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UDK 005.6

Assessing the Performance of Quality Management Systems in the Context of Enterprise Information Security Policy during the Pandemic

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Key words and phrases: PEST analysis; pandemic; quality assurance of electronic components; quality management systems; information security management; information security policy.

Abstract. The purpose of the article is to evaluate the effectiveness of the system quality management of enterprises in the radio-electronic industry in accordance with the procedures for dividing by stages. The authors proposed changes that include the surrounding surpluses due to the risk pandemic and their systemic quality management. The PEST analysis is applied as a technique for analyzing an enterprise's external environment, which considers political, economic, social, and production technology factors. The study analyzes possible pandemic-related changes to the PEST analysis technique enabling the analysis of risks and opportunities that manifest in changes of the relevant factors affecting the considered industry workflows. The information security issues of implemented projects are assessed both regarding external and internal threats.

Introduction

During the development, production, and quality assurance of electronic components, companies of the radio-electronic industry should consider and analyze the existing external environment, as well as predict changes in their external environment to keep business profitable. The external environment of an enterprise is a complex set of rules and regulations, as well as their dynamic transformations. It affects any company developing and producing electronic components, reducing or exacerbating the existing risks (which should be additionally considered) and providing opportunities with varying degrees of feasibility depending on the ongoing global changes [1]. Distinguished among others, the PEST analysis is a commonly used method that allows analyzing the regional performance [2], creating environmental protection programs [3], improving the applied logistics schemes [4], aiding the development of software [5] and information management systems [6], as well as developing strategies for expanding the range of the company's products [7], which is important in case of a sharp change of market

and labor organization rules.

Pest Analysis Stages

One of the popular methods for analyzing the macro environment of an organization is PEST analysis. This analysis is sometimes also referred to as STEP analysis. This is a simple and convenient method of studying the external environment, which can be effectively used by any company. Pest-analysis includes the identification of a list of political (Political), economic (Economic), social (Social) and technological (Technological) environmental factors that directly and indirectly affect the business. PEST-analysis also serves as a tool for long-term strategic planning and is compiled for 3-5 years ahead, with annual data updates.

Despite the apparent ease of use, the effectiveness of PEST analysis depends on the correctness of its implementation and the qualitative interpretation of the results. As the study showed, PEST-analysis is a sequence of certain stages, among which it is customary to single out the following:

Definition of factors for analysis

As part of this stage, it is necessary to compile a list of factors that can have a direct or indirect impact on the future performance of the organization, which are divided into 4 groups: political, economic, social and technological.

Determining the degree of influence of factors

After being the factors influencing the company activities are identified, it is necessary to determine the strength of the influence of each factor on a point scale. Most often, a 3-point scale is used, according to which, the larger the number on the scale, the more macro-environmental factors can affect the company.

Evaluation of the probability of changing the factor

At this stage, the probability of fluctuations is assessed on a 5-point scale, where “1” means the minimum probability of a change in the environmental factor, and “5” – the maximum probability.

Assessment of the real significance of factors

The next step is to evaluate the influence of each individual factor selected for analysis. Here it is necessary to clearly identify those factors that can directly affect the company and constantly control them.

Drawing up a summary table of PEST analysis

The final step of the analysis is to bring all calculations into a matrix form. All factors in descending order of their importance are placed in the table.

The main stages of the PEST analysis for the electronics industry are determination and identification of external and internal factors relevant to a particular enterprise. It should be noted that the identified severity of these factors at the initial stage can be significantly subjective, which is introduced by the choice of a scoring system and specific opinions of experts involved in this activity. The PEST analysis methodology includes mandatory classification of all factors into political, economic, social, and technological.

The company HR restrictions and the implementation of logistics activities related to the pandemic should be classified during the PEST analysis into all four categories. Regarding political factors, it is necessary to assign a higher significance to the always considered parameter associated with the dependence on public procurement, as well as the parameter

reflecting the state support to industry and enterprises. Regarding economic factors, it is necessary to address the change in the impact of economic instability risks, as well as the risks traditionally used for analysis reflecting the high average age of employees and low wages in this industry sector. As practice shows, the producers of electronic components are among those whose activities continue during the pandemic. This means that working conditions meeting safety standards can be created for their employees. Regarding social factors, it is necessary to highlight the risks associated with insufficient population awareness. As well as take into account the impact of a specific situation in the respective locations of personnel residence on loyalty to the company, which significantly depends on the location. Regarding technological factors, it is worth considering the risks associated with increased requirements for quality management systems or changes in their functioning and audit requirements, which asks for appropriate prompt changes. The need to prepare design and production equipment documentation in electronic form for the producers of electronic components depending on the computers available to the relevant personnel in self-isolation locations should be considered as an additional opportunity for development and diversification. Recommendations for increasing influence levels when considering PEST analysis factors:

Political factors

Politics plays an important role in shaping the business environment in the region, state and globally. One adopted law can limit the prospects for running a particular business or, on the contrary, give new opportunities for the company.

The following factors must be observed:

– global political situation, which countries are on good terms with each other, between which disagreements are outlined, which countries will become the arena of military operations or political sanctions;
– foreign policy of the country in which the jurisdiction of the company is located;
– entry/exit of the country into various unions and societies (many opportunities for growth are hidden here);
– domestic policy at the state level;
– tax policy;
– the level of state influence on the industry, its attitude to the industry;
– the attitude of the state to foreign capital, the level of influence on investment processes;
– subsidizing by the state of specific regions, legislative indulgence for the regions;
– internal policy at the regional and municipal level;
– various interstate agreements on disclosure of information, on the avoidance of double taxation, etc.

Economic factors

Key economic factors to be analyzed before conducting a PEST analysis:

– dynamics of gross domestic product;
– inflation rate;
– the refinancing rate and related dynamics in the banking sector;
– unemployment rate;
– dynamics of incomes of the population;
– oil prices;
– growth and saturation of industry markets;
– level of competition;
– dynamics in adjacent markets that affect the company's costs;
– the level of use of tax schemes in the industry.

Social factors

Social factors affect the company's success. These include:

– demographic data: birth rate, death rate, age composition of the population, migration dynamics;
– standard of living of the population, salary expectations;
– customs and values, established consumption norms and myths;
– level of education, qualification of personnel;
– work capacity and productivity of the population.

Technological factors

These are risks associated with increased requirements for quality management systems or changes in their functioning and audit requirements. Technological factors include:

– scientific discoveries, new technologies;
– changes in patent law and industry;
– the impact of the Internet and mobile technologies on the industry;
– R&D spending by competitors.

Assessing the Performance of Quality Management Systems during the Pandemic

One of the mandatory components of the company producing electronic components in the modern market conditions is the presence of testing and calibration laboratories (or an integrated unit of similar purpose), which are a necessary link in the process of quality assurance of electronic components. The processes implemented in these laboratories (in full or in cooperation with other structural units of the enterprise) should be included in the set of functions covered by the quality management system or integrated management system (if any) of the enterprise. For a relevant operating system, one of the mandatory activities ensuring the adequate condition of the considered system is regular audits with a known (or recommended) or established frequency, for instance, annual audits, or internal and external audits conducted with other frequency.

The analysis of data obtained during the audits allows investigating and assessing the effectiveness of enterprise quality management systems [1]. While the development of appropriate methods [2; 3], improvement of programs [4; 5], and standards [6; 7] is an object of constant attention in the scientific sources.

At the audit process planning stage, in order to factor in the existing or predicted changes in the context of an enterprise, it is necessary to focus on the task of data collection about the applied changes and the ongoing quality management system operation improvement in conditions where part of the electronic industry enterprise personnel (which may be associated with processes of modification or development of certain documentation in electronic form) can carry out its activities during self-isolation or even quarantine when having appropriate technical means. Also, the task associated with a self-assessment of the enterprise quality management system maturity level requires clarification and decomposition. The system should additionally include procedures for safe work and restrictions on corresponding social contacts of employees while creating special technical capabilities.

At the analysis stage, the input data shall be used to distinguish, identify and address the external and internal factors associated with the pandemic conditions in a particular area or local part of the region. It is necessary to analyze any changes in the set goals, which should include activities to preserve the life and health of people in the special pandemic-related conditions [8].

At the analysis and report generation stages, special attention should be paid to modifications

in risk management systems that are made by the enterprise to ensure the quality of electronic components during the pandemic, which is associated both with the need to ensure appropriate working and resting conditions for employees, as well as with additional risks of labor potential loss depending on the infected case count in the local region during the pandemic.

Conclusions

The proposed PEST analysis method allows assessing changes that take into account sharp changes in the company's working conditions during the pandemic, assessing the external environment for maintaining and developing the enterprise, as well as assessing the prospects for diversification in the current situation. The current pandemic-related conditions of social restrictions impose requirements for the implementation of changes during the assessment of the quality management system effectiveness at each stage, which leads to corresponding changes in the scoring systems and considered factors, as well as changes in the results interpretation system. During the pandemic, an urgent matter is the development of an information security policy and the introduction of the related information security program into the company integrated management system or quality management system. Being on the key documents ensuring the arrangement of appropriate measures to achieve the set goals in this area, the information security policy will reduce or allow timely responding to the risks associated with activities at the state level and entering the international market.

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Оценка результативности систем менеджмента качества с учетом политики информационной безопасности на предприятии в условиях пандемии

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Ключевые слова и фразы: PEST-анализ; обеспечение качества электронных средств; пандемия; политика информационной безопасности; системы менеджмента качества; управление информационной безопасностью.

