

IMPROVING EMAIL MARKETING EFFICIENCY WITH ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

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ABSTRACT	KEYWORDS
This article explores modern approaches to improving email marketing effectiveness using artificial intelligence and machine learning technologies. It examines the historical stages of email marketing development, the theoretical foundations of intelligent algorithms, and the specifics of using machine learning methods for audience segmentation, content personalization, user behavior prediction, and marketing communications automation. Practical mechanisms for implementing artificial intelligence are analyzed, including intelligent message timing, recommender systems, predictive analytics, and generative AI models. Particular attention is paid to assessing the effectiveness of intelligent technologies based on key marketing metrics and the prospects for further development of email marketing in the context of digital transformation. It is concluded that the use of artificial intelligence and machine learning contributes to improved marketing campaign performance, increased personalization of customer interactions, increased conversion rates and return on investment, and the formation of sustainable competitive advantages for organizations. Scientific Novelty. The scientific novelty of this study lies in its comprehensive analysis of modern artificial intelligence and machine learning technologies in the context of improving email marketing effectiveness. The main areas of application of intelligent algorithms in audience segmentation, content personalization, predictive analytics, and marketing communications automation are systematized. Modern approaches to assessing the effectiveness of implementing artificial intelligence in email marketing are summarized, using both traditional marketing metrics and machine learning model quality metrics. A structured classification of practical mechanisms for applying artificial intelligence in email marketing is proposed, allowing for a comprehensive assessment of their impact on improving the effectiveness of digital communications and the efficiency of organizations' interactions with consumers. Purpose of the Study. The purpose of this study is to explore the potential of using artificial intelligence and machine learning technologies to improve email marketing effectiveness, analyze modern methods for intelligent personalization of marketing communications, and identify potential applications of intelligent algorithms to optimize customer interactions in the context of digital economic transformation.	Email marketing, artificial intelligence, machine learning, digital marketing, personalization, predictive analytics, marketing automation, generative artificial intelligence, big data, digital transformation.

Introduction

The development of the digital economy and the rapid transformation of marketing communications have led to a significant shift in the role of email marketing in how organizations interact with consumers. Despite the rapid expansion of social media, messaging apps, and mobile apps, email remains one of the most effective and cost-effective digital marketing tools. Modern companies use email newsletters not only to inform customers about new products and special offers but also to build long-term relationships with consumers, increase loyalty, automate sales, and personalize the customer experience.

The history of email marketing is closely linked to the development of email itself. The first email was sent by American engineer Ray Tomlinson in 1971, who also proposed using the "@" symbol to separate the username and server address. By the late 1970s, email had begun to be used not only in the scientific community but also for commercial purposes. One of the first known uses of email for marketing communications is considered to be a mass mailing by Digital Equipment Corporation in 1978. Although this mailing was sent to a limited number of ARPANET users, it had a significant commercial impact and marked the beginning of the development of email marketing as an independent digital promotional approach.

During the 1980s and 1990s, with the rise of personal computers and the internet, the volume of electronic communications increased significantly. However, the lack of uniform standards led to a rapid increase in spam, necessitating the development of spam filtering mechanisms and regulatory frameworks for email marketing. At the beginning of the 21st century, legislation was passed regulating the use of email for marketing purposes, including the US CAN-SPAM Act (2003) and European data protection regulations, later enshrined in the General Data Protection Regulation (GDPR). These changes facilitated companies' transition to opt-in principles, improved content quality, and the development of personalized communications technologies.

The next stage in the evolution of email marketing was the development of marketing automation systems. The emergence of specialized platforms made it possible to abandon mass, identical email campaigns in favor of segmented campaigns based on audience characteristics, purchase history, and user behavior. Automated email sequences, triggered scenarios, dynamic content, and integration with CRM systems significantly increased the effectiveness of customer interactions and enabled customer support throughout all stages of the lifecycle.

The current stage of email marketing development is characterized by the widespread adoption of artificial intelligence (AI) and machine learning (ML) technologies. These technologies enable the analysis of vast amounts of user behavior data, predicting purchase probabilities, automatically generating personalized email content, choosing optimal sending times, identifying the most effective subject lines, and predicting the likelihood of opens or clicks. By using intelligent algorithms, companies can significantly increase the conversion rate of marketing campaigns while simultaneously reducing their costs.

Despite significant progress in marketing communications automation, the practical implementation of artificial intelligence technologies faces a number of challenges. These include the need to ensure high-quality source data, compliance with personal data protection laws, transparency of decision-making algorithms, prevention of discrimination against certain categories of users, and maintaining consumer trust in automated communications. Furthermore, the effectiveness of intelligent systems is largely

determined by the quality of training samples, the specifics of the machine learning models used, and the degree of integration with the company's existing digital infrastructure.

