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THE STRATEGY FOR DEVELOPING A RECOMMENDATION SYSTEM BASED ON BIG DATA ANALYTICS IN E-COMMERCE

The popularity of modern e-commerce sites has had a big impact on IT technology. As e-commerce companies strive to provide their customers with the best possible experience, many technologies are used to do so. One way to attract loyal customers is to develop recommendations based on analyzing purchases as well as opinions of other users. This paper discusses the strategy for developing a recommendation system based on big data analytics in e-commerce. Relevant technologies and algorithms of e-commerce recommendation systems are analyzed, and the architecture of e-commerce recommendation system is proposed. Examples of successful implementation of recommendation system based on big data analytics for marketplaces are given.

Keywords: *e-commerce; big data analytics; design strategy; recommendation system.*
Fig.: 5. Tables: 5. References: 10.

Urgency of the research. The popularity of modern e-commerce websites has had a great impact on IT technology. As e-commerce companies strive to provide the best experience to their customers, many technologies are used to do so. One way to attract loyal customers is to develop recommendations based on analysing purchases as well as opinions of other users.

Target setting. Today, e-commerce encompasses almost all spheres of society. It is believed that their volume doubles every two years. They have become an important resource, the role of which is constantly increasing and affecting all areas of technology and business, increasing benefits for organizations and individuals. Therefore, the research objective is defined, characterized by effective approaches to apply the recommendation system based on big data analytics in e-commerce, which is becoming a driving force in innovative business models and products.

Actual scientific research and issues analysis. Currently, the term “big data” is most common in information technology research, while it does not have a universally accepted definition [1]. The analysis of existing diverse interpretations, their constant updating provides an opportunity to fill in the components of this phenomenon but does not always orient with regard to the prospects and directions of its evolution. There are many ways of using big data in the sphere of electronic commerce. All of them have one thing in common. They can be used to improve user experience, increase sales and optimize internal processes in an organization [2]. However, lack of knowledge in this matter can lead e-commerce companies to lose customers and, as a consequence, to lower profits and profitability.

Uninvestigated parts of general matters defining. The UI optimization plays a critical role in understanding customer behaviour as much as big data analytics. The usability of free classifieds platforms can be significantly improved by investigating the application of big data in this environment. The unreliability and incompleteness of information about products and services creates significant obstacles for complex data processing by analytical systems on free classifieds platforms. Interface design solutions directly affect user satisfaction and behavioural patterns when interacting with such platforms.

The use of big data-driven technologies creates a number of obstacles for online commerce. Earning trust from business representatives becomes a key challenge, requiring convincing evidence that big data analytics can improve business performance. In addition, online retailers face difficulties in organizing data collection, shortage of qualified technical staff in the labour market, and the need to develop the right strategy when developing data storage systems.

The research objective. To characterize the strategies for developing recommendation system based on big data analytics in e-commerce, to develop recommendations for e-commerce.

The statement of basic materials. At the heart of personalized e-commerce marketing is a comprehensive recommendation system, which effectiveness is determined by accuracy of the options offered to the user. To create relevant offers for each customer, advanced big data analytics and detailed customer analysis are used.

By studying the history of visits, preferences and consumer behavior patterns, the system forms an individual portrait of each user. Based on this data, the intelligent recommendation mechanism is built, which is a key element of modern online commerce [1].

The purpose of this article is to characterize strategies for developing the recommendation system based on big data analysis in e-commerce, to develop recommendations for e-commerce.

Big data are large amounts of information that companies collect and process every day. They can include sales data, customer behavior, social media statistics, and more.

There are many reasons why big data-driven recommendations and e-commerce fit together so well. In fact, the ability to utilize big data analytics is one of the most important factors in the success of any online business. Big data analytics can clearly show which processes in the company are going well and what can be improved.

Data analytics in online commerce offers many opportunities to optimise business processes. Improving the customer's experience, increasing sales and improving the internal structure of the company - that's what various methods of applying this data have in common.

