

# METHODOLOGY OF SCENARIO DEVELOPMENT BASED ON UKRAINIAN BRANCH OF THE WDC INTERDISCIPLINARY DATA ON SUSTAINABLE DEVELOPMENT

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## ABSTRACT

*This article describes methodology of scenario construction for development of countries, regions, cities based on the sustainable development data, scenario approach, SWOT-analysis. Sustainable development data are the indexes and indicators values that include economical, ecological, socially-institutional development characteristics. These data are collected and made available by competent international organizations. They are accumulated and kept in warehouse of Ukrainian branch of the World Data Center (WDC) [1] with possibility of free and convenient access. While scenario developing SWOT-analysis and method of sustainable development gauging matrix – SDGM, that is described in [2], are used. The results of scenarios constructing for Ukraine's development on short-term, middle-term, long-term periods are given as an example of methods implementation.*

**Keywords:** *sustainable development, SWOT-analysis, scenario, indicator, index, strengths, weaknesses, opportunities, threats, peer group.*

## 1 INTRODUCTION

Nowadays mankind is faced with even greater number of problems caused by its activity. Climate changes (temperature rise on 3C comparing with preindustrial period), population growth, lack of drinking water, natural resources exhaustion, unequal profit distribution between the regions and numerous results of these and other factors [3]. All these mentioned problems badly influence and in the near future may put under the question mankind being. Emergency change of mankind development principles is required to avoid such outcome. Many countries have already realized this and accepted sustainable development concept. According to it future generations that will live on Earth need to have at least the same conditions for living. To make it possible current generation must care to establish sustainable orientation.

Task of construction for scenario development and choice of optimal from sustainable point of view became actual for the big number of countries. Actuality of this task increase because of necessity to solve the problem for Ukraine.

Method of scenario constructing will be described according to the plan:

1. Substantiation of the scenario approach and choice of methods for scenarios construction.
2. Preparation of initial data for scenarios construction.
3. Application of formal procedures of scenarios construction.
4. Application of methodology to Ukraine's development scenarios construction.

## 2 SUBSTANTIATION OF SCENARIO APPROACH AND SWOT-ANALYSIS METHOD FOR SCENARIOS CONSTRUCTION

The task that will be described here lays in scenario construction for development of countries, regions, cities. Scenario approach, SWOT-analysis, sustainable development data are the base for the work. Forth coming explanation of reasons for the elements to be chosen.

Its necessary to take into account and effect on many parameters in order to change the character of such complex systems as countries, regions, cities. Limited number of parameters, according to analysis held in [2], was chosen in this work for mentioned objects characterizing.

Scenario planning has been used for decades by large corporations and holdings, proving the successfulness of this approach (in particular, a vivid example is the oil-gas holding Shell [4]).

The scenario method consists in the organization of iteration research procedure of scenario construction of possible development of the system which is analyzed. It is a method of organization of interdisciplinary prognostic in which experts of various fields and different views regarding the considered problem take part. All procedures of the method are based on the combination of logical-heuristic analysis with formal methods of research, in particular, using mathematical models. The scenario approach allows avoid the “tunnel vision” – a very categorical view on the things happening in the world, which may lead to making unsuccessful decisions, though they seem reasonable at the moment they are taken.

The task of researchers taking part in the scenario preparation is the creation of the unified presentation of the object of analysis, regularities and possible ways of its development on the unified methodological and methodical basis.

Here, a **scenario** is understood as a hypothetical sequence of events which shows how under the known initial conditions the state of the investigated object may successively change.

One of the convenient methods for analysis and construction of scenarios is such a tool of strategic planning as SWOT-analysis [5]. In SWOT-analysis we define strong characteristics of an object – Strengths, weak characteristics – Weaknesses, opportunities of an object – Opportunities and threats for an object – Threats. The technology of SWOT-analysis was suggested by professor Albert Humphrey who carried out the first research based on SWOT-analysis at the Stanford University in 1960-1970s.

