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Introducing smart technologies into marketing logistics: Personalising the supply chain and improving the customer experience

Abstract. The implementation of Industry 4.0 smart technologies is particularly significant for enhancing the efficiency of marketing logistics, due to the multiplicative nature of their impact and the synergistic effects arising from the convergence of Logistics 4.0 and Marketing 4.0. This underscores the need for a rigorous scientific examination of the importance and distinctive features of Marketing Logistics 4.0, as well as the development of methodological approaches to identify effective strategies for integrating this concept into enterprise activities, which constituted the primary objective of this study. Cluster analysis was employed to segment a sample of 100 customers of a warehouse-store in Kyiv (Ukraine) into three clusters characterised by similar behavioural and logistical profiles, including order volume, purchase frequency, location, and satisfaction level. Incorporating both behavioural and logistical characteristics of customers served as the basis for developing recommendations on the prioritisation of strategies for implementing smart technologies in marketing logistics tailored to each identified cluster. The highest priority for smart technology implementation in marketing logistics was assigned to strategies aimed at retaining and incentivising loyal customers through the Internet of Things, big data, information systems, automation, and robotics. The next priority involves the application of machine learning, cognitive technologies, virtual and augmented reality, and digital twins to enhance transparency, trust, and engagement among profitable customers. Blockchain technology was deemed the lowest priority for low-potential customers, as its impact on loyalty and the financial attractiveness of the enterprise is limited. The proposed methodological approach for prioritising strategies offers significant practical value in contexts characterised by constrained financial resources and the high costs associated with implementing smart technologies

Keywords: digital business transformation; data analytics in marketing; Industry 4.0; Logistics 4.0; Marketing 4.0; key performance indicators

INTRODUCTION

In the context of large-scale intellectualisation of logistics and marketing as key areas of activity of any enterprise, the development of scientific approaches to managing the processes of implementing smart technologies in the

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marketing logistics of enterprises is of particular importance, the expected results of which are an increase in the level of personalisation of supply chains, improvement of logistics and marketing services, ensuring customer loyalty and overall business competitiveness. The use of smart technologies in marketing logistics allows enterprises to obtain a multiplicative effect from the optimisation of both marketing and logistics functions simultaneously. This is due to the fact that any smart technology has a multifaceted impact on all areas of enterprise activity, with marketing and logistics being the most sensitive to intellectualisation processes.

Analysing the prospects for the use of smart technologies, scientists highlighted the importance of certain innovations of Industry 4.0 in the transformation of modern marketing. A.T. Rosário & J.C. Dias (2022) emphasised that the greatest impact on marketing was made by technologies in the field of information processing, namely the Internet of Things (IoT), big data analytics, cloud computing, customer profiling and artificial intelligence (AI). The authors attributed the priority of these technologies to their great potential for collecting, analysing, interpreting and using customer data regarding their activity in the offline and online environment. Summarising the impact of Industry 4.0 on marketing, researchers noted the intellectualisation of marketing, the renewal of its basic principles (collaboration, conversation, co-creation, cognition, and connection).

A.T. Rosário & J.C. Dias (2022) emphasised that IoT technology plays a crucial role in collecting strategically important information about target markets. Cloud computing, in turn, significantly contributes to the development of the critical information infrastructure necessary for effective marketing, as it enables digital marketing professionals to remotely access data in various file formats, including real-time consumer feedback on products, services, and brands. Furthermore, big data has a critical role in gathering, aggregating, and commercialising personal and customer information, providing marketers with a comprehensive view of consumer behaviour patterns. This, in turn, allows them to create and implement customer-centric advertising content and marketing strategies that precisely respond to consumers' current needs and preferences. AI has had a revolutionary impact on marketing by enhancing the prediction of consumer behaviour, facilitating the generation of new ideas, and supporting decision-making processes regarding marketing initiatives and their progress.

As noted by M. Vijayakumar *et al*. (2025), the synergy of Industry 4.0 and Marketing 4.0 technologies is manifested in establishing a continuous connection, when smart data helps companies automatically sort customers, send relevant deals and predict their behaviour, improving the marketing effectiveness of the business. The authors recommended assessing improvements in marketing effectiveness by analysing the impact of smart technologies on key performance indicators (KPIs). They noted that return on investment (ROI) and customer lifetime value demonstrate efficiency gains in personalised marketing campaigns achieved through the use of AI and predictive analytics. Customer retention and churn indicators reveal increased effectiveness of push notifications resulting from the integration of customer relationship management (CRM) systems with the IoT. Moreover, the additional sales ratio and customer loyalty metrics, such as the Net Promoter Score, improve due to the synchronisation of enterprise resource planning (ERP) systems with machine learning, which strengthens customer loyalty. Conversion rates and customer return levels rise as a result of employing augmented and virtual reality (AR and VR) technologies for product testing, as well as digital twin technologies and cloud computing in the product creation process.

