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Article

The integration of artificial intelligence in retail: Benefits, challenges and a dedicated conceptual framework

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**THE INTEGRATION OF ARTIFICIAL INTELLIGENCE IN RETAIL: BENEFITS,
CHALLENGES AND A DEDICATED CONCEPTUAL FRAMEWORK**Ionuț Anica-Popa^{1*}, Liana Anica-Popa², Cristina Rădulescu³
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Abstract

The aim of this study is to identify the practical benefits and associated risks generated by the implementation of artificial intelligence (AI) in retail and capitalize on the results by developing a conceptual framework for integrating AI technologies in the information systems of retail companies. To this end, a systematic study of recent literature was conducted by carefully examining the topic of AI implementations. The main results of the documentation were used to substantiate the conceptual framework introduced by the paper. The research revealed a variety of advanced solutions, benefits, but also risks that AI generates in retail, in different segments of the value chain, abbreviated CECoR, from improving the customer experience (*Customer Experience*, CE) with the help of virtual agents (chatbots, virtual assistants, etc.), to cost reductions (*Cost*, Co) by using smart shelves, and to increasing revenues (*Revenue*, R) due to product recommendations and personalized offers or discounts. The proposed conceptual framework is focused on customer profiles and includes recommendations on AI implementations in a retail company, from the perspective of CECoR drivers. The results of the research can be capitalized by practitioners and researchers in the field, who are presented with concrete examples of benefits, challenges, and risks generated by AI technologies. The CECoR framework could be a useful tool for both retail and AI specialists, providing common and clear guidelines for initiating and overseeing projects for integrating AI in a company's information systems. Literature-based CECoR analysis dimensions have allowed the restriction of the research area, which is particularly wide, at the confluence of retail and AI. The originality of the article lies in the CECoR orientation of the research and the conceptual framework focused on customer profiling.

Keywords: artificial intelligence, retail, customer experience, cost reduction, revenue increase, CECoR conceptual framework.

JEL Classification: F43, M15, N70, O33

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Introduction

In today's dynamic, super-connected business environment, organizations are forced to use systems, mechanisms and tools that allow them to obtain a significant competitive advantage. With a wide variety of applications, artificial intelligence (AI) is considered disruptive and revolutionary because it allows “the simulation of human intelligence, which replaces human beings in complex tasks” (Yang, 2020). Research efforts target aspects such as natural language recognition and processing, image recognition, object manipulation, and there are various categories of AI tools: analytical, human-inspired, and humanized (Kaplan and Haenlein, 2019).

Retail is one of the industries where the number of successful implementations of AI technologies is constantly increasing. Other new technologies – process automation (*Robotic Process Automation*, RPA), Internet of Things (IoT), virtual / augmented reality (VR / AR), robotic and autonomous vehicles, etc. – also have a significant impact on retail, which is expected to grow further.

On the other hand, the costs of AI, the issues of reorganizing human resources in the integration of such technologies, but also the perception that a company's customers and public opinion have on the specific way in which machines and algorithms manage the huge amount of personal information collected by companies, represent major challenges for any organization from retail and require an appropriate treatment in the context of risk management associated with AI.

To ensure a competitive advantage by adopting emerging technologies, retailers must consider three key elements: (1) improving the consumer experience, (2) reducing costs, and (3) increasing revenues and business profitability (Hetu, 2020). The present study aims to identify and highlight the main benefits and challenges of implementing AI technologies in retail along the three mentioned axes. The cognitive acquis thus obtained was capitalized by developing a conceptual framework for integrating AI techniques and algorithms in the information systems of companies in the retail sector. To this end, efforts have been focused on the work areas delimited by the following two research questions: (1) “What are, from the CECoR perspective, the benefits and risks reported by retailers, generated by the AI implementation?”; (2) “How could the initiation and management of an AI technology integration project be supported through this research?”.

The research results consist of the practical benefits and risks identified in connection with the use of AI in retail companies. Conducting the research along the three axes of the CECoR analysis and automated management of customer profiles at general, individual, and contextual levels are original approaches, which led to the development of a conceptual framework that could provide useful guidelines for implementation teams initiating and running projects aimed at integration of AI with the information systems supporting retail activities.

The article has three main sections. The first part focuses on the benefits created using AI in retail, analysed from the perspective of CECoR drivers. The same CECoR axes were used to investigate the challenges and risks associated with AI implementations. The second section describes the research methodology, and the third section is dedicated to the presentation of the research results: CECoR conceptual framework, a scenario illustrating how the CECoR integration architecture is actually used, along with aspects concerning risks and practical implementation issues.

