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METHOD AND INFORMATION TECHNOLOGY TO RESEARCH THE COMPONENT ARCHITECTURE OF PRODUCTS TO JUSTIFY INVESTMENTS OF HIGH-TECH ENTERPRISE

The development of enterprises in strategic industries depends on funding made innovative products that are in demand in the markets for high-tech products. The interest of investors depends on the innovation and competitiveness of the products that the enterprise can produce. The enterprise should make a new, diversified portfolio of orders to attract funding from potential investors. The innovativeness of the product is determined by the novelty of the components in its composition. Therefore, the pressing challenge is to study the innovation of high-tech products based on their component architecture. It makes it possible for investors to assess the possibility of enterprise financing while making a promising diversified portfolio of orders. The study develops a method to justify investments into the new orders that are based on the research of the component architecture of the complex product.

The tasks analyzed the product component architecture innovation and investment attractiveness, justify and select the diversified portfolio of orders, simulate and assess orders portfolio feasibility are stated and solved. The paper proposes the component method that makes it possible to evaluate the architecture of the new product in terms of innovation and investment attractiveness. The research of innovation is conducted depending on the composition of the components in the architecture of the whole product. These components can be either new that require a new cycle of creation, or "old" ones, taken from previous experience with the possible adaptation to the technical requirements of the new product. By using the proposed multifactor planning of the experiment, the possible options are considered and the main indicators of the new product are assessed: investment attractiveness, costs, timelines, and risks of order fulfillment. Using lexicographic ordering of alternatives the compromised selection of the optimal option in terms of limited capabilities of the enterprise is conducted. To optimize the diversified portfolio of orders the method of integer (Boolean) programming is used. Investment attractiveness is used as a target function. The restrictions consider allowable costs, timelines, and risks of the orders portfolio fulfillment.

In the last part of the paper, the method of simulation agent modeling in a form of applied information technology is used to assess the timeline for order fulfillment and the impact of risks on the feasibility of the diversified portfolio of orders.

The novelty of the results is related to the justification of the choice of a diversified portfolio of orders, which in contrast to the already existing approaches, is based on the advanced component architecture of complex products and the simulation of orders portfolio selection considering innovation and investor interests.

The proposed method and information technology are planned for the future development of an enterprise that makes it possible to assess the competitiveness of products, as well as the possibility to attract funding.

Key words: *component architecture; high-tech production; competitiveness; investment attractiveness; innovativeness of high-tech products; optimization of diversification of orders portfolio; agent-based simulation; applied information technology.*

Introduction

Increasing competition between producers of high-tech products, as well as unstable behavior of markets, leads to the need for innovative development of enterprises, diversification of their activities and making the portfolio of future orders, which is interesting for investors [1]. The transition to the new innovative production technologies that fully meet the requirements of Industry 4.0 depends on the impact of political and economic risks [2]. Thus, there is a contradiction between the desire of developing enterprises to introduce innovations and the lack of scientific justification for the diversification of their production activities to attract investments [3]. This raises a complex scientific and technical problem of a compromise nature for developing enterprise to create a diversified portfolio of orders, which on the one hand is interesting for investors due to its innovative attractiveness and possible competitiveness in the market of high-tech products, and on the other – may result in longer time periods because of possible risks, as well as unjustified economic costs when creating the innovative products.

The goal of the publication is to develop a scientific justification for the method of attracting investments into the innovative development of the enterprise. In order to achieve this goal the following tasks are solved in the paper:

1. Propose the component method to analyze innovation of high-tech products being created.
2. Conduct the research of the investment attractiveness of the innovative order by means of expert assessments and the method of experiments planning.
3. Justify the composition of the diversified orders portfolio for investment, considering the limited capabilities of the enterprise on the basis of integer optimization method.
4. Simulate the execution of the orders portfolio on the basis of agent information technology.

The structure of the paper fully corresponds to the tasks to be solved and consists of the following sections:

1. Component method to research the architecture of innovative product.
2. Research of investment attractiveness of the innovative order.
3. Justification of the diversified orders portfolio composition.
4. Simulation of the diversified orders portfolio execution.