The unprecedented impact of Industry 4.0 technologies on logistics has also been studied by many scientists, including S. El Hamdi & A. Abouabdellah (2022). The summary of the scientific results of 47 publications allowed the authors to conclude that Industry 4.0 technologies support the logistics paradigm in two areas: physical operations and resource management, highlighting the importance of AI and big data analytics to support decision-making in logistics; the IoT for smart sensors to ensure the interconnection of logistics objects and their identification; IT systems and cloud computing to optimise information flows. S. El Hamdi & A. Abouabdellah (2022) consider the following as the main components of Logistics 4.0: big data, blockchain technology, radio-frequency identification, GPS, IoT, sensors (cameras and humidity/temperature sensors), 3D printing, AR and smart products, as well as investments, innovation management and value chain integration, automation of material flow in warehouse and transport, ERP, warehouse management system, smart transport systems (drones, robots and autonomous vehicles).

Therefore, the introduction of Industry 4.0 technologies into marketing and logistics activities has led to the intellectualisation of these concepts to the level of Logistics 4.0 and Marketing 4.0. At the same time, as E. Sós (2021) noted, the concepts of logistics and marketing are considered separately in most studies, despite the growing recognition that the implementation of a marketing logistics strategy is necessary to achieve customer satisfaction. The purpose of the article was to substantiate the importance and study the features of Marketing Logistics 4.0 and develop methodological approaches to determining effective strategies for implementing this concept in the activities of enterprises.

MATERIALS AND METHODS

The study was conducted in three stages. The first stage was devoted to substantiating the importance of implementing the concept of marketing logistics by modern enterprises. The second stage included a comparative analysis of the impact of smart technologies on logistics and marketing, identifying the synergistic effect of the impact of these technologies on marketing logistics, identifying the features and KPIs of Marketing Logistics 4.0. The third stage involved the development of a methodological approach to determining a strategy for implementing smart technologies in the marketing logistics of enterprises. This stage of the study included the empirical part, which contains the clustering of the sample, which is represented by 100 customers of the warehouse-store (Kyiv, Ukraine). The source of information was the data of the warehouse-store CRM system.

The main criteria for forming the sample were defined as follows. The target population consisted of warehouse-store customers who had placed at least one order during the 12 months of 2024, with the research limited to the Kyiv, including all its administrative districts. The

inclusion criteria required that each customer record contain complete contact and logistics information (such as an address or district), as well as basic data on the number of orders placed during 2024, the total order volume or value, and a satisfaction assessment obtained through a survey. Additionally, only customers who were legally or physically active – meaning they had placed orders within the last 12 months of 2024 – were included.

Certain exclusions were also applied: duplicate entries of the same customer were removed, with the most recent or most complete record retained; "mosaic" records with more than 30% of key fields missing were excluded; and customer records showing abnormally small or large values, clearly caused by data errors (for instance, a zero amount despite recorded orders), were omitted. For the selection method, if the total customer list exceeded 100 entries, a stratified random sampling approach was used – either by city district to preserve spatial representativeness or by previous purchase frequency (high, medium, or low) – with proportional selection within each stratum. If the list contained exactly 100 customers, all were included in the sample. In cases where the list had fewer than 100 customers, all available records were used, and any sampling limitations were explicitly stated. The cluster analysis method was chosen to group customers. The clustering procedure was carried out using the k-means method and Nearest Neighbour Analysis, both performed with the IBM SPSS Statistics software package.

RESULTS

Based on modern definitions, marketing logistics is an approach to corporate management and a field of activity implemented on its basis, which permeates all corporate activities, integrates the results of both disciplines, and involves mutual knowledge of managers in related industries and is aimed at a synergistic effect (Barbosa-Povoa & Pinto, 2020; Sós, 2021). The importance of developing the modern concept of marketing logistics is due to its significant synergistic potential in the field of satisfying consumer needs, because marketing forms and manages demand, and logistics satisfies this demand in the most effective way. The transformation of the classic marketing 4 Ps into the modern 7 Ps (product, price, promotion, place, people, process, physical evidence) has increased the impact of marketing on logistics: the introduction of new products increases logistics costs; price changes affect the entire logistics system due to changes in demand; the promotion of goods and services leads to additional logistics costs and the expansion of logistics services due to increased turnover; the increase in distribution channels affects delivery times and logistics costs; personnel affects all logistics processes of the company; customer marketing service processes affect the technologies used, flexibility, order fulfilment times, inventories, etc.; the environment in which the product/service operates can determine the quality assessment (Sós, 2021).

