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PREDICTIVE ANALYTICS AND MARKETING MANAGEMENT: IMPLEMENTING BUSINESS STRATEGIES THROUGH INTELLIGENT MODELS

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INTRODUCTION. In today's digital economy and highly competitive market conditions, companies are faced with the need to quickly adapt to changes in consumer behavior, market trends, and technological trends. In these conditions, marketing management ceases to be an exclusively intuitive art and is transformed into a systematic activity based on data analysis, customer behavior prediction, and customer interaction management based on objective patterns.

One of the key tools that allows for such a transformation is predictive analytics, which provides companies with the ability to proactively make decisions aimed at meeting customer needs, optimizing resources, and creating sustainable competitive advantages.

The relevance of combining predictive analytics and marketing management is due to the need to increase the accuracy of demand forecasts, adapt marketing strategies to market changes and personalize communications with consumers, which in turn helps to strengthen the positions of enterprises in the market and form long-term relationships with customers. The use of intelligent models, such as decision trees, allows you to structure data, highlight key factors that influence consumer behavior, and create understandable and practically applicable predictive models that are the basis for effective management of marketing processes.

THE HYPOTHESIS OF THE STUDY is to apply predictive analytics tools in marketing management, in the practical sphere of business, despite the existing challenges associated with the lack of readiness of enterprises for digital transformation, limited data, lack of competencies in the field of analytics, as well as the need to ensure the ethical and lawful use of personal data. Substantiation of theoretical and applied aspects of integrating predictive analytics into business marketing management with an emphasis on the use of intelligent models, in particular decision trees, to improve the effectiveness of management decisions, personalize interaction with customers and form sustainable competitive advantages in the activities of enterprises. Achieving this goal requires studying the essence and role of marketing management in modern business, analyzing tools and methods of predictive analytics, as well as assessing the opportunities and challenges of integrating intelligent models into the marketing activities of enterprises.

PURPOSE OF THE STUDY of predictive analytics tools in marketing management for business efficiency and competitiveness

METHODS GENERAL scientific and special analytical methods: analysis, synthesis, generalization Decision tree method, which is based on determining the criteria for splitting data to maximize information gain or minimize entropy, which allows identifying significant factors that influence consumer behavior or the results of marketing campaigns. In business analytics, a decision tree is used to predict the probability of purchase, customer churn, response to marketing offers, and optimize communication strategies. Its advantage is not only the ability to work with large amounts of data, but also the ease of explaining management results to make informed management decisions (Basu et al., 2023).

The integration of predictive analytics into marketing management creates the prerequisites for the formation of intelligent marketing strategies based on data and allowing to achieve high accuracy in forecasts, increase the level of personalization of communications, adapt offers to the needs of individual consumer segments, and promptly respond to changes in the market environment. This transforms marketing activities from a cost function into a strategic asset that ensures sustainable business development and forms long-term consumer loyalty.

These factors require comprehensive scientific analysis, the development of methodological recommendations for the effective integration of analytical tools into the marketing activities of enterprises, and the assessment of the economic feasibility of introducing such tools into management practice.

RESULTS. Marketing management in modern business is a set of processes for planning, implementing, controlling and correcting marketing actions of an enterprise aimed at creating and maintaining competitive advantages, satisfying consumer needs and achieving the strategic goals of the organization. It covers the management of product policy, pricing, promotion, distribution and communications with target markets, based on a systematic analysis of the market and consumer behavior (Aghazadeh, 2015).

In modern conditions of digitalization, marketing management is moving from intuitive decision-making to data-driven management, where predictive analytics plays a key role. (Chaffey & Ellis-Chadwick, 2019). (Golub, 2024). Predictive analytics is a methodology that uses statistical algorithms, machine learning, and big data analysis techniques to predict future events based on historical data and behavioral patterns (Müller et al., 2016). The essence of predictive analytics is to identify hidden patterns in data sets, which allows building predictive models to predict customer behavior, demand volumes, marketing campaign effectiveness, and enterprise resource optimization (Adekunle et al., 2021). In marketing management, predictive analytics is used to solve tasks such as segmenting customers based on behavioral characteristics, predicting customer churn, generating personalized offers, determining the optimal time for communications, planning inventory and resources, and evaluating the effectiveness of marketing activities in real time (Basu et al., 2023). This allows you to ensure the flexibility of the marketing strategy, increase its adaptability to changes in the external environment and achieve strategic business goals in conditions of high market competition. (Wedel & Kannan, 2016) (Davenport & Harris, 2017).

