

Електронний журнал «Ефективна економіка» включено до переліку наукових фахових видань України з питань економіки (Категорія «Б», Наказ Міністерства освіти і науки України № 975 від 11.07.2019). Спеціальності – 051, 071, 072, 073, 075, 076, 292. Ефективна економіка. 2025. № 5.

DOI: <http://doi.org/10.32702/2307-2105.2025.5.76>

УДК 658.5:330.341.1

V. Shuklina,

PhD in Economics, Associate Professor, Associate Professor of the Department of Management, Marketing and Tourism, Kherson National Technical University

ORCID ID: <https://orcid.org/0000-0002-2284-092X>

S. Ivashchenko,

Postgraduate student, Kherson National Technical University

ARTIFICIAL ALGORITHMS FOR MANAGING INFORMATION FLOWS IN THE MARKETING OF SMALL BUSINESS ENTERPRISES

В. В. Шукліна,

к. е. н, доцент, доцент кафедри менеджменту, маркетингу і туризму,

Херсонський національний технічний університет

С. М. Іващенко,

аспірант, Херсонський національний технічний університет

ШТУЧНІ АЛГОРИТМИ УПРАВЛІННЯ ІНФОРМАЦІЙНИМИ ПОТОКАМИ В МАРКЕТИНГУ ПІДПРИЄМСТВ МАЛОГО БІЗНЕСУ

The article explores the main artificial algorithms for managing information flows in the marketing of small business enterprises, particularly their types and possibilities of application in the realities of the digitalization of the environment. It is noted that digital marketing technologies in the activities of enterprises both

strengthen protection and cause new risks in the intensive information flows of small business enterprises and management systems of their subjects, in which their implementation should be formed as a strategic direction of development. The article defines the growing role of digital approaches to information flow management in the marketing of small business enterprises as part of the product offered to consumers, which can provide flexibility to marketing complexes and reduce uncertainty of demand and the need for stocks and resources. Machine learning is considered a branch of artificial intelligence research in marketing information flows, focused on developing algorithms that can learn and generalize from data to solve problems that depend on many factors and require solutions with complex algorithmization. The article substantiates the transforming function of artificial algorithms in the information space of marketing management of small business enterprises, with the transition to the possibilities of qualitative and quantitative analysis of the content of information from numerous sources, which allows continuous identification and measuring processes and phenomena based on the results of interactive monitoring. A complex application of artificial algorithms of classical learning and neural networks is proposed, and their tasks in the processes of management of information flows of marketing of small business enterprises are shown. The prospects of continuous management based on the results of interactive monitoring of consumers and timely receipt of the necessary information for the development of accurate and effective marketing solutions are analyzed, and their main advantages of introducing artificial algorithms in the construction and optimization of information flow in the marketing of small business enterprises are proved. The main disadvantages of using artificial algorithms in the management of information flow in the marketing of small business enterprises are the inaccuracy of models based on poor quality data, the difficulty of correct interpretation of results and elimination of uncertainty, resource intensity of processes, challenges in ensuring confidentiality and security when working with large data sets.

У статті досліджено основні штучні алгоритми управління інформаційними потоками в маркетингу підприємств малого бізнесу, зокрема, їх типи та можливості застосування в реаліях цифровізації середовища. Відзначено, що технології цифрового маркетингу в діяльності підприємств одночасно як посилюють захист, так і стають причиною нових ризиків в інтенсивних інформаційних потоках малого бізнесу та системах управління його суб'єктами, в яких їх впровадження має формуватися стратегічним напрямом розвитку. Визначено зростаючу роль цифрових підходів управління інформаційними потоками в маркетингу підприємств малого бізнесу як частини товарної пропозиції для споживачів, здатної забезпечити гнучкість маркетингових комплексів, знизити невизначеність попиту та потребу в запасах і ресурсах. Розглянуто машинне навчання, як галузь досліджень штучного інтелекту в маркетингових інформаційних потоках, зосереджене на розробці алгоритмів, здатних навчатися і узагальнюватися з даних для розв'язання задач, які залежать від багатьох факторів, потребують рішень зі складною алгоритмізацією. Обґрунтовано, трансформуючу функцію штучних алгоритмів в інформаційному просторі управління маркетингом підприємств малого бізнесу, з переходом в можливості якісно-кількісного аналізу змісту інформації з численних джерел, що дозволяє безперервно виявляти й вимірювати процеси і явища за результатами інтерактивного моніторингу. Запропоновано комплексне застосування штучних алгоритмів класичного навчання й нейронних мереж та показано їх завдання в процесах управління інформаційними потоками маркетингу підприємств малого бізнесу. Проаналізовано перспективи безперервного управління за результатами інтерактивного моніторингу споживачів, своєчасне отримання необхідної інформації для розробки точних і результативних маркетингових рішень та доведено їх основними перевагами впровадження штучних алгоритмів в побудову та оптимізацію інформаційних потоків в маркетингу підприємств малого бізнесу. Показано основними недоліками застосування штучних алгоритмів в управлінні

