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ENVIRONMENTALLY-ORIENTED PRODUCTION AND DIGITAL TRANSFORMATION OF MARKETING

The article discusses the main digital marketing approaches in the context of environmentally friendly production. A number of key factors that determine the development of the modern marketing sector are identified. This study focuses on the introduction of environmental aspects into the digitalisation of industry, which will increase the efficiency of the transition to sustainable development. The integration of environmentally oriented strategies and digital technologies into industrial production is defined as a strategic vector of economic development in the context of convergence of sustainable development. It is considered that the high cost of implementing digital solutions and environmentally friendly technologies creates obstacles for small and medium-sized businesses, and the insufficient number of available financial instruments to support sustainable industrial development, the inconsistency of strategies for digital and environmental transformation of marketing processes contribute to an in-depth study of this issue.

The integration of environmentally sustainable strategies and digital technologies into

industrial production serves as a strategic driver of economic development, aligning with the broader convergence of sustainable development principles. The convergence of sustainable development principles and digital transformation in the production of a synergistic approach that increases resource efficiency, reduces environmental impact and ensures long-term economic sustainability through innovation and technological integration is considered. The main drivers of convergence of sustainable development and digitalization of production processes are proposed - IoT technologies, Big Data and automated resource management systems. They help optimize processes, minimize the negative impact on the environment and create economically profitable business models of the future.

Thus, the convergence of sustainable development and digital transformation in manufacturing is becoming the foundation of a new industrial paradigm based on smart technologies, resource conservation and environmental responsibility. Key aspects of digitalization of marketing in environmentally-oriented companies are proposed.

Keywords: marketing, digital marketing, MarTech, CRM, convergence, management, eco-oriented production, transformation, processes, digital management, sustainable development.

Introduction. Climate change, environmental degradation, and the depletion of natural resources are forcing a global shift toward more sustainable production models. Environmentally oriented manufacturing is becoming a necessary response to these challenges, aiming to reduce negative environmental impacts through resource conservation, waste minimisation, and the implementation of closed-loop production cycles. At the same time, the digital transformation of marketing is increasingly viewed as a powerful driver of sustainable development. The deployment of advanced technologies — such as Industry 4.0, artificial intelligence, big data, and digital twins — enables the optimisation of production processes, reduction of operational costs, and significant gains in energy efficiency. Digital tools also support the implementation of lean and waste-free production approaches that correspond with the principles of sustainability.

In addition to technological advancement, companies that prioritise environmentally friendly solutions and digitalisation benefit from improved competitiveness. They gain access to new markets, attract investment, and form strategic partnerships by aligning with ESG (Environmental, Social, and Governance) criteria. These trends are further supported by growing regulatory pressure, decarbonisation initiatives at both national and international levels, and institutional encouragement for the adoption of green technologies.

Consumer expectations are also rapidly changing. Increasingly, customers favour products manufactured in accordance with environmental standards, which motivates businesses to adapt their production methods and

incorporate elements of environmental marketing.

Taken together, these factors indicate that the integration of environmentally oriented strategies with digital marketing technologies is not merely a timely response, but a strategic imperative for the sustainable development of industrial enterprises.

Literature review. The issues of eco-oriented production and the digitalization of marketing are the subject of active scholarly investigation, reflecting the growing relevance of sustainability and technological transformation in the industrial sector. Recent research highlights the need for novel conceptual approaches and innovative tools to address the challenges and opportunities arising from the convergence of environmental priorities and digital marketing practices.

For instance, Berestetska [1] explores the potential of digital transformation in achieving Ukraine's environmental sustainability goals by 2030. Her study clarifies the concept of "eco-transformation" and examines its implications for balancing economic development with environmental protection. In a related context, Vnukova [2] analyses the impact of digital technologies on the transformation of industrial enterprises, focusing on changes in technological architecture, applications, and infrastructure in Ukraine.

Chyhryn and Shcherbak [3] address contemporary challenges associated with the implementation of environmentally friendly business practices. They identify key national priorities and assess the benefits of clean production models for enterprises. Kharchenko and Panchenko [4] develop a model for environmentally friendly production adapted to the Ukrainian context, presenting an implementation scheme and evaluating its ecological and economic effectiveness. Their research also introduces a conceptual framework for digital strategizing within industrial systems, grounded in the paradigm of sustainable eco-innovation and circular business models aligned with Industry 4.0 [5–6].

Further contributions by Robul [7–8] focus on the digital transformation of the economy and its influence on the evolution of marketing systems at the macroeconomic level. His work underscores the role of artificial intelligence, big data, and automation in shaping digital marketing strategies. In turn, Sadchenko [9–12] examines the integration of ESG (Environmental, Social, and Governance) principles into production and marketing processes, particularly in the context of sustainable development and the circular economy. Her studies highlight the application of

Industry 4.0 technologies to operationalize ESG frameworks.

