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THE IMPACT OF ARTIFICIAL INTELLIGENCE ON E-COMMERCE: THE SYNERGY BETWEEN INNOVATION AND OPERATIONAL EFFICIENCY

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Abstract
In the field of e-commerce, artificial intelligence has managed to change the very way we shop online, not only by changing the shopping experience, making it simple, efficient and, above all, personalized for the user, but it has also revolutionized the way companies manage their online stores, improving inventory management and optimizing marketing operations. In this context, this paper analyzes how the technological frontiers of artificial intelligence are increasingly entering into synergy, increasing the efficiency of e-commerce services. The analysis performed highlights the innovative impact that artificial intelligence brings in improving operational management, personalizing the user experience and perfecting the production of digital products offered for sale, demonstrating how these innovations are completely redefining the world of e-commerce.

Key words: *technological frontiers; artificial intelligence; e-commerce; operational efficiency; user experience (UX)*

JEL Classification: *L81, M2*

INTRODUCTION

In 2022, the OpenAI organization entered the international market with the launch of ChatGPT (Chat Generative Pre-Trained Transformer) artificial intelligence model, based on large-scale language models, constantly trained with huge amounts of data from the internet, which allows it to understand and generate natural language with high fluency. The launch of ChatGPT kick-started the artificial intelligence boom, spurring the exit of competitors such as Google Gemini, Claude, DeepSeek, Grok, Alibaba AI, LLaMA, etc (Chină, 2024; López et al., 2024). The evolution of ChatGPT has been made possible through supervised learning, whereby incorrect answers are corrected by developers, and reinforcement learning, whereby answers are independently improved based on user feedback. While initially the main function of a chatbot was limited to emulating a human conversation, ChatGPT Plus has greatly expanded the versatility of the AI tool (Teubner et al., 2023). It can be used to program, compose music, generate business ideas, translate, and summarize, while providing access to hundreds of plug-ins designed to make the ChatBot more precise and accurate in certain domains and extend its capabilities beyond simple text conversation. The integration of ChatBots across industries, especially e-commerce, contributes significantly to streamlining processes, improving customer experience, and ultimately increasing sales (Huseynov, 2023; Rahevar & Darji, 2024). During the COVID-19 pandemic, although some sectors such as HORECA encountered difficulties, the online commerce sector with the Asymmetric Digital Subscriber Line (ADSL) and smart phones experienced accelerated growth, which subsequently became a worldwide success. There are situations where they may have difficulty understanding natural language in complex or ambiguous ways, which can lead to inappropriate responses. Also, ensuring an adequate level of personalization and empathy in automated interactions remains a challenge, especially in sensitive situations or where customers expect more human-like interactions (Dragomir et al., 2021; Grosu et al., 2022).

Despite the advanced capabilities of this new technology, the use of ChatGPT and other similar tools has been the subject of much debate in academia, with its use banned for school and university projects and content. This raises important ethical issues and questions about students' contribution to research and learning (Chină, 2024; Stahl & Eke, 2024). There are also discussions about the widespread adoption of artificial intelligence in e-commerce which raises a number of key challenges related to data privacy, data security and the impact on jobs (Bores & Hlaciuc, 2016; Dragomir, 2017; Rane et al., 2024).

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In this context, this paper aims to analyze how the technological frontiers of artificial intelligence are increasingly entering into synergy, increasing the efficiency of e-commerce services. In order to achieve this goal, the following objectives have been set: O1: A concise presentation on the emergence and development of e-commerce in close relation with artificial intelligence; O2: An in-depth analysis of how these innovations work and interact with each other. O3: Analyze how artificial intelligence tools can, in the design phase, influence the role of the designer within an e-shop in order to improve the user experience (UX).