Afterwards the methods of SWOT-analysis have been developed and improved. Now SWOT-analysis is an important part of strategic planning and is used by large companies and holdings for construction of possible scenarios of their future development. SWOT-analysis is often used also for construction of scenarios of development of such complex systems as large megalopolises, regions and even countries [6].

The essence of SWOT-analysis consists in defining and comparing strong and weak characteristics of a system in regard to opportunities and threats of the environment. The analysis procedure defines whether the investigated object has strategic prospects and possibilities of their realization.

Proceeding from the introduced peculiarities of the scenario approach and SWOT-analysis we choose them as main tools for construction of scenarios development.

### 3 PREPARATION OF INITIAL DATA FOR SCENARIOS CONSTRUCTION

An important condition for carrying out the above indicated research is the preparation of objective and complete data on which the research will be based upon. In this study we suggest to use as the basis for formation of the country's characteristics the indicators of the sustainable development gauging matrix – SDGM [2]. In SDGM 63 indicators are used which quite fully embrace such areas of the state activities as economic, social-institutional and ecological. Taking these indicators as the basis and using the inverse analysis procedure of SDGM [2], we get the space of strong and weak indicators for object of analysis. To define opportunities and threats it is suggested to use the method of expert estimation [7] by involving experts and organizing their work in several stages.

On the base of SDGM indicators system of critical indicators will be formed to examine object. The system of critical indicator is a set of indicators that will reflect weak and strong sides of the object. To determine them Peer group will be formed, where will be included similar objects from the point of research aim (for countries – countries, for cities – cities). Peer group may consist of neighboring countries or leading countries on the specific directions.

As a peer group to define system of critical parameters in Ukraine Russian Federation, the country's biggest neighbor, postsoviet country, member of CEA, was chosen.

To divide SDGM indicators into strengths and weaknesses relative deviations of their values from values for Peer group were calculated according to the formula:

$$D = \frac{P(U) - P(\text{PeerGroup})}{P(\text{PeerGroup})} \times 100\%, \quad (\%)$$

where  $D$  is relative deviation of the value from the parameter,  $P(U)$ – value of SDGM indicator for object,  $P(\text{PeerGroup})$ – values of the same parameter of the peer group.

Those indicators the relative deviation of which was then 10% were ascribed to strengths and those whose comparative deviation was less than 10% - to weaknesses and those comparative deviation of which was in 10% range – to neutral characteristics.

According to the procedure described above internal characteristics of the object, Strengths and Weaknesses, are required to SWOT-analysis.

For the analysis of the outer environment of the state and for indicating the opportunities and threats experts were involved. Their work was performed according to the method of expert estimation [7] according to aims and resources of research.

## 4 APPLICATION OF THE FORMAL PROCEDURE IN SCENARIOS CONSTRUCTION

The next stage of the method is to apply the formal procedure of scenarios construction. It will be describe in this part.

On the previous stages we have found out four components of SWOT-analysis: strengths, weaknesses, opportunities and treats. The strengths will be denoted as  $S_t, t \in N$ , weaknesses as  $W_j, j \in N$ , opportunities as  $O_k, k \in N$ , treats as  $T_l, l \in N$ . Further we shall compare these four components. The comparison is held according to the following four submatrices:

<b>Submatrix ST</b> Strengths that could make up for threats	<b>Submatrix SO</b> Strengths that make the following opportunities real
<b>Submatrix WT</b> Weaknesses that could increase the following threats	<b>Submatrix WO</b> Weaknesses that lessen the following opportunities

The results of such comparison may be presented as a table 1.

**Table 1.** Matrix for comparing of SWOT-analysis components

	T1				Tl		Tn	O1			Ok		Om
S1													
Si													
Sr													
W1													
Wj													
Wp													

In the table 1 cells that correspond to intersection are marked with the color:

- I strength of the object and treat that may be partly compensated by the strong side;
- I weakness of the object and treat that may be partly increased by the weak side;
- I strength of the object and opportunity that becomes more probable because of the strong side;
- I weakness of the object and opportunity that becomes less probable because of the weak side.

