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Article



O. Korostin
 Classic Private University
 master's degree

FORECASTING MARKET TRENDS IN MARITIME SHIPPING BASED ON BIG DATA ANALYSIS

Abstract: The article is dedicated to forecasting market trends in the field of maritime freight transportation using big data (BD) analysis methods. It explores the fundamentals of maritime shipping in the USA and examines the role of BD in this sector. The study analyzes approaches to collecting and processing large volumes of data, including machine learning algorithms and analytical tools. Particular attention is given to studying the impact of BD on strategic planning in maritime freight transportation in the USA.

Key words: big data, forecasting, market trends, maritime freight transportation, strategic planning, logistics, data analysis.

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Introduction

Maritime transportation makes up a significant part of world trade, playing an important role in the supply of goods and resources around the world. In the United States, one of the largest economic and trading nations, maritime shipping holds particular importance. The country's ports serve as vital hubs for trade and transportation, and their efficient management and planning require accurate and timely data.

Traditional methods of forecasting market trends, which rely on historical data and expert opinions, are not always capable of adequately responding to rapidly changing conditions and complex factors affecting the market. The application of big data (BD) presents an innovative solution that can significantly enhance the accuracy of forecasts

and improve strategic planning. They include a huge amount of information coming from various sources. The aim of this article is to explore the possibilities of forecasting market trends in maritime shipping based on BD analysis.

Main part. Fundamentals of maritime shipping in the USA

Maritime shipping is a crucial component of the logistics infrastructure in the USA, facilitating the transportation of goods both domestically and internationally. The majority of maritime shipments (51% of exports and 60,3% of imports) are attributed to the USA [1]. Overall, there has been an increase in the growth rates of transport volumes in tons and ton-miles in 2023, with forecasts for 2024 significantly exceeding the corresponding figures for 2022 (fig. 1).

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Figure 1. Growth of maritime shipping volume in tons and ton-miles, 2000–2024 [1]

In recent years, there have been several important trends in maritime navigation. Digitalization and automation are becoming integral parts of the industry, enhancing operational efficiency and reducing costs. Sustainability and environmental responsibility are becoming important aspects for companies [2]. Given the current innovations, the successful development of this sector will depend on the ability of companies to adapt to changes and leverage new technologies to improve efficiency and sustainability.

Application of BD in maritime shipping

The concept of BD refers to large, complex, and rapidly evolving sets of information that require specialized methods and technologies for storage, processing, and analysis. They are characterized by three main aspects known as the "three V": volume, velocity, and variety [3]. They are characterized by a huge amount of information that can be collected in a short period of time. In the context of maritime transport, this can be data on millions of transactions, ship movements and port operations. In maritime shipping, data on vessel movements and changes in weather conditions are received in real time. Data can come from various sources and formats, including structured, semi-structured, and unstructured data, which characterizes their variety.

In recent years, the shipping industry has grown even stronger due to the use of BD. This data is used to control ship sensors and for predictive analytics, which are necessary to prevent delays and improve the overall operational efficiency of the industry. By properly tracking shipments over several years, insights can be gained regarding the causes of vessel losses at sea, container losses within or outside terminals or warehouses, and other shipping-related issues. This data can be used by the shipping industry for future decision-making, to predict costly problems

and prevent their occurrence, as well as to create more reliable cargo delivery options. Additionally, BD analysis plays a crucial role in vessel operations. Terminal operators and agents can track vessels and make appropriate or even instantaneous decisions regarding dock and terminal placements [5]. These timely decisions can be very important for the day-to-day operation of vessels. They can be easily obtained using information collected from GPS devices, sensors, or control panels. It is expected that the use of BD in the shipping industry will significantly expand in the future.

The application of BD in maritime shipping opens new horizons for optimizing operations and enhancing efficiency. Companies that can effectively leverage this data will not only improve their performance but also gain a competitive advantage in a rapidly changing industry.

Methods for analyzing and forecasting market trends in maritime shipping based on BD

As cargo flow volumes increase and logistics chains become more complex, companies face the necessity of adapting to rapidly changing market conditions. In this context, BD analysis becomes an integral part of strategic planning and operational activities.

Methods for analyzing and forecasting market trends based on BD enable companies to identify hidden patterns, predict changes in demand, and optimize their operations. They provide the capability for effective risk management, cost reduction, and enhanced customer service quality. As a result, companies employing these methods can significantly improve their competitiveness and adaptability to external challenges. Table 1 presents the main methods of analysis and forecasting used in USA maritime shipping.

