

PAPER • OPEN ACCESS

Diversification instruments for machine-building enterprises

To cite this article: M A Prilutskaya *et al* 2020 *IOP Conf. Ser.: Mater. Sci. Eng.* **971** 052012

View the [article online](#) for updates and enhancements.

 <p>The Electrochemical Society Advancing solid state & electrochemical science & technology 2021 Virtual Education</p> <p>Fundamentals of Electrochemistry: Basic Theory and Kinetic Methods Instructed by: Dr. James Noël Sun, Sept 19 & Mon, Sept 20 at 12h–15h ET</p> <p>Register early and save!</p>	
--	--

Diversification instruments for machine-building enterprises

M A Prilutskaya*, A D Murukina, L M Tipner and N A Kalinina

Institute of New Materials and Technologies, Ural Federal University named after the first President of Russia B.N. Yeltsin, 620002, 19 Mira street, Ekaterinburg, Russia

*M.A.Prilutskaya@urfu.ru

Abstract. Improving the competitiveness of engineering products, import substitution and increasing high-tech exports are priority government tasks. The development of the high-tech products production is ensured through the diversification of engineering enterprises. The study revealed a number of problems that machine-building enterprises are facing when mastering the production of new products. The diversification methods and tools used largely determine the effectiveness of activities throughout the entire product life cycle. The authors consider the value analysis method as a key instrument for implementing the diversification strategy. Value analysis includes a variety of instruments, such as conducting marketing and patent research, reverse engineering, cooperative chain design, and others. The determination of the company's preparedness for diversification is of particular importance. The article presents an approach to assessing the key functional areas of the enterprise that indicate its preparedness for diversification.

1. Introduction

The main tasks of industrial development, defined by the Consolidated Strategy for the Development of Manufacturing Industry of the Russian Federation [1] until 2024 and for the period until 2035, include such trends as stimulating demand for domestic products and increasing the share of non-resource and non-energy export. A significant part of such export should consist of mechanical engineering products [2].

For many enterprises, diversification aimed at developing the production of new competitive products is the main way to achieve their goals. The high level of technical complexity and the long life cycle of engineering products create special requirements for diversification instruments. Determining the parameters of the product that create value for the consumer, establishing a fair competitive price and calculating the target cost become the most important tasks [3]. According to the authors, the effectiveness of the instruments used directly depends upon the preparedness of the enterprise's internal functional systems for diversification.

The objectives of the study - to classify the problems encountered by machine-building enterprises in the process of new products development; to examine the diversification instruments corresponding to the peculiarities of engineering products; to propose an approach to assessing the preparedness of an enterprise for diversification.

2. Actual diversification problems of machine-building enterprises

According to Peter Drucker, managers can use two approaches that provide a diversification strategy – development from scratch and acquisition [4]. Each approach requires the use of specific instruments.



Content from this work may be used under the terms of the [Creative Commons Attribution 3.0 licence](https://creativecommons.org/licenses/by/3.0/). Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.

As stated above, the state sets the task for machine-building enterprises to ensure the production of competitive export-oriented products through the efficient use of existing capacities, competencies and the development of cooperation. In this case, the diversification strategy is implemented through the development of the new high-tech products production. The development and the production of new products become effective when the value is created for the consumer (compliance of the product parameters with the consumer requirements) and the economic result is ensured for the manufacturer (compliance of actual costs with the target cost) throughout the life cycle [5].

The results of the diversification problems study conducted by the authors of the article in 2017-2018, as well as studies of other authors [6-9] made it possible to identify the most actual problems in the high-tech products production development. For research purposes, the problems are grouped in accordance with the main stages of the product life cycle, and the results are presented in table 1.

Table 1. Actual problems of diversification.