Among the tools of predictive analytics, a special place is occupied by the decision tree method, which is widely used in business analytics due to its interpretability and effectiveness in solving classification and forecasting problems. A decision tree is an algorithmic model that allows you to divide data into subsets based on the values of certain attributes, creating a visual structure where nodes reflect conditions, and branches – the results of checking these conditions (Lee et al., 2022).

CONCLUSIONS. Analysis of the theoretical foundations of the integration of predictive analytics into marketing management allows us to draw conclusions that modern enterprises are moving from intuitive decision-making to the systematic use of data as a strategic resource for forming effective marketing decisions. Predictive analytics, based on the analysis of large volumes of structured and unstructured data, allows you to build predictive models that increase the accuracy of planning and adaptability of marketing strategies to changes in consumer behavior and market dynamics.

The decision tree method, as one of the leading tools of predictive business analytics, provides visual interpretation of data and allows you to identify key factors that affect the effectiveness of marketing activities, increasing the accuracy of forecasts and facilitating the process of making management decisions. The use of predictive analytics in marketing management contributes not only to increasing the effectiveness of advertising campaigns, but also to optimizing the use of enterprise resources, creating conditions for creating personalized communications with consumers and developing long-term relationships with them.

The integration of predictive analytics into marketing management is a strategic necessity for modern business, which seeks to achieve sustainable competitive advantages and ensure adaptability in an environment of high market turbulence. Based on these theoretical provisions, there is a need to study intellectual models, in particular decision trees, as tools for implementing marketing strategies in the practice of enterprises.

KEYWORDS: business; business analytics; decision tree; business efficiency; predictive analytics; management; marketing management.

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ПРЕДИКТИВНА АНАЛІТИКА ТА МАРКЕТИНГОВЕ УПРАВЛІННЯ: РЕАЛІЗАЦІЯ БІЗНЕС-СТРАТЕГІЙ ЧЕРЕЗ ІНТЕЛЕКТУАЛЬНІ МОДЕЛІ

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ВСТУП. У сучасних умовах розвитку цифрової економіки та високої ринкової конкуренції підприємства стикаються з необхідністю швидко адаптуватися до змін у поведінці споживачів, ринкових тенденцій та технологічних трендів. У цих умовах маркетингове управління перестає бути виключно інтуїтивним мистецтвом і трансформується у системну діяльність, що базується на аналізі даних, прогнозуванні поведінки клієнтів та управлінні взаємодією зі споживачами на основі об'єктивних закономірностей. Одним із ключових інструментів, що дозволяє здійснювати таку трансформацію, є предиктивна аналітика, яка забезпечує підприємства можливістю проактивного ухвалення рішень, спрямованих на задоволення потреб клієнтів, оптимізацію ресурсів та формування сталих конкурентних переваг. Актуальність поєднання предиктивної аналітики та маркетингового управління зумовлена потребою підвищення точності прогнозів попиту, адаптації маркетингових стратегій до змін ринку та персоналізації комунікацій зі споживачами, що у свою чергу сприяє зміцненню позицій підприємств на ринку та формуванню довгострокових відносин із клієнтами. Використання інтелектуальних моделей, таких як дерева рішень, дозволяє структурувати дані, виділяти ключові фактори, що впливають на поведінку споживачів, та створювати зрозумілі та практично застосовні прогностичні моделі, які є основою для ефективного управління маркетинговими процесами.

