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Technological Audit of the Industrial Cluster Enterprises for the Processing of Forest Waste in the Territory of Yenisei Siberia[1]

Viktor V. Prokhorov[1], Tatyana V. Zelenskaya[2], Marina S. Patrina[3], Yulia A. Anikina[4]

[1] PhD in Economics, Associate Professor at the Department of Organization and Management of Science-Intensive Industries, Siberian State University of Science and Technology
31, Newspaper Krasnoyarsk Worker Avenue, 660037, Krasnoyarsk, Russian Federation
Phone: 7(904)895-88-24
E-mail: krasnoyarsk@naufor.ru
[2]Associate Professor of Economic Sciences, Professor, Director, Scientific and Educational Center for Innovative, Technological and International Development of Programs and Projects, Siberian State University of Science and Technology, 31, Newspaper Krasnoyarsk Worker Avenue, 660037, Krasnoyarsk, Russian Federation
Phone: 7(391)215-96-06
E-mail: tvzel@mail.ru
[3]PhD in Biological Sciences, Krasnoyarsk Regional Center for Biotechnological Engineering
75, Svobodny Avenue, Krasnoyarsk, 660018, Krasnoyarsk, Russian Federation
E-mail: patrinamarina@mail.ru
[4] PhD in Economics, Deputy Director
Scientific and Educational Center for Innovative, Technological and International Development of Programs and Projects
Associate Professor at the Department of International Business
Siberian State University of Science and Technology
31, Newspaper Krasnoyarsk Worker Avenue, 660037, Krasnoyarsk, Russian Federation
Phone: 7(391)213-96-08
E-mail: anikinay@inbox.ru

Abstract
The research subject is the issues related to the technical audit of enterprises in the forestry complex of the Yenisei Siberia macro-region. Methods of conducting a technological audit at an enterprise with their subsequent classification were considered. It is proposed to conduct a technological audit of enterprises within the industrial cluster subject to additional conditions. The study's purpose was to develop a methodology for conducting a technological audit within an industrial cluster for making a management decision to include it in this technological association. The study result was the development of strategic analysis matrices that take into account the readiness levels of an enterprise in various fields of activity in comparison with the required readiness levels of an industrial cluster. A logical diagram of

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the procedure for carrying out procedures for the inclusion of an enterprise in an industrial cluster based on strategic analysis matrices is proposed. The developed technique was tested in the timber industry complex of the Krasnoyarsk Territory.

Keywords: technology audit; industrial cluster; forestry complex; strategic analysis matrices.

Introduction

In the Russian Federation, in the year 2020, due to the coronavirus pandemic and the deterioration in the price situation in the world commodity markets, there was a serious decrease in the national gross domestic product, which, according to various forecasts, may reach from 5 to 7% in the year under review. To reverse this negative trend, the country's government requires decisive steps in the economic sphere.

A plan for such action is at the disposal of the Russian government. They are generally spelled out in several regulatory documents, including the Federal Law named 'The Strategic Planning in the Russian Federation', 'The Industrial Policy in the Russian Federation', the decree of the President of the Russian Federation 'The National goals and strategic objectives for the development of the Russian Federation for the period up to 2024', 'The main directions of activity of the Government of the Russian Federation for the period up to 2024' and some other documents that take into account the coronavirus pandemic.

One of the main documents aimed at the development of the Russian economy is the Federal Law named 'The Industrial Policy in the Russian Federation', which sets the goals and objectives of the country's economic development. So one of the goals of industrial policy is the creation of a high-tech and competitive industry, which should ensure the transition from a resource-based economy to an innovative one. To do this, it is proposed to stimulate business entities in the industrial sphere, to more efficiently use available resources (like natural, labor, financial, and others), to increase labor productivity and to carry out import substitution, etc.

This regulatory document proposes one of the effective mechanisms for the territorial development of industry, which is based on the formation of industrial clusters in the subjects of the federation. Their formation should take into account not only the spatial development strategy of Russia but also the territorial planning schemes of the country and its regions (Federal Law No. 488, 2014).