Collectively, these publications provide a substantive basis for rethinking the digital transformation of marketing in the context of ecological imperatives. They offer both theoretical insights and practical recommendations for integrating environmentally oriented strategies with digital marketing technologies, thereby contributing to the advancement of sustainable industrial development and enhancing the competitiveness of Ukrainian enterprises.

Objectives and tasks. Despite the growing body of research on eco-oriented production and the digitalisation of marketing, current studies tend to address these phenomena either in isolation or within limited thematic scopes. While existing literature offers valuable insights into the theoretical foundations, policy directions, and technological implications of digital transformation and environmental sustainability, there remains a clear need for a more integrated analysis of how digital tools can be strategically embedded in the marketing processes of environmentally responsible enterprises. In particular, insufficient attention has been paid to the practical convergence of sustainable development goals and marketing innovations at the enterprise level, including the formation of effective digital strategies in eco-oriented production contexts.

In response to these gaps, the present study aims to explore the strategic and technological aspects of implementing digital solutions in the marketing processes of environmentally oriented enterprises. The objective is to provide a holistic understanding of how digital transformation can enhance the effectiveness, adaptability, and sustainability of marketing practices in green industries. Achieving this aim will make it possible to deepen the understanding of the relationship between environmental sustainability and digital marketing and to develop practical approaches that improve the competitiveness of enterprises operating in accordance with sustainable development principles.

Research Methods. To address the research objectives, a comprehensive methodological approach has been applied, combining theoretical and empirical methods. Theoretical methods include analysis and synthesis, which were employed to study scientific literature on sustainable development, digital transformation, and environmentally oriented marketing. Comparative analysis was used to contrast traditional and digital marketing strategies within the context of environmentally responsible production. A systems approach served as a conceptual framework, enabling the consideration of eco-oriented production and digital marketing as interconnected components of a broader socio-economic and technological system.

Empirical methods were applied to gather and interpret data on the practical implementation of digital tools in sustainable industrial contexts. Content analysis was conducted on company reports, government programmes, and statistical data related to the adoption of digital technologies in eco-oriented production. The case study method was used to explore best practices of companies that successfully integrate digital marketing into their sustainability strategies. Expert interviews with professionals in the fields of sustainable development, digital marketing, and industrial management were carried out to gain insights into current trends, challenges, and perspectives. In addition, questionnaires and surveys were utilised to collect the opinions of consumers and business representatives regarding the effectiveness of digital technologies in promoting environmentally friendly products.

To complement these methods, modelling was applied to develop possible scenarios for the implementation of digital tools in marketing strategies of environmentally oriented enterprises. This methodological framework ensures a thorough examination of the interplay between digital transformation and sustainable marketing and provides a basis for developing practical recommendations for businesses operating in the green economy.

Results and discussion. In the context of modern market dynamics, companies are compelled not only to enhance efficiency but also to fundamentally revise their marketing strategies in light of digital transformation and the imperatives of sustainability. Eco-oriented production, which aims to minimise environmental impact while creating long-term value for stakeholders, necessitates the integration of advanced digital marketing tools. These tools must align with the principles of sustainable development and support the transformation of business models toward environmental and social responsibility.

The accelerating pace of technological innovation, combined with pressing global environmental challenges, creates both opportunities and significant obstacles for industrial enterprises. On one hand, the digital transformation of marketing offers substantial benefits: optimisation of production and distribution processes, reduction in operational costs, real-time data management, and the ability to adapt quickly to changing consumer preferences. On the other hand, enterprises — especially small and medium-sized businesses — often face a number of persistent challenges in implementing digital and environmentally friendly solutions. These include

high initial investment costs, insufficient access to financial instruments, a lack of strategic coordination between digitalisation and sustainability goals, and limitations in organisational capacity and technological infrastructure.

Moreover, many companies still approach digital transformation as a set of isolated initiatives, rather than as part of a coherent strategy that incorporates environmental goals. This fragmented approach undermines the potential impact of digital marketing tools and weakens the alignment of business practices with ESG principles. As a result, there is a growing need for a systemic transformation that integrates sustainable development priorities and digital capabilities into a unified strategic framework.

A comprehensive approach to the integration of digital technologies into the marketing of environmentally oriented enterprises involves several key dimensions — see Table 1.

Table 1

Dimensions of integration of digital technollogies into marketing of environmentally oriented enterprises

Dimension	Description
Big Data and Analytics	Collection and analysis of large data sets to support personalised, sustainability-oriented marketing and strategic decision-making.
Artificial Intelligence and Machine Learning	Automation of marketing functions, demand forecasting, and personalization based on environmental and behavioral data.
Internet of Things (IoT)	Life cycle monitoring and transparency in supply chains using smart sensors and connected devices.
Blockchain	Verification of product origin, documentation of carbon footprints, and enforcement of sustainability standards.
Digital Platforms and Content Ecosystems	Use of digital media and online communities to communicate environmental values and educate stakeholders.
Marketing Automation (MarTech)	CRM, programmatic advertising, and other automation tools for consistent and targeted promotion of eco-products.
Green E-commerce and Marketplaces	Online platforms that support the scalable sale and verification of environmentally friendly products.