ГІПОТЕЗА ДОСЛІДЖЕННЯ полягає у застосуванні інструментарію предиктивної аналітики у маркетинговому управлінні, в практичній площині бізнесу попри існуючі виклики, пов'язані з недостатньою готовністю підприємств до цифрової трансформації, обмеженістю даних, браком компетенцій у сфері аналітики, а також необхідністю забезпечення етичного та правомірного використання персональних даних. Обґрунтування теоретичних і прикладних аспектів інтеграції предиктивної аналітики у маркетингове управління бізнесом з акцентом на використанні інтелектуальних моделей, зокрема дерева рішень, для підвищення ефективності управлінських рішень, персоналізації взаємодії з клієнтами та формування сталих конкурентних переваг у діяльності підприємств. Досягнення цієї мети потребує дослідження сутності та ролі маркетингового управління у сучасному бізнесі, аналізу інструментів і методів предиктивної аналітики, а також оцінки можливостей і викликів інтеграції інтелектуальних моделей у маркетингову діяльність підприємств.

МЕТА ДОСЛІДЖЕННЯ інструментарію предиктивної аналітики в маркетинговому управління для ефективності та кокурентоспроможності бізнесу

МЕТОДИ. Загальнонаукові та спеціальні аналітичні методи: аналізу, синтезу, узагальнення Метод дерева рішень, який базується на визначенні критеріїв розбиття даних для максимізації інформаційного приросту або мінімізації ентропії, що дозволяє виявляти значущі фактори, які впливають на поведінку споживачів чи результати маркетингових кампаній. У бізнес-аналітиці дерево рішень використовується для прогнозування ймовірності покупки, відтоку клієнтів, реакції на маркетингові пропозиції та оптимізації комунікаційних стратегій. Його перевагою є не лише здатність працювати з великими обсягами даних, а й легкість у поясненні результатів менеджменту для ухвалення обґрунтованих управлінських рішень (Basu et al., 2023).

Інтеграція предиктивної аналітики у маркетингове управління створює передумови для формування інтелектуальних маркетингових стратегій, що ґрунтуються на даних і дозволяють досягати високої точності у прогнозах, підвищувати рівень персоналізації комунікацій, адаптувати пропозиції під потреби окремих сегментів споживачів та оперативно реагувати на зміни у ринковому середовищі. Це перетворює маркетингову

діяльність із витратної функції на стратегічний актив, що забезпечує сталий розвиток бізнесу та формує довгострокову лояльність споживачів.

Ці фактори потребують комплексного наукового аналізу, розробки методичних рекомендацій для ефективної інтеграції аналітичних інструментів у маркетингову діяльність підприємств та оцінки економічної доцільності впровадження таких інструментів у практику управління.

РЕЗУЛЬТАТИ. Маркетингове управління у сучасному бізнесі виступає комплексом процесів планування, реалізації, контролю та корекції маркетингових дій підприємства, спрямованих на створення та підтримання конкурентних переваг, задоволення потреб споживачів і досягнення стратегічних цілей організації. Воно охоплює управління товарною політикою, ціноутворенням, просуванням, розподілом та комунікаціями з цільовими ринками, ґрунтуючись на системному аналізі ринку та поведінки споживачів (Aghazadeh, 2015).

У сучасних умовах цифровізації маркетингове управління переходить від інтуїтивного ухвалення рішень до управління на основі даних, де ключову роль відіграє предиктивна аналітика. (Chaffey & Ellis-Chadwick, 2019). (Golub, 2024). Предиктивна аналітика – це методологія використання статистичних алгоритмів, машинного навчання та методів аналізу великих даних для прогнозування майбутніх подій на основі історичних даних та поведінкових патернів (Müller et al., 2016). Сутність предиктивної аналітики полягає у виявленні прихованих закономірностей у масивах даних, що дозволяє будувати прогностичні моделі для передбачення поведінки клієнтів, обсягів попиту, ефективності маркетингових кампаній та оптимізації ресурсів підприємства (Adekunle et al., 2021).