One of the promising areas for the industrial clusters formation in the country and its regions is the forestry complex, which can use a wide range of renewable and available resources. At the same time, the final product produced in the forestry complex is environmentally friendly and in demand, both on the world market and within the country.

The most promising territory of the country where an active cluster policy can be implemented is Yenisei Siberia. On its territory, there is an opportunity to form several industrial clusters, including based on processing waste from the activities of forestry enterprises.

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It must be said that these wastes are potentially valuable raw materials for the production of biofuels, synthetic rubber, chemical threads, and fabrics made from them, paper, biodegradable packaging materials, wood-based boards, paints and varnishes, feed additives, etc. The point is that more than a dozen sectors of the economy can develop on the territory of Yenisei Siberia due to the processing of forest waste.

At the same time, it is necessary to take into account the fact that this waste is a rather serious problem for the inhabitants of this macro region. For example, in the Krasnoyarsk Territory alone, the annual growth in the volume of such waste is at least 2-3 million tons. At the same time, due to non-observance of safety measures for their storage and storage, constant fires occur, which leads to serious material damage for enterprises and individuals (Krasnoyarsk Region Order No. 271, 2020).

The Russian state stimulates the recycling of forestry waste in the direction of the development of wood chemistry. In particular, within the framework of the national project ‘Ecology’ (2018) and in its federal project ‘Implementation of the best available technologies’ (Decree of the Government of the Russian Federation No. 1458, 2014) it is proposed to develop the processing of waste from the forestry complex associated with the production of cellulose, wood pulp, paper, and cardboard.

As an incentive for the development of this activity within the framework of these projects, it is proposed to subsidize a part of the interest payments (up to 90%) on corporate bond loans at the expense of which this activity is financed. And since the production of cellulose, wood pulp, paper, and cardboard is the primary link in the production of a finished product, it could become the basis for the development of industrial clusters on the territory of Yenisei Siberia (Resolution of the Government of the Russian Federation No. 702, 2016).

The study aimed to develop a methodology for conducting a technological audit of forestry enterprises in Yenisei Siberia to justify their inclusion in industrial clusters for processing forest waste based on the required technological level, which will solve existing environmental problems and organize the production of export-oriented competitive products that meet the parameters of international markets.

Methods

The methodological basis of this study is the systemic and situational approaches. Within the framework of the approaches under consideration, many studies of conducting a technological audit can be distinguished, including one based on determining the technological level of enterprise development. Among them, one can single out studies devoted to the choice of priority technological areas in industry (Khamatkhanova, 2016), scheduling and financial planning based on the level of readiness of an enterprise (Filimonov, 2018), stages of technological audit behavior (Vokina, 2014), establishing uniform requirements for conducting a technological audit (Rykovskiy, 2016 a), accounting risks during technological audit (Ragozina et al., 2020; Anikina et al., 2019; Anikina et al., 2020), organizational and methodological support of technological audit (Rykovskiy, 2018; Rutko, 2012; Rykovskiy, 2016 b) and others.

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The widespread use of industrial clusters is limited by several interrelated technological and economic problems, which generally reduce the efficiency of their use in the country. One of them is the discrepancy between the enterprises included in the cluster in terms of the minimum level of their technological development.

The minimum level of technological development in the complex takes into account a fairly wide range of indicators, including technological and production capabilities, management, marketing, research and financial activities and other indicators of the enterprise. Their inconsistency leads to the emergence of so-called ‘bottlenecks’ within the cluster technological chain, which reduce the productivity of enterprises in the industrial cluster, and also lead to a deterioration in the quality of the final product, which in turn negatively affects its demand.

The fall in demand for the cluster’s products leads not only to a decrease in the efficiency of its activities, but also there is a potential danger of its liquidation. This is also confirmed by the cluster theory, since in this case one of the main conditions for the emergence and development of clusters is violated.

