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STRATEGY FOR MODERNIZING INDUSTRIAL ENTERPRISES IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT: TERMINOLOGICAL AND CONCEPTUAL ANALYSIS

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The article provides a comprehensive terminological and conceptual analysis of the strategy for modernizing industrial enterprises through the prism of the sustainable development paradigm. The relevance of the study is determined by the need for post-war reconstruction of Ukraine's industrial sector and the integration of domestic enterprises into the European economic space, which requires compliance with strict environmental standards (European Green Deal) and the implementation of Industry 4.0 principles. The aim of the work is to deepen the theoretical and methodological foundations for the formation of a modernization strategy and to develop the author's conceptualization of this process in the context of resource constraints and environmental challenges. The methodological basis of the study consists of methods of semantic analysis, a systematic approach, comparison, and generalization. As a result of analyzing the evolution of scientific thought (the works of A. Chandler, M. Porter, V. Heiets), it has been established that in modern conditions, the category of “strategy” is transforming from rigid long-term planning to a flexible model of adaptive change management. The essence of the concept of “modernization” has been studied, and the limitations of the technocratic approach, which equates modernization exclusively with technical re-equipment or reconstruction of fixed assets, have been proven. The necessity of transitioning to “eco-modernization” based on the triad of sustainable development: economic efficiency, environmental safety, and social responsibility has been substantiated. Based on the systematization of approaches, the author proposes a definition of “strategy of sustainable modernization of an industrial enterprise” as a systematic management process aimed at qualitative renewal of the technological base and organizational structure to ensure growth in added value while reducing resource intensity and minimizing negative impact on the ecosystem. A matrix of target vectors for comprehensive modernization has been developed, covering the technical, technological, organizational, environmental, and social levels of transformation. The practical significance of the proposed approaches is confirmed by the case study of Golden Tile Ceramic Group, where the introduction of energy-efficient technologies (cogeneration) and closed production cycles has made it possible to achieve high competitiveness indicators. It is concluded that systematic eco-modernization is the only way to ensure the economic security of industrial enterprises in Ukraine.

Keywords: strategy, modernization, industrial enterprise, sustainable development, technological renewal, environmental management, competitiveness.

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**Strategy for modernizing industrial enterprises in the context of sustainable development:
terminological and conceptual analysis**

Introduction and formulation of the problem

The current stage of global economic development is characterized by fundamental changes in approaches to industrial business. The fourth industrial revolution (Industry 4.0), the digitization of production processes, and strict environmental safety requirements (in particular, within the framework of the European Green Deal) pose new challenges for Ukrainian industrial enterprises [1].

Most domestic enterprises operate on the basis of a technological structure that was formed in the middle of the last century, which leads to excessive energy consumption, low labor productivity, and a significant technogenic load on the environment.

In this context, the issue of modernization comes to the fore. However, simply “patching holes” or replacing equipment on an ad hoc basis is no longer enough to ensure competitiveness.

A comprehensive strategy is needed that takes into account not only economic efficiency but also the principles of sustainable development.

The issues of strategic management and modernization are covered in the works of many scholars, such as O. Amosha, Z. Shershnyova, and others. However, despite significant scientific achievements, there is a certain discrepancy in the interpretation of key concepts, especially in the context of their combination with the concept of sustainability.

Modernization is often equated with reconstruction or repair, which narrows its strategic significance.

Purpose of the article

The purpose of the article is to conduct a terminological and conceptual analysis of the concepts of “enterprise strategy” and “modernization” in order to form a holistic vision of the modernization strategy of an industrial enterprise in the context of sustainable development.

Presentation of the main material

Evolution and modern interpretation of the concept of “enterprise strategy”. The first step in forming the concept of modernization is a clear understanding of the category of “strategy.” This concept has come a long way from military terminology to the basis of modern management. Analysis of scientific literature allows us to identify several key approaches to defining this term.

In classical management theory, strategy was primarily viewed as long-term planning, defining the main long-term goals and objectives of a company and approving the course of action and allocation of resources necessary to achieve these goals.