У маркетинговому управлінні предиктивна аналітика використовується для вирішення таких завдань, як сегментація клієнтів на основі поведінкових характеристик, прогнозування відтоку клієнтів, формування персоналізованих пропозицій, визначення оптимального часу для комунікацій, планування товарних запасів та ресурсів, а також оцінювання ефективності маркетингових заходів у режимі реального часу (Basu et al., 2023). Це дозволяє забезпечити гнучкість маркетингової стратегії, підвищити її адаптивність до змін у зовнішньому середовищі та досягати стратегічних бізнес-цілей за умов високої ринкової конкуренції. (Wedel & Kannan, 2016) (Davenport & Harris, 2017).

Серед інструментів предиктивної аналітики особливе місце займає метод дерева рішень, який широко застосовується у бізнес-аналітиці завдяки своїй інтерпретованості та ефективності у вирішенні завдань класифікації та прогнозування. Дерево рішень – це алгоритмічна модель, що дозволяє розділяти дані на підмножини на основі значень певних атрибутів, створюючи наочну структуру, де вузли відображають умови, а гілки – результати перевірки цих умов (Lee et al., 2022).

ВИСНОВКИ. Аналіз теоретичних основ інтеграції предиктивної аналітики у маркетингове управління дозволяє зробити висновки, що сучасні підприємства переходять від інтуїтивного ухвалення рішень до системного використання даних як стратегічного ресурсу для формування ефективних маркетингових рішень. Предиктивна аналітика, ґрунтуючись на аналізі великих обсягів структурованих та неструктурованих даних, дозволяє будувати прогностичні моделі, які підвищують точність планування та адаптивність маркетингових стратегій до змін у поведінці споживачів та динаміки ринку.

Метод дерева рішень, як один із провідних інструментів предиктивної бізнес-аналітики, забезпечує візуальну інтерпретацію даних та дозволяє виявляти ключові фактори, що впливають на ефективність маркетингових заходів, підвищуючи точність прогнозів та полегшуючи процес ухвалення управлінських рішень. Використання предиктивної аналітики у маркетинговому управлінні сприяє не лише підвищенню ефективності рекламних кампаній, а й оптимізації використання ресурсів підприємства, формуючи умови для створення персоналізованих комунікацій зі споживачами та розвитку довгострокових відносин із ними.

Інтеграція предиктивної аналітики в маркетингове управління є стратегічною необхідністю для сучасного бізнесу, який прагне досягти сталих конкурентних переваг та забезпечити адаптивність у середовищі високої ринкової турбулентності. На основі цих теоретичних положень постає потреба у дослідженні інтелектуальних моделей, зокрема дерева рішень, як інструментів реалізації маркетингових стратегій у практиці підприємств.

КЛЮЧОВІ СЛОВА: бізнес; бізнес-аналітика; дерево рішень; ефективність бізнесу; предиктивна аналітика; управління; маркетингове управління.

Statement of the problem and its relation to important scientific and practical tasks. Personalization of marketing communications is one of the most important areas of modern marketing management, allowing to create value for customers through individualized approaches in interaction (Fuchs & Schreier, 2011). The use of predictive analytics in this process makes it possible to predict consumer behavioral patterns, taking into account their purchase history, transaction frequency, reaction to previous marketing campaigns, feedback and interaction with digital channels.

The purpose of the study is a study of predictive analytics as a tool for effective marketing management in a business environment.

Analysis of recent publications on the problem. Scientific studies show that companies that implement personalized strategies can increase conversion by 18–25% by increasing the relevance of communications and reducing advertising costs through precise targeting (Basu et al., 2023; Popko & Filatov, 2023).

Intelligent models based on decision trees as a tool for implementing marketing strategies.

A decision tree is one of the most effective and intuitive predictive analytics tools that is actively used in marketing management. The decision tree construction method is based on the recursive division of a data set into subsets according to the values of certain attributes. Each node of the tree represents a check of a certain feature, and each branch reflects the result of this check. The leaves of the tree contain predictions or decisions based on the analysis of selected features (Lee et al., 2022).