Thus we define which strong and weak sides may influence realization of relevant treats and opportunities. On the next stage will define quantity of relevant strong and weak characteristics. The results of such comparison may be presented as a table 2.

**Table 2.** Quantity of the corresponding strengths and weaknesses having influence on implementation of each opportunity or threat (data for Ukraine on short-term period).

Number of threat/ opportunity	T1	T2	T3	T4	T5	T6	T7	T8	T9	O1	O2	O3	O4	O5	O6	O7	O8
Quantity of strengths	0	0	0	4	1	1	1	2	4	3	2	2	2	0	3	0	2
Quantity of weaknesses	3	6	4	7	5	3	3	4	8	3	3	4	4	3	6	3	2
<i>D</i>	-3	-6	-4	-3	-4	-2	-2	-2	-4	0	-1	-2	-2	-3	-3	-3	0

Where *D* – influence factor (difference between the quantity of strengths and weaknesses for each opportunity and threat).

We will calculate for each weak and strength the number of threats and opportunities which they influence to find out which of weaknesses are most dangerous from the point of view of weakening the greatest number of opportunities and strengthening the greatest number of threats, and which of strengths are most promising (in the same sense). The results of this stage may be presented in the tables 3,4.

**Table 3.** Quantity of threats and opportunities influenced by each of strengths (data for Ukraine on short-term period).

Strengths	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
Quantity of threats that may be lessened by strengths	1	0	0	0	4	1	0	1	2	2
Quantity of opportunities, that may be promoted by strengths	0	2	2	2	0	2	1	2	2	1
<i>F</i>	1	2	2	2	4	3	1	3	4	3

Where *F* – is the influence factor (sum of the threats and opportunities influenced by strengths).

**Table 4.** Quantity of threats and opportunities influenced by each of weakness (data for Ukraine on short-term period).

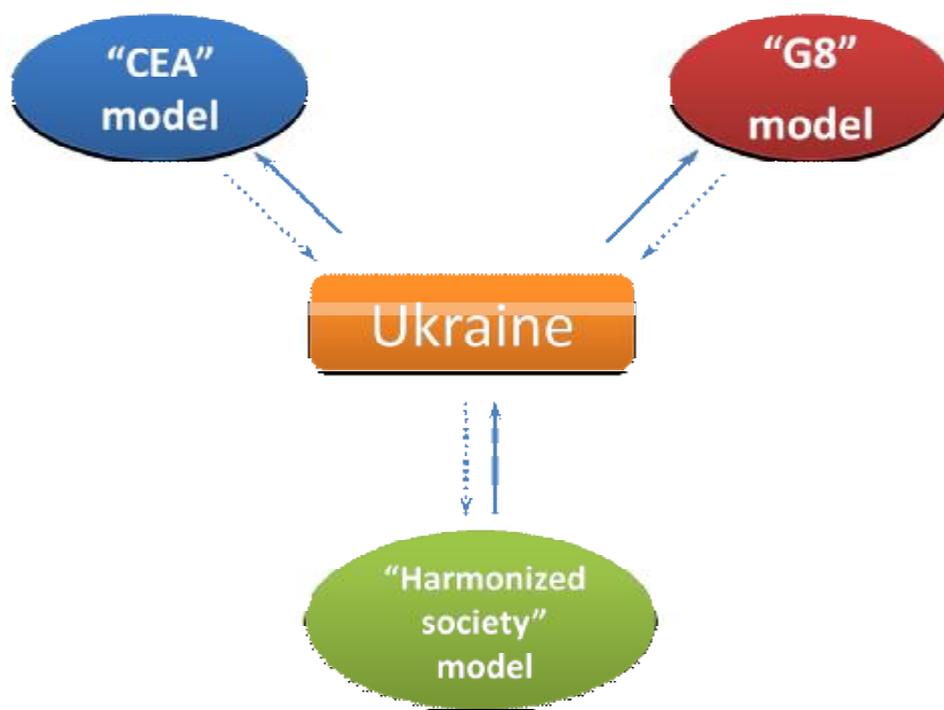
Weaknesses	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15	W16	W17	W18	W19
Quantity of threats increased by weaknesses	0	1	1	2	4	0	2	5	4	1	1	2	4	2	3	0	5	2	2
Quantity of opportunities lessened by weaknesses	1	0	0	0	0	0	1	0	0	0	1	1	5	1	4	1	6	5	2
<i>G</i>	1	1	1	2	4	0	3	5	4	1	2	3	9	3	7	1	11	7	4