No.	Life cycle stages	Problems	Results
1	Research and Engineering	<ul style="list-style-type: none"> - lack of reliable and accessible statistics on target markets; - lack of information on the needs and requirements of targeted consumer focus groups; - difficulties in conducting an audit of enterprise capacities and competencies. 	unreasonable selection of a product for development and production launch
2	Design	<ul style="list-style-type: none"> - lack of data on the product target parameters; - the impossibility of design and technological decisions verification; - lack of established criteria for decisions optimality. 	development of a non-competitive product and inefficient technological processes; long product development time
3	Production	<ul style="list-style-type: none"> - unreasonable organization of labor and production; - underdeveloped research and production cooperation; - dependency on imported component base; - insufficient use of quality management tools. 	actual costs do not allow for a competitive price; reduced product quality
4	Delivery (realization)	<ul style="list-style-type: none"> - highly competitive markets are dominated by foreign manufacturers, creating high entry barriers; 	low sales and growth in production costs; disruption of terms and volumes of supplies
5	Operation (consumption, storage)	<ul style="list-style-type: none"> - low customer focus. - lack of experience with life cycle contracts; - insufficient monitoring of customer satisfaction; - inefficient work with claims; - long time for troubleshooting. 	cost of ownership exceeds the optimal level for the consumer
6	Utilization	<ul style="list-style-type: none"> - lack of experience with life cycle contracts in a circular economy; - high requirements of foreign markets for the environmental friendliness of industrial products. 	the cost and disposal risks not taken into account at the stage of product design increase

The listed problems have a clearly expressed continuity and ability to increase their influence as they move from one stage of the life cycle to another. This necessitates the use of such diversification tools that provide efficiency throughout the entire life cycle and allow us, firstly, to select and design the best product solution, and secondly, to ensure the target cost.

3. Value analysis as an instrument for diversification of machine-building enterprises

Value analysis (VA) combines many instruments, such as comparative competitive analysis, designing a value chain, calculating fair prices using normative and parametric methods, determining target costs, building a patent landscape, reverse engineering, algorithms for solving inventive problems, designing cooperation chains, etc. The VA has its own tasks at each stage of the life cycle [10]. In relation to the development of new products, VA instruments in an enlarged form is shown in Figure 1.

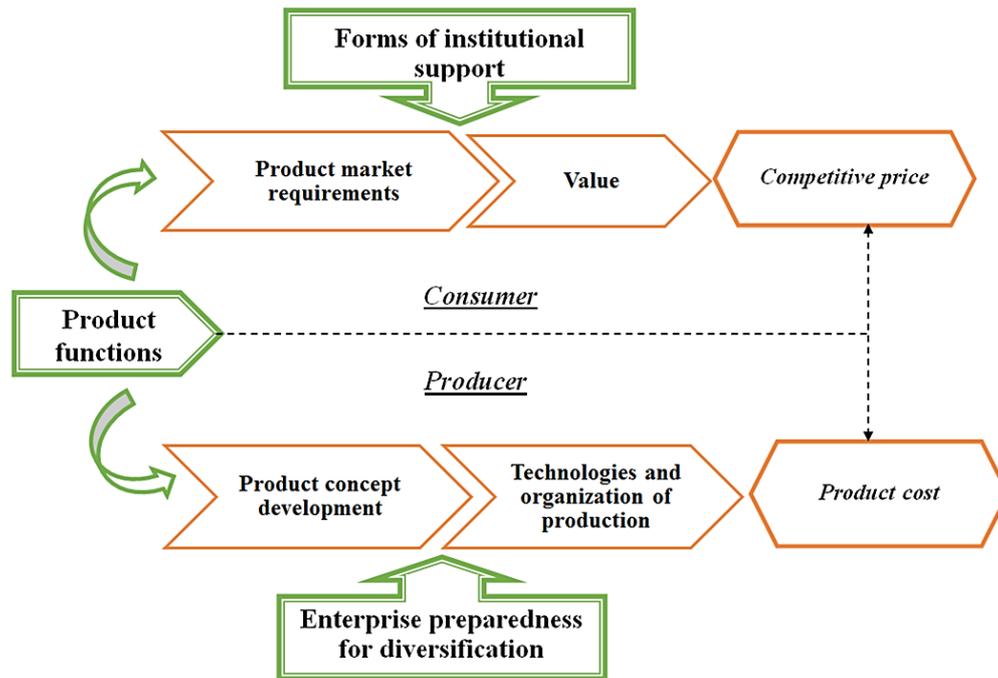


Figure 1. Value analysis as a diversification instrument.

The effectiveness of VA instruments application directly depends on the company's internal preparedness for diversification and factors of external institutional support. External factors include various forms of financial, informational, organizational and regulatory support of the government, including the implementation of federal targeted programs and resources of national projects. The authors pay special attention to assessing the company's preparedness for diversification.

4. Methodology for assessing the enterprise preparedness for diversification

Successful implementation of the diversification strategy is associated with the preparedness of the enterprise's capacities for the production of new products, the presence of managerial, design and marketing competencies.

