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ARTICLE

SIMULATION MODELING OF INVESTMENT ACTIVITIES RESULTS OF THE OIL PRODUCING COMPANY

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ABSTRACT

The study is devoted to the development of the author's methodology for assessing the results of the investment activities of the oil producing company using the simulation modeling. The investment project for the well construction for oil production using the Steam Assisted Gravity Drainage (SAGD) para-gravitational effect technology lies at the heart of the developed model. A meaningful interpretation of the author's approach to the construction of an algorithm for economic and mathematical modeling and an explanation of its key specific features is the basis for justifying the prerequisites for applying the simulation model as part of the methodological tool for assessing the production investments of oil producing organizations. The composition of the indicators with variable and fixed values forming the array of initial model data characterizes the preparation period for the field development, including well construction and arrangement of adjacent territories, as well as the oil production stage. The statistical analysis of the experimental values of the net cash flow, based on the variation of the OIBDA and CAPEX indicators, allows quickly assessing the current efficiency of the project and revise it in a timely manner, taking into account the adjustment of the range of values of the initial variables as a result of changes in the technical and economic conditions of the project, explained by a significant volatility level of the modern economic conjuncture.

KEY WORDS
imitation modeling, oil producing company, investment activity, SAGD para-gravitational effect technology, VAR technique.

INTRODUCTION

The presence of a wide range of financial instruments and methods provides an opportunity for analysts and managers to manage the financial and economic activities of the organizations in various ways. The management methods are regularly improved, which contributes to the emergence of newer quality approaches to solving the issues posed.

The main attention in this paper is drawn to the simulation method, which has such features as universality and multitasking. The usage of the chosen method allows modeling the states of the economic system by specifying certain parameters and requirements, and obtaining various options for developing such systems with a further choice of the most suitable one.

METHODS

Recently, the use of economic-mathematical, including simulation models, has become widespread in the process of managing the economic activities of a commercial organization. Thus, the theory of constructing virtual models, business simulations in the economy is the fundamental basis of this study [1]. The use of simulation modeling is popular in the creation of socio-economic process models at all levels: global, national, regional, sectoral and enterprise level [2, 3, 4, 5, 6]. The scientific work reflected the econometric aspects of the implementation of the Monte Carlo model, implying the simulation of random processes using a random number generator [7]. The author's judgments are also based on the analysis of sources devoted to applied issues of the use of econometric algorithm of simulation modeling in solving specific managerial and financial problems [8, 10, 11].

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RESULTS

Within the framework of this scientific paper, we have developed an authorial approach to the simulation process using the example of evaluating the results of investment activities of an oil producing company. In [Fig. 1], the proposed set of instructions allows making a comprehensive assessment of the financial results of the planned investment project. The analysis of the simulation results provides an opportunity to identify key factors that have a significant impact on the financial results, develop recommendations for practitioners to improve the management of real economic processes, and decide on the choice of the project with the most optimal risk-return ratio. The developed algorithm includes several stages, each of which will be discussed in more detail later.

The investment project, which is analyzed in the framework of the scientific article, involves well construction for the production of super viscous oil using the Steam Assisted Gravity Drainage (SAGD) para-gravitational effect technology. It involves drilling two horizontal wells designed for steam injection into the formation and creation of a high-temperature steam chamber (upper well) and for oil production (bottom well). The oil production process is quite labor-intensive. It requires the project compilers to more comprehensively form the presentation of the full cycle of field development, from its discovery to decommissioning.

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Two periods were reflected in the model: preparation for the field development, including the well construction and development of adjacent areas, and the oil production stage. The planning horizon according to the investment project was adopted in one year. The resulting indicator, which characterizes the project effectiveness, was a net cash flow based on such indicators as OIBDA and CAPEX. The final indicator was chosen based on the widespread opinion of specialists that the operating profit is an objective indicator of an increase in value from the project. Taking into account the influence of the degree of execution of the capital expenditure budget, the model becomes objectively indicative.

