

**DIRECTIONS OF SUSTAINABLE DEVELOPMENT OF A MACHINE-BUILDING ENTERPRISE ON THE EXAMPLE OF SE “SILPROEKT”**

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**Abstract.** The paper presents the results of analysing the activities of a machine-building enterprise, taking into account the influence of factors of the political and socio-economic crisis. Based on the results of the PEST- and SWOT-analysis, the most promising directions of sustainable development of an engineering enterprise are identified, namely, implementation of energy-efficient solutions, use of circular economy principles, application of environmentally friendly technologies, digitalisation, and personnel training. The introduction of an environmental management system will significantly contribute to expanding the development opportunities of machine-building enterprises, increasing their competitiveness and ensuring sustainable development.

**Keywords:** sustainable development, machine-building enterprise, PEST-analysis, SWOT-analysis, energy efficiency.

## **1. Introduction**

In the modern world, sustainability is becoming a key issue for businesses in all industries, and the machine building industry is no exception. In the context of global climate change, depletion of natural resources and increasing competitiveness in international markets, machine-building companies must adapt to new challenges. For this purpose, it is important to implement the principles of sustainable development aimed at minimising the negative impact

on the environment, optimising the use of resources and ensuring long-term socio-economic growth and environmental safety.

The issues of defining the essence of the mechanism of sustainable development of an enterprise and the directions of its formation have become relevant and are covered in a number of works by foreign researchers (Hall et al., 2010; Kates et al., 2005; Dyllick & Muff, 2015; Baumgartner, 2013). In Ukraine, scientists from various fields, including economics, ecology, engineering and management, are engaged in the problems of sustainable development of enterprises. The works of Ukrainian scientists explore various economic and environmental aspects of sustainable development to optimise production processes (Kvyatkovska, 2013; Hrechko, & Ocheretiana, 2020; Mishchenko, 2011; Kuzmina, 2015), areas of implementation of energy-efficient and resource-saving technologies at enterprises (Veremeenko, 2018; Dzhezdzhula, 2014; Denysiuk & Vasylenko, 2016), methods of forming social responsibility of entrepreneurial structures and their motivation (Kyrych et al., 2015; Melnyk et al., 2018), effectiveness of implementation of the environmental management system (Dekaliuk & Stasiuk, 2010; Vasylenko et al., 2017).

The sustainable development of industrial enterprises is a continuous dynamic process of innovative development based on technological modernisation, which ensures the scientific and technological security

of the country and improves the quality of life of the population (Rahmana & Bawono, 2021). Therefore, there is a need for further research aimed at studying the activities of machine-building enterprises in the difficult conditions of war and socio-economic crisis in Ukraine, which significantly affects their development. However, despite these challenges, it is the crises that stimulate enterprises to find new solutions, modernise production facilities, introduce innovations and energy-efficient technologies, and switch to more sustainable business models. In particular, machine-building enterprises that produce equipment for processing agricultural raw materials may gain additional opportunities for sustainable development by increasing demand for products that are essential for food security in Ukraine and other countries.

The purpose of the study is to analyse the activities of an engineering enterprise, taking into account the factors of the political and socio-economic crisis, and to substantiate its further development in the context of sustainable solutions to ensure economic, food and environmental security.

## **2. Materials and Methods**

Today, the Ukrainian economy is facing unprecedented challenges in its history. Russia's full-scale military invasion has dealt a powerful blow to all parts of our country's economic system (The economy of war and post-war economic development of Ukraine, 2022). Due to the hostilities and disrupted supply chains, many businesses are losing access to raw materials, components or markets. This leads to production shutdowns or significant slowdowns. In Ukraine, the destruction of transport infrastructure, power supply and other critical facilities seriously hinder the efficient operation of industrial structures. The lack of stable communications complicates both production and logistics processes. Rising costs of energy, materials and logistics lead to higher production costs, which reduces the competitiveness of enterprises in the domestic and foreign markets. There is a shortage of capital due to economic difficulties. The war leads to the mobilization of labour, loss of specialists, and migration of skilled personnel to other countries. Businesses face a shortage of skilled workers. At the same time, consumers may reconsider their priorities and demand for goods and services, preferring more sustainable and affordable options. Such a crisis situation can pose a serious threat to an industrial enterprise, forcing it to adapt to new realities.