The algorithm for constructing a decision tree can be summarized as follows:

1. Select the attribute that best separates the original data set based on some criterion (e.g., information gain or Gini index).
2. Create a decision node that partitions the data set by the selected attribute.
3. Repeat the process recursively for each created subset of data until the algorithm's termination condition is met (e.g., reaching a given tree depth or minimum node size).

One of the most common criteria for selecting the optimal attribute for partitioning is the Information Gain, which is calculated by the formula:

$$IG(T,a) = H(T) - \sum_{v \in Values(a)} \frac{|Tv|}{|T|} * H(Tv), \quad (1)$$

where:

IG(T, a) – information gain of the data set T by attribute a;

H(T) – entropy of the original data set T;

T_v – a subset of data containing the value v of attribute a;• $|T_v|$, $|T|$ – кількість елементів у відповідних множинах;

$H(T_v)$ – entropy of the subset T_v.

The advantages of using decision trees in marketing tasks include the following aspects (Lee et al., 2022):

• Interpretation: Decision trees are easily visualized and understandable even to specialists without deep knowledge of statistics.

• Versatility: Work with numerical and categorical data.

• Speed of work: Quickly generate predictions, which allows you to quickly make management decisions.

• Undemanding to preliminary data preparation: Can work effectively even with partially filled or not entirely accurate data.

Practical use of decision trees for predicting customer behavior

One of the key aspects of using decision trees in marketing is predicting customer behavior. Decision trees allow you to identify key factors that influence customer decisions to purchase, switch to a competitor, or respond to marketing campaigns (Basu et al., 2023).

For example, a decision tree can be used to predict customer churn (churn prediction), where nodes reflect parameters such as purchase frequency, average check, satisfaction level, etc. Based on these parameters, the company can offer personalized incentives to retain customers in a timely manner.

Mathematically, the prediction of customer behavior using a decision tree can be described through the class probability estimate:

$$P(class \mid x) = \frac{N\_class, x}{N\_x}, \quad (2)$$

where:

P(class | x) – the probability that object x belongs to a certain class (for example, "will remain a customer" or "will go to a competitor");

N_class,x – the number of instances in a node with attributes x belonging to the class;

N_x – the total number of instances in the node with attributes x.

One successful example of the use of decision trees is Amazon, which uses decision tree algorithms to personalize product recommendations. By analyzing the purchase history, reviews, and ratings of users, Amazon predicts future purchases and offers products that best match the individual preferences of customers (Basu et al., 2023). Another successful case is presented in the study of Lee et al. (2022), where decision trees were used to predict customer responses to marketing campaigns. This allowed companies to significantly

increase the effectiveness of targeted promotions and reduce marketing costs by more accurately identifying target consumer segments.

Materials and methods. A key tool in personalization is customer segmentation, which is carried out using cluster analysis and machine learning algorithms. Clustering allows you to group customers into groups based on similar characteristics, creating deep consumer portraits for further targeted communication. In cluster analysis, the Euclidean distance formula is used to assess the similarity between customers:

$$\mathbf{d(x, y) = \sqrt{\sum(x_i - y_i)^2}}, \quad (3)$$

where:

d(x, y) – Euclidean distance between customers x and y;

x_i, y_i – parameter values for customers x and y;

n – number of indicators being analyzed (average check, purchase frequency, preferences, etc.).

Using recommendation models. In addition to segmentation, personalization uses recommendation systems based on predictive models, such as k-nearest neighbors (k-NN) and decision trees, to predict which products or services customers may be interested in in the future.

The forecast is calculated as:

$$\mathbf{P\_rec = (1/k) * \sum r_i}, \quad (4)$$

where:

P_rec – predicted product rating or purchase probability;

r_i – product rating by similar users;

k – number of nearest neighbors considered in the model.

Such systems increase the relevance of recommendations by 30–40%, which significantly increases the average check and customer satisfaction level.

Statement of the main results and rationale. Integrating personalization into your marketing strategy

Personalization is implemented through:

• targeted email campaigns;

• personalized social media advertising;

• push notifications that take into account user behavior in real time;

• dynamic content on company websites.

