

J.E.Maharramli
“IDS Borjomi Azerbaijan” LLC
maharramli.javid@gmail.com
ORCID 0009-0007-0798-0143
R.A.Mardiyev
Azerbaijan Technical University
rafael.mardiyev@gmail.com

Məqalə redaksiyaya daxil olub 27.11.2025

The article was received by editorial board on 27.11.2025

Статья принята к печати 27.11.2025

BIG DATA ANALYTICS FOR DEMAND FORECASTING: INSIGHTS AND PRACTICES IN GLOBAL AND AZERBAIJAN MARKETS

Abstract

This article examines the critical role of advanced inventory management and demand forecasting techniques within the retail sector of Azerbaijan, set against a backdrop of rapid market changes and economic fluctuations. Traditional methods relying on historical data often fall short in addressing the dynamic nature of consumer demand. By leveraging Big Data analytics, businesses can uncover significant patterns through modern methodologies like machine learning, exponential smoothing, and linear regression, enabling more precise forecasting than conventional approaches. Advanced Tools of Microsoft Excel, such as Power BI, play a vital role in this transformation, allowing companies to analyze real-time data and make informed decisions aligned with market trends. However, the adoption of these advanced technologies comes with challenges, including data integration issues and the need for employee training. Despite these hurdles, the integration of Big Data tools is essential for retail companies in Azerbaijan to enhance operational efficiency and profitability. This article highlights the importance of refining demand forecasting practices to improve inventory management and supports the development of innovative strategies that can better respond to consumer needs in a competitive landscape. Ultimately, it emphasizes that effective adoption of analytics can significantly boost market performance and business resilience.

Keywords: Azerbaijan, demand forecasting, Big Data Analytics, inventory management, supply chain.

INTRODUCTION

In today's fast-paced market environment, effective inventory management is pivotal within the broader scope of supply chain management, aimed at maintaining optimal product levels to meet customer demand while simultaneously minimizing costs [1]. The traditional reliance on historical data for demand forecasting often presents challenges, as these methods struggle to account for rapid market changes and economic fluctuations. This is particularly evident in Azerbaijan, where the government emphasizes leveraging natural resources for development, despite inconsistencies in production and consumption strategies within the retail sector.

The emergence of Big Data analytics has revolutionized inventory management and demand forecasting across various sectors, especially retail. By utilizing vast datasets and employing advanced data methods and tools, businesses can uncover intricate patterns and generate actionable insights that significantly enhance forecasting accuracy. Specifically, this article explores methodologies such as machine learning algorithms, exponential smoothing, moving averages, and simple linear regression to analyze demand trends. These advanced analytical techniques can process real-time data, enabling more accurate predictions than traditional approaches, such as seasonal

weighted averages. The advanced analytical capabilities provided by Power BI tools are essential for the retail industry in Azerbaijan. These tools empower businesses to effectively harness and analyze data, offering a more dynamic and comprehensive understanding of market dynamics compared to traditional methods. By utilizing these advanced technologies, retailers can enhance their forecasting accuracy and make data-driven decisions that better align with consumer trends.

However, the transition to using these advanced tools may present certain challenges. Companies might encounter difficulties with data integration, particularly if they have existing systems that are not fully compatible. Additionally, there may be a learning curve for staff as they adapt to the advanced features of Power BI and advanced Excel tools. Ensuring consistent data quality and accuracy is also critical, as any discrepancies in the underlying data can impact forecasting outcomes.

Considering these challenges, integrating Big Data tools, including those discussed in this article, is advantageous and essential for businesses in Azerbaijan to thrive in a competitive landscape. Companies that embrace data-driven methodologies can not only improve their operational efficiency but also align their inventory strategies with the evolving demands of consumers, ultimately enhancing their profitability and market performance.

Ultimately, refining demand forecasting practices is essential for improving inventory management, supporting better decision-making, and enhancing the overall performance of businesses in Azerbaijan and similar markets. As technology advances, particularly in areas like big data analytics, companies can enhance their forecasting accuracy, respond more effectively to market fluctuations, and boost their competitive edge.

