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НАУЧНО-ИССЛЕДОВАТЕЛЬСКИЙ ИНСТИТУТ РАЗВИТИЯ ЦИФРОВЫХ ТЕХНОЛОГИЙ И ИСКУССТВЕННОГО ИНТЕЛЛЕКТА

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В настоящем сборнике вниманию читателей представлены доклады, отражающие результаты научных изысканий по направлениям интеллектуального анализа данных, обработки текстов, изображений и речевых сигналов, машинного обучения и представления знаний, развития цифровых технологий, математического моделирования, алгоритмизации, управления и оптимизации в технических, экономических и социальных системах, а также вопросы педагогики и образования в условиях цифровой трансформации. Авторами докладов рассматривается широкий спектр проблем развития технологий искусственного интеллекта. Освещаются вопросы применения цифровых технологий, анализа данных и машинного обучения при решении задач моделирования и управления объектами различной природы. Значительное место занимают исследования, связанные с теоретическими и прикладными вопросами разработки математических моделей, вычислительных алгоритмов и программного обеспечения. Приводятся результаты разработок моделей и программно-технических средств систем информационной безопасности, прикладных систем обработки информации, принятия решений и управления в нефтегазовой, машиностроительной, агропромышленной, телекоммуникационной, финансово-экономической отраслях и в образовании. Содержание сборника ориентировано на научных работников, докторантов, инженерно-технических работников, преподавателей ВУЗов, осуществляющих исследования, прикладные разработки, внедрение и эксплуатацию информационно-коммуникационных технологий, а также подготовку специалистов по соответствующим направлениям.

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GENERATIVE ARTIFICIAL INTELLIGENCE

Saidov U.Y.

u.y.saidov@buxdu.uz
Bukhara State University, Bukhara, Uzbekistan

Annotation. The purpose of this article is to highlight the role and importance of generative artificial intelligence in supply chain management. We look at how generative artificial intelligence is being used in various aspects of supply chain management and analyze the experiences of companies that have successfully implemented the technology. We will also discuss the main problems in the implementation of technology and ways to solve them.

Keywords: artificial intelligence, generative artificial intelligence, application, problems, analysis, strategies, management, optimization, product, control, content.

1 Introduction

Generative Artificial Intelligence is a new and rapidly developing field of artificial intelligence that uses deep learning algorithms to generate new, never-before-seen content. Generative artificial intelligence systems work by analyzing existing data sets and generating new patterns from them. Nowadays, this technology is used to create images, texts, sounds and even videos. Traditional artificial intelligence systems are mainly focused on analyzing and classifying existing data. They are usually programmed and trained to perform specific tasks. Generative AI does the opposite - it creates new content. Generative models learn key features of the data and then create new, similar patterns based on those features.

2 Methods

Supply chain management is a complex and multifaceted process that often requires analyzing large amounts of data and making real-time decisions.

Generative AI is transforming supply chains in ways that are fundamentally different from traditional methods. Here are some key aspects of how generative AI-powered supply chains differ from traditional supply chains[1]:

1.Proactivity. Traditional supply chains respond reactively to changes in demand, disruptions in supply, or logistical problems.

And generative AI can predict these changes before they happen, allowing companies to be proactive rather than reactive.

2. Dynamic optimization

Traditional supply chain operations rely on static planning models that do not change unless manually updated.

Generative AI logistics introduces dynamic optimization that continuously learns and adapts to new data and optimizes operations in real-time.

3. Automated analysis

Previously, data analysis was often done manually, time-consuming, and prone to human error. Generative AI processes large volumes of data quickly and accurately through automated analysis for the supply chain.

4. Tailored strategies

Traditional supply chains often employ one-size-fits-all but suboptimal solutions.

Generative AI can develop supply chain strategies tailored to each supply chain's unique challenges and opportunities.

Thus, generative artificial intelligence is creating positive changes in the market for supply chain and encouraging more companies to implement generative artificial intelligence in their supply chain operations. This technology enables companies to create more agile, flexible and efficient supply chains and helps them achieve a competitive advantage. The application of generative artificial intelligence to supply chain management allows companies to better meet the needs of their customers, optimize costs and quickly adapt to changing market conditions.

