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Working of the development strategies of municipalities on the basis of simulation modeling

The article deals with the urgent problems and approaches to modeling the development of territorial socio-economic systems. The authors suggest an approach to working out the integrated tools for modeling the development of territory and represent some results of its practical testing within the framework of development «Comprehensive Program of Socio-Economic Development of the city district of Ufa in 2011 – 2015».

Economic policy, simulation, strategy of development, scenario analysis.



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Managing the development of social and economic systems of macro-level requires that the decision maker has a clear vision of not only past and current states of the system, but also sound idea about how this system will develop in the future. Meanwhile, one should consider both internal processes inside the system itself and external factors leading to the change of its condition. Thus, the task of forecasting is one of the primary tasks in territorial management.

However as of today forecasting as a part of the overall management of territorial development in the Russian Federation is coupled with a number of difficulties. The reason for this is common unresolved issues and controversies in the management of meso-and macro-economic systems.

Among the most serious problems affecting the quality of decisions we should note the following:

1. Lack of coordination in purposes at different levels of government. The presence of several control loops at various levels, implementing the management of area (the federal government and regional government, local authorities) requires the coordination of their actions and the avoidance of duplication of functions [5]. There is also a lack of coordination in the purposes of long-term development and received short-term solutions. In most cases the decisions taken at the municipal level are situational in nature and are not correlated with the long-term development programs. This is largely due to the lack of adequate resources (budget deficit), and this fact limits the possibility of financing the projects aimed at development.

2. The functioning of the municipal system, a great number of economic players, the objectives of which are different from those of other agents and authorities of state and municipal government. In this regard, there is no single criterion of optimality of development.

3. The absence of systemic nature of economic policy. The person responsible for making certain decisions in the sphere of social and economic development cannot take into account the diversity of factors that influence the processes under study. The complexity of accounting for such factors is also in the fact that the influence of some of them may be hidden, indirect or consequential. In this regard, working out the management decisions are based on experience and intuition and does not have sufficient scientific evidence.

4. Poor quality of initial information about the functioning of the municipality. The problems of statistical registration and use of statistics and lack of information on certain issues often lead to inefficient decisions. In some cases the cause of it is the data garbling. At the same time there is no clear system of analysis and effective use of management information.

5. Openness of the system and significant impact of external influences on the economy of the municipality. At the same time there is an underestimated effect of various internal and external factors, forming the imbalances of development, and all this together with previous problems increases the likelihood of making poor quality decisions.

These problems are urgent for both the state and the municipal levels of government. However, it is the municipality level that shows the problems most clearly because of a number of features (relatively small space, proximity of governing bodies to people and economic entities, low autonomy). However, many problems of management of municipal development are interrelated and interdependent. In this regard, a comprehensive approach to remove them requires. One of the most promising directions in this area is the use of tools and techniques of modeling. This approach allows us to go to a pro-active management, during which there is an opportunity not to eliminate the negative consequences of deviations but to prevent their occurrence.

As of today the theory and practice of economic and mathematical modeling use a number of fundamentally different approaches to modeling of social and economic systems. In particular, it may be a class of models based on the principles of economic equilibrium. The most common representatives of this class are various inter-industry models which are the modification of the classical "input – output" model by V. Leontiev. This class may include Wharton's annual model of the U.S. economy, Brooking model, the LIFT model, a model of fiscal policy the United States. In Russia this approach is realized within the framework of working out the projects SIREN, RIM. Another directions of the development of this approach are the CGE-models (RUSEC, CGE with built-in neural networks, Russia: Centre - Federal District), as well as the models of supply and demand [1].

The second large class of models of development of the territory is based on finding probabilistic and statistical regularities. In particular, this approach is represented by econometric models (Wharton model, Brooking model, Project LINK, R. Fera quarterly model, etc.). In the Russian practice the most famous member of this class of models is “Econometric Model of the Russian economy” developed in Central Economic and Mathematical Institute of RAS under the leadership of PhD in Economics S.A. Ayyazyan [1]. This class of models can be used under sufficiently long observation of the object relatively constant in its development [4]. The models are used most often to build short-term macroeconomic forecasts and scenario analysis.