In this context, the emphasis is on a logical sequence: goal – plan – resources.

Over time, the approach has transformed. In a

dynamic market, strategy began to be viewed as a way to gain competitive advantage, as a choice of what not to do. In other words, strategy was seen as a way to create a unique and advantageous position, involving a specific set of activities. For modernization, this means not just updating everything indiscriminately, but selectively improving those processes that create the most value.

The domestic scientific school has also made a significant contribution to the development of this concept, adapting it to the conditions of a transitional economy. It defines a company’s strategy as a general model of actions necessary to achieve its goals through the coordination and allocation of the company’s resources. The idea of coordination is important here, as modernization requires the alignment of the interests of different departments.

Another Ukrainian scientist, Z. Shershnyova, suggests considering strategy as an adaptation tool: “Strategy is a long-term direction of enterprise development that leads it to a specific goal through the implementation of a system of coordinated decisions” [4].

Summarizing the above definitions, we can conclude that for the purposes of our study, strategy is not a static document, but a dynamic set of rules and principles that allow an enterprise to effectively transform its resources (including through modernization) for survival and development in an aggressive external environment.

The phenomenon of “modernization”: from technical re-equipment to systemic transformation. The term “modernization” (from the French “modern” – newest, modern) is often used intuitively, but in scientific discourse it has different nuances.

In the narrowest, technical sense, modernization is understood as the improvement of existing equipment. The economic dictionary defines modernization as updating, improving, giving something a contemporary look, transforming economic systems in accordance with modern requirements [5]. This approach is typical for engineering and technical personnel, but it is insufficient for top management, as it does not take into account economic returns.

A more profound approach is demonstrated by researchers who link modernization with innovative development. O. I. Amosha considers modernization as a structural restructuring: “Modernization of the economy is structural and technological changes aimed at increasing the competitiveness of national production based on innovation” [6]. Here, modernization is not an end in itself, but a means of increasing competitiveness.

In foreign literature, the term “modernization” is often replaced or supplemented by the concepts of ‘retrofitting’ (modernization of old equipment) or “revamping” (reconstruction). Researchers T. Stock and G. Seliger note in the context of Industry 4.0 that modernization for Industry 4.0 is a cost-effective strategy for implementing smart manufacturing solutions in existing production systems [7].

It is important to distinguish between the concepts of “modernization,” “reconstruction,” and “technical re-equipment”:

- technical re-equipment is the replacement of old equipment with new equipment without changing the technological process;

- reconstruction is the rebuilding of existing workshops and facilities;

- modernization is a broader concept that encompasses both the first and second, but is necessarily accompanied by qualitative changes in product properties or process efficiency.

Thus, the modernization of an industrial enterprise is a comprehensive process of upgrading the production and technical base, technological processes, and management system, the purpose of which is to overcome technical backwardness and achieve compliance with modern international standards.

Conceptualization of the modernization strategy in the context of sustainable development. Today, it is impossible to consider modernization in isolation from the concept of sustainable development. The traditional model of modernization often ignored

environmental consequences, focusing solely on profit.

The concept of sustainable development is based on a triad: Economy + Ecology + Society. Accordingly, the modernization strategy must be transformed. As L. G. Melnyk notes: “The essence of ‘green’ modernization lies not simply in installing treatment facilities (“end of pipe”), but in restructuring the technological process so that waste is minimized or converted into a resource” [8].

An analysis of scientific sources allows us to identify fundamental differences between traditional and sustainable modernization strategies (Table).

A practical example of eco-modernization: the Golden Tile Ceramic Group case study. An illustration of the successful implementation of a sustainable modernization strategy in domestic practice is the experience of one of the leaders in the production of building ceramics and faience – the Golden Tile Ceramic Group (Golden Tile Ceramic Group), whose production facilities are based at the Private Joint Stock Company “Kharkiv Tile Plant” [9].