Generative AI can be of great value in many areas of supply chain management, including demand forecasting, raw material inventory management, and supplier selection. It enables companies to optimize operations, reduce costs and increase competitiveness. Below is a brief overview of some of the main application areas [2]:

Demand Forecasting Generative AI can play an important role in demand forecasting (forecasting) by analyzing factors such as historical sales data, seasonality, promotions and economic conditions. Artificial intelligence models can generate more accurate demand forecasts based on this data. This allows companies to better manage their inventory, allocate resources, and anticipate market trends. Inventory Optimization Generative AI models continuously monitor changes in customer demand, supplier activity and delivery times. It can recommend optimal order points and quantities to minimize inventory holding costs and avoid stockouts.

Formulating Procurement Strategy Generative models can help determine the best procurement strategy by taking into account various factors such as supplier performance, price changes and economic performance. This allows companies to optimize costs, ensure supply stability and quickly adapt to market changes. Route Optimization In logistics and transportation, generative artificial intelligence can calculate optimal truck routes or determine the most efficient location of distribution centers, taking into account factors such as road conditions, fuel prices and delivery windows. This allows to reduce delivery time and reduce logistics costs.

Supply Chain Simulation Simulating different scenarios using generative artificial intelligence allows companies to understand potential problems, vulnerabilities and opportunities in their supply chain. This enables them to develop more robust strategies and improve supply chain sustainability.Supplier Selection Generative AI can help companies select suppliers that match their specific needs, taking into account factors such as price, quality, delivery time and geographic location. This allows companies to find the most suitable suppliers and work effectively with them. Risk Management Generative AI can identify potential risks in the supply chain, such as natural disasters, geopolitical events, or changes in regulations. This allows companies to develop contingency plans and mitigate potential impacts. New Product Launch Generative AI can optimize new product launch by simulating different new product manufacturing and distribution scenarios, taking into account production capacity, lead times and market demand.

Waste reduction By analyzing production and consumption data, generative artificial intelligence can identify areas where waste can be reduced, leading to more efficient use of resources and cost savings. Manufacturing Customized Products In industries where flexibility is important, such as fashion or electronics, generative artificial intelligence can help create customized products based on individual preferences while taking into account production constraints. Quality Control Generative AI can detect anomalies in production data, which can help improve quality control processes by identifying defects or deviations from expected norms. Supply Chain Visualization Generative models can create visual representations of supply chain processes, making it easier for stakeholders to understand processes and identify potential improvements or inefficiencies.

As generative artificial intelligence technologies continue to develop rapidly, new and innovative applications may emerge in the near future.

3 Results

Application of Generative Artificial Intelligence across the manufacturing value chain[3].

Value chain stage	Generative AI use cases
Supply chain - warehousing and logistics	Content creation:
	- Automatically design a route using routing algorithms to reduce cost and delivery time
	- Create and verify necessary documents for transportation
	Create useful information:
	- Provide cargo and delivery time updates through a chatbot interface
	- Provide drivers with general information providing an interactive virtual assistant to extend the services provided (for example, road navigation)
	- Improving yard management processes based on sensor and camera data
	- Optimizing material reordering to minimize stock-outs and inventory levels
	Interaction:
	- Order collection routes automating warehouse design to facilitate
Production - Efficiency, Maintenance and Health and Safety	Content creation:
	- Create employee training videos and maintenance problem solving role plays
	- Write standard operating procedures and policies and automatically translate documents into other languages
	Interaction:
	- Identify hazardous work conditions and identify relevant stakeholders as needed inform preventive measures
	Generate actionable information:
	- Automate root cause analysis to identify the root causes of quality non-conformances without manual data analysis
	- Predict precise machine failure modes and automatically develop intervention plans
	- IoT, RFID and orders adjust production orders in real-time based on tracking data
	- get performance updates, priorities and advice from AI chatbots
Planning - production planning and procurement	Content creation:
	- Develop production plans based on available materials, equipment and resources
	- Discover new supplier profiles across different sources
	Create actionable information:
	- Pre-screen, summarize and extract interesting clauses across contracts and risks evaluation
	Interaction:
	- Automatic execution of ERP exception messages to achieve optimal inventory levels
Planning - product development	Content creation:
	- Create product concepts and engineering drawings to reduce research and experimentation time
	- Discover new materials through testing to determine their suitability and function as alternative raw materials
	Create useful information:
	- Consumer /predict product market fit using market data

Table 1. Generative AI can accelerate, scale and automate manufacturing and supply chain operations.

