

AI-DRIVEN DEMAND FORECASTING AS A TOOL FOR SUSTAINABLE FMCG DISTRIBUTION

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Abstract

This thesis explores AI-driven demand forecasting as a strategic tool for sustainable FMCG distribution. It shows how AI enhances inventory accuracy, reduces waste, and optimizes logistics. Global best practices (Unilever, P&G) illustrate real-world applications, while the case for Uzbekistan emphasizes digital integration to align with green economy goals.

Keywords: AI, demand forecasting, FMCG, sustainable distribution, green economy, logistics, Uzbekistan.

Annotatsiya

Tezisdan tez aylanadigan iste'mol tovarlari (FMCG) taqsimotida barqarorlikni ta'minlashda sun'iy intellekt (AI) asosidagi talab prognozlash texnologiyalarining roli yoritilgan. AI yordamida logistika, ombor va yetkazib berish jarayonlari aniq prognozlarni asosida optimallashtiriladi, ortiqcha zahira va chiqindilar kamayadi. Misollar global kompaniyalar tajribasini aks ettirib, O'zbekiston sharoitida ham bunday texnologiyalarni joriy etish istiqbollari tahlil qilinadi.

Kalit so'zlar: AI, talab prognozi, FMCG, barqaror taqsimot, yashil iqtisodiyot, logistika, O'zbekiston.

Аннотация

В тезисе рассматривается применение прогнозирования спроса на основе искусственного интеллекта (ИИ) для устойчивого распределения товаров повседневного спроса (FMCG). ИИ позволяет оптимизировать запасы, снизить издержки и выбросы CO₂, а также повысить точность поставок. Представлены успешные кейсы глобальных компаний и возможности внедрения данных решений в Узбекистане с целью поддержки «зелёной» экономики.

Ключевые слова: ИИ, прогноз спроса, FMCG, устойчивое распределение, зелёная экономика, логистика, Узбекистан.

Sustainability is becoming one of the key priorities for fast-moving consumer goods (FMCG) companies worldwide [1]. Distribution inefficiencies, such as stockouts, overstock, and unnecessary transportation, increase costs and environmental impact [2]. In this context, artificial intelligence (AI)-driven demand forecasting emerges as a transformative solution to support sustainable distribution practices [3]. AI-based forecasting systems analyze vast amounts of structured and unstructured data, including historical sales figures, seasonal trends, consumer preferences, and even external variables such as weather or macroeconomic conditions [4].

By integrating these diverse data sources, machine learning models can generate more precise demand predictions than traditional statistical methods [5]. This higher level of accuracy not only reduces product waste but also allows distributors to

optimize warehouse operations, streamline transportation routes, and allocate resources more effectively [6]. Furthermore, AI enables real-time adjustments to demand forecasts, making it possible for FMCG companies to quickly respond to unexpected market changes [7]. Ultimately, AI-driven forecasting enhances both economic efficiency and ecological responsibility, contributing to a more sustainable distribution ecosystem [8].

AI forecasting relies on machine learning models that analyze historical sales, consumer trends, and external factors such as seasonality or macroeconomic conditions [4]. Compared to traditional statistical models, AI offers higher accuracy, flexibility, and adaptability to dynamic FMCG markets [5]. Demand forecasting has traditionally relied on statistical and econometric models, such as moving averages, exponential smoothing, and regression analysis [2]. While these methods provide useful insights, they often fail to capture the complexity and volatility of modern FMCG markets [1]. In contrast, artificial intelligence introduces advanced techniques such as machine learning, neural networks, and natural language processing that allow for the identification of hidden patterns in large and diverse datasets [3].

Machine learning models are capable of continuously improving their accuracy as new data is introduced, making them particularly suited for dynamic distribution environments [4]. For example, recurrent neural networks (RNNs) and long short-term memory (LSTM) models have been shown to outperform traditional approaches in predicting demand across multiple product categories [5]. Moreover, AI-based forecasting systems can incorporate non-traditional data sources, including social media trends, weather patterns, and competitor activities, which enhances their predictive capacity [6]. From a sustainability perspective, the theoretical contribution of AI lies in its ability to balance supply with actual market demand, thereby minimizing resource waste [7]. By shifting from reactive to proactive distribution planning, AI establishes a framework where operational efficiency and environmental responsibility reinforce each other [8].