Choosing optimal development strategies becomes more likely when entrepreneurs rely on data analytics. Decision-making based on specific indicators is a key advantage of recommendations generated by big data processing in e-business. The analysis helps to identify the most effective channels for attracting visitors, determine audience preferences and establish which content elicits the maximum response [2].

Understanding customers becomes better by analyzing their buying preferences. This information can be used to improve marketing campaigns, user experience or product mix.

In addition, the buying process is simplified and supported by all kinds of data.

E-commerce firms that the data collected to identify patterns and target customer buying behavior can reap big rewards.

The sheer amount of data that e-commerce companies work with on a daily basis makes the application of big data essential to making informed and accurate data-driven decisions.

Big data is essential for e-commerce and serves as a rich source of information that drives business growth and enhances business competitiveness [3].

Strategies for developing recommendations based on big data for e-commerce are reflected in Fig. 1.

Practical relevance of this data lies not only in its collection, but also in its effective analysis and application. For e-commerce, big data enables personalized marketing that attracts and retains customers, ultimately increasing sales and profits. They also optimize inventory management by accurately predicting demand, reducing shortages and surplus goods.

Big data is also revolutionizing the approach to supply chain management by streamlining operations, reducing costs, and ensuring on-time deliveries. In addition, they enable improved pricing strategies based on market trends and competitor analysis, balancing profitability and competitiveness. Finally, big data improves risk management and fraud detection by identifying patterns to proactively address potential risks.

In essence, big data is changing all aspects of e-commerce, giving companies tools to succeed in the competitive marketplace [4].

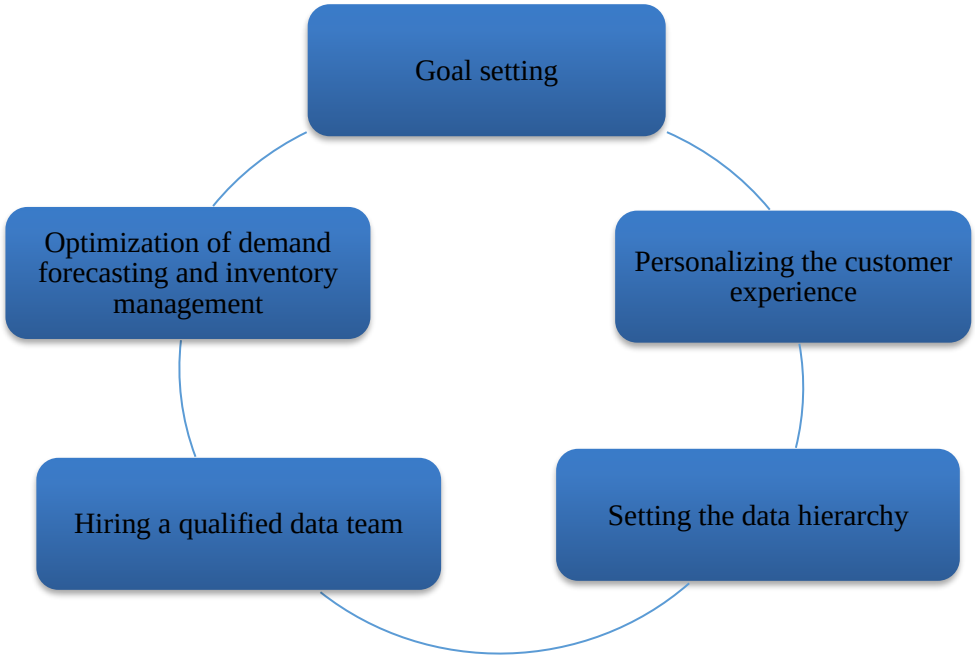

Fig. 1. Strategies for developing recommendations based on big data for e-commerce
Source: developed by the author.

Big data is changing e-commerce logistics and supply chain management by improving planning, scheduling, and delivery processes. Using big data analytics, companies can more accurately forecast demand, optimize delivery routes, and reduce delivery times, significantly reducing operational costs.