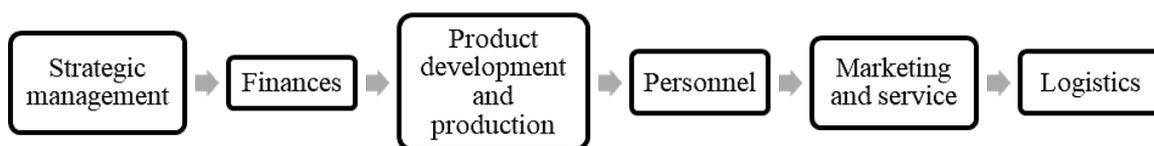


Figure 2. Functional areas of diversification factors.

In previous publications [11, 12], the authors proposed a system of diversification success factors, including the parameters of the external and internal environment. Internal factors are classified according to the functional basis into 7 main groups (Fig. 2). This article proposes a

model for the quantitative assessment of factors, the use of which allows us to make a diagnosis of the company's preparedness for diversification.

As part of the study, the significance of internal factors was assessed using the T.L. Saati method based on the example of several machine-building enterprises. The hierarchy analysis method is based on pairwise comparisons of alternative options according to various criteria. A nine-point scale and ranking of a set of alternatives for all criteria and goals are used [13, 14]. Thus, an expert assessment of the factors significance was carried out in respect to the achievement of the goal – to master the production of new competitive high-tech products. Elements of one level of the hierarchy are compared in pairs by the strength of their influence on the elements of a higher level. The criteria for assessing the significance are given in the table 2. Comparing an element with itself, we get equal significance of “1”, i.e. the main diagonal of the matrix consists of ones. The hierarchy analysis method uses a 9-point scale; the results are entered into the matrix of paired comparisons.

Table 2. The scale of relative importance.

Degree of importance	Definition	Explanation
1	Equal importance	Actions contribute equally to the goal
3	Some predominance of the significance of one action over another (weak significance)	Experience and judgment give little preference to one action over another
5	Essential or strong significance	Experience and judgment strongly favor one action over another
7	Very strong or obvious significance	The preference of one action over another is very strong. Its superiority is almost obvious
9	Absolute significance	Evidence of a preference for one action over another is highly convincing.
2, 4, 6, 8	Intermediate values between adjacent scale values	A situation where a compromise solution is needed

At first, we find the sum of the elements of each column. Then it is necessary to divide the elements of the matrix by the sum of the elements of the corresponding column. These actions are called matrix normalization. Matrixes of paired comparisons are compiled for each group of factors. As an example, the results for the functional area “Product development and production” are given (Tables 3, 4).

Table 3. Matrix of pairwise comparisons for factors of the group “Product development and production”

Factors of the group “Product development and production”	1	2	3	4	5
1	1	5	3	3	7
2	1/5	1	1/7	1/7	1/3
3	1/3	7	1	3	1/3
4	1/3	7	1/3	1	1/3
5	1/7	3	3	3	1
Sum	2.01	23.00	7.48	10.14	9.00

This group contains the following list of factors:

1. R&D experience;
2. Availability of technological competencies;
3. Preparation of production for the release of high-tech products with a target cost;
4. Availability of production capacity to produce high-tech products;

5. Organization of operational production management (implementation of the MES system).

The results showed that in order to achieve the goal (to master the production of new competitive high-tech products) the factor “R&D experience” takes on the greatest importance (44%). The factors “Organization of operational production management” (20%) and “Preparation of production for the release of high-tech products with a target cost” (19%) are next in importance.

Table 4. Weights of factors of the group “Product Development and Production”

A _{ij}	1	2	3	4	5	Average value	Weight in percentage
1	0.50	0.22	0.40	0.30	0.78	0.44	44%
2	0.10	0.04	0.02	0.01	0.04	0.04	4%
3	0.17	0.30	0.13	0.30	0.04	0.19	19%
4	0.17	0.30	0.04	0.10	0.04	0.13	13%
5	0.07	0.13	0.40	0.29	0.11	0.20	20%

Then, an expert assessment of the implementation level of each factors group and elements within the group was made using a scale from 0 to 10 points. 0 points are assigned if the factor is not implemented; 5 points - partially implemented; 10 points - fully implemented (Table 5).

Table 5. Scoring of factors.