1. Component method to research the architecture of innovative product

The component method is based on the division of architecture of a high-tech product into components with a modular structure and the possibility to combine them to create new products [4, 5]. In this case the basic platform consists of many basic components and is developed by a separate group of highly qualified designers with the prospect of forming a new family of competitive products. In the course of fulfilling a specific order, the selection and structuring of basic components with their possible adaptation to the requirements and technical characteristics of the new product is carried out.

In the component representation of a complex high-tech product, it is possible to separate the following components:

- simple components used at the lower levels of product architecture;
- complex components, which are structurally interconnected simple components;
- components of past positive experience of use in a number of generations of the product;
- new components not used before and that need to be created, i.e. full life cycle is required, which includes R&D, training and serial production.

It should be noted that the creation of new components may increase the design time, retraining of personnel and new technological equipment [6]. The greater number of new components in the architecture of a new product will cause the greater design time and the cost of creating a new product. In addition, it may increase the risks of product sales, which may affect the possible risks of investors attracting.

2. Research of investment attractiveness of the innovative order

In the course of assessing the capabilities of a developing enterprise diversifying to fulfill new innovative orders, a component architecture in the presentation of a complex product, which may contain both "old" known components that need to be adapted (changed) to the technical requirements of the new product and new innovative components that add investment attractiveness due to possible competitiveness in the market of high-tech products.

The following main indicators will be used in order to assess the creation of a new product:

- percentage ratio of new and "old" components – P (%);
- innovative attractiveness (in the form of level or qualitative assessments) – Q;
- cost of creating a new product – W;
- timelines of creation of a new product – T;
- risks of creating a new product - R.

The research solution will be carried out in three stages:

1. Evaluation of innovativeness of a single order for the manufacture of a new high-tech product.
2. Estimation of diversified orders portfolio of the developing enterprise.
3. Modeling the execution of the orders portfolio.

For the purpose of studying the innovativeness of a single order, the expert opinion designed in the form of a set of estimates and presented using a multifactorial experiment plan was used.

A complete factorial experiment enables assessment of the product innovativeness by changing the values of factors. Individual components of the product can be used as factors in the form of new or "old" components.

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Let us assume that individual component in the form of a factor x_j equals:

x_j=1, if the j-th component has an innovative nature, i.e. is new;

x_j=0, if the j-th component was taken from past experience (in the form of "old" one) with possible further adaptation to technical requirements of the new product.

The complete factorial experiment (PFE) contains a complete list of values of all factors and has the following form for three components in the new product (Fig. 1):

No.	x_1	x_2	x_3	P(%)	Q	W	T	R
1	0	0	0					
2	0	0	1					
3	0	1	0					
4	0	1	1					
5	1	0	0					
6	1	0	1					
7	1	1	0					
8	1	1	1					

Fig. 1. Complete factorial experiment

Here, the combination 010, for instance, means that in the new product, the first and third components were taken from past experience, whereas the second is a new component. As an example, various models of the created family of aircraft An-178 can be considered, where the main components are fuselage (x1), engine (x2), avionics (x3). Then 111 means the complete innovation of the product, which contains new components. The right columns in the PFE plan contains "responses" of experiment which are expert estimations of innovation in the form of P (%) values, and also estimations concerning investment attractiveness (Q), costs for creation (W), timelines of manufacturing (T), risks of product creation (R).

This experimental plan is multi-responsive and enables simultaneous evaluation of the indicators of interest: P (%), Q, W, T, R. Both quantitative and qualitative values of indicators can be used as expert estimates. For the quantitative values of indicators, it is possible, from the results of the experiment with the participation of experts, to build a regressive correlation and to identify significant factors (components) that affect investment attractiveness. Further is an illustrated example of PFE use for expert evaluation of possible modifications of An-178 (Fig. 2).

In this example, P (%) corresponds to the percentage ratio of new/"old" components, Q is a quantitative assessment of the level of investment attractiveness on a ten-point scale; W, T, R are costs, production timelines, risks, which are presented in the quality scale:

A – the best value of the indicator;
B – excellent value of the indicator;
C – good value of the indicator;
D – fair value of the indicator;
E – satisfactory value of the indicator.