Research Objective

The primary objective of this research is to explore how Big Data analytics can enhance demand forecasting accuracy within the retail sector in Azerbaijan. By examining the role of various Big Data techniques and tools, such as machine learning, statistical analysis methods also integrated with advanced Microsoft Excel tools like Power BI and advanced data processing, this study aims to identify best practices that lead to improved demand predictions. The research will provide a comprehensive analysis of common forecasting practices in the retail sector, supported by quantitative data from multiple sources, including sales records and consumer behavior analytics. Furthermore, the study seeks to highlight comparative insights from global practices that serve as benchmarks, ultimately offering actionable recommendations for Azerbaijani retail businesses to optimize their inventory management and align more closely with market demands.

Data collection tools and advanced analytics have made it possible to enhance demand forecasting accuracy. In recent years, big data has become an important part of the decision-making process for several organizations. In particular, the capability to perform real-time, low-latency monitoring and analysis of business events is seen as a competitive advantage [2]. The research will primarily utilize datasets from the retail sector, comprising weekly, monthly, and annual sales data collected from different retail companies. This data will provide valuable insights into consumer purchasing behaviors and demand patterns. Each dataset will cover the period from 2015 to 2024, allowing for a thorough analysis of trends and fluctuations over time. The study will focus on essential analytical attributes, such as seasonality, promotional impacts, and regional variations in consumer behavior, all relevant to optimizing inventory management in retail. The involvement of small to medium enterprises (SMEs) within these datasets will ensure the findings are applicable and beneficial to a significant segment of the retail market in Azerbaijan, ultimately highlighting strategies that can enhance forecasting accuracy and operational efficiency.

Problem Statement

Big data refers to extensive datasets that can be computationally analyzed to uncover patterns and trends, particularly in the retail sector. In today's market, information is an invaluable asset for companies, encompassing not just business data but also insights derived from advanced analytical techniques. The rapid growth of data generation underscores the need to effectively harness this information. Big Data Analytics enables businesses to extract meaningful conclusions from vast

datasets, addressing the increasingly diverse demands of consumers who seek tailored products and services.

Azerbaijan faces several challenges in demand forecasting, specifically within its Fast-Moving Consumer Goods (FMCG) and retail sectors. A significant issue is the lack of accurate, timely, and comprehensive data, which is crucial for making informed predictions and understanding market dynamics. The economy's reliance on varying market conditions creates unpredictability in consumer demand patterns. The changing behaviors of consumers, particularly about product preferences and buying habits, introduce additional variability that can be difficult to anticipate. To effectively address these issues, it is essential to invest in data collection and analysis technologies, enhance regulatory frameworks, and foster collaboration between the private and public sectors to improve forecasting accuracy.

The growing interest in developing robust forecasting methodologies is driven by the substantial benefits, including improved customer service, reduced waste, efficient promotions, and enhanced stock management. Traditional forecasting methods often struggle with large and complex datasets, underscoring the necessity for sophisticated analytical approaches.

On the inventory management side, businesses frequently report the inability to effectively staff and manage their operational units due to a lack of accurate demand forecasts. For instance, companies in the retail sector often find themselves either understaffed or overstaffed as they attempt to cope with fluctuating demand [3].

Extensive literature on sales and demand forecasting highlights a reliance on simple methods, especially among small to medium enterprises. However, new research indicates that accuracy can be significantly improved through increased data availability, in-house report analyses, and machine learning. Despite widespread acknowledgment of the critical nature of this topic, there remains a notable underrepresentation of academic work addressing the support of decision-making processes using big data analytics in the retail sector [4]. This study will discuss how businesses, both in Azerbaijan and globally, can adopt big data analytics frameworks to enhance sales and demand forecasting, providing a comprehensive overview of current practices and innovations across different markets. The leverage of technological advancements and improved data processing capabilities can result in a more extensive use of AI technologies [5].

