Sustainable Development of the Metallurgical Industry based on the Development of Waste-free Technologies and an Environmentally Oriented Economy

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Abstract: The article presents innovations in the organization of labor activity and personnel management of an industrial enterprise. The topic of lean and eco-friendly production has been actively analyzed. The unrestrained uncontrolled growth of the market economy leads to an increase in consumption and production of goods, natural resources used for this, to an increase in harmful emissions and production waste into the biosphere (environment). Humanity has come to an increasingly acute contradiction between its growing needs and the inability of the biosphere to provide them with resources without collapsing. Aluminum is called a material for the "green economy".

1 INTRODUCTION

The problem of studying the sustainability of the development of the economy of the metallurgical sector of industry is becoming increasingly important today. This is due to the fact that one of the most important problems in the organization's activities is the insufficiently effective use of working time by staff. The relevance of the study of this problem is determined by the peculiarities of modern reality, when the internal environment of the organization becomes more complex, and the external environment requires the organization to constantly search for improving work efficiency.The working time of most employees of modern organizations is condensed to the limit, the working day is not standardized, and yet it is often not possible to complete all the planned tasks by the specified deadline, and the results of the activity itself do not always satisfy the management. Therefore, the problem of managing the rationalization of the use of working time by personnel as society develops, increasing the dynamism of changes, increasing the "information component" in the final product, becomes a significant factor in the effectiveness of the organization.

2 MATERIALS AND METHODS

The methodological basis of the research consists of general scientific dialectical, systemic and situational approaches, laws of logic, typology, basic provisions of economic theory and entrepreneurship theory, as well as methods of economic and mathematical modeling, economic analysis and synthesis, empirical generalization, etc.

The empirical basis of the study was the official information of the Federal State Statistics Service, the Ministry of Economic Development of the Russian Federation, the Ministry of Energy of the Russian Federation, open sources of petrochemical companies and their divisions (Rosneft Oil Company, Gazprom Neft, Sibur Holding, etc.), published materials and the results of research by domestic and foreign scientists, and also, the primary information of economic research carried out with the direct participation of the author for fourteen years (2008-2021)

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(Chapman,2003; Das, 2004; Marler, 2010; Stone, 2009).

In the development of industry, along with large-scale investment projects, the following characteristic stages can be distinguished: over the past 15-20 years - the development and expansion of the application of the concept of lean manufacturing; over the past 10 years, the addition to the "lean" environmental agenda; in recent years and months, the transition to the concept of sustainable development, including the above and the social sphere.

The concept of lean manufacturing was developed by Toyota, which was actively perceived and developed by a large number of companies around the world. With its adaptations and features, with different names, this system of continuous improvements, involving as many employees as possible, has become an integral part of the production and overall business activities of all modern successful metallurgical companies. This experience is reflected in a large number of book publications, articles, studies and essays (Marler, 2010; Schmidt).

The unrestrained uncontrolled growth of the market economy leads to an increase in consumption and production of goods, natural resources used for this, to an increase in harmful emissions and production waste into the biosphere (environment). Humanity has come to an increasingly acute contradiction between its growing needs and the inability of the biosphere to provide them with resources without collapsing.

Awareness of this problem led to the idea and strategy of sustainable development of global civilization, states, regions, industrial companies and enterprises.

Locally, in a number of regions of agglomerations and single-industry towns, there is a significant excess of emissions over absorption. The Federal project "Clean Air" has set a goal to reduce harmful emissions by 20% in 12 major industrial centers by 2024. In his annual message, the President proposed to expand such quotas to all cities where the problem of air quality is acute, and there are more than 40 of them in the country (Das, 2004; Sapunova, 2018).

In general, over the next 30 years, i.e. by 2050, the task has been set to ensure in the Russian Federation a better net result on the difference between emissions and absorption of greenhouse gases than neutral in the European Union. This goal is quite achievable with an active policy of decarbonization of industry and the economy, with a significant potential for the absorption of greenhouse gases.

Responsible industrial corporations and companies, including metallurgical ones, create and implement their development strategies and programs that provide for a significant reduction in energy consumption and harmful emissions in the regions and places of their production locations.

Among the metallurgical companies, the production of aluminum and metal products from aluminum alloys is interesting. Aluminum is called a material for the "green economy". Firstly, it is produced in the Russian Federation mainly using renewable sources of electricity (HPP). Secondly, the waste from this during production or during disposal (at the end of the life cycle of the final products) is fully involved in production cycles. Thirdly, the use of aluminum and its alloys due to their unique properties provides a low mass of structures, sufficient strength, high corrosion and cryogenic resistance, etc., brings an improvement in the technical characteristics of products and benefits in their operation, both economic and environmental. The figure 1 shows the areas of application of aluminum.