Modern logistics and the concept of supply chain management affect all aspects of marketing, because the implementation of marketing decisions, both strategic and tactical/operational, takes place in supply chains. Considering the 7 Rs of logistics ("right" product, customer, time, place, cost, quantity and quality), each "R" has a special meaning precisely in that part of the supply chain where finished products go to the consumer, that is, in the marketing and logistics sales channels, the management of which is in the direct competence of marketing logistics. Compliance with all 7 Rs of logistics is a prerequisite for consumer satisfaction and fulfilment of the "ideal" order. The logistics strategy of any company is subordinate to the marketing strategy and contributes to its implementation in the most effective way.

Therefore, the mutual influence, close integration and interaction of two concepts, two strategies – marketing and logistics – ensure synergy in sales channels through the implementation of the most effective marketing logistics strategy. In the era of Industry 4.0, the integration of the two concepts of Marketing 4.0 and Logistics 4.0 leads to the transition of Marketing Logistics to the 4.0 level. The features of Marketing Logistics 4.0, due to the integration of technologies and concepts of Industry 4.0 into the management of the physical movement of goods, are aimed at increasing the efficiency, transparency and responsiveness of the supply chain and improving the overall effectiveness of marketing. The generalisation of literary sources allowed to identify the key features/indicators of Marketing Logistics 4.0 as a result of the implementation of Industry 4.0 technologies in logistics and marketing processes (Table 1).

Table 1. Key features and corresponding KPIs of Marketing Logistics 4.0 in terms of implementing Industry 4.0 technologies in marketing and logistics processes

Industry 4.0 technology/ concept	Logistics 4.0 integration result	Marketing 4.0 integration result	Key features of Marketing Logistics 4.0	KPIs Marketing Logistics 4.0
IoT	Ensuring the interconnection of logistics facilities and their identification (El Hamdi & Abouabdellah, 2022)	Gathering strategically important information regarding target markets (Rosário & Dias, 2022)	Improved visibility, transparency and predictability in sales channels	Customer retention, customer churn metrics (Vijayakumar *et al.*, 2025). Order execution time. Time to recovery. Order cycle time. Capacity utilisation. Risk assessment frequency. Supply and demand variation. Number of nodes in SC. Service level. On-time delivery. Equipment efficiency. Inventory movement speed. Inventory level. Forecast accuracy (Marinagi *et al.*, 2023)
Big data	Increased organisational efficiency; environmental, economic and social sustainability, supply chains (Lee & Mangalaraj, 2022)	Collection, aggregation, commercialisation of personal data and customer information (Rosário & Dias, 2022)	Data-driven decision-making, sustainable development of sales channels	ROI. Long-term customer value (Vijayakumar *et al.*, 2025). Order fulfilment time. Time to recovery. Capacity utilisation. Risk assessment frequency. Supply and demand variation. Number of nodes in the distribution channel. Proximity to suppliers and customers. Service level. On-time delivery. Equipment efficiency. Inventory turnover rate. Inventory level. Forecasting accuracy (Marinagi *et al.*, 2023)