Benefits of big data in logistics and supply chain management are summarized in Figure 2.

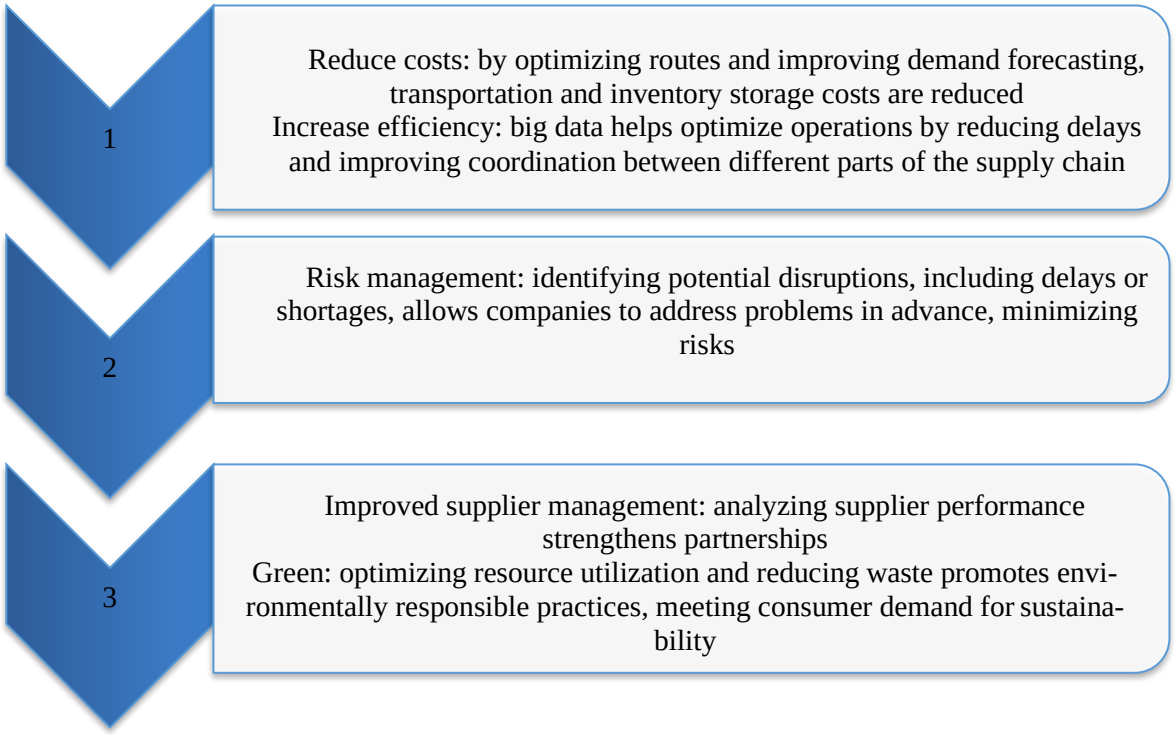

Fig. 2. Benefits of big data in logistics and supply chain management
Source: developed by the author.

Also, setting right price is crucial for increasing sales, as customers tend to be attracted to lower prices. In e-commerce, this requires analyzing various data sources - a time-consuming but important task to stay competitive.

Today, big data offers a solution by allowing companies to optimize pricing strategies through detailed analysis of data from sources such as price comparison tools, coupon platforms, online catalogs, and competitor websites.

While web scraping tools are widely available, effectively analyzing the data they collect remains a challenge. In the past, retailers relied on manual monitoring and analysis by specialized analysts to track price changes and competitor strategies.

Using big data tools, e-commerce retailers can streamline this process and potentially save significant resources that would otherwise be spent on manual research and analysis [5].

Online commerce is undergoing revolutionary changes thanks to large-scale data analytics. Virtual commerce companies have been able to maintain market leadership through deep insights into consumer trends. Unlike outdated tools like Google Trends, today's technology can predict consumer purchasing decisions with incredible accuracy. Comprehensive analyses of customer preferences enable businesses to adjust their strategic plans in advance. Unprecedented granularity in understanding consumer needs and behavioural patterns is transforming the way e-business is conducted.