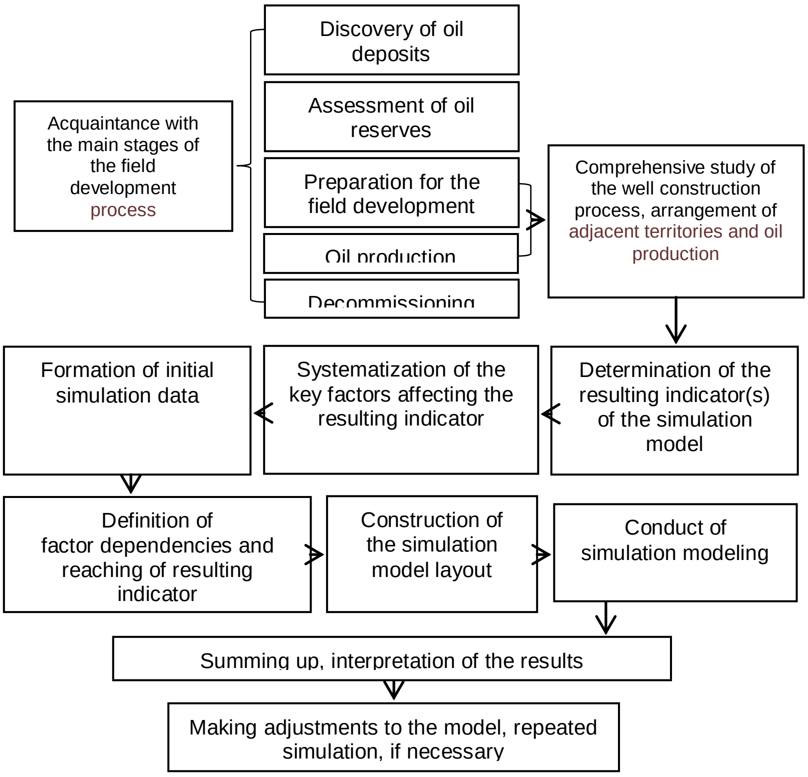

Fig. 1: Stages of the developed economic and mathematical modeling algorithm

At the next stage, it is necessary to determine the factors that influence the final indicator, and to form a data system that will form the basis for the model calculations. [Fig. 2] shows the groups of indicators used in the simulation modeling process.

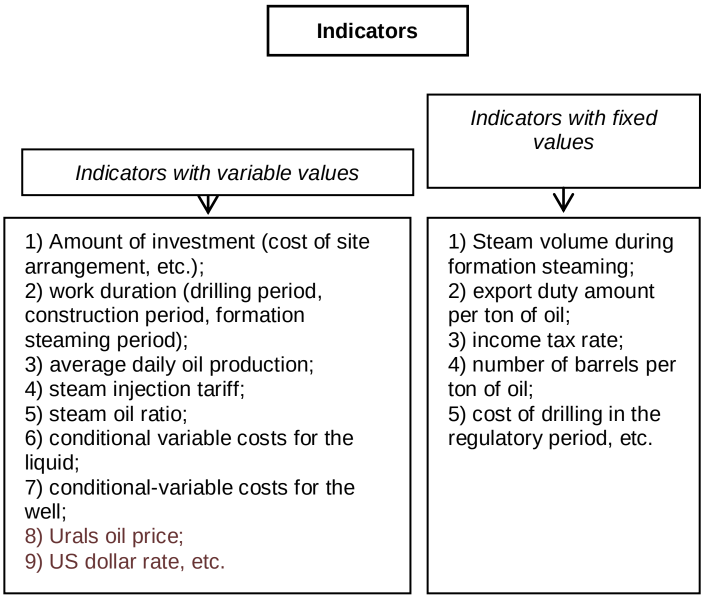

Fig. 2: Initial data for the simulation model construction.

The main classification criterion for the separation of indicators into separate groups was their variability. The first block included indicators that change their values in each experiment (for the indicators of this

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group, the lower and upper boundaries of the change ranges are defined), the second block contains indicators that do not change throughout the simulation modeling phase.