No.	x_1	x_2	x_3	P(%)	Q	W	T	R
1	0	0	0	0	1	A	A	A
2	0	0	1	10	2	B	B	A
3	0	1	0	10	3	B	C	C
4	0	1	1	20	5	C	C	C
5	1	0	0	10	4	B	D	C
6	1	0	1	20	6	C	D	C
7	1	1	0	20	7	D	D	D
8	1	1	1	30	10	E	E	E

Fig. 2. An illustrated example of a multi-response complete factorial experiment

With the help of PFE and using a standard method of calculation one can obtain the following regression using quantitative values of investment attractiveness:

$$Q = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_{12}x_1x_2 +$$
$$+b_{13}x_1x_3 + b_{23}x_2x_3 + b_{123}x_1x_2x_3.$$

In the course of calculations for PFE, it is necessary to represent zero as the lower value of "-1"factor, and to represent one as the upper value of "+1" factor.

Taking into consideration the importance of the linear part of regression dependence only for assessment of importance of factors, we obtain:

$$y = b_0 + b_1x_1 + b_2x_2 + b_3x_3 =$$
$$= 4,75 + 2x_1 + 1,5x_2 + x_3.$$

This shows that for illustrated example of assessing the investment attractiveness of An-178 aircraft, the important factor is the modification of the fuselage, less important factor is the modification of the engine, and the least important one is the avionics.

The values of all P (%), Q, W, T, R indicators in both quantitative and qualitative forms of presentation shall be taken into account to choose an aircraft model interesting for investors.

For this purpose the lexicographic ordering of values of indicators is used. The values of indicators are placed in the form of a series, where the most important indicator is in the first place, and the least important is in the last place.

Suppose the indicators are ranged in the following importance order:

Q, W, T, R.

Then estimates of all possible options for upgrading An-178 can be represented as a set:

1. 1, A, A, A
2. 2, B, B, A
3. 3, B, C, C
4. 5, C, C, C
5. 4, B, D, C
6. 6, C, D, C
7. 7, D, D, D
8. 10, E, E, E.

Then options for aircraft modification are lexicographically organized and we obtain the following:

8. 10, E, E, E
7. 7, D, D, D
6. 6, C, D, C
4. 5, C, C, C
5. 4, B, D, C
3. 3, B, C, C
2. 2, B, B, A
1. 1, A, A, A.

Investment attractiveness will be greatest in the 8th option. However, this option has the worst values of all recent indicators (W, T, R). To choose a compromise option, the "threshold" value of indicators will be used, which is set by experts in the form of **5, B, B, B** "word". Taking into account the lexicographic ordering, this "word" is put in the received ordered list of options for aircraft modification. We obtain the following:

8. 10, E, E, E
7. 7, D, D, D
6. 6, C, D, C

5, B, B, B

4. 5, C, C, C
5. 4, B, D, C
3. 3, B, C, C
2. 2, B, B, A
1. 1, A, A, A.

This demonstrated that the compromise option with innovative attractiveness is in the set:

8. 10, E, E, E
7. 7, D, D, D
6. 6, C, D, C.

Given the values of indicators W, T, R, it is advisable to invest in the modernization project 7. 7, D, D, D with good values of W, T, R indicators and fairly good investment attractiveness.

3. Justification of the diversified orders portfolio composition

The process of forming a diversified orders portfolio of a developing enterprise shall take into account possible large dimension of the problem, which is associated with both the number of components in the architecture of innovative products and the number of orders in the portfolio [7]. Therefore, to solve this problem the methods of integer (Boolean) programming are used. For this purpose variables x_{kj} are introduced, where:

$$x_{kj} = \begin{cases} 1, \text{ if the } j_{th} \text{ innovation component} \\ \quad \text{will be used in the } k_{th} \text{ product;} \\ 0, \text{ if the } j_{th} \text{ component from previous} \\ \quad \text{experience will be used in the } k_{th} \text{ product.} \end{cases}$$

Then w_{kj} is the cost of creating the j-th innovative component in the k-th product;

w'_{kj} is the cost of adapting the j-th component taken from past experience to the technical requirements of the k-th product;

t_{kj} is the timelines for creation of the j-th innovative component for the k-th product;

t'_{kj} is the timelines for adaptation of the j-th component taken from past experience to the technical requirements of the k-th product;

r_{kj} is the risks associated with creation of the j-th innovative component of the k-th product;

r'_{kj} is the risks of adaptation of the j-th component taken from past experience to the technical requirements of the k-th product.