Over the years, online retailers have collected enormous amounts of information, including years of data archives. By applying technology to analyse these large-scale information flows, companies can optimise supply chains, reduce warehousing costs and significantly improve the efficiency of all operational processes.

Implementing big data solutions facilitates rapid data-driven decision making. By automating complex analytical tasks and integrating real-time data streams, online retailers can respond quickly to market changes, capitalize on opportunities, and effectively mitigate risk. This proactive approach not only improves operational efficiency but also promotes growth and innovation in the organization [6].

Thus, big data enables e-commerce companies to gain better customer insights, optimize resource allocation, and make strategic decisions. Using data analytics capabilities, companies can successfully operate in a competitive market, improve customer satisfaction and achieve sustainable business growth.

Alibaba effectively utilizes big data to transform e-commerce and microfinance, providing significant assistance to small and micro enterprises. Founded by Jack Ma in 1999, Alibaba, including the Taobao platform, supports millions of small sellers. Key highlights:

1.Alifinance: launched in 2011:

- Uses a data-driven credit rating based on revenue growth and transaction history;
- offers unsecured, flexible loans managed entirely online;
- manages a 105 billion yuan loan portfolio with a very low percentage of problem loans.

Alibaba's big data initiatives are also driving economic growth in rural areas through TaoBao.

2.Village Program: widely used Taobao, which helps the local economy by:

- providing access to wider markets;
- reducing costs for small producers;
- stimulating economic activity and creating jobs in underdeveloped regions.

3.Alipay, Alibaba's online payment platform, demonstrates its big data strategy:

- More than 800 million users processing millions of transactions daily;
- has expanded into mobile payments, especially in less developed regions;
- partnered with Yuebao, a money market fund attracting millions through higher returns and transaction flexibility.

These initiatives demonstrate Alibaba's innovative use of big data to improve financial services and support small business growth.

Amazon's revolutionary approach to inventory management and customer demand forecasting is realised through data science. The company applies sophisticated machine learning models and algorithms to analyse historical sales, behavioural patterns and external factors to accurately anticipate future demand.

The most notable advancement has been personalisation, built on processing colossal amounts of data. Amazon generates customised offers for each user based on comprehensive analysis of browsing history, shopping habits and product ratings, making the user experience unique to each customer.

Through information analytics, the organisation efficiently adjusts stock balances, avoiding both shortages and oversupply of products. During times of high consumer demand - whether it's Prime Day or Black Friday sales - Amazon applies intelligent analytics to predict shopping activity, ensuring there are sufficient quantities of in-demand products at its logistics centres.

The company also uses data science to create an agile supply chain that adapts to changing market conditions. Real-time data analytics helps identify trends, allowing Amazon to effectively adjust inventory levels, distribution routes, and purchasing strategies.

Amazon utilizes a robust security framework, reinforced by data science, to combat fraudulent activity and implement best prevention practices across its vast e-commerce ecosystem. Using machine learning algorithms, Amazon can analyze behavior patterns and identify anomalous activities that may indicate potential fraud [7].

Amazon's systems automatically trigger the investigation when abnormal behaviour is detected, such as irregular purchases or a spike in account login attempts. To strengthen protection against unauthorised access, biometric verification and multi-factor authentication are implemented in the customer interface.

When potentially fraudulent activity is detected, Amazon employs advanced prevention techniques, such as blocking suspicious transactions in real time or temporarily locking accounts until further verification [8].

Marketplace managers face the problem of spending more time updating product information than adding it. This challenge necessitated development of the mechanism that would allow easy export of price list files in the right formats from the existing product range. The second aspect is the regular updating of price and availability information to remain relevant.

It follows that the price list file should be universal, it should contain those fields that distinguish the information systems of all stores. XML standards RSS, Atom and YML are accepted formats. Each price list file can have individual settings that affect the product offerings in it. To manage the content in the PriceList parameters, it is enough to select the desired types and categories of products.

