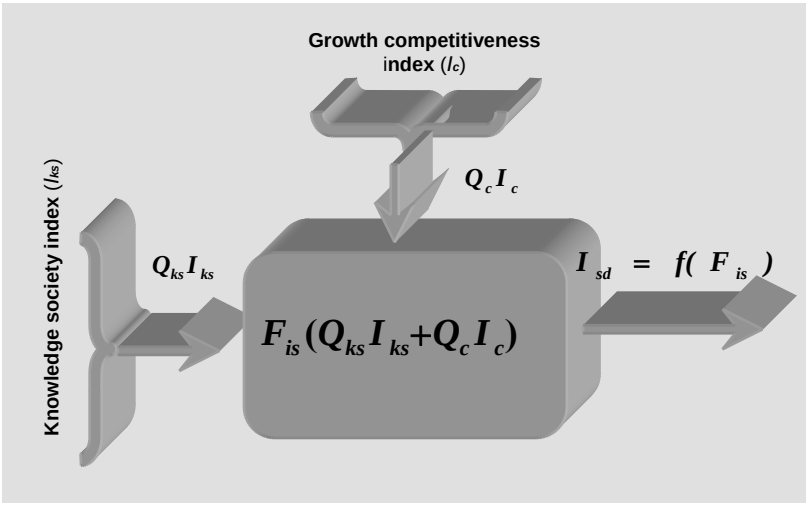

Figure 3. Estimation of the information society's impact on sustainable development (Model 2)

All data, indicators, and indices that are included in the model (Fig. 3) are measured in different units and have various interpretations. Consequently, they are reduced to the normal form in such a way that their changes, and the changes of the indices themselves, are in the range from 0 to 1. In this case the lowest values of the above indicators will correspond to the numerical values close to 0, and the highest will approximate these values to 1. Such normalization allows calculation of each of the indices Iec, Ie, Is, and Isd in the form of an averaged sum of its constituents with the corresponding weighting coefficients. In their turn, the weighting coefficients used in the calculation of the sustainable development index (Isd) are chosen in such a way that allows the same weights of economic, ecological, and social measures in this index. As a result, according to the mathematical model, the sustainable development index (Isd) is calculated for 48 countries (Table 2)

Table 2.

Ranking	Country	GGP per capita by the parity of purchasing capacity (thous. dol. USA)	Index of sustainable development	Index of the economic measure	Index of the ecological measure	Index of the social measure
1	Finland	29,650	*0,786*	0,567	0,751	0,802
2	Iceland	41,804	*0,780*	0,561	0,708	0,839
3	Sweden	30,590	*0,774*	0,538	0,717	0,84
4	Norway	39,590	*0,755*	0,488	0,734	0,829
5	Switzerland	33,580	*0,738*	0,538	0,637	0,82
6	Luxemburg	69,737	*0,738*	0,558	0,618	0,816
7	Denmark	32,490	*0,731*	0,563	0,582	0,828
8	Canada	34,150	*0,720*	0,525	0,644	0,777
9	Ireland	36,790	*0,716*	0,559	0,592	0,779
10	Australia	31,010	*0,716*	0,532	0,61	0,792
11	New Zealand	25,110	*0,713*	0,526	0,61	0,79
12	Austria	31,420	*0,708*	0,504	0,627	0,785
13	USA	41,529	*0,695*	0,562	0,53	0,779
14	Germany	28,250	*0,687*	0,51	0,57	0,777
15	Netherlands	30,920	*0,684*	0,524	0,537	0,787
16	Japan	30,750	*0,680*	0,48	0,573	0,793
17	England	31,150	*0,674*	0,543	0,502	0,773