Problem-solving methods and Approbation

This article outlines various problem-solving methods utilized in demand forecasting, emphasizing traditional statistical techniques, Integration with Microsoft Excel advanced tools, machine learning, and AI technologies. These methodologies offer structured approaches to analyzing data and predicting consumer demand.

Traditional statistical methods, such as Simple Linear Regression, Moving Average, and Exponential Smoothing, provide foundational tools for understanding historical sales patterns. Simple Linear Regression predicts demand (Y) based on influential factors (X), while Moving Average and Exponential Smoothing help identify underlying trends by reducing short-term fluctuations.

Leading organizations, such as “Danone” and “IDS Borjomi Georgia”, apply these problem-solving methods to refine their forecasting processes. Danone utilizes the SAP planning tools and Microsoft Excel advanced tools to enhance its forecasting capabilities in the dairy market, allowing for swift supply chain adjustments. Borjomi employs Microsoft Dynamics, JDA, and Power BI for advanced statistical techniques and AI, aligning its demand forecasting with consumer preferences [Author].

Demand Forecasting Calculation Techniques:

Simple Linear Regression:

$$[Y = a + bX] \quad (1)$$

Explanation:

(Y) represents the predicted demand that we seek to estimate based on past data.

(a) is the Y-intercept, the expected demand value when the independent variable (X) is zero.

(b) is the slope of the regression line, which indicates the change in demand for each unit increase in (X) is the independent variable used to explain the changes in demand, which could include historical sales data or marketing expenditure.

Using this formula, analysts gather data on demand about one or more predictive variables. By applying statistical techniques, businesses can structure their forecasting models to estimate future demand based on current trends and historical data.

Integration with Microsoft Excel tools

Evaluations of demands that are still in the process of being fulfilled or have already been satisfied are called latent demand for needs. The market needs can only be forecasted without any strict indicators if they have not yet been expressed in demand, intentionally or unintentionally [6].

Calculation of Demand Forecast and order quantity based on historical data (weekly short-term forecast for Danone Azerbaijan LLC) [Author 2020].

Table 1

1	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
2	Product name	W32	W33	W34	W35	W36	Average sales in pcs	Actual stock	Stock in Transit	Average daily sales	Needed for week	Coverage check for week	DOS coverage check	Demand Forecast	Safety stock days	Safety stock PCS	Order
3	CHEESE 170 STRAWBERRY	2673	2857	2830	2580	3056	2799	1281	3200	616	4312	169	0,3	2799	1	616	3246
4	CHEESE 170 PEACH	2032	2431	2542	2444	2890	2468	564	3200	543	3801	0	0,0	2468	1	543	3011
5	YOGHURT 150 NATURAL	3487	3480	3525	3521	3875	3578	2370	6360	788	5516	3214	4,1	3578	1	788	1152
6	YOGHURT 150 BANANA	5538	6672	5846	4804	5579	5688	3611	10800	1252	8764	5647	4,5	5688	1	1252	1293
7	YOGHURT 150 PRUNES	7899	11790	8964	6547	10795	9199	4215	15600	2024	14168	5647	2,8	9199	1	2024	5576
8	DRINK 270 PEACH	2160	2731	1247	1678	682	1700	1	0	340	3400	0	0,0	1734	2	680	2414
9	DRINK 270 NUTS	2226	2884	2522	2469	606	2141	1	0	429	4290	0	0,0	2184	2	858	3042
10	PRO BUTTER 180 82%	85	195	1407	144	342	435	0		87	609	0	0,0	443	1,5	130,5	574
11	PRO MILKUP 950 0,5%	630	772	0	759	938	620	13	0	124	868	0	0,0	632	10	1240	1872
12	PRO MILKUP 950 1,5%	1679	2943	0	4013	964	1920	612	0	384	2688	0	0,0	1920	10	3840	5760
13	PRO MILKUP 950 2,5%	2765	4016	0	3835	2616	2646	14	0	530	3710	0	0,0	2699	10	5300	7999
14	PRO MILKUP 950 3,2%	2054	5861	0	5491	3804	3442	54	0	689	4823	0	0,0	3511	10	6890	10401
15	TOTAL	33228	46632	28883	38285	36147	36635	12736	39160	7806	56949	14677		36855		24162	46340