These conditions were formulated by Porter M.E. (2002). In his cluster model, he singled out four such main conditions (acting forces), including: the presence of production factors; availability of state support; availability of demand; presence of related and supporting industries. Therefore, the drop in demand and general casts doubt on the future of any cluster. Therefore, to avoid such negative consequences, it is necessary to pay special attention when deciding whether to include specific enterprises in the industrial cluster.

It must be said that the procedure for inclusion in an industrial cluster is regulated by legislation, where the main such normative document is the resolution of the Government of the Russian Federation named ‘Industrial clusters and specialized organizations of industrial clusters’ No. 779 (2015, July 31). It spelled out a certain procedure for the participation of enterprises in the activities of the industrial cluster. All candidates for participation in its activities legally formalize their relationships within its framework. To do this, they sign an agreement with a specialized organization of the industrial cluster, which performs the function of a management company (like organization, methodology, etc.).

To avoid the occurrence of this problem, it becomes necessary to conduct a feasibility study for the inclusion of certain enterprises in the emerging or existing industrial cluster. This justification should be carried out based on analytical objective data on the enterprises in question. They can be obtained based on conducting a technological audit on the data of enterprises, which is an assessment of the state and capabilities of the organization's production and technological base, the results of intellectual activity and several other factors. This fully applies to industrial clusters in the forestry complex, both in Russia and other states with forest resources.

A technology audit allows you to evaluate a wide range of data, including technological and production capabilities, human resources, management, marketing, research and development and financial activities, etc. The analytical information obtained as a result of the technological audit makes it possible to assess the current and possibly future technical level

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of the enterprise's development, which makes it possible to manage the risks associated with the possible loss of material, financial, human and other resources. All this makes it possible to conclude the possibility of including an enterprise in an industrial cluster or its exclusion, both at the stage of its formation and at the stage of its activity.

When conducting a technological audit of an enterprise within an industrial cluster, a certain methodological problem arises, which is associated with the accounting and analysis of information in conjunction with other enterprises belonging to the industrial cluster. This requires new methodological approaches to assessing the level of technological development of enterprises in the cluster. To decide on new approaches to conducting a technology audit, it is necessary to carry out a theoretical generalization of domestic and foreign experience on this topic.

Results

It should be noted that purely intuitively, the basic elements of technological audit began to be applied back in the 19th century in the production of technically complex products. But methodologically, it began to take shape in the second half of the 20th century. And today, depending on the industry and the tasks solved during the technological audit, there is a fairly wide list of methods for its implementation, which can be conditionally divided into several groups.

The first group, which can be attributed to all methods based on the principles proposed in the 1970s of the twentieth century by the National Aeronautics and Space Administration of the United States (NASA). They were formulated to address issues that were identified by the US Audit Office in the course of audits of national aerospace programs. In particular, it was revealed that the costs of the programs exceed the funds allocated for their implementation and there is a serious lag behind the schedules of work on them. Based on this, it was concluded that the main reason that led to such unfavorable consequences was an incorrect assessment of the degree of readiness of technologies and production for the release of new aerospace products.

To eliminate this reason, NASA proposed a technique called the Technology Readiness Level or TRL. In the methodology, seven levels of technology readiness were initially identified, and then their number was increased to nine, where the first six levels fall on the research stage, the seventh and eighth levels are at the development stage, and at the ninth level we are talking about serial production of the product.

Later, it was modified and acquired a more modern look due to the use of several additional levels of readiness for various areas of enterprise activity, including Manufacturing Readiness Level or MRL, Commercialization Readiness Level or CRL, Engineering Readiness Level or ERL, Organizational Readiness Level or ORL, Investment Readiness Level or IRL, Benefits and Risks Level or BRL. Their analysis makes it possible to timely determine future technological, production, sales and other problems (material, temporary, etc.) associated with the creation and development of new products by the enterprise, and therefore to respond to them in time for all participants in this process (owners, investors, financial organizations, government agencies, etc.). It should be noted, however, that these levels of

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readiness can be applied both jointly and separately (Mankins, 1995; Sadin et al., 1989; Hirshorn and Sharon, 2016; ISO 16290:2013 Space systems, 2013).

