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Optimization Of Indicators For Management Of Enterprise: Finance, Production, Marketing, Personnel

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ABSTRACT

The multidimensionality and multi-objectivity are the main characteristics of the socio-economic systems development that are considered to be the most complex study objects in modern science, including all levels of its management. The article describes the formulation of multi-objective problem of optimizing enterprise development indicators. Selection of genetic algorithm for solving multi-objective optimization problem of enterprise development indicators through the process of analysis involving disadvantages and advantages of modern methods of solving multi-objective optimization problems has been substantiated. An analytical approach is suggested to construct partial criteria in a multi-objective optimization problem in economics as stochastic dependencies of development components on indicators in the form of latent factors, that should be marked by factor analysis. These defined optimal values of development indicators are recommended to use as an information basis for the implementation of all functions of enterprise management

Keywords: Application guidance, Certain criteria, Genetic algorithm, Indicators of management, Multi-objective optimization problem**.**

JEL classification: C54, C31, M21, O12

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1. Introduction

Taking into account the multidimensionality and multi-objectivity of both macro-micro economic systems, it can be said that such aspects are considered to be necessary conditions for establishing effective sustainable development. So far as the main link in the production process is an enterprise, its development is determined by the main components: finance, production, marketing and personnel. The record of these four essential components and indicators optimization ensure an enterprise profit growth. The main components, indicators for enterprise development and its management based on Balanced Scorecard (BSC) were discussed by Robert S. Kaplan and David Norton in their studies published in "Harvard Business Review" during 1966-2012 and many other scientists from different countries (Niven, 2006; Rampersad, 2001; Meyer, 2003). The overwhelming majority of scientists and economists admit that general deficiency of classical economics and its management methodology is financial indicators focusing that led to the weakness of strategic management in business and problems of taking it as integral systems as its development is accomplished by various entrepreneurial activities (Grigoroudis et al. 2012). The following conceptual deficiency such as the record of multidimensionality and multi-objectivity of enterprise development even in the process of standard optimization methods application also should be added and noted (Malyarets et al. 2019). Also another problem involving method selection process for solving multi-objective optimization problems of enterprise development should be concluded (Hassani et al. 2019).

It should be highlighted that in the recent years, the development of new algorithms for multi-objective optimization has considerably grown as well. A large number of performance indicators has been introduced to measure the quality of Pareto fronts approximations produced by these algorithms (Audeta et al. 2018). They propose a review of a total of 57 performance indicators partitioned into four groups according to their properties: cardinality, convergence, distribution and spread.

The majority of modern methods of the strategy for the effective management of large industrial enterprises are based on concepts and information systems methodologies as well as artificial intelligence (Lu, 2019). Huge amount of data cannot be processed using traditional data processing systems and technologies. Big data analytics is a process of examining information and patterns from huge data (Bendre et al. 2016).

It should be marked that many scientists admit that optimization problem based on the simulation modeling is formulated in the following way: it is necessary to find the values of input variables (factors) that optimize the main source of indicator system - a general criterion (feedback).

At the same time, it is assumed that the response function cannot be calculated analytically, however it can be calculated by means of simulation, i.e. by conducting a simulation experiment using a model of complex systems. Using simulation models, the response value is calculated for different combinations of factor values that the optimization algorithm offers. Optimization algorithm based on search using response values improves the process and result of solution. But one of the main problems of long-runs of simulation models and preliminary convergence behaviour of the optimization algorithm still remains (Ajith et al. 2004).

Proposed GACC algorithm with new population initialisation criteria. In this population creation mechanism, the usual random selection of chromosomes is replaced with more refined and distinct clusters as chromosomes (Sharma et al. 2017). This mechanism prohibits the user to initialise the population size as well. They examine optimised feature selection, genetic algorithm that incorporates the information gain for feature selection and combined with bagging technique and KNN for improving the accuracy of sentiment classification.