Explanation:

Average weekly sales (Column "G"): = Average of 5 weeks' sales data:

$[\text{AVERAGE}\{B3:F3\}]$

(2)

Average daily sales (Column "J"): = Average of 5 weeks divided by 5 working days:

$[\text{CEILING}\{\text{left}(\frac{I4}{5} \cdot 1.1, 0)\text{right}\}]$

(3)

Coverage check for 1 week (Column "L"): = If Actual stock (Column "H") plus Stock in Transit (Column "I") minus Needed stock for 1 week (Column "K") is below zero, it means we cannot cover next week sale, If this formula above zero, we need to check how many days do we cover:

$[\text{IF}\{H2 + I2 - K2 < 0, 0, H2 + I2 - K2\}]$

(4)

DOS (Days of Outstanding Sales) (Column "M"): = Coverage check for week (Column "L") divided by Average daily sales (Column "J")

$[\frac{L2}{J2}]$

(5)

Demand Forecast calculation (Column "N"): = If Actual stock (Column "H") is below Average daily sales (Column "J"), it means we don't have yet stock even for 1 day sale so we need to get as the demand, average weekly sales quantity +20% (growing trend indicator) which is indicated in (Column "G") if actual stock above 1 day sale we get as a demand 100% of average 5 week sales.

$[\text{ROUND}\{\text{left}(\text{IF}\{H2 < J2, G2 \cdot 1.02, G2\}, 0)\text{right}\}]$

(6)

Order quantity calculation (Column "Q"): = If the Demand forecast (Column "N") plus Safety Stock (Column "P") minus Coverage for week sale (Column "L") is below zero, it means no need for ordering any quantity, if above zero we ordering the quantity with calculating Demand forecast (Column "N") plus Safety Stock (Column "P") minus Coverage for week sale (Column "L").

$[\text{ROUND}\{\text{left}(\text{IF}\{N2 + P2 - L2 < 0, 0, N2 + P2 - L2\}, 0)\text{right}\}]$

(7)

Table 1. An example of the weekly Demand Calculation techniques of the Azerbaijan representative of the Danone company.

Last estimation of the Demand-Supply balance (Glass products) calculation report for “IDS Borjomi Georgia” LLC) [Author 2024].