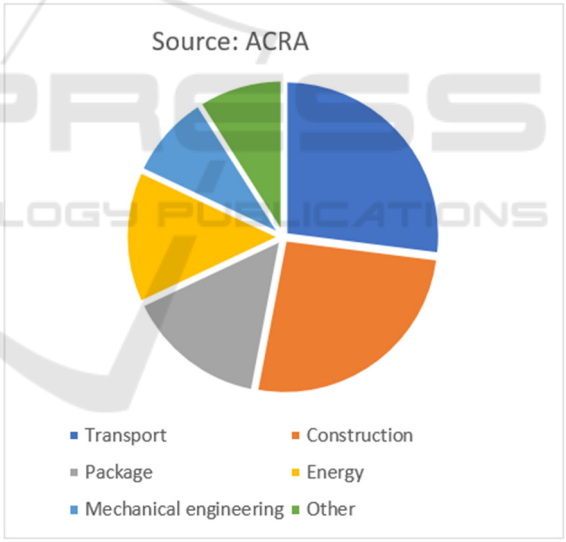

Figure 1: Areas of aluminum consumption by industry (%).

The priorities of the aluminum industry in developed countries include the expansion of the use of aluminum in various consumer industries and the development of production of products with high added value. Russian aluminum production enterprises have been merged into RUSAL Corporation. At the end of last year, they produced 3.75 million tons of aluminum. The corporation positions itself as a manufacturer of products with a low carbon footprint, which is less than 4 tons of CO_2

per ton of metal. Mainly due to the fact that the energy of hydroelectric power plants (HPPs) is used in the production of aluminum. The global average is 12 tons of CO_2. In China, the largest producer of aluminum, where coal plants form the basis of energy, the carbon footprint reaches up to 18 tons per ton of metal (Strohmeier, 2007; Tzafrir, 2005).

RUSAL has registered its own brand of "low-carbon" aluminum Allow, including for its more successful promotion with the "green brand" on the world market. RUSAL plans to develop its advantages, has begun a large-scale modernization of its four largest plants in Krasnoyarsk, Bratsk, Shelekhov (near Irkutsk) and Novokuznetsk. This project will require 380 billion rubles and is designed for 2022-2027. RUSAL expects that by updating production and switching from the traditional electrolysis technology used worldwide to the prebaked anode electrolysis technology, it will make its aluminum production even more productive, environmentally friendly and economical.

Along with aluminum producers (RUSAL, etc.), manufacturers of metal products made of aluminum alloys (tapes, sheets, profiles, pipes, rods, stampings) adopt and implement their strategies and programs for the transition to "green technologies" and "green metal products" together with increased productivity.

So, for example, Arconic Corporation (Arconic), which includes the company Arconic SMZ JSC (hereinafter SMZ - Samara Metallurgical Plant), due to the "greening" of their technologies, significantly improved environmental indicators for 2020 - according to the corporation, greenhouse gas emissions were reduced at plants around the world (-14%), consumption energy (-12%) and water (-8%); SMZ reduced the consumption of electricity (-6%), gas (-7%) and water (-13%) (Sarukhanyan, 2016) (Sarukhanyan, 2016;GOST R ISO 14001-2016).

In 2020, SMZ once again confirmed compliance with the requirements of the international environmental standard ISO 14001, and also received professional recognition from the international organization ASI (Aluminum Stewardship Initiative), which develops and promotes standards for responsible management of aluminum production and marketing. In the annual regional competition of the Samara region "Eco-leader – 2020", SMZ took first place in the nomination "Industrial Giant". Constant investments help the plant to comply with advanced technologies and environmental standards: since 2005, USD 0.5 billion have been allocated for the modernization of the SMZ, including for the improvement of environmental protection and industrial safety systems – more than USD 40 million.

A multi-year program for the conservation of the biodiversity of the Samara region, which is supported by the Arconic Foundation, contributes to the protection of the ecological well-being of the Samara region. Over 5 years, the Fund has allocated USD 235 thousand for the implementation of environmental projects in the Samarskaya Luka National Park and the Zhiguli State Reserve (Amrutha, 2020; Zakharov, 2019).

Arconic and SMZ aluminum metal products can be attributed to the leaders in environmental friendliness – to "green semi-finished products". Their use in subsequent technological conversion industries (packaging, mechanical engineering, construction, etc.), producing the final "green products", carries not only an improvement in the technical characteristics of products and economic benefits, but also positive environmental effects.