інформаційними потоками маркетингу підприємств малого бізнесу неточність моделей, побудованих на неякісних даних, складність правильної інтерпретації результатів і усунення невизначеності, ресурсомісткість процесів, труднощі забезпечення конфіденційності та безпеки при роботі з великими масивами даних.

Keywords: *artificial algorithm, information flow, digital marketing, machine learning, continuous management, interactive monitoring, personalization, enterprise, small business.*

Ключові слова: *штучний алгоритм, інформаційний потік, цифровий маркетинг, машинне навчання, безперервне управління, інтерактивний моніторинг, персоналізація, підприємство, малий бізнес.*

Problem and its connection with important scientific or practical tasks. Transformational changes and the integration of traditional and digital marketing affect the entire spectrum of business, process management, and consumer interaction. Digitalization simplifies the procedures for information support for the marketing activities of small business market participants, significantly increasing their intensity. However, the instability of the business environment, coupled with the existing resource constraints of small business enterprises, necessitates using artificial intelligence, the latest technologies, and other innovative programs in managing marketing information flows relevant to the strategic perspective of decisions.

Analysis of recent research and publications. The scientific works of both domestic and foreign experts study the problems of functioning of marketing information systems, transformation and adaptation of information support technologies for marketing management processes by the needs of enterprises, taking into account the impact of digitalization processes, in particular G. Armstrong, D. Aaker, G. Assel, L. Balabanova, F. Brassington, N. Buga, L. Bushuieva, A. Voichak, O. Hryshchenko, D. Jobber, E. Dichtl, Y. Dovgan,

D. Emily, S. Iliashenko, O. Kanishchenko, E. Krykavskyi, A. Kuznietsov, M. Oklander, A. Pavlenko, N. Pryimak, N. Proskurnina, I. Reshetnikova, B. Soloviov, O. Tielietov, A. Fedorchenko, H. Hershgen, G. Churchill, N. Chukhrai, N. Yudina, K. Jarek and many others.

Formulation of the objectives of the article. The article aims to highlight the role of artificial algorithms for managing information flows in the marketing of small business enterprises in the context of digitalization of the environment.

Presentation of the main research material. Information flows in marketing, which in the general sense are the movement of structured data in the environment, can be represented by a set of messages circulating in its system and linking to the external environment as a requirement for managing its programs. Management influence, especially in small business enterprises, is characterised by the emergence of a periodic need to make urgent decisions, the effectiveness of which is determined by the timeliness of their processing. The development of the electronic information environment enriches the marketing of enterprises with the latest, advanced technologies, which, at the same time, increases the intensity of information flows [6]. Therefore, in the context of various resource constraints of small business enterprises, studying these issues in the management system should be conducted in a strategic development direction. At the same time, the role of information flows in modern enterprise marketing is growing because information increases the flexibility of marketing complexes, reduces the uncertainty of demand and the need for stocks and labour resources [9], and is part of the product offer for consumers.

The internal situation in the country and global processes are raising the issue of digitalization of enterprise management, including marketing, as an essential component of the future, and therefore attracting attention to find optimal algorithms for building and optimizing information flows in business, where small and large companies compete on an equal footing [5, p.121; 8]. However, the possibility of significantly high budgets does not mean victory in the competition; rather, it depends on how well the information strategy is implemented in each

unique situation. Small business enterprises are trying to use different types of digital marketing as a process of marketing products or services to potential customers through digital channels and the internet, such as search engine optimization (SEO), social media marketing (SMM), email marketing, content creation and more to promote their brand to potential customers or retain their customers [4;7].