For effective work with tasks of this type, the key principle is as follows: absolute distinction between the display of information and its processing. This allows you to modify and extend individual components of the program independently of each other. In this context, the use of the Data Transfer Object (DTO) design pattern for transferring prepared data between components is appropriate. Implementation begins with the creation of DTO structures. The names of the common file fields are disclosed in Tables 1, 2, 3, 4, 5 (all tables have been developed by the author).

Table 1 - Data fields PriceListData

Field	Data type	Description
CurrencyId	String	ISO currency code
Offers	OfferData	Collection of product offerings
Categories	CategoryData	Collection of product offer categories

Table 2 - Data fields CategoryData

Field	Data type	Description
Id	Int	Category ID
ParentId	Int|null	Parental category
Title	String	Category Header

Table 3 - Data fields MeasurementsData

Field	Data type	Description
Weight	Float	Weight
Dimensions	DimensionsData	Dimensions

Table 4 - Data fields DimensionsData

Field	Data type	Description
Length	Int	Length
Width	Int	Width
Height	Int	Height

Table 5 - Data fields OfferParamData

Field	Data type	Description
Name	String	Parameter Name
Value	String	Parameter value

Development of file templates was the next step after filling the PriceListData object with test data without linking to real products.

To implement the concept, it is important that in the developed system each final instance of the price list object has only one public method called export. All necessary logic should be hidden inside the classes.

The class diagram of the described structure is presented in Figure 3:

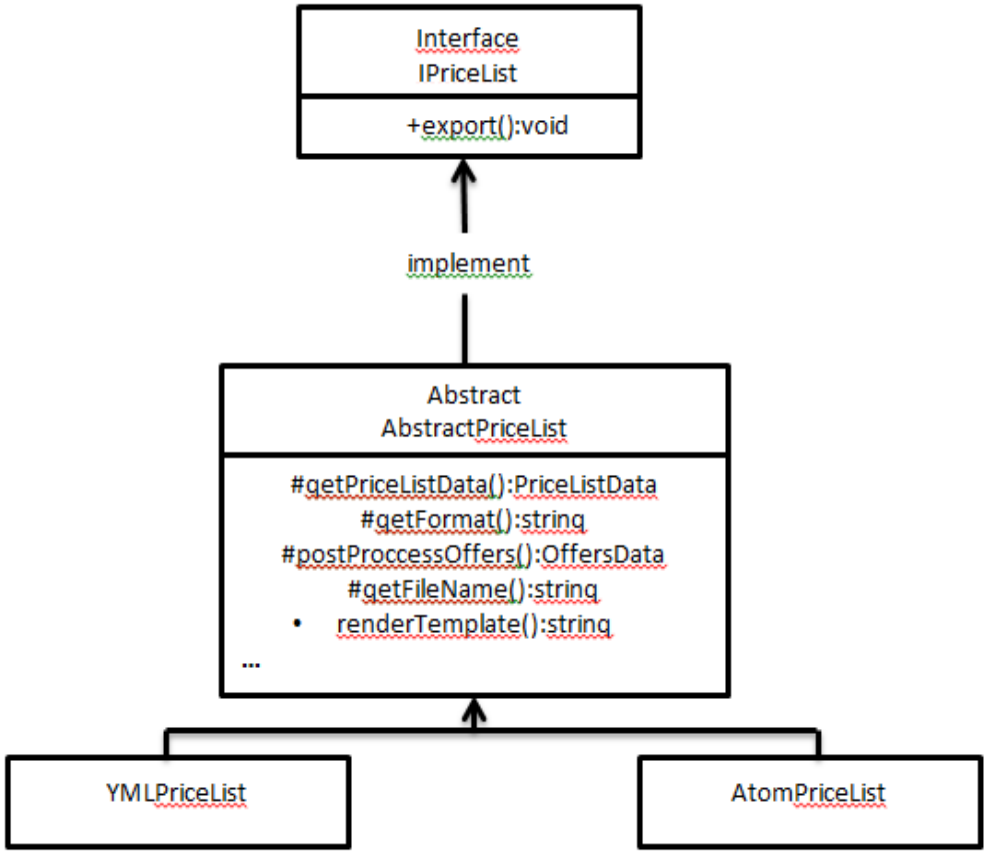

Fig. 3. Class diagram of the data formation structure

Source: developed by the author

To achieve the goal of exporting files, you can simply extract an array of instances of objects implementing the IPriceList interface. Then it is worth iterating over this array and calling the export method on each object. The PriceListsBuilder class is supposed to be created for these operations. Its constructor provides for obtaining the list of price list objects and then saving the results in a private field. The only public method of this class performs a pass through the list, initiating the process of exporting all price lists contained in it. The class diagram is shown in Figure 4.

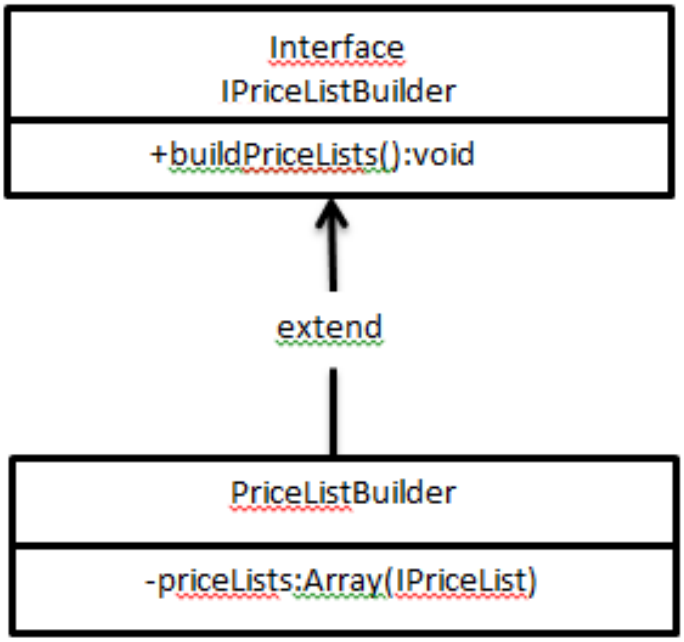

Fig. 4. Class diagram of obtaining the list of PL objects

Source: developed by the author

CRON task allows to rebuild price lists by changing product information at once or at certain time intervals. Unix systems widely use CRON to schedule execution of various tasks at the operating system level. Operations are executed at set times with specified intervals.

Obtaining information about a product before uploading it to the marketplace goes as follows:

1. Information is stored in the warehouse accounting system.
2. It is updated in the CMS.
3. Item data is collected into a common XML file.
4. The link to the XML file is transferred to the marketplace information system.

The improved algorithm of data exchange is presented in Figure 5.

In today's world, e-commerce is rapidly evolving, opening up new horizons for interaction with consumers. Revolutionary changes in online commerce owe much to introduction of advanced Big Data technologies. These innovations make it possible to create fundamentally new approaches to the formation of personalized recommendations for customers.

Intelligent recommendation systems based on the analysis of big data arrays are becoming a key tool for increasing efficiency of e-commerce. They can take into account many factors: from purchase history to users' behavioral patterns in real time. This makes it possible to form accurate forecasts of consumer preferences and offer relevant goods and services.