According to Ming-Hui Huang and Ronald Rust, artificial intelligence is a digital model of human intelligence capable of reproducing or surpassing human cognitive and mechanical functions [1]. A key difference between AI and traditional technologies is its ability to autonomously learn and adapt based on incoming data without the need for constant external programming. In the context of marketing, this means the use of intelligent systems to optimize business processes. AI-enabled marketing is based on automated data collection and analysis, allowing companies not only to predict market trends but also to independently make decisions on the implementation of marketing strategies [2, 3].

In an increasingly competitive digital marketplace, exploring the potential of artificial intelligence and machine learning technologies in email marketing is gaining particular scientific and practical significance. The use of intelligent data processing methods enables a shift from traditional mass marketing to hyper-personalized communications based on in-depth analysis of each user's behavior. This contributes to increased marketing campaign effectiveness, increased email open rates, click-through rates, conversion rates, and return on marketing investment (ROI), as well as the development of sustainable competitive advantages for organizations.

A review of scientific research on the application of artificial intelligence in email marketing

The development of artificial intelligence technologies has significantly changed scientific approaches to digital marketing research. While at the beginning of the 21st century, most research focused on email automation, audience segmentation, and evaluating the effectiveness of marketing campaigns, modern scientific studies increasingly consider intelligent algorithms as the basis for marketing decision-making. The use of artificial intelligence technologies facilitates the optimization of marketing processes. The uniqueness of AI lies in its ability to self-learn and dynamically adapt to the external environment. Unlike traditional tools, AI is capable of autonomous data processing and continuous algorithm improvement, eliminating the need for constant manual intervention in system configuration.

In recent years, there has been a steady increase in the number of publications devoted to the use of machine learning, neural networks, and generative artificial intelligence in customer relationship management (CRM) systems and email communication automation.

One of the most researched areas is the personalization of marketing messages. In the classic email marketing model, personalization was limited to using the recipient's name, location, or recent purchase history. However, modern research shows that this level of personalization is no longer sufficient to ensure high levels of audience engagement. In a highly competitive environment, companies are seeking to consider a significantly greater number of factors, including user behavioral characteristics, website interaction patterns, browsing history, preferred product categories, purchase frequency, active time, and even the predicted likelihood of a subsequent order.

Scientific research confirms that the use of machine learning algorithms can significantly improve the quality of customer segmentation. Unlike traditional statistical methods, intelligent models can independently identify hidden patterns in large data sets, creating dynamic user segments whose characteristics are constantly updated as new information accumulates. This eliminates fixed customer groups and allows for the continuous adaptation of marketing strategies [4].

Researchers are paying particular attention to predictive analytics. Predictive models allow for forecasting future user actions based on accumulated historical data. In email marketing, such models are used to predict the likelihood of email opens, link clicks, purchases, unsubscribes, prolonged periods of inactivity, and the likelihood of a customer defecting to a competitor.

Modern research demonstrates that the use of predictive methods can significantly reduce the number of ineffective email campaigns. Instead of sending identical emails to the entire subscriber base, intelligent systems intelligently identify users most likely to interact with a specific offer. This reduces the load on email services, reduces the number of spam complaints, and improves the overall effectiveness of marketing campaigns [5].

An important area of scientific research is choosing the optimal time to send messages. The traditional approach was based on analyzing average statistical open rates for emails at specific times of day or days of the week. However, modern machine learning algorithms make it possible to calculate individual sending times for each user. Dozens of parameters are analyzed, including previous email open history, time zone, user device, activity across various communication channels, and behavior patterns over different time periods.

Research shows that using intelligent delivery timing algorithms increases open rates and click-through rates without increasing the overall number of messages sent. This allows companies to improve the effectiveness of their communications without incurring additional costs associated with expanding their advertising budget.

Natural Language Processing (NLP) algorithms are of significant interest. This technology is used to automatically analyze email content, determine the emotional content of the text, assess the readability of messages, and generate personalized content. Modern language models can take into account the communication style of a particular user, adapting the structure of the email, the length of the text, the vocabulary used, and the sequence of information presentation.

In recent years, the scientific community has focused particular attention on generative artificial intelligence. Large language models enable the automatic generation of email subject lines, newsletter texts, promotional offers, personalized recommendations, and call-to-action options. Compared to traditional templated emails, such messages demonstrate a higher level of relevance and better match the interests of a specific user.