This allows you to achieve deep interaction with customers, stimulate repeat purchases and form an emotional connection with the brand.

Amazon uses predictive analytics and personalized recommendation systems to offer products that meet customers' interests. This allowed them to

increase sales by 29% thanks to personalized recommendations based on the analysis of purchase history, search queries and views (Basu et al., 2023).

Resource optimization and demand management is one of the central functions of marketing management in a dynamic market competition, where the accuracy of demand forecasts determines the effectiveness of the enterprise. The use of predictive analytics in this process allows not only to predict changes in consumer behavior, but also to adapt management decisions aimed at balancing production volumes, inventories and logistics operations in accordance with actual and forecasted demand (Adekunle et al., 2021). The essence of predictive forecasting in marketing management is to use historical data, including sales, seasonal fluctuations, customer behavioral patterns, macroeconomic indicators and market trends to build models that can predict future demand volumes with high accuracy. Among the most common tools used in this process are time series models, regression analysis, decision trees, neural networks and combined machine learning methods, which allow you to adapt predictive models to the specifics of the market (Lee et al., 2022; Müller et al., 2016).

The linear trend model in demand forecasting is often expressed as the equation:

$$y_t = \alpha + \beta t + \varepsilon_t, \quad (5)$$

where:

y_t – the predicted value of demand at time t;

α – a constant that determines the initial level of demand;

β – a coefficient that characterizes the average change in demand over time;

ε_t – a random error that takes into account the influence of random factors.

The use of such models allows business managers to make informed decisions regarding inventory management, allocation of financial and human resources, and planning of advertising and production campaigns. For example, in the study of Adekunle et al. (2021), the use of time series models allowed to optimize the level of product inventories by 15%, which reduced storage costs and minimized the risks of shortages during peak demand periods.

An important aspect of using predictive analytics for demand management is to take into account seasonal fluctuations and changes in consumer preferences, which often requires the implementation of flexible models with the ability to update forecasts in real time based on new data. For this, automated analytical platforms are used that allow the integration of data from CRM systems, ERP, external sources of statistics and market research, creating a

comprehensive environment for monitoring and forecasting demand (Müller et al., 2016).

In the context of marketing activities, demand management using predictive analytics also allows companies to adapt their pricing policies based on forecasted demand. This helps maximize revenue by adjusting prices during periods of high or low demand, increasing the effectiveness of promotions and marketing activities, and flexibly managing advertising budgets based on forecasted consumer activity (Aghazadeh, 2015).

A practical example of the effective use of predictive analytics is the activities of retail companies that use forecasting models to manage inventory in stores, ensuring the availability of popular products during periods of high demand and minimizing inventory during periods of low consumer activity. This not only optimizes product turnover, but also improves the experience of customers who receive the necessary product at the right time.

Using predictive models in demand management allows companies to not only increase operational efficiency, but also adapt marketing strategies in response to changes in consumer behavior, creating a sustainable competitive advantage in the market. Predictive analytics is becoming a key element of modern marketing management, ensuring effective planning and implementation of strategic and tactical decisions in the activities of enterprises.Інтелектуальні маркетингові стратегії (Intelligent Marketing Strategies, IMS) виступають інструментом досягнення сталих конкурентних переваг в умовах динамічного ринку, де швидкість змін у поведінці споживачів, технологічних трендах та конкурентному середовищі вимагає адаптивних і обґрунтованих управлінських рішень. IMS базуються на інтеграції даних, інноваційних знань та використанні предиктивної аналітики для формування стратегій, що спрямовані на створення унікальної цінності для споживачів, підвищення їх лояльності та зміцнення позицій підприємства на ринку (Aghazadeh, 2015; Kazimirova, 2024).

The essence of IMS is to use large amounts of consumer and market data to build predictive models that allow predicting customer needs, market trends, and competitor actions. This creates the prerequisites for developing marketing strategies focused on proactive demand management, adapting products and services to the needs of target segments, and developing individualized marketing campaigns that increase the effectiveness of communication with customers (Basu et al., 2023).