Where *G* - influence factor (sum of threats and opportunities that are influenced by corresponding weaknesses).

We define the most promising opportunities and the most dangerous threats, the most important strengths and weaknesses by analysis of the built tables.

## 5 RESULTS OF DEVELOPED METHODOLOGY IMPLEMENTATION FOR UKRAINE'S DEVELOPMENT SCENARIOS CONSTRUCTION

In this part the results of developed methodology implementation for Ukraine's development scenario construction are described. Nowadays Ukraine is in the condition of internal chaotic struggle. The country has not determined yet with strategy of its development. It would be reasonable to use the experience accumulated by human society and examine existing model of countries' development to define the direction for Ukraine's future development. In the present world some models of development are operating, among them “G 8” model, the model of “common economic area” (“CEA” model), characteristic for Russia and some countries of Eurasia and “Harmonized society” model, characteristic of the Scandinavian countries, Switzerland, Iceland, etc. (Fig.1). However, Ukraine has not yet decided the main question: - which model should be chosen?



**Figure 1.** Possible model of Ukraine's development

It is clear that “G8” is operating in the countries' club formed during the time of “Cold war”. These countries have their unique achievements and features and Ukraine could hardly duplicate and repeat them. That is why this model is not real for it. Since in the model “common economic area” the main factors of cooperation are power resources, this model can be successfully used in such countries as Russia, Kazakhstan, Azerbaijan, Turkmenistan. Ukraine, having no powerful energetic resources, will not be a successful player in the framework of this model.

Therefore, the model of “Harmonized society” seems most promising for Ukraine, since applying it the country could to the greatest extent take advantage of its main assets – high quality human capital.

Thus, we will define “Harmonized society” model as strategical direction of Ukraine's development. According to this, using developed methodology, three scenarios were developed on three time intervals:

- I short-term (before 2010);
- I medium-term (2010-2020);
- I long-term (2020-2050).

We will describe the results for each time interval.

### 5.1 Scenario the «Old politicians» for the short-term time period (2010).

Having built SWOT-tables for this period the following results of threats have been achieved (below indicated only the most dangerous ones):

- 1) Threat T2 presenting the imbalance between the biological capacity and human needs is one of most serious for the country, since simultaneously 6 weaknesses make it most probable and there not a single strength which could interfere with its realization (influence factor  $D = -6$  ).
- 2) Threat T3 – disorientation in a geopolitical situation, T5 – low level of struggle against criminality, T9 – increasing inequality between the different strata of population of country, take the second position as to the probability of their realization. For T3 there are no strengths which could impede it, at the same time for T9 there are 8 weaknesses making dangerous and 4 strengths which could interfere with this threat (influence factor  $D = -4$  ).
- 3) For T1 – the threat of energy security of Ukraine, there are 3 weaknesses making it dangerous for the country and there is not a single strength which could diminish it (influence factor  $D = -3$  ).

- 4) For T4 – worsening of the demographic situation there are 4 corresponding strengths and 7 weaknesses. This threat may become quite dangerous, if the existing strengths are not sufficient in totality to compensate this threat, taking into account 7 weaknesses that intensify it (influence factor  $D = -3$  ).

