

Analysis of Relationships Among the Characterizing Factors of Regional Stable Development

Zurab GASITASHVILI*
Mzia KIKNADZE**
Zviad JANKHARASHVILI***

Abstract

The stable development of regional economics requires research and analysis based on the set of management scenarios. Implementation of the latter can be achieved by building stable development models. They will allow us to select the best scenarios taking into account the mentality of our country and implement forecast of region stable development.

The problems of building research and analysis models for the effective planning of region stable development based on situation self-development scenario and control impact on it is considered in the paper.

In weakly structured organizational systems the need of making decision in course of control process appears. Situation development laws and patterns are described in qualitative manner. In situations where dynamics of their development is not subject of any patterns experts and analytics take part. They use their own experience and intuition when making decisions.

Keywords: Region Stable Development, Goals Tree, Local Goal, Global Goal, Region Development Model

Introduction

The important stage of creation, development and implementation of organizational systems is pre-design analysis and modeling. Development of modern large-scale complex systems has stimulated keen interest to modeling methodology.

When analyzing complex organizational systems the set of goals and factors to be achieved by the system can be formulated.

Information technology for selection of optimal set of system goals and operation modes consists of the several phases:

Structuring system goal means that main or global goal of system operation is selected. This is assigned a zero level and the latter is their decomposed by sub-goals.[1]

The main goal (the global one) is the stable development of a region. This is denoted as C0 and it is assigned a zero level. Then (or on the first level) it is decomposed by sub-goals C1, C2, C3 and C4, the second level is decomposed by sub-goals (C11, C12, ..., C21, ..., C31 ...). The table 1 shows the actual factors of the region stable development – values of goals and their relevant sub-goals (parts):

Symbol	Meaning
C0	Region's sustainable development
C1	Social indicator
C11	Struggle against poverty (%)
C12	Demographic dynamics (%)
C13	Support of education, personnel preparation and society's awareness (%)
C14	Health protection of population (%)
C15	Support of population's sustainable development (%)
C111	Growth rate of population's employment (%)
C112	Ratio of average wage of men and women (%)
C113	Population living under poverty threshold (%)
C114	Ratio of incomes of rich and poor
C121	Population's growth rate (%)
C122	Population's migration rate (%)
C1211	Population's density (%)
C1221	Growth of birth rate (%)

* Prof. Dr., Faculty of Technical Science, Georgian Technical University, Tbilisi, Georgia.
E-mail: zur_gas@gtu.ge

** Prof. Dr., Faculty of Informatics and Control Systems, Georgian Technical University, Tbilisi, Georgia.
E-mail: mziakiknadze@gmail.com

*** Ph.D, Georgian Technical University, Tbilisi, Georgia.
E-mail: zviad_jan@gtu.ge

C131	Growth rate of school age population (%)
C132	Growth of quantity of graders (%)
C133	Growth of quantity of pupils of secondary school (%)
C134	Ratio of educated people among old (%)
C1341	Population with 5-class education (%)
C1342	Average quantity of school classes
C1321	Ratio of national income per capita (%)
C1331	Number of girls per 100 boys in secondary school
C1332	Number of women per 100 men in service field
C141	Ratio of population living without clean drinking water
C142	Ratio of population living without sewerage (%)
C143	Ratio of population living in environment with contaminated, hazardous air (%)
C144	Death rate per 1000 newborns (%)
C1441	Population's average life expectancy
C145	Death rate of mothers per 1000 newborns
C1411	Ratio of expenses on health protection (%)
C1412	Ratio of population without access to primary health care (%)
C1413	Ratio of population without access to immunization against different diseases (%)
C151	Growth rate of urban population (%)
C1511	Ratio of urban population per national income (%)
C15111	Expenses on building of cheap housing (%)
C15112	Expenses on public transport (%)
C1512	Infrastructural expenses per capita (%)
C1512	Marginal population and area (m2/quantity)
C1513	Ratio of residential area per capita (m2)
C1514	Entrepreneurship (%)
C1515	Export ratio (%)
C152	Fuel consumption per capita (%)
C153	Ratio of urban population (%)
C154	Ratio of rural population (%)
C1513	Ratio of deceased because of different natural disasters (%)
C2	Economic Indicator
C21	Economic development (%)
C211	Growth ratio of gross domestic product per capita (%)
C212	Export of goods and services (%)
C213	Import of goods and services (%)
C2131	Gross domestic product per capita
C2132	Adjusted gross domestic product per capita (%)
C2133	Export ratio of gross domestic product (%)
C2134	Investment ratio (%)
C22	Change of demands
C221	Ratio of shortening of natural resources (%)
C222	Energy consumption per capita
C23	Financial mechanisms and resources (%)
C231	Ratio of resource selling per gross domestic product (%)
C2311	External support for development (%)
C2312	Ratio of debts per domestic product (%)
C2313	Debt services (% according to debt)
C23131	Ratio of gross domestic product per environment protection (%)
C23132	Ecologic taxation and subsidies (%)