The third approach is simulation modeling based on the construction of various models such as recurrent models and / or models of systematic economic dynamics and using the sequence of calculations they enable to reproduce the trajectory of “evolution” of socio-economic system with the specified parameters under various factors of effect and changes in the conditions of internal and external environment [2]. On the basis of the models of this class the information-analytical complex Prognoz (Perm State University), territorial automated system TAIS (Samara State Academy of Economics) have been implemented.

The fourth group includes the models based on the use of various intellectual information technologies, including incorporation of neural network modeling techniques into the structure of the model, of expert systems with knowledge bases, the apparatus of fuzzy logic and the “soft computing”.

The expert systems are successfully used in the study of poorly formalized systems and processes, but they require substantial efforts and expenses to create knowledge base, which also makes them hardly applicable in the situations that are unknown to the experts making up the knowledge base.

Many models used in practice combine the elements of different classes and therefore it is impossible to assign them to one group. However, the practice of using data models and information systems shows that despite the wide functionality they also have important drawbacks that prevent obtaining high-quality forecasts.

In order to develop the researches in this area we offer a vision of building an integrated economic-mathematical model of the municipality, within the framework of the single computing diagram this vision is based on the integration of systematic and functional relationships of the elements of socio-economic system, algorithms of scenario modeling and a lot of finite indicators to carry out a comprehensive modeling and system presentation of the results of socio-economic development of the municipality.

The construction of the model was carried out in accordance with the following algorithm:

1. Building an information-logical model based on the existing economic relations between the elements of the system and forming a set of indicators for the further design of the model. At this stage the boundaries of the model are defined too.
2. Based on the formed set of indicators one collects baseline data for the formalization of the identified logical relationships and dependencies;
3. Formalizing the relationships and constructing a mathematical model (the stage supposes the use of a wide range of methods).
4. Defining the boundaries and the degree of change in the scenario parameters used in the model under different conditions defined by the development of the situation.
5. Checking the adequacy of the resulting model by analyzing the basic statistical criteria, as well as by validating and verification of the obtained results.
6. Construction of the system of final indicators to assess the effectiveness of the economic system.

7. Software implementation of the model.

8. Conducting experiments on the base of the model aimed at obtaining new knowledge about the functioning and development of the economic system and getting predictions.

Based on the proposed concept there was developed a model of economic system of the municipality, it allows conducting the experiments on modeling and quantitative evaluating the consequences of implication of different strategies for socio-economic development. The basis of the functioning of the model is the relationship between the three main economic agents – “Households”, “Producers” and “State”. Interacting in the markets of resources (material, financial, labor, etc.), these agents form the economic system.

Wielding economic resources (first of all, labor), the households (individuals and their families) as agents of proposal are their salespeople. Thereby, obtaining cash income for consumer goods and services, they become an agent of demand. The main purpose of their activities is to increase real incomes.

The economic agent “Producers” reflects the activity of economic entities. Purchasing the necessary resources, the company acts as a “consumer” (the agent of demand). Transforming the resources into the work-in-process first and then into the finished products during the production process, the agent plays the role of “producer”. By passing the finished product to the sphere of circulation, it becomes a “resource provider” and the agent of proposal.

The economic agent “State” is a system of institutions of state and municipal authorities. Its main function is to ensure the social needs. At the same time he actively interferes in the economy, using various forms and methods (including fiscal policy).

The development of economic-and-mathematical model and further simulation are implemented on the basis of reporting statistics on the results of socio-economic development of the city of Ufa in the period 2000 – 2010.

External and scenarios conditions in the simulation process are accepted by the relevant general macroeconomic conditions of development in the medium-term outlook of the Republic of Bashkortostan and the Russian Federation. In this case three strategies have been identified.

Basic strategy in general implies the preservation of the existing medium-term trends of development for the main socio-economic indicators. The scenario and control parameters of this strategy form a “moderate” intensity of investment and fiscal policy. The calculations contain the pace of development of investment in fixed capital (at the level of 2010 with regard to the effects of the 2008 – 2009 financial crisis), wage increases and the dynamics of budget expenditures.

The main results of the basic strategy for the period up to 2015 in the context of the considered indicators are presented in *table 1* (in the prices of relevant years).