Source: own elaboration of the authors

Big Data and advanced analytics enable the collection, processing, and interpretation of large volumes of data on consumer behaviour, environmental trends, and market dynamics. Such insights can be used to design personalised and sustainability-focused marketing campaigns,

enhance targeting accuracy, and inform long-term strategic planning. Artificial intelligence and machine learning support the automation of marketing processes, including dynamic pricing, real-time content personalisation, and customer segmentation. They also provide predictive modelling capabilities for consumer demand and behaviour, which are essential for promoting eco-products and forecasting responses to sustainability efforts. Internet of Things (IoT) technologies contribute to increasing transparency and traceability in supply chains. With the help of smart sensors and connected devices, companies can monitor product lifecycles from sourcing to post-consumption recycling, thereby enhancing the credibility of sustainability claims. Blockchain solutions strengthen supply chain integrity by offering decentralised and tamper-proof documentation of environmental credentials. These technologies allow verification of origin, compliance with sustainability standards, and accurate carbon footprint reporting. Digital platforms and content ecosystems—including social media, branded communities, and multimedia content—enable companies to share their environmental values and engage stakeholders in a deeper, more interactive manner. These channels help build trust and promote behavioural change. Marketing process automation (MarTech) tools such as CRM systems, automated advertising platforms, and email marketing systems allow for consistent, scalable communication with consumers and more efficient promotion of eco-products. Finally, digital marketplaces and green e-commerce channels facilitate the sale and distribution of environmentally responsible goods by enhancing visibility, credibility, and consumer access.

The use of digital platforms to promote and distribute environmentally friendly goods is becoming an integral part of sustainable marketing. Green marketplaces enable scalable growth for eco-brands and provide consumers with access to transparent, verified, and low-impact products.

The implementation of these technologies yields several notable outcomes: increased consumer trust, cost reductions through automation and efficiency, enhanced brand reputation, and stronger customer loyalty. More broadly, the convergence of digitalisation and environmental sustainability contributes to the development of new, agile, and environmentally responsible business models. Companies that successfully integrate digital marketing tools with eco-oriented production processes gain strategic advantages in innovation, risk management, and access to ESG investment capital.

The convergence of digitalisation and sustainability is not a parallel evolution of two independent trends. Rather, it represents a transformative synergy that redefines industrial practices. By integrating smart technologies with environmental responsibility, companies can achieve systemic improvements in production efficiency, resource management, and market competitiveness. Digital twins, predictive analytics, smart grids, and circular business models are examples of how such convergence is already shaping the future of industry.

The concept of «Green Industry 4.0» emerges at the intersection of these dynamics. It unites digital transformation tools — AI, IoT, cloud computing, and blockchain — with sustainable production practices, such as circular design, resource conservation, and emissions reduction. In this context, reverse logistics, eco-design, and closed-loop supply chains become not just add-ons but core elements of strategic marketing.

Reverse logistics, supported by Big Data and blockchain, enables efficient collection, sorting, and processing of used goods. Companies can now trace the entire lifecycle of a product and plan recycling or re-use in advance. Predictive analytics informs optimal disposal points, while route optimisation technologies reduce emissions in the logistics chain. Leading enterprises such as IKEA, BMW, and Dell already use digital systems to manage product returns and extend product life cycles.

Eco-design is also gaining traction as a proactive strategy for reducing environmental impact. It involves designing products with minimal resource consumption, maximised durability, and simplified end-of-life recycling. Examples include modular smartphones (e.g., Fairphone), biodegradable packaging (e.g., IKEA), and clothing made from recycled ocean plastics (e.g., Adidas x Parley). Integrating eco-design principles into product development contributes not only to sustainability goals but also to brand differentiation and consumer engagement.

Blockchain-based supply chain systems provide real-time visibility into product origins and movement. This increases transparency, combats counterfeiting, and builds trust. For example, IBM's Food Trust and platforms like Everledger and VeChain offer tools for supply chain monitoring that document sourcing, compliance, and emissions. These systems support carbon accounting, verified certification, and green investment transparency [13].

In addition, the Industrial Internet of Things (IoT) and predictive maintenance algorithms enable better energy management, equipment

reliability, and resource planning. AI-driven microgrids and peer-to-peer energy platforms support decentralised renewable energy exchanges, while digital solutions for hydrogen production and biomanufacturing expand the toolkit for sustainable industrial practices.