Digital marketing is inextricably linked to the development of the latest technologies, as reality and the virtual world in the online environment trigger further transformation of socio-economic systems and relationships. The digitalization of information flows in marketing has significant advantages, which are reflected in the harmonious combination of synergy effects into an integrated system. Changes in traditional marketing towards its digitalization affect process management, simplifying specific procedures and offering significant benefits for developing forms of interaction and models for forecasting consumer behavior [2;3]. The latest technologies and artificial intelligence in digital marketing allow small business enterprises to improve the quality of information flow management and promptly solve problems of justifying marketing decisions. In today's environment, it is necessary to stimulate factors that will positively affect the speed of digital technology implementation, primarily internal capabilities and interest in implementing digital technologies. The prospects for the digitalization of marketing involve new innovative development and a sufficient level of transformation of social institutions, economic models [1, p.7], and the specifics of running a small business, with a transition from consuming material elements to producing the necessary information product.

The digitalization of marketing is changing how small business enterprises run and use information technologies in various areas of enterprise operations [6]. The key models of digital marketing transformation include digital design and modeling of technological processes, electronic document management and control, mathematical modeling of rapid learning, and the introduction of new approaches to marketing activities. According to some scientists, the key features

of digital marketing of enterprises are online business processes, cloud technologies, artificial intelligence, digital personalization, automation of the Internet of Things, digital business models, platforms, and communication channels, consumer information technologies with a rethinking of the use of information [3; 5, p.120; 7]. Their combination with traditional marketing tools contributes to the formation and development of advantages in reaching global and niche audiences, customer loyalty, increased return on investment, trackable and measurable results, increased social currency, interactive marketing, improved conversion, etc [8]. Implementation of the digital development strategy of small business enterprises will help to increase the analytical capacity and efficiency of marketing decision-making by creating a new model of a single standard integrated information environment in the field of management systems, built on an integrator that allows the digital environment to function on the ability of various electronic information equipment and software to freely exchange information without resource restrictions with simultaneous comprehensive protection of information [1, p. 6]. However, the compatibility of blockchain technologies means the ability of their multiple blocks to communicate with each other, which determines the future breadth of their implementation and decentralization. Electronic documentation should become an integral part of digital marketing for small business enterprises, capable of effectively directing information flows, bringing them closer to the unified digital environment of the state and the EU through the harmonization of their microenvironment objects, which make decisions on information flow management, reflecting the hierarchy of the controlling and managed systems in information on the functional direction and personnel, resources and performance. According to different criteria, marketing management can be divided into horizontal or vertical, external or internal, and imported or exported, according to the direction related to the marketing system and information flows [1, p.5; 9]. The main characteristic of digital marketing information flows is the interconnection with the traditional one, providing access to the necessary data when needed. The advantages are faster and less expensive

access to the required information by reducing the number of intermediaries and simplifying search algorithms. To ensure the development of digital marketing as an environment for optimizing information flows of small business enterprises, it is necessary to have high competence of specialists working with information and communication technologies, development of modern digital infrastructure can have goals [5, p. 115], be unidirectional or multidirectional and represented by various types of media [1].

In the general model, the information flow in the marketing of small business enterprises is a measure of the amount of information that is transmitted or processed over a certain period by the number of transmitted, processed documents, the number of components in these documents [9], or the amount of information contained in a particular message.

The information flows of small business enterprises reflect market goals, which are also marketing goals formed outside the marketing system at a higher organizational level and are included in mandatory plans, business plans, and other regulatory documents approved by management. In addition, information flows that characterize the company's position in the market, including the achieved levels of the set goals (deviations from them), are important since, in general, the set of parameters is broader than the set of goals (it can be changed and revised) and additionally includes unique indicators. The information flow on the strategy and requirements for the marketing complex is associated with marketing programs, which are specified by algorithms for implementing the parameters, deadlines, and responsible persons.