At different times in the studies devoted to solving process of multi-objective optimization problems using simulation models and genetic algorithms (Deb, 2001; Zitzler et al. 2008; Cheng et al. 2012; Martí et al. 2016; Dilettoso et al. 2017). They recommend such software as AutoStat AutoSimulations (Inc AutoMod),simulation software AutoSched, search procedures: evolution strategies; OptQuest Optimization (Technologies, Inc.), simulation software: Arena, Micro Saint, QUEST, search procedures: Scatter search, Tabu search, Neural Networks; OPTIMIZ (Visual Thinking

International Ltd.), simulation software search procedures: evolution strategies, neural networks; SimRunner2 (PROMODEL Corp.), simulation software: MedModel, ProModel, Service Model; search procedures: evolution strategies, genetic algorithms; WITNESS Optimizer (Lanner Group, Inc.), WITNESS simulation software, search procedures: Simulated Annealing, Tabu search.

2. Materials and methods

Using the term "packaging optimization" in the context of solution searching procedures, most of it uses evolution strategies and genetic algorithms, that are established as multipurpose and global search algorithms that allow to find quasi-optimal solutions for the shortest appropriate period of time. Multi-objective optimization problems solving process is based on the metamodel development, that is an approximate mathematical model obtained from the simulation modeling experimental results to replace it during the optimization process. At the same time, the main methods of metamodeling are regression models and Artificial Neural Networks due to its approximation capabilities (Bao et al. 2017; Gerber et al. 2012; Ghosh et al. 2017; Omelchenko et al. 2018). Thus, the following algorithms of solution search implementation using evolutionary computation and neural network metamodels are known: an algorithm based on the individuals control and an algorithm based on generation control, as well as an algorithm based on the operator awareness strategy of genetic algorithms, that for its part, involves the number of descendants in crossover and mutation of operators of genetic algorithm and subsequent calculations of their appropriateness using a metamodel. A genetic algorithm is a heuristic method for evolutionary computation and finding optimal solutions, based on the principles of the evolutionary theory of living organisms. Genetic algorithms should be used to solve optimization problems, that cannot be always solved using standard optimization methods. First of all, this method is used to solve optimization problems when the objective function is nonlinear, stochastic or discontinuous, non-differentiable, or whether the derivatives are not sufficiently defined, and the system of constraints can be represented both by the interval of change of variables and their functional dependencies. Modern multi-objective optimization problem solving methods are methods used for simulation models and genetic algorithms construction (Ehrgott, 2005; Kaliszewski et al. 2016; Reiff, 2016; Dinesh, 2016; Us et al. 2018).

Thus, modern multi-objective optimization problem solving methods analysis concerning its deficiencies and advantages made it possible to suggest a particular method for solving multi-objective problems in the economy (Table 1).

Considering the advantages of each interactive algorithm, it is recommended to combine them. Nowadays there is no general strategy for choosing the parameters of specific systems optimization, but there are agreeing opinions among well-known analysts that were solving the multi-objective optimization problem concerning the question whether it would benefit from the presence of optimization blocks in the computational algorithms. For example, genetic algorithm, metamodeling, database block or block experts. So, the architecture of optimization system on the basis of simulation modeling, genetic algorithm and neural network metamodels can be constructed that way. Solution search based on the genetic algorithm starts, metamodel formation using a database to transmit training examples in order to "train" the neural network, determine the number of simulation runs of the model for one individual, that offers a genetic algorithm. Metamodel-based search strategy is being implemented. Experts' objective involves determination of the number of offspring and its generation method in crossover and mutation operators at each step of solution search.

Three types of heuristic algorithms are implemented in Matlab environment: genetic, based on the principles of evolutionary theory of living organisms, direct search, based on simplex transformations and simulated annealing algorithm, based on the physical process of temperature annealing of metals to form a molecular structure with minimal deformation. Direct search method is used to solve optimization problems when any information about the gradient of the target functionis missing.