Table 1. Continued

Industry 4.0 technology/ concept	Logistics 4.0 integration result	Marketing 4.0 integration result	Key features of Marketing Logistics 4.0	KPIs Marketing Logistics 4.0
AI	Rapid logistics decision-making, forecasting supply chain trends and logistical challenges. Reducing risks and increasing operational efficiency (Samuels & Motatsa, 2025)	Predicting consumer behaviour; generating new ideas, making decisions about marketing initiatives and progress (Rosário & Dias, 2022)	Increased flexibility, responsiveness and efficiency of sales channels	ROI. Long-term customer value (Vijayakumar *et al.*, 2025). Order fulfilment time. Time to recovery. Capacity utilisation. Risk assessment frequency. Supply and demand variation. Number of nodes in the distribution channel. Proximity to suppliers and customers. Service level. On-time delivery. Equipment efficiency. Inventory turnover rate. Inventory level. Forecasting accuracy (Marinagi *et al.*, 2023)
Machine learning and cognitive technologies	Accurate forecasting, automated decision-making, reduced operating costs, improved service quality and supply chain sustainability (Gafiatullin & Mukhanova, 2025)	Increasing customer loyalty (Vijayakumar *et al.*, 2025)	Personalised marketing logistics and on-demand marketing logistics	Cross-selling ratio. Customer loyalty system indicators (Vijayakumar *et al.*, 2025). Order fulfilment time. Time to recovery. Order cycle time. Capacity utilisation. Risk assessment frequency. Supply and demand variation. Number of nodes in the sales channel. Service level. On-time delivery. Equipment efficiency. Inventory turnover rate. Inventory level. Forecast accuracy (Marinagi *et al.*, 2023)
Automation and robotics	Transformation of warehouse and transportation processes, increased speed, accuracy and efficiency (El Hamdi & Abouabdellah, 2022)	Marketing automation can make the planning and management process easier, marketing programmes (Byba, 2023)	Improved customer experience, faster and more reliable delivery	ROI. Long-term customer value. Cross-selling ratio. Customer loyalty system indicators (Vijayakumar *et al.*, 2025). Order execution time. Time to recovery. Order cycle time. Capacity utilisation. Number of nodes in the sales channel. Service ratio. On-time delivery. Equipment efficiency. Inventory turnover rate. Inventory level. Forecasting accuracy (Marinagi *et al.*, 2023)
Supplemented/ VR, digital twin technologies	Monitoring, evaluation, forecasting, optimisation, control, system management, system integration and adaptation (Liu *et al.*, 2024). Increasing safety and reducing risks, increasing efficiency (Sariisik, 2025)	Product marketing testing	Improved customer experience, faster and more reliable delivery	Conversion rates, customer returns. Marketing budget optimisation metrics (Vijayakumar *et al.*, 2025). Order fulfilment time. Time to recovery. Capacity utilisation. Risk assessment frequency. Supply and demand variation. Number of nodes in the sales channel. Service level. On-time delivery. Equipment efficiency. Inventory turnover rate. Inventory level. Forecast accuracy (Marinagi *et al.*, 2023)
IT systems and cloud computing	Optimisation of information flows (El Hamdi & Abouabdellah, 2022)	Customer data management, real-time collaboration, reduced hardware and software costs, scalability and strategy correction, flexibility and adaptability (Besim & Sharma, 2023).	Decentralised decision-making to reduce overall costs in sales channels	Conversion rates, customer returns. Marketing budget optimisation metrics (Vijayakumar *et al.*, 2025). Order fulfilment time. Time to recovery. Capacity utilisation. Service cycle time. Supply and demand variation. Service level. On-time delivery. Equipment efficiency. Inventory movement speed. Inventory level. Forecast accuracy (Marinagi *et al.*, 2023)
Blockchain	Increased trust and transparency, improved monitoring and compliance (Kumar *et al.*, 2025)	Eliminating intermediaries, increasing transparency, privacy and security of consumers, customer loyalty programmes, social media channels, progressive, customer interaction skills. Customer influence in advertising and marketing (Adıgüzel, 2021)	Increased transparency, security and efficiency: improved product traceability, optimised supply chains and automated processes. Reduced fraud, increased resilience and customer-centricity of sales channels	ROI. Long-term customer value. Coefficient of additional sales. Customer Loyalty System Indicators (Vijayakumar *et al.*, 2025). Order execution time. Time to recovery. Order cycle time. Capacity utilisation. Frequency of risk assessment. Supply and demand variation. Number of nodes in the distribution channel. Service level. On-time delivery. Inventory level. Forecasting accuracy (Marinagi *et al.*, 2023)

Source: developed by the authors

The introduction of smart technologies into the marketing logistics of enterprises significantly affects its effectiveness, with each technology having a specific impact on certain KPIs (Table 1). When considering the prospects for implementing any Industry 4.0 technology, enterprises should consider the ROI in this technology. Therefore, the process of selecting the most promising smart technologies for business requires a well-founded approach, consistent with the marketing logistics strategy. Special attention deserves the preliminary use of mathematical modelling, in particular, cluster analysis, for the purpose of a well-founded implementation of certain smart technologies and the corresponding definition of marketing logistics strategies for certain groups of

consumers/clients.In view of the above, a sample consisting of 100 customers of a warehouse-store (Kyiv, Ukraine) with certain behavioural and logistical characteristics (order volume, frequency of purchases, location, level of satisfaction) was formed for cluster analysis (Table 2). Grouping customers by similar characteristics will allow determining the most effective strategies for implementing smart technologies in marketing logistics that serve each of the formed groups.

Table 2. Data on customers of the warehouse-store for 2024

Customer	Purchase frequency	Average order amount ($)	Distance to warehouse (km)	Satisfaction level (1-5)
C001	89	8.22	3	4
C002	52	14.4	14	4
C003	64	18.56	24	5
C004	51	14.36	25	4
C005	56	13.11	11	5
C013	92	10.48	10	5
C014	53	17.73	27	5
…	…	…	…	…
C 100	67	16.84	4	5

Source: developed by the authors

The clustering procedure (k-means) was carried out using IBM software SPSS Statistics. After normalising the data and selecting the number of clusters, the k-means algorithm divided customers into three groups (Fig. 1). Cluster 1: customers with high purchase frequency, small amounts and high satisfaction level (regular buyers, loyal). Cluster 2: customers who are located a long distance from the warehouse have a low level of satisfaction (inactive or dissatisfied customers). Cluster 3: customers with average purchase frequency, large order amounts, and average satisfaction level (infrequent but large orders).