GLASS Demand-Supply Balance 2024

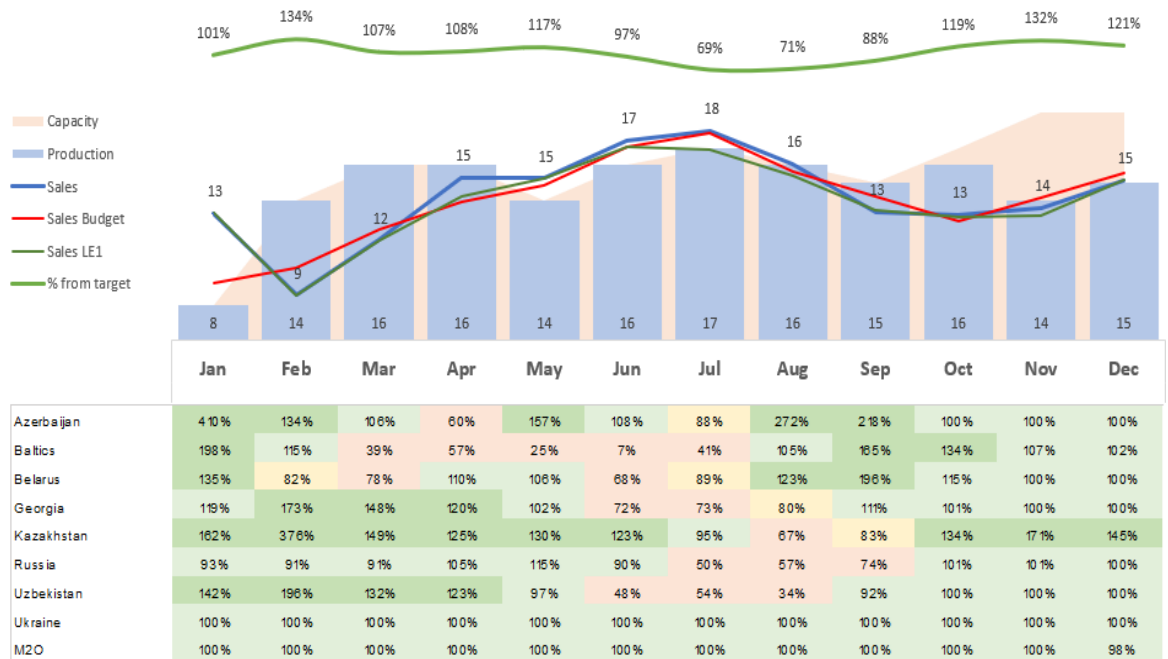


Figure 1.

DISCUSSION

Data for this report were collected from various business units to evaluate the balance between demand and supply for glass format products. Analysis was conducted using Power BI and the in-house JDA program, which are essential for processing large datasets and enhancing decision-making, particularly for predicting production capacity. As per analysis result:

The glass product utilization remains high until October. From November, the production of Glass 2 is planned to start, with direct materials included in December. November's Glass 2 production is primarily allocated to the Geo region for calculation purposes, though it may be adjusted to include CA as well. The production address for KZ is still to be confirmed. The stock target is expected to be managed within a one-month timeframe, mainly focusing on KZ and RU regions.

Key Time Series Forecasting Techniques

Moving Average: $[MA_t = \frac{1}{n} \sum_{i=0}^{n-1} Y_{t-i}]$ (8)

Explanation:

(MA_t) gives the moving average at time (t) .

(n) is the number of past periods (for instance, months or weeks) used to calculate the average, which can smooth out short-term fluctuations.

(Y_{t-i}) represents the observed sales values at previous periods (from the most recent back to the (n^{th}) previous period).

The moving average helps identify underlying trends in sales data by filtering out random variations, thus providing a clearer view of demand patterns over time.

Exponential Smoothing: $[S_t = \alpha Y_t + (1 - \alpha) S_{t-1}]$ (9)

Explanation:

(S_t) is the smoothed forecast value for the current period.

(Y_t) is the actual demand observed in the current period.

(S_{t-1}) is the forecasted value from the previous period.

The parameter (α) (smoothing constant) determines how much weight is given to the most recent observation versus the previous forecast, with values between 0 and 1.

Annual 2023 forecast, demand and budget fluctuations diagram with demonstrating trends and seasonality of IDS Borjomi Azerbaijan [Author 2023].

