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IMPLEMENTATION OF GREEN MANAGEMENT PRINCIPLES IN MANUFACTURING

The relevance of the research is driven by the increasing importance of implementing green management principles in manufacturing in the modern world, where environmental sustainability and production resilience have become key objectives for businesses. The outlined variability is driven by a range of trends that shape and continually expand the significance of applying the GREEN concept. This is due to the strengthening ability of enterprises or even entire sectors of the economy to ensure the production of goods or services with minimal negative impact on the environment, thus providing long-term stability. The article aims to identify how GREEN management can be implemented in production systems and processes of economic entities. According to research, it has been confirmed that the fundamental principles of GREEN management (such as waste minimization, maximization of energy efficiency, achieving zero environmental impact, and fostering green innovations) are considered crucial means of ensuring environmentally sustainable and efficient production. Furthermore, the specification of GREEN management principles reveals their complexity and the need for a comprehensive approach to their implementation. It has been proven that a comprehensive approach encompasses not only the implementation of specific green practices and technologies but also their integration into the culture and management systems of the enterprise. Additionally, emphasis is placed on the importance of the sustainability of such practices over time and the need for continuous auditing and support from the leadership and all levels of the organization. The research highlights the significance of the widespread implementation of environmentally friendly methods in manufacturing processes. This means that all aspects of production and supply should adopt green practices and technologies to reduce waste, optimize resources, and mitigate environmental impact. The practical significance of the research lies in confirming the importance and relevance of GREEN management principles for modern producers and in laying the groundwork for the development of a systematic approach to their implementation and support.

Keywords: green innovations, waste recycling, zero environmental impact, energy efficiency, waste minimization, GREEN management measures.

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ВПРОВАДЖЕННЯ ПРИНЦИПІВ GREEN-МЕНЕДЖМЕНТУ У ВИРОБНИЦТВІ

Актуальність дослідження зумовлена тим, що впровадження принципів GREEN-менеджменту у виробництві набуває все більшої актуальності в сучасному світі, де екологічна стійкість та сталість виробництва стають ключовими завданнями для бізнесу. Окреслена змінність зумовлене цілим рядом тенденцій, що не лише формують, але й постійно розширюють значущість застосування GREEN-концепції, через посилення здатності підприємства або навіть цілої галузі економіки забезпечити виробництво товарів або послуг за мінімального негативного впливу на навколишнє середовище та забезпечує стабільність у довгостроковій перспективі. Відтак, метою статті є визначення особливостей впровадження GREEN-менеджменту в виробництві, а саме у виробничих системах та виробничих процесах окремих суб'єктів господарювання. За результатами дослідження констатовано, що основні принципи GREEN-менеджменту (такі як мінімізація відходів, максимізація енергоефективності, досягнення нульового впливу на довкілля та стимулювання зелених інновацій) розглядаються як ключові засоби забезпечення екологічно стійкого та ефективного виробництва. Крім того, конкретизація принципів GREEN-менеджменту виявляє їх складність та потребу у комплексному підході до їх впровадження. Доведено, що комплексний підхід охоплює не лише заходи з впровадження конкретних зелених практик та технологій, але і їх інтеграцію в культуру та системи управління підприємства. Крім того, наголошується на важливості стійкості таких практик у часі та на потребі у постійному

їх аудиті та підтримці з боку керівництва та всіх рівнів організації. Дослідження підкреслює значення дифузійного насичення зеленими практиками у виробництві. Це означає, що зелені практики та технології повинні стати стандартом для всіх аспектів виробництва та постачання, щоб досягти максимального ефекту в зменшенні відходів, оптимізації використання ресурсів та зменшенні впливу на довкілля. Практична значущість дослідження полягає у підтвердженні важливості та актуальності принципів GREEN-менеджменту для сучасних виробників та у формуванні передумов для розробки системного підходу до їх впровадження та підтримки.

Ключові слова: зелені інновації, переробка відходів, нульовий вплив на довкілля, енергоефективність, мінімізація відходів, заходи GREEN-менеджменту.