Initial Cluster Centers

	Cluster 1	2	3
Purchase frequency	97.00	3.00	35.00
Average order amount ($)	5.51	35.81	499.09
Distance to warehouse (km)	1.00	466.00	50.00
Satisfaction level (1–5)	4.00	2.00	3.00

Final Cluster Centers

	Cluster 1	2	3
Purchase frequency	66.96	10.00	29.20
Average order amount ($)	17.06	67.66	351.64
Distance to warehouse (km)	23.19	328.55	40.26
Satisfaction level (1–5)	4.31	1.55	3.29

Figure 1. Characteristics of three clusters of warehouse-store customers using the k-means algorithm
Source: developed by the authors

It should be noted that the largest number of clients was in Cluster 1, the smallest in Cluster 2, and the average number in Cluster 3 (Fig. 2).

Cluster	1	54.000
	2	11.000
	3	35.000
Valid		100.000
Missing		.000

Figure 2. Number of warehouse-store customers in each cluster (obtained from IBM SPSS Statistics
Source: developed by the authors

Conducting cluster analysis using the Nearest Neighbour Analysis provided the opportunity to visualise the results of customer clustering. Graphical representation of cluster analysis using the Nearest Neighbour Analysis in Figure 3 shows several groupings (clusters).

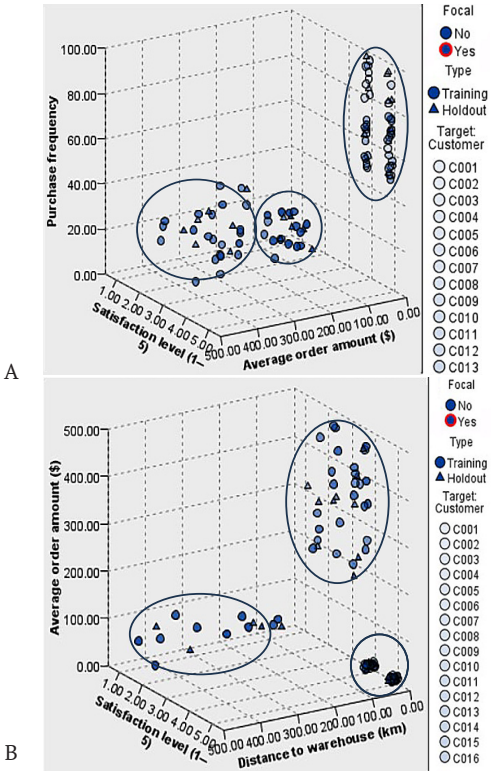

Figure 3. 3D scatter plot of warehouse-store customers
Note: the coordinate axes correspond to the clustering factors (X axis – satisfaction level; Y axis – purchase frequency in image A and average order size in image B; Z axis – average order size in image A and distance to the warehouse in image B); the points correspond to customers (blue circles – Training (training sample); blue triangles – Holdout (control sample); red points – Focal (focal customers)); the distinction between Training and Holdout shows that the data is used both to train the clustering model and to test its stability
Source: developed by the authors

Cluster 1. With a high level of satisfaction (X = 4 - 5) and small average orders (up to $50), a group of customers with a high frequency of purchases is visible (image A). Near the X axis (image B) = high level of satisfaction (4-5) and close proximity to the cluster of customers with a low average order (≈ up to $50). This is a typical profile of loyal regular customers. Cluster 2. At a low level of satisfaction (X = 1 - 2) and with small average orders (up to $100), with a long distance to the warehouse (⩾300 km), a group of customers with a low frequency of purchases is concentrated – low-prospect or "risky" customers. Cluster 3. At medium satisfaction values (X = 2 - 3) and short distances to the warehouse (⩽50 km), there are customers with medium or large order volumes (>$300-500) – perhaps these are strategic customers. The allocation of focal customers in each cluster made it possible to identify the most representative groups, and the division of data into Training and Holdout confirmed the stability and consistency of the model. Thus, the analysis results provide the basis for customer segmentation and the development of personalised logistics service strategies based on the implementation of smart technologies and aimed at increasing the company's loyalty and profitability. The conducted customer clustering allows to more accurately determine the needs of different customer segments and offer more effective strategies for implementing the recommended smart technologies of Marketing Logistics 4.0 (Table 3).

Table 3. Recommended smart technologies of Marketing Logistics 4.0 for warehouse-store customer clusters

Customer cluster	Smart technologies of Marketing Logistics 4.0							
	IoT	Big data	AI	Machine learning and cognitive technologies	Automation and robotics	Supplemented/ VR, digital twin technologies	IT systems and cloud computing	Blockchain
Cluster 1	+	+			+		+	
Cluster 2	+	+					+	+
Cluster 3	+	+	+	+		+	+	

Source: developed by the authors

The implementation of the following technologies for all three clusters is considered relevant: IoT, big data, IT systems, and cloud computing. These technologies are universal for marketing logistics and enhance visibility, transparency, and predictability within sales channels; enable data-driven decision-making; and support the decentralised adoption of optimal solutions under conditions of cost reduction across sales channels. For all clusters, under conditions of unstable demand and changing sales markets, the integration of clustering with a smart supply chain management system (including IoT sensors in warehouses, CRM systems, and analytical modules) is deemed advisable to ensure real-time adaptation of marketing logistics to each customer group. Regarding specific smart technologies, the following is proposed.