I. THE ROLE OF AI IN E-COMMERCE TRANSFORMATION

As technology develops, AI becomes an integral part of running a successful online business. Artificial Intelligence (AI) has revolutionized multiple industries, and e-commerce is no exception. Introducing AI into sales, marketing and inventory management is the natural way forward in the evolution of modern commerce. Today, artificial intelligence is managing a large number of customer interactions, revolutionizing the way companies operate in the e-commerce sector (Lari et al., 2022). Even a small online store can create huge amounts of data on a daily basis that a single person, or even a team of experts, could never hope to understand and utilize without the use of machine learning, deep learning and data science technologies. In order to better understand how AI technologies are being deployed in e-commerce, it is essential to distinguish between their applications on the management side of the business, which concerns direct interaction with customers, and how AI can become an integral part of the product being sold (Rane et al., 2024). AI is already changing the way e-commerce companies operate and is starting to integrate into every aspect of e-commerce business. With AI, e-commerce stores and websites are now able to personalize the customer shopping experience, increase e-commerce sales and streamline operations. AI can also be used to detect fraudulent activities, predict customer behavior, and optimize pricing strategies (Cosmulese et al., 2021; Gkikas & Theodoridis, 2021; Babu et al., 2023). AI solutions for e-commerce are becoming increasingly popular, with the e-commerce platform enabling e-commerce businesses to thrive.

There are many ways to use artificial intelligence in e-commerce, from chatbots that help customers shop to recommendation engines that suggest products based on previous purchases. So, in terms of using AI-based chatbots in e-commerce customer service, these intelligent programs are able to quickly and efficiently answer customer questions and assist them in the buying process. Also, another aspect is the automation of logistics processes with the help of AI in e-commerce. AI enables optimal warehouse management and shipment tracking, leading to faster and more efficient delivery of orders. In addition, by using AI, one can accurately analyze customer behavior data and often predict market trends, which will enable accurate business decisions (Dragomir & Alexandrescu, 2017; Dalal et al., 2024).

There are a multitude of ways in which artificial intelligence contributes to the development and efficiency of e-commerce. Among such examples of customized GPTs designed to support the management and design of e-commerce from both user and business perspectives are the following (see Table 1).

Table 1. Synergy between artificial intelligence and e-commerce - impact and benefits

Application domain	AI technologies used	Impact on e-commerce	Benefits for users	Benefits for businesses
User Experience	Neural networks, NLP, machine learning	Personalization of interface and product recommendations	Offers and products tailored to individual preferences	Increase conversion rates and customer loyalty
Marketing optimization	Prediction algorithms, big data analysis, AI automation	Precise targeting and optimized advertising campaigns	Relevant advertisements and personalized offers	Reduce advertising costs and increase ROI
Inventory management	Predictive models, real-time data analysis	Optimize replenishment and prevent overstocking	Increased product availability and fast deliveries	Reduce wastage and streamline the supply chain
Customer care and support	Intelligent chatbots, virtual assistants, sentiment analysis	Fast responses and efficient problem resolution	24/7 support and more natural interactions	Reduce support costs and improve customer satisfaction
Dynamic pricing and strategies	Machine learning algorithms, competitive analysis	Real-time price adjustments based on demand and competition	Great deals and competitive prices	Maximize profit and adapt to market dynamics
Role of the UI/UX designer	Generative AI, user behavior analysis	Creating intuitive and interactive interfaces	Improved navigation and a pleasant visual experience	Increase engagement and improve user retention

Source: Adapted after Nichiforet al., 2021 and Qi et al., 2024

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Clearly, these are still development-stage technologies that can currently only provide support by reducing the number of employees needed and the number of working hours, but they cannot yet fully replace a team of domain experts. Despite this, there are already specific applications of artificial intelligence that are revolutionizing key areas in e-commerce management. AI is being used by major internet e-commerce companies for inventory management, which is carried out using machine-learning algorithms that analyze data on past sales, current market trends and customer behavior. Amazon, for example, uses this technology to optimize inventory levels by automating product reordering, minimizing the risk of out-of-stocks and storage costs (Suhel, 2024).