This enterprise is a representative example of the transition from the Soviet economic model to a modern vertically integrated ecosystem. The ceramics and faience industry is traditionally characterized by high energy consumption (firing products requires significant amounts of natural gas) and the generation of solid waste. Aware of these risks, the company’s management chose a modernization strategy based not only on upgrading its equipment, but also on the principles of closed-loop and energy efficiency.

Table

Comparative analysis of approaches to enterprise modernization

Comparison Criteria:	Traditional (Technocratic) Modernization:	Modernization Based on Sustainable Development (Eco-modernization):
Main objective	Increase in production volumes, reduction in production costs	Eco-efficiency, social responsibility, brand value growth
Main Goal	Increasing production volumes, reducing production costs.	Eco-efficiency, social responsibility, brand value growth
Object of Impact	ROI (Return On Investment), payback period	ESG- criteria (Environmental, Social, Governance), carbon footprint
The role of personnel	Operators who need to be trained to work with new equipment	Active participants in change, promoters of a culture of lean manufacturing
Attitude towards resources	Extensive use	Circular economy (closed loop)

Source: proposed by the author based on works [6, 11, 14, 15]

An analysis of Golden Tile’s modernization measures reveals the key elements of its sustainable development strategy:

- energy autonomy and cogeneration. The most significant step towards eco-modernization was the

introduction of cogeneration technologies. The company installed cogeneration units (based on GE Jenbacher engines) that allow it to generate its own electricity. A critically important aspect here is heat utilization: the thermal energy released during

electricity generation is not emitted into the atmosphere but is directed to technological needs – in particular, to spray dryers for the preparation of press powder. The result: This is a classic example of environmental optimization, which has significantly reduced natural gas consumption (reducing the carbon footprint) and lowered the cost of production, making it competitive in EU markets;

– resource efficiency and waste-free production.

The company’s modernization strategy involves a transition to the principles of the circular economy. A system for recycling technological waste has been implemented at the plant. Broken tiles and faience (shards), which were previously taken to landfills, are now crushed and returned to the production cycle as chamotte. In addition, the water purification system operates in a closed cycle: after use, technical water is purified and returned to production, which minimizes water intake from natural sources and eliminates the discharge of wastewater into the environment;

– technological re-equipment (Industry 4.0). The modernization of production lines was carried out with the involvement of the world leader in machine building for the ceramic industry – the Italian group SACMI. The introduction of digital printing technologies has not only improved the aesthetic qualities of the products, but also reduced the consumption of pigments and chemical reagents, as the pattern is applied in a precise and measured manner, unlike the outdated methods of silk-screen printing, which were accompanied by significant paint losses;

– social and environmental aspect. The modernization of the aspiration system and the installation of modern filters on the kilns allowed the company to minimize dust and sulfur compound emissions into the atmosphere, which is critically important for a company located within a large city (Kharkiv).

Thus, the experience of Golden Tile confirms our hypothesis that modernization is impossible without an environmental component. The company did not simply purchase new machines, but changed its entire production philosophy. The economic effect (reduction of the share of energy carriers in the cost price) was achieved precisely thanks to environmental solutions (cogeneration, recycling) [10]. This clearly demonstrates that in the context of sustainable development, ecology is a driver of economic efficiency, not an obstacle to it. Thus, the Golden Tile strategy can serve as a benchmark for other enterprises in Ukraine’s industrial sector that are planning recovery and modernization processes in the post-war period.

Foreign researcher Joseph Huber, one of the founders of the theory of ecological modernization, argues that ecological innovations are central to the strategy of ecological modernization. They include efficiency strategies as well as coherence strategies [11].

This leads us to the need for a synthesis of concepts. The combination of strategic vision, modernization imperatives, and sustainability principles allows us to formulate a new category.

Based on the analysis, we propose the following definition: “A strategy for the sustainable modernization of an industrial enterprise» is a long-term model of systemic transformations of the material and technical base and organizational structure, aimed at achieving technological leadership through the introduction of resource-saving and low-waste technologies, ensuring a balance between economic profitability, environmental safety, and social development of the workforce.”