FMCG distributors face challenges related to inventory planning, warehouse optimization, and last-mile delivery [1]. AI algorithms can forecast demand more precisely, reduce overproduction, and align logistics with real consumer needs [3]. This minimizes both product waste and transportation costs [6]. In the context of FMCG distribution, demand forecasting plays a decisive role in ensuring product availability while minimizing waste across the supply chain. Distributors often manage thousands of stock-keeping units (SKUs) across multiple regions, making accurate prediction of demand highly challenging. Traditional forecasting systems, which rely heavily on past sales alone, are insufficient in such complex environments. Artificial intelligence provides a practical solution by combining sales histories with external factors such as promotions, consumer sentiment, holidays, and even mobility data to generate more reliable forecasts.

For distributors, AI-driven forecasting directly influences critical operational areas [5]. Inventory management becomes more efficient, with reduced risk of overstocking perishable goods such as dairy products or beverages [6]. Warehouse

operations benefit from improved allocation of space, while logistics teams can design more sustainable delivery routes by anticipating order volumes with greater precision [7]. Moreover, by enabling just-in-time replenishment, AI reduces the need for safety stock, lowering both storage costs and carbon emissions from excess transportation [8]. A growing number of global FMCG firms, including Unilever and Nestlé, have already reported success in implementing AI-based forecasting solutions, resulting in measurable reductions in waste and cost [9]. For emerging markets like Uzbekistan, adopting similar tools offers an opportunity to leapfrog traditional inefficiencies and align distribution practices with green economy priorities [10].

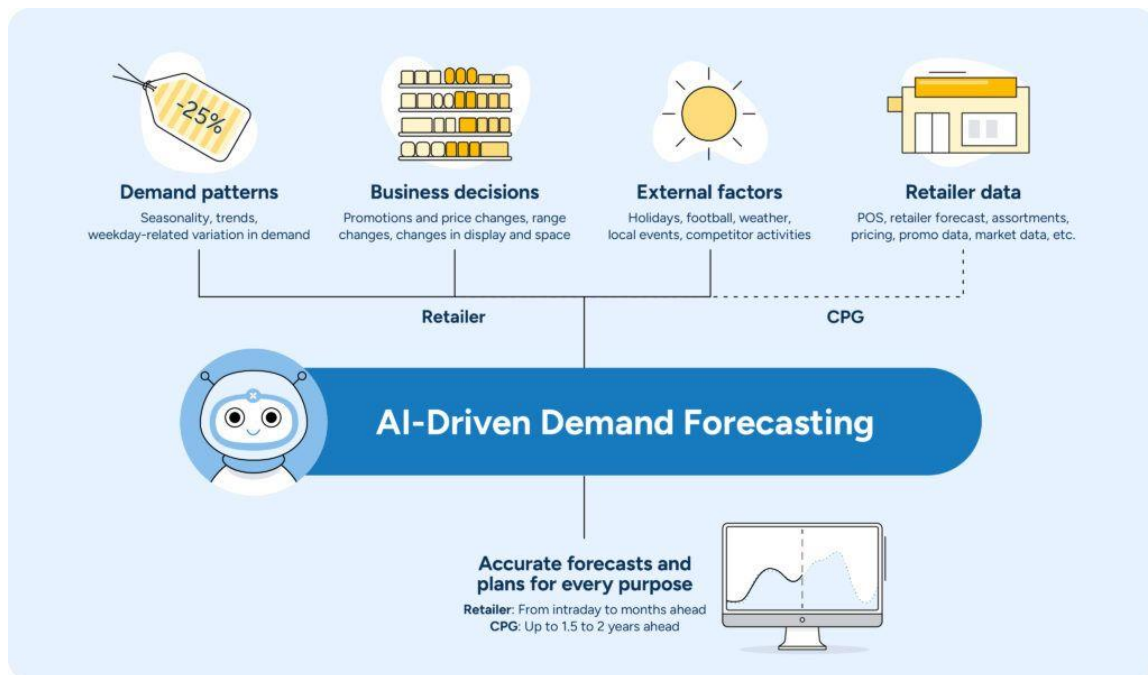


Figure 1. Key components and external factors in AI-driven demand forecasting for FMCG distribution (CPG = Consumer Packaged Goods).