The costs of executing a diversified orders portfolio, which consists of N orders (products), include two components:

$$W = \sum_{k=1}^{N}\sum_{j=1}^{n_k}(1-x_{kj})w'_{kj} + \sum_{k=1}^{N}\sum_{j=1}^{n_k}x_{kj}\cdot w_{kj},$$

where $(1-x_{kj})w'_{kj}$ is the costs associated with the use (adaptation) of the j-th component taken from past experience to the technical requirements of the k-th product;

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$x_{kj} \cdot w_{kj}$ are the costs associated with creating an innovative component in the k-th product.

The timelines of execution of the orders portfolio are calculated as follows:

$$T = \sum_{k=1}^{N}\sum_{j=1}^{n_k}(1-x_{kj})t'_{kj} + \sum_{k=1}^{N}\sum_{j=1}^{n_k}x_{kj} \cdot t_{kj}.$$

Risks of realization of the diversified orders portfolio are calculated as follows:

$$R = \sum_{k=1}^{N}\sum_{j=1}^{n_k}(1-x_{kj})r'_{kj} + \sum_{k=1}^{N}\sum_{j=1}^{n_k}x_{kj} \cdot r_{kj}.$$

The main criterion related to the investment attractiveness of the diversified portfolio of N orders (products) is calculated as follows:

$$Q = \sum_{k=1}^{N}\sum_{j=1}^{n_k}(1-x_{kj})q'_{kj} + \sum_{k=1}^{N}\sum_{j=1}^{n_k}x_{kj} \cdot q_{kj},$$

where q'_{kj} is investment attractiveness of the k-th order, which uses the j-th component taken from past experience;

q_{kj} is investment attractiveness of the k-th order, which uses the j-th innovation component.

The investment attractiveness of the diversified orders portfolio shall be maximized:

$$\max Q, Q = \sum_{k=1}^{N}\sum_{j=1}^{n_k}(1-x_{kj})q'_{kj} + $$
$$+\sum_{k=1}^{N}\sum_{j=1}^{n_k}x_{kj} \cdot q_{kj}.$$

In addition, it is necessary to meet the restrictions on costs, timelines for the orders portfolio and risks:

$$W \le W, W = \sum_{k=1}^{N}\sum_{j=1}^{n_k}(1-x_{kj})w'_{kj} + \sum_{k=1}^{N}\sum_{j=1}^{n_k}x_{kj} \cdot w_{kj},$$
$$T \le T, T = \sum_{k=1}^{N}\sum_{j=1}^{n_k}(1-x_{kj})t'_{kj} + \sum_{k=1}^{N}\sum_{j=1}^{n_k}x_{kj} \cdot t_{kj},$$
$$R \le R, R = \sum_{k=1}^{N}\sum_{j=1}^{n_k}(1-x_{kj})r'_{kj} + \sum_{k=1}^{N}\sum_{j=1}^{n_k}x_{kj} \cdot r_{kj},$$

where W is eligible costs associated with the execution of the diversified orders portfolio;

T is admissible timelines of execution of diversified orders portfolio;

R is acceptable risks associated with the implementation of a diversified orders portfolio.

4. Simulation of the diversified orders portfolio execution

For the purpose of modeling the diversified orders portfolio, an applied information technology of agent-based simulation modeling was developed [8]. The modeling will take into account the timeline of execution of the orders portfolio, as well as the impact of risks on the timelines and realization of orders.

Simulation modeling of the diversified orders portfolio of enterprise requires the following types of agents:

1. Agent of generation of the order execution commencement.
2. Agent of previous work related to the preparation of manufacturing of product components (new or "old").
3. Agent for creation of a new component.
4. Agent for adaptation of components taken from past experience to the technical requirements of the new product.
5. Agent connected with logistics of moving manufactured components to assembly production.
6. Agent of preparation of assembly production of a new high-tech product.
7. Agent of assembly work on the manufactured new product.
8. Agent of simulation of risks concerning performance of works during creation of a new product.
9. Agent MONITOR to control the progress of simulation event modeling.
10. Agent of description of component architecture of a new product.
11. Agent of simulation results.