Table 1. The choice of a mathematical method for solving a multi-objective problem in economics

Mathematical method	Economic problem
methods without participation of a decision maker	to optimize the importance of indicators performance of enterprises under conditions of uncertainty;
methods based on a scalar convolution of criteria	to determine the maximum level of enterprise assessment, taking into account the importance of aggregates and indicators;
methods that use criteria restrictions	determining the optimal values of indicators, taking into account the production and economic capabilities of the enterprise;
the main criterion method	optimization of the indicators values of the enterprise using targeting;
method of successive concessions	optimization of the indicators values of the enterprise using the definition of sustainability;
targeted programming methods	determination of the optimal indicators values to achieve the enterprise sustainability;
a method of guaranteed result	optimization of the performance indicators of the guaranteed efficiency enterprise;
a method based on the concept of utility unction	determination of the optimal indicators values taking into account the preferences of the DM in management;
analytic hierarchy process	determination of the optimal indicators values based on the analysis of their feasibility;
ELECTRE method	determination of the optimal indicators values based on purposeful management, taking into account the preferences of activity areas;
Geoffrion-Dyer-Feinberg method	optimization of performance indicators with sustainability;
Zayonts-Wallenius method	optimization of the indicators values taking into account the feasibility of alternatives;
Steuer's method	business performance maximization, taking into account management benefits;
Steuer's and Chu's method	activity effectiveness maximization taking into account real nonlinear trends in the values of indicators and its relationship;
STEM method	an activity effectiveness maximization taking into account the preferences in indicator values changes;
fuzzy logic methods	activity effectiveness maximization taking into account the conditions of uncertainty functions;
FFANN method	activity effectiveness maximization of an enterprise with finding optimal indicators values, taking into account priority areas of operation;
methods that use genetic algorithms for simulation models	enterprise efficiency maximization, taking into account trends in the indicators values.

In contrast to the more traditional optimization methods, that use information about the gradient and derivatives when searching for the optimal point, direct search algorithms calculate which sequence of points (simplexes) aimed at moving in the direction closer to the acceptable optimal point. At each step, the algorithm searches for some simplex, in this case it is called the grid around the current point - namely the point defined at the previous algorithm step. This algorithm forms a grid by adding the current point to a scalar multiplier of a fixed set of vectors called a structure. Supposing that after some iteration there is a point in the obtained grid that leads to improvement of the target function relative to the current point, then this new point becomes the current point for the next step. Direct search method can be used to solve such problems, when the target function is undifferentiated or broken. It is known that the genetic algorithm repeats a certain number of times the procedure of population modification (a set of individual solutions), thus achieving new sets of solutions (new populations). At the same time, at each step, "parent individuals" are selected from the population, i.e. solutions, joint modification of which (crossing) leads to the formation of a new individual in the next generation. The genetic algorithm uses three types of rules, on the basis of which the new generation is formed: selection, cross-over, and mutation rules. Characteristics peculiar to the genetic algorithm contribute to their effective application in multi-objective optimization problems solving process as it based on the use of many potential solutions - population and global search in several directions.

The classical genetic algorithm is performed according to the following steps (Table 2).

Table 2. Logic of the classical genetic algorithm stages

Steps	The content of the stage
1	$t = 0$;
2	to initialize a population P_t of randomly selected individuals $\{0,1\}^t$;
3	to define a Fitness Function of all individuals P_t;
4	while loop to repeat when condition is false: 4.1) select individuals for reproduction P_t, based on their fitness values; 4.2) apply genetic reproductive operator or operators in order to produce new offspring; 4.3) calculate the fitness-function of offspring; 4.4) replace individuals P_t with descendants and compose P_{t+1}; 4.5) $t = t + 1$;
5	the end.

The problem of evolutionary algorithms, including the genetic algorithm, is the question of convergence. Conditions laid down must be accomplished:

1) the population sequence $P_0, P_1, \ldots$, that is generated by the algorithm is monotonic, i.e.:

$\forall\, i \in N : min\{f(a) | a \in P_{t+1}\} \leq min\{f(a) | a \in P_t\}$.

2) $\forall\, a$ the Element a is achievable through mutation and crossover, i.e. through the sequence of transitions in a number of structures. Then the global optimum a^* of the function f is found with probability1: $\lim_{t \to \infty} p\{a^* \in P_t\} = 1$.