NASA's methodology has also been developed in the Russian Federation. It, as in the United States, began to be used primarily in the aviation and space industry under the name Technology Readiness Level or TRL. It was proposed by the National Research Center 'Institute named after Zhukovsky N.Y.', and in 2017 this technique was formalized in the form of GOST R 58048-2017 (2017), as 'Guidelines for assessing the level of maturity of technologies'.

These guidelines use the term maturity to assess the development of technologies and systems with their application. It characterizes a specific technology in its development within the life cycle - from a scientific idea to practical application. The very same assessment of the achievement of a particular maturity is carried out based on the use of scales of readiness levels. Like NASA, it allows you to identify risks at an early stage, and then to reduce them, when implementing projects and programs related to the development of technologies and components of complex technical systems, including those associated with the excess of actual costs over planned ones, delays in terms of work execution, etc.

When assessing the level of maturity of technology and systems with its application in the guidelines, it is recommended to evaluate not all elements of a technology (system), but only critical technology elements or CET. It is understood as such an element, on the compliance of which with the operational requirements the effectiveness and efficiency of the technology (system) depends. It is critical technology elements or CET that contains the main technological risk of a new technology being developed. Also, this approach allows you to reduce the time and overall costs for assessing the actual state of affairs in projects related to the development of new technology.

The very assessment of the level of maturity of technology is carried out with the joint use of four different levels of readiness, including: levels of readiness of technologies (9 levels); production readiness levels (10 levels); integration readiness levels (9 levels); system readiness levels (5 levels). Their assessment is carried out within the life cycle of the assessed technology with comparison with each other, which makes it possible to timely determine future technological, production and other problems (like material, temporary, etc.) associated with the creation and development of new products by the enterprise (GOST R 58048-2017, 2017).

The assessment of the levels of readiness proposed in the 'Guidelines for assessing the level of maturity of technologies' can be applied independently, as a separate type of technology audit, and as part of a more advanced technology audit of an enterprise. A more extensive composition of the technological audit is described in the national standard GOST R 57194.3-2016 (2016) 'Technology transfer. Technological audit', which has been in effect in the country since 2017. Its effect applies to all organizations, regardless of their type, size, form of ownership, scale and products supplied (or services provided). And it can be either voluntary or mandatory.

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It is used as a methodology for assessing the technological state of an enterprise, which allows you to identify its strengths and weaknesses, and primarily the organization's ability to develop and implement new technologies. This ability is largely based on the correspondence of the production and technological base available at the enterprise with the design and technological complexity of the products, including accuracy, productivity, labor intensity, production volumes, etc.

In the process of conducting a technology audit based on the national standard, all levels of planning are examined, including strategic, operational and current planning and their effectiveness. The staff of the enterprise is assessed, including the level of training of personnel, its sufficiency to ensure the activities of the organization, etc. The provision of the enterprise with all types of technological resources is studied, including those necessary for their maintenance, improvement and expansion. The application of innovations in the technological process is investigated, including the use of in-house and third-party innovative developments. The experience of introducing innovations in the technological process is being studied. Ways and ways of selling products are considered, as well as the possibilities of promoting products to new markets. The organization and management of production, production equipment is evaluated. The suppliers of raw materials are analyzed for the release of a planned product or service. Developed measures to improve product quality are being studied.