Fig. 3 shows a block diagram of the agent-based model for implementation of diversified orders portfolio of the developing enterprise.

Conclusions

A method for analyzing the diversified orders portfolio to assess the investment attractiveness of a developing enterprise was developed. The method is complex because it contains an analysis of the investment attractiveness of a single innovation order, a study of the diversified orders portfolio, as well as modeling the implementation of a diversified orders portfolio in terms of risks and restrictions of the developing enterprise.

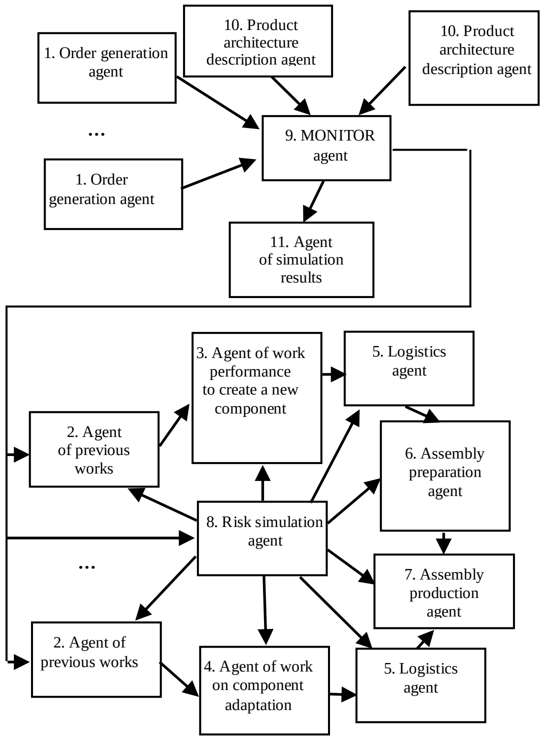

Fig. 3. Block diagram of agent-based modeling of the diversified orders portfolio of enterprise

Modern methods of system analysis, component design, multi-criteria optimization, expert evaluation and agent-based modeling in the form of applied information technology are used.

The proposed approach shall be used in the tasks of strategic planning of a developing enterprise to ensure its investment attractiveness and competitiveness in the market of high-tech products.

References (GOST 7.1:2006)

1. System modeling of goals and directions in projects of innovative development of high-tech enterprise [Text] / O. E. Fedorovich, O. S. Uruskyi, V. V. Kosenko, Yu. L. Pronchakov // Information systems and innovative technologies in project and program management. Collective monograph edited by I. Lindle, I. Chumachenko, V. Timofeyev. – Riga : ISMA, 2020. – P. 39-53.

2. Models and methods of management a professional level of internal project participants [Text] / O. V. Maleyeyeva, N. Yu. Nosova, R. V. Artyuch // Information systems and innovative technologies in project and program management. Collective monograph edited by I. Lindle, I. Chumachenko, V. Timofeyev. – Riga : ISMA, 2019. – P. 35-47.

3. Федорович, О. Є. Метод формування логістичних транспортних взаємодій для нового портфелю замовлень розподіленого віртуального виробництва [Текст] / О. Є. Федорович, Ю. Л. Прончаков // Радіоелектронні і комп'ютерні системи. – 2020. – № 2(94). – С. 102-108. DOI: 10.32620/reks.2020.2.09.

4. Decomposition Method for Synthesizing the Computer System Architecture [Text] / V. Mukhin, N. Kuchuk, N. Kosenko, R. Artiukh, A. Yelizyeva, O. Malyeyeva, H. Kuchuk // Advances in Intelligent Systems and Computing, 2020, vol. 938. Springer, Cham. – P. 298-300. DOI: 10.1007/978-3-030-16621-2_27.

5. Yin, Yong. Product architecture, product development process, system integrator and product global performance [Text] / Yong Yin, Ikou Kaku, ChenGuang Liu // Production Planning & Control. The Management of Operations. – 2014. – Vol. 25, Iss. 3. – P. 203-219. DOI: 10.1080/09537287.2012.660208.

6. Fixson, Sebastian K. A roadmap for product architecture costing [Electronic resource] / Sebastian K. Fixson. – Access mode: https://faculty.babson.edu/sfixson/Fixson%202006%20ProdFamilyChapterPA costing.pdf. – 20.11.2020.