1. Literature review

1.1. The benefits of Artificial Intelligence in retail

Defined as the ability of a system to acquire and interpret data, learn, and then apply the new knowledge to achieve certain results or execute a task through adaptive behaviour, AI includes many subdomains. Among them we can mention Machine Learning (ML), with supervised, unsupervised, and semi-supervised algorithms for training a software agent, and Deep Learning (DL), based on artificial neural network techniques that can perform complex learning tasks (Lee and Shin, 2020; Madurai Elavarasan and Pugazhendhi, 2020). Learning algorithms (artificial neural networks, Bayesian networks, genetic algorithms, nearest k neighbours, vector support machines, etc.) use advanced processing capabilities to make associations, classifications, groupings, and regressions, by analysing large volumes of data. (Kartal, et al., 2016). Deep Neural Networks (DNNs) combine many machine learning tasks and leverage other advanced technologies, such as cloud computing, the Internet of Things, or big data, enabling general purpose machine learning algorithms (GPML) to manage various data (video, audio, text) and to improve the accuracy of product demand forecasting by analysing customer behaviour. Moreover, by capitalizing on GPML technologies and other digital platform features, small retail firms have managed to increase their visibility and expand their business globally (Meltzer, 2018).

1.1.1. Improving customer experience through Artificial Intelligence technologies

The development of e-commerce and the exponential growth of customer data have generalized the efforts of companies to identify solutions for predicting customer behaviour and improving consumer experience (CE). According to Maghraoui and Belghith (2019), the data shared on the internet in the last decade exceeds those of the entire history of mankind. As a result, the company that owns, analyses, and harnesses this data properly will gain differentiation advantage.

According to a study by BearingPoint (2019) there are two broad categories of emerging AI technologies that help improve the CE: (1) technologies facilitating direct interactions with customers; (2) technologies allowing for a better treatment of customer demands and expectations.

Semantic recognition technologies or so-called *chatbots* improve the CE by providing 24/7 services while offering the great advantage of reducing the volume of low added value contacts involving human workers. These technologies are currently enjoying increasing popularity due to messaging applications. Retail companies use chatbots to align online and offline experiences. For example, in 2016 H&M was ahead of its competitors when it launched a chatbot on the Canadian messaging application Kik (Prokopiško, 2019), allowing customers to view, share and purchase products from the H&M catalogue. A personal stylist service was also provided by the chatbot, which uses photo options and asks questions about the buyer's style, creating a style profile for the customer. The supermarket chain Lidl delivered another example: the conversational chatbot Margot on Facebook Messenger, able to understand natural language and help buyers get the best product in the range of wines. It also provides users with tips on combining food with wines and tests their knowledge, generating a better customer experience.

Voice recognition technologies involve the use of virtual assistants, able to perform various tasks (taking phone orders, searching for information, sending recommendations to

customers, etc.). By transforming the voice into text, the customer's voice command is transmitted to the order taking systems, automatically or via an email. A notable experience is provided by McDonald's Corp., which has created an automated and highly complex, multilingual, and multi-accent ordering tool (Diakantonis, 2019).

Visual recognition technologies are based on virtual assistants able to identify shapes or people, track the status of product shipments, open accounts remotely, and detect internet users' preferences for certain brands. For example, using facial recognition technology, a retailer could identify a frequent shopper or a loyalty card holder, as soon as they enter the store. Digital signage is not new in retail, but when combined with facial recognition and Big Data analysis, it can directly target a specific customer based on his previous buying behaviour. This means that labels and shelf screens could display customer-oriented messages or advertisements, drawing attention to certain items or offers that may be of interest. As far as payment is concerned, biometric and object recognition POS systems allow for a much-improved CE, the POS solution identifies both the buyer, and the products placed on the counter (Worley, 2017). Amazon introduced visual search in its main iOS app in 2014, giving its users the ability to search for a specific product using their smartphone cameras.

Technologies that use autonomous robots allow execution of actions or tasks by adapting behaviour to the environment. One of the ways retailers use robots in stores is to help customers find the products they need. In 2016, the LoweBot robot of the retailer Lowe's was used in its stores in San Francisco (Underwood, 2020). LoweBot gathers information as it works, with the goal of identifying the buying patterns for that location to better understand what goods are moving faster and in what seasons or days of the week. The customers' curiosity to see them in action allows retail robots to become an important lever in adopting a brand and improving the CE.

Predictive analytics technologies enable large companies to anticipate future customer behaviours using past or current behavioural patterns and thus substantiate their strategic decisions. Predictive analytics can be used for reducing the churn rate of the brand (by identifying dissatisfied customers) and for detecting risk situations. Relevant examples include Urban Outfitters, Sephora, and Under Armor, which use an advanced machine learning engine provided by Dynamic Yield to segment their customers.