Аннотация. Целью написания статьи является оценка результативности систем менеджмента качества предприятий радиоэлектронной отрасли в соответствии с принятым разделением указанной процедуры на этапы. Авторами предложены изменения, внесение которых обусловлено изменившимися в связи с пандемией условиями функционирования предприятий и их систем менеджмента качества. Рассматривается PEST-анализ как методика анализа внешней среды предприятия, который призван учитывать политические, экономические, социальные и технологические факторы. В статье анализируются возможные изменения в условиях пандемии, которые могут быть включены в метод PEST-анализа с целью анализа рисков и возможностей, которые проявляются в изменении соответствующих факторов, влияющих на организацию работы отрасли. Приведена оценка вопросов информационной безопасности исполняемых проектов как с точки зрения наличия внешних угроз, так и с точки зрения существования внутренних угроз.

UDK 711.5

Methodological Basis of Ecological Zoning of Disturbed and Contaminated Areas Using SMART Technologies

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Key words and phrases: zoning of territories; integral indicator; multicomponent pollution; principles of organization; SMART technologies.

Abstract. The aim of the study is to develop a methodology for the SMART-technology of ecological zoning of disturbed and oil-contaminated territories in identifying the ecological-indicator properties of the environment. The principles of construction and algorithmic and informational support of the organization of SMART technologies for environmental zoning and control of pollution migration within a localized zone are formulated. SMART technologies are suitable for monitoring the migration of pollution within a localized zone and comparing them with respect to the generalized scale of their indicators and integral assessment of temporal and spatial dynamics in a unified form.

Multicomponent pollution, characterized by a high migration capacity, inevitably arises from the long-term impact of oil and oil products storage facilities and the disposal of hydrocarbon-containing waste on the environment [1].

The indicators of the impact of pollutants on the geological environment are the concentrations along the soil profile of the underlying layers, and in some cases, the wedging-out of colored groundwater.

The most dangerous consequence of the studied pollution is the penetration of pollutants into deep geological layers and their further vertical and horizontal migration and accumulation of substances between individual components of the landscape, which increases the total area of disturbed and oil-contaminated territories. Such entry into the environment of harmful substances or other objects, in quantities exceeding the natural background, is in some cases unpredictable, the processes and characteristics of its movement are difficult to predict [2–4].

The main difficulty in introducing the time component is the need to model the spatial-temporal correlation of the analyzed data and the subjectivity of the choice and determination of the weight coefficients. It is also necessary to establish a relationship between spatial and temporal dependencies in a convenient form of calculating a generalized indicator and weighting factors.

The factor of uncertainty of the initial information is associated with the impossibility of timely identification and zoning of hazards, making the problem the most dangerous source of

the formation of additional man-made flows. They differ in the multi-element composition of the secondary pollution of the territories adjacent to the objects under consideration by polar and high-molecular hydrocarbons, heavy metals and radionuclides.

Intermediate links between the stages of goal-setting and the formation of specific work plans for the creation and operation of digitalized observation systems that are applicable to analyze the dynamics of the formation of geochemical and geophysical zonations also require independent substantiation.

Therefore, it is necessary to timely obtain data on the direction of changes in the possible state of natural-anthropogenic complexes in the zone of their influence and to assess the predicted changes in the natural environment and their consequences for a given period of time in the study area.

In article [5], the basis for carrying out a geoecological study of the territory under consideration was such indicators as: a comprehensive index of atmospheric pollution; environmental hazard index; index of chemical pollution of soils; noise pollution; indicators of the environment-reproducing capacity of the territory; specific gravity of influencing objects, etc.

Ecological zoning is considered as a process of territorial distribution in terms of qualitative and quantitative indicators, with the identification of objects and subjects of the habitat with varying degrees of anthropogenic load [5]. In this case, the leading role in the geochemical organization and differentiation of the natural-anthropogenic complex belongs to the lithogenic factor [3–8].

Environmental zoning, used as a digitalized tool for the differentiation under consideration, has recently been in wide demand. Despite the existing experience of application in various regional soil-geochemical and bioclimatic conditions, the methodological foundations in this field of activity are still poorly developed and tested.

In this work, ecological zoning is understood as a problem-oriented classification and multi-sign zoning of the study area into zones and the establishment for each of them of a special regime of nature management and environmental protection.

Considering the level of development of new information and communication technologies, it is proposed for the purposes of ecological zoning of disturbed and oil-contaminated territories to use a certain set of technical means of control with an intelligent mode as part of SMART (Specific – Measurable – Attainable – Relevant – Time-bounded) of the information-analytical complex [9].

At the stage of goal-setting SMART technologies enable to generalize all available information and determine the sufficiency of resources [10].

The aim of the study is to develop a methodology for the SMART technology of ecological zoning of disturbed and oil-contaminated territories in identifying the ecological-indicator properties of the environment.

The properties of the Harrington's desirability function were used to implement the above goal [11], which is applicable to solving various optimization problems.

Continuity, monotony and smoothness make it possible to use it for an integral assessment of the state of the landscape under conditions of technogenic pollution and under the influence of natural factors in relation to the concentration of chemical elements and their compounds involved in a single biogeochemical cycle [12].

When using the Harrington's desirability function, as a rule, the assigned scale is divided into five categories [13]. When studying the chemical composition of the main components of natural-territorial complexes [12], the scale is as follows: (0.8–1.0) – no chemical pollution ("very good"), (0.63–0.8) – a low level pollution ("good"), (0.37–0.63) – medium ("satisfactory"),

Table 1. Desirability function scale categories

No	Partial values of the desirability function	Desirability scale categories	Meaning Decrease in IIBS, %
1	0.8 – 1.0	normal performance of ecosystem function	5
2	0.63 – 0.8	violation of information ecosystem functions	5–10
3	0.37 – 0.63	violation of information, biochemical, physicochemical, chemical and integral ecosystem functions	10–25
4	0.2 – 0.37	violation of all of the above functions, as well as physical ecosystem functions	25
5	< 0.2	loss of ecosystem functions	> 25

(0.2–0.37) – high ("bad"), (< 0.2) – extremely high levels of chemical pollution ("very bad") [12; 13].

In the case of monitoring pollution migration within a localized zone of a natural-territorial complex, a decrease in environmental hazard occurs with a unidirectional change in the indicator, and the limitation is one-sided.

For ecological zoning of disturbed and oil-contaminated territories, it is advisable to use the integral indicator of the biological state (**IIBS**) of the soil [14], determined on the basis of the most sensitive and informative biological indicators [15] according to the following relationship:

$$IIBS = GPA/Con, \quad (1)$$

where *GPA* is the average estimated score of all indicators, g/kg; *Con* is the residual content of oil or oil products in the soil (oil content in the soil within 1 g/kg – "permissible", 1–2 g/kg – "low", 2–3 g/kg – "medium", 3–5 g/kg – "high" and more than 5 g/kg – "very high" [16]).

To adapt the scale of desirability to the assessment, it is proposed to replace the accepted qualitative characteristics with the values of IIBS of ecosystem functions of soils, taking into account the results of works [14; 15] (Table 1).

The algorithm for ecological zoning of disturbed and oil-contaminated territories using the desirability function relative to the integral indicator in the IIBS format is shown in Fig. 1.

The Harrington's function is a transformation of natural values of indicators (y_1, y_2, y_3, …, y_n) into dimensionless (d_1, d_2, d_3, … d_n), described by the scale of desirability.

The desirability function for one-way constraint (d) is expressed by the equation [12; 13]:

$$d = e^{-e^{-y'}}, \quad (2)$$

where e is the designation of the exponent; y' is the coded value of the private parameter y, that is, its value on a conditional scale.

For the generalized desirability index (D_i) the formula is used:

– without considering the weighting factors:

$$D = \sqrt[n]{\prod_i^n d_i}; \quad (3)$$

– considering the weighting factors:

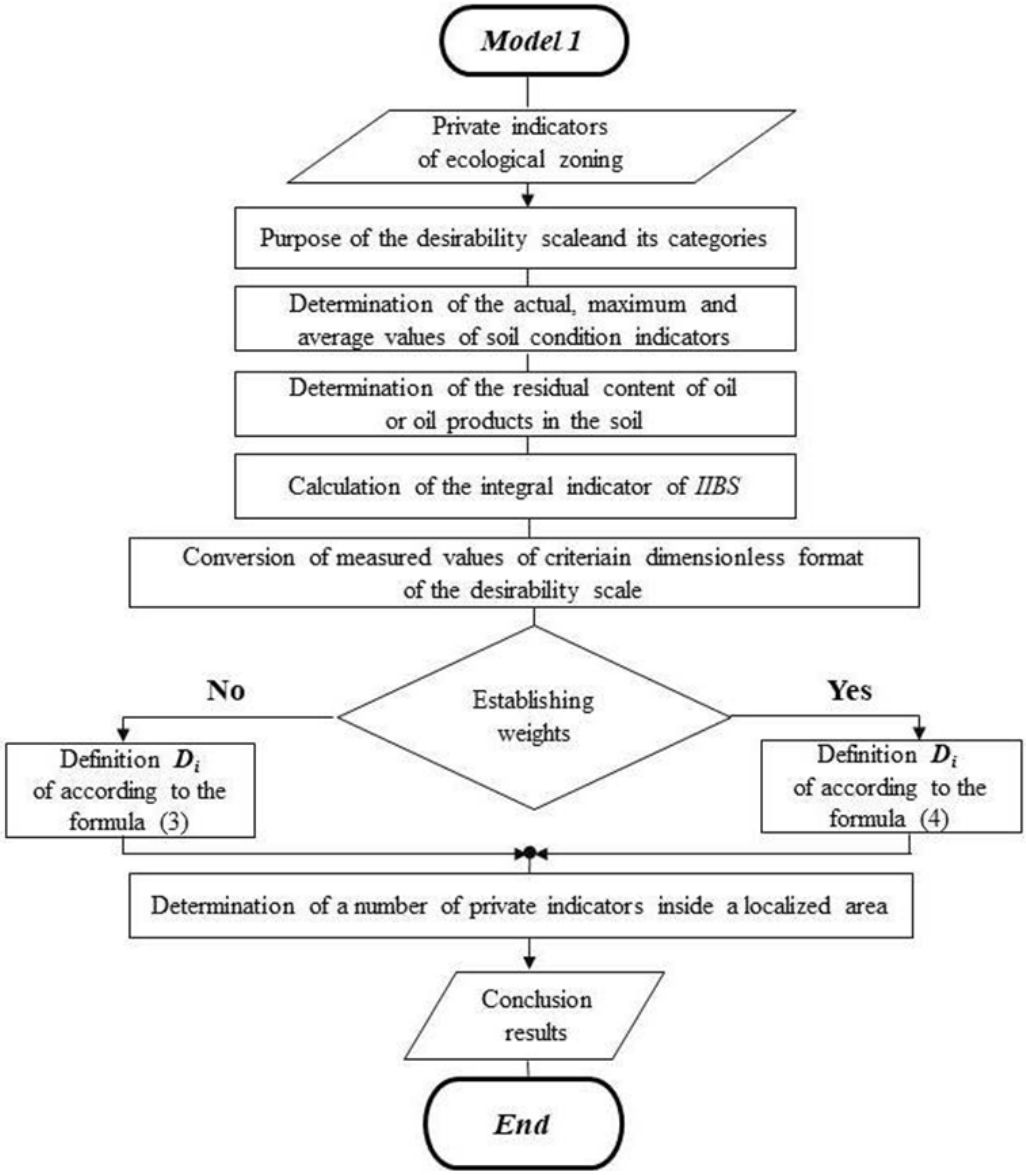

Fig. 1. The algorithm for ecological zoning of disturbed and oil-contaminated territories

$$D' = \sqrt[n]{\prod_{i=1}^{n} (d_i)^{m_i}}, \quad (4)$$

where d_i is a specific index of desirability; m_i is a weighting factor.

The translation of the values of the dimensional indicators of the IIBS (x) into dimensionless ones with a linear relationship between them is feasible according to the already approved model concepts [11–15].

Logarithm twice the equation (4) in the linear case gives:

$$\ln\left(\ln\frac{1}{d}\right) = -y. \quad (5)$$

Depending on the adaptation of the specified model, the corresponding criteria for assessing the dimensional indicators of the IIBS are also selected, which are applicable to identify the ecological-indicator properties of the environment (Fig. 1).

The use of the technique provides for the establishment of the dependence of the value of the measured y', i.e. indicator of the impact of pollutants on the geological environment, and dimensionless value y.

The assessment used in assessing the ecological situation of the territories in categories is represented by gradations of “no pollution”, “low level”, “medium level”, “high”, “extremely high level of pollution” [12]: less than 1.2; 1.2–2.0; 2.0–4.0; 4.0–10 and more than 10 background values (respectively).

SMART technology, which uses mechanisms for the accumulation, transmission and processing of structured information relative to the desirability scale, facilitates the process of comparing the ecological-indicator properties of the environment, making it clearer.

The application of the method of ecological zoning of disturbed and oil-contaminated territories is promising in establishing specific differences in the levels and types of pollution of the identified functional zones for a number of natural-anthropogenic complexes. This greatly simplifies and speeds up the secondary processing of data, and further systematization of the data obtained based on their quantity, degree of reliability and the assessment of the relevance for solving research problems.

It is also possible to use it in identifying ecological-indicator properties, studying the formation of technogenic eco-anomalies in relation to the integral characteristics of the environment and obtaining representative data on its state.

The implementation of the methodology includes a sequence of research methods involved, which have the maximum efficiency of the convolution of heterogeneous information and provide reliable search criteria, for example, the confidence level of identifying contaminated zones.

Using SMART technologies, the technique is also suitable for monitoring the migration of pollution within a localized zone and comparing them with respect to the generalized scale of their indicators and integral assessment of temporal and spatial dynamics in a unified form.

Timely implementation of the considered methodological foundations will make it possible to achieve an improvement in regional target indicators of the state of the environment, to establish the boundaries of the spread of pollutants, to differentiate environmental management regimes, taking into account the nature of the use of degraded lands, and to carry out a comparative analysis of the monitoring results.

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Методологические основы экологического зонирования нарушенных и загрязненных территорий с использованием интеллектуальных технологий

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Ключевые слова и фразы: зонирование территорий; интегральный показатель; мно-

гокомпонентное загрязнение; принципы организации; ресурсосберегающие технологии; SMART-технологии.

Аннотация. Цель исследования – разработка методики SMART-технологии экологического зонирования нарушенных и нефтезагрязненных территорий при выявлении эколого-индикационных свойств окружающей среды. Сформулированы принципы построения и алгоритмическо-информационное обеспечение организации SMART-технологий экологического зонирования и контроля миграции загрязнения внутри локализованной зоны. С использованием SMART-технологий методика удобна для мониторинга миграции загрязнений в пределах локализованной зоны и сопоставления их по обобщенной шкале их показателей и интегральной оценки временной и пространственной динамики в унифицированном виде.

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Resource Distribution Optimization Using a Network Graph by the Method of Linear Programming

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Key words and phrases: economic effect; network planning; production process; resource allocation optimization; simplex method algorithm; textile industry enterprises.

Abstract. The purpose of the presented research: based on the analysis of the financial and economic activities of the St. Petersburg Light Industry Enterprise CJSC NPP "ANA" to develop an original approach to optimizing resource allocation using a network graph. The research objectives are to consider the main economic indicators of light industry in recent years, to analyze the current state of light industry enterprises, to focus on strengthening the market positions of enterprises introducing innovative products. The applied method is optimization of the network graph using the algorithm of the simplex method of linear programming. The scientific hypothesis is based on the assumption that the solution of the problem of optimizing the allocation of enterprise resources is crucial in the issues of effective production management. The result of the research is an original approach to solving the network graph optimization problem using the simplex method algorithm to optimize the distribution of resources of an industrial enterprise.

At present, the need for the mechanisms for the development of textile industry is relevant in the context of sanctions pressure and import substitution programs. Domestic enterprises strive not to lose customers and market positions, retain suppliers or reorient themselves to new markets for products, maneuvering between sanctions bans from Western countries. Despite the economic and political difficulties, due to the exit of many foreign brands, there is a need to fill these niches with domestic brands, which should not be inferior to foreign companies in quality, design and assortment.

If we turn to the historical development of textile industry in Russia, it can be noted that a person's need for clothes and shoes arose back in the days of Ancient Russia, women mastered the skill of sewing, various weaving techniques were used, and products were created from flax, wool, and hemp. Peter the Great was a conductor of new ideas in all sectors of the national

economy, and the idea of creating the first weaving silk and cloth manufactories in Russia belonged to the first Russian emperor.

The active phase of the construction of garment factories and factories in the country began only in the 1920–1930s in the USSR. The Soviet Union occupied a leading position in terms of quantitative indicators of the production of textile industry products and was among the top five countries in the world producing clothing, footwear, leather goods, etc. Imports did not exceed 3%, the industry generated about 12 % of GDP, the number of employees was about 3 million people. After the Great Patriotic War, the output of textile industry products decreased, but then, thanks to the economic policy of the state and the active involvement of foreign specialists and imported equipment, a new stage in the development of textile industry began, which gave impetus to the development of the industry for decades to come.

The Soviet experience today is very valuable for the Russian textile industry, which shows that our country has a huge potential for development, and success can be achieved thanks to innovative technologies and the provision of its own production of raw materials and components. “According to the analytical company, the overall growth in sales of workwear in Russia last year amounted to 43.9 % and reached 1.16 billion units. From 2016 to 2020, sales in the country in physical terms increased by 79.9 %. 49.2 % of sales of overalls in the Russian market (572 million units) in 2020 are professional and industrial gloves, 45.6 % (531 million units) are other types of overalls, including body armor, industrial and professional clothing, as well as specialized means of protection against radiation and other adverse environmental factors” [2].

As a tool for achieving the goals of increasing the efficiency of textile industry enterprises, the authors propose to turn to the main methods of production management, the main task of which is to control production processes, that is, the process of creating a product. There are various methods of production management, which, as a rule, are combined into several groups: organizational methods, administrative methods, economic and socio-psychological, as well as balance, budget and network methods.

In the practice of the textile industry, the most common method for calculating the network graph is the graphical method (directly on the network); it involves the following sequence of filling in the graph data [1]:

1. The early term of the events is calculated (tp). To do this, moving from the initial event, the early date of which is 0, to the final event of the chart, it is worth noting that the early completion date of each event is determined by the maximum sum of the completions of all previous works.

2. Next, the late date for the completion of events (tn) is calculated. From the final event, the late date of which is equal to the critical path, they move to the initial event of the chart, and the late completion date of each event is determined by the minimum difference between the duration of the critical path and the duration of all paths.

One of the important steps in building a network model is the determination of the event time reserve (P), which is calculated as the difference between the late date of the event and the early date of the event [1]. An important advantage of network modeling in comparison with other methods of management and planning is the ability to analyze the original version of the schedule in order to reduce the time of work. Experts check the reliability of time estimates of work located in the critical zone, if the check confirms the correctness of the estimates, then the network schedule is optimized.