At the same time, methods for intelligent A/B testing are being actively researched. The classic approach involves creating several email variations and then comparing their effectiveness on a limited group of users. Modern machine learning algorithms can continuously analyze test results and automatically redistribute traffic to the most successful variations in near real time. These methods, known as multi-armed bandit algorithms, significantly reduce the time it takes to run experiments while simultaneously increasing their accuracy.

An equally important area of research is the use of recommendation systems. Modern algorithms generate personalized product and service recommendations immediately before sending an email. This is done by analyzing recent user activity, product assortment changes, demand trends, in-stock availability, and the actions of users with similar behavior. This ensures that the email content is as relevant as possible at the moment it's received.

Deep learning methods are receiving significant attention in modern scientific research. In particular, neural network architectures effectively solve problems of finding nonlinear patterns between customer profiles and responses to marketing activities. The advantage of deep learning over traditional

algorithms lies in its ability to perform multimodal analysis: the integration of text, numerical, visual, and behavioral data enables the creation of highly accurate predictive models for evaluating the effectiveness of email campaigns [6].

Along with the advantages of using artificial intelligence, researchers identify a number of limitations. One of the main challenges remains the quality of training data. Inaccurate or incomplete customer information leads to reduced forecast accuracy and degraded performance of intelligent models. Additional difficulties arise when integrating artificial intelligence algorithms with existing CRM platforms and marketing automation systems.

Special attention is paid to the ethical use of artificial intelligence. Current research addresses issues of algorithm transparency, the ability to explain system decisions, ensuring the confidentiality of personal data, and compliance with international data protection requirements. In the face of increasingly stringent legislation, companies are forced to find a balance between high levels of personalization and respect for users' privacy rights.

Theoretical Foundations of Artificial Intelligence and Machine Learning in Email Marketing.

The development of digital technologies and the increasing volume of data generated by users while interacting with digital services have led to a shift in marketing toward fundamentally new models of customer communication management. While traditional email marketing relied primarily on pre-designed interaction scenarios and static audience segments, modern intelligent technologies enable the development of adaptive systems capable of independently analyzing data, identifying patterns, and making decisions without direct human intervention. Artificial intelligence and machine learning technologies play a central role in this process, automating information processing and improving the quality of marketing decisions.

Artificial intelligence is a set of methods and algorithms aimed at simulating human intellectual activity using computing systems. In marketing, AI is used to analyze user behavior, forecast demand, personalize interactions, automate decision-making, and optimize business processes. Unlike traditional software solutions that operate according to predetermined rules, intelligent systems are capable of adapting to changing conditions, refining their models based on accumulated experience.

One of the most significant components of artificial intelligence is machine learning. Machine learning refers to a set of methods for constructing mathematical models that enable computer systems to identify relationships in data and make decisions without explicitly programming each rule. The main advantage of machine learning is its ability to automatically improve the accuracy of predictions as the amount of available information increases.

In modern scientific literature, several main approaches to machine learning are distinguished, each of which is applied to solving various email marketing problems.

Supervised learning is used when pre-labeled data on the results of previous marketing campaigns is available. For example, the algorithm receives user data, including whether they opened emails, clicked links, and made purchases after receiving the newsletter. Based on this data, a model is formed to predict the behavior of new users.

The most common supervised learning algorithms include logistic regression, decision trees, random forests, gradient boosting, support vector machines, and artificial neural networks. Each of these methods has its own advantages and is used depending on the complexity of the problem and the structure of the source data.

Unsupervised learning is used in situations where predetermined results are not available. Algorithms independently identify hidden patterns and form groups of objects with similar characteristics. In email marketing, this approach is primarily used for intelligent segmentation of the customer base.

The most well-known algorithm is the K-Means method, which allows for dividing users into clusters based on their behavior. For example, the system can automatically identify groups of active buyers, potential customers, users with a high likelihood of repeat purchases, and subscribers demonstrating declining activity. More complex clustering methods can consider dozens or hundreds of different parameters simultaneously, providing significantly more accurate audience segmentation than traditional demographic criteria.

A separate area is reinforcement learning, in which an intelligent system independently selects optimal actions by analyzing the results of previous decisions. In email marketing, this approach is used to select the most effective message sending times, communication sequences, create customized interaction scenarios, and optimize marketing strategies in real time.

The theoretical basis for the application of artificial intelligence is the concept of big data analysis. Modern marketing platforms collect vast amounts of information on user behavior daily. The most common data sources include CRM systems, web analytics, mobile apps, customer relationship management systems, social media, online stores, loyalty programs, and e-commerce services.