As it is noted that in real-valued genetic algorithms the second condition is always accomplished. It is the theoretical justification of monotonicity for various combinations of genetic operators that is a modern actual scientific objective.

Therefore, these substantiations explain the choice of genetic algorithm for problem solving process of enterprise development management.

3. Results and discussion

The aim of the research was to develop new multi-objective optimization problem of enterprise development management, that is structured by the such components as finance, production, marketing, personnel, that are considered to be its private criteria and are based on their internal causal relationships, real changes limits in the indicators values and it also provides genetic algorithm usage. The following objectives were set in order to achieve the objective:

1) to substantiate the choice of interactive method of multi-objective optimization - genetic algorithm for problem solving process of enterprise development management taking into account economic trends and possibilities of programming environments;

2) to define the system of indicators, that are structured in order to reflect four components of

enterprise development management: finance, production, marketing, personnel;

3) to develop private criteria of enterprise development management, taking into account internal cause-effect relationship in each component;

4) to substantiate the system of restrictions of indicator values changes taking into account their numerical characteristics;

5) to test the solution of multi-objective optimization task of development management on the basis of genetic algorithm using the example of industrial enterprise.

Formulation and setting of multi-objective optimization problem of enterprise development indicators. The maximum of the function of enterprise development must be found by four components: finance (F_1), production (F_2), marketing (F_3), personnel (F_4):

$F_1(x_{11}, x_{12}, x_{13}, x_{14}, x_{15}, x_{16}, x_{17}) \rightarrow max$,

$F_2(x_{21}, x_{22}, x_{23}, x_{24}, x_{25}, x_{26}, x_{27}, x_{28}, x_{29}, x_{30}) \rightarrow max$,

$F_3(x_{31}, x_{32}, x_{33}, x_{35}, x_{36}, x_{37}) \rightarrow max$,

$F_4(x_{41}, x_{42}, x_{43}, x_{44}) \rightarrow max$,

where F_1, F_2, F_3, F_4 – partial criteria.

At the same time, it is proposed to determine the development of each component using such indicators, that can be quantitatively calculated on the basis of official statistical information of enterprises. Table 3 shows the indicators of enterprise development into four components.

Table 3. The system of indicators for the components of enterprise development

The number of the component	Component's indicators
1. finance	enterprise profitability (x_{11}), sales profitability (x_{12}), receivables turnover ratio (x_{13}), return on equity (x_{14}), absolute liquidity ratios (x_{15}), autonomy ratio (x_{16});
2. production development	percentage increases and decreases (x_{21}), return on assets (x_{22}), depreciation to fixed assets ratio (x_{23}), percentage of expenditures (x_{24}), stock construction ratio (x_{25}), fixed asset definition (x_{26}), market share (x_{27}), product nomenclature renewal ratio (x_{28});
3. marketing development	share of expenditures for product promotion (x_{32}) volume compliance of supplied resources with its need (x_{33}) share of products for warranty service (x_{34}), specific weight of supplies under direct contracts (x_{35});
4. personnel development	growth rate of the number of employees (x_{41}) specific weight of employees who have advanced their skills in the reporting year (x_{42}) specific weight of employees under 50 years (x_{43}) specific weight of employees performing scientific and technical work (x_{44}).

Since the majority of relationships and dependencies in the economy are causal, it confirms the objectivity of the recommendation to use stochastic dependencies in the development of private criteria. Such recommendation has been tested in experimental practice in the enterprise management. Optimal solutions for multi-objective optimization problems have been found, that constitute an objective information basis in enterprise management.