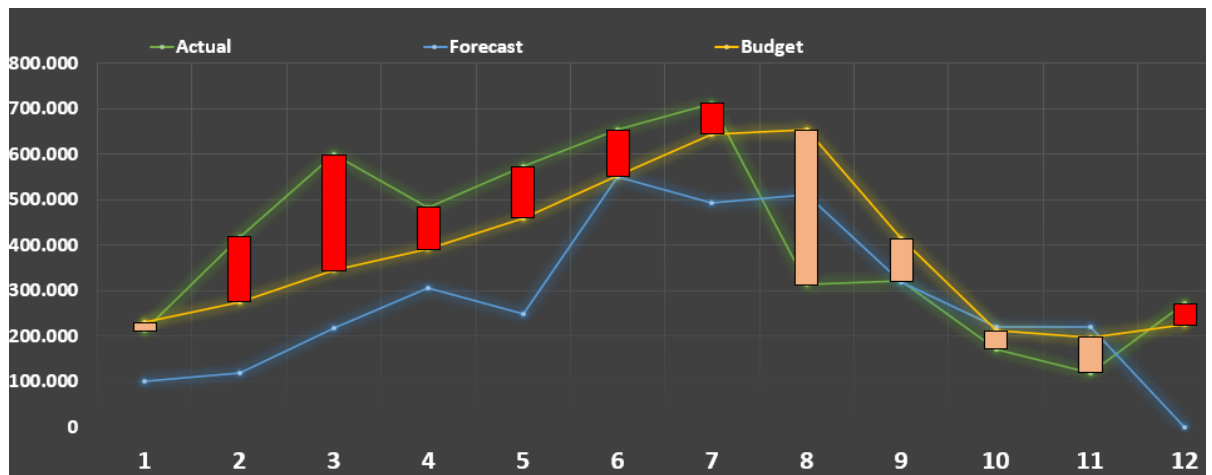


Figure 2.

Machine Learning Algorithms Techniques

Machine learning algorithms significantly enhance demand forecasting and operational efficiency by analyzing patterns within historical datasets. These algorithms adjust and improve as more data becomes available.

Evaluation Metrics for Forecast Accuracy. Mean Absolute Error (MAE):

$$[MAE = \frac{1}{N} \sum_{t=1}^N |Y_t - \hat{Y}_t|] \quad (10)$$

Explanation:

(Y_t) is the actual demand at time (t).

($\hat{Y}_t$) is the forecasted demand at time (t).

(N) is the total number of forecasts evaluated.

MAE measures average forecasting errors, serving as a key metric for assessing accuracy and helping businesses reduce discrepancies between forecasted and actual demand

Mean Absolute Percentage Error (MAPE): $[MAPE = \frac{100}{N} \sum_{t=1}^N \left| \frac{Y_t - \hat{Y}_t}{Y_t} \right|]$ (11)

Explanation:

Similar to MAE, but assesses the errors as a percentage of the actual demand.

MAPE allows organizations to understand forecast performance relative to the scale of actual sales, making it easier to compare accuracy across different products or market segments [5].

Calculation of Monthly Forecast Accuracy (MFA) for “IDS Borjomi Azerbaijan” LLC) on an example of Annual 2024 total [Author 2024].

Table 2

ANNUAL 2024	January	February	March	April	May	June	July	August	September	October	November	December	TOTAL
Forecast	128838	175590	310253	357219	381367	558237	642363	430945	327248	321768	258445	247896	4140169
Actual	110637	143891	253154	341292	379593	575217	638000	526826	325830	321542	343818	333815	4293615
Error	40122	59497	86361	116151	117320	70016	100496	166969	96143	71082	134323	107446	1165926
MFA	64%	59%	66%	66%	69%	88%	84%	68%	70%	78%	61%	68%	75%

Explanation:

Absolute value of a number (ABS) calculation:

$$[\text{ABS}(\{\text{Actual}\} - \{\text{Forecast}\})] \quad (12)$$

Forecast Accuracy (FA) calculation: If 100% minus “Error” is divided by Forecast below zero, then the value will be zero; otherwise, the value will be 100% minus “Error” divided by “Forecast”.

$$[\text{IF} \left(1 - \frac{\text{Error}}{\text{Forecast}} < 0, 0, 1 - \frac{\text{Error}}{\text{Forecast}} \right)]$$
(13)

Visualisation of MFA report 2024 (Figure 3.)