3 RESEARCH RESULTS

An example of a "green metal product" of SMZ is an aluminum tape for beverage cans. Aluminum can is a leader in recycling and environmental friendliness. The figure 2 shows the scheme of production and recycling of aluminum, tin tape and cans. From 4 tons of bauxite, 2 tons of alumina are obtained, of which 1 ton of aluminum. Further along the production cycle and recycling, all waste (there is a permanent program to reduce them) and recycled cans are fully involved in production. Treatment and recycling of one aluminum can (0.5 liters – 14 grams) instead of producing an appropriate amount of primary aluminum by electrolysis, prevents the release of 100 grams of $_{CO2}$. In Russia, there are factories for the production of aluminum cans with a total output of several billion pieces per year. Aluminum alloys, due to their advantages, are increasingly used in transport engineering. Arconic Corporation is actively working in this direction. Along with the supply of metal products for the aircraft industry, Arconic, together with manufacturers of ground transport equipment, participates in the creation of new types and models of machines using aluminum parts and structures. The corporation's enterprises master and supply the new types and sizes of metal products necessary for this. For example, Ford uses an all-aluminum body made of Arconic sheets and profiles in the manufacture of the F-150 SUV pickup truck. SMZ initiates and participates in a number of projects for the use of its products in special road and rail transport. Examples of such machines are railway hoppers – for the transportation of bulk products, tankers for the

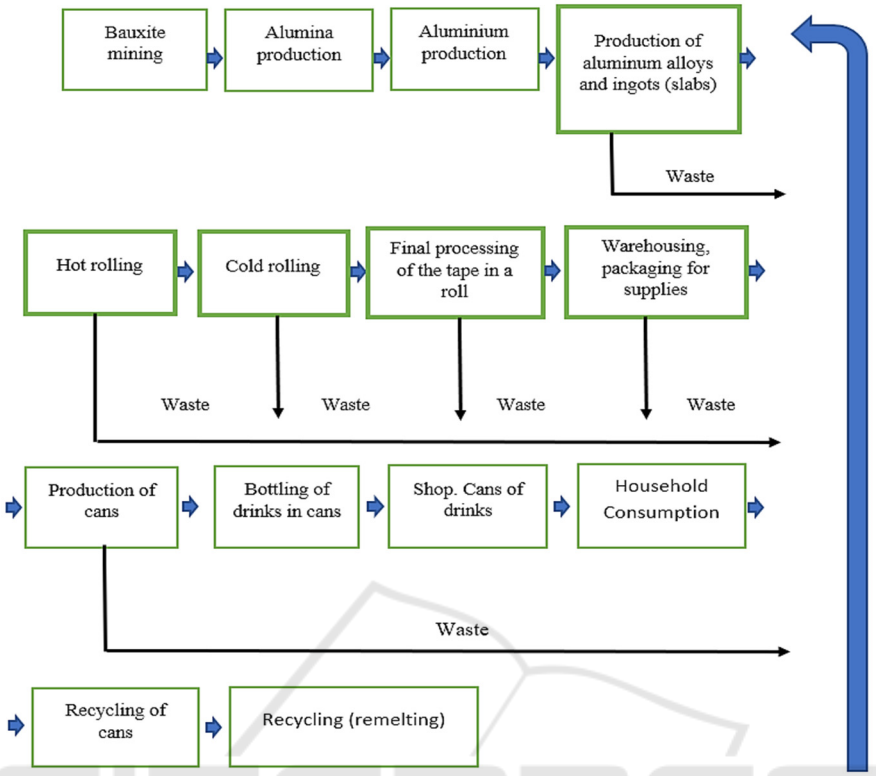

Figure 2: Aluminum production and recycling of aluminum tape and cans.

transportation of fuel, aggressive acids and cryogenic liquid products, etc. The bodies and tanks for them are made of aluminum metal products with special properties. Compared with steel analogues, the load capacity increases, energy costs and CO_2 emissions decrease, corrosion resistance and service life increase, intrinsic safety is guaranteed (important when transporting fuel), etc (Teo, 2001; Ryazantsev, 2020).

The social sphere is the sphere of human capital, its condition and development: employees of the company and the surrounding community. For employees, these are, first of all, conditions for safe and comfortable work, conditions of remuneration and social package, conditions for training and development, conditions for equality and fairness, for involvement in improvements in all spheres and business processes. For the community, this is the company's activity to improve the ecology and socio-cultural environment, to improve the professional level and vocational guidance of young people in places (locations) of activity, etc. Attention is also paid to the younger generation – through career guidance programs at school, robotics classes, etc. The corporation and the plant cooperate with universities and colleges in the locations of the main required specialties. Meetings are held with applicants and students.