Global FMCG leaders such as Unilever and Procter & Gamble have already implemented AI forecasting systems to cut waste and improve efficiency [9]. In Uzbekistan, FMCG distribution companies can integrate AI forecasting into their digital platforms to optimize stock levels in regional warehouses [10]. Global experience demonstrates that artificial intelligence in demand forecasting is not only feasible but also highly effective in FMCG distribution. For instance, Unilever employs AI algorithms to process real-time sales and climate data, which helps the company predict demand for seasonal products such as ice cream [9]. Similarly, Procter & Gamble uses machine learning to integrate retailer and distributor data, improving accuracy in replenishment cycles and reducing waste in its supply chain [11]. These cases show how large multinational corporations have successfully embedded AI tools into their daily operations, gaining both economic and environmental benefits. In addition to multinational players, regional FMCG companies in markets such as India and Brazil have also implemented AI-driven solutions, often through partnerships with

technology startups [12]. These initiatives reveal that AI is not limited to global giants but can be scaled for developing markets with resource constraints [13].

For Uzbekistan, where distribution networks are rapidly modernizing, the introduction of AI forecasting could address chronic inefficiencies such as uneven stock levels between urban and rural outlets [10]. By collaborating with local universities and technology providers, FMCG distributors can pilot AI-based demand planning systems [14]. This would not only improve profitability but also support national goals for sustainable economic growth and integration into the global green economy [15].

AI reduces excess inventory, lowers fuel consumption through better logistics planning, and decreases carbon emissions [7]. By aligning business goals with sustainability, FMCG distributors contribute directly to green economy objectives [8]. The integration of AI-driven demand forecasting into FMCG distribution extends beyond operational efficiency to broader contributions to the green economy [10]. By aligning production and distribution with actual consumer demand, companies can significantly reduce product losses, particularly in categories with short shelf lives such as dairy, bakery, and beverages [6]. This reduction in waste directly supports environmental sustainability, as fewer resources are consumed in manufacturing and less waste ends up in landfills. AI-enhanced forecasting also contributes to energy efficiency and lower emissions [7]. Optimized transportation schedules minimize unnecessary trips, thereby reducing fuel consumption and carbon output [8]. In addition, smarter inventory planning lowers the need for excessive warehousing, decreasing electricity usage for refrigeration and lighting [5]. Collectively, these effects reduce the ecological footprint of FMCG distribution networks.

From a marketing perspective, positioning AI-enabled distribution as part of a company's green strategy enhances corporate reputation and builds stronger relationships with environmentally conscious consumers and business partners [12]. In countries like Uzbekistan, where sustainable development is becoming a government priority, such practices can serve as a competitive advantage [15]. Thus, AI-driven demand forecasting becomes not only a tool for efficiency but also a driver of sustainable innovation, reinforcing the transition to a green economy.

From a marketing perspective, positioning AI-enabled distribution as part of a company's green strategy enhances corporate reputation and builds stronger relationships with environmentally conscious consumers and business partners [12]. In countries like Uzbekistan, where sustainable development is becoming a government priority, such practices can serve as a competitive advantage [15]. Artificial intelligence-driven demand forecasting is emerging as a transformative tool for achieving both operational efficiency and sustainability in FMCG distribution [5]. By leveraging advanced algorithms and real-time data, companies can anticipate demand with greater accuracy, reduce waste, and align logistics with actual consumer needs [7]. This dual impact—improving profitability while minimizing environmental harm—makes AI forecasting a strategic priority for modern distribution networks.

For FMCG distributors in Uzbekistan and other developing markets, the implementation of AI forecasting represents a timely opportunity to overcome long-standing inefficiencies [10]. To achieve this, several steps are recommended. First, companies should invest in digital infrastructure and establish partnerships with technology providers capable of delivering customized AI solutions [14]. Second, staff training is essential to ensure that decision-makers can effectively interpret AI-generated insights [13]. Third, collaboration with academic institutions and government agencies can accelerate adoption, providing both knowledge and policy support [15].

Ultimately, AI-driven demand forecasting strengthens the resilience of supply chains, supports national goals for sustainable development, and enhances corporate competitiveness [8]. Its integration into FMCG distribution not only addresses immediate business challenges but also contributes to the global transition toward a green economy.

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