Cluster 1. Focus on retaining and encouraging loyal customers. Recommended smart technology is automation and robotics (pick-by-robot, conveyors, automated shelving). The use of this technology in a warehouse-store can significantly improve the quality of service for loyal regular customers. Due to faster order fulfilment, reduced errors, and stable deliveries, such customers receive a sense of reliability and care, which strengthens their commitment to the company. In addition, automated systems allow to personalise offers and more effectively take into account individual preferences. At the same time, it is important to maintain a balance between technological solutions and the "human factor" in order to maintain an emotional connection with customers, which is the basis of their long-term loyalty.

Cluster 2. It is necessary to improve the service for these customers or try to reduce the distance to the warehouse (for example, by opening new collection points or warehouses). Customer service can also be improved through the implementation of blockchain technology. The use of blockchain technologies in working with a warehouse-store can partially affect "risky" customers, who are characterised by low satisfaction levels, small orders and significant remoteness. Due to the transparency of supply chains, the ability to track each stage of delivery and the use of smart contracts, blockchain increases customer trust and reduces the risk of fraud. This is especially true for remote buyers who may doubt the reliability of the service.

Cluster 3. Since these are "profitable" customers, it is worth considering strategies to increase their purchase frequency, perhaps through personalised offers or advertising. Recommended smart technologies are AI; machine learning and cognitive technologies; AR and VR, as well as digital twin technologies. Using AI in warehouse-store operations can significantly increase the value of customers in this cluster. AI allows to personalise offers and recommendations, forecast demand and optimise inventory, as well as automate service through chatbots and virtual assistants, which ensures a quick response to customer requests. In addition, AI-based analytics helps identify high-potential customers and direct marketing and logistics resources to them. Together, these capabilities contribute to increasing loyalty, increasing order volumes and forming a strategically important customer segment for the enterprise;

The use of machine learning and cognitive technologies can provide personalisation of offers, forecasting needs and using intelligent support services, so customers receive a higher level of service (for example, related products, special discounts, chatbots, virtual assistants), which has a positive effect on their loyalty. Machine learning-based analytics allows to timely identify customers with high future potential (for example, those who gradually increase their orders) and focus marketing efforts on them. These technologies can turn this cluster into a more promising and strategically important one for the company. AR/VR solutions enable customers to interactively explore the range, virtually test products or processes, which improves their experience and engagement. Digital twin technologies, in turn, allow for the modelling of orders and logistics processes, providing transparency, predictability

and reducing the risk of supply disruptions. Taken together, this strengthens the sense of partnership between the customer and the company and contributes to the transformation of this cluster into a strategically important one.

Therefore, generalising the prospects for implementing smart technologies in marketing logistics gives grounds to argue for the need for a certain prioritisation of strategies to determine the most important areas of action and tasks that ensure the achievement of the long-term goals of a trade organisation by ranking them by importance, timeliness, and expected effect. According to research results, the most promising strategy in the near future is the strategy for further retaining and encouraging loyal customers, based on the use of the following smart technologies: IoT; big data; IT systems and cloud computing; automation and robotics.

The next priority is the strategy of implementing machine learning, cognitive technologies, AR and VR, digital twin technologies to increase customer loyalty, transparency of information for customers (regarding the state of stocks, the process of picking and delivery), which strengthens trust in the supplier and reduces risks, creates a sense of involvement for customers. At the same time, these technologies require significant investments, which is not always justified if the cluster does not demonstrate the expected growth. The last priority is the strategy of using blockchain technology in working with the warehouse-store. This strategy received the lowest priority due to its limited effectiveness in the group of customers with low frequency and small order volumes; therefore, the implementation of this technology will not provide a significant increase in loyalty or financial attractiveness of this cluster of customers.