The machine building industry is one of the leading sectors of the Ukrainian economy. To operate successfully, the industry needs to provide its facilities with fuel and energy resources, metals, various raw materials, water resources, labour and transport networks. Developed infrastructure in cities and the presence of other related industries allow engineering companies to obtain all the resources they need for production. The processing of raw materials and the production of finished products in the machine building industry involve the generation of a large amount of various wastes that can have a negative impact on the environment.

Given the significant material and energy intensity of production processes at machine-building enterprises, the implementation of sustainable development principles in the crisis is crucial for the long-term competitiveness and survival of the business (Lepeiko, & Mazorenko, 2017). Enterprises that implement sustainable development strategies can improve the efficiency of energy and material resources. This helps to reduce costs, which is especially important during the economic crisis. Sustainable development encourages businesses to innovate and create new products or services that can meet market needs in times of crisis, such as environmentally friendly products or new business models related to the circular economy. Companies that demonstrate sustainability and responsibility to society and the environment can strengthen their reputation and consumer confidence, which is an important factor for survival during a crisis (Demyanenko, 2020). At the same time, investors increasingly prefer companies that adhere to the principles of sustainable development and environmentally friendly production. This can be an additional source of funding during a crisis (Kravchenko & Prudkyi, 2020). All of the above involves analysing and managing environmental and social risks, which allows businesses to be more flexible and prepared for changing market conditions.

Taking into account all the above, we can identify the main directions of sustainable development of an engineering enterprise, which will contribute to increasing its resilience to socio-economic and environmental risks.

1. Energy efficiency and carbon footprint reduction. Implementing technologies that reduce energy consumption is of paramount importance. This includes:
  - optimisation of production processes, using highly efficient equipment;
  - switching to renewable energy sources such as solar or wind power;

- energy recovery systems that allow for the reuse of excess heat and other resources;

- reducing the carbon footprint also requires the development and implementation of methods to minimise CO<sub>2</sub> and other harmful emissions.

2. Rational use of resources at all stages of the production cycle with minimal losses. Key steps in this direction include:

- use of secondary materials and recycling of production waste;

- designing products with a view to recycling and reusing components;

- optimisation of supply chains to minimise losses in transportation and storage of resources.

These measures not only reduce the environmental impact but also increase economic efficiency by reducing the cost of raw materials.

3. Implementation of environmentally friendly production technologies, including:

- application of green technologies in production processes that minimise environmental pollution;

- development and use of environmentally friendly materials that are easily recycled and do not harm ecosystems;

- continuous monitoring and reduction of harmful emissions and production waste, which is especially important in the context of tightening environmental regulations and standards.

The use of such technologies allows companies not only to meet regulatory requirements but also to strengthen their image as a responsible producer.

4. Implementation of digital technologies and automation, which contributes to

- optimisation of production processes to increase efficiency

- improving control over resource consumption and minimising losses;

- improving the accuracy of forecasting and planning to reduce the risks of overproduction and related losses;

- reducing the number of errors and defective products associated with the human factor.

5. Social responsibility, staff development and environmental awareness:

- ensuring safe and comfortable working conditions for employees;

- implementation of professional training and development programmes to improve staff qualifications and raise environmental awareness;

- development of corporate social responsibility aimed at supporting local communities and solving social problems.

Improving the social environment at an enterprise helps to increase employee loyalty and reduce staff turnover, which has a positive impact on business sustainability.

Thus, sustainable development is not only a tool for improving efficiency, but also a strategic advantage that allows companies to adapt to crisis conditions while maintaining their competitiveness in the market.

To analyze the activities of a machine-building enterprise in the context of sustainable development, PEST-analysis and SWOT-analysis methods were used. These methods complement each other as they cover different but interconnected aspects of strategic analysis. PEST-analysis (Political, Economic, Social, Technological) helps assess the external environment of the company by identifying macroeconomic factors that may affect its operations. SWOT-analysis (Strengths, Weaknesses, Opportunities, Threats) combines an analysis of internal factors (strengths and weaknesses) with an analysis of external factors (opportunities and threats). Thus, the combined use of these methods provides a more comprehensive understanding of the company's position and helps develop an effective strategy for its further development.

The primary data for the study were the company's annual reports, equipment quality certificates, technological documentation, and a series of interviews with the company's administration and employees.