*Similarly we will analyse opportunities for Ukraine:*

- 1) For opportunities O1 – adaptation of country to the terms of WTO and O8 – to receive the associated membership in the Seventh scope program of EU to 2010 year, there is equal number of strengths and weaknesses influencing their realization. Thus, these opportunities, if strengths are efficiently used, are fully realistic for the country and could be used with the probability of 50% (influence factor  $D = 0$  ).
- 2) For the opportunity O2 – preservation of the main state institutions for the future there are 2 strengths positively influencing its realization and 3 weaknesses which may impeded it. This opportunity is also probable for Ukraine (influence factor  $D = -1$  ).
- 3) For opportunities O3 – saving of transporting and transit networks and O4 – to take middle and upper middle harvest of agriculture products there are 2 strengths and 4 weaknesses. Taking into account their accumulative impact, many difficulties must be overcome to realize opportunities O3 and O4 (influence factor  $D = -1$  ).

The strengths which make the greatest influence on threats and opportunities are:

- 1) Strengths S5 – high percentage of the country has access to improved sanitary conditions and S9 - high adult literacy rate and general educational rate are the most valuable, since each of them in totality influences the greatest number of opportunities and threats (influence factor  $F = 4$  ).
- 2) Each of strengths S6 – profitable geographic position and S10 – Ukraine has relatively mild climate influence 3 factors of external environment and is very useful for the country (influence factor  $F = 3$  ).
- 3) Strengths S2 – tariff and non-tariff barriers on the way to access to market of Ukraine are small and insignificant, S3 – transparency of bank and financial system and S4 – well developed infrastructure influence 2 factors of external environment (influence factor  $F = 2$  ).

*Let us define most and least dangerous weaknesses:*

- 1) Weaknesses W17 – significant political instability in the country, W13 – macroeconomic stability and W15 – high rate of the inflation influence accordingly 11, 9 and 7 factors of external environment, respectively, creating obstacles for realization of opportunities and intensifying the probability of threats realization. These weaknesses must be overcome first of all, since they make the country susceptible to threats to the most extent (influence factors are  $G = 11, G = 9 \text{ u } G = 7$  , respectively).
- 2) Weaknesses W5 – high cost of living, W8 – low quality and lack of drinking water, W19 – lack of consolidation of political powers in society around national aims and priorities, preference of group and party interests of political elite) are next in regard of their danger for the country from point of view of realization of its opportunities and its vulnerability. These weaknesses influence 4 or 5 factors of external environment (influence factors are  $G = 4, G = 5 \text{ u } G = 4$  , respectively).
- 3) Weaknesses W4 – high rate of the emissions (for electricity generated and emissions per capita), W7 – low GDP per capita (PPP US\$), W12 – insufficient labor freedom, W14 – irrigation Stress influence 2-3 factors of external environment (influence factors are  $G = 2, G = 3, G = 3 \text{ u } G = 3$  , respectively).

## **5.2 “New generation” scenario for the medium term time period (2010—2020)**

The results for time interval 2010-2020.

Threats:

- 1) Threat T9 - deterioration of demographic situation is most dangerous. The susceptibility to it intensifies simultaneously seven weaknesses (the influence factor  $F = -4$  ).
- 2) For each of threats T1 - energy crisis increase, T2 - worsening of ecological situation, T10 – lack of drinking water and deterioration of its quality there are three weaknesses intensifying the susceptibility of the country to them and there is not a single strengths to impede them (influence factor  $F = -3$  ).

Analyzing the opportunities, we get:

- 1) For opportunity O1 – breakthroughs on the international level are the greatest number of strengths promoting it and make realizable. The number of weaknesses impeding this opportunity also is rather high. However the total influence of strengths compensate the influence of weaknesses (influence factor  $F = 1$  ).
- 2) For opportunity O2 – breakthroughs in agriculture, O3 – expansion of export in electric power supplies, O4 – breakthroughs on IT markets, O5 – development of tourism, the difference between the number of strengths having positive impact and weaknesses with negative impact equals minus two (the influence factor  $F = -2$  ). A number of difficulties must be overcome to realize these opportunities. However there are strengths promoting their realization.
- 3) The greatest number of obstacles exist for opportunity O6 – development of transit potential (influence factor  $F = -5$  ). Taking into account that it is one of the important opportunities for Ukraine, but there are also the greatest number of obstacles on the way to its realization, the country must mobilize great effort.