Introduction. In today's world, ecological sustainability and production stability are becoming key priorities for businesses. The GREEN management principles, which aim to minimize negative impact on the environment while ensuring long-term stability, are thus increasingly relevant in production. This concept enhances the ability of a company or even an entire industry to produce goods or services in an environmentally responsible way. The growing significance of applying GREEN principles is driven by various trends that continue to emphasize the importance of sustainability and eco-friendliness in modern business practices. First of all, consumers are increasingly preferring companies that demonstrate their responsibility towards nature. *Secondly*, there is a growing need for efficient resource utilization, which helps businesses reduce costs on energy, water, raw materials, and other resources. Thirdly, in response to environmental pollution threats and climate change, many countries are refining their environmental standards and legislation. Consequently, regulatory requirements are being established to control emissions of toxic substances, limit energy consumption, ensure the replenishment of natural resources, and incentivize the use of environmentally friendly technologies. It's worth noting that companies that implement environmentally-friendly management practices improve their reputation and attract more clients, investors, and employees.

Materials and methods. Several studies have analyzed the implementation of green management in production. Notably, authors including Berezna Y.S. [1], Zhukov S.A., Masligan O.O., and Toderishko E.V. [5] have explored the relationship between the development of the "green economy" and trends in economic greening. Moreover, Pakhnenko O., Kolomiets P. [6], Horbach L., Ruban O. and Humenyuk Ya. [3] have studied measures aimed at achieving environmentally sustainable and efficient production. However, the principles of GREEN management in production systems and processes of economic entities are not detailed in such studies. Therefore, we interpret them as a promising object for further research.

The article aims to identify how GREEN management can be implemented in production systems and processes of economic entities. To accomplish this goal, the following tasks have been outlined:

1) providing a general overview of GREEN management principles in production systems and processes of economic entities; 2) identifying the specific features of implementing each of the GREEN management principles in production systems and processes of economic entities.

Results. Within the study, it is emphasized that GREEN management in production is a management strategy aimed at ensuring environmentally sustainable and efficient production. Essentially, this concept combines principles of environmental protection and efficient resource management to achieve sustainable development. In particular, among the entities currently applying this concept are:

– Automobile manufacturers. For instance, the company Tesla is renowned for its efforts to reduce CO₂ emissions during production and through the use of electric motor vehicles, thereby contributing to environmental impact reduction. Characteristic examples include companies like Nestlé and Beyond Meat, whose leadership has committed to achieving zero environmental impact by 2030 through reducing greenhouse gas emissions and optimizing water usage. Another example is Danone, whose management has directed efforts towards waste reduction, energy, and water usage, as well as the implementation of environmentally friendly technologies;

– Textile and textile product manufacturers. Many of the mentioned economic entities are seeking ways to reduce water and chemical usage during clothing production. For instance, companies like Reformation and Adidas are implementing methods of secondary processing of textile industry waste to create new materials.

– Electronics manufacturers. Many of the mentioned economic entities have focused on using environmentally friendly materials, improving energy efficiency, and implementing programs for the reuse of electronic devices. In particular, Apple has set ambitious goals to reduce its carbon footprint, aiming to become a completely carbon-neutral company by 2030. Samsung is improving the energy efficiency of its manufacturing processes, utilizing renewable energy sources, and actively engaging in waste recycling.

– Builders. In the construction industry, companies focus on creating energy-efficient and environmentally sustainable buildings, utilizing renewable

materials, improving insulation, and optimizing heating and cooling systems. For example, in 2016, Skanska completed “The 2+U” office complex in Seattle, USA, designed using advanced technologies for energy efficiency and environmental sustainability. Currently, it holds a LEED Platinum certification, the highest level of certification for energy efficiency standards.

These are a few instances of manufacturers adopting GREEN management practices in their operations. It’s worth noting that in the early 2000s, merely 2% of manufacturers recognized the significance of maintaining a balance between production and environmental preservation for sustainable development. However, by the start of 2023, this number had risen to 45% [4]. This trend indicates that the average manufacturer recognizes their role in environmental preservation, feels responsible for their impacts on it, and therefore strives to apply GREEN management principles in their production processes.

