**Factors shaping consumer behavior in e-commerce**

**Abstract.** Modern consumer behavior management concepts are based on traditional methods and tools, such as advertising, merchandising, and shopping programs, and innovative techniques based on digital communications and e-commerce. Currently, many technologies are aimed at analyzing consumer behavior to systematize and manage it. In this regard, the issues of building multidimensional consumer models are highly relevant to various sectors of the economy since the digitalization process affects virtually all areas of economic activity. The scientific article aimed to consider the features of building a multidimensional model for managing consumer behavior in retail markets. The chosen goal of the study also predetermines the scientific significance of the work; the study of consumer behavior from a scientific point of view can contribute to the systematization of consumer analysis tools and increase its effectiveness. The practical significance of the scientific article lies in the comparative analysis of the applied modeling algorithms for predicting consumer behavior, as well as identifying their positive and negative sides. Based on the methods of study, synthesis, and analogy, proposals were formed to optimize the consumer behavior management system, which can be used in the practical activities of trading companies and enterprises of other types of exercise, considering the adaptation of the consumer profile to this area. The proposed optimization option may be relevant for marketers and business owners when planning the analysis of the consumer environment and optimizing strategies to meet the changing needs and preferences of digital consumers in the context of digitalization.

Effective management of consumer behavior is one of the fundamental goals for various areas of economic activity and represents a set of all techniques and mechanisms of marketing technologies. In today's environment, consumer behavior management is critical to business as it provides insight into consumers' needs, preferences, and decision-making processes. By understanding consumer behavior, companies can tailor their marketing strategies, product offerings, and customer experiences to meet consumer expectations effectively.

Managing consumer behavior allows companies to anticipate and adapt to changing market trends to stay ahead of the competition. This helps improve customer satisfaction and build strong customer relationships, increasing customer loyalty and advocacy. Ultimately, managing consumer behavior allows companies to make data-driven decisions, optimize resources, and achieve long-term success in the market [9; 10].

The conditions described above and the opinions of modern experts confirm the need to search for innovative approaches to working with the system to manage the population's consumer power. At the same time, the issue of revising approaches to managing consumer behavior is essential for enterprises in Kazakhstan, which determines the relevance of considering the chosen topic.

Modern marketing technologies and their research go beyond simple tools for sales or economic development of an enterprise. Along with this, they embody the search process, which has transformed thanks to innovative technologies, significantly influencing the personalized characteristics of consumers [8].

On the other hand, as modern authors note, consumer behavior is the purchase of a product or receipt of a service and a historical set of data that can be stored and systematized in the digital economy. Previously, processing information about customers' needs, interests, and purchases required many employees, such as marketers and managers. However, nowadays, this function can be performed by special programs, such as chatbots or automated algorithms that model consumer behavior. It significantly reduces personnel costs and efficiently processes information about customers' needs and purchases [3].

Despite the conditions for detailed statistical processing, it is also necessary to take into account personalized factors of consumer behavior, which include:

* influence of family members;
* opinion of the reference group surrounding the buyer;
* emotional background;
* presence of motivation, etc.

Taking into account individual characteristics allows us to understand consumer behavior better, contributing to the practical adaptation of marketing strategies.

Various factors can influence the consumer's product selection process at each purchase decision stage. In addition, many of these factors can impose their own opinion on the product, which emphasizes the importance of monitoring the process of receiving reviews and objective reactions to them on the part of marketers and other company employees. To successfully manage consumer behavior on electronic commercial platforms, it is necessary to consider consumers' factors, such as professional and social status, worldview, value orientations, and interests. The use of innovative technologies can significantly facilitate the process of managing consumer behavior. However, adequately managing consumer behavior remains open and requires constant monitoring and analysis [1].

Based on the goal, the object of research was determined - modern aspects of consumer behavior in the context of constructing a multidimensional model for managing human consumer behavior.

The main research objectives:

* review of the position of various researchers in the field of marketing technologies for managing consumer behavior;
* construction of a multidimensional model of consumer behavior management;
* description of a universal algorithm for constructing a multifaceted model of consumer behavior management.