### 3. Results and Discussion

The international TransLearn project analysed the sustainability of the machine-building enterprise "Silproekt", located in Mykolaiv. "Silproekt" has been operating in the Ukrainian market of equipment for the food and grain processing industry as a manufacturer since 1994. Since 1998, it has also been operating on the foreign market. The main activity of the company is the development and production of a universal, energy-saving cereal complex UKR-2 for processing cereals into groats and flakes, as well as related units. The company manufactures UKR-2 cereal lines: equipment for the production of cereals and flakes from wheat, buckwheat, millet, barley, corn, peas, oats, rice, spelt, and lentils.

The cereal market, like any other market, is an area of interaction between supply and demand. The food traditions established in Ukraine determine a significant demand from the population for various cereals made from buckwheat, millet, rice, oats, barley, wheat, corn and peas. External demand for domestic cereal products has a significant potential for growth, given the worsening global food crisis. At the same time, the expansion of its supply by Ukrainian producers is constrained by

significant fluctuations in profitability and periodic interventions of cheap cereals at reduced prices from neighbouring countries in cases of overproduction.

To identify the main external factors affecting the activities of the machine-building enterprise, a PEST analysis was conducted, which is a strategic analysis tool that allows identifying and taking into account potential risks and opportunities arising from changes in the current external environment (Table 1).

Table 1

**PEST-analysis of factors influencing the activities of SE “Silproekt”**

Political	Economical
Military actions Liberalisation of legislation and easier access to EU markets Frequent changes in the legislative system Market restrictions	Increased cost of raw materials Devaluation of the national currency Decrease in real incomes of potential consumers Change of suppliers due to military operations
Social	Technological
Social tensions, first due to the COVID-19 pandemic, then due to military actions Increased consumer demands for quality of service, equipment repair, and equipment design Changing consumer tastes and needs due to the development of healthy food systems	Increased speed of technology transfer The need to upgrade the equipment manufacturing base Access to modern technologies Weak state support for innovation

Having examined the generalised PEST-analysis matrix, it can be concluded that the most influential factors for the enterprise are economic factors, namely changes in the level of prices for raw materials and opportunities for obtaining them, as well as political factors, which are manifested in political instability and changes in legislation.

Another useful tool for assessing the current state and development prospects of an engineering company, especially in the context of sustainable development, is a SWOT-analysis. It is necessary due to several important factors:

- assessment of internal potential. Strengths help to identify the key competitive advantages of the company: the availability of advanced technologies, qualified personnel, high efficiency of production processes and stable relationships with suppliers and customers. Weaknesses reveal internal shortcomings: low energy efficiency, outdated equipment, lack of investment in research and development, which can limit the potential for sustainable development.

- Identification of opportunities and threats. Opportunities are related to external factors, such as new technologies, government or market support for environmental initiatives, and new markets for environmentally friendly products that can contribute to the company’s growth. Threats include factors that may hinder the realisation of sustainable development goals: increased

environmental standards, competition from more environmentally friendly businesses, changes in legislation, and resource shortages.

- Sustainable development planning. A SWOT-analysis helps to strategically plan how to maximise your strengths and external opportunities for sustainable growth. For example, if a company has strengths in innovation, it can be directed towards the development of green technologies. The analysis also reveals which weaknesses should be addressed to meet the requirements of sustainable development.

- Risk mitigation. An assessment of threats and weaknesses allows a company to prepare in advance for potential risks, such as rising energy costs or the introduction of new environmental regulations. This allows the company to be more flexible and ready for external changes.

- Decision-making support. SWOT-analysis serves as a basis for strategic decision-making. In the context of sustainable development, it helps to understand what steps need to be taken to reduce the environmental footprint, improve energy efficiency and comply with the principles of the circular economy.

The SWOT-analysis helps machine-building companies to effectively integrate sustainable practices into their operations, reducing risks and opening up new opportunities for growth and innovation (Table 2).

In the context of martial law and the dangerous location of the enterprise, it would seem inappropriate to talk about sustainable development. However, the company has been awarded many awards, diplomas and certificates at agricultural and industrial exhibitions for technological products, for the best development for agriculture, for the active implementation of energy-saving technologies, and for the best project to restore agricultural production from 1994 to 2020.