Within the study, these principles are interpreted by us as the main measures aimed at ensuring environmentally sustainable and efficient production.

It should be noted that the main principles of green management in production systems and processes of economic entities include:

1. Minimization of waste and utilization of secondary resources in the production systems and processes of economic entities. Essentially, this means decreasing the number of raw materials used in production, while increasing the utilization of renewable sources and secondary resources (in areas where it can significantly reduce waste and negative environmental impact [2]).

2. Maximization of energy efficiency in production systems and processes. Essentially, this involves reducing energy consumption volumes through the implementation of energy-efficient technologies, optimization of production processes, and the utilization of alternative energy sources (in areas where it can reduce CO₂ emissions and other harmful substances [2]).

3. Achieving zero impact of production systems and processes on the environment. This involves using non-toxic materials, minimizing emissions of harmful substances, and producing environmentally friendly products that contribute to environmental preservation and the health of employees and consumers.

4. Stimulating green innovations in production systems and processes to engage stakeholders. The aim is to stimulate green innovations in production, including the development of new technologies, products, and services that meet environmental requirements through interaction with various stakeholders such as government agencies, non-governmental organizations, and consumers. This collaboration facilitates the search for effective solutions in the ecology and sustainable development fields [1-2].

The specification of GREEN management principles in production systems and processes of economic entities and their targeted action demonstrates that this process has peculiarities. These characteristics entail the application of a comprehensive approach to changes in production systems and in each of the production processes through their diffusion with green practices and technologies (encompassing resource utilization, energy efficiency, and waste recycling [1]). So, considering the outlined needs, let’s examine the specificity of implementing each of the highlighted GREEN management principles in production.

Implementation of the principle of waste minimization and utilization of secondary resources in production systems and processes of economic entities may involve several specific measures, including: process optimization, waste recycling (of materials no longer used or deemed valueless for their original purpose), and the use of secondary raw materials. In unison, these measures facilitate the transition from a linear production model, where raw materials are used once and discarded, to a cyclical approach, where waste is recycled and reused in production according to the specifics outlined in Figure 1.

It should be noted that in practice, the implementation of the outlined GREEN management principle in production systems and processes of economic entities through continuous innovation stimulation (which allows for reduced raw material usage and waste generation [5]) should gradually diminish the negative impact of creating material and social goods on the environment, while also enhancing resource efficiency, thereby promoting the formation and deepening of the circular economy. In this context, the gradual and consistent nature of changes is crucial.

Implementation of the principle of maximizing energy efficiency in production systems and processes can include several specific measures, including: implementing energy-efficient technologies, optimizing production processes, and utilizing renewable energy sources. Taken together, these measures ensure the rationalization of non-renewable energy resource consumption, thus contributing to their preservation for future generations, in accordance with the specifics outlined in Figure 2.

It’s important to note that in theory, the implementation of this outlined principle of green management, through continuous energy efficiency audits and heat flow management (which determine opportunities for reducing energy resource consumption [4]), should gradually reduce dependence on non-renewable energy sources such as coal, oil, and natural gas, and decrease emissions of harmful substances into the atmosphere.

In the future, this principle may contribute to the creation of fully energy-autonomous green productions, involving all levels of the economic entity’s