A literature review on the research topic was conducted to implement one of the research objectives. According to experts B.N. Gerasimova, K.B. Gerasimova, and V.A. Vasacheva, by considering the activities of modern advertising agencies and marketing services in consumer behavior management, it is possible to identify both positive and negative trends. Scientists considered the positive trend that modern companies strive to use innovative methods when building consumer relationships. Hostile areas include significant losses in sales levels during periods of restrictions and volatility, which indicates the presence of imperfections in modern methods of interaction with consumers and the need for their improvement [6].

Researchers such as A. Androniceanu, I. Georgescu, and J. Kinnunen note in their works the need to use personalized consumer characteristics to identify personal values and benefits of consumers [1; 2].

N.A. continues this topic. Egina, E.S. Zemskova, and other authors say that innovative marketing methods, when addressing consumers, are used within the framework of visual implementation, which is especially important during mass events. Still, gradually, they lose their significance when working remotely with consumers. Classic marketing mechanisms, such as commercials using images that evoke strong emotions in the viewer, are gradually losing their relevance and are being replaced by other technologies [4].

Modern scientists also point out that commercial companies are increasingly testing text mining, statistical theory, association analysis, and visualization, which are used to implement sentiment and user influence analysis [15].

Several experts note the importance of digitalization trends in building predictive models of consumer behavior. So, in collaboration with other researchers, S.V. Mkhitaryan confirms that e-commerce is a multidimensional process associated with the execution of other virtual tasks by the consumer. At the same time, the payment solution represents the integration and unity of consumer demand, motivation, and activity. Scientists have confirmed that analyzing network data makes it possible to identify potential connections underlying several purchases and consumer behavior and implement a forecasting function. But at the same time, it is necessary not only to analyze and synthesize the accumulated data but also to work directly with the data provided by the consumers [11].

The literature review results revealed that a significant part of the research confirms the change in the relevance of certain consumer behavior factors caused by economic digitalization. It should also be emphasized that in modern literature, great importance is given to managing consumer behavior for business. Scientists and specialists emphasize the importance of understanding the needs and preferences of consumers since these tools allow companies to use specific marketing technologies effectively. The ability to tailor marketing strategies based on consumer behavior ensures that companies successfully engage their target audience. Companies can build solid relationships and strengthen loyalty by improving the customer experience and implementing customer-centric strategies. Anticipating market trends and adapting accordingly allows companies to stay ahead of the competition. Additionally, consumer behavior management is critical in product development and innovation in overall business growth. All the factors described above confirm the importance of modeling individual consumer processes and the need to adapt modern algorithms for planning and forecasting consumer behavior, taking into account the transformation of their behavior under the influence of the digitalization of the economy.

To study the factors that directly and indirectly impact buyers' consumer behavior in the context of the digitalization of the economy, a study was conducted that used primary tools, such as questionnaires and statistical methods, to quantify the results obtained.

The survey aimed to collect data on consumer behavior in Kazakhstan by surveying 500 participants. A stratified random sampling method was used to ensure that the survey population was representative of various demographic characteristics, including age, gender, income level, and geographic location. Data was collected through personal interviews, telephone surveys, and online questionnaires, which made it possible to compare the results of face-to-face interactions and remote responses. The collected data was analyzed using statistical software to obtain information and valid conclusions about consumer behavior patterns in Kazakhstan.

The object of study: factors influencing consumers' behavior and purchasing power in the context of digitalization of the economy.

Hypothesis: in the conditions of e-commerce, consumers change the process of making a purchase, which confirms the need to build a step-by-step algorithm for modeling consumer behavior.

Methods of calculating frequency distributions and cross-tabulation were used to process the data obtained as a result of questioning a group of study participants. These data processing techniques made it possible to summarize the information obtained and identify several trends.

Based on the survey results, it was revealed that consumers in the framework of e-commerce, for some reason, can hide or distort the actual value of their expenses, purchases, and interests. Based on purchase history, which is generated automatically, it can be assumed that consumers are trying to eliminate receiving advertising through mailings and notifications.

The results confirm the importance of introducing additional algorithms when making forecasts and modeling consumer behavior [5].

The questionnaire included several questions to collect information about consumer behavior and preferences in e-commerce. The first question sought to determine the age of the respondents by providing demographic information. A total of 500 respondents, men and women aged from 23 to 45 years, took part in the survey. This age category was rated as the most active when making online purchases.