C23133	Additional financing for sustainable development (%)
C23134	Program of integration of ecological and economic reports (%)
C3	Ecological Indicator
C31	Water resources (%)
C32	Terrestrial resources (%)
C33	Other natural resources (%)
C34	Atmosphere
C35	Waste (ton per year)
C311	Protection of resources and quality of fresh water (%)
C3111	Annual water expenses (ton)
C31111	Reserves of ground waters (m2)
C31112	Concentration of excrements in reserves of fresh water (100ml)
C31113	Biochemical and chemical contamination of oxygen (%)

The Fig.2 depicts the tree for the above goals and sub-goals:

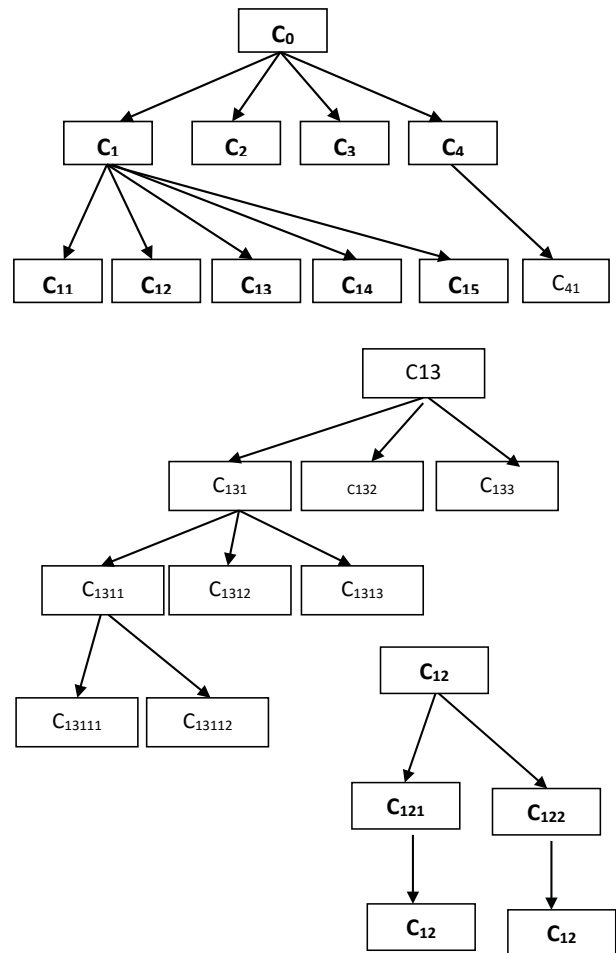


Figure 2. Goals and sub-goals tree.

Assigning weights to system goals. Ranking of goals occurs by evaluation of each of them through numerical values – their “weights”. Experts or expert group make this evaluation and assignment. This evaluation has subjective character. The goal is de-scribed by text sentences and can contain numerical indices. The method is known as hierarchical analysis method.

Interaction of goals to determine if how important is the goal (to introduce tree's nodes weights) is evaluated and in accordance with the expert evaluation points are introduced. The interaction strengths of goals C_i and C_j are evaluated by linguistic formulas and are expressed numerically in the interval [1-10].

For each fragment of the goal tree (starting from the zero one) a quadratic matrix $R=||r_{ij}||$ is created.

The matrix columns correspond to tree's nodes. In the upper entry of the he right column the weight of the root node (for the global goal C_0 the weight is $W_0 =1$) is given. At the intersection of the row C_i and column C_j the value r_{ij} is determined, this value is equal to 1 if $C_i =C_j$; if C_i is more important than C_j then b_{ij} is determined, otherwise - the value $1/ b_{ij}$.

Let us select a two-level fragments (from top to bottom) that consist of root node and all nodes that are incident to it. The fragment that contains the tree's root node is assigned the zero rank. The lower level's nodes of this fragment represent the root level for the first rank nodes.

The goal tree' s fragment (C_0,C_1,C_2,C_3,C_4) has the zero rank. The goal tree' s fragments ($C_1,C_{12},C_{13},C_{14},C_{15}$), (C_2,C_{21},C_{22},C_{23}), ($C_3,C_{31},C_{32},C_{33},C_{34}, C_{35}$), etc. have the first rank.

In the example under consideration the equation system relevant to zero fragment has the form (1):

$$\begin{aligned}
 w_1 &= \frac{1}{4}(w_1 + 3w_2 + 3w_3 + 3w_4) \\
 w_2 &= \frac{1}{4}\left(\frac{1}{3}w_1 + w_2 + 3w_3 + 3w_4\right) \\
 w_3 &= \frac{1}{4}\left(3w_1 + \frac{1}{3}w_2 + 3w_3 + 3w_4\right) \\
 w_4 &= 1 - (w_1 + w_2 + w_3 + w_4)
 \end{aligned}$$

As a result of solving this system we obtain the weights of goals C_1,C_2,C_3,C_4 .