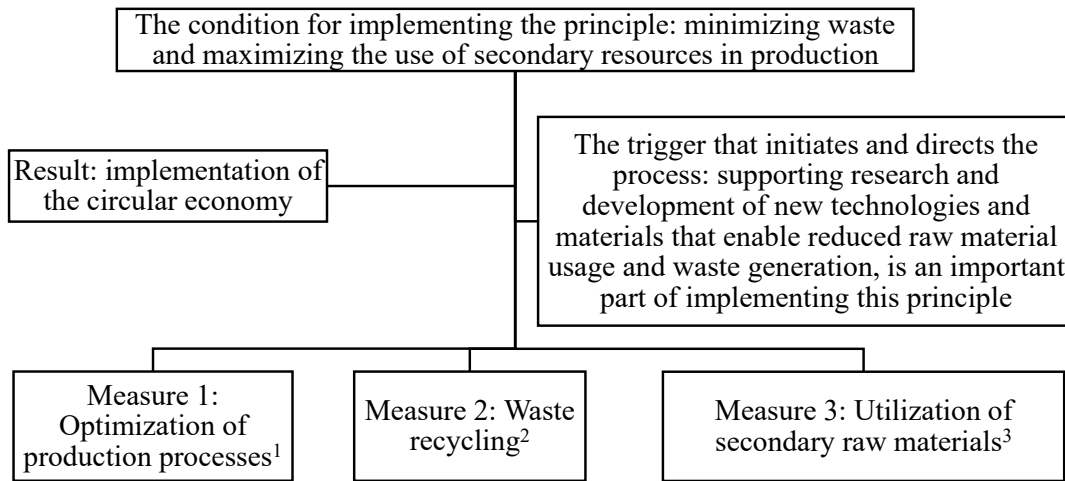


Figure 1 – Implementation of the principle of waste minimization and utilization of secondary resources in the production systems and processes of economic entities

Note

¹ This may involve improving production technologies, using more efficient equipment and methods, and implementing production control and management systems.

² This may involve developing a waste processing system that allows secondary resources utilization rather than disposing of them. This may include sorting, purification, recycling, and other processing methods to reduce waste and preserve resources.

³ This may involve the use of secondary metals, plastics, glass, and other materials that can be reclaimed and recycled.

Source: formed based on [2; 6-7]

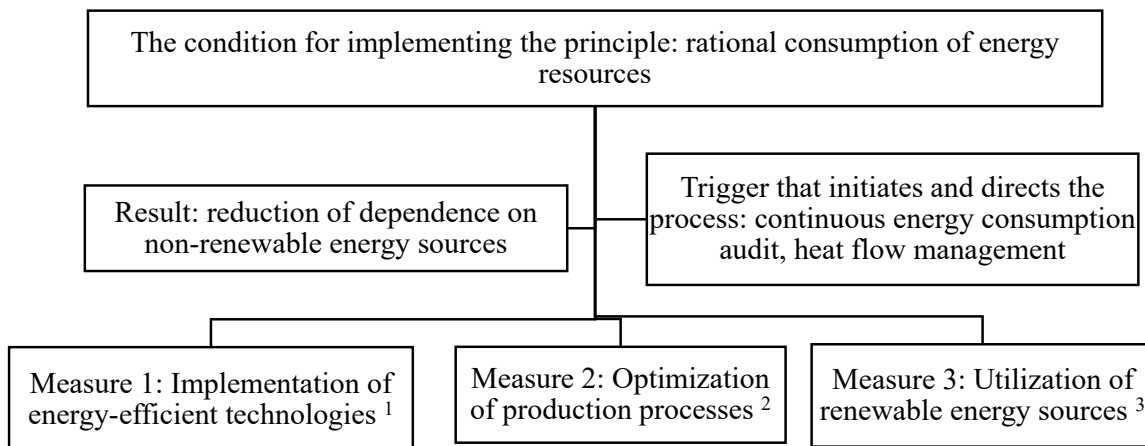


Figure 2 – Implementation of the principle of maximizing energy efficiency in production systems and processes of economic entities

Note

¹ This may include replacing outdated equipment and systems with more energy-efficient alternatives that consume less energy or use it more efficiently.

² This may include reducing energy losses by optimizing the operation modes of machines and equipment, reducing downtime, and using more efficient production methods

³ This may include integrating solar panels, wind turbines, or other systems utilizing renewable energy sources into the energy supply systems of production to provide part or all of the electricity needed for the production process.

Source: formed based on [1; 6-7]

production system. Ideally, these productions will be independent of traditional energy sources and will not emit harmful substances into the environment [3; 5].