Other questions in the first block of the questionnaire concerned the propensity to make online purchases, assessed the frequency of visits to various online stores and the likelihood of making repeat purchases, and aimed to identify their behavioral characteristics in the digital environment.

The survey found that a significant portion of consumers (about 70% of respondents surveyed) reported shifting to online shopping due to the digital economy. This shift has been driven by convenience, broader product selection, and competitive prices. Additionally, the survey found that consumers actively search for product information online, with nearly 90% relying on digital sources when making purchasing decisions.

Respondents were asked a series of questions regarding their shopping habits, motivations, and experiences. Due to the digitalization of processes, the traditional purchasing frequency has changed. The survey found consumers in retail settings tend to shop more frequently than e-commerce consumers. Approximately 67% of retail shoppers visited physical stores at least once a week, while only 33% of e-commerce shoppers shopped online weekly.

The convenience of shopping was cited as a top driver for e-commerce consumers, with over 80% noting the ability to shop from anywhere at any time as a critical benefit.

Another feature of e-commerce influencing consumer habits was the wider range of products available compared to retail stores. About 63% of e-commerce consumers believe they can access a more comprehensive selection of products than physical stores.

Figure 1. Main conclusions from the survey block «Basic characteristics of consumers in e-commerce”

Note: compiled by the authors based on the research conducted

Consumer decision-making in e-commerce has also transformed. The study results showed that consumer behavior in the digital economy is characterized by greater flexibility and adaptability compared to the traditional shopping sphere. About 70% of respondents reported exploring new brands and products online, demonstrating their willingness to experiment and deviate from their established preferences.

Respondents also noted a change in return and exchange policies, with e-commerce consumers citing the convenience of easy returns and exchanges as a key benefit. Approximately 58% of e-commerce consumers said that hassle-free returns policies influenced their decision to shop online. At the same time, the factor was less significant for retail shoppers.

Another critical factor in the consumer environment in the digital economy has been the change in personalized offers. The study found that consumers are influenced by customized recommendations, with about 55% of respondents surveyed preferring personalized product suggestions based on their online behavior. However, despite these conditions, 45% of respondents noted that they often need to be more open to providing reliable information when surveying advertising and products of interest.

Figure 2. Main conclusions from the survey block «Consumer Behavior in E-Commerce»

Note: compiled by the authors based on the research conducted

The main reasons why consumers misrepresent their data when making purchases in e-commerce were identified:

* Privacy concerns: Several consumers surveyed misrepresented their data due to concerns about the privacy and security of their personal information.
* Avoidance of targeted advertising: Some consumers deliberately misrepresent themselves to avoid targeted advertising or marketing campaigns. By providing inaccurate information, they hope to limit the targeted marketing they receive in the current environment.
* Receiving more advantageous offers. A small percentage of consumers (about 15%) misrepresent themselves, such as income or purchase history, to try to qualify for discounts, promotions, or special offers. They may attempt to get better prices or exclusive offers by presenting themselves as a specific type of consumer.
* In rare cases (up to 7% of respondents), consumers misrepresent their data to take advantage of certain benefits or rewards offered by e-commerce platforms. Buyers manipulate their information to access restricted areas, promotions, or loyalty programs.
* Up to 2% of consumers also admitted to intentionally providing inaccurate information to see how it affected the personalized recommendations they received. By deliberately misrepresenting their preferences or interests, they were consumers assessing the accuracy and relevance of the recommendations they were provided.

Figure 3. Reasons for data misrepresentation by consumers

Note: compiled by the authors based on the research conducted

Based on the survey results, it is clear that e-commerce consumers may hide or misrepresent their actual spending, purchases, and interests for various reasons. Data suggests that consumers may behave in ways that avoid receiving advertising through mailings and notifications, as evidenced by the history of their automatically generated purchase records. These results highlight the importance of incorporating additional algorithms when predicting and modeling consumer behavior and support the established hypothesis. The survey identified privacy concerns and a desire to avoid targeted advertising as the top reasons consumers misrepresent their data in e-commerce transactions. Overall, the findings point to the evolving complex dynamics of consumer behavior in the digital economy and highlight the need for businesses to address privacy concerns, adapt their marketing strategies, and intensify personalization efforts to meet changing consumer expectations.