A wide range of characteristics can be analyzed for each user, including age, geographic location, purchase history, website frequency, active time, device type, operating system, browser, responses to previous newsletters, preferred product categories, average order value, duration of interaction with the company, and many other parameters. The greater the volume of available information, the greater the potential accuracy of intelligent models.

Predictive analytics plays a key role in modern email marketing systems. Its primary purpose is to forecast future user behavior based on historical data. These forecasts are based on mathematical models that estimate the likelihood of an email being opened, a link being clicked, a purchase being made, a subscription being unsubscribed, or a company ceasing to engage with the user.

Predictive analytics enables a shift from reactive marketing communications management to a proactive model, where the system determines the most effective actions in advance. For example, if an algorithm predicts a user's high likelihood of unsubscribing, a company can automatically offer them a personalized discount, adjust the frequency of emails, or suggest a different format for interaction.

Natural language processing (NLP) plays a significant role in intelligent systems. This field of artificial intelligence deals with the analysis and generation of text information. In email marketing, NLP technologies are used to automatically generate email content, analyze the emotional content of messages, assess text clarity, identify key semantic structures, and personalize marketing materials.

Modern language models can take into account the communication style of a specific user, adapting the text length, sentence structure, and vocabulary used. This increases the likelihood of a positive response from the recipient to the content of the email.

Another important area is the use of recommendation systems. The main task of such systems is to predict the most interesting products or services for each user. Depending on the algorithms used, a distinction is made between collaborative filtering, content filtering, and hybrid recommendation models. Collaborative filtering is based on the behavioral analysis of users with similar interests. If two customers have previously made similar purchases, the system assumes they may be interested in the

same products. Content filtering, on the other hand, analyzes the characteristics of the objects themselves and recommends products that are most similar to previously purchased items. Modern hybrid systems combine the advantages of both approaches, providing higher recommendation accuracy.

A key characteristic of intelligent systems is their ability to self-learn. As new data accumulates, algorithms are regularly retrained, adjusting model parameters and improving forecasting accuracy. This allows email marketing to gradually increase its effectiveness without the need for constant manual intervention.

Despite its obvious advantages, the use of artificial intelligence requires adherence to a number of principles. Key among these are the quality of source data, transparency of algorithmic decisions, protection of user personal information, the absence of algorithmic discrimination, and the ability to interpret the results of intelligent models. Failure to comply with these requirements may lead to a decrease in user trust, reduced effectiveness of marketing campaigns, and the emergence of legal risks.

Table 1 - Comparative characteristics of traditional email marketing and email marketing using artificial intelligence technologies

Criterion	Traditional email marketing	Email Marketing with AI
Audience segmentation	Performed manually according to fixed characteristics	Automatic dynamic segmentation based on user behavior
Personalization	Template letters and recipient's name are used	Personalized content for each user
Selecting the sending time	Determined by a marketer or based on general statistics	Calculated individually by machine learning algorithms
Content creation	Prepared manually by specialists	Generated and optimized using generative AI
Performance analysis	Executed after the campaign is completed	It is carried out continuously in real time.
Decision making	Based on the experience of a marketer	Based on big data analysis and predictive models

To clearly demonstrate the benefits of implementing intelligent technologies, it is advisable to compare traditional approaches to organizing email marketing with modern solutions based on the use of artificial intelligence (Table 1).

Practical mechanisms for increasing email marketing efficiency using artificial intelligence and machine learning technologies. The practical application of artificial intelligence and machine learning technologies in email marketing is aimed at solving a range of problems related to improving the quality of customer interactions, automating decision-making processes, and increasing the cost-effectiveness of marketing campaigns. Unlike traditional email marketing methods, which rely primarily on predefined rules and manual parameter settings, modern intelligent systems are capable

of autonomously analyzing data, identifying hidden patterns, and adapting marketing strategies in real time.

Modern machine learning algorithms analyze a much broader range of parameters. When processing information, they consider purchase history, site visit frequency, average order value, responses to previous emails, preferred product categories, user activity time, devices used, page views, number of interactions with the brand, and many other characteristics. Based on this data, the system automatically creates dynamic audience segments, the composition of which constantly changes as new information is received. Using intelligent segmentation significantly improves the relevance of messages sent. Users receive only those offers that best match their current interests, which increases email open rates and boosts conversion rates.

The next important area is personalization of email content. While personalization was previously limited to addressing the recipient by name and using general information about the user, modern technologies make it possible to create a virtually unique email for each recipient.

Artificial intelligence algorithms can automatically select the most suitable products, modify email structure, create customized offers, adapt visual design, select images, and change the order of information presentation. As a result, the content of each email is tailored to the user's expectations.