7. Ernst, H. Innovation portfolio management: an understudied driver of innovation success? [Text] / H. Ernst, U. Lichtenthaler // International Journal of Technology Intelligence and Planning. – 2009. – Vol. 5, No. 2. – P. 111-117. DOI: 10.1504/IJTIP.2009.024173.

8. Кравец, Р. О. Динамічна координація стратегий мультіагентних систем [Текст] / Р. О. Кравец // Бюлетень Національного університету «Львівська політехніка». – 2011. – № 699. – Р. 134–144.

References (BSI)

1. Fedorovich, O. E, Uruskyi, O. S., Kosenko, V. V., Pronchakov, Yu. L. System modeling of goals and directions in projects of innovative development of high-tech enterprise. *Information systems and innovative technologies in project and program management. Collective monograph edited by I. Lindle, I. Chumachenko, V. Timofeyev.* Riga, ISMA, 2020, pp. 39-53.

2. Maleyeyeva, O. V., Nosova, N. Yu., Artyuch, R. V. Models and methods of management a professional level of internal project participants. *Information systems and innovative technologies in project and program management. Collective monograph edited by I. Lindle, I. Chumachenko, V. Timofeyev.* Riga, 2019, pp. 35-47. ISBN 978-9984-891-08-8.

3. Fedorovich, O., Pronchakov, Yu. Metod formuvannya lohistychnykh transportnykh vzayemodiy dlya novoho portfelyu zamovlen' rozpodilenoho virtual'noho vyrobnytstva [Method to organize logistic transport interactions for the new order portfolio of distributed virtual manufacture]. *Radioelektronni i komp'uterni sistemi – Radioelectronic and computer systems*, 2020, vol. 2(94), pp. 102-108. DOI: 10.32620/reks.2020.2.09.

ISSN 1814-4225 (print)
ISSN 2663-2012 (online)

4. Mukhin, V., Kuchuk, N., Kosenko, N., Artiukh, R., Yelizyeva, A., Malyeyeva, O., Kuchuk, H. Decomposition Method for Synthesizing the Computer System Architecture. *Advances in Intelligent Systems and Computing*, 2020, vol. 938. Springer, Cham., pp. 298-300. DOI: 10.1007/978-3-030-16621-2_27.

5. Yin, Yong., Kaku, Ikou., Liu, ChenGuang. Product architecture, product development process, system integrator and product global performance. *Production Planning & Control. The Management of Operations*, 2014, vol. 25, iss. 3, pp. 203-219. DOI: 10.1080/09537287.2012.660208.

6. Fixson, Sebastian K. *A roadmap for product architecture costing.* Available at: https://faculty.babson.edu/sfixson/Fixson%202006%20ProdFamilyChapterPAcosting.pdf. (accessed 20.11.2020).

7. Ernst, H., Lichtenthaler, U. Innovation portfolio management: an understudied driver of innovation success? *International Journal of Technology Intelligence and Planning*, 2009, vol. 5, no. 2, pp. 111-117. DOI: 10.1504/IJTIP.2009.024173.

8. Kravets, P. O. Dynamichna koordynatsiya stratehiy mul′tyahentnykh system [Dynamic coordination of multi-agent systems strategies]. *Bulletin of the National University "Lviv Polytechnic"*, 2011, no. 699, pp. 134-144.

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МЕТОД И ИНФОРМАЦИОННАЯ ТЕХНОЛОГИЯ ИССЛЕДОВАНИЯ КОМПОНЕНТНОЙ АРХИТЕКТУРЫ ИЗДЕЛИЙ ДЛЯ ОБОСНОВАНИЯ ИНВЕСТИЦИЙ ВЫСОКОТЕХНОЛОГИЧЕСКОГО ПРЕДПРИЯТИЯ

О. Е. Федорович, О. С. Уруский, Ю. Л. Прончаков, М. И. Луханин

Обоснование и выбор стратегии развития промышленных предприятий, связанных с созданием высокотехнологичной продукции, зависит от инвестирования этих предприятий в условиях ограниченных возможностей финансирования, наличия политических и экономических вызовов и угроз. Привлекательность продукции зависит от возможной конкурентоспособности и инновационности продукции, которую предприятие может поставлять на рынки высокотехнологичных изделий. В публикации предложен новый компонентный метод, который позволяет оценить архитектуру нового изделия, с точки зрения инновационной и инвестиционной привлекательности.