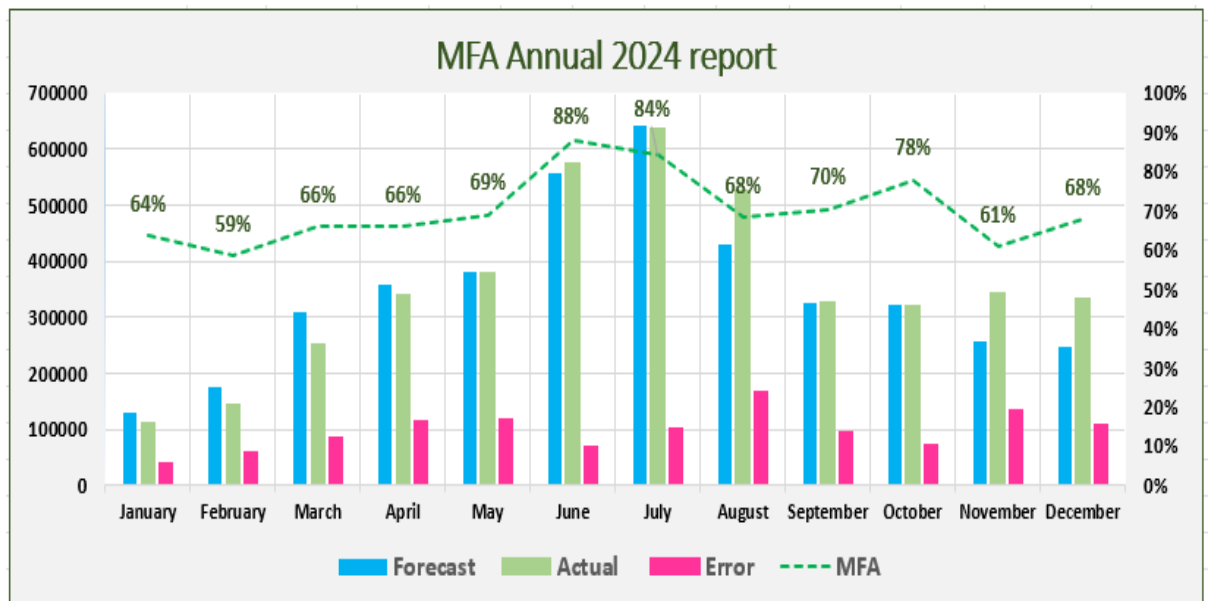


Figure 3.

CONCLUSION

This study highlights the profound impact of Big Data analytics on enhancing demand forecasting accuracy in Azerbaijan's retail market. Among the methodologies analyzed, machine learning algorithms stand out as the most effective for addressing demand planning challenges. These advanced techniques enable real-time data analysis and pattern recognition, resulting in more precise forecasts than traditional methods like Simple Linear Regression and Exponential Smoothing.

Companies such as Danone and IDS Borjomi Georgia exemplify the successful use of these methodologies, employing tools like Power BI and advanced Microsoft Excel functions to optimize inventory management and reduce costs. Their integration of data-driven techniques illustrates how organizations can align supply chains more effectively with changing consumer demands.

Moreover, collaboration among industry leaders enhances knowledge sharing, fostering improved forecasting practices that can address the unique challenges in Azerbaijan's market. Future research should explore the ongoing evolution of these methodologies and how further advancements in collaborative data practices can strengthen the role of Big Data analytics in demand planning, ensuring business competitiveness in a dynamic economic landscape.

References:

1. Taghizadeh, E. (n.d.). Utilizing Artificial Neural Networks to predict Demand for weather-sensitive products at Retail stores
2. Vera-Baquero, A., Colomo-Palacios, R., Molloy, O., & Elbattah, M. (2022). Business process improvement by means of Big Data based Decision Support Systems: A case study on Call Centers. *International Journal of Information Systems and Project Management*, 3(1), 5–26.
3. Rehmani, K., Naseem, A., Ahmad, Y., Mirza, M. Z., & Syed, T. H. (2021). Development of a hybrid framework for inventory leanness in Technical Services Organizations. *PLOS ONE*, 16(2)
4. Choi, Y., Lee, H., & Irani, Z. (2018). Big data-driven fuzzy cognitive map for prioritising IT service procurement in the public sector. *Annals of Operations Research*, 270(1–2), 75–104.