Such a strategy should include the following stages:

– diagnostic: assessment of the level of physical and moral wear and tear of assets, as well as an environmental audit;

– target: setting KPIs (e.g., reducing energy consumption by 20%, increasing automation by 30%);

– resource: search for funding (including green loans and grants);

– implementation: direct procurement and installation, retraining of personnel.

Thus, the stages of developing a modernization strategy can be represented as follows (Fig.).

In our opinion, this is how the logic of modernization should look in practice. The main difference between this scheme and traditional approaches is its cyclical nature. We are moving away from the idea that modernization is a one-time action (“bought – installed – forgotten”). Instead, we propose a closed loop consisting of four steps (Fig.).

It all starts with diagnostics. Without a real understanding of the current state of the funds, there is no point in moving forward. Here, we emphasize the use of SMART goals (Specific, Measurable, Attainable, Relevant, Time-bound) so that plans are tied to specific figures and deadlines and do not remain abstract.

Next is the strategy stage. This is when technologies are selected. As the experience of Golden Tile, mentioned above, shows, this is where the fate of the project is decided: whether it will be a simple replacement of equipment or the implementation of systemic solutions such as cogeneration. It is important that the technology map is strictly tied to business goals.

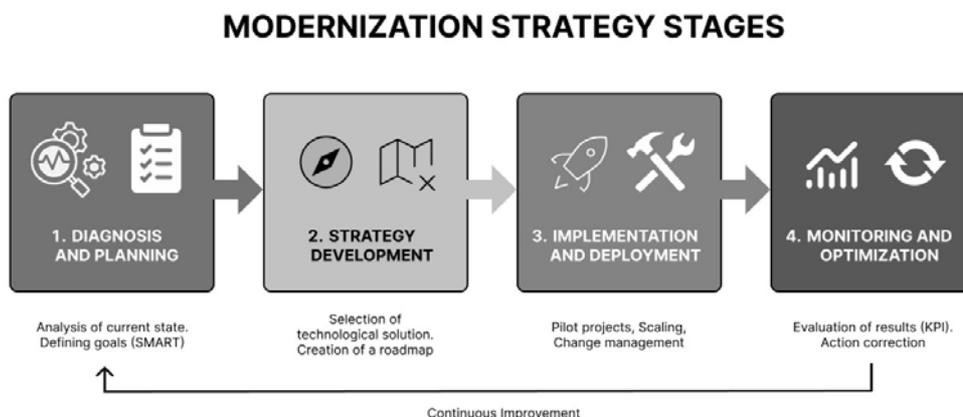


Fig. Stages of the modernization strategy

Source: composed by author based on analysis of scientific sources

The third block of the scheme concerns implementation. Here, the emphasis is on two things: pilot launches (so as not to risk the entire production at once) and working with people. Without adequate change management, even the best equipment can be idle due to staff resistance.

Monitoring closes the circle. We evaluate KPIs and look at the real figures for savings or efficiency. And most importantly, pay attention to the feedback arrow at the bottom of the diagram. It takes us back to the diagnostic stage.

In the current Ukrainian reality, where energy prices are constantly rising, we cannot afford to stop. The completion of one stage of modernization automatically becomes the start of the search for new reserves of efficiency.

Conclusions

The terminological and conceptual analysis conducted in this article allows us to draw the following conclusions:

The category of “business strategy” in modern scientific literature has evolved from rigid planning to a flexible model of searching for unique competitive advantages. In the context of industry, strategy is a tool for adapting the production system to a changing environment. Whereas previously it was a rigid plan for years to come, now it is flexibility. In conditions of complete uncertainty, strategy is transformed from a folder of documents into a set of living principles. It is a tool that allows an enterprise to quickly maneuver resources and find its unique advantages in an aggressive market environment.

The concept of “modernization” has gone beyond the purely engineering term. Today, it is not just a

matter of replacing an old machine with a new one, but a comprehensive innovation process that affects technology, management, and human resources. It has been proven that equating modernization solely with repair or reconstruction is a mistake and limits the development of a company. It is wrong to think that it is just a matter of “patching holes” or purchasing new equipment. Modern modernization is a systematic process. It affects not only the “hardware,” but also the management logic and organizational structure. It is not an end in itself, but a real way to bridge the technological gap and integrate innovation into daily work.