Factors	Weight	Assessment scores	Weighted average rating
<i>Factors of the group «Strategic management»</i>			
1-4	$\Sigma=1.00$	Arithmetic average =1.25	$\Sigma=0.2$ points
<i>Factors of the group «Finances»</i>			
1-4	$\Sigma=1.00$	Arithmetic average =7.50	$\Sigma=6.8$ points
<i>Factors of the group «Product development and production»</i>			
1	0.44	10	4.4
2	0.04	0	0.4
3	0.19	10	1.9
4	0.13	10	1.3
5	0.20	5	1.0
	$\Sigma=1.00$	Arithmetic average =7.00	$\Sigma=9.0$ points
<i>Factors of the group «Personnel»</i>			
1-5	$\Sigma=1.00$	Arithmetic average =4.00	$\Sigma=4.5$ points
<i>Factors of the group «Marketing and service»</i>			
1-5	$\Sigma=1.00$	Arithmetic average =2.00	$\Sigma=1.0$ points
<i>Factors of the group «Logistics»</i>			
1-2	$\Sigma=1.00$	Arithmetic average =0	$\Sigma=0$ points

The calculation results showed that the most problematic areas requiring improvement are logistics, strategic management, marketing and service. An in-depth analysis of individual factors related to problem areas should be carried out in the future.

5. Conclusion

Mastering the release of new high-tech products is a serious challenge for the machine-building enterprise. The study showed that the diversification strategy, on the one hand, requires the development of additional competencies in the field of R&D, organization of production, marketing and service, logistics, strategic management. On the other hand, diversification can become a factor of the industry innovative development and open up new product and technological niches for enterprises.

Value analysis tools are needed to make an informed choice of a product solution and to ensure target cost [15]. The proposed methodology for assessing the enterprise's preparedness for diversification allows us to identify areas requiring improvement and timely management decisions.

References

- [1] The official website of the Russian Government URL: <http://government.ru/news/39452/>
- [2] The official website of the Russian Minpromtorg URL: <http://minpromtorg.gov.ru/press-centre/news/#!1340315781>
- [3] Prilytskaya M, Murukina A, Podoliak O 2020 Operation of high-technology product development based on functions and value *IOP Conf. Ser: Mat. Sc. and Eng.* 709(3) 033049 doi: 10.1088/1757-899X/709/3/033049
- [4] Drucker P. 1969 Management's new role *Har. Bus. Rev.* **6** p 49-55
- [5] Leber M, Bastic M, Mavrič M, Ivanišević A 2014 Value Analysis as an Integral Part of New Product Development *Proc. Eng.* **69** p 90–98 doi:10.1016/j.proeng.2014.02.207
- [6] Rylov V, Udalov V 2010 About theoretical and pragmatic aspects of production diversification for conversional engineering enterprises analyzing prospects of systemsituational approach *Omsk Sc. Her.* **6** p 56-61
- [7] Sannikova K and Malikova D Issues of diversification of civilian production at the defense industry enterprises *Soc. Econ. Manag.: Th. Prac.* **32** p 48-51
- [8] Achasov O, Babkin G and Kosenko A 2016 Diversification as a factor in improving the efficiency of the defense industry complex *Armament and Economics* **4** p 19-29
- [9] Diversification of the military-industrial complex - a strategy for change URL: <https://dfnc.ru/reforma/dmitrij-rogozin-kachestvo-grazhdanskoj-produktsii-predpriyatij-opk-vopros-prestizha/>
- [10] Karpunin M 1987 *The practice of functional-cost analysis in the electrical industry* (Moscow: Energoatomizdat) p 288
- [11] Murukina A, Tipner L 2019 Actual problems and monitoring the implementation of conversion success factors *In. Econ. Is.* **9(1)** p 151-166 doi: [10.18334/vinec.9.1.39960](https://doi.org/10.18334/vinec.9.1.39960)
- [12] Murukina A, Tipner L, Kalinina N. 2020 Factors of successful diversification for machine-building enterprises. *IOP Conference Series: Materials Science and Engineering* **709(3)** 033048 doi: 10.1088/1757-899X/709/3/033048
- [13] Saati T, Vargas L. 2012 Models, Methods, Concepts & Applications of the Analytic Hierarchy Process *Springer Science & Business Media Publ* (New York) p 345
- [14] Saati T, Vargas L. 2012 The possibility of group choice: pairwise comparisons and merging functions *Soc. Ch. Welf.* **38(3)** p 481-496 doi: 10.1007/s00355-011-0541-6
- [15] Manuel T 2015 Value Analysis Going into a further dimension *Eng, Tech. & Ap. Sc. Res.* **5(2)** p 781-789