The analysis of implications of this strategy shows that in general for the period up to 2015 the significant changes in the dynamics and the proportions of social and economic indicators are not observed. At the same time a positive dynamics of growth is planned by some certain indicators. The increase in value of fixed production assets and in the number of population employed in the economy provides nominal growth of products shipped - over the period 2010 – 2015 by 1.26 times.

By some socially relevant indicators (including the value of cash income) a decrease in the positive dynamics is predicted. In the structure of population’s income a slight increase in the share of income received as social transfers (from 13.9% in 2010 to 14.7% in 2015) is expected.

During the implementation of this strategy we also expect gradually decline in the share of expenditure on the purchase of goods and services from 87.3% to 85.7%. A share of compulsory payments and voluntary contributions will increase approximately by 2.2% (up to 10.0%).

Table 1. Forecast of the main indicators of socio-economic development of the city of Ufa for the period from 2010 to 2015 (option 1 – Basic Development Strategy)

No	Indicators	2010	2011	2012	2013	2014	2015
1	The volume of shipped products, mln.	485086.0	512659.0	544006.0	568704.0	584111.0	609008.0
2	Fixed capital investment, mln.	51650.0	53920.0	57750.0	62950.0	67990.0	72270.0
3	Labour productivity, thousand rubles / person	1000.18	1052.69	1114.77	1162.99	1192.06	1240.34
4	The average annual number of permanent residents, thousands of people	1040.0	1041.0	1041.4	1041.7	1041.9	1042.0
5	The average number of employed, thous.	485.0	487.0	488.0	489.0	490.0	491.0
6	The growth rate of average monthly wages,% to previous year	102.3	103.0	105.0	107.0	110.0	112.0
7	Money income per capita, rubles per month*	19034.0	20152.0	21230.0	22956.0	24604.0	25342.0
8	Cash disbursements per capita, rubles per month	29862.0	31377.0	32789.0	34626.0	36703.0	38905.0
9	Housing provision per capita, sq.m	21.0	21.3	21.6	21.9	22.6	23.3
10	Birthrate per thousand people	13.4	13.3	13.2	13.0	12.9	12.7
11	Tax and nontax budget incomes, Ufa, mln. rubles	8209.0	9203.0	9479.0	9763.0	9863.0	9961.0
12	Budget expenditures in Ufa**, mln. rubles, including:						
	State issues, mln. rubles	1052.8	1114.9	1179.6	1244.8	1307.4	1368.2
	National economy, mln. rubles	888.4	524.1	537.7	567.5	596.0	623.7
	Education, mln. rubles	4823.2	2845.3	2873.7	2902.5	2965.0	3102.7
	Health care, physical training and sport, mln. rubles	2610.3	1539.9	1580.1	1667.4	1751.3	1832.6
	Social policy, mln. rubles	397.3	441.8	490.8	541.1	596.5	657.7
13	Average monthly wage, rubles	20022.0	20539.0	21521.0	23028.0	25331.0	28370.0

* For the main sources of income (wages, income from entrepreneurial activity, property income, social transfers) averaging by the republic about 70% of all cash income of the population. The so-called «Other income» used in official statistics as a balancing item include income hidden or minimized in order to evade taxation, and therefore they can be calculated only indirectly. In this connection the article doesn't consider them.

** Expenses excluding the inter-budgetary transfers (except the year of 2010).

The structure of own revenue budget of Ufa is characterized by a slight increase in the share of tax revenues that will continue to be formed mainly by a tax on personal income – nearly by 86.0%. The structure of budget expenditures in Ufa is a controlled parameter and it depends on the specific tasks solved at a certain stage of socio-economic development. The basic strategy involves the preservation of existing ratios, small variations in the structure, which during the period (in most cases) do not exceed 0.5%. The results of calculations also showed that in 2011 – 2015 under the implementation of the baseline scenario we expect reducing the budget deficit of the city of Ufa. By other indicators the predicted growth is largely nominal and in real terms it is not considerable.

Within the framework of **socially-oriented strategy** the priority direction is directing resources for social development, concentration of efforts on the solution of significant issues for the city's population.