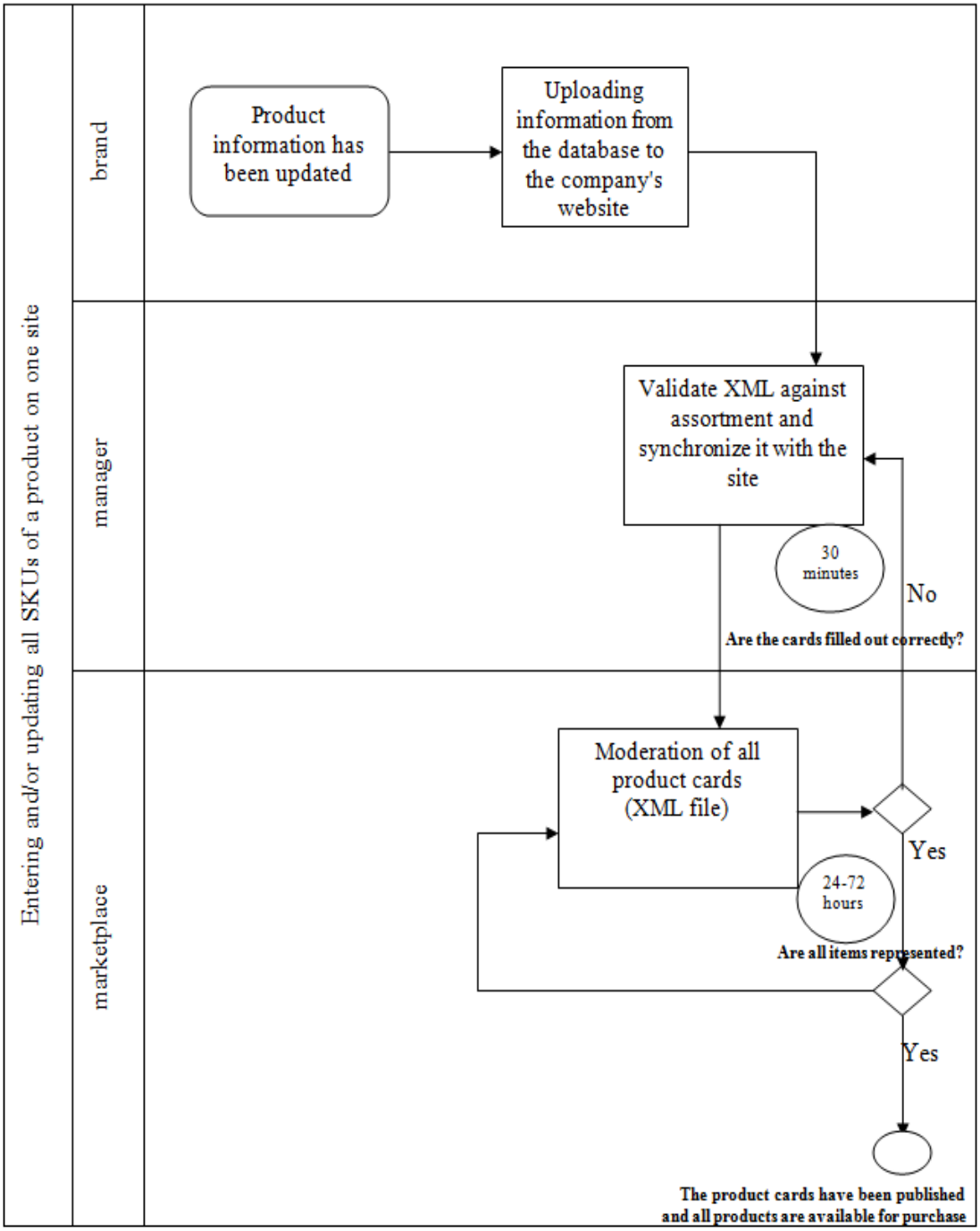

Fig. 5. Improved data exchange algorithm

Source: developed by the author

Development of machine learning technologies opens up new opportunities for improving recommendation systems. Algorithms are becoming more accurate and capable of self-learning, which significantly improves quality of personalization. It is important to note that successful implementation of these systems requires the integrated approach to data collection and processing, as well as compliance with strict rules of personal information protection.

In the future, further integration of recommendation systems with artificial intelligence and predictive analytics technologies is expected, which will make it possible to create even more advanced mechanisms for personalizing the shopping experience. This will not only increase customer satisfaction, but also open new opportunities for e-commerce business growth [9].

Thus, development of recommendation systems based on big data is becoming one of the key drivers of modern e-commerce development, determining the future of retailing in the digital era.