5. Žunić, E., Korjenić, K., Delalić, S., & Šubara, Z. (2021). Comparison Analysis of Facebook's Prophet, Amazon's DeepAR+ and CNN-QR Algorithms for Successful Real-World Sales Forecasting. *International Journal of Computer Science and Information Technology*, 13(2), 67–84.
6. Hızıroğlu, A., & Cebeci, H. İ. (2013). A Conceptual Framework of a Cloud-Based Customer Analytics Tool for Retail SMEs. *Periodicals of Engineering and Natural Sciences (PEN)*, 1(2).
7. Aktas, E., & Meng, Y. (2017). An Exploration of Big Data Practices in Retail Sector. *Logistics*, 1(2), 12.
8. Kosenko, V., Gopejenko, V., & Persyanova, E. (2019). Models and Applied Information technology for Supply Logistics in the context of Demand swings. *Innovative Technologies and Scientific Solutions for Industries*, 0(1 (7)), 59–68.
9. Petropoulos, F., Grushka-Cockayne, Y., Siemsen, E., & Spiliotis, E. (2023). Wielding Occam's razor: Fast and frugal retail forecasting (No. arXiv:2102.13209). arxiv.
10. Schnegg, M., & Möller, K. (2022). Strategies for data analytics projects in business performance forecasting: A field study. *Journal of Management Control*, 33(2), 241–271.

C.E.Məhərrəmli

“IDS Borjomi Azərbaycan” MMC

ORCID 0009-0007-0798-0143

R.A.Mərdiyev

Azərbaycan Texniki Universiteti

Tələbin proqnozlaşdırılması üçün böyük verilənlərin analitikası: global və Azərbaycan bazarlarında məlumat və praktiki təcrübələr

Xülasə

Məqalədə sürətli bazar dəyişiklikləri və iqtisadi dalğalanmalar fonunda Azərbaycanın parakəndə satış sektorunda qabaqcıl inventar idarəetməsi və tələb proqnozlaşdırma texnikalarının kritik rolu araşdırılır. Tarixi məlumatlara əsaslanan ənənəvi metodlar istehlakçı tələbinin dinamik təbiətini həll etməkdə çox vaxt çatışmır. Böyük Məlumat analitikasından istifadə etməklə, müəssisələr maşın öyrənməsi, eksponensial hamarlaşdırma və xətti reqressiya kimi müasir metodologiyalar vasitəsilə əhəmiyyətli nümunələri aşkar edə bilər və bu da ənənəvi yanaşmalardan daha dəqiq proqnozlaşdırmaya imkan verir. Power BI kimi Microsoft Excel-in qabaqcıl alətləri bu transformasiyada mühüm rol oynayır və şirkətlərə real vaxt məlumatlarını təhlil etməyə və bazar tendensiyalarına uyğun olaraq məlumatlı qərarlar qəbul etməyə imkan verir. Lakin, bu qabaqcıl texnologiyaların tətbiqi məlumatların integrasiyası problemləri və işçilərin təliminə ehtiyac da daxil olmaqla çətinliklərlə qarşılaşır. Bu maneələrə baxmayaraq, Böyük Məlumat alətlərinin integrasiyası Azərbaycandakı parakəndə satış şirkətləri üçün əməliyyat səmərəliliyini və gəlirliliyini artırmaq üçün vacibdir. Bu məqalədə inventar idarəetməsini təkmilləşdirmək üçün tələb proqnozlaşdırma təcrübələrinin təkmilləşdirilməsinin vacibliyi vurğulanır və rəqabət mühitində istehlakçı ehtiyaclarına daha yaxşı cavab verə biləcək innovativ strategiyaların hazırlanmasını dəstəkləyir. Nəticədə, analitikanın effektiv tətbiqinin bazar performansını və biznesin dayanıqlığını əhəmiyyətli dərəcədə artırma biləcəyi vurğulanır.

Açar sözlər: Azərbaycan, tələb proqnozlaşdırılması, Böyük Məlumatların Analitikası, inventar idarəetməsi, təchizat zənciri.