The key components of intelligent marketing strategies are:

• use of analytical tools (decision trees, neural networks, regression models, clusters) for market segmentation and predicting consumer behavior;

• application of machine learning algorithms to generate personalized offers;

• integration of data from CRM systems, social networks, online platforms, and other sources to form a comprehensive customer portrait;

• automation of marketing processes through analytical platforms for the prompt implementation of real-time solutions (Müller et al., 2016).

Of particular importance in the implementation of IMS is the VRIO concept, which involves assessing the resources and capabilities of the enterprise according to the following criteria:

• Value – resources must create value for customers;

• Rarity – resources must be unique;

• Imitability – resources must be difficult for competitors to copy;

• Organization – the enterprise must be able to organize the use of resources to create competitive advantages (Aghazadeh, 2015).

Intelligent marketing strategies allow:

• to implement dynamic pricing depending on the forecasted demand and consumer behavior;

• to adapt the product range depending on the trends of consumer preferences;

• to optimize advertising campaigns by directing resources to the most promising market segments;

• to increase the level of customer retention through personalized approaches and forecasting customer needs.

Aghazadeh (2015) found that companies that have implemented IMS demonstrate a 20–35% increase in marketing ROI through more effective customer engagement and cost optimization. Leading companies' experience confirms that integrating predictive analytics into marketing management allows for flexible strategies that can quickly adapt to changing market conditions and provide companies with long-term competitive advantages (Adekunle et al., 2021; Lee et al., 2022; Wamba et al., 2017)

The use of intelligent marketing strategies based on predictive analytics not only increases the effectiveness of marketing activities, but also creates conditions for the formation of sustainable competitive advantages for companies, ensuring their development in the medium and long term in highly competitive markets.

The study showed that integrating predictive analytics into marketing management opens up new opportunities for improving business process efficiency, creating personalized interactions with consumers, and building sustainable competitive advantages. The use of predictive models, including cluster analysis, k-nearest neighbors, decision trees, and time series models, allows companies to analyze large data sets to identify customer behavioral patterns, forecast demand, and optimize management decisions.

The use of personalization in marketing communications based on predictive analytics helps to increase customer satisfaction, increase conversion rates, and average check through precise targeting and relevant offers. In turn, the use of predictive models for demand management allows companies to optimize inventory levels, effectively plan production capacities and advertising campaigns, reduce costs, and avoid product shortages during peak demand periods.

Intelligent marketing strategies, based on data, analytics, and flexible forecasting models, are becoming the foundation of strategic marketing management in modern business. They allow not only to adapt the company's activities to changes in consumer behavior and market conditions, but also to create new points of contact with customers, forming long-term loyalty and increasing business profitability.

Predictive analytics in marketing management is not just a technological tool, but a strategic asset of the enterprise, ensuring its development, flexibility and competitiveness in today's conditions of high market turbulence.

The integration of predictive analytics and intelligent models, in particular decision trees, into marketing management opens up significant opportunities for increasing the efficiency of business processes, forming personalized strategies for interacting with consumers and optimizing resource provision of enterprises (Verhoef et al., 2021) The use of analytical tools allows enterprises to transition from reactive to proactive marketing management, based on forecasting customer needs, market trends and adapting the enterprise's activities in accordance with expected changes in the environment (Basu et al., 2023).

However, the implementation of predictive analytics in marketing management practice is accompanied by a number of challenges, the key ones being: lack of high-quality and structured data, limitations in the use of historical data due to the variability of consumer behavior, technical limitations in the implementation of analytical platforms, as well as insufficient staff competence in working with analytical tools and machine learning algorithms (Müller et al., 2016).

Methodological recommendations for the effective implementation of predictive analytics in marketing management include, first of all, the creation of a data collection and processing system that includes the integration of CRM systems, social networks, website analytics and external sources of statistical information. An important aspect is the training of personnel, the development of analytical competencies and the formation of cross-functional interaction between marketing, sales and IT departments to ensure a full cycle of implementation of analytical models in business processes (Adekunle et al., 2021).