18	Estonia	14,800	*0,662*	0,533	0,582	0,658
19	Uruguay	8,869	*0,647*	0,382	0,718	0,659
20	Chile	12,120	*0,642*	0,511	0,536	0,678
21	France	30,640	*0,641*	0,438	0,552	0,754
22	Spain	25,370	*0,626*	0,455	0,488	0,758
23	Israel	21,310	*0,623*	0,454	0,509	0,725
24	Latvia	11,862	*0,618*	0,42	0,604	0,649
25	Belgium	30,660	*0,615*	0,468	0,444	0,755
26	Italy	27,960	*0,613*	0,411	0,501	0,759
27	Costa Rica	9,000	*0,607*	0,372	0,596	0,685
28	Czech Republic	17,600	*0,602*	0,459	0,466	0,703
29	Slovakia	15,513	*0,601*	0,428	0,528	0,673
30	Hungary	16,047	*0,601*	0,424	0,52	0,686
31	Croatia	11,870	*0,596*	0,367	0,595	0,661
32	Korea	23,360	*0,591*	0,444	0,43	0,729
33	Malaysia	10,450	*0,590*	0,413	0,54	0,643
34	Greece	22,340	*0,586*	0,392	0,501	0,703
35	Panama	6,760	*0,583*	0,363	0,577	0,646
36	Brazil	8,760	*0,581*	0,347	0,622	0,61
37	Columbia	7,330	*0,565*	0,35	0,589	0,597
38	Poland	12,825	*0,559*	0,401	0,45	0,667
39	Bulgaria	8,664	*0,549*	0,365	0,5	0,628
40	Mexico	10,000	*0,546*	0,373	0,462	0,649
41	Tunis	7,910	*0,544*	0,37	0,518	0,586
42	Bolivia	3,680	*0,542*	0,322	0,595	0,556
43	Romania	6.105	*0.519*	0.34	0.462	0.616
44	Russia	9.81	*0.5.15*	0.319	0.561	0.52
45	Moldova	2,280	*0,506*	0,33	0,512	0,529
46	Trinidad	11,720	*0,500*	0,391	0,363	0,599
47	Ukraine	6,500	*0,485*	0,319	0,447	0,554
48	Egypt	3,930	*0,484*	0,337	0,44	0,535

by using the introduced measures, global indices, corresponding indicators, and datasets (Fig. 3).

Proceeding from the mathematical analysis (Fig. 3), we see that 48 indicators and 188 datasets are used to calculate the sustainable development index. 14 indicators and datasets directly characterize the content of the information society (Table 3).

Table 3.

№	Description	Weighting coefficients
	A. Index of the knowledge society (*Iks*)	
1	Years of schooling	0.066
2	Young population	0.066
3	Newspapers per 1000 pop.	0.066
4	Internet users per 10000 pop.	0.066
5	Main Phone Liners per 100 pop.	0.066
6	Call Phones per 100 pop.	0.066

7	R&D Expenditure (% of GDP)	0.066
8	Pupils per teacher	0.066
9	Gini Index	0.066
		Qks=0.60
	B. Growth Competetiveness Index (*Ic*)	
10	Cell Phones per 100 pop.	0.050
11	Internet users per 10000 pop.	0.050
12	Internet hosts per 10000 pop.	0.050
13	Main Phone Liners per 100 pop.	0.050
14	Personal Computers per 100 pop.	0.050
		Qc=0.25

They are included into the index of knowledge society (Iks) and the growth competitiveness index (Ic). Taking into account the weighting coefficients of the above indicators and datasets in the indices (Iks) and (Ic), the impact of the information society on sustainable development can be estimated by the mathematical model (Fig. 4),

$$\text{Fis (Impact)} = 5.37\,\frac{I_c}{I_{sd}} + 6.6\,\frac{I_{is}}{I_{sd}};$$

where Fis is an impact factor of the information society on sustainable development; Qks and Qc are summarized weighting coefficients of indicators and datasets characterizing the information society and are included in the indices (Iks) and (Ic), respectively.

To determine the dependence of the sustainable development index (Isd) on the impact factor of the information society (Fis) *in the global context,* calculations were made by using the model of sustainable development (Fig. 3) and the system of estimating the impact factor (Fis) of the information society on sustainable development (Fig. 4). The ranking of 46 countries by the impact factor of the information society on sustainable development is given in Table 4.