DISCUSSION

Marketing logistics is an integrated management approach that unites marketing and logistics to achieve synergy in fulfilling consumer needs. Within the framework of Industry 4.0, the concept evolves into Marketing Logistics 4.0, characterised by the adoption of smart technologies such as IoT, big data, AI, automation, and robotics to enhance efficiency, transparency, flexibility, and customer-centricity, driving sustainable business development and competitiveness. According to Y. Tiazhkun (2024), the modern integration of marketing and logistics is a key factor in forming a customer-oriented business model. The study highlights that the introduction of innovative technologies – in particular automation, blockchain, IoT, and green logistics – contributes to improving the efficiency of distribution channels, reducing logistics costs, and strengthening customer trust. Such a combination of marketing and logistics processes creates the foundation for the Marketing Logistics 4.0 concept. According to V. Parsyak & O. Zhukova (2022), modern marketing logistics is formed as an integrated system that combines marketing tools with digital technologies for managing material and information flows. The author emphasised that it is precisely the combination of big data analytics, cloud services, and automated management systems that forms the foundation of the "intelligent marketing logistics" concept, which enhances the competitiveness of enterprises in the digital marketplace. S.O. Kliuiev & B.V. Yurov (2021) investigated the transformation of transport logistics in Ukraine under Industry 4.0 conditions and emphasised that the implementation of IoT, 3D printing, and autonomous transport technologies is already reshaping logistics chains and product movement schemes. Their study highlighted that the integration of digital and cyber-physical technologies contributes to the creation of intelligent logistics systems capable of improving flexibility, transparency, and sustainability in supply chain management.

The obtained results of clustering of customers of a warehouse-store confirmed the feasibility of using behavioural and logistical characteristics for customer segmentation in order to personalise marketing logistics. As a result of the analysis using the k-means method, three clusters of customers were formed, differing in the frequency of purchases, order volume, location and level of satisfaction. This approach allowed developing targeted strategies for implementing smart technologies that increase the efficiency of logistics services and the level of customer loyalty. The study continues and expands upon previous research on the implementation of smart technologies in marketing and logistics processes conducted by various authors. Thus, the research of I. Lee & G. Mangalaraj (2022), which is devoted to the role of big data analytics in improving the efficiency of decisions and personalising supply chains, was expanded supplementing them with a marketing aspect and specifying the corresponding KPIs. A. Samuels & K. Motatsa (2025) in their work focused on AI in the context of environmental impact and sustainability of logistics systems, while the present study revealed the potential of AI to achieve customer personalisation and synergy of marketing logistics.

The results of the research of Y. Liu *et al*. (2024) and F. Gafiatullin & G. Mukhanova (2025), on the use of machine learning, cognitive technologies and digital twins in logistics were supplemented with applied solutions on customer clustering, improving customer experience and choosing Smart technology strategies. The works of V. Byba (2023), devoted to the impact of automation on marketing decision-making, and G. Sariisik (2025), focused on the use of VR/AR as smart technologies to enhance customer interaction, were supplemented with a logistical perspective, taking into account the synergistic effect achieved through the integration of marketing and logistics. The studies by R. Besim & B. Sharma (2023) on cloud technologies as a driver of digital business transformation, as well as S. Adıgüzel (2021) and N. Kumar *et al*. (2025) on the impact of blockchain in marketing and logistics, served as the basis for substantiating the role of these technologies in decentralised decision-making within sales channels and marketing logistics. In the article by C. Marinagi *et al*. (2023), the impact of Industry 4.0 on KPIs was assessed at the macro level, namely for supply chains. This research was extended by examining the impact at the micro level of the enterprise, with particular emphasis on Marketing Logistics 4.0.

The cluster analysis method is an effective and most frequently used method in similar scientific studies in recent years, such as P.S. Durga *et al*. (2023), A.D. Rana *et al*. (2025) and M.A. Rani *et al*. (2024). Regarding customer clustering, similar results were observed in the study by A.D. Rana *et al*. (2025), who also applied cluster analysis (RFM – T model clustering) for segmenting customers of trading companies. The authors proved that the use of a multifactor model (frequency of purchases, monetary

amount, time of the last purchase and type of customer) provides a deeper interpretation of consumer behavioural patterns. The results obtained by them are consistent with conclusions about the effectiveness of clustering for the formation of personalised service strategies. At the same time, in the current study, a spatial component was added to the model – the location of customers, which allows to combine marketing and logistics aspects. Thus, the proposed segmentation model is more comprehensive and aligns more effectively with the objectives of Marketing Logistics 4.0.

P.S. Durga *et al*. (2023) confirmed the effectiveness of the cluster approach for increasing sales and improving customer service. They used the k-means method to group consumers by frequency and number of purchases, and used the results to optimise marketing campaigns. Compared to their findings, this study is different in that it focuses not only on increasing sales, but also on improving the efficiency of logistics processes, which integrates the principles of Marketing 4.0 and Logistics 4.0. In addition, in the current work, segmentation is used as a tool for prioritising the implementation of smart technologies, which allows taking into account the investment constraints of the enterprise. In turn, M.A. Rani *et al*. (2024) focused on the technical aspects of using the k-means algorithm for segmenting retail customers. They confirmed that this method provides reliable grouping of consumers according to their behavioural indicators and can be used to create more effective marketing strategies. This study develops the authors' approach, supplementing it with a logistical component – including the distance indicator to the warehouse and the level of customer satisfaction. This allows to apply the results of clustering not only for marketing, but also for operational decisions in the field of logistics, for example, optimising delivery routes, warehouse placement and improving service.