The following methods of optimization (replanning) of network graphs are known:

1. It is possible to reduce the duration of some works in the critical zone by redistributing

existing resources and attracting additional ones, and by improving the organization and technological component of these works. It is possible to transfer some workers from less stressful jobs to jobs on the critical path, the result will be a reduction in the critical path, and the management of the enterprise, based on the analysis of the production process, may transfer additional equipment, materials, etc.

2. Changing the composition and sequence of individual works of the network schedule by dividing individual works into several and bringing them to parallel paths.

It is worth noting that when there is a choice between several optimization methods, it is necessary, through a technical and economic analysis, to choose the most rational one from the point of view of duration and cost of work.

When optimizing network graphs, the main method is to reduce the time of the most "cheapest" jobs, which are the links of the path and are located on the critical path. "Cheap jobs are considered to be those that allow reducing the time required to complete a set of works. To solve network graph optimization problems, it is possible to use methods and models of linear programming as a toolkit. The task of resource planning is reduced to drawing up such a production program for the implementation of the corresponding volume of services, which, on the one hand, will provide the closest approximation to the potential market share in terms of sales volumes, i.e. which the market can consume, and on the other hand, will provide maximum profit for each segment [4].

Consider a linear programming problem requiring minimization of the cost of planned activities. The critical time tcr is the minimum amount of time spent on work. It follows that tcr is numerically equal to the longest path from the initial event 0 to the last *n*:

$$t_{cr} = \max\{t_l^e\}.$$

The path from 0 to *n* that has the maximum value is denoted as the critical path. If t_j^e is the early date of the event *i*, t_j^l is the late date of the event *j*, and t_{i-j} are the duration of work *i* – *j*, then the total reserve of time for this work R_{i-j}^t will be determined by the difference $t_j^l - t_i^e - t_{i-j}$, hence it is obvious that for any (*i* – *j*)-th job the condition:

$$t_j^1 - t_i^e - t_{i-j} \geq 0.$$

It can be assumed that of all the paths connecting 0 to n, the critical one is the one whose total slack is 0:

$$t_j^1 - t_i^e - t_{i-j} = 0.$$

For non-critical jobs, the following inequality is true:

$$t_j^1 - t_i^e - t_{i-j} > 0.$$

Cost reduction for the entire range of works can be achieved through non-critical work:

$$t_j^1 = t_i^e.$$

It can be assumed that if before the optimization of the network schedule the time of non-critical work was t_{i-j}, then after that the duration may increase:

$$t_j^1 - t_i^e \geq t_{i-j}.$$

In case of adding new designations, we get the following expression:

$$t_n = t_{cr},\ t_j - t_i \geq t_{i-j}.$$

Suppose that Ci-j of each job depends on its time, i.e.

$$C_{i-j} = a_{i-j} - b_{i-j} \times t_{i-j},$$

where a_{i-j} and b_{i-j} are constants, the goal of optimizing the network graph can be expressed as follows (compiled based on the materials [1]):

$$L(t) = \sum_{i,j}[a_{i-j} - b_{i-j}(t_j - t_i)] > \min.$$

Let us analyze the main indicators of the economic activity of the St. Petersburg textile industry enterprise CJSC Research and Production Enterprise "ANA" [3], which has been operating since 1992 and has several industrial sites in St. Petersburg and Karelia. The main products of the enterprise are military equipment and uniforms, in the manufacture of which the most modern technologies and innovative materials are used. The company's products are distinguished by reliability and high quality, confirmed by the opinion of specialists and their actual use in extreme conditions.

The company is constantly working to improve all business processes and improve the quality of products. At present, under the conditions of the sanctions blockade, the activities of the Research and Production Enterprise "ANA" [3] are particularly relevant and important. The company performs strategic tasks to provide the domestic economy with high-quality and technologically advanced products.

We analyze on a specific example of the production process of tailoring the "Night 91 M" suit by the Research and Production Enterprise "ANA". The main data are presented in Table 1 and Figure 1. The approved completion date is 2.5 days (t^y). It is required to change this network schedule so that all work is completed within the specified time, and the number of workers involved in reducing the critical path is minimal. The critical network path for the tailoring of the "Night 91 M" suit is 1,736 minutes or 28.93 hours (3.6 days), matching the earliest time for the end event to occur t_{24}^r = 1736 minutes with approved t^y = 1636 minutes. The reduction in the duration of the critical path should be 100 minutes. It is proposed to optimize a part of the network graph with the following works: 12–13, 13–14, 14–15, 15–20 and 12–16, 16–17, 17–18, 19–20, since this segment of the graph is the most time-consuming, according to the production process.

To confirm the optimality of the chosen solution, we turn to linear programming methods. The objective function is to minimize the number of workers involved to speed up the production of the product. Using the initial data (Table 1, Fig. 1), it can be argued that the period for the production of the "Night 91 M" suit should be reduced. This condition can be fulfilled due to the reduction of individual works. If we imagine that x_{i-j} is the number of working days by which, according to the condition, it is required to reduce the travel time from *i* to *j*, then we get the following:

$$t_j^l - t_i^e = t_{i-j} - x_{i-j}.$$

Table 1. The production process of tailoring the costume “Night 91 M”

Work code	Title of work	Previous work	Labor intensity, man-hour (in minutes)	Expected duration in days	Performers, their number	Early start of work	Early completion of works	Late start of work	Late completion of work	Full reserve	Free reserve	Private reserve
0-1	Development of an experimental model		**480**	**0.33**	1 constructor 1 technologist 4 sewers	0	480	0	480	0	0	0
1-2	Cutting 34 sets of products	Development of an experimental model	**60**	0.04	1 tailor	480	540	480	540	0	0	0
2-3	Transportation of the cut to the sewing workshop	Cutting of the product	**2**	0.00	1 loader	540	542	751	753	211	211	211
3-4	Processing the lining of the jacket	Transportation of the cut to the sewing workshop	**87**	0.06	1 seamstress	542	629	851	938	309	-211	98
4-5	Dummy job	Before starting work 5-6 get the results of work 3-4	**0**	**0.00**		629	629	938	938	309	-211	0
3-5	Patch pocket processing	Transportation of the cut to the sewing workshop	**185**	0.13	1 seamstress	542	727	753	938	211	-211	0
5-6	Shelf processing	Patch pocket processing	**272**	0.19	1 seamstress	727	999	938	1210	211	-211	0
3-7	Sleeve pocket finishing	Transportation of the cut to the sewing workshop	**226**	0.16	1 seamstress	542	768	906	1132	364	-211	153
7-8	Sleeve processing	Sleeve pocket finishing	**78**	0.05	1 seamstress	768	846	1132	1210	364	-364	0
6-8	Dummy job	Before starting work 8-10 get the results of work 5-6	**0**	**0.00**		999	999	1210	1210	211	-364	0

Table 1. The production process of tailoring the costume “Night 91 M”

Work code	Title of work	Previous work	Labor intensity, man-hour (in minutes)	Expected duration in days	Performers, their number	Early start of work	Early completion of works	Late start of work	Late completion of work	Full reserve	Free reserve	Private reserve
8-10	Mounting the jacket	Shelf processing, sleeve processing	**121**	0.08	1 seamstress	846	967	1210	1331	364	-364	0
3-9	Collar processing	Transportation of the cut to the sewing workshop	**239**	0.17	1 seamstress	542	781	1092	1331	550	-211	339
9-10	Dummy job	Before starting work 10-11 get the results of work 3-9	**0**	**0.00**		781	781	1331	1331	550	-364	0
10-11	Mounting the jacket	Collar processing	**208**	0.14		967	1175	1331	1539	364	-364	0
2-12	Transportation of the cut to the sewing workshop	Cutting products	**2**	0.00	1 loader	540	542	540	542	0	0	0
12-13	Processing the front halves of trousers	Transportation of the cut to the sewing workshop	**74**	0.05	1 seamstress	542	616	546	620	4	0	4
13-14	Processing front patch pockets	Processing the front halves of trousers	**191**	0.13	1 seamstress	616	807	620	811	4	-4	0
14-15	Amplifier Processing	Processing front patch pockets	**246**	0.17	1 seamstress	807	1053	811	1057	4	-4	0
12-16	Processing the back halves of trousers	Transportation of the cut to the sewing workshop	**19**	0.01	1 seamstress	542	561	542	561	0	0	0
16-17	Processing patch pockets on the back halves of trousers	Processing the back halves of trousers	**191**	0.13	1 seamstress	561	752	561	752	0	0	0

Table 1. The production process of tailoring the costume “Night 91 M”

Work code	Title of work	Previous work	Labor intensity, man-hour (in minutes)	Expected duration in days	Performers, their number	Early start of work	Early completion of works	Late start of work	Late completion of work	Full reserve	Free reserve	Private reserve
17-18	Processing pockets for signal cartridges	Processing patch pockets on the back halves of trousers	**122**	0.08	1 seamstress	752	874	752	874	0	0	0
18-19	Knife pocket processing	Processing pockets for signal cartridges	**126**	0.09	1 seamstress	874	1000	874	1000	0	0	0
19-20	Processing of dustproof parts	Knife pocket processing	**57**	0.04	1 seamstress	1000	1057	1000	1057	0	0	0
15-20	Dummy job	Before the start of work 20-21 get the results of work 14–15	**0**	0.00		1053	1053	1057	1057	4	0	0
20-21	Mounting trousers	Processing of dustproof parts, processing of front patch pockets	**136**	0.09	1 seamstress	1057	1193	1057	1193	0	0	0
21-22	Processing of the upper and lower sections of the trousers	Mounting trousers	**346**	0.24	1 seamstress	1193	1539	1193	1539	0	0	0
11-22	Dummy job	Before the start of work 22-23 get the results of work 10-11	0	**0.00**		1175	1175	1539	1539	364	0	0
22-23	OTK	Dummy job	**173**	0.12	1 seamstress	1539	1712	1539	1712	0	0	0
23-24	Marking	Quality Control	**24**	0.02	1 seamstress	1712	1736	1712	1736	0	0	0