According to previous researches expediency of private criteria designing of an enterprise activity estimation is substantiated (Us et al. 2016). Therefore, it was defined by four components: financial, a component of internal business processes, client and a component of personnel training and development in the form of curves of indicators growth. The problem was also solved by means of genetic algorithm in MatLab software environment. Optimal indicators values have served as a basis for comparative assessment and as a basis for developing strategies for the activities of a large industrial enterprise in Ukraine. In order to ensure comprehensiveness of the enterprises' activities evaluation, the second problem was solved as well, in which private criteria were the level of development of each component and their functional dependence on the relevant indicators for the calculation of which it was proposed to use the mini-max method. The first criteria were the development level of each component of the enterprise's activity, it is reasonable to make scalar taking into account the dependences of the level of development of the corresponding component on its factors during the research period. Other criteria were functional dependences of development levels of other components and general level of activity based on the same factors. The optimization problem of the maximum level of export and import development potential of the enterprise and efficiency of its use was solved in the article, whereas private criteria were the dependences of these integral indicators on the indicators, they are defined (Malyarets et al. 2018). In the process of developing private criteria, the impact of each individual factor on export and import potential was taken into account. For this purpose, it is necessary to calculate pairwise dependencies of corresponding levels on each separate factor. In this multi-objective optimization problem, change intervals in the factors values also taking into account its numerical characteristics, standard error, have been used as limitations.

Partial criteria were constructed taking into account the level dependencies of use of export-import potential at the enterprise on its factors with established weight coefficients, based on the priority of solving problems in functional strategies. As a result of the decision of the given problem optimum values of indicators have received an information basis in the course of formation of the administrative decision on increase of efficiency of use of export-import enterprise potential. The multi-objective optimization problem was also solved, where the development of export and import activity of the enterprise was equal as private criteria. The development of private criteria took into account the influence of each individual factor on the level (Malyarets, Barannik et al. 2018).

Continuing the research, in order to formalize the private criteria, it is recommended to determine the latent factors of the company's activity development using the multidimensional statistical method of factor analysis. The choice of this particular method for the development of private criteria is explained by the fact that latent factors - components are correlated ratios of elementary features, that means that some complex features are defined through others or the whole such group of features are manifestations (consequences) of a common reason for them, the nature of which is unknown, hence, is not studied. Knowing the manifestations (consequences) of latent factors, it is possible to construct a model for studying these latent factors, its number is much smaller than the total number of attributes. Besides, if it is possible to describe briefly a large array of data, it means that a certain objective regularity has been found, that caused the possibility of this brief description, i.e. information compression.

The initial factors (component) system is drawn up according to the extreme principle - the first component should explain the maximum of all the shifts of all features; the second component is independent and should explain the maximum of the residual shift of features etc. A small number of such components is able to restore almost all the general variability of elementary traits.

The component is expressed as a linear combination:

$$V = u_1 Z_1 + u_2 Z_2 + \ldots + u_m Z_m = ZU$$

where the coefficients u_k must be found from the maximum dispersion condition:

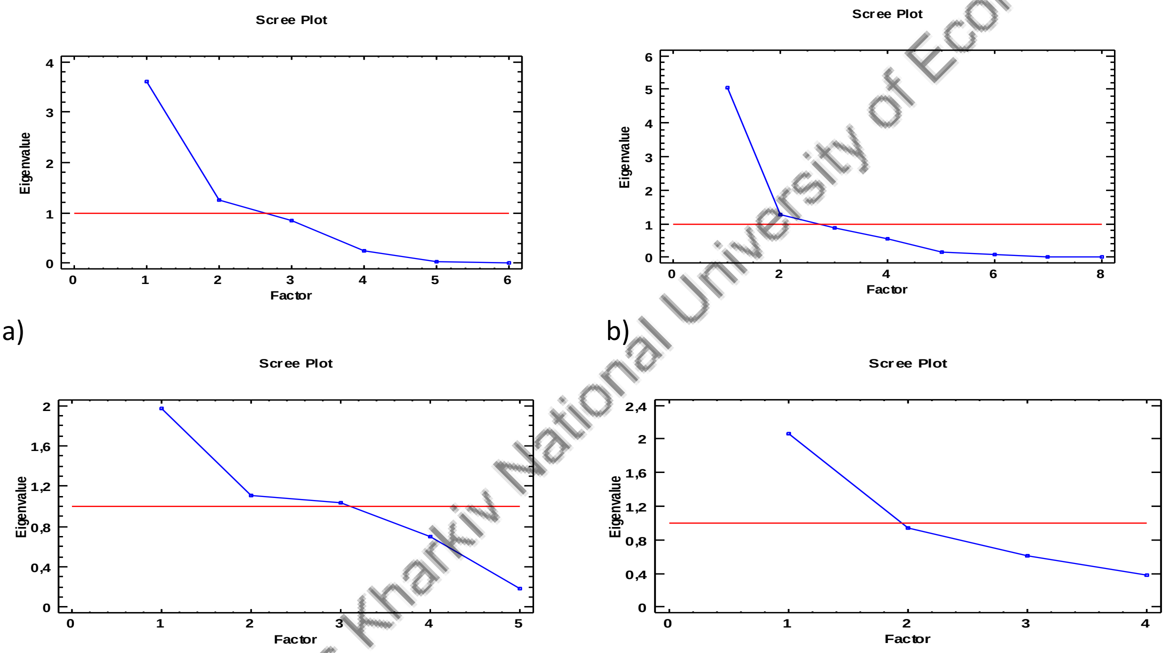
$$S_V^2 = \frac{1}{n-1}\boldsymbol{V}'\boldsymbol{V} = \frac{1}{n-1}(\boldsymbol{ZU})'(\boldsymbol{ZU}) = \frac{1}{n-1}\boldsymbol{U}'\boldsymbol{Z}'\boldsymbol{ZU} = \boldsymbol{U}'\boldsymbol{RU},$$