Another use of AI is the use of IoT (Internet of Things) sensors that monitor the status of warehouses in real time, ensuring optimal stocking of products, a technology that could be very useful in e-commerce dealing with food or health and wellness products. Marketing operations Machine learning algorithms are able to analyze large amounts of data to create detailed profiles and then optimize advertising campaigns. Additionally, AI is able to personalize marketing operations based on user preferences and behavior, while artificial intelligence tools like HubSpot and Marketo's are able to automate email advertising campaigns, personalizing content in real-time based on user interactions.

When it comes to improving the user interface and user experience, AI technology plays a key role in enabling e-commerce websites to offer personalized, efficient and engaging services, revolutionizing consumer interaction on e-commerce platforms (Alkudah & Almomani, 2024; Mocovei, 2024). Today's artificial intelligence tools succeed in transforming the user experience by using advanced machine learning algorithms and data analytics to better understand user behavior and preferences, enabling accurate and targeted product recommendations. For example, relevant products can be suggested differently to each user, reducing search time and increasing customer satisfaction. Among the various possible integrations of artificial intelligence into an e-commerce website, the most discussed and widely used are visual product search (Song et al., 2019; Fedorko et al., 2022). Another concrete example of this new reality is the start-up Dobles, founded in 2023. The platform allows users to upload images and specify stylistic preferences through filters or even simple text prompts to generate unique graphics in moments that can later be applied to merchandising products that can be purchased by the user.

II. APPLICABILITY OF ARTIFICIAL INTELLIGENCE IN E-COMMERCE

Artificial intelligence plays a key role in the transformation of e-commerce, having a major impact on both the user experience and the operational efficiency of companies. AI-driven E-commerce enables process automation, supply chain optimization and personalization of interactions between customers and online platforms, redefining the way digital commerce is conducted. A notable example of this is Amazon and Zalando, which use artificial intelligence in multiple aspects of its ecosystem, from product recommendation and inventory management to logistics, virtual assistance and improving user experience, as illustrated in the table below.

Amazon

With the passage of time and the development of technology, Amazon has started to integrate the use of artificial intelligence into different domains and applications, from business management to improving user experience. Table 2 below summarizes the main application areas, the technologies used, examples from the Amazon ecosystem, and the benefits for users and businesses to highlight how AI is transforming e-commerce.

Table 2. Artificial Intelligence in the Amazon Ecosystem

Application domain	AI technologies used	Implementation example (Amazon)	Benefits for users	Benefits for companies
Product recommendation	Machine learning, behavioral analysis	Advanced prediction algorithms for personalized suggestions	Quickly find relevant products	Increased sales through cross-selling and up-selling strategies
Stock management	Predictive modeling, big data, automation	Stock optimization to reduce delays and losses	Constantly available products and faster delivery	Reduced logistics costs and increased operational efficiency
Logistics and deliveries	AI for route optimization, autonomous drones, IoT	Delivery route optimization and drone testing for shipping	Faster and more efficient deliveries	Reduced transportation costs and optimized delivery times
ChatBot support	NLP (Natural Language Processing), conversational neural networks	Chatbot "Rufus" for procurement support	Quick responses and easier shopping experience	Reduced support costs and improved customer relations

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Personalize the experience	Machine learning algorithms, preference analysis	Adjust interface and display content according to the user	More intuitive navigation and user-friendly interface	Increased customer retention and improved loyalty
Virtual Try	Augmented reality (AR), deep learning	Virtual fitting of clothes and shoes	Reduced returns and safer purchasing decisions	Reduced returns losses and improved customer confidence
Visual product search	Computer vision, deep learning	"Amazon Image Search to identify products through images	Find products quickly without difficult text descriptions	Higher conversions and reduced shopping cart abandonment

Source: Adapted after La Rossa, 2024

Not only Amazon but the other e-commerce giants are demonstrating that AI integration is not just a trend, but a necessity for the future of the industry. This technology is redefining how consumers interact with online shopping platforms and helping to optimize every step of the supply and sales chain.