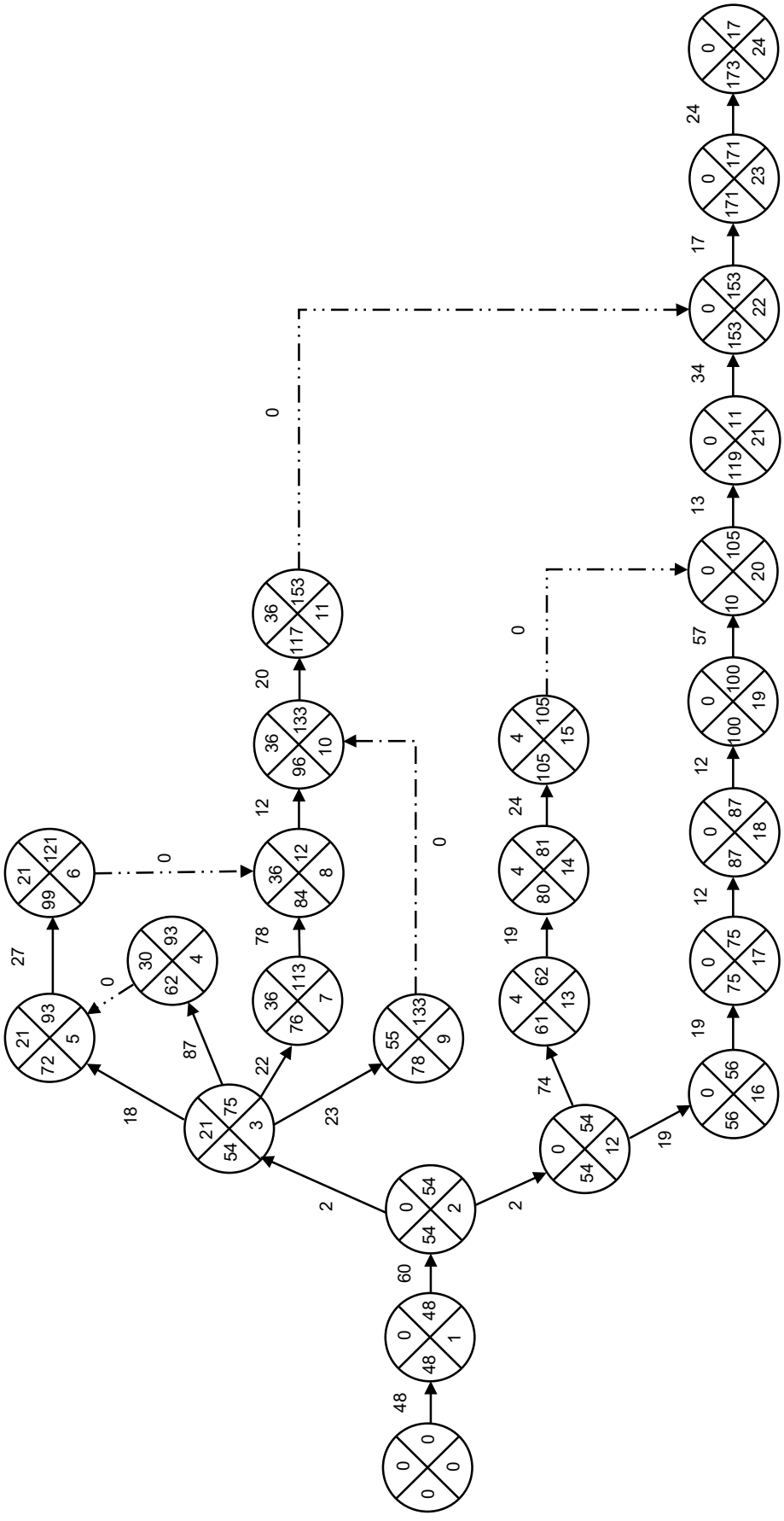

Fig. 1. Production network graph process of tailoring the "Night 91 M" suit

Table 2. Solving the problem of network graph optimization using the simplex method algorithm

	t1	t2	t3	t4	t5	t6	t7	t8	t9	t10	t11	t12	t13	t14	t15	t16	t17	Objective function
Variables	74	265	511	19	185	292	368	415	0	0	0	0	25	15	50	10	0	
Target function coefficient	–2	–1	4	0	0	4	–3	1	0	0	0	0	0	0	0	0	0	2110
Restriction 1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	74
Restriction 2	–1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	191
Restriction 3	0	–1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	246
Restriction 4	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	19
Restriction 5	0	0	0	–1	1	0	0	0	0	0	0	0	1	0	0	0	0	191
Restriction 6	0	0	0	0	–1	1	0	0	0	0	0	0	0	1	0	0	0	122
Restriction 7	0	0	0	0	0	–1	1	0	0	0	0	0	0	0	1	0	0	126
Restriction 8	0	0	0	0	0	0	–1	1	0	0	0	0	0	0	0	1	0	57
Restriction 9	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	415

According to the condition of the task, we can also write:

$$t_i > 0,\ i = 1, 2, \ldots, n;$$
$$x_{i-j} \geq 0,\ j = 0, 1, 2, \ldots, n-1;\ j = 1, 2, \ldots, n.$$

According to the condition of the approved task, the number b_{i-j} corresponds to the number of workers required to reduce the $(i-j)$-th job by 1 day, and t_{i-j} is the duration of the job. It follows that the requirement to minimize the number of employed workers can be replaced by the requirement to maximize the following objective function:

$$L(t) = \sum_{i,j} b_{i-j}(t_j - t_i) \rightarrow \max;$$
$$L(t) = 1\times(t_{13} - t_{12}) + 3\times(t_{14} - t_{13}) + 4\times(t_{15} - t_{14}) + 1\times(t_{16} - t_{12}) + 2\times(t_{17} - t_{16}) + 2\times(t_{18} - t_{17}) + 2\times(t_{19} - t_{18}) + 1\times(t_{20} - t_{19}) \rightarrow \max;$$
$$L(t) = -2\times t_{13} - 1\times t_{14} + 4\times t_{15} + 4\times t_{18} - 4\times t_{19} + t_{20} \rightarrow \max.$$

Provided that the early date of the event is equal to zero $t_0^e = 0$, condition for the completion of the complex of works within the specified time:

$$t^e_{12-20} = t^y = 415,$$

conditions for reducing the duration of work on x_{i-j} minutes:

$$t_{13} - t_{12} = 74 - x_{12-13};$$
$$t_{14} - t_{13} = 191 - x_{13-14};$$
$$t_{15} - t_{14} = 246 - x_{14-15};$$

$$t_{16} - t_{12} = 19 - x_{12-16};$$
$$t_{17} - t_{16} = 191 - x_{16-17};$$
$$t_{18} - t_{17} = 122 - x_{17-18};$$
$$t_{19} - t_{18} = 126 - x_{18-19};$$
$$t_{20} - t_{19} = 57 - x_{19-20};$$
$$t_{20} - t_{12} = 415 - x_{12-20}.$$

and also under the following conditions: $t_{12} > 0$; $t_{13} > 0$; $t_{14} > 0$; $t_{15} > 0$; $t_{16} > 0$; $t_{17} > 0$; $t_{18} > 0$; $t_{19} > 0$; $t_{20} > 0$ and $x_{12-13} \geq 0$; $x_{13-14} \geq 0$; $x_{14-15} \geq 0$; $x_{15-16} \geq 0$; $x_{16-17} \geq 0$; $x_{17-18} \geq 0$; $x_{18-19} \geq 0$; $x_{19-20} \geq 0$.

The application of the simplex method algorithm showed that it is possible to reduce the critical path by 100 minutes in the analyzed segment, in particular, by reducing the operation 16–17 by 25 minutes, 17–18 by 15 minutes, 18–19 by 50 minutes, 19–20 by 10 minutes, while connecting the minimum number of employees (see table 2).

The effectiveness of the use of linear programming for the problems of optimizing the use of enterprise resources has been confirmed by many scientists: The most suitable for our task is the toolkit of the linear programming problem on the distribution of resources. It is no coincidence that this device is used in the vast majority of works, one way or another related to the subject of scientific research. However, the classical formulation of the problem does not adequately reflect the economic basis for planning the production and marketing of an industrial enterprise.

This task of linear programming needs to be rethought again from the standpoint of long-term planning, return on investment to increase the resource base of the enterprise, as well as combining resource and market approaches to strategic management [5]. A detailed study and study of approaches and models is required for effective use in solving applied problems.

Within the framework of the presented study, an analysis of the financial and economic activities of the St. Petersburg Innovation Company CJSC Scientific and Production Enterprise “ANA” was carried out. The proposed original solution of the network graph optimization problem using the simplex method algorithm to optimize the distribution of enterprise resources has proved its effectiveness in the process of testing and implementation at CJSC NPP ANA and can be recommended for use at other textile industry enterprises.

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Оптимизация распределения ресурсов с использованием сетевого графа методом линейного программирования

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Ключевые слова и фразы: алгоритм симплексного метода; оптимизация распределения ресурсов; предприятия легкой промышленности; производственный процесс; сетевое планирование; экономический эффект.