where R – the matrix of pairwise correlation coefficients between elementary features, expressed by economic indicators.

So, it is considered that the components are centered (as a linear combination of standardized elementary features Z_k). The coefficients u_k correspond to the normalization condition and just increasing these coefficients $U'U = 1$, you can make the dispersion of the linear combination as large as you want.

At the same time, the restrictions system of the development indicators values should be formed taking into account the numerical characteristics of the distribution of the enterprise performance indicators values at a certain time interval (Cuba-Borda et al. 2018).

According to example of quantitative values of indicators development of a large industrial enterprise JSC «TURBOATOM» (official site Join-stock corporation «TURBOATOM»), that is one of the leaders of machine-building industry in Ukraine, the multi-objective optimization problem of development management based on the use of genetic algorithm was solved. First, to establish the equations of private criteria for each component of the development of the enterprise, a factor analysis was calculated. Figure 1 presents the number of latent factors in each component of the development of the enterprise, which indicates the advisability of using each first factor in each component of development.



a) b) c) d)

Figure 1. The number of key latent factors in each component of enterprise development

The equation of private criteria are latent factors of development of four components:

$F_1 = 0{,}981x_{11} + 0{,}953x_{12} + 0{,}115x_{13} + 0{,}996x_{14} + 0{,}795x_{15} + 0{,}179x_{16} \rightarrow max$;

$F_2 = 0{,}004x_{21} + 0{,}834x_{22} - 0{,}864x_{23} + 0{,}72x_{24} + 0{,}889x_{25} + 0{,}871x_{26} + 0{,}491x_{27} + 0{,}771x_{28} \rightarrow max;$

$F_3 = -0{,}112x_{31} + 0{,}893x_{32} + 0{,}925x_{33} + 0{,}11x_{34} - 0{,}031x_{35} \rightarrow max$;

$F_4 = 0{,}772x_{41} + 0{,}721x_{42} - 0{,}8x_{43} + 0{,}559x_{44} \rightarrow max$;

Taking into account the intervals of changes in indicator values and numerical characteristics of their distributions, the system of restrictions looks the following way:

$0{,}018 \le x_{11} \le 0{,}0972$; $0{,}1092 \le x_{12} \le 0{,}3648$; $0{,}0086 \le x_{13} \le 0{,}0224$; $0{,}0078 \le x_{14} \le 0{,}1032$; $0{,}7631 \le x_{15} \le 1{,}0079$; $0{,}782 \le x_{16} \le 0{,}877$; $0{,}8776 \le x_{21} \le 1{,}7724$; $1{,}3904 \le x_{22} \le 1{,}5296$; $0{,}336 \le x_{23} \le 0{,}543$; $0{,}0542 \le x_{24} \le 0{,}2958$; $13180{,}8295 \le x_{25} \le 29900{,}1705$; $0{,}1135 \le x_{26} \le 0{,}2865$; $0{,}0303 \le x_{27} \le 0{,}0797$; $0{,}0403 \le x_{28} \le 0{,}0897$; $0{,}0851 \le x_{31} \le 0{,}1649$; $0{,}2585 \le x_{32} \le 1{,}2415$; $0{,}0343 \le x_{33} \le 0{,}0657$; $1{,}0883 \le x_{34} \le 1{,}1927$; $0{,}7795 \le x_{35} \le 0{,}8705$; $0{,}9621 \le x_{41} \le 1{,}0363$; $0{,}0089 \le x_{42} \le 0{,}0141$; $0{,}5246 \le x_{43} \le 0{,}5524$; $0{,}0205 \le x_{44} \le 0{,}0225$

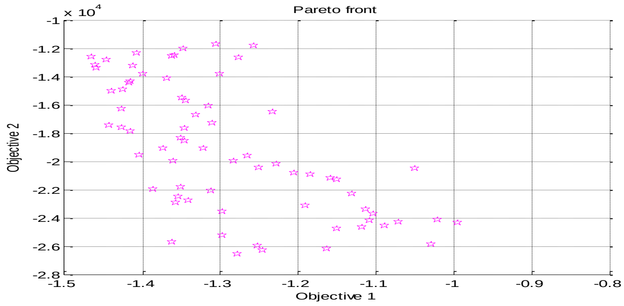


Figure 2. The Pareto front points of the Multi-objective optimization problem of enterprise development

Using MatLab software environment we will find different Pareto solutions, precisely implementing multi-objective optimization using Genetic Algorithm, abbreviated as «gamultiobj». The calculation procedure took into account the population type as a double vector with the population size 105, and the selection function is implemented as a random selection of two persons with playback parameters 0.3 and 0.5. The mutation function depends on limitations, with average crossing, migration direction, that is in the direction of the last subpopulation and every 20 generations. Figure 2 and Table 4 shows the values of private criteria according to the Pareto front points.

It is recommended to choose the optimal solution of the problem from the Pareto front points based on the general scalar function of the target:

$$FF = \alpha_1 F_1 + \alpha_2 F_2 + \alpha_3 F_3 + \alpha_4 F_4,$$

Where $\alpha_1, \alpha_2, \alpha_3, \alpha_4$ – weighting factors to take into account advantages in the pace of development of finance, production, marketing or personnel. This function of the target can be used as an integral indicator of the development level of the enterprise to assess and analyze its activities.

Assuming the equality of private criteria $\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4$, so the optimal values of indicators of enterprise development for JSC «TURBOATOM» (Ukraine) is:

$$x_{11} = 0{,}0737,\ x_{12} = 0{,}2144,\ x_{13} = 0{,}0116,\ x_{14} = 0{,}0874,\ x_{15} = 0{,}9582,\ x_{16} = 0{,}8498,$$

$$x_{21} = 1{,}4817,\ x_{22} = 1{,}5109,\ x_{23} = 0{,}4833,\ x_{24} = 0{,}2876,\ x_{25} = 29889{,}0583,\ x_{26} = 0{,}2848,$$
$$x_{27} = 0{,}0665,\ \ x_{28} = 0{,}0894,$$

$$x_{31} = 0{,}1583,\ x_{32} = 0{,}9011,\ x_{33} = 0{,}0593,\ x_{34} = 1{,}1896,\ x_{35} = 0{,}7955,$$

$$x_{41} = 1{,}0282,\ x_{42} = 0{,}0134,\ x_{43} = 0{,}5415,\ x_{44} = 0{,}0219\ .$$

The optimal indicators values of enterprise development have been found. It should be used as an information base in the development of management decisions, as well as in the implementation of management functions such as assessment, analysis, control, regulation, diagnostics, monitoring in the formation process of all functional strategies for enterprise development.