The use of generative artificial intelligence plays a particularly important role. Large language models enable the automatic generation of various email subject lines, advertising texts, personalized recommendations, and calls to action. The system takes into account the characteristics of the target audience, the company's communication style, and the results of previous marketing campaigns.

For example, when preparing a seasonal advertising campaign, a generative model can automatically generate dozens of email subject lines, varying in style, emotional tone, and structure. After automated testing, the most effective version is selected for the main email campaign, without any marketer intervention.

Another practical mechanism for increasing email marketing effectiveness is intelligent message sending timing. Numerous studies show that the likelihood of an email being opened depends significantly on the time it's received. However, there's no universal sending time that's equally effective for all users.

Machine learning algorithms analyze each customer's email interaction history, identifying their peak periods of activity. Optimal timing is calculated based on dozens of factors, including day of the week, time zone, user device, seasonal behavior patterns, professional activity, and previous email engagement.

As a result, each subscriber receives an email at the precise moment when they are most likely to be opened. This approach significantly increases open rates without increasing the overall number of emails.

Based on these predictions, the intelligent system automatically adjusts the marketing strategy. For example, users with a high purchase probability can be sent personalized, limited-time offers, while customers showing signs of declining activity can be offered loyalty programs, bonuses, or special partnership terms.

Recommendation systems integrated into email marketing have become widespread. Their purpose is to automatically select the most relevant products or services immediately before sending an email. Unlike static recommendations, intelligent algorithms analyze the user's current interests in real time.

For example, if a customer recently viewed a specific product category but didn't complete their order, the system can automatically include those products in the email. Additionally, related products, similar items, or personalized discounts based on their purchase history can be offered.

Intelligent frequency optimization has a significant impact on email marketing effectiveness. One of the most common reasons for users unsubscribing is receiving too many messages.

Using machine learning algorithms, the system analyzes each customer's response to previous emails and determines the optimal communication frequency for each individual. Highly active subscribers can receive messages more frequently, while less engaged subscribers automatically receive fewer emails. This reduces unsubscribe rates and improves customer satisfaction.

A key element of modern intelligent platforms is automated A/B testing. The traditional approach involves sequentially comparing several email variants based on one or more performance metrics. However, with a large number of parameters to test, conducting such experiments is time-consuming. Artificial intelligence algorithms can simultaneously analyze the effectiveness of various email subject lines, text structure, visual design, images, call-to-action buttons, and sending time. Based on these preliminary results, the system automatically reallocates the email volume to the most successful options, ensuring maximum marketing campaign effectiveness.

Depending on the identified reasons for the decline in activity, users may be offered personalized discounts, bonus programs, individualized recommendations, or modified mailing parameters. This approach significantly increases customer retention rates and enhances their lifetime value [7].

The practical effectiveness of artificial intelligence also manifests itself in the automation of customer lifecycle management. Intelligent systems automatically determine the user's stage of interaction with the company and generate a corresponding sequence of emails. Welcome series of messages are created for new subscribers, information chains for potential buyers, loyalty programs for regular customers, and re-engagement campaigns for users who have lost their activity.

The integrated use of these technologies can significantly improve key email marketing performance indicators. According to modern research, the implementation of artificial intelligence can increase email open rates, improve click-through rates, enhance conversion rates, reduce unsubscribe rates, and boost return on investment in marketing campaigns.

Table 2 - Main areas of application of artificial intelligence in email marketing and expected results

Direction of AI application	Practical result
Intelligent customer segmentation	Improving the relevance of marketing messages
Predictive Analytics	Predicting Purchase Likelihood and Customer Retention
Automatic selection of sending time	Increased email open rates
Generating personalized content	Increasing user engagement
Recommendation algorithms	Increase in average order value and conversion rate
Automated A/B testing	Optimize marketing campaigns and increase ROI

The practical application of artificial intelligence technologies covers various stages of email campaign preparation and execution. The main areas of application of intelligent algorithms and the expected results are presented in Table 2.

Assessing the effectiveness of implementing artificial intelligence technologies in email marketing. Assessing the effectiveness of implementing artificial intelligence and machine learning technologies is a key step in managing modern email marketing systems. The use of intelligent algorithms requires significant investment in software, information system integration, data preparation, and staff training. Therefore, developing a comprehensive metrics system that allows for an objective assessment of the results of using artificial intelligence technologies and determining their impact on the effectiveness of an organization's marketing activities is particularly important.