It makes it possible to assess the current situation in various areas of the enterprise, including technological, production, personnel, intellectual, etc. and on this basis, develop and justify full-scale measures to improve these areas of activity. First, on the technological re-equipment of the enterprise, repair, modernization and replacement of technological equipment in the interests of implementing promising production programs to introduce advanced resource-saving, innovative and other technologies. Secondly, for the production of promising types of high-tech, innovative products (Methodology, Ministry of Education and Science of the Russian Federation (2017), as well as the use of the results of intellectual activity at the enterprise. Thirdly, to improve the management system of production and technological processes, including planning and monitoring of production processes, the placement of technological equipment, the layout of workplaces, logistics flows, etc. Fourth, to improve the efficiency of the supply system for raw materials, materials and components for production needs. Fifth, to improve the quality management systems for technological processes and quality control of products. Sixth, to improve the qualifications of the main and auxiliary personnel, engineering and technical workers associated with the implementation of a promising production program. Seventh, to improve the existing system of operation, maintenance and repair of technological equipment. Eighth, on planning production volumes based on monitoring possible markets for products. Ninth, to improve the completeness and quality of internal normative and technical documentation. In general, this makes it possible to form a technological strategy at the enterprise that allows, in general, to increase the efficiency of the enterprise (Prokhorov et al., 2020).

The second group includes methods that, when conducting a technological audit, assess the impact of the external environment on the current and future state of the enterprise. This

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group includes PEST analysis as well as SWOT analysis, M. Porter's five forces model and some other methods. All of them are quite well known, but their main disadvantage is that they are tied to a certain area of the enterprise's external environment. So PEST analysis analyzes the environment of indirect impact on enterprises. In turn, M. Porter's model of five forces evaluates the external environment, which directly affects the enterprise. A SWOT analysis assesses the strengths and weaknesses of the enterprise, as well as the opportunities and threats the enterprise has. They do not so deeply consider the technological, production and other activities of enterprises. Their main task is to help in the long-term planning of the company's operational activities.

The third group of techniques for conducting a technology audit is a kind of modification of the second group, but with some peculiarities. They also take into account the external and internal environment of the enterprise, which makes it possible to conclude the current and future state of many activities of the organization. At the same time, their features are that they include some interrelated audits of the enterprise, including: institutional audit; commercial audit; technical audit; social audit; environmental audit; economic audit; risk audit; financial audit (Heydarov, 2012).

Joint analysis of the results of these audits allows us to draw certain conclusions on the technical and technological state of the analyzed business entity. So institutional audit allows you to determine to what extent the external environment and internal environment of the enterprise contributes to the organization of the release of new products. Commercial audit makes it possible to determine whether there is a demand for the enterprise planned to release new products. A technical audit allows you to determine whether the release of a new product is technically and technologically sound at the enterprise. Social audit determines whether the release of new products of the enterprise violates the existing social conditions, the interests of all social groups, the solution of existing social problems, etc. An environmental audit must determine what impact the release of a new product will have on the environment, as well as possible penalties associated with this release. An economic audit makes it possible to show the effectiveness of the release of new products for society as a whole. Risk audit allows you to determine what risks will be present during the organization and release of new products and to what extent they can affect the results of these activities. The financial audit is final and makes it possible to determine whether the costs identified in the process of carrying out various audits and associated with the organization of the release of new products of the enterprise will be reimbursed.

Based on such a comprehensive audit, stakeholders receive sufficiently objective information to make correct management decisions on organizing the release of new products, including the start of financing for these works. All this allows the company to reduce risks, including technological, production, commercial, investment and others, and therefore avoid possible material, financial and other losses.

The fourth group of techniques for conducting a technological audit includes techniques that are tied to the life cycle of an enterprise. Conventionally, there are three main such audits, including: prestart audit; update audit; upgrade audit.

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Restart audit is carried out before or at the start of production. This is an audit of enterprises that create a new production, where an audit of an investment project is carried out to determine its effectiveness. Update-audit is carried out to identify areas for improving existing production, where the possibility of reducing costs by adjusting existing technologies, including resource saving, automation of technological processes, strengthening control over product quality, etc. is being considered. Upgrade audit is carried out with the aim of reconstruction of the enterprise, where tasks are solved to increase productivity, master new products, etc. (Gorodetsky et al., 2014).

The fifth group includes the methods of conducting a technological audit, which are used to manage the quality of products manufactured by an enterprise. These methods are widely known. These include functional cost analysis, functional physical analysis, structuring of quality functions (OFD), analysis of consequences and causes of failures (FMEA analysis), ABC analysis, and others. In general, they allow, based on market requirements for products, to assess the current and possibly future technical and technological state of the enterprise.