The scenario and control parameters within the framework of this strategy form a “moderate” intensity of investment policy under “high” intensity of social policy and fiscal policy in terms of budget expenditures by categories “Health”, “Education”, “Social Policy”. The main results of the community-oriented strategy are given in *table 2*. The analysis and evaluation of the results of this strategy show that for the period up to 2015 some parameters will be changed in comparison with the basic strategy of economic development.

Table 2. Forecast of the main indicators of socio-economic development of the city of Ufa for the period from 2010 to 2015 (option 2 – Socially-oriented Development Strategy)

№	Indicators	2010	2011	2012	2013	2014	2015
1	The volume of shipped products, mln.	485086.0	511160.0	538042.0	561528.0	585511.0	609996.0
2	Fixed capital investment, mln.	51650.0	52750.0	55200.0	58860.0	63300.0	64900.0
3	Labour productivity, thousand rubles / person	1000.18	1045.53	1097.60	1143.18	1190.06	1238.32
4	The average annual number of permanent residents, thousands of people	1040.0	1041.9	1042.2	1042.9	1043.1	1043.4
5	The average number of employed, thous.	485.0	488.9	490.2	491.2	492.0	492.6
6	The growth rate of average monthly wages,% to previous year	102.3	115.6	116.3	114.0	112.6	113.9
7	Money income per capita, rubles per month.	19034.0	25287.0	28355.0	31274.0	34125.0	37363.0
8	Cash disbursements per capita, rubles per month	29862.0	36167.0	39316.0	42100.0	44449.0	46948.0
9	Housing provision per capita, sq.m.	21.0	21.3	21.9	22.4	22.9	23.4
10	Birthrate per thousand people	13.4	13.6	13.6	13.8	13.9	14.2
11	Tax and nontax budget incomes, Ufa, mln. rubles	8209.0	9437.0	9922.0	10602.0	11150.0	11852.0
12	Budget expenditures in Ufa, mln. rubles, including:						
	State issues, mln. rubles	1052.8	772.8	837.9	907.5	978.0	1059.0
	National economy, mln. rubles	888.4	539.2	572.5	625.9	680.5	745.1
	Education, mln. rubles	4823.2	3068.2	2966.8	3449.0	4013.6	4669.4
	Health care, physical training and sport, mln. rubles	2610.3	1498.2	1669.7	1921.7	2203.8	2518.9
	Social policy, mln. rubles	397.3	252.9	369.4	525.3	737.6	1081.8
13	Average monthly wage, rubles	20022.0	23145.0	26918.0	30686.0	34553.0	39356.0

Welfare and life quality indicators will increase – the average increase in wages for the period of 2010 – 2015 makes up 14.5%, cash incomes of the population will increase by 1.3 times respectively in real terms, the overall growth of the budget provision – by 1.4 times. The growth rate of labor productivity is inferior to the growth rate of remuneration of labor and makes up 4.4%. The implementation of this strategy is less conducive to the development of small and medium-sized businesses in the short term. In the structure of population's income the share of wage increases from 43.7% to 50.3% and the share of income from entrepreneurial activity decreased from 25.9% to 18.6%. The trend of decline in consumers' expenditure to 64.0% and the trend of growth of the savings to 27.0% by 2015 intensify. The structure of municipal budget income won't expect significant changes compared with the basic option.

As to the budget spending, the share of expenditures for education increases by 6.0%,

for health, physical culture and sports – by 3.0%. By the indicators of production and economic activity the most indicators keep the growth dynamics at the level of the basic (inertial) development strategy.

An innovation-oriented strategy supposes a priority direction of financial and material resources into the real economy, in the sphere of production. The implementation of this strategy will require attracting significant investment resources at the expense of all sources of funding.

The scenario and control parameters within the framework of this strategy form a “moderate” intensity of social policy when stirring up the investment policy and fiscal policy in terms of budget expenditure in the part “National Economy”. When calculating the rate of increase in wage one sets averaged indices over the previous years, when calculating the rate of increase in investments in fixed capital and the dynamics of budget

expenditures for the national economy one sets the range between average and maximum increase of index over the preceding period. The main results of the innovation-oriented development strategy of Ufa for the period up to 2015 are given in *table 3*.