Traditionally, email marketing effectiveness is assessed using a system of key performance indicators (KPIs). The most common include delivery rate, open rate, click-through rate (CTR), conversion rate, unsubscribe rate, spam compliance rate, return on investment (ROI), and customer lifetime value (CLV). However, the use of artificial intelligence significantly expands the capabilities of marketing communications effectiveness analysis, allowing one to consider not only the final results but also the quality of the system's decisions.

One of the most important metrics is the email open rate, which characterizes the proportion of users who open the message they receive. This metric is influenced by various factors, including the quality of the email subject line, sender reputation, sending time, and the level of personalization of the content. Using artificial intelligence algorithms, we can automatically optimize these parameters, thereby increasing the likelihood that each user will open the message.

An equally important metric is the click-through rate (CTR), which reflects the proportion of users who clicked on links contained in an email. An increase in this metric indicates increased relevance of the message content and the effectiveness of the recommendations used. Machine learning algorithms can analyze user preferences and automatically generate personalized offers, which helps increase audience engagement.

Conversion rate, which measures the proportion of users who complete a target action after interacting with an email, holds a special place. Depending on the marketing campaign's goals, these actions may include placing an order, registering on a website, downloading a mobile app, filling out a contact form, or subscribing to additional services. Modern artificial intelligence systems predict conversion probability even before sending an email, allowing you to identify the most promising recipients in advance and optimize the allocation of marketing resources.

Return on investment (ROI) remains one of the most important economic metrics. This indicator characterizes the ratio of profit earned to the costs associated with a marketing campaign. The use of artificial intelligence allows for simultaneous revenue growth through increased conversion rates and cost reduction through automated content preparation, intelligent email management, and the reduction of ineffective communications. This results in a significant increase in the overall economic efficiency of marketing activities.

Modern intelligent platforms allow for the analysis of not only traditional metrics but also the performance of machine learning algorithms themselves. Specific metrics widely used in artificial intelligence are used to evaluate the effectiveness of forecasting models.

When solving classification problems, such as predicting email open rates or purchase probabilities, the following metrics are used: Accuracy, Precision, Recall, and F1-score. Accuracy reflects the overall

proportion of correctly classified observations. Precision characterizes the accuracy of positive predictions, while Recall measures the model's ability to detect all true positive cases. The F1-score, which combines Precision and Recall into a single criterion for evaluating the model's performance, is an integral performance metric.

When predicting the probability of various events, the area under the receiver operating characteristic (AUC-ROC) metric is widely used. The closer this metric's value is to one, the greater the model's ability to correctly distinguish between users with a high and low probability of performing a target action.

To assess the accuracy of quantitative forecasting, the mean absolute error (MAE), mean squared error (MSE), and root mean squared error (RMSE) are used. These metrics allow us to determine the degree to which predicted values deviate from the actual results of marketing campaigns.

An important area of effectiveness assessment is analyzing the level of personalization. Recent research shows that increasing the degree of personalization in email content has a positive impact on virtually all key email marketing metrics. However, excessive personalization can be perceived by users as a violation of privacy. Therefore, the effectiveness of intelligent systems should be assessed not only in terms of increased marketing metrics but also in terms of customer satisfaction with the quality of interaction.

Experimental analysis methods are widely used to objectively evaluate the results of implementing artificial intelligence technologies. The most common method involves conducting controlled experiments in which one group of users receives emails generated using traditional methods, while another receives personalized messages generated using artificial intelligence algorithms. Comparing the results allows us to determine the statistically significant impact of intelligent technologies on the effectiveness of marketing communications.

Despite the obvious advantages of using intelligent technologies, the implementation of artificial intelligence comes with certain risks. One of the main limitations is the dependence of forecast quality on the completeness and reliability of the source data. Errors in data collection, omissions, outdated data, or unbalanced training samples can significantly reduce the effectiveness of machine learning algorithms.

A key factor in the successful implementation of artificial intelligence is ensuring compliance with legal requirements regarding personal data protection. Machine learning technologies require the processing of significant amounts of user information, which requires adherence to principles of legality, transparency, and data security.

Prospects for the Development of Artificial Intelligence Technologies in Email Marketing The rapid advancement of artificial intelligence and machine learning technologies is driving the further transformation of email marketing and the emergence of new models for how organizations interact with consumers. In the coming years, we expect a shift from automated email marketing systems to intelligent platforms capable of making autonomous marketing decisions based on analyzing large volumes of data, predicting user behavior, and continuous learning. As a result, email marketing will increasingly integrate into the enterprise's digital ecosystem, ensuring personalized customer interactions throughout the entire lifecycle [8].