For strengths we get:

- 1) On the medium-term time period the Most valuable will be the following strengths: S6 – advantageous geographical position and S9 – high level of adult population erudition and high general education level (influence factors are  $F = 5$  and  $F = 7$  , respectively).
- 2) Strengths S4 – well developed infrastructure, S5 – high percentage of the country population has access to improved sanitary conditions, S8 – high percentage of the population has high education, S10 – comfortable climate - will be very important, since each of them positively influences four factors of external environment (influence factor  $F = 4$  ).
- 3) strengths S1 – well developed citizens' political rights and freedom, S2 – insignificant tariff and non-tariff barriers impeding access to the market of Ukraine, S3 – transparency of bank and financial systems, S7 – high percentage of chernozem - each influencing one factor of external environment and is of somewhat less, but still considerable importance for the medium-term time period (influence factor  $F = 1$  ).

Regarding weaknesses we get:

- 1) The weaknesses which are to be diminished first of all, since they influence the greatest number of external factors are W17 – internal political instability and W13 – macroeconomic instability (influence factors  $G = 12$  and  $G = 14$  , respectively).
- 2) The next in regard to their danger and negative impact are such weaknesses as W5 - high cost of living, W9 – low quality and lack of drinking water, W11 – limited business freedom, W16 - low quality of infrastructure. Each of them influences 5-6 threats and opportunities (influence factors  $G = 6, G = 5, G = 5, G = 5$  , respectively).
- 3) Weaknesses W4 - high level of greenhouse gases emissions, W8 – high level of corruption, W12 – limited labor freedom, each of them influences four factors of external environment and are also quite dangerous and the problems connected with them should be solved as soon as possible (influence factors  $G = 4, G = 4, G = 4$  , respectively).

### 5.3 “Fast development” scenario for the long-term time period (2020-2050)

On long-term time period (2020-2050) “Fast development” scenario was constructed. The number of possibilities for long-term period increases due to the great number of possibilities which existed in previous periods. In connection with this only “optimistic” scenario for long-term period was built. This scenario may be realized in case of successful following the guidelines for previous periods. We will describe this scenario.

In the long-term prospect the strategic potential of Ukraine and high level of population's education will provide the chance to develop the human capital, which will become the basic advantage and main strong characteristic (“corner stone”) of the nation. If, as a priority, there will be an objective to bring up the competitive young generation of Ukrainian politicians, scientists and diplomats, Ukraine will have success in the first half of XXI century.

Properly planned strategic application of knowledge, development of science and technology will create a generation of Ukrainians who would be able lead the country to the advanced positions among the countries of the Central and Eastern Europe. Ukraine's relations with Russia, European Union and the United States of America will develop evenly and positively. To take advantage of these opportunities Ukraine should have a number of new strong characteristics.

In particular, preservation of high human potential and taking it to a qualitatively new level is very important. Among main objective should be the preservation and renewal of infrastructure, development of hi-tech production, investment in the development of hi-tech science, greater attention to the ecological indicators. At the same time intensive development of agriculture and going up to the leading positions in providing a considerable part of the world with foodstuff, as well as the development of qualitative social characteristics should become the guarantee of future and make real the realization of the “fast development” scenario.

## 6 CONCLUSION

The methodology of scenario construction for development of countries, regions, cities based on objective data (indexes and indicators of sustainable development), scenario approach, SWOT-analysis, experts methods was describe in this article. As a result of developed methodology implementation for Ukraine, the country's development scenarios on three time-periods (short-term – until 2010, middle-term – 2010-2020, long-term - 2020-2050) were built.

“Harmonized society” model was chose as strategical development direction. To achieve the positive trends in its development Ukraine should improve parameters of SDGM indicators, which were used as a base for this analysis. These parameters are objective characteristics of sustainable development of the country. Ukraine also should follow the guidelines for prevention the negative influence of weaknesses, conservation of strengths, realization of opportunities and prevent the most dangerous treats for development.

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