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Table 1. Methods of analyzing and forecasting market trends in maritime shipping based on BD [6, 7]

Methods	Description	Application	Tools/ Algorithms
Data analytics	Collection and analysis of large volumes of data to identify trends.	Identification of seasonal fluctuations, route analysis.	SQL, Python, R, Tableau, Power BI
Machine learning	Algorithms for forecasting based on historical data.	Forecasting cargo volumes.	Regression, Decision Trees, Neural Networks
Time series forecasting	Time series analysis to predict future values.	Predicting cargo flows and freight rates.	ARIMA, Exponential Smoothing, Facebook Prophet
Sensitivity analysis	Assessment of the impact of changes in input parameters on outcomes.	Analyzing the impact of fuel prices and regulatory changes.	Various models and scenarios
Geographic information systems	Visualization and analysis of spatial data.	Optimizing routes and assessing port congestion.	ArcGIS, QGIS
Competitive environment analysis	Comparative analysis of competitor data.	Identifying strengths and weaknesses of competitors.	SWOT analysis, PESTEL analysis
Scenario modeling	Creation of various scenarios to evaluate possible outcomes.	Evaluating the impact of economic changes.	Specialized software products
Forecasting using social media	Analysis of data from social media to assess trends.	Determining consumer preferences.	Analytical platforms for social media

The author's perspective is that methods for analyzing and forecasting market trends in USA maritime shipping, based on BD, represent a powerful tool for optimizing business processes and enhancing competitiveness. Each of the described methods offers unique approaches to addressing challenges related to the rapidly changing market. The integration of these methods into strategic planning and operational activities becomes an important step towards successful adaptation to the challenges and opportunities emerging in the maritime transportation market.

The impact of BD on strategic planning in USA maritime shipping

The strategic planning of maritime shipping in the USA relies heavily on BD, enabling more accurate and efficient decision-making. Modern companies in this sector use data to optimize routes and logistics. Contemporary monitoring and forecasting systems analyze weather conditions and traffic in real-time. This allows for the selection of the safest and most efficient routes, avoiding areas with adverse weather conditions or congested waterways. These data systems help analyze historical data on routes, speeds, and delays, optimizing route plans to reduce travel time and fuel costs.

Data analytics is used to assess competitive advantages. Predictive data helps companies identify changes in demand for specific types of cargo, new

trade routes, and trends in the global economy, enabling them to adapt their strategies and strengthen their competitive advantages [8]. The use of competitor activity data, such as shipping volumes and pricing strategies, allows companies to adjust their tactics to maintain competitiveness.

Analyzing customer data and preferences enables companies to offer more personalized services. This increases customer satisfaction and fosters long-term relationships. Data helps improve management across the entire supply chain, from suppliers to end customers. This leads to reduced delivery times and lower storage costs. They allow you to analyze the impact of various external factors on the market, such as economic indicators, changes in the political landscape, weather conditions and fluctuations in oil prices. This helps identify correlations and predict how these factors may influence demand.

Companies can create various scenarios based on BD analysis, allowing them to assess potential risks and opportunities. Such scenarios may include changes in legislation, economic fluctuations, or technological innovations [9]. Thus, the use of BD enables maritime carriers to enhance operational efficiency, reduce costs, and maintain competitiveness by adapting to rapidly changing conditions.

An example of forecasting market trends in maritime shipping based on BD analysis for strategic

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planning is the experience of **Crowley Maritime Corporation**. They use analytics to predict vessel arrival times and optimize warehouse operations, which reduces costs and increases delivery speed. They also analyze BD to assess risks associated with weather conditions and other factors, enabling more informed route decisions [10].

One of the largest logistics companies, **C.H. Robinson**, actively employs technology and BD analysis to optimize its operations and forecast market trends. They collect and analyze large volumes of shipping data, helping them identify patterns and trends that may indicate changes in demand. C.H. Robinson also uses data on current and expected conditions on roads, in ports, and at airports to optimize logistics routes. The company considers economic indicators, changes in legislation, and even weather conditions when planning operations. Forecasting and optimization have significantly improved C.H. Robinson's operational efficiency, reducing transportation time and costs, while also allowing them to offer more accurate and personalized solutions for their clients. The experience of USA

maritime companies shows that the use of BD is becoming an integral part of strategic planning and operations in the shipping sector [11].

Conclusions

Forecasting market trends in maritime shipping based on BD analysis represents a powerful tool that facilitates significant improvements in the industry. Implementing data analytics allows for more accurate predictions of demand changes, identification of new market opportunities, and adaptation of fleet and port infrastructure management strategies. The application of BD helps companies respond promptly to changing market conditions, optimize routes and resources, and effectively manage costs and risks.

This approach not only enhances operational efficiency and reduces costs but also provides competitive advantages in the context of globalization and increasing market dynamism. Companies that actively use analytical tools to forecast market trends are capable of achieving higher levels of performance and resilience, meeting customer needs and improving overall competitiveness in maritime shipping.

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