Проводится исследование инновационности в зависимости от состава компонент в архитектуре изделия, которые могут быть как новыми и требуют нового цикла создания, так и и «старыми», теми, которые были взяты из прошлого опыта с возможной адаптацией к техническим требованиям нового изделия. С помощью предложенного многофакторного планирования эксперимента оценивается основные показатели нового изделия: инвестиционная привлекательность, расходы, сроки и риски выполнения заказов. С использованием лексикографического упорядочения вариантов, осуществляется компромиссный выбор оптимального варианта с учетом ограниченных возможностей предприятия. Для оптимизации диверсификационного портфеля заказов использован метод целочисленного (булевого) программирования. В качестве целевой функции используется инвестиционная привлекательность. В ограничениях учитываются допустимые расходы, сроки и риски выполнения диверсификационного портфеля заказов.

В последней части статьи, для оценки сроков выполнения заказов и влияния рисков на реализуемость диверсификационного портфеля заказов, использован метод агентного имитационного моделирования в виде прикладной информационной технологии.

В целом, предложенный метод направлен на реализацию задачи стратегического планирования развивающегося предприятия и позволяет оценить его конкурентоспособность, а также возможность получения инвестиций.

Ключевые слова: компонентная архитектура; высокотехнологичное производство; конкурентоспособность; инвестиционная привлекательность; инновационность высокотехнологичного изделия; оптимизация диверсификационного портфеля заказов; имитационное агентное моделирования; прикладная информационная технология.

МЕТОД ТА ІНФОРМАЦІЙНА ТЕХНОЛОГІЯ ДОСЛІДЖЕННЯ КОМПОНЕНТНОЇ АРХІТЕКТУРИ ВИРОБІВ ДЛЯ ОБҐРУНТУВАННЯ ІНВЕСТИЦІЙ ВИСОКОТЕХНОЛОГІЧНОГО ПІДПРИЄМСТВА

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Обґрунтування та вибір стратегії розвитку промислових підприємств, пов'язаних зі створенням високотехнологічної продукції, залежить від можливостей інвестування цих підприємств в умовах обмежених можливостей фінансування, наявності політичних та економічних ризиків та загроз. Привабливість продукції залежить від конкурентоспроможності та інноваційності продукції, яку підприємства можуть поставляти на ринки високотехнологічних виробів. У публікації запропоновано компонентний метод, який дозволяє оцінити архітектуру нового виробу з точки зору інноваційності та інвестиційної привабливості.

Проводиться дослідження інноваційності у залежності від складу компонент в архітектурі виробу, які можуть бути як новими та потребують нового циклу створення та «старими», тими, які було взято з минулого досвіду з можливою адаптацією до технічних вимог нового виробу. За допомогою запропонованого багатофакторного планування експерименту оцінюється основні показники нового виробу: інвестиційна привабливість, витрати, строки та ризики виконання замовлень. З використанням лексикографічного впорядкування варіантів здійснюється компромісний вибір оптимального з урахуванням обмежених можливостей підприємства. Для оптимізації диверсифікаційного портфелю замовлень використано метод цілочисельного (булевого) програмування. В якості цілевої функції використовується інвестиційна привабливість. В обмеженнях враховуються допустимі витрати, строки та ризики виконання портфелю замовлень.

У останній частині публікації, для оцінки строків виконання замовлень та вплив ризиків на реалізованість диверсифікаційного портфелю замовлень, використано метод агентного імітаційного моделювання у вигляді прикладної інформаційної технології.

В цілому, запропонований метод спрямовано на реалізацію задачі стратегічного планування підприємства, що розвивається, та дозволяє оцінити його конкурентоспроможність, а також можливість залучення інвестицій.

Ключові слова: компонентна архітектура; високотехнологічне виробництво; конкурентоспроможність; інвестиційна привабливість; інноваційність високотехнологічного виробу; оптимізація диверсифікаційного портфелю замовлень; імітаційне агентне моделювання; прикладна інформаційна технологія.

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