Zalando

The adoption of artificial intelligence in e-commerce not only enhances the user experience, but also optimizes companies' internal operations, enabling more efficient management of offers and customer interactions. The other relevant example is Zalando, one of Europe's leading online retailers, which has integrated various AI technologies to personalize product filtering, improve customer support through intelligent chatbots and optimize recommendations, detailed in Table 3 below.

Table 3. Artificial Intelligence in the Zalando Ecosystem

Application domain	**AI technologies used**	**Implementation in Zalando**	**Benefits for users**	**Benefits for the company**
Customize product filtering	Machine learning, behavioral analysis	Personalized labels and filters	Faster and more relevant search	Increased conversion and retention rates
Chatbot support	NLP (Natural Language Processing), conversational AI	Interactive chatbot to guide users	Fast assistance and natural interaction	Reduce support costs and optimize the buying process
Optimize product recommendations	Predictive algorithms, big data	Personalized suggestions based on browsing history	More intuitive shopping experience	Increase average shopping cart value
Inventory management automation	Predictive models, real-time data analysis	Replenishment predictability	Constant availability of the products you want	Reduce wastage and optimize logistics
Segmentation and marketing strategies	AI for data analytics, deep learning	Marketing campaigns tailored to customer profile	Relevant offers and discounts	Maximize effectiveness of advertising campaigns

Source: Adapted after La Rossa, 2024

Unlike Amazon, Zalando has focused exclusively on e-commerce since its inception, without having a network of physical stores or an extensive diversification of services like the American giant. This fundamental difference has allowed Zalando to adapt quickly to changes in the market and invest heavily in advanced personalization technologies, such as smart tags and filters, which improve the browsing experience and increase conversion rates. Amazon, on the other hand, is taking a much broader approach, using artificial intelligence not only to optimize the checkout process, but also to manage complex logistics, automate warehouses, and even innovations like drone delivery. While Amazon builds its success on a broad ecosystem, including its marketplace for third-party sellers, cloud services (AWS) and voice recognition technologies (Alexa), Zalando remains specialized in the fashion and beauty segment, optimizing every stage of the user experience through AI.

Another distinctive aspect is the use of chatbots. Both companies have deployed such solutions, but while Amazon has developed virtual assistants such as "Rufus" to guide users through the product selection process, Zalando has focused on direct interaction, offering a chatbot that not only assists but also analyzes customer preferences to generate personalized recommendations. Indeed, Amazon and Zalando are two successful examples of the use of artificial intelligence in e-commerce, but their strategies differ significantly: Amazon maximizes its efficiency through a massive, automated infrastructure, while Zalando focuses on user experience, personalization and optimization of its niche segment.

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III. CONCLUSION

The analysis conducted in this paper highlights the deep connection between artificial intelligence and e-commerce, two fast-developing technological fields that have the potential to completely transform the digital commerce landscape in the coming years. By studying two significant examples, Amazon and Zalando, the innovative impact of artificial intelligence in improving operational management and personalizing the user experience has been highlighted, demonstrating how these technologies are fundamentally redefining e-commerce. However, the widespread adoption of artificial intelligence in e-commerce raises a number of key challenges related to data privacy, data security and the impact on jobs. In this context, technological progress needs to be accompanied by thorough research and ethical debate to ensure the protection of users' rights and to prevent possible associated risks. Regulations and legislation on the use of AI also need to be developed to prevent abuses and ensure a balance between innovation and the protection of individual interests.

In terms of future research directions, there would be a need to further explore the effectiveness and impact of different AI technologies on different segments of e-commerce, as well as to further investigate the ethical and legal implications of their use. A promising direction could be studies that explore how AI can contribute to improving sustainability in online commerce, given the growing environmental and economic demands of consumers. In addition, it would be useful to study how data integrity can be managed more effectively in the face of algorithmic developments in e-commerce. In conclusion, artificial intelligence has the potential to radically transform e-commerce and revolutionize the way people shop online. However, the success of this technology depends not only on technical innovation, but also on the decisions and regulations that are now being made on its use and regulation, so that the technological benefits do not come at the expense of users' fundamental rights and security.

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