According to the results published by Capgemini (2019), 73% of the organizations that implemented AI technologies noticed an increase of about 10% in customer satisfaction. The Capgemini investigation shows that 72% of the surveyed organizations experienced a decrease in the number of customer complaints, and 66% noticed a reduction in the churn rate of the brand. Another research conducted by Futurum Research (2019) anticipates an increase in the usage of AI technologies for purchasing experiences. Thus, 65% of consumers expect to have contact with a chatbot for customer support by 2025, while 81% expect this to happen by 2030. If 47% of surveyed consumers consider that using an AI assistant, such as Alexa or Siri, can be a good way to interact in assisting customers, 38% admit that it is not easy for them to use or adapt to the technology used by merchants and 53% admit that facial recognition technologies cause them discomfort. According to Servion Global Solutions, a company cited by Microsoft Corp. (2017), by 2025, 95% of customer interactions will be made through AI-assisted channels, and chatbot applications will be key components in assisting the next generation of consumers.

1.1.2. Cost-driven savings

Complementary to the other two business drivers, customer experience improvement and revenue increase, cost reduction should be carefully considered when assessing the impact of emerging technologies for retail companies. There are some generators for AI-driven cost savings: effectively reaching the target consumers (Grewal, Roggeveen and Nordfält, 2017), human workforce reduction (Holmqvist, Van Vaerenbergh and Gronroos, 2017; Inman and Nikolova, 2017; van Doorn, et al., 2017), and inventory optimization.

- *Reaching targeted consumers with lower costs.* Timing is crucial in retail: delivering the right message for the right customer, at the right time, could determine a significant increase in sales. Applying big data technologies, such as predictive analytics, retailers are able to “estimate” the consumers’ behaviour and adjust their offerings accordingly. According to Bradlow et al. (2017), the five dimensions of big data for retail are time, customer, product, location (geo-spatial), and sales channel. Terabytes of new data (e.g., in case of Walmart or Amazon) are integrated with historical data about millions of customers and billions of *journeys* of sold products. AI-backed tools can process this ever-increasing volume of data with fewer technical requirements, incomparably less time and money than humans or pre-existing computer systems, while running without errors or interruption, consequently generating significant cost savings.

- *Human workforce reduction.* Sensors, mobile, and AI technologies provide new possibilities for cutting down on in-store staff accomplishing “algorithmic” task execution (Olsen and Tomlin, 2020). Smart shelves, encapsulating meshes of strain sensors, photodetectors, microphones, and spillage sensor, collect data on product status and send notifications to the store staff when product quantities on the shelves is below a predefined value; additionally, real-time inventory AI-based management enables grocery stores to apply multiple automated price updates for all products that expire on the current date (Quante, Meyr and Fleischmann, 2009; Inman and Nikolova, 2017). Hence, as smart shelves are self-managed, there is no need for the store staff to periodically check the stock of products on shelves, and then to summarize collected data and send it to the person in charge.

Amazon’s approach to intelligent stores involves Amazon Go app, which allows users to enter a physical store, buy products without scanning them manually, and then leave the store without staying in line to pay (Amazon, 2020). In a very short description, this process consists of three steps: (1) when entering the store, the customer must register using the Amazon Go app from the smartphone; (2) when a product is picked from a shelf (or put back), shelf sensors detect the move and the software updates the customer’s virtual cart; (3) when the customer leaves the store, a receipt is generated automatically and the Amazon account is charged. None of these tasks involves the store staff.

Sensors, automation, robotics, and artificial intelligence help reduce staff costs generated not only by stores, but also by the warehouses managed by retail companies. Erik Nieves, CEO of Plus One Robotics, the leader in vision-guided robotics for logistics, maintains that before it reaches its destination, a package gets touched by an average of 21 peoples. If supported by an “intelligent” warehouse, the remodelled delivery process will include the following steps: (1) based on order details, a box is selected and a “route” of shelves is configured; (2) when the box reaches a shelf that contains some of the products on the order, a robot picks the products from the shelf and put them into the box; (3) when all products are in the box, it goes to packing, and then is shipped to the customer.