Аннотация. Цель представленного исследования – на основе проведение анализа финансово-хозяйственной деятельности Санкт-Петербургского предприятия легкой промышленности ЗАО НПП «АНА» разработать оригинальный подход к оптимизации распределения ресурсов с использованием сетевого графа. Задачи исследования: рассмотреть основные экономические показатели легкой промышленности за последние годы, проанализировать текущее состояние предприятий легкой промышленности, сделать акценты на усилении рыночных позиций предприятий, внедряющих инновационную продукцию. Используемый метод – оптимизации сетевого графа с применением алгоритма симплексного метода линейного программирования. Научная гипотеза строится на предположении, что решение задачи оптимизации распределения ресурсов предприятия является ключевым моментом в вопросах эффективного управления производством. Результатом исследования является оригинальный подход к решению задачи оптимизации сетевого графа с применением алгоритма симплексного метода для оптимизации распределения ресурсов промышленного предприятия.

UDK 004.94

Computer Simulation Modeling of the Operation of Mobile Woodworking Equipment in the Climatic Conditions of the Far North

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Key words and phrases: modeling; low temperatures; timber; logging; logging site; Far North.

Abstract. The article considers the possibility of processing logging residues into wood flour under logging operations. Simulation modeling of the knife machine operation was carried out using the Compass 3D and SolidWorks software products in the climatic conditions of the Far North. Basing on the analysis of the results of simulation modeling, the authors substantiated the temperature regimes which make it is possible to obtain wood flour with satisfactory quality indicators.

Until recently, the only thing significant in the forest industry was the trunk. Everything else, including the crown, small shoots and branches, were considered waste that filled the cutting areas and created a favorable environment for the reproduction of forest pests, and also became a forest fire threat [1–3]. In turn, a large accumulation of such waste in cutting areas was characterized by inadequate use of the wood reserve [4–6].

The analysis of practical experience and works of modern researchers [7–8] showed that the most appropriate way to use logging waste in the form of branches and twigs is the production of wood flour. This product has found its wide application in various industries. For processing branches, a model of a mobile knife machine was developed (Fig. 1) using the Compass-3D integrated design application.

A 3D model of the working bodies of the mobile machine was developed (Fig. 2) in order to analyze the processes and phenomena that occur as a result of the processing of logging residues into wood flour. As it can be seen in Fig. 2, the grinding process consists mainly in crushing and rubbing effects on wood, occurring in the working chamber. The drive shaft is connected to the belt drive through a belt drive pulley. The torque from the electric motor is transmitted by means of a belt drive to the drive shaft 1, where a crown with teeth 2 is installed. It rotates due to the engagement of the teeth of the crown of the driven shaft 3. Getting wood flour is carried out in the gap between the teeth of the crowns. The driving and driven shafts are fixed in ball bearings 5. Between them there are spacer rings 6.

The SolidWorks 3D modeling system was chosen with an integrated Flow Simulation module in order to assess the possibility of using the proposed mobile machine for processing logging waste in the climatic conditions of the Far North. The simulation modeling of the process

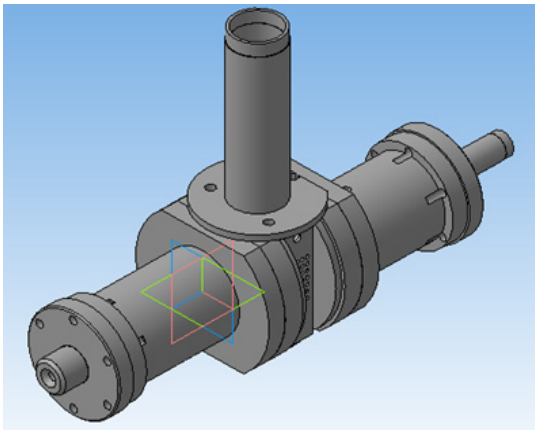

Fig. 1. 3D model of the grinding machine

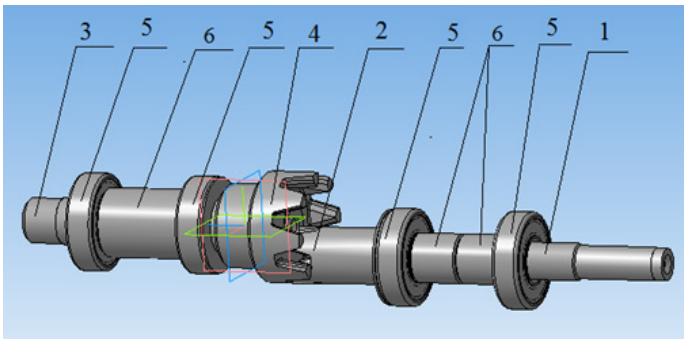

Fig. 2. Working parts of the machine

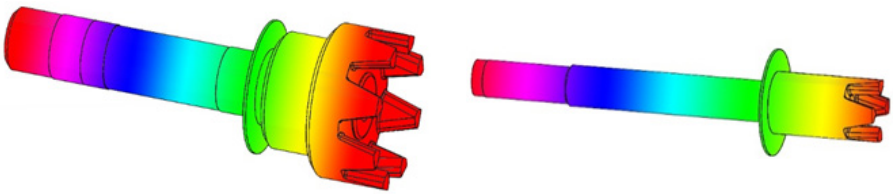

Fig. 3. Diagram of the stress occurrence on the working bodies when the ambient temperature drops

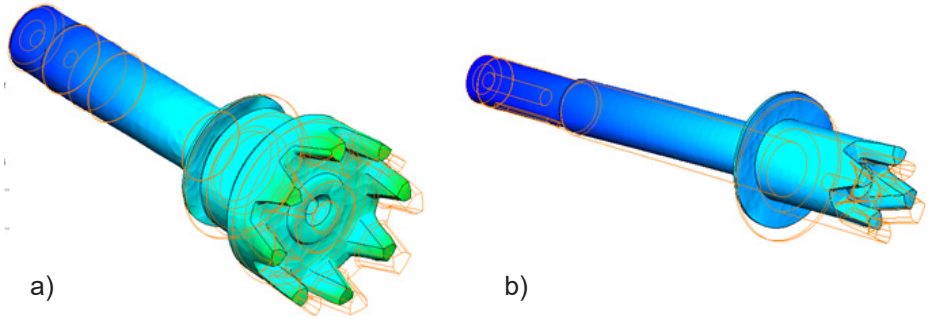

Fig. 4. A diagram of the deformation occurrence on the working bodies when the ambient temperature drops: a) driven shaft assembly; b) drive shaft assembly

of obtaining wood flour was implemented in the Solid Works environment to study the effect of negative temperatures on the working parts of the equipment. This experiment is focused on determining the stresses and deformations of the working bodies of the machine at extreme temperatures up to –55 °C.

Analyzing the models presented in Fig. 3, it can be seen that when the ambient temperature decreases, the maximum stresses appear on the crowns of the working elements of the machine. This will lead to an increase in the fragility of the material of the crowns and their increased deterioration during operation [9–11].

Fig. 4 shows the scheme of deformations of the working bodies with a decrease in the

Table 1. The research results of the dependence of the wood particles size on the ambient temperature

Ambient temperature, °C	Reduction of the working gap value, %	Size of wood particles, mm
–55	25	3
–50	20	2
–45	18	2
–40	14	1
–35	11	1
–30	9	0.9
–25	8	0.8
–20	6	0.6
–15	4	0.5
–10	3	0.5
–5	2	0.4
0	1	0.4
5	1	0.3
10	0	0.3
15	0	0.3
20	0	0.3
25	0	0.3
30	0	0.3

ambient temperature. The diagram shows a negative temperature of –55 °C decreases the working gap by 25 %. The actual gap will increase by 12.5 μm to 62.5 μm instead of the optimal gap of 50 μm. which will negatively affect the quality of the wood flour.

Considering natural and climatic conditions, an assessment of the influence of the temperature regime on maintaining the value of the working gap was made to substantiate the technological and design parameters and their adjustment. The table below shows the design parameters of the operating gap and the size of the wood particles at various ambient temperatures. The table shows that the size of wood particles reaches its standard value of 0.3–0.5 mm at an ambient temperature of at least –15 °C.

Thus, through simulation modeling of the operation process of mobile woodworking equipment at different temperatures, it was found that deformations of the working bodies and an increase in the working gap occur at temperatures below –15 °C. The increased gap leads to the fact that the particle sizes of wood flour exceed the standard values. As a result, this will lead to low quality of the resulting products.

Modern information technologies made it possible to substantiate the possibility of using a mobile machine in the climatic conditions of the Far North. It was found that the quality of wood flour meets the requirements of industrial standards at ambient temperatures down to –15 °C. With a further decrease in ambient temperature, the quality of wood flour deteriorates. As a result, in order to obtain wood flour from logging residues at lower temperatures, it is necessary to warm up the working bodies by means of grinding a small amount of raw materials with

closed outlet grates of the installation chamber.

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Компьютерное моделирование процесса работы мобильного деревоперерабатывающего оборудования в климатических условиях Крайнего Севера

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Ключевые слова и фразы: древесина; Крайний Север; лесозаготовки; лесосека; моделирование; низкие температуры.

Аннотация. В статье рассмотрена возможность переработки порубочных остатков в древесную муку в условиях лесозаготовительных работ. Выполнено имитационное моделирование процесса работы ножевой установки в климатических условиях Крайнего Севера при помощи программных продуктов Компас 3D и SolidWorks. На основании анализа результатов имитационного моделирования были обоснованы температурные режимы, при которых возможно получение древесной муки с удовлетворительными качественными показателями.

UDK 334

Economical Mechanism to Attain 2050 Forecasts with Focus on Africa

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Key words and phrases: 2050 year; Africa; economic; forecast; Nigeria.