For example, one original energy-saving feature is that buckwheat husks are used as fuel for steaming, and energy consumption is 1 kW per 100 kg of processed grain. For comparison, hydrothermal grain processing of cereals of similar capacity, using standard technology, consumes 65 kW per 100 kg of buckwheat processed. The payback period for cereal processing plants, including all costs, is 5 to 9 months when operating in two shifts.

Table 2

### SWOT-analysis of SE “Silproekt” activities in the context of sustainable development

Strength	Weakness
Competitiveness Extensive experience in various economic conditions Already a well-known brand Energy efficiency of the equipment Own production plant and processing workshop Possibility to train personnel who will work on the manufactured products High share of the domestic market Loyal pricing policy Profitable operations. Ability to supply spare parts to customers Availability of space for scientific research and its implementation in production	Decrease in sales volumes Changes in marketing and advertising support Lack of innovative technologies and equipment for manufacturing parts High production costs Low foreign economic activity
Opportunity	Threats
Lower barriers to entry to the EU market Growing demand for cereal products Introduction of innovative technologies Opportunity to participate in grant support programmes	War Growing political and economic crisis. Increased competition in the production market Increased cost of raw materials Devaluation of the national currency Decreased solvency of potential consumers Increase in energy prices Decrease in the number of people Saturation of the market with products Mobilisation of employees

To improve its operations in line with sustainable development goals, SE “Silproekt” participated in the Solar Energy programme to install solar panels and equipment that switches from transformer to inverter operation. The company switched from a common heating system with high heat losses to its own pellet heating; re-equipped the entire technological process to use and recycle production waste; reduced the installed capacity of equipment through the introduction of the latest technologies in production, re-equipment of production and reduction of energy intensity of equipment.

In addition, as a stakeholder, “Silproekt” has established long-term relations with the Admiral Makarov National University of Shipbuilding. This cooperation is mutually beneficial and has a signi-

ficant impact on the innovative development of both parties. The university has a strong research base and experts in various fields who can help the company develop new technologies and products and provide advice on specialised technical issues, helping the company to optimise production or solve technical problems. A university can be a source of innovation through its students and researchers. Collaboration with university-based start-ups can give a business access to new solutions and technologies.

SE “Silproekt” works closely with the University to train specialists that meet their needs. For this purpose, internships and training at the company’s production sites are provided, which allows students to gain real production experience. In its

turn, “Silproekt” actively participates in the discussion and development of educational programmes in the fields of Ecology and Environmental Protection Technologies.

Such synergy contributes to both the technological progress of the enterprise and the improvement of students’ training and research at the university, which generally improves the competitiveness of both parties in the market.

Thus, even in times of war and being close to the front line, the machine-building enterprise is implementing energy-efficient measures and fruitfully cooperating with the university to further achieve its sustainable development goals.

#### 4. Conclusions

Sustainable development of machine-building enterprises is a multifaceted process that includes both technological and social aspects. Implementation of energy-efficient solutions, use of circular economy principles, application of environmentally friendly technologies, digitalisation and attention to personnel development all play a key role in creating a competitive and sustainable enterprise. In the face of global challenges and market changes, only those companies that actively apply these principles and integrate them into their daily operations will succeed.

Given the achievements already made by “Silproekt” in the context of energy efficiency and resource conservation, it would be advisable to implement an environmental management system that would help expand the capabilities of the machine-building enterprise and provide certain benefits:

- reduction of the enterprise’s production costs, in particular, by reducing energy consumption, waste and recycling of materials;
- improvement of production processes leads to an increase in the overall efficiency of the enterprise and product quality;
- development of new technologies that are more energy efficient and less harmful to the environment, which also stimulates the search for new, environmentally friendly materials and production processes;
- compliance with environmental standards and regulations opens up access to environmentally orientated markets and tenders, and reduces the risk of fines and sanctions;
- an environmentally conscious company creates a positive image in society, which can help increase customer loyalty and attract new partners. It also helps

improve relations with local communities and government agencies;

- more motivated employees who feel that they are working for the benefit of society and the environment. This helps to increase employee loyalty and productivity;
- the ability to anticipate and minimise environmental risks that may arise in the course of operations. This includes preventing accidents that could lead to environmental disasters and reducing the risk of reputational damage.

Thus, the implementation of environmental management at an engineering enterprise is a strategy that not only helps to protect the environment, but also contributes to the efficiency in crisis situations, competitiveness and long-term success of the enterprise to ensure sustainable development.

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