Furthermore, ESG-focused business models increasingly rely on digital reporting systems to ensure compliance and accountability. Automated sustainability dashboards and smart contract mechanisms facilitate monitoring and disclosure, helping businesses meet stakeholder expectations and regulatory requirements.

Finally, smart logistics, sustainable packaging, and adaptive manufacturing using 3D printing and biodegradable inputs are emerging as cornerstones of digital sustainability. Predictive tools enable continuous optimisation of transport routes and warehouse operations, contributing to the reduction of emissions and waste.

In summary, the digitalisation of marketing within eco-oriented enterprises is more than a technical upgrade — it is a strategic transformation. It enhances the alignment of business operations with global sustainability goals, supports customer-centric innovation, and reinforces the long-term competitiveness of enterprises. The synergy between digital tools and environmental values defines the future of marketing in the age of sustainable industry.

Conclusions. The digitalisation of industrial resources plays a critical role in minimising losses, enhancing operational efficiency, and reducing overall costs. Intelligent technologies—such as automated accounting, predictive analytics, and process automation—form the foundation of a sustainable and competitive business environment under conditions of digital transformation.

Modern industrial enterprises are increasingly adopting integrated approaches that combine sustainability principles with advanced digital tools. The application of Internet of Things (IoT), big data, artificial intelligence, and blockchain technologies enables enterprises to optimise resource consumption, reduce emissions, and increase the transparency and accountability of production processes. These technologies not only support compliance with environmental standards but also improve product quality and stimulate the development of innovative, flexible business models.

The integration of digital solutions into eco-oriented production strengthens the market position of companies by aligning with ESG principles and responding to consumer demand for environmentally responsible practices. Moreover, growing regulatory pressures and rising societal

expectations are accelerating the transition to digital sustainability in industry.

Nevertheless, the transition is not without challenges. High initial investment requirements, the complexity of redesigning business processes, and the shortage of specialised personnel can hinder the effective implementation of digital innovations. Addressing these issues requires coordinated efforts at the organisational, governmental, and policy levels.

Looking forward, the development of smart factories, circular economy practices, and carbon-neutral production chains — enabled by digital infrastructure — will become strategic priorities for industrial transformation. The convergence of eco-oriented production and digital transformation must be approached as a unified process, laying the groundwork for sustainable growth, innovation, and long-term competitiveness in the global economy.

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ЕКОЛОГІЧНО-ОРІЄНТОВАНЕ ВИРОБНИЦТВО ТА ЦИФРОВА ТРАНСФОРМАЦІЯ МАРКЕТИНГУ

У статті розглядаються основні цифрові маркетингові підходи за умов еколого-орієнтованого виробництва. Визначено низку ключових факторів, що визначають розвиток сучасного маркетингового сектора. Це дослідження фокусується на впровадженні у цифровізацію промисловості екологічних аспектів, що підвищить ефективність переходу до сталого розвитку. Визначено інтеграцію екологічно орієнтованих стратегій та цифрових технологій у промислове виробництво як стратегічний вектор розвитку економіки в умовах конвергенції сталого розвитку. Розглянуто, що висока вартість впровадження цифрових рішень та екологічно чистих технологій створює перешкоди для підприємств малого та середнього бізнесу, а недостатня кількість доступних фінансових інструментів для підтримки сталого розвитку промисловості, неузгодженість стратегій цифрової та екологічної трансформації процесів маркетингу сприяють глибокому вивченню цього питання.

Інтеграція екологічно стійких стратегій та цифрових технологій у промислове виробництво є стратегічним драйвером економічного розвитку, відповідаючи ширшій конвергенції принципів сталого розвитку. Розглянуто конвергенцію принципів сталого розвитку та цифрової трансформації у виробництві синергетичного підходу, який підвищує ефективність використання ресурсів, знижує вплив на навколишнє середовище та забезпечує довгострокову економічну стійкість за рахунок інновацій та технологічної інтеграції. Запропоновано головні драйвери конвергенції сталого розвитку та цифровізації виробничих процесів — технології IoT, Big Data та автоматизовані системи управління ресурсами. Вони допомагають оптимізувати процеси, мінімізувати негативний вплив на довкілля та створювати економічно вигідні бізнес-моделі майбутнього.

Так, конвергенція сталого розвитку та цифрової трансформації у виробництві стає фундаментом нової промислової парадигми, заснованої на інтелектуальних технологіях, ресурсозбереженні та екологічній відповідальності. Запропоновано ключові аспекти цифровізації маркетингу в еколого-орієнтованих компаніях.

Ключові слова: маркетинг, цифровий маркетинг, MarTech, CRM, конвергенція, менеджмент, екоорієнтоване виробництво, трансформація, менеджмент, процеси, цифровий менеджмент, сталий розвиток.

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