One of the most promising trends is the further development of generative artificial intelligence. Modern large-scale language models are already capable of creating high-quality marketing texts, but

their functionality is expected to expand significantly in the future. Generative algorithms will automatically develop complex email campaigns, structure emails, select visual elements, create personalized offers, and tailor message content to each user's needs.

Unlike today's template-based email campaigns, advanced intelligent systems will be able to create completely unique content in real time [9]. For example, if a user has repeatedly viewed certain product categories, the system will generate an email tailored exclusively to their current interests, including personalized text, images, recommendations, discounts, and customized calls to action. This level of personalization will significantly increase audience engagement and the effectiveness of marketing communications.

The next development direction will be the implementation of hyper-personalization technologies. While traditional personalization is based primarily on purchase history and customer demographics, hyper-personalization involves the use of a much broader range of data. Intelligent algorithms will consider user behavioral characteristics, interaction context, current location, seasonal factors, preferred communication channels, social media activity, customer support history, and many other parameters.

By integrating data from various sources, intelligent platforms will be able to generate highly relevant offers in near real-time. This will significantly improve the user experience and increase the likelihood of achieving marketing goals.

Next-generation predictive analytics will play a key role in the development of email marketing. Modern algorithms can already predict the likelihood of an email being opened or a purchase being made. However, further refinement of machine learning models will enable forecasting much more complex aspects of user behavior, including changes in consumer preferences, the likelihood of long-term loyalty, the potential lifetime value of a customer, and the likelihood of switching to competitors. Based on such forecasts, intelligent systems will be able to automatically generate individualized engagement strategies for each user, choosing not only the content of the email, but also the communication sequence, optimal sending frequency, and the most effective marketing offers.

A promising direction is the use of autonomous marketing technologies. In this model, artificial intelligence will independently analyze the results of previous campaigns, identify the causes of performance fluctuations, adjust communications strategies, and launch new marketing scenarios without the direct involvement of specialists. The role of the marketer will gradually shift from routine operations to monitoring the operation of intelligent systems, setting strategic goals, and evaluating their performance.

The integration of email marketing with omnichannel communications is becoming a key trend. Consumers today interact with organizations simultaneously through email, mobile apps, social media, messaging, websites, and offline channels. Artificial intelligence (AI) enables the unification of information from all touchpoints, creating a unified user profile and aligning communications across multiple channels.

For example, if a user ignores an email but is active in a mobile app, the intelligent system can automatically adjust the next interaction by sending a personalized push notification or offering special offers through another communication channel. This approach ensures continuous communication and improves the overall effectiveness of the marketing strategy.

As artificial intelligence capabilities expand, the importance of information security and personal data protection is growing. Modern intelligent systems process large volumes of confidential information,

requiring compliance with international standards in cybersecurity, algorithmic transparency, and the ethical use of user data. Going forward, particular attention will be paid to the development of explainable AI technologies, which enable the interpretation of the reasons behind algorithmic decisions and increase user trust in intelligent systems.

Another promising area is the use of federated machine learning technologies. Unlike traditional approaches that rely on centralized data storage, federated learning allows models to be trained directly on users' devices without transmitting personal information to a central server. This technology enhances privacy and reduces the risk of personal data leakage.

Improvements in technologies for analyzing users' emotional states will have a significant impact on the development of email marketing. Modern natural language processing algorithms can identify the emotional content of texts and account for communication characteristics. In the future, intelligent systems will be able to tailor email content based on the recipient's predicted emotional state, making interactions more natural and effective.

Despite significant development prospects, the widespread adoption of artificial intelligence faces a number of challenges. These include the need to ensure high-quality source data, prevent algorithmic bias, comply with privacy laws, increase the transparency of machine learning models, and train specialists with competencies in data analysis and intelligent technologies [10].

The study found that artificial intelligence and machine learning technologies are having a significant impact on the development of modern email marketing, enabling a shift from traditional mass mailings to intelligent, personalized communications. An analysis of the historical evolution of email marketing revealed that the increasing volume of digital data, the development of computing technologies, and the refinement of data analysis methods have become the primary drivers for the implementation of intelligent algorithms in organizational marketing.

A study of the theoretical foundations of artificial intelligence applications has identified key areas for using machine learning in email marketing, including intelligent customer segmentation, email content personalization, predictive analytics, recommendation systems, automated message timing, and the use of generative artificial intelligence to create marketing content. It has been established that the integrated use of these technologies significantly improves the quality of customer interactions and the effectiveness of digital communications.