The analyst who develops the model project independently makes a decision regarding the division of indicators into groups, which depends on the specific nature of the investment project, the complexity of functional dependencies and the amount of data used. We propose to formulate all the initial data based on four model components: investment amount, work period, production technology and operating costs. All four elements are in close relationship with each other, the dependencies of which in the model are described mathematically.

We use the example of such an indicator as the operating costs for the liquid. [Fig. 3] shows the process of constructing dependencies. Thus, the operating costs for the liquid depend on the expenditure per 1 ton of liquid and the volume of liquid production in the natural measurement, which in turn depends on the volume of liquid production per day (this factor is affected by the water cut ratio), the average daily production rate of the produced oil and the production duration.

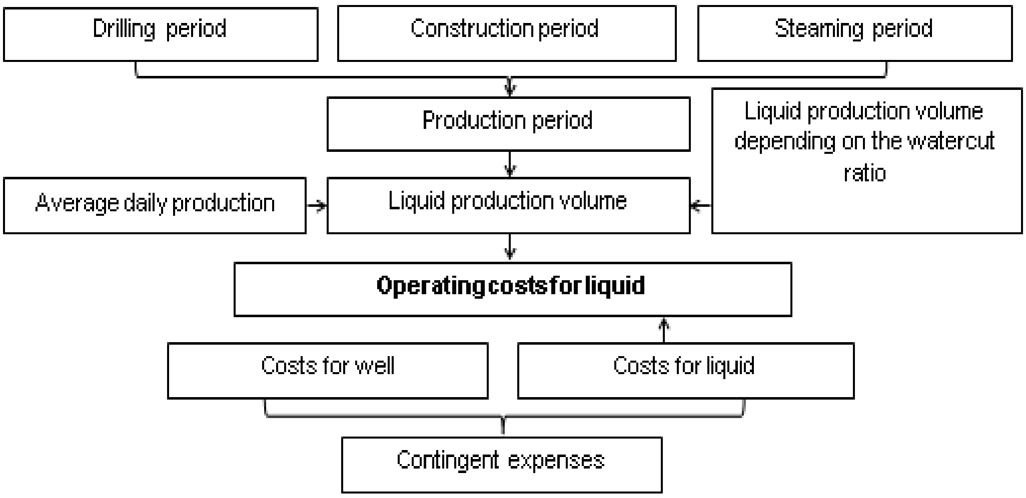

Fig. 3: Dependencies construction on the example of the operating costs for liquid indicator.

The calculation of intermediate indicators is the basis for determining the resulting indicators. In most cases, one such indicator is a net cash flow, defined as the difference between cash inflows and outflows from the project. [Fig. 4] systematically presents the factors that influence the indicator under study in the framework of the analyzed investment project. Any investment project has specific factors influencing the financial results of the company, which also need to be taken into account when building the simulation models. One of such factors, for example, can be the currency exchange rate in which the materials and/or equipment are purchased.

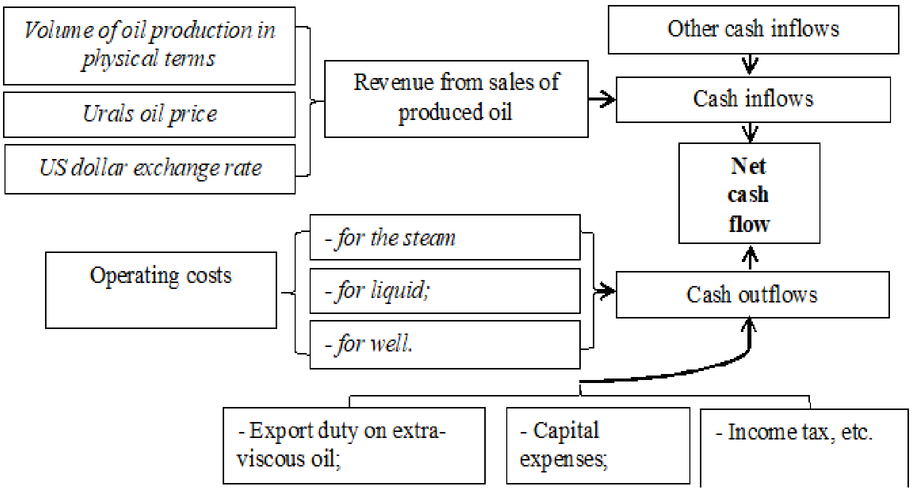

Fig. 4: Formation of resulting indicator using net cash flow as an example.