Abstract. The goal of this research is to focus on the forecasts that have been made about the future of African economics in 2050. The research methods include both methodological and theoretical approaches to dig-out facts and figures generated from scholars worldwide about the theme. It should be noted that Africa with the influence of China and exposure to Internet in recent years seems poised for 2050 forecasts. Nigeria being one of the biggest players economically in the continent is at the centre of examination in this research. The results of this research reveal African's awareness and preparedness for this big future. The hypothesis used is regression analysis, Nigerian institutions' data were used for forecasting purposes.

Introduction

Africa being one of the most disadvantaged continent economic wise has received a boost with future forecast of its economics, population and social welfare. While one may argue about the rise of population as a disadvantage for Africa, a close look at the emergence of China as one of the biggest economies in the world at the moment spells it is positive for the growth of African population in 2050.

According to the Division of the department of Economic and Social Affairs of the United Nations Secretariat in 2011, most African countries will double or even triple their working population by 2050. The sole reason to these developments is due to the fact that African countries have achieved quite low levels of child birth mortality. Also HIV/AIDS as a major threat is a thing of the past; fertility rate in these regions is high in comparison to other part of the world. Also, 25th August 2020, Africa made history with the African Region Certification Commission for Polio Eradication independently certifying that the Region was free of wild polio-virus. That is after 4 years without a single case of wild polio.

With the current crises in Ukraine which has led to the surge of gas prices, African countries Nigeria particularly is at a big gain. Although, 2050 is still far away, according to K.F. Nwanze (2019), "While our governments struggle to balance between saving lives and keeping their economies alive", if African countries combine resources effectively, work harder on preparation, don't neglect any sphere of their economics, focus on human resources, form committees to

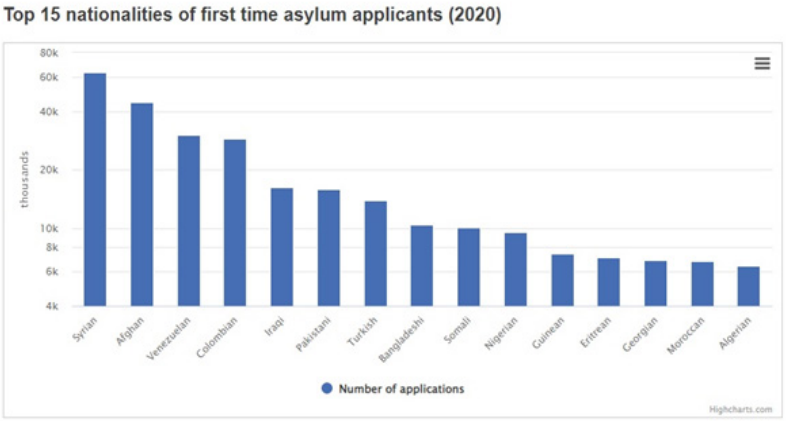
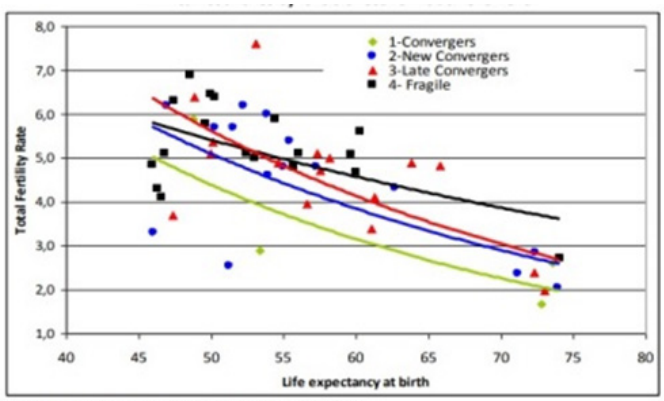


Fig. 1. Asylum seeks in 2020 in EU countries



Source: United Nations 2011 and calculations of the authors.
Note: R^2 values range from 0.316 for "Fragile", to 0.500 for "Late Convergers", to 0.446 for "New Convergers", and to 0.671 for "Convergers".

Fig. 2. Total fertility rates and life expectancy at birth rates from 2005–2010 in African countries by levels of economic achievement

work towards these goals and adopt a Chinese approach. It will surely attain those economic prospects predicted by the United Nations in 2011 and be also able to manage its high population adequately.

Demographic Discourse

Nigeria is predicted to be the fourth population wise by 2050 with the population of 397 million, which means it'll be larger than Central African's in it's entirely. Only China, India and the United States of America will be higher.

The United Nations used couple of instruments to forecast the population of the world by 2050. This is very important because there is need to plan and be prepared for stability and growth. It will be interesting to see how the global pandemic will affect these predictions since it was made in 2011 and the pandemic in 2020. Migration is also another factor which might play a big role in the alteration of the 2050 population growth.

With notably 5 African countries on this list, predictions of 2050 might be affected if eventually numbers increase in the nearest future before 2050. Anyway, the numbers could

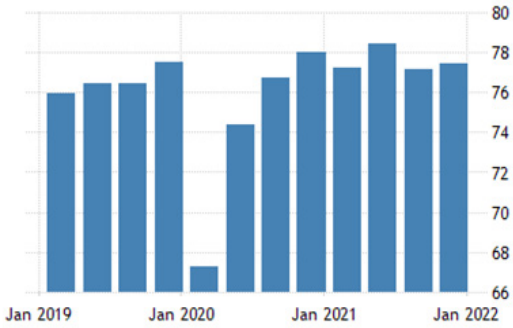


Fig. 3. China's industrial capacity utilization – 2021 Data – 2022 Forecast

reduce if people begin to see prospects back home.

The need to accelerate simultaneously mortality and fertility decline is justified by the relationship between these two variables. This relationship is illustrated to some extent by the simple correlation between the total fertility rates (**TFR**), i.e., the average number of births per woman, and the life expectancies at birth, i.e., the average number of years lived by every person, for the four groups of countries according to the "Convergence Model" classification.

As it can be observed, these two key demographic indicators gradually improve as countries go through the four stages of this convergence process, i.e., from "Fragile" to "Late-convergers" to 6 "New Convergers" and finally to "Convergers" status. It should be noted that only four countries belong to the "Convergers" group (Fig. 2).

From what we see above, a significant improvement has been achieved by African countries. In Nigeria, in 2015, the fertility rate was 5.5 births per woman, but this increased in 2016 to 5.8 births per woman. This means that women in Nigeria will have, on the average, 5.8 children each during their entire childbearing years. Strong sense of culture and religion will be what will spike Nigeria to meet up with the future predictions.

China's Trend

China ended 1970 with a population of 829,920,000 people, which represents an increase of 23,208,000 people compared to 1969. This was the beginning of China's population boom. What China did was to amass a great population before making reforms to contain it, control and transform it into a prosperous society which it is today.

While African countries might not be a socialist country, there is every chance for them to strive if they adopt policies that could integrate African great cultural heritage to economic goals and development. African culture upholds child-bearing as a priority so population boom in comparison of that of China could be achieved.

China is a diligent and wise nation with a long history. It has created a brilliant political civilization. All of five thousand years ago, ancient Chinese began to explore the concept that people are the foundation of a state. After revolution in China, on the 1st October 1949, the People's Republic OF China was established. Their main focuses were:

1) building and consolidating state power;
2) completing the socialist transformation of the means of production;
3) promulgating the first Constitution of the PRC;
4) establishing the system of people's congresses, the system of CPC-led multiparty cooperation and political consultation, and the system of regional ethnic autonomy.

Production in African countries

There is a need for focus on production, industrialization and resource management. The effective combination of these policies is what has made China an economical giant today. Another issue which was crucial was corruption. Corruption in China could lead to death penalty. The result of such a strict system has produced state loyalists and dedicated servicemen.

China applies a system of community-level self-governance represented by villagers' autonomy, urban residents' autonomy, and employees' congresses. It should be noted that China has eliminated poverty in 2020. This simply means Africa following suit even though it might take time.

Huddles for Africa and Nigeria

To claim what 2050 has in sight, Africa must overcome its current challenges which ranges from the seat of the government to every household on the continent.

Political Instability. Last September in 2021 military leaders in Guinea led by Colonel Mamady Doumbouya oust the democractic government. In May, 2021 Colonel Assimi Golta led his men to plot a second coup in nine months in Mali. The coup leaders deposed the transitioning President, Bah Ndaw and Prime Minister Mostar Quane. These are few examples to show that without a long-term visionary government, no country to attain remarkable success.

Corruption. It is another issue that needs proper attention. If it continues, it means resources meant for development of both urban and rural areas will be looted and people left deprived of basic amenities which should trigger prosperity of the big future of 2050. In Nigeria for example, the EFCC are working hard to mop out corruption but it hasn't been easy even with President Mohammed Buhari who is serving his second tenure and won on the basis of anti-corruption campaign.

Energy. Africa is tagged 'the black continent' not only because of the people but because of power outage. For industries to spring up and strive, there's need for a stable and sustainable power supply just like in developed countries. Nigeria is contracted to Russia's Rosatom for the second and third nuclear plant in Africa, so it seems the issue will be tackled.

Water. Without clean water to drink, the risk of different diseases threatens any society. And only a healthy society can go ahead to achieve greatness. Nigeria resort it's water consumption mainly from 'pure water' enterprises. There is need for the government to provide portable water to drink both for local and big cities.

Transportation. A typical example can be seen in Nigeria. Although the railway was opened in 1898, it didn't operate for decades and was only operational again under the government of President Goodluck Jonathan. It might interests you to know that the Corporation recorded 2.2 billion Naira (about €4.66.4 million) revenue in the first quarter of 2021, while there are other huddles like health care, crime, redundancy, education etc. Africa must jump over, the above are really crucial in attaining 2050.