The integration of the concept of sustainable development into the modernization process is an unavoidable requirement of our time. The sources analyzed (both Ukrainian and foreign) indicate a shift in emphasis from “technocratic modernization” to “eco-modernization.” The study clearly shows that spending on “green” technologies is not a burden on the budget, but rather a powerful driver of competitiveness.

The author’s proposed definition of a “sustainable modernization strategy” emphasizes consistency and balance of interests. The practical implementation of such a strategy will allow Ukrainian industrial enterprises not only to renew their fixed assets, but also to integrate into global value chains that require compliance with high environmental and social standards.

Finally, let us consider the strategic importance for Ukraine. For our enterprises, such a transformation is inevitable. In the context of post-war reconstruction and movement towards Europe (with the requirements

of the Green Deal), we have no other choice. Given the prices of energy resources, energy-efficient modernization is becoming a matter of economic security and physical survival for Ukrainian industry in global markets. Further research should focus on developing a methodology for assessing the effectiveness of implementing a sustainable modernization strategy at enterprises in various industries.

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СТРАТЕГІЯ МОДЕРНІЗАЦІЇ ПРОМИСЛОВОГО ПІДПРИЄМСТВА В УМОВАХ СТАЛОГО РОЗВИТКУ: ТЕРМІНОЛОГІЧНИЙ І КОНЦЕПТУАЛЬНИЙ АНАЛІЗ

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У статті здійснено комплексний термінологічний та концептуальний аналіз стратегії модернізації промислових підприємств крізь призму парадигми сталого розвитку. Актуальність дослідження зумовлена необхідністю повоєнної відбудови промислового сектору України та інтеграції вітчизняних підприємств у європейський економічний простір, що вимагає дотримання жорстких екологічних стандартів (European Green Deal) та впровадження принципів Industry 4.0. Метою роботи є поглиблення теоретико-методичних засад формування стратегії модернізації та розробка авторської концептуалізації цього процесу в умовах ресурсних обмежень та екологічних викликів. Методологічну основу дослідження становлять методи семантичного аналізу, системного підходу, порівняння та узагальнення. У результаті аналізу еволюції наукової думки встановлено, що в сучасних умовах категорія «стратегія» трансформується від жорсткого довгострокового планування до гнучкої моделі адаптивного управління змінами. Досліджено сутність поняття «модернізація», доведено обмеженість технократичного підходу, який ототожнює модернізацію виключно з технічним переозброєнням або реконструкцією основних фондів. Обґрунтовано необхідність переходу до «еко-модернізації», що базується на тріаді сталого розвитку: економічній ефективності, екологічній безпеці та соціальній відповідальності. На основі систематизації підходів запропоновано авторське визначення «стратегії сталої модернізації промислового підприємства» як системного управлінського процесу, спрямованого на якісне оновлення технологічної бази та організаційної структури для забезпечення зростання доданої вартості при одночасному зниженні ресурсоемності та мінімізації негативного впливу на екосистему. Розроблено матрицю цільових векторів комплексної модернізації, яка охоплює техніко-технологічний, організаційний, екологічний та соціальний рівні трансформації. Практичну значущість запропонованих підходів підтверджено на прикладі кейсу «Golden Tile Ceramic Group», де впровадження енергоефективних технологій (когенерація) та замкнених циклів виробництва дозволило досягти високих показників конкурентоспроможності. Зроблено висновок, що системна еко-модернізація є безальтернативним шляхом забезпечення економічної безпеки промислових підприємств України.

Ключові слова: стратегія, модернізація, промислове підприємство, сталий розвиток, технологічне оновлення, екологічний менеджмент, конкурентоспроможність.

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Keywords: strategy, modernization, industrial enterprise, sustainable development, technological renewal, environmental management, competitiveness.

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