• *Inventory optimization.* Minimizing the inventory costs – direct costs, represented by storage cost, and indirect costs, generated by lost sales – is one of the most critical optimization problems for the retail sector. The quantities of ordered products and the time of ordering for stock replenishment are highly sensitive decisions to make, as they have a direct impact on inventory costs and, consequently, on profit maximization (Miller and John, 2010; Mousavi, et al., 2016). This is why inventory optimization emerges as a major use case for AI implementation by retail companies; for example, machine learning algorithms for classification (Bayes classifiers, artificial neural networks, and support vector machines) can be used to predict the ABC classification of inventory (where A is the class with the most, and C with the least frequently sold items), with high accuracy (Kartal, et al., 2016). Using machine learning algorithms, Priyadarshi, et al. (2019) also attained the best forecasting models of the weekly seasonality trend, with least possible errors. In practical terms, predictive analytics helps retailers determine the optimum daily amount of fresh products to be supplied, reduce the inventory of perishable food items, minimize the waste by optimally defining the appropriate amount of produce at required locations and intelligently synchronize downstream and upstream supply levels.

1.1.3. AI-enhanced revenue growth

Technological trends have led the rapid diffusion of AI applications across the retail field, with positive results for business revenues, profitability, and efficiency. In this section, we analyse the impact on revenue drivers of various retailing activities that integrate AI technologies.

Discussing the integration of AI and ML tools in the sales process specific to the ongoing fourth industrial revolution, Syam and Sharma (2018) labelled this retail reshaping as “sales renaissance”. They reported many use cases of AI and ML in *sales reinforcement*. Among them, a Harley-Davidson dealership in New York have attained 40 instead of 1 qualified lead per day and an increase of 2930% in its total number of qualified leads, through AI-based lead generation algorithms applied for three months. With the help of a ML solution that leverages dashboards containing pricing variables, qualified leads, IP addresses and other customers’ data, sales representatives have determined, in real time, *the best price* for different segments of their customer base; also, in the post-order stage, a Gainsight system integrated sales features, customer service and questionnaire results, alerting sales teams when to invoice and *to suggest upsell and cross-sell products* etc.

AI technologies may help retailers to *consolidate the sales strategy* by leveraging existing stores features (Feng and Fay, 2020). Prices optimization and sales maximization objectives have led to an increasing use of AI-enhanced big data technologies, detecting correlations between independent variables such as promoted price, display location, assortment expansions, and dependent variables like store sales and profitability, brand switching, etc. (Grewal, Roggeveen and Nordfält, 2017). It was demonstrated that survey-based indicators like purchase intentions or positive evaluations must be considered to *stimulate customers’ engagement and increase revenues*. Kumar, Anand and Song (2017) cited by (Grewal, Roggeveen and Nordfält, 2017) also highlighted the strong relationship between analytics and retail profitability.

Analysing the impact of AI adoption on online returns policies, Yang, Ji, and Tan (2020) found that an enhanced personalized virtual experience could lower or even eliminate product fit uncertainty and *improve after-sales services*, by deeming consumers’ returns as

opportunities to facilitate their continuous searches of exchanges. European retail companies have begun using AI-based fraud prevention to address the vulnerabilities of both manned and unmanned checkouts and *regain the corresponding revenues* (Fujitsu, 2019). Going further, a smart unstaffed retail shop (SURS) architecture supporting consumer identification and commodity recognition (Xu, et al., 2020) combines AI and IoT technologies, engendering *customer flow and transactions' volume increase* by 21.7% and 26.8% respectively, after a month of observation.

Acknowledging the recent development of e-commerce, accelerated by at least five years due to the current pandemic, specialists have forewarned that retailers failing to leverage new AI technologies like Augmented Reality/Virtual Reality, IoT, mobility will not be able to improve overall business performance by addressing the expanding demands of both consumers and own employees (Durbin, 2020).

1.2. The challenges and risks of using Artificial Intelligence in retail

This section takes a risk management perspective on the three categories of AI benefits analysed previously, by examining potential challenges in the way of positive outcomes.

- *AI technological issues.* A key AI challenge is ensuring a consistently high quality of data, considering that data volumes and diversity (web, social media, mobile devices, sensors and IoT) have increased significantly. For example, in case of ML algorithms, if a population is underrepresented in the data used to train the model, that model has a built-in bias, a vulnerability often attributed to AI (Shneiderman, 2016). Moreover, due to algorithm opacity, ML models are perceived as “black boxes” and it can be difficult to explain how they arrive at particular predictions or recommendations (Adadi and Berrada, 2018, Miller, 2019). Building generalized learning techniques represents another important challenge, as AI systems are still not able to understand contextual details of a business situation and derive the right meaning from it (Lake, et al., 2017). As they become more complex, AI learning models create new vulnerabilities, AI systems being prone to unexpected errors and undetectable attacks. Furthermore, seemingly non-sensitive marketing data feeding AI systems could also be exploited with potentially disastrous effects, e.g., reputational, financial, and regulatory consequences for the target companies.