It must be said that this work does not cover all methods of conducting a technological audit at an enterprise. There are others that, for several reasons, were not included in this study.

Discussion

The considered methods of conducting a technological audit, depending on the tasks of the study, are quite effective tools for conducting a technological audit of an individual enterprise. But at the same time, they are not suitable for conducting a technological audit of an enterprise, taking into account the minimum requirements of an industrial cluster, including: to its technological, production and engineering potential; management and marketing; etc.

As a result, a situation arises that from the enterprise, this activity is efficient and optimized, but for the industrial cluster, it does not meet its minimum requirements. Therefore, there is a need to search for new methods for conducting a technological audit of an enterprise, but already within the framework of an industrial cluster.

To solve this problem, you can take as a basis the existing NASA methodology for assessing the readiness levels of various areas of enterprise activity, including Technology Readiness Level or TRL, Manufacturing Readiness Level or MRL, Commercialization Readiness Level or CRL, Engineering Readiness Level or ERL, Organizational Readiness Level or ORL, Investment Readiness Level or IRL and Benefits and Risks Level or BRL while applying additional criteria based on strategic analysis matrices. Additional criteria in the strategic analysis matrices are the required levels of availability in the industrial cluster. At the same time, for each level of readiness, its strategic analysis matrices are compiled.

A typical form of strategic analysis matrix for assessing the readiness levels of an enterprise for an industrial cluster inclusion is shown in figure 1. Based on the matrix, the readiness levels of a particular enterprise are compared with the required readiness levels of an industrial cluster with the calculation of points. Depending on the scores received, a further management decision is made in the comparison.

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If the product is from 1 to 3 points, then the enterprise in terms of readiness does not fully meet all the requirements of the industrial cluster. In the future it is not considered as a potential candidate for the industrial cluster inclusion. From 4 to 21 points, the enterprise in terms of readiness as a whole does not meet the requirements of the industrial cluster. In the future, under certain circumstances, it can be considered as a candidate for the industrial cluster inclusion. From 24 to 30 points, in terms of readiness, the enterprise mostly meets the requirements of the industrial cluster. To make a final decision on the industrial cluster inclusion, an additional technology audit is required. From 31 to 49 points, in terms of readiness, the enterprise generally meets the requirements of the industrial cluster. The enterprise is conditionally included in the industrial cluster with some reservations that must be eliminated within a certain time. From 50 to 70 points, the enterprise fully meets the requirements of the industrial cluster in terms of readiness. The enterprise is included in the industrial cluster. From 71 to 100 points, in terms of readiness, the enterprise exceeds those corresponding to the requirements of the industrial cluster. Unconditional industrial cluster inclusion.

Table 1. A typical strategic analysis matrix for determining the readiness levels of an enterprise for an industrial cluster inclusion.

Required availability levels of an industrial cluster (TRL, MRL, CRL, ERL, ORL, and BRL)	**Enterprise readiness levels (TRL, MRL, CRL, ERL, ORL, and BRL)**		
	High (8-10 points)	Average (4-7 points)	Low (1-3 points)
High (8-10 points)	Unconditional cluster inclusion	Cluster inclusion	Additional technology audit
Average (4-7 points)	Cluster inclusion	Conditional cluster inclusion	Temporary rejection
Low (1-3 points)	Additional technology audit	Temporary rejection	Total rejection

It must be said that similar matrices of strategic analysis can be used for an industrial cluster and based on the domestic methodology described in 'Methodological guidelines for assessing the level of maturity of technologies’, including on Technology Readiness Level or TRL, Manufacturing Readiness Level or MRL, Integration Readiness Level or IRL and System Readiness Level or SRL. In this case, the point calculation will be similar.

The proposed methodology for the inclusion of an enterprise in an industrial cluster, based on the matrices of strategic analysis, allows a specialized organization of an industrial cluster, using established procedures, to make an informed management decision on the inclusion of a particular enterprise in the cluster. The logic diagram of the procedure is shown in Figure 1.