At this stage, we would like to pay special attention to the methodology for calculating the export duty and revenue from the sales of produced oil. The model assumes that all produced oil is sold. Thus, the period of oil production (sales) (PP)will be calculated using the following formula:

PP = 365 – PD - PC - PS,

where: PD - the period of drilling parallel horizontal wells; PC - the period of facilities construction; PP - the period of primary steaming. Thus, the volume of produced (sold) oil directly depends on the duration of drilling, construction and steaming works, as well as the average daily production rate. Such indicators as sales volume in physical terms, US dollar exchange rate, oil price and export duty were forecasted for each month of the analyzed period separately. The predicted values of the US dollar exchange rate and oil prices were determined using a widely used VAR technique, which involves calculating left and right quantiles based on the probability accepted at 95%. To calculate the mean and standard deviation for these two indicators, we took historical data for the period from April 2006 to April 2018.

When calculating the export duty, we took into account the allowances for the difficult-to-recover minerals, which included extra-viscous oil. In addition to the export duty exemption, the extra-viscous oil is subject to zero rates for the mineral extraction tax and property tax, which is also taken into account in the model construction.

Having determined the initial data and revealing the dependencies between the factors under consideration, the analyst proceeds to construct a model layout for carrying out the simulation modeling. Such a layout is recommended to be presented in a graphic form, using various block diagrams, histograms, graphs, maps, tables, matrices, etc. Graphic images of the model will allow increasing the degree of visualization that provides an opportunity to systematize all the elements of the system, reflect the degree of their influence on each other, identify the internal and external links, and determine the sequence of actions, etc.

In the process of simulation modeling, we conducted 1000 experiments with randomly assigned values. As mentioned earlier, we set fixed values for some indicators and defined the ranges of value changes for others. The array of primary and calculated digital data is quite significant, therefore, [Table 1] includes some fragmentary data on the experiments performed, which allow tracing the algorithm of economic and mathematical modeling, the sequence of calculating intermediate indicators, and the methods for determining the resulting indicators.

Table 1: Generalized algorithm for the form of presentation of initial data and results of simulation modeling

Indicators		Measure ment unit	Range of changes		Experiment number						
			from	to	1	2	3	4	5	…	1000
Work period	Drilling	day	13	20	15	13	13	14	18	…	15
	Construction	day	25	36	34	35	33	31	36	…	27
	Formation steaming	day	20	30	24	26	24	28	25	…	21
Average daily production rate		t/day	20	30	30	26	23	26	24	…	28
Cost of site arrangement		US dollars	149254	298 507	178612	192866	235701	149567	214552	…	291045
Steam injection tariff		US dollars/t	6.72	8.21	6.78	7.54	7.15	7.07	7.81	…	7.97
Conditional variable costs for liquid		US dollars/t	0.67	0.89	0.69	0.75	0.69	0.72	0.69	…	0.88
Conditional constant costs for well per year		US dollars	119,403	134,328	130552	126493	124701	122507	129552	…	122254
Oil and gas ratio during production		unit	3	6	6	3	3	3	3	…	6
Liquid production volume for the entire period		t	x	x	19564	18915	16225	20732	17732	…	21442
Production period		day	x	x	292	291	295	292	286	…	302
Drilling cost		US dollars	x	x	746269	746269	746269	746269	835821	…	746269
Investments		US dollars	x	x	924881	939134	981970	895836	1050373	…	1037313
Initial steam volume at formation steaming		t	x	x	120	130	120	140	125	…	105
Oil production volume per year		t	x	x	8760	7566	6785	7592	6864	…	8456
Steam injection volume during oil production		t	x	x	52560	22698	20355	22776	20592	…	50736
Operating costs	For the steam production	US dollars	x	x	356970	172060	146388	162119	161716	…	405209
	Conditional variable costs for liquid	US dollars	x	x	13433	14119	11134	14851	12179	…	18881
	Conditional constant costs	US dollars	x	x	130552	126493	124701	122507	129552	…	122254