Information flows that reflect the actual, achieved values of the parameters of the marketing complex, with control over the degree of achievement of their planned levels in the form of internal feedback on information about the actual state and degree of achievement of the intended market goals, are of great importance in the management of small business enterprises. Information about needs, desires, wants, and demand, consumer attitudes to the product, and their intentions are reflected in the flows of consumer behavior, the relationship of

which reflects the essence of the applied concept focused on meeting their demand management needs. Information flows are controlled by the following parameters [4]: non-economic results (consumer behavior), marketing mix as a whole and its tools, and economic results (sales, market share, etc).

Modern marketing technologies of small business enterprises are characterized by a dual nature: they can both strengthen the protection of information flows and become the cause of new risks. Encryption protects confidential data during the transmission and storage of information and data, reducing the risk of leaks, but anonymization is also used to hide the activities of criminals. Due to the distributed nature of its operation, blockchain increases data security. It ensures the integrity and transparency of transactions. Still, it reduces the security of some processes due to the irreversibility of erroneous transactions, the risk of losing access keys, vulnerabilities of smart contracts, other specifics [1].

Artificial intelligence technology also demonstrates the dual nature, which can improve the security of small business marketing information flows by anticipating potential attacks, analyzing large amounts of data, detecting anomalies, and adequately implementing security measures. At the same time, its misuse can be used to automate hacker attacks and other undesirable actions.

Artificial intelligence in marketing can be defined as a set of technologies, algorithms, and methods that imitate human intelligence in a particular model of reality [8]. The main techniques of artificial intelligence in marketing information flows are Data Science and Machine Learning, which are used to solve problems that depend on many factors and require complex solutions with sophisticated algorithms [3]. Machine learning, as a field of artificial intelligence in the marketing of small business enterprises, uses algorithms to obtain data and learn from it - learning from experience - to automate the solution of various analytical tasks of managing information flows. In managing the information flows of small business marketing, the following main types of machine learning algorithms are distinguished [6;9]: classical learning (regression, classification, clustering, association rule search algorithms) (Table 1), neural networks, and deep learning.

Artificial neural network algorithms in the management of small business marketing information flows are an integral part of the development of artificial intelligence and computer vision systems OpenCV and Face Recognition for face recognition on single-board computers such as Raspberry Pi based on the open source computer vision library, image processing, and numerical schemes with a reasonably wide functionality in the OCR Solutions system - a service for recognizing technical and foreign passports and other documents based on the library's implementation, with support for Python, Java, Matlab, Lua and other languages, including for cropping, size reduction in convolutional neural networks, rotation, and gradation of color images, inscriptions, etc. [3;7].

Table 1: Application of classical machine learning algorithms in the management of information flows of small business marketing

Algorithm type	Characteristics and tasks for application
Classical machine learning, including :	It is based on classical statistical algorithms and solves issues related to data-driven decision-making; it is actively used in offline and online marketing to predict user behavior and recommendations on interests. A trained system selects options that may be of interest. Algorithms are often used in Data Mining and considered as a part of Data Science for high-quality content search, effective cross-sales, analysis of available customer information, acceleration and automation of business processes, etc
classification	The most popular machine learning task in marketing, which involves object categorization and division of objects according to specific and predefined features (customers: by the number of purchases, frequency of visits to the site, buying habits) with the additional product - the ability to identify everything that does not fit into standard classes; can learn to solve regression problems
regression	This is when, based on a given set of features, it is necessary to predict a target marketing variable with a prediction of the place on a numerical line (what the market volume of certain goods will be in three years); it is built into various computer systems, even into the classic Excel
clustering	The task of dividing a given data sample in such a way that each cluster consists of similar objects and objects of different clusters differ significantly from each other to predict the correspondence of sample objects to their classes, forming clusters used to analyze and search for features that can be used to combine objects, compress data and search for novelty
search for associative rules	The task of searching for associative rules (finding patterns in the data stream)

Source: compiled by the author based on [7;8]