When using the domestic methodology described in the ‘Methodological guidelines for assessing the level of maturity of technologies’, the logical scheme of the procedures will also be similar to the above. Technology readiness levels will be considered first, then

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production readiness levels, after integration readiness levels, and then system readiness levels.

The methodology proposed by the authors for conducting a technological audit within the industrial cluster was tested in the timber industry complex or LPK of the Krasnoyarsk Territory. The approbation was carried out taking into account the peculiarities of the timber industry complex of the region, which consists in the fact that in the territory of the region there were several isolated industrial centers for processing timber several hundred kilometers distant from each other, including Lesosibirskiy, Boguchanskiy, Kanskiy, Krasnoyarsk and Minusinskiy.

Among them, the most interesting is the city of Lesosibirsk. There are serious timber processing facilities, transport infrastructure (like railway, Yenisei River and highways), qualified personnel, etc. Therefore, the city of Lesosibirsk was chosen to test the methodology. At the same time, the production of final products from the waste of the timber industry complex was considered as the basis of the industrial cluster.

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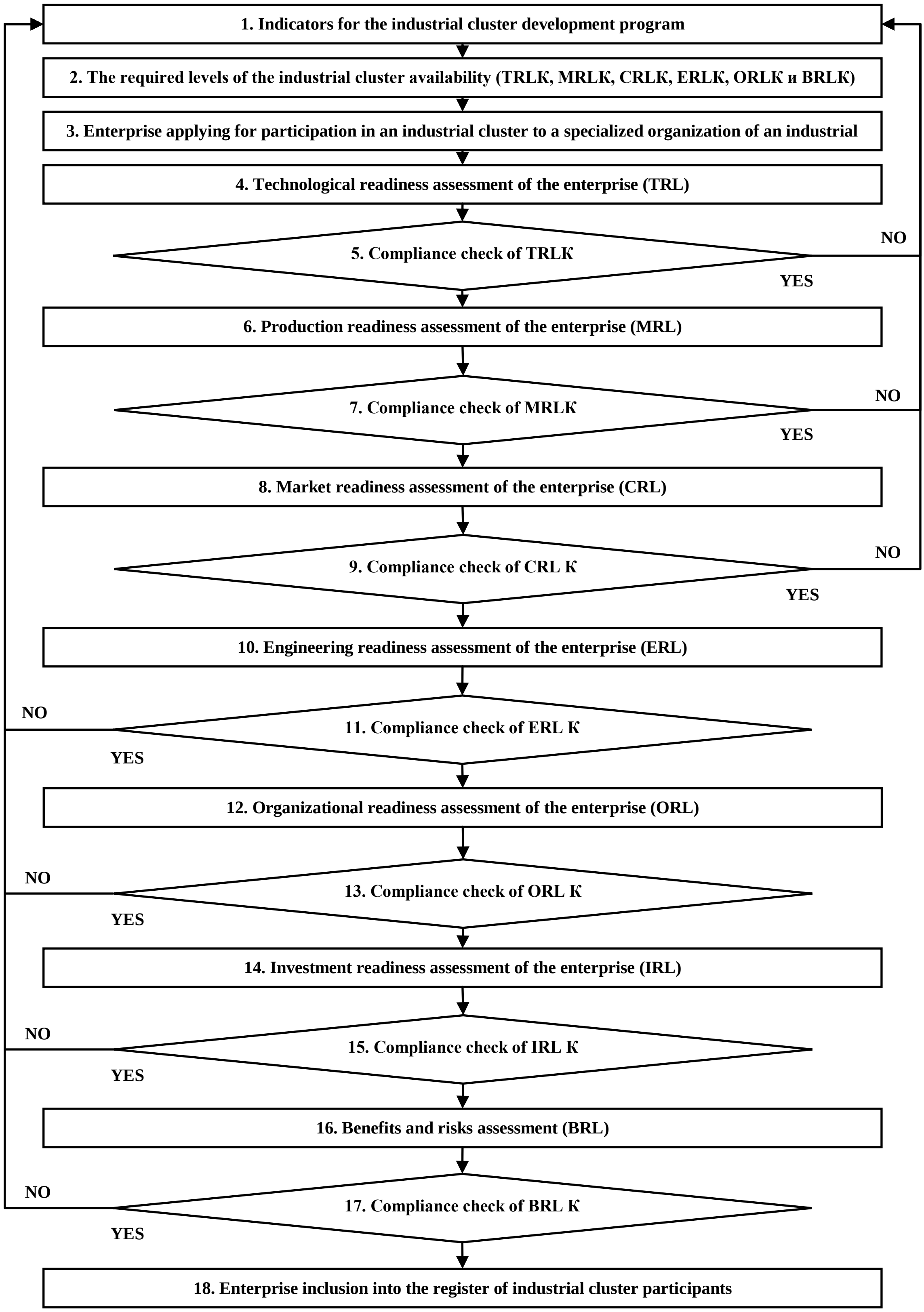