Table 4.

Ranking	**Country**	**Index of sust. develop-ment (Isd)**	**Index of economic dimension (Iec)**	**Index of ecological dimension (Ie)**	**Index of social dimension (Is)**	**Impact of IS on sust. develop-ment %**
1	Denmark	0.731	0.563	0.582	0.828	11.046
2	Japan	0.680	0.480	0.573	0.793	10.847
3	Great Britain	0.674	0.543	0.502	0.773	10.808
4	Germany	0.687	0.510	0.570	0.777	10.682
5	Israel	0.623	0.454	0.509	0.725	10.664
6	Netherlands	0.684	0.524	0.537	0.787	10.614
7	Belgium	0.615	0.468	0.444	0.755	10.606
8	Sweden	0.774	0.538	0.717	0.840	10.545
9	USA	0.695	0.562	0.530	0.779	10.496
10	France	0.641	0.438	0.552	0.754	10.343
11	Switzerland	0.737	0.538	0.637	0.820	10.298
12	Iceland	0.780	0.561	0.708	0.839	10.289
13	New Zealand	0.713	0.526	0.610	0.790	10.247

14	Austria	0.708	0.504	0.627	0.785	10.213
15	Czech Republic	0.602	0.459	0.466	0.703	10.210
16	Spain	0.626	0.455	0.488	0.758	10.149
17	Norway	0.755	0.488	0.734	0.829	10.128
18	Finland	0.786	0.567	0.751	0.802	9.968
19	Poland	0.559	0.401	0.450	0.667	9.892
20	Hungary	0.601	0.424	0.520	0.686	9.879
21	Luxemburg	0.735	0.557	0.618	0.815	9.833
22	Tunisia	0.544	0.370	0.518	0.586	9.820
23	Italy	0.612	0.411	0.501	0.759	9.763
24	Malaysia	0.589	0.413	0.540	0.643	9.741
25	Slovakia	0.602	0.428	0.528	0.673	9.698
26	Australia	0.716	0.532	0.610	0.792	9.692
27	Canada	0.721	0.525	0.644	0.777	9.502
28	Romania	0.519	0.340	0.462	0.616	8.781
29	Egypt	0.482	0.337	0.440	0.528	9.399
30	Mexico	0.545	0.373	0.462	0.649	9.394
31	Costa Rica	0.606	0.372	0.596	0.685	9.348
32	Greece	0.586	0.392	0.501	0.703	9.340
33	Estonia	0.662	0.533	0.582	0.658	9.296
34	Bulgaria	0.549	0.365	0.500	0.628	9.288
35	Chile	0.642	0.511	0.536	0.678	9.272
36	Latvia	0.618	0.420	0.604	0.649	9.183
37	Croatia	0.596	0.367	0.595	0.661	9.031
38	Moldova	0.506	0.330	0.512	0.529	8.996
39	Ukraine	0.486	0.319	0.447	0.554	8.996
40	Trinidad	0.500	0.391	0.363	0.599	8.955
41	Panama	0.583	0.363	0.577	0.646	8.928
42	Ireland	0.717	0.559	0.592	0.779	8.784
43	Russia	0.515	0.319	0.561	0.520	8.618
44	Uruguay	0.648	0.382	0.718	0.659	8.358
45	Columbia	0.566	0.350	0.589	0.597	8.189
46	Brazil	0.581	0.347	0.622	0.610	7.850

From a regional prospective, the dependencies are given in Table 5 for a group of the leading countries referred to as SMART societies in accordance with the sustainable development index.

Table 5.