In addition, the survey results support the view that consumers are changing traditional behavior patterns in the digital economy. The survey suggests that a step-by-step algorithm for modeling consumer behavior should consider the variability of consumer choice, the influence of digital platforms, and the importance of personalized experiences. By incorporating these elements into the modeling process, businesses can better anticipate and adapt to changing consumer behavior in the digital economy. The results show that various factors, including digital platforms, online shopping, and access to information, influence consumer behavior. This suggests that step-by-step consumer behavior modeling must be adaptable and flexible to match the dynamic nature of the digital economy.

In this regard, the following recommendations can be put forward for the development of electronic platforms for commercial activities:

* take into account the interests of a wide range of stakeholders: particular emphasis on different groups of visitors (taking into account consumer preferences) and business representatives (creating favorable conditions for cooperation and cost-effective offers to attract the highest quality vendors to participate);
* the characteristics of digital behavior should segment regular customers in the field of e-commerce;
* data on the digital behavior of individual consumer segments should be used in demand planning and product purchasing.

A review of modern literature and the results of an interview confirmed the existence of a certain amount of data on consumer behavior on the Internet and their low correlation with users' interests [14]. For these reasons, when considering the algorithm for constructing a consumer behavior management model, it is necessary to evaluate the behavior when purchasing, adding to the cart, and receiving goods.

Based on the results obtained, it is necessary to introduce an updated sequence of consumer data when modeling consumer behavior.

Under the current circumstances, the updated data sequence may be a behavioral data tracking model that uses a sequence of collected behavioral data (D) consisting of user interactions (di, ti), where di denotes a specific user action, and it represents the corresponding timestamp.

The model is interpreted as follows:

D = [(d1, t1), (d2, t2), ..., (dn, tn)] (1)

Where:

D is the sequence of collected behavioral data;

d1, d2, dn – specific user action;

t1, t2, tn – time stamp of the user action.

Each element in the sequence D is represented as (di, ti), where di represents a specific user interaction or action, and it represents the corresponding timestamp indicating when the interaction occurred.

As a new user interaction occurs, the sequence D is updated by adding the latest activity with its timestamp to the existing sequence: D = [(d1, t1), (d2, t2), ..., (dn, tn), (dn+1, tn+1)].

To maintain a manageable and relevant sequence, the maximum length is denoted as "n." If the D sequence exceeds this length, the oldest actions are removed, ensuring that the sequence reflects the user's most recent behavior.

In other words, the described model is a behavioral data tracker that uses a sequence of collected behavioral data (D) consisting of user interactions represented as (di, ti), where di denotes a specific user action and ti represents the corresponding timestamp.

The model is built based on five analytical blocks:

1. Data collection and updating: The model collects user actions and adds them to the existing sequence (D), including the corresponding timestamps. New actions are added as (dn+1, tn+1). A maximum length (n) is determined to ensure that the sequence remains manageable. If the sequence exceeds this length, the oldest actions are removed to preserve the most recent user behavior.

2. Real-Time Analysis: Behavioral Data Tracker performs sequence (D) analysis in real-time, using algorithms and techniques to extract information and patterns regarding user behavior, preferences, and habits. The study considers actions and corresponding timestamps, providing a comprehensive view of user behavior over time.

3. Predictive Modeling: The model develops predictive models based on the analyzed behavioral data in sequence (D). These models consider both actions and their timestamps to anticipate user actions, such as predicting the likelihood that a user will purchase or click a particular item at a given time. This allows for personalized recommendations and targeted marketing strategies.

4. Personalization: Behavioral Data Tracker uses historical sequence (D) to personalize the user experience. The model tailors content, recommendations, and suggestions to users' preferences and habits by considering both actions and their timestamps. This improves user engagement, satisfaction, and overall experience.

5. Continuous Iteration: The model works iteratively, continuously updating the sequence (D) as new data arrives. It analyzes updated data, refines predictive models, and adapts to changing user behavior patterns. This iterative process ensures the model remains relevant and effective in capturing users' changing preferences and habits.