One of the key areas of integrating predictive analytics into marketing is the use of decision trees, which allow you to structure data, identify key factors that influence consumer behavior, and build predictive models to predict customer churn, the effectiveness of marketing campaigns, and make data-driven management decisions (Lee et al., 2022). The use of decision trees in marketing practice allows you to increase the accuracy of forecasts, the clarity of models for management, and the effectiveness of market risk management, which helps optimize strategic and operational marketing decisions.

Among the main difficulties in implementing predictive analytics in business practice, one should highlight the insufficient level of digital transformation of business processes, which complicates the integration of data between different subsystems of the enterprise, as well as limited financial resources for the implementation of analytical platforms and big data processing algorithms (Chaffey & Ellis-Chadwick, 2019). An additional challenge is the ethical and legal aspects of using consumer personal data, which requires compliance with data protection standards and transparency in the use of information to build forecasts and personalized offers (Müller et al., 2016). The prospects for the development of marketing management based on predictive analytics are associated with the spread of artificial intelligence, machine learning and automation of analytical processes, which will allow enterprises to predict consumer behavior in real time, adapt marketing strategies and form personalized offers in accordance with customer expectations and needs (Basu et al., 2023; Brynjolfsson & McAfee, 2017). In the future, the use of predictive analytics will allow enterprises to create intelligent marketing systems that provide high flexibility, adaptability and competitiveness in a rapidly changing environment, creating conditions for sustainable business development and long-term customer loyalty (Brynjolfsson & McElheran, 2016).

The integration of predictive analytics and intelligent models into marketing management is not only a challenge that requires solving technical, organizational and ethical issues, but also opens up significant opportunities for increasing the efficiency of marketing processes, adapting to dynamic market changes and creating competitive advantages for enterprises in the modern conditions of the digital economy.

Conclusions and prospects for further research. The study substantiated the theoretical and practical principles of integrating predictive analytics into marketing management of modern enterprises with an emphasis on the use of intelligent models, in particular decision trees, as tools for implementing marketing strategies. An analysis of literary sources and modern approaches allowed us to determine that data-based marketing management allows enterprises to move from intuitive decision-making to systematic management,

supported by analytical forecasts of consumer behavior, demand, and the effectiveness of marketing activities.

The use of predictive analytics in marketing management contributes to increasing the accuracy of forecasting, optimizing enterprise resources, forming personalized offers for customers, and increasing the effectiveness of marketing communications. The use of a decision tree allows you to structure data, identify key factors that influence consumer behavior, and create visually understandable models for making informed management decisions. As a result, enterprises are able to proactively manage marketing activities, ensuring adaptability to changes in the market environment.

The practical significance of the research is to identify opportunities for using predictive analytics to improve the effectiveness of management decisions in marketing activities, in particular in such areas as personalization of marketing communications, demand management, optimization of advertising budgets and the formation of intelligent marketing strategies. The use of decision tree models in this context allows enterprises not only to increase the accuracy of forecasts, but also to provide a clear interpretation of the results, which is important for the implementation of intelligent decision-making support systems in marketing activities.

The results of the research can be used in the practical activities of enterprises in various industries to improve the effectiveness of marketing management, as well as in the educational process when training specialists in marketing, analytics and business management.

For further research, it is advisable to in-depth study the use of combined predictive analytics models (neural networks, ensemble methods) in marketing practice, analyze the cost-effectiveness of implementing predictive analytics in small and medium-sized enterprises, as well as study the impact of implementing intelligent marketing management systems on the level of consumer satisfaction and loyalty. In addition, it is promising to study the ethical and legal aspects of using personal data in predictive analytics to ensure the safe and ethical use of data in marketing activities.

Thus, predictive analytics and intelligent models, in particular decision trees, are important tools for the development of marketing management in modern business, contributing to the creation of additional value for customers, increasing the competitiveness of enterprises and ensuring their sustainable development in a highly competitive market environment.

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