This paper examines practical mechanisms for implementing artificial intelligence in email marketing management processes. It has been determined that the use of intelligent algorithms helps increase email open rates, click-through rates, conversion rates, customer retention, and return on investment in marketing campaigns. At the same time, a significant portion of routine operations are automated, reducing the time and cost of marketing activities for organizations.

An analysis of performance evaluation methods revealed that the effectiveness of artificial intelligence implementation should be determined using a comprehensive system of indicators, including both traditional marketing metrics and specific indicators of the quality of machine learning models. This approach ensures an objective assessment of the effectiveness of intelligent technologies and enables timely adjustments to digital marketing strategies.

A study of development prospects revealed that the further evolution of email marketing will be driven by the expansion of generative artificial intelligence capabilities, the development of hyper-personalization, autonomous marketing systems, multimodal models, omnichannel communications, and explainable artificial intelligence technologies. However, successful implementation of these

technologies requires addressing issues of information security, personal data protection, algorithmic transparency, and the training of qualified specialists.

The practical significance of this study lies in the potential application of the presented theoretical principles and practical recommendations in the development and improvement of corporate email marketing systems based on artificial intelligence and machine learning technologies. The proposed approaches can be used by organizations across various industries to improve the effectiveness of marketing communications, optimize customer interactions, and enhance business competitiveness in the context of digital transformation.

References

1. Khachatryan Karine Surenovna, Ponomareva Svetlana Vasilievna, Koryushov Nikolay Vladimirovich Artificial Intelligence in Marketing as a New Concept and Business Opportunity for Improving the Efficiency of Companies // Bulletin of Eurasian Science. 2023. No. 3. URL: <https://cyberleninka.ru/article/n/iskusstvennyy-intellekt-v-marketinge-kak-novaya-kontseptsiya-i-biznes-vozmozhnost-dlya-povysheniya-effektivnosti-kompaniy>
2. Rosário, A. Industry 4.0 and Marketing: Towards an Integrated Future Research Agenda / Rosário A., Dias J. DOI <https://doi.org/10.3390/jsan11030030> // Journal of Sensor and Actuator Networks. - 2022. - No. 11. - P. 1–20. URL: <https://www.mdpi.com/2224-2708/11/3/30>
3. Shaily, S. Integration of Artificial Intelligence Marketing to Get Brand Recognition for Social Business / Shaily S., Emma N. DOI 10.32479/irmm.11542 // International Review of Management and Marketing. — 2021. — No. 11. — P. 29–37. URL: <https://econjournals.com/index.php/irmm/article/view/11542>
5. Huang, M.-H. A strategic framework for artificial intelligence in marketing / Huang M.-H., Rust RT DOI <https://doi.org/10.1007/s11747-020-00749-9> // Journal of the Academy of Marketing Science. - 2021. - No. 49. - P. 30–50. URL: <https://link.springer.com/article/10.1007/s11747-020-00749-9#citeas>
6. Huang, M.-H. A Framework for Collaborative Artificial Intelligence in Marketing / Huang M.-H., Rust RT DOI <https://doi.org/10.1016/j.jretai.2021.03.001> // Journal of Retailing. - 2021. - No. 2. - P. 209–223. URL: <https://www.sciencedirect.com/science/article/abs/pii/S0022435921000142>
7. Savich, A.A. Machine learning as a tool for automating business processes / A.A. Savich, A.S. Kravchuk. — DOI 10.24412/9215-0365-2021-75-4-29-33 // The Scientific Heritage. — 2021. — No. 75-4(75). — P. 29–33. URL: <http://www.scientific-heritage.com/wp-content/uploads/2021/02/VOL-3-No-60-60-2021.pdf>
8. Tyurina, A.G. Big data in small business / A.G. Tyurina. - DOI 10.46554/ScienceXXI-2022.03-1.2-pp.173 // Science of the XXI century: current directions of development. - 2022. - No. 1-2. - P. 173-176. URL: <http://si.sseu.ru/sites/default/files/2016/04/zaoch.k.ch.1.pdf>
9. Chen, H. Development Countermeasures of Business Management Informatization Based on Machine Learning Algorithm / Chen H. DOI <https://doi.org/10.1155/2022/9108656> // Mobile Information Systems. - 2022. - No. 2022. - P. 1–11. URL: <https://www.hindawi.com/journals/misy/2022/9108656/>
10. Chirkina I. INFLUENCE OF ARTIFICIAL INTELLIGENCE TECHNOLOGIES ON MODERN METHODS IN MARKETING // Science Bulletin. 2024. No. 3 (72). URL: <https://cyberleninka.ru/article/n/vliyanie-tehnologiy-iskusstvennogo-intellekta-na-sovremennyye-metody-v-marketinge>