Such kind of equation systems are formed for other fragments. By solving equations systems for the first rank fragment ($C_1,C_{12},C_{13},C_{14},C_{15}$), etc. the weights of goals $C_{11}, C_{12},C_{13},C_{14}, C_{15}$ is obtained.

$$\begin{aligned}
 W_{11} &= \frac{1}{5}(3W_{11} + 3W_{12} + 3W_{13} + 3W_{14}) \\
 W_{12} &= \frac{1}{5}\left(\frac{1}{3}W_{11} + 3W_{12} + 3W_{13} + 3W_{14}\right) \\
 W_{13} &= \frac{1}{5}\left(\frac{1}{3}W_{11} + W_{12} + W_{13} + 3W_{14}\right) \\
 W_{14} &= \frac{1}{5}\left(\frac{1}{3}W_{11} + \frac{1}{3}W_{12} + \frac{1}{3}W_{13} + W_{14}\right) \\
 W_{15} &= 1 - (W_{11} + W_{12} + W_{13} + W_{14})
 \end{aligned}$$

Minimization of system local goals. Since the amount of simple goals and factors can be very large, it is necessary to carry out numerical evaluation and ranking of the most important goals and factors in order to select the most effective goals and factors. To build the cognitive map of local goals interdependency the fact that the table's rows and columns correspond to local goals. As a result of analysis and agreement with experts the cognitive map, which has the form for given fragments, was obtained (fig.3). The numerical indices – reachability degrees of global (C_0) and local (C_j) goals – were introduced. They have the following form for the above-considered zero rank tree's fragments (2):

$$\begin{aligned}
 (2) \quad J(C_0) &= \sum_{j=1}^N (\alpha_{11} + \alpha_{12} + \alpha_{13} + \alpha_{14}) \cdot W_j \\
 &= (\alpha_{11} + \alpha_{12} + \alpha_{13} + \alpha_{14}) \cdot W_1 + (\alpha_{11} + \alpha_{12} + \alpha_{13} + \alpha_{14}) \cdot W_2 + (\alpha_{11} + \alpha_{12} + \alpha_{13} + \alpha_{14}) \cdot W_3 + (\alpha_{11} + \alpha_{12} + \alpha_{13} + \alpha_{14}) \cdot W_4 = 3,5101
 \end{aligned}$$

Goals	C_1	C_2	C_3	C_4	C_{11}	C_{12}	C_{13}	C_{14}	C_{15}	C_{21}	C_{22}	Weights
C_1	+1.				+0.	-0,7	+0.	+0.	+0.			0.5000
C_2		+1.								+0.	0	0.2778
C_3			+1.									0.1543
C_4				+1.	0	0	0	0	0			0.0679
C_{11}	-0,5	0	0	0	+1.	0	0	0	0			0.2143
C_{12}	+0.	0	0	0		+1.						0.1327
C_{13}	+0.	0	0	0	0	0	+1.					0.0821
C_{14}	+0.	0	0	0	0			+1.				0.0508
C_{15}	+0.				0	0	0	0	+1.			0.0201

Figure 3. The fragment of the cognitive map.

The computations gave the result: $J(C_0) = 3.501$.

The reachability degree for the subsets of foals (taken into account their interdependency) is expressed by the formula:

$$J(C^*) = J(c_{ji}) + \dots + J(c_{jk})$$

$J(C^*)$ is the maximum acceptable reachability degree and is denoted as Δ . In the considered case its value is 0.2101.

Let us form the minimization problem: $C^* C$ must be found so that the following conditions would be fulfilled simultaneously:

$$(3) \quad J(C^*) \leq \Delta$$

$$|C^*| = \max$$

The result of minimization for the local goals is $E=\{b_1, b_2,b_3, b_4,b_5,b_6, b_7, b_8\}$.

References

Luditsky, S. A., & Vladislavlev, P. N. (2005). Foundations of pre-project analysis of organizational systems. Finance and Statistics,

Vladislavlev, P. N. (2005). Choice of an optimal scenario of organizational systems behavior"//Control of large-scale projects. Proceedings of the Institute of Control Problems of the Russian Academy of Sciences, edited by D.A. Novikov, Moscow.

Gubko, M. V. (2002). Games Theory in organizational systems control. Moscow, CYNTET.

Verulava, I., Verulava, D., Pranghishvili, A., Gasitashvili, Z. (2006). Cognitive approach to integrated study and modeling of the Georgian fuel and energy complex. Georgian Electronic Scientific Journal: Computer Science and Telecommunications, 1(8),

Larichev, O. I. (2000). Theory and methods of decision making, and as well as the chronicle of events in Magic Mountains. Moscow, Logos.

Kulnin, A. A. & Maksimov, V. I. (1998). The system of conceptual modeling of social and political situations. Compass, proceedings of Modern control technologies, pp.115-123

Baratashvili, E., & Macharadze, M. (2009).The concept of study of regional economy discipline. International reviewed scientific journal"Economy", Tbilisi.

Tcimitia, K., & Macharadze, M. (2009). Basic aspects of region stable development. International reviewed scientific journal "Economy", Tbilisi.

Khartishvili, M. P., & Macharadze, M. G. (2011). Modeling of social and political development of modern territorial formation. Georgian technical University, "Georgian Engineering news", #1.