Problems in the introduction of generative artificial intelligence

Although generative artificial intelligence has great potential in supply chain management, there are a number of challenges in its implementation. Without addressing these challenges, organizations will not be able to harness the full potential of generative artificial intelligence.

Data limitations The first problem is related to data limitations. Generative AI models rely on large amounts of high-quality data. However, in many companies, data may be poorly structured, incomplete, or of poor quality. The process of collecting, cleaning, and preparing data can be time- and resource-intensive. According to a study by the Boston Consulting Group, more than 60% of companies consider data quality to be the main obstacle to implementing artificial intelligence.

Integrating technology into existing systems The second challenge is related to integrating technology into existing systems. Generative AI typically works in conjunction with other technologies such as cloud computing, big data, and the Internet of Things (IoT). Integrating these technologies into existing business processes and IT systems can be complex and expensive. Companies may be forced to upgrade their infrastructure and ensure seamless data flow between different platforms.

Security and Privacy Security and privacy are also important concerns. Supply chain information is often confidential and strategically important. Transferring this data to cloud platforms and using third-party solutions can pose security and privacy risks. Companies must implement strong security protocols to protect data and comply with regulatory requirements. According to a Deloitte survey, more than 70% of companies believe that security and privacy are the biggest challenges in AI projects[4].

Lack of skilled professionals Lack of skilled professionals can also be a barrier to the implementation of generative artificial intelligence. Because this technology is relatively new and rapidly evolving, many organizations lack experts with deep knowledge of generative artificial intelligence. Companies will need to train their employees or hire new employees with expertise in AI. According to LinkedIn, AI jobs have grown 74% over the past five years, but there is a shortage of qualified candidates in the job market.

To solve these problems, companies must take a strategic approach to the introduction of generative artificial intelligence. They need to invest in improving the quality of their data, integrating technology with existing systems, ensuring security and privacy, and upskilling their employees. Companies should also take a carefully planned and phased approach to implementing generative AI. Starting with small projects, building on successful results and scaling up over time allows companies to effectively implement technology and get the most out of it.

Recommendations for applying generative artificial intelligence to supply chain management

Directions for improving state policy

The state plays an important role in creating favorable conditions for the large-scale introduction of generative artificial intelligence. They should focus on policy improvement in the following areas:

Developing a strategy for the development of artificial intelligence States should develop national strategies that define specific goals and objectives for the development of artificial intelligence, including generative artificial intelligence. These strategies should include technology introduction, training, infrastructure development and international cooperation.

Investment incentives States should introduce financial incentives, such as tax credits, grants, and subsidies, to encourage investments in generative artificial intelligence. This will help support innovative projects and accelerate the large-scale implementation of technology.

Improving the regulatory framework States need to improve the legislation and regulatory framework governing the use of artificial intelligence. This should cover data security, privacy protection, intellectual property rights and ethics. Clear and transparent regulations allow companies to implement the technology with confidence[4] .

Development of Public-Private Partnerships States should encourage cooperation between the public and private sectors in the development and implementation of generative artificial intelligence. This may include collaborative projects between research institutes, universities and industry, as well as cooperation with government organizations in the application and implementation of technology for testing.

Training and upskilling States need to invest in education and professional development programs to train and upskill existing AI professionals. They should encourage collaboration between higher education institutions, research institutes and industry, and support career guidance and inspiration

initiatives to attract talented young people to the field of artificial intelligence. Improving public policy in these areas will create a favorable environment for the large-scale use of generative artificial intelligence. Government support and incentives allow companies to confidently introduce technology and fully utilize its potential. The state's proactive policy also accelerates the country's digital transformation and stimulates economic growth.

Practical recommendations for the business community. In order for companies to successfully implement generative artificial intelligence into their supply chain operations, it is important that they consider the following practical recommendations:

Testing the technology Companies should test generative AI through small projects or trials. This allows them to understand the capabilities and limitations of the technology and to identify solutions that fit their needs. Successful trials can serve as a basis for large-scale implementation.

Improving data quality Generative AI models depend on high-quality and structured data. Companies need to focus on their data collection, cleaning and preparation processes, as well as invest in integrating and standardizing data from different sources. Quality data increases the accuracy of generative models and leads to reliable results. Redesigning Processes Implementing generative artificial intelligence often requires redesigning business processes. Companies need to optimize and automate their processes to work with artificial intelligence. This may include improving data flows, developing new workflows, and aligning staff roles[4].