Table 4. The importance of private criteria according to the Pareto front points

№	F_1	F_2	F_3	F_4	№	F_1	F_2	F_3	F_4
1	1,279	26572,778	0,948	0,382	36	1,404	19539,757	1,163	0,386
2	1,246	26315,607	1,208	0,350	37	1,321	19098,979	1,181	0,375
3	1,164	26182,969	1,237	0,353	38	1,373	19056,386	0,878	0,394
4	1,253	25969,671	0,919	0,385	39	1,346	18542,072	0,668	0,397
5	1,031	25842,366	0,902	0,387	40	1,351	18321,124	0,995	0,392
6	1,362	25689,982	0,711	0,388	41	1,416	17891,269	0,634	0,392
7	1,298	25236,033	1,062	0,389	42	1,347	17657,480	0,384	0,399
8	1,150	24767,741	0,790	0,394	43	1,427	17603,974	0,491	0,387
9	1,119	24653,368	0,834	0,393	44	1,442	17457,132	0,471	0,395
10	1,089	24562,494	0,869	0,392	45	1,310	17283,084	0,804	0,399
11	0,997	24317,992	0,776	0,397	46	1,331	16725,890	0,935	0,397
12	1,072	24298,962	1,017	0,390	47	1,234	16516,619	0,546	0,401
13	1,109	24189,546	1,077	0,379	48	1,426	16289,883	0,436	0,397
14	1,022	24115,974	1,131	0,388	49	1,315	16069,023	0,886	0,399
15	1,103	23736,548	1,248	0,355	50	1,345	15730,023	0,354	0,401
16	1,298	23534,649	1,111	0,330	51	1,350	15525,711	0,808	0,399
17	1,114	23383,145	0,618	0,399	52	1,439	15052,303	0,641	0,394
18	1,191	23114,226	1,217	0,344	53	1,426	14925,642	0,701	0,394
19	1,357	22939,635	1,003	0,378	54	1,417	14451,984	0,766	0,382
20	1,342	22758,553	1,150	0,363	55	1,415	14325,170	0,858	0,390
21	1,354	22503,355	1,104	0,337	56	1,369	14142,199	0,372	0,402
22	1,131	22289,378	0,591	0,400	57	1,300	13835,752	0,849	0,399
23	1,312	22068,437	0,797	0,395	58	1,399	13797,647	0,754	0,394
24	1,386	21948,412	1,083	0,324	59	1,458	13411,015	0,506	0,385
25	1,350	21825,023	0,665	0,398	60	1,412	13254,507	0,425	0,401
26	1,151	21299,717	1,244	0,358	61	1,460	13180,441	0,502	0,387
27	1,159	21189,447	1,259	0,335	62	1,446	12797,651	0,433	0,395
28	1,185	20915,700	1,198	0,366	63	1,277	12665,727	0,950	0,402
29	1,206	20840,627	1,244	0,362	64	1,465	12593,195	0,456	0,392
30	1,050	20494,586	1,021	0,395	65	1,363	12537,537	0,350	0,403
31	1,251	20430,433	0,812	0,399	66	1,359	12519,100	0,403	0,403
32	1,229	20187,421	1,052	0,397	67	1,408	12344,061	0,732	0,397
33	1,282	19967,576	1,202	0,361	68	1,347	12031,106	0,572	0,403
34	1,360	19952,083	0,976	0,385	69	1,258	11815,090	0,600	0,403
35	1,265	19599,169	1,034	0,396	70	1,305	11719,009	0,575	0,403

4. Conclusions

So, using a genetic algorithm in multi-objective problem solving process of indicators optimization of an enterprise development, it is recommended to apply the following criteria: partial criteria are designed as stochastic dependencies of development components on indicators in the form of latent factors of these components; system restrictions should be represented as an interval of indicator values taking into account its numerical characteristics, that allows to develop an acceptable solution range, therefore it limits optimal values search in genetic algorithm; genetic algorithm should be run for several times in order to determine the intervals of optimal values of indicators development. Indicators and their optimal values are information support of the all of management functions and establishing benchmarks for comparative assessment development of various conditions of enterprise progress; according to its base, it is recommended to determine underutilized business opportunities as well as hidden strategic reserves of development.

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