Figure 1. Enterprise inclusion algorithm into the register of the industrial cluster based on readiness levels assessment

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According to the data of the unified register of small and medium-sized businesses (The Federal Tax Service, 2020) within the territory of Lesosibirsk, as of September 2020, 2,036 entities were registered, of which 113 in this register carry out activities related to logging and wood processing (57 enterprises) and the production of wood products (56 enterprises).

During the approbation, the activities of 113 enterprises were analyzed for the possibility of their inclusion in the industrial cluster based on an assessment of their level of readiness and development prospects. While conducting a technological audit, all analyzed enterprises were divided into groups according to the level of technological readiness.

The first group included 53 enterprises. The total score for these enterprises varies from 1 to 3 points. In terms of readiness, they do not fully meet all the requirements of the industrial cluster and are not considered as potential candidates for inclusion in this association in the future. These are usually micro-enterprises, with antediluvian equipment, low technological level and a minimum number of employees.

The second group includes 29 enterprises. The total score for these enterprises varies from 6 to 17 points. It is also impractical to include them in the industrial cluster. They show positive dynamics in their development. In the future, they may be recommended for the industrial cluster inclusion.

The third group includes 6 enterprises. The total score for these enterprises varies from 26 to 30 points. These enterprises mostly meet the requirements of the industrial cluster. To meet all the requirements of an industrial cluster, they will take time and additional serious costs.

The fourth group includes 16 enterprises. The total score for them varies from 42 to 48 points. Enterprises can be included in an industrial cluster, but with some caveats that they eliminate quickly enough.

The fifth group includes 9 enterprises that fully meet the requirements of the industrial cluster. The total score for these enterprises varies from 54 to 70 points.

The sixth group did not include any enterprise in Lesosibirsk.

Thus, the formed cluster can be represented by twenty-five enterprises. The main type of product in this cluster is the production of solid biofuel from forest waste. Subsequently, this cluster can be redesigned for the production of wood chemical products.

Conclusion

The forestry complex of Yenisei Siberia is rather heterogeneous, since its enterprises are at different levels of technological development. Some of them use antediluvian technology from the early 1950s of the 20th century, others are high-tech industries using the latest technological advances. But all of them in the process of their activities receive a large amount of wood waste.

This waste is not only an environmental problem in the macro-region of Yenisei Siberia, but also a valuable raw material for the production of liquid products. Recycling of forest waste can be most efficiently carried out within the framework of industrial clusters. And their

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formation must be carried out based on a technical audit of enterprises of potential candidates for it.

It is this task that allows solving the proposed methodology for conducting a technological audit within the framework of an industrial cluster, including for the processing of forest waste. It allows, in compliance with established procedures, to carry out a feasibility study for the industrial cluster inclusion of an enterprise. This, in turn, gives in the future a certain economic stability in its activities and, in general, will have a beneficial effect on the economic development of such a macro region as Yenisei Siberia.

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