Figure 4. Description of the behavioral data model

Note: compiled by the authors based on the research conducted

By implementing the Behavioral Data Tracker model, companies can gain valuable insight into user behavior, make data-driven decisions, and deliver personalized experiences based on timestamps and repeat actions. This approach increases user satisfaction, improves targeting, and helps achieve business goals.

The proposed multidimensional model adapted to the digital environment and based on statistical modeling, can be used to predict consumer interests and consumer behavior. However, it has both positive and negative sides. The latter includes its imperfection since working with voluminous information data only sometimes has a final result. It is also necessary to add to this the human and behavioral factor itself, which is unpredictable. Behavioral forecasts allow you to apply approximate data sets and provide consumers with the most relevant products and services. Therefore, modeling a consumer activity management system should take into account variables such as:

* personal consumer preferences and habits;
* consumer interests;
* the emotional coloring of the presented products and reviews;
* consistency of information about products provided to consumers.

On the one hand, new trends in consumer behavior have emerged, caused by the filling of information surrounding a product and service. But on the other hand, categories such as impulsiveness and emotionality of perception are also reserved for users. Therefore, they must be used and applied in practice, especially considering that the modern buyer is gradually ceasing to respond to traditional means of disseminating information about a product.

A multidimensional sequence model can also increase the reliability of the information obtained from the consumer behavior algorithm rather than from transmitted personal data.

The survey results indicate that consumers in the e-commerce environment may misrepresent or misrepresent their data, especially when participating in surveys or providing information about advertising and product preferences. This bias can pose challenges for companies seeking to predict and understand consumer digital behavior accurately.

A statistical modeling approach that considers online consumer behavior has been proposed to address this complexity. By analyzing consumers' browsing history, purchasing patterns, and other relevant online interactions, the proposed model aims to provide more accurate consumer behavior predictions in the e-commerce environment.

**By tracking online consumer behavior through modeling, companies can gain deeper insight into consumer preferences, needs, and motivations. This can help optimize marketing strategies, personalize experiences, and increase customer engagement in e-commerce.**

**The described Behavioral Data Tracker model can be configured and implemented in various modern programs and platforms for tracking and analyzing user behavior.**

**Some examples of programs and platforms where this model can be applied:**

**1. E-commerce platforms. Online retailers can use this model to track user interactions and behavior, analyze purchasing patterns, and provide personalized product recommendations based on historical data and timestamps.**

**2. Social media platforms. Social networks can use this model to analyze user engagement, identify popular topics, and personalize content and advertising for individual users based on their activities and timestamps.**

**3. Content recommendation systems. Streaming platforms and websites can use this model to understand user preferences, predict following content choices, and offer personalized recommendations.**

**4. Digital marketing and advertising platforms. Digital marketers can use this model to analyze how users interact with ads, predict how users will react, and optimize ad targeting based on historical behavior and timestamps.**

**5. Customer Relationship Management (CRM): Companies can integrate this model into their CRM systems to gain insight into customer behavior, preferences, and habits, helping to improve customer engagement and satisfaction.**

**6. Mobile applications. Mobile app developers can implement a model to track user interactions, predict user behavior, and provide a personalized app experience.**

**7. Web Analytics Tools: Web analytics platforms can use this model to provide real-time insights into website user behavior, allowing website owners to optimize the user experience and increase conversions.**

**8. Online gaming platforms. Gaming companies can use this model to analyze game user actions and interactions, understand player preferences, and improve the gaming experience.**

**9. User Experience (UX) Research: UX researchers can use the model to collect and analyze user behavior data to understand how users interact with websites, apps, or products and identify areas for improvement.**

**Overall, the Behavioral Data Tracker model described can be a valuable tool for businesses and organizations in various industries, helping them gain valuable insights into user behavior, make data-driven decisions, and provide personalized experiences to improve user satisfaction and achieve their goals.**

**Overall, the study highlights the importance of considering data bias when managing consumer behavior in e-commerce. By recognizing this challenge and implementing innovative statistical modeling techniques, businesses can better address the challenges of understanding and predicting consumer behavior in a dynamic digital environment.**

**The research confirms that further modeling, forecasting, and managing consumer behavior require detailed study and application of deep data analysis methods.**

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