Developing a skilled workforce The successful implementation of generative artificial intelligence depends on a skilled workforce. Companies need to train and upskill their employees in AI and data analytics. They also need to attract and retain AI experts. Employees with strong technology knowledge and skills drive innovation and drive digital transformation.

Development of cooperation and partnerships Companies should develop cooperation and partnerships in pooling knowledge and resources in the field of generative artificial intelligence. They can collaborate with technology suppliers, research organizations and other industry players. Such cooperation promotes new ideas and innovations, as well as lowers the cost of technology implementation. Ensuring Security and Privacy Generative AI models process large amounts of data, which may pose security and privacy risks. Companies must implement strong security protocols to protect data and ensure privacy. They also need to consider the ethical and legal aspects of the use of artificial intelligence and ensure transparency and accountability.

Continuous improvement Generative artificial intelligence is a rapidly evolving field, and companies need to stay abreast of the latest advances in technology and constantly update their systems. They must regularly assess the capabilities and limitations of technology and adapt it to fit their business needs. Continuous improvement allows companies to maintain a competitive edge and quickly adapt to market changes. Taking these recommendations into account will allow companies to successfully integrate generative artificial intelligence into their supply chain operations and take full advantage of the technology. Proactive and strategic approaches by the business community can lead to widespread adoption of generative artificial intelligence and significant changes in supply chain management[5].

Issues of personnel training and professional development.

For the large-scale implementation of generative artificial intelligence, it is important to train experts in the field of artificial intelligence and improve the skills of existing personnel. The following measures will help to develop human resources:

Improving the higher education system Universities and other higher education institutions should develop new educational programs and courses in artificial intelligence, data analysis and programming. These programs should focus on combining theoretical knowledge and practical skills. It is also necessary for higher education institutions to strengthen cooperation with industry and ensure that students participate in real projects. Expand professional development opportunities Companies and educational institutions should provide professional development opportunities for experts in the field of artificial intelligence. This may include technical workshops, certification programmes, mentoring schemes and internship programmes. Such initiatives help to continuously update the knowledge and skills of the existing personnel.

Developing technical skills To effectively deploy generative artificial intelligence, employees must have strong technical skills in programming, data analysis, and algorithms. Companies and educational institutions should offer training programs in these areas and improve the skills of participants through practical projects. Developing Soft Skills In addition to technical skills, AI professionals must also possess creativity, problem-solving, critical thinking, and communication skills. Training programs should focus on developing these soft skills and teach participants how to apply technology to solve business problems. Career guidance and inspiration In order to attract young people to the field of artificial intelligence, schools, universities and companies should implement career guidance and inspiration initiatives. These can include technology masterclasses, hackathons and competitions. Such events help identify talented young people and attract them to the industry[6]. Development of international cooperation It is important that educational institutions and companies develop international cooperation and study global experiences. They should establish cooperation with foreign universities, research centers and leading companies. Such cooperation ensures the exchange of new knowledge and innovations and increases the quality of personnel training.

Strengthening public-private partnership Strengthening cooperation between state authorities, educational institutions and the business community plays an important role in the development of human resources. The state should support education and research projects in the field of artificial intelligence, and the private sector should provide opportunities for internships and internships. Such partnerships increase the efficiency of the training system and ensure that it matches the needs of the workforce[6]. By implementing these measures, countries can build the highly skilled workforce needed for generative artificial intelligence. Human resource development lays the groundwork for successful implementation of technology and maximum benefit from it. At the same time, it increases the competitiveness of the economy and ensures innovative development of the country.

4 Conclusions

Generative AI has the potential to revolutionize supply chain management. It offers significant improvements in areas such as demand forecasting, inventory optimization, risk management, and rationalization of supply processes. Generative models increase efficiency and intelligent operations at all stages of the supply chain by analyzing large volumes of data, identifying hidden data and relationships, and supporting real-time decision-making. At the same time, caution is needed in the introduction of technology. The limitations and risks of generative models should be considered, as well as the ethical and social implications. In the future, generative artificial intelligence will become an integral part of supply chain management, allowing companies to optimize their operations and quickly adapt to changing market conditions[7]. It plays an important role in developing cooperation and improving sustainability in the supply chain. Smart and responsible use of generative artificial intelligence will shape the future of supply chains and drive transformational change across industries.

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