In managing small business marketing information flows, deep learning technologies use multilayer artificial neural networks to ensure the highest accuracy

of object detection, speech recognition, language translation, etc. Unlike ML, DL requires high-performance hardware, powerful graphics processors, video cards, etc. The following are the advantages of machine learning among artificial algorithms for managing enterprise small business marketing information flows [1;8]:

- instantaneous awareness of the general, essential properties of a particular subject or phenomenon based on data from algorithms that can analyze large amounts of data to identify patterns and ideas that a specialist misses,
- efficiency by automating repetitive tasks, allowing professionals to focus on more complex and creative tasks;
- consistency in performing tasks without getting tired, which leads to fewer errors compared to manual processes,
- adaptability to new data, with improvements over time,
- reduction of errors by achieving greater accuracy and reliability.

However, the disadvantages of machine learning in artificial algorithms for managing information flow in enterprise small business marketing are that poor-quality data can lead to inaccurate models, working with large data sets, especially personal data, raises significant privacy and security concerns, resource intensity, and the difficulty of correctly interpreting results and eliminating uncertainty.

Using artificial algorithms to manage digital marketing information flows for small business enterprises allows marketers to offer users a personalized experience based on their actions or preferences and tailor content to individual preferences and requirements. Automated artificial intelligence schemes for analyzing massive data sets rely on previous data to predict new trends, behaviors, and results of marketing activities of enterprises to make informed decisions, predict customer requirements, and increase the effectiveness of marketing programs. Saving time and energy in managing small business marketing information flows, artificial algorithms help simplify the process of creating written content according to user preferences. Intelligent chatbot agents based on artificial intelligence allow providing round-the-clock customer support and service. In addition, marketing automation systems based on artificial algorithms

optimize routine tasks, allowing marketers to focus on more strategic projects, campaign scaling, and predictive analytics. AI algorithms can improve targeting and optimization by learning from vast amounts of data to find the most relevant people, the right keywords, and the best ad spots.

According to the Gartner Hype Cycle for Artificial Intelligence report [7], artificial intelligence algorithms enhance the security of information flows of small business enterprises by Intelligent threat detection, automated protective measures when detected, and behavioral analysis of user actions. According to the same publication, serious risks in managing information marketing flows are associated with the use of artificial intelligence by small business enterprises as a source of more sophisticated attacks, a place to generate false alarms, and a violation of negative trends in ethical and legal issues for automatically made decisions. Marketing managers at small business enterprises should invest in implementing artificial algorithms, employee training, and developing effective incident response strategies and multi-level security solutions. As artificial algorithms for managing information flows of small business enterprises improve, their role will increase, along with the responsibility for digital marketing ethics.

Conclusions and further essearch. The carried out research gives grounds to conclude that artificial algorithms of marketing management in small business enterprises transform their information space with the help of digital mechanisms, providing opportunities for qualitative and quantitative analysis of the content of information from numerous sources to identify or measure processes and phenomena on a particular topic, continuous management based on the results of interactive monitoring of consumers, timely receipt of the necessary information for the development of accurate and effective marketing decisions. Prospects for further research in this area are related to assessing the advantages and disadvantages of using Internet technologies to obtain information and implement steps to achieve the set marketing goals.