Labor productivity is one of the most important means (factors) and methods of sustainable development and is the subject of modern research in the field of economic and social sciences. Systematic work to stimulate its growth is carried out through specialized centers of competence and labor productivity growth created in a number of countries (an overview of which is given in our article). At the same time, recent research papers often emphasize the importance of social growth factors along with technical ones. Attention is paid to the introduction of lean manufacturing practices and organizational culture modernization programs (Sapunov, 2021; Simionescu, 2020).

There are various metrics to measure performance. Their choice for specific research is determined by the policy vector, as well as the availability of data. The coefficient used to evaluate labor productivity allows you to evaluate the efficiency of using resources for the production of goods and services. In this case, both total employment and the total number of hours worked can be considered as indicators of resource utilization.

One of the most widely used approaches at the country level is the measurement of labor productivity as gross domestic product (GDP) per hour of work. Productivity that takes into account working hours is more indicative in terms of reflecting labor costs than productivity that takes into account the number of employees (OECD, 2019). If you rely on the number of employees, the study will miss the impact of the development of part-time and overtime work (Das, 2004; Ryazanov, 2021).

The disadvantage of using the number of hours worked in the denominator of the formula is the complexity of obtaining statistical data and their reliability. Even in developed countries, working hours are most often recorded in terms of the number of hours paid, rather than the actual hours worked. Accordingly, such non-working hours as paid annual leave, sick leave, maternity leave, parental leave, etc. are not adjusted. There is a common situation when statistics are collected only for certain categories of workers (only for employees) or for certain categories of enterprises (belonging to key sectors of the economy or having a sufficiently large size) (ILO, 2015). For underdeveloped countries, these problems are getting worse.

The models that allow the country to achieve a high level of labor productivity are:

1) low cost of the final product with a large volume of production and a low percentage of employees (typical for Arab countries specializing in oil production);
2) production of expensive products with a high (or at least average) percentage of the employed population (typical for the United States and most Western European countries);
3) production of expensive products with a low percentage of the employed population.

Labor productivity in a broad sense includes the productivity of materialized labor (characterized by the profitability of capital investments) and the productivity of human labor (characterized by the volume of production). When forming the policy of labor productivity management, special attention is paid to the technical side of the issue - the purchase of new equipment, the introduction of resource-saving technologies, modernization of production lines, etc. All this requires additional costs, as it is associated with investment activities. In a resource-constrained environment, more and more companies decide to activate their internal reserves and develop measures aimed at increasing labor productivity through the proper organization of the workspace, business processes and the introduction of lean manufacturing technologies.

The main provisions of the scientific organization of labor are:

- improvement of labor specialization,
- improvement of workplace organization,
- improvement of working methods,
- optimization of the labor force rating,
- staff training (Krivov, 2016).

One of the modern forms of labor specialization is outsourcing of non-core functions, standard and mass operations using similar algorithms for different enterprises. The obvious advantages of outsourcing are the absence of the need for investments in specialized equipment and training of qualified employees, the guarantee of uninterrupted operation, the possibility of applying the best practices and experience, as well as the ease of control "by results". At the SMZ, for example, vehicles used to deliver products to customers have been outsourced.

Within the framework of personnel management at a new level of automation, such tools for improving the efficiency of employees' working hours as timekeeping and photographing working hours, as well as standardization of operations, have become widespread.

4 CONCLUSIONS

The methods used to assess the level of labor productivity often do not reflect the real picture. This makes it difficult not only to conduct international comparisons, but also to assess changes in dynamics.

Analysis of some existing methods and performance management policies has shown that they can be divided into two groups. The first is focused on the use of reserves, optimization of existing business processes, production, logistics, etc. The second involves additional investments and is aimed at introducing modern technologies. The latter will be effective only if all the processes at the enterprise are sufficiently developed and fixed, and the organizational culture corresponds to the goals and objectives of the company (Bikmukhametova, 2019).

Building a policy of labor productivity management, most countries rely on small and medium-sized businesses, form effective consulting and methodological support for enterprises participating in the program, and create regional and industrial support centers.

The question of whether labor productivity is a source of structural changes or, conversely, arises as a result of economic restructuring remains debatable.

A number of economists note in their works that the problem of labor productivity management is not so relevant and does not require special attention, it is necessary to focus on managing domestic demand and developing tools to stimulate it. In our opinion, labor productivity management is the most important condition for ensuring sustainable socio-economic development. In the conditions of the demographic trap, the growth of labor productivity will ensure a decent level and quality of life of the population, the restructuring of the economy to a new regime. At the same time, labor productivity should be understood in a broad sense, when not only technical growth factors play an important role, but also the transformation of social and organizational components, the involvement of all employees in a continuous process of improvement. Only an integrated approach can ensure the achievement of growth targets and the stability of the economic system.

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