Conclusion. As a result of the study, the set goal was achieved - strategies for developing the recommender system based on big data analytics in e-commerce were characterized, and recommendations for e-commerce were developed.

Big data is impacting all aspects of the highly competitive field of e-commerce. When properly analyzed, this growing sea of information provides online retailers with a wealth of insights, increasing their profits.

An exceptional customer experience is an important advantage for online stores as it increases brand loyalty and reduces customer churn. By analyzing big data, online stores can improve user experience, combine data from multiple platforms to create accurate customer profiles, and personalize product recommendations and content to communicate with customers [10].

Companies can also properly optimize prices, forecast trends, demand, and offer diverse and secure payment methods.

More and more e-commerce companies are using big data analytics to maximize useful information from the endless stream of raw data.

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СТРАТЕГІЯ РОЗРОБКИ РЕКОМЕНДАЦІЙНОЇ СИСТЕМИ НА ОСНОВІ АНАЛІТИКИ ВЕЛИКИХ ДАНИХ В E-COMMERCE

Популярність сучасних веб-сайтів електронної комерції сильно вплинула на IT-технології. Оскільки компанії електронної комерції прагнуть забезпечити найкращий досвід для своїх клієнтів, вони використовують для цього багато технологій. Один із способів залучити лояльних клієнтів – це розробка рекомендацій на основі аналізу покупок, а також думок інших користувачів.

Сьогодні електронна комерція охоплює практично всі сфери життя суспільства. Вважається, що кожні два роки їх обсяг подвоюється. Вони стали важливим ресурсом, роль якого постійно зростає і впливає на всі сфери технологій і бізнесу, збільшуючи вигоди для організацій і окремих людей. Таким чином, визначено мету дослідження, яка характеризується ефективними підходами до застосування системи рекомендацій на основі аналізу великих даних в електронній комерції, яка стає рушійною силою у сфері інноваційних бізнес-моделей і продуктів.

Наразі термін «великі дані» є найбільш поширеним у дослідженнях інформаційних технологій, але не має загальноприйнятого визначення [1]. Аналіз існуючих різноманітних трактувань, їх постійне оновлення дає можливість наповнити складові цього феномену, але не завжди зорієнтує щодо перспектив і напрямів його еволюції. Існує багато способів використання великих даних у сфері електронної комерції. Усіх їх об'єднує одне. Їх можна використовувати для покращення взаємодії з користувачем, збільшення продажів та оптимізації внутрішніх процесів в організації [2]. Однак відсутність знань у цьому питанні може призвести до того, що компанії електронної комерції втратять клієнтів і, як наслідок, до зниження прибутку та прибутковості.

Оптимізація інтерфейсу користувача відіграє вирішальну роль у розумінні поведінки клієнтів так само, як і аналіз великих даних. Зручність використання платформ безкоштовних оголошень можна значно покращити, дослідивши застосування великих даних у цьому середовищі. Недостовірність і неповнота інформації про товари та послуги створює значні перешкоди для комплексної обробки даних аналітичними системами на платформах безкоштовних оголошень. Дизайнерські рішення інтерфейсу безпосередньо впливають на задоволеність користувачів і моделі поведінки під час взаємодії з такими платформами.

Використання технологій, що керуються великими даними, створює низку перешкод для онлайн-комерції. Завоювання довіри представників бізнесу стає ключовим завданням, яке вимагає переконливих доказів того, що аналітика великих даних може покращити ефективність бізнесу. Крім того, онлайн-рітейлери стикаються з труднощами в організації збору даних, дефіцитом кваліфікованого технічного персоналу на ринку праці та необхідністю розробки правильної стратегії при розробці систем зберігання даних.

В результаті досягнуто мети - охарактеризовано стратегію розробки системи рекомендацій на основі аналітики великих даних в електронній комерції, розробити рекомендації для електронної комерції.

Ключові слова: *електронна комерція, аналіз великих даних, стратегія розвитку, система рекомендацій.*

Рис.: 5. Табл.: 5. Бібл.: 10.

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