Implementation of the principle of zero environmental impact in production systems and processes

can include several specific measures, including implementing environmentally friendly product design, ensuring an environmentally neutral production cycle, involving all participants in the supply chain in the adoption of environmentally neutral practices, as per the specifics outlined in Figure 3.

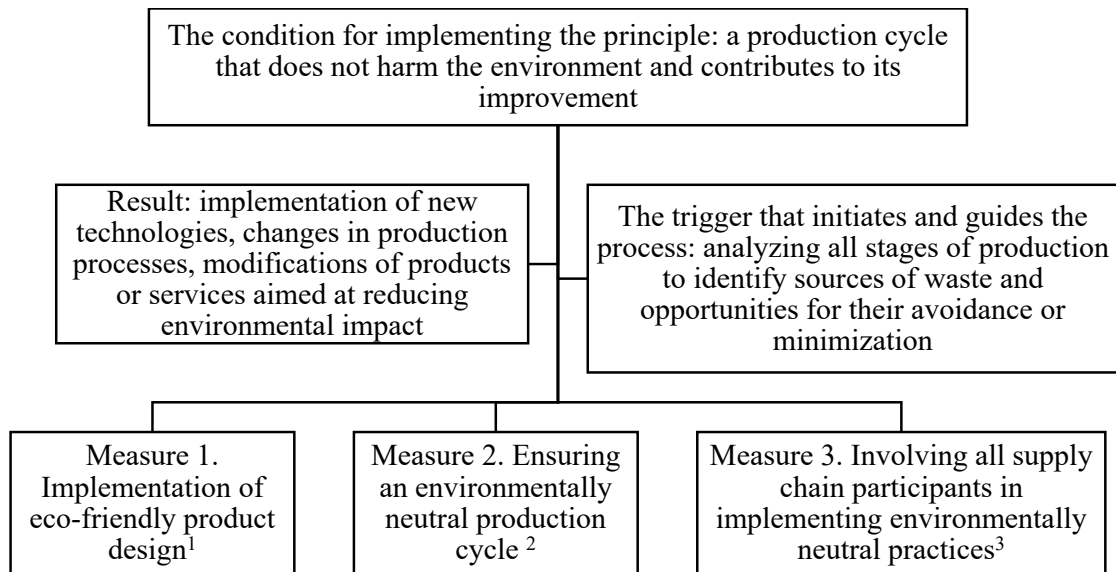


Figure 3 – Implementation of the principle of zero environmental impact in the production systems and processes of economic entities

Note

¹ This measure involves developing products considering their environmental impact at all life cycle stages. Environmental design involves using renewable materials, reducing toxic substances in products, extending their service life, and enabling reuse or recycling at the end of their life cycle.

² This involves taking measures to minimize waste and the negative environmental impact of production at all stages, from initial raw material extraction to waste processing.

³ This includes collaborating with suppliers, partners, and clients to implement environmentally neutral practices across all areas of operation, including raw material sourcing, production, transportation, and product distribution.

Source: formed based on [3; 5-6]

It is important to note that by consistently conducting audits of production systems and processes according to the principle of green management, it is possible to develop a production cycle that prevents harm to the environment and contributes to its improvement. Indeed, one example of a production cycle that does not harm the environment and even contributes to its improvement is the meat production in bioreactors. This production method requires significantly less land, water, and other resources compared to traditional animal farming, and it also greatly reduces greenhouse gas emissions (such as methane, which is emitted in large quantities by livestock). Artificial meat cultivation helps reduce animal suffering because it does not require the breeding and slaughtering of animals to obtain the final product. Another example of a production cycle that does not harm the environment is organic waste processing systems into biogas, during which organic fertilizer is formed, which can be used to increase soil fertility in agriculture and horticulture.

Implementation of the principle of incentivizing green innovations in production systems and processes may involve several specific measures, including research and development of new environmental technologies, investment in the production of green products, and establishment of green production lines, according to the specifics outlined in Figure 4.