Література

1. Дзямулич М. І., Шматковська Т. О. Вплив сучасних інформаційних систем і технологій на формування цифрової економіки. *Економічний форум*. 2022. №2. С. 3-8. DOI:<https://doi.org/10.36910/6775-2308-8559-2022-2-1>.
2. Іжевський П., Самарічева Т., Кудельський В. Цифрові інновації в розвитку малого бізнесу. *Економіка та суспільство*. 2024. №63. DOI:<https://doi.org/10.32782/2524-0072/2024-63-78> (дата звернення: 07.04.2025).
3. Карпенко В. Л. Цифрові технології та штучний інтелект у сучасному маркетингу в Україні: виклики та перспективи. *Актуальні питання економічних наук*. 2023. №2. DOI:<https://doi.org/10.5281/zenodo.13610743> (дата звернення: 03.04.2025).
4. Ковбаса О. М., Максимчик А. Ю. Удосконалення системи управління малим підприємством для забезпечення його розвитку. *Економіка та суспільство*. 2024. №62. DOI: <https://doi.org/10.32782/2524-0072/2024-62-140> (дата звернення: 07.04.2025).
5. Кулиняк І. Я., Головецький Д. І. Цифрові інструменти маркетингового менеджменту підприємств: роль, переваги та виклики використання. *Вісник Національного університету «Львівська політехніка»*. 2023. №7. С. 114-125. DOI:<https://doi.org/10.23939/semi2023.02.114>.
6. Ларченко О. Сучасні проблеми управління: маркетинг і менеджмент малого бізнесу. *Таврійський науковий вісник. Серія: Економіка*. 2023. №16. С.128-132. DOI:<https://doi.org/10.32782/2708-0366/2023.16.17>.
7. Поліщук І. І., Якушевська О. В. Маркетингова стратегія в цифровому середовищі: огляд компонентів та ключових аспектів. *Ефективна економіка*. 2024. №5. DOI: <https://doi.org/10.32702/2307-2105.2024.5.11> (дата звернення: 05.04.2025).
8. Фостолович В. А. Штучний інтелект в сучасному бізнесі: потенціал, сучасні тренди та перспективи інтегрування у різні сфери господарської діяльності і життєдіяльності людини. *Ефективна економіка*.

2022. №7. DOI: <https://doi.org/10.32702/2307-2105.2022.7.4> (дата звернення: 07.04.2025).

9. Янковий О., Горлова О., Орленко О. Моделі управління інформаційними потоками логістичних бізнес-процесів на підприємстві. *Економіка та суспільство*. 2023. №58. DOI:<https://doi.org/10.32782/2524-0072/2023-58-65> (дата звернення: 03.04.2025).

References

1. Dzyamulych, M.I. and Shmatkovska, T.O. (2022), “The impact of modern information systems and technologies on the formation of the digital economy”, *Economic Forum*, vol. 2, pp. 3-8. DOI:<https://doi.org/10.36910/6775-2308-8559-2022-2-1>.

2. Izhevsky, P. Samaricheva, T. and Kudelsky, V. (2024), “Digital innovations in the development of small business”, *Economy and Society*, [Online], vol. 63, available at: <https://economyandsociety.in.ua/> (Accessed 7 April 2025)

3. Karpenko, V.L. (2023), “Digital technologies and artificial intelligence in modern marketing in Ukraine: challenges and prospects”, *Current issues of economic sciences*, [Online], vol. 2, available at: <https://a-economics.com.ua/index.php/home/index> (Accessed 3 April 2025)

4. Kovbasa, O.M. and Maksichka, A.Yu. (2024), “Improving the management system of a small enterprise to ensure its development”, *Economy and society*, [Online], vol. 62, available at: <https://economyandsociety.in.ua/> (Accessed 7 April 2025)

5. Kulinyak, I.Ya. and Golovetskyi, D.I. (2023), “Digital tools of marketing management of enterprises: role, advantages and challenges of use”, *Bulletin of the National University “Lviv Polytechnic”*, vol. 7, pp. 114-125. DOI:<https://doi.org/10.23939/semi2023.02.114>.

6. Larchenko, O. (2023), “Modern problems of management: marketing and management of small business”, *Tavria Scientific Bulletin. Series: Economics*, vol. 16, pp. 128-132. DOI:<https://doi.org/10.32782/2708-0366/2023.16.17>.

7. Polishchuk, I.I. and Yakushevska, O.V. (2024), “Marketing strategy in the digital environment: a review of components and key aspects”, *Effective economy*, [Online], vol. 5, available at: <http://www.economy.nayka.com.ua> (Accessed 5 April 2025).

8. Fostolovych, V.A. (2022), “Artificial intelligence in modern business: potential, current trends and prospects for integration into various spheres of economic activity and human life”, *Effective economy*, [Online], vol. 7, available at: <http://www.economy.nayka.com.ua> (Accessed 7 April 2025).

9. Yankovy, O., Gorlova, O. and Orlenko, O. (2023), “Models of information flow management of logistics business processes at the enterprise”, *Economy and Society*, [Online], vol. 58, available at: <https://economyandsociety.in.ua/> (Accessed 3 April 2025).

Стаття надійшла до редакції 12.05.2025 р.