	for well										
	Depreciation	US dollars	x	x	69373	70433	73642	67194	78776	…	86448
Revenue		US dollars	x	x	3879 209	3398 209	3088 955	4124 493	3274 925	…	3448 030
Export duty		US dollars	x	x	95388	79791	77687	95791	82597	…	95851
OIBDA		US dollars	x	x	3282 866	3005 746	2729 045	3729 224	2888 881	…	2805 836
CAPEX		US dollars	x	x	924881	939134	981970	895836	1050 373	…	1037 313
OIBDA – CAPEX		US dollars	x	x	2357 985	2066 612	1747 075	2833 388	1838 507	…	1768 522
Earnings before tax		US dollars	x	x	3213 507	2935 313	2655 338	3662 045	2810 104	…	2719 388
Income tax		US dollars	x	x	642701	587060	531075	732403	562015	…	543881
Net profit		US dollars	x	x	2570 806	2348 254	2124 313	2929 627	2248 090	…	2175 507
Inflows		US dollars	x	x	3879 209	3398 209	3088 955	4124 493	3274 925	..	3448 030
Outflows		US dollars	x	x	2163 925	1918 657	1872 955	2023 507	1998 433	…	2223 388
Net cash flow		US dollars	x	x	1715 284	1479 552	1216 000	2100 985	1276 493	…	1224 642

CONCLUSION

The final stage is the stage of summing up and interpreting the results. The important results of the analysis of key indicators of descriptive statistics, obtained during the simulation, are summarized in [Table 2].

Table 2: Results of the analysis of key indicators of simulation modeling

Indicators	Net flow	OIBDA	OIBDA – CAPEX
Mean value, US dollars	1 605 060	3 271 940	2,243 851
Standard deviation, US dollar	453 478	552 716	563 194
Variation ratio, %	28.25	16.89	25.10
Minimum, US dollars	535,627	2,014 522	937,045
Maximum, US dollars	3,362 642	5,343 955	4,415 970
Number of unprofitable experiments, units	0	0	0
Percentage of unprofitable experiments, %	0	0	0

Analyzing the simulation results obtained, it is obvious that the amount of unprofitable experiments was 0% of the total number of positions in the sample. This shows that the investment project is quite attractive, and it is expected to receive positive financial results even in the most pessimistic cases. The minimum values for three main resulting indicators showed positive values in all the experiments. The average values of the main indicators are as follows: for the net cash flow - 1,605,060 US dollars, for OIBDA - 3,271,940 US dollars, for the difference between the OIBDA and CAPEX indicators - 2,243,851 US dollars. The obtained values of modal intervals in these indicators are located in the positive area and not so close to the zero mark, which once again confirms the overall positive potential of the investment project.

The simulation model describing the oil company's investment project for the construction of two horizontal wells for the production of extra-viscous oil made it possible to conduct a large number of experiments with a wide variety of project factors, determine the upper and lower boundaries of the valuation indicators, calculate financial indicators for the case of the most pessimistic scenario. Thus, the results of simulation modeling form the basis of the economic justification for the budget performance of the oil company.

In conclusion, it should be noted that the model developed by us has a dynamic nature due to the possibility of a regular reassessment of the efficiency of production investments, taking into account the adjustment of the range of values of the initial variables as a result of changes in the technical and economic conditions of the project, explained by the significant volatility of the current economic situation.

CONFLICT OF INTEREST

There is no conflict of interest.

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