Ranking	Country	Index of sustainable development (Isd)	Index of economic dimension (Iec)	Index of ecological dimens. (Ie)	Index of social dimens. (Is)	Impact of IS on sustainable developent %
1	Denmark	0.731	0.563	0.582	0.828	11.046
2	Sweden	0.774	0.538	0.717	0.840	10.545
4	Switzerland	0.737	0.538	0.637	0.820	10.298
3	Iceland	0.780	0.561	0.708	0.839	10.289
5	Norway	0.755	0.488	0.734	0.829	10.128
7	Finland	0.786	0.567	0.751	0.802	9.968
6	Luxemburg	0.735	0.557	0.618	0.815	9.833
8	Australia	0.716	0.532	0.610	0.792	9.692
9	Canada	0.721	0.525	0.644	0.777	9.502
10	Ireland	0.717	0.559	0.592	0.779	8.784

For G8 countries, these dependences are given in Table 6.

Table 6.

Ranking	Country	Index of sustainable development (Isd)	Index of economic dimension (Iec)	Index of ecological dimension (Ie)	Index of social dimension (Is)	Impact of IS on sustainable development %
1	Japan	0.680	0.480	0.573	0.793	10.847
2	Great Britain	0.674	0.543	0.502	0.773	10.808
3	Germany	0.687	0.510	0.570	0.777	10.682
4	USA	0.695	0.562	0.530	0.779	10.496
5	France	0.641	0.438	0.552	0.754	10.343
6	Italy	0.612	0.411	0.501	0.759	9.763
7	Canada	0.721	0.525	0.644	0.777	9.502
8	Russia	0,515	0,319	0,561	0,520	6,360

A group of the former socialist countries is shown in Table 7.

Table 7.

Ranking	Country	Index of sustainable development (Isd)	Index of economic dimension (Iec)	Index of ecological dimens. (Ie)	Index of social dimens.(Is)	Impact of IS on sustainab.develop. (%)
1	Czech Republic	0.602	0.459	0.466	0.703	10.210
2	Poland	0.559	0.401	0.450	0.667	9.892
3	Slovak Republic	0.602	0.428	0.528	0.673	9.698
5	Estonia	0.662	0.533	0.582	0.658	9.296
6	Bulgaria	0.549	0.365	0.500	0.628	9.288
7	Latvia	0.618	0.420	0.604	0.649	9.183
8	Croatia	0.596	0.367	0.595	0.661	9.031
9	Moldova	0.506	0.330	0.512	0.529	8.996
10	Ukraine	0.486	0.319	0.447	0.554	8.996

Thus, the developed mathematical models or metrics allow carrying out a variety of research with the purpose of revealing a measure of influence of different factors on sustainable development.

In Table 8, for example, the average values of the impact factor Fis for all 46 countries, and for groups of G8, SMARTcountries, and the former socialist countries are presented. We see that the influence of the information society on sustainable development is the most essential for G8. For SMART countries this influence is somewhat weaker, while for the former socialist countries it is even less.

Table 8.

Groups of countries	Average Impact (%)	Correlation between Fis and Isd	Correlation between Corruption Perception and Isd
46 countries	9,711	KFI=0,87	0,916
G8	10,132	KFI=0,783	0,833
SMART countries	10,008	KFI=0,737	0,707
Post Sov. Countries	9,409	KFI=0,985	0,904

The correlation between the impact factor Fis and sustainable development index is the greatest for the former socialist countries. For G8 members and for SMART countries, it is lower. The former socialist countries, on the other hand, demonstrate the highest development rates of the information society despite their current low positions, unlike the G8 members and other SMART countries. Besides the character of the development of the information society in the former socialist countries mostly corresponds to the character of sustainable development.

The correlation of the corruption perception index and the index of sustainable development is presented in column 4 of Table 8, for comparison. We see that this correlation is the highest for the former socialist countries, at a lower level for G8, and at much lower for SMART countries, respectively.

CONCLUSIONS

1. A new sustainable development measuring system (metric) was worked out. This metric allows the obtaining of quantitative estimations of the sustainable development process depending on the groups of economic, ecological, and social indicators and datasets.
2. The impact of the information society on sustainable development was studied on the global and regional scale based on the sustainable development mathematical model.
3. This newly created tool allows development of recommendations regarding ways to improve the standards of life quality and safety in specific countries and regions of the world by the advance of the information society and competitive growth parameters.

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