A comparative analysis of the above studies shows that they all confirm the universality of the clustering method for customer segmentation in different industries. A common feature is the emphasis on enhancing the customer experience, while the proposed approach is interdisciplinary, integrating both marketing and logistics variables. The difference also lies in the practical purpose: in the presented study, clustering is used to determine strategic priorities for the implementation of smart technologies in marketing logistics. This allows not only to understand customer behaviour, but also to reasonably invest in those technologies that most increase the efficiency of a particular segment. Thus, the study deepens the scientific discourse on the integration of smart technologies into marketing logistics, expanding the application of cluster analysis in the direction of intellectualisation of supply chain management. The results obtained are consistent with the conclusions of previous studies, but at the same time offer a practically oriented model that can be used by enterprises to develop personalised strategies for the digital transformation of marketing logistics.

CONCLUSIONS

The article substantiates the importance and features of Marketing Logistics 4.0 and develops methodological approaches to implementing this concept in the activities of enterprises. The study, conducted in three stages, confirmed the need to develop modern marketing logistics strategies, showed the synergistic effect of integrating smart technologies into marketing and logistics, and also allowed to clarify the key indicators of the effectiveness of Marketing Logistics 4.0. Based on the cluster analysis of warehouse-store customers, a methodological approach to the priority implementation of smart technologies was developed, which allows to increase customer loyalty, process transparency and the efficiency of enterprises.

The priority strategy for implementing smart technologies in marketing logistics is to retain and encourage loyal customers through IoT, big data, IT systems, automation and robotics. The next priority strategy according to the study is the use of machine learning, cognitive technologies, AR/VR and digital twins to increase transparency, trust and customer engagement, although they require greater investment. The strategy of using blockchain for low-potential customers received the lowest priority, since its effect on loyalty and financial attractiveness is limited. The results obtained can serve as the basis for the practical application of Marketing Logistics 4.0 and strategic planning of enterprise development in the digital era, as they provide the opportunity to: personalise service for different client segments; optimise investments in smart technologies taking into account the potential of each cluster; increase the level of customer loyalty, speed of order processing and transparency of supply processes. Further research expedient to direct on development integrated models digital marketing logistics, which will include elements AI for prognostication behaviour customers, analysis big data in mode real time and automatic adjustment logistic strategies depending from changes market conditions.

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Впровадження smart-технологій у маркетингову логістику: персоналізація ланцюга постачання та покращення клієнтського досвіду

Анотація. Впровадження інтелектуальних технологій Індустрії 4.0 має особливо важливе значення для підвищення ефективності маркетингової логістики завдяки мультиплікативному характеру їхнього впливу та синергетичним ефектам, що виникають внаслідок конвергенції Логістики 4.0 та Маркету 4.0. Це підкреслює необхідність ретельного наукового дослідження важливості та відмінних рис Маркетингової Логістики 4.0, а також розробки методологічних підходів для визначення ефективних стратегій інтеграції цієї концепції в діяльність підприємства, що було основною метою цього дослідження. Кластерний аналіз був використаний для сегментації вибірки зі 100 клієнтів складу-магазину в Києві (Україна) на три кластери, що характеризуються подібними поведінковими та логістичними характеристиками, включаючи обсяг замовлень, частоту покупок, місцезнаходження та рівень задоволеності. Врахування як поведінкових, так і логістичних характеристик клієнтів послужило основою для розробки рекомендацій щодо пріоритетності стратегій впровадження інтелектуальних технологій у маркетинговій логістиці, адаптованих до кожного визначеного кластера. Найвищий пріоритет у впровадженні розумних технологій у маркетингову логістику було надано стратегіям, спрямованим на утримання та стимулювання лояльних клієнтів через Інтернет речей, великі дані, інформаційні системи, автоматизацію та робототехніку. Наступний пріоритет включає застосування машинного навчання, когнітивних технологій, віртуальної та доповненої реальності, а також цифрових двійників для підвищення прозорості, довіри та залученості серед прибуткових клієнтів. Технологія блокчейн була визнана найнижчим пріоритетом для клієнтів із низьким потенціалом, оскільки її вплив на лояльність та фінансову привабливість підприємства обмежений. Запропонований методичний підхід до визначення пріоритетних стратегій має значну практичну цінність в контексті обмежених фінансових ресурсів підприємств та високих витрат, пов'язаних з впровадженням розумних технологій

Ключові слова: цифрова трансформація бізнесу; аналітика даних у маркетингу; Індустрія 4.0; Логістика 4.0; Маркетинг 4.0; ключові індикатори ефективності