Indeed, in theory, implementing the outlined principle of GREEN management through collaborative access to new ideas, resources, and expertise with other economic entities can enhance a company's reputation in the eyes of consumers and investors, thereby positively impacting the brand and financial performance. Regarding new ideas and resources, gradual implementation should be supported

Conclusions. The research indicates that most manufacturers are aware of their role in environmental conservation and feel responsible for their impacts. As a result, they try to apply GREEN management principles in their production systems and processes. The following conclusions have been drawn:

1. The main principles of GREEN management, such as waste minimization, maximizing energy efficiency, achieving zero environmental impact, and stimulating green innovations, are considered key means of ensuring environmentally sustainable and efficient production.

2. The specification of green management principles reveals their complexity and the need for a comprehensive approach to their implementation. A comprehensive approach includes not only implementing specific green practices and technologies but also integrating them into the culture and management systems of the enterprise. Moreover, it is important for these practices to remain sustainable over time,

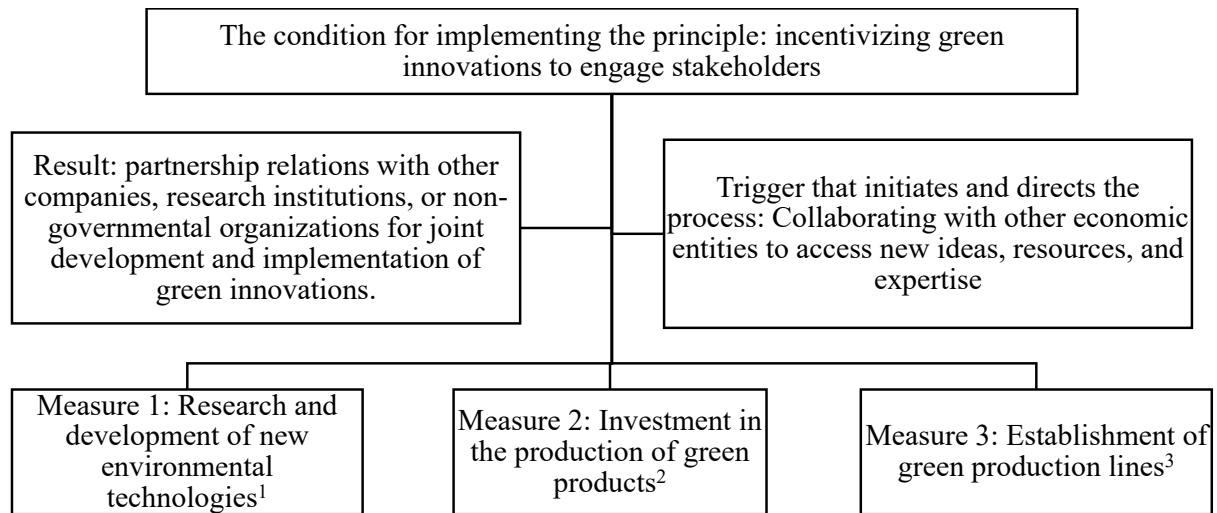


Figure 4 – Implementation of the principle of stimulating green innovations in production systems and processes of economic entities

Note

¹ This may involve investing in research and development of new environmental technologies aimed at reducing emissions, optimizing resource utilization, and enhancing the energy efficiency of production processes.

² This may involve investing in the development of new technologies and production methods that are more environmentally friendly and sustainable.

³ This may involve using biodegradable packaging, reducing the use of chemicals, or implementing closed-loop processes to minimize waste.

Source: formed based on [2; 6-7]

which requires ongoing auditing and support from management and all levels of the organization.

3. The research underscores the importance of the widespread adoption of green practices in manufacturing. This means that green practices and technologies should become the standard for all aspects of production and supply to achieve maximum impact in

waste reduction, resource optimization, and environmental impact reduction.

Thus, the research confirms the importance and relevance of GREEN management principles for modern manufacturers and identifies the development of a systematic approach to their implementation and support as promising areas for further research.

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