The analysis and evaluation of this strategy show that for the period up to 2015 some parameters of development of Ufa will change as compared with both the basic strategy and the socially-oriented strategy. Compared with the basic strategy when increasing the volume of investment in fixed capital during the period 2010-2015, the respective increase in the volume of shipped products will increase by no more than 1.57 times. The quality of life is predicted to be improved relatively – the increase in population's cash incomes from 1.18 to 1.55 times, the increase in the birth rate to 14.1 people per 10 thousand people.

At the same time the level of fiscal capacity is expected to increase – from 1.2 to 1.3 times in nominal terms.

The advantage of innovation-oriented strategy compared with the socio-oriented development strategy is outstripping dynamics of production and economic activity. Meanwhile by the indicators of social nature a slight decrease of positive dynamics is predicted (population's cash income – from 1.73 to 1.55 times, the average rate of wage increases – from 12.2% to 6.5%). In the structure of population incomes the trend of growth in the share of income from entrepreneurial activity (to 28.8% by 2015) while reducing the share of wages to 39.4%. The tendencies of reduce in consumption expenditure to 77.3% and the growth of the savings rate to 12.8% by 2015 will intensify. Similar changes in the structure of expenditures are due to the degree of cash incomes growth which leads to reduction in the share of expenditure for purchasing goods and services.

The implementation of innovation-oriented strategy will increase the tax and nontax budget incomes up to 10582.0 million rubles by 2015.

Table 3. Forecast of the main indicators of socio-economic development of the city of Ufa for the period from 2010 to 2015 (option 3 – Innovation-oriented Development Strategy)

No	Indicators	2010	2011	2012	2013	2014	2015
1	The volume of shipped products, mln.	485086.0	522632.0	579235.0	644900.0	685204.0	762030.0
2	Fixed capital investment, mln.	51650.0	54630.0	58455.0	68570.0	73380.0	83950.0
3	Labour productivity, thousand rubles / person	1000.18	1069.00	1181.63	1312.91	1392.69	1546.95
4	The average annual number of permanent residents, thousands of people	1040.0	1041.8	1042.0	1042.7	1043.0	1043.3
5	The average number of employed, thous.	485.0	488.9	490.2	491.2	492.0	492.6
6	The growth rate of average monthly wages,% to previous year	102.3	108.6	108.6	106.9	106.4	106.1
7	Money income per capita, rubles per month	19034.0	24527.0	26754.0	28938.0	31200.0	33510.0
8	Cash disbursements per capita, rubles per month	29862.0	34971.0	36857.0	38644.0	40291.0	41700.0
9	Housing provision per capita, sq.m.	21.0	21.3	21.7	22.2	22.7	23.3
10	Birthrate per thousand people	13.4	13.5	13.5	13.7	13.9	14.1
11	Tax and nontax budget incomes, Ufa, mln. of rubles	8209.0	9232.0	9501.0	9979.0	10356.0	10782.0
12	Budget expenditures in Ufa, mln. rubles, including:						
	State issues, mln. rubles	1052.8	759.1	809.1	864.5	922.9	984.6
	National economy, mln. rubles	888.4	540.8	654.2	802.1	997.1	1235.2
	Education, mln. rubles	4823.2	2851.7	2518.8	2688.6	2866.5	3053.1
	Health care, physical training and sport, mln. rubles	2610.3	1541.9	1588.1	1687.1	1787.7	1890.5
	Social policy, mln. rubles	397.3	301.6	339.9	384.0	436.6	498.7
13	Average monthly wage, rubles	20022.0	21744.0	23614.0	25243.0	26859.0	28497.0

The strategy involves an active investment activity and therefore the share of expenditures for “National economy” will grow by 5.4% including due to reducing the share of social expenditures (expenditures for education and health, physical education and sport about by 1.0%). The implementation of innovation-oriented development scenario will provide the reduction in budget deficit by 2015. By other indicators the dynamics of indicators is generally in keeping with other considered scenario options.

The scenario calculations evaluation based on the formed set of indicators and the proposed strategies generally justify the relative preference for innovation-oriented development strategy for the city district of Ufa. The positive trends and results of the implementation of this strategy are most evident in the medium and long term. The developed model allows us to perform scenario calculations and can be used as a practical tool for substantiation of development strategies for state and municipal government.

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