Conclusion

According to Fayode (2019), "One of the greatest global challenges today – feeding the World-is also our greatest opportunity". Nigeria is a tropical country which has the capability of feeding a large part of the world if it's agriculture could meet advanced technology and good management. I believe agricultural exports can make the country great just like Russia as one

the largest wheat producing nation in the world.

Yes we can see traits, in Nigeria, there are already smart houses in Abuja, companies like Facebook, Google, MEST are opening hubs in Lagos. The rise in this sphere will definitely will be beneficial for Nigeria, Africa and could pave way for the realization of 2050 targets.

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Прогнозирование уровня развития экономики в африканских странах до 2050 г.

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Ключевые слова и фразы: 2050 г.; Африка; Нигерия; прогноз; экономика.

Аннотация. Рассмотрены прогнозы, сделанные в отношении будущего африканской экономики на период до 2050 г. Исследование проведено с учетом методологических и теоретических подходов к выявлению фактов и цифр по данной теме. Следует отметить, что Африка с учетом влияния Китая и доступа к интернету в последние годы, похоже, готова к прогнозам на 2050 г. Нигерия, являющаяся одним из крупнейших экономических игроков на континенте, находится в центре внимания этого исследования. Результаты исследования показывают осведомленность и готовность африканцев к большому будущему. Гипотеза исследования представляет собой регрессионный анализ, в целях прогнозирования использовались официальные статистические данные по Нигерии.

UDK 332.1

Benefits and Losses in the Russian Arctic in Relation to the Sensitivity of the Economy to Climate Changes

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Key words and phrases: benefits from using natural resources; climate change; meteorological reasons; losses; natural risks; sensitivity of the economy.

Abstract. The article discusses the investigation of the regularity of the economic sensitivity to climatic changes in the conditions of the North region. The purpose of the article is to consider the losses of the Russian economy in the Arctic with the predicted changes in the natural conditions of its functioning and the benefits that will be obtained. The hypothesis of the study is that any climatic changes can lead not only to the occurrence of probable losses, but also provide an opportunity to develop the economic potential of territories and industries. The main research methods in the article are the analysis of scientific literature and statistical data. As a result of the conducted research, the authors highlight the need to maintain a positive balance of benefits and losses for the Russian economy, not only minimizing the likely losses due to meteorological reasons, but also maximizing profits from a complete useing of the Arctic territories potential.

The economy of the Arctic region of Russia is the most sensitive to the global climate. At the same time, the impact of climate is ambiguous: on the one hand, climate change causes the risk of adverse consequences for human life (including economic, economic), including long-term consequences; on the other side of climate change Thus, climate changes have become an important component, which ultimately draws attention to economic indicators in the form of GDP growth dynamics.

However, there is a difficulty in assessing climate change consequences objectively. Firstly, there are significant deviations in the horizon of the dynamics of technological processes, so that climate change forecasts based on physical and climate models cover 50–100 years, which does not correspond to the expected economic forecasts (10–20 years). Secondly, modern climate risk assessments (losses from the manifestations of natural forces of nature) reveal only global catastrophic events. That is, such scenarios, for example, with the onset of permafrost due to temperature in the Arctic, lead to direct damage to the economic and social sphere both in the entire international space and in the near future. Indeed, melting permafrost threatens

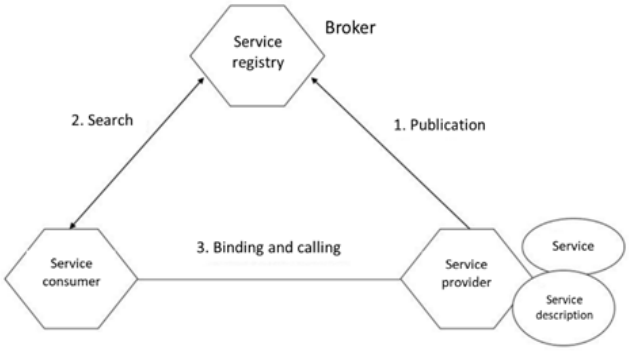

Fig. 1. Reference architectural model SOA [1]

privacy and a limited greenhouse effect.

For Russia, whose territory is two-thirds of the permafrost zone, this problem is most seriously approached as a factor of critical climate risk. Due to the higher rate of temperature increase in the Russian Arctic, according to Roshydromet, the temperature of the proposed region will increase by 7 ºC before the end of the century.

According to published data from studies conducted at the University of Exeter, the University of Oslo, and the University of Stockholm, with a one degree warming in the world, 4 million square meters are lost. km of permafrost. The rate of climate change is being accelerated by the degradation of permafrost, which contains more carbon than the atmosphere. Given that by 2040, 20 % of permafrost will melt and release CO_2 contained in the upper layers of its surface. In addition to carbon dioxide, the melting of the permafrost releases methane, which is stronger in its greenhouse effect than carbon dioxide. The release of methane and carbon dioxide could kick off a cycle in which increased emissions cause more warming of the atmosphere, and more warming increases the rate of permafrost melt, which in turn increases emissions. Accordingly, warming in the Arctic zone, according to some estimates, will lead to direct losses for all mankind in the amount of about $160 trillion over the next 100 years, or an average of $1.9 trillion per year, which could be 1.1–1.2 % of world GDP. For Russia, these losses will amount to 2–3 % of GDP per year, or 5–6 % of regional GDP.

In addition, according to the calculations of the Ministry of Natural Resources of the Russian Federation, the degradation of the permafrost zone will have a catastrophic impact on the state and functioning of the existing infrastructure. Permafrost thawing may affect more than 20% of Russian infrastructure, as already 40 % of industrial facilities in the Northern regions have been damaged. Companies such as Gazprom, NOVATEK, ALROSA, and Norilsk Nickel are at risk. If we consider that the share of the oil and gas sector in Russia's GDP is 15.2 %, then by 2050 the country's economy may lose $68 billion.

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The climatic factor is not the only one that determines the dynamics of GDP, especially in the medium term. In addition, the impact of climate change on the country's economy can

have a positive effect, since for some industries these changes improve the conditions for reproduction. Global warming can lead to significant savings associated with a reduction in the heating season, lower energy and fuel costs; the expansion of agricultural production as a result of both the increase in the duration of the growing season and the expansion of the area of agriculture; increasing the efficiency of using the Northern Sea Route through an increase in the time of navigation in the waters of the Arctic Ocean and, accordingly, the possibilities for the development of water transport, etc.

The opening of the region for navigation promises significant benefits for Russia, according to various estimates, the cargo flow on the northern sea route by 2024 can reach from 60 to 92.6 million tons. With the development of Arctic projects and the intensification of shipping in the Arctic, a multiplier effect will be observed in many sectors of the economy throughout Russia, first of all, the demand for shipbuilding products and ship repair services will be formed. World production of offshore oil and gas is estimated at $80–100 billion per year.

A number of long-term economic forecasts show that the cumulative economic effect of the listed favorable consequences of climate change for the economy of the Russian Federation will be characterized by an excess of benefits over losses from the manifestation of natural forces, including the consequences of climate change. However, it should be noted that the calculation of costs did not include measures to overcome the adverse effects of climate change, the cost of adapting the country's economy to new conditions. Also, the volume of investments in the development of the infrastructure of the Northern regions of Russia, the high degree of deterioration of which causes its increasing vulnerability to the effects of weather and climate factors, is not taken into account. And in order to realize the potential of Russia in the development of hydrocarbon deposits on the shelf, it is necessary to take into account investment in the creation and construction of special marine equipment, etc.

At the same time, the orientation of the calculation of the country's main macroeconomic indicators on costs, i.e. ignoring or underestimating the above-mentioned favorable effects of climate factors, means that state programs and measures of adaptation to climate change are biased exclusively towards protective measures. Investments in which, according to World Bank estimates, between 2010 and 2030 could reach $600 billion. fossil fuels) investment in the amount of 140 to 175 billion dollars per year. Bearing in mind that the benefits derived from such investments are only realized over time. Measures to adapt the world economy to climate change are projected to require more than $70 billion in investments, to reduce greenhouse gas emissions and implement other measures to prevent emissions – $400 billion per year, which in total could be about 0.30 % of the global GDP.

It seems, however, that it is possible to achieve positive results in the implementation of state programs for the development of the Arctic only by achieving a positive balance of gains and costs, not only minimizing probable losses due to meteorological reasons, but also maximizing income from a fuller use of the potential of the Arctic territories.

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Доходы и потери российской Арктики во взаимосвязи с чувствительностью экономики к изменениям климата

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Ключевые слова и фразы: выигрыш от использования природных ресурсов; климатические изменения; потери по метеорологическим причинам; природные риски; чувствительность экономики.

Аннотация. Статья посвящена исследованию закономерности чувствительности экономики к климатическим изменениям в условиях Крайнего Севера. Целью статьи является рассмотрение потерь Российской экономики в Арктике при прогнозируемом изменении природных условий ее функционирования и выгоды, которые удастся получить. Гипотеза исследования заключается в предположении, что любые климатические изменения могут приводить не только к возникновению вероятных потерь, но и дают возможность развивать экономический потенциал территорий, отраслей. Основные методы исследования в статье – анализ научной литературы и статистических данных. В качестве результата проведенного исследования авторами выделяется необходимость соблюдения положительного сальдо выигрыша и потерь для Российской экономики не только минимизируя вероятные потери по метеорологическим причинам, но и максимизируя доходы от более полного использования потенциала Арктических территорий.

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