- *Challenges to AI-driven cost reduction.* The financial implications of the research and development for building AI systems expose such technologies as not easily accessible. Hence, a first-order challenge for any retailer is setting priorities when deciding where in the business (e.g. distribution, marketing, customer services, etc.) to deploy a potentially highly costly AI infrastructure. Since AI shortcomings relative to learning generalization and contextualization still represent important barriers to the continuous drive to automation, a more realistic “human in the loop” approach seems to emerge for AI-based processes. As humans are able to manage situations that require empathy, creativity, and thinking beyond algorithms, at present and in the near future AI is focused on enhancing human capability, not on displacing it (Afza and Kumar, 2018). However, AI leads to important shifts in the nature of the jobs (Huang and Rust, 2018; Makridakis, 2018), which means that important financial resources must be directed to employee training or retraining and upskilling. Furthermore, while low and middle-waged jobs are mainly represented by automatable activities which are likely to decline, high-wage technical jobs related to AI implementation are expected to grow, adding up to the total AI operating costs.

• *Challenges to AI-driven revenue increase and enhanced customer experience.* The potential increase in retail revenues due to AI implementation is inherently dependent on the quality and quantity of personal information that companies collect from their customers. However, this leads to ethical considerations relative to the right balance between personalization benefits and privacy risks (Inman and Nikolova, 2017). In order to enjoy the advantages of an AI-powered shopping experience, customers are subjected to an increasing pressure to share private information, so they could easily become mistrustful of AI and privacy issues. Collecting and using personal information for marketing purposes has always raised privacy concerns, but these concerns are growing in AI contexts, as the consumer data is being extracted and processed by machines and algorithms. Knowing and forecasting consumers' demand across interconnected supply chains and then customizing their shopping experience are central AI drivers. However, the expected positive effect on sales and revenues could be moderated by AI technical limitations related to generalized learning (Lake, et al., 2017). For example, basing sales forecasting on past consumer behaviours may perpetuate a bias, e.g. represent a past or random concern no longer relevant to a customer's current buying needs.

AI recommendation systems may lead to sales teams not feeling in control of retail processes and worrying about opportunities that automated systems cannot detect. Furthermore, since AI learning algorithms have difficulties in transferring their experiences from one context to another, companies must allocate considerable resources to train new models for highly similar use cases; for example, in case of a virtual assistant, a customer's preferences in one area (such as music) should be, ideally, extended to other related domains (movies, books, etc.).

• *Ethical concerns as moderators for AI benefits.* The rapid pace of AI development increases the concerns on how companies deal with ethical issues and creates challenges connected to responsible exploitation of AI systems. Therefore, ethical guidance, adequate policies, and a legal framework to prevent the misuse of AI must be developed and enacted by regulators (Bryson and Winfield, 2017). However, as complex AI platforms often aggregate AI subsystems in the form of software-as-a-service (SaaS) offerings, all risks drivers reviewed here may well originate from third-party solutions, further complicating AI risk management for the beneficiary company; for example, a global retailer consuming a software service in the form of an AI engine must consider regulatory and compliance risks for multiple geographical regions. While regulatory aspects concern legal risks, which are difficult to ignore or circumvent due to potentially serious consequences enforced by law, ethical issues are no less important. Ethical issues are major reputational risk drivers, so it's important to carefully manage IA aspects in relation to which each retailer is publicly perceived as paying attention not only to business success but also to customer's and society's well-being. When not properly managed, reputational risk could lead to dramatic drop in sales and significant increase in costs for restoring customer trust and brand image. An AI concern with ethical implications involves ML algorithms, which are prone to incorporate the biases of their human creators. This could lead to consequences such as discriminatory algorithms and racist or sexist chatbots. For example, the vast majority of digital assistants are portrayed as young Caucasian women that support the stereotyped perception of women in secretarial roles secretară (Spencer, Poggi și Gheerawo, 2018). It is therefore obvious that responsible development and training of AI algorithms is a must for avoiding costly errors. Deployment of algorithms to tailor pricing and promotions increases the need for ethical constructs, as retailers could use AI as a social discrimination vehicle when targeting customers with different messages and prices, based on profiles created about them (Gerlick and Liozu, 2020). From this perspective, AI emerges not only as an effective marketing tool, but also as a powerful manipulation tool. On the other hand, AI-enabled aggressive strategies pose a significant reputational risk that could generate major financial and operational predicaments.

2. Research methodology

The aim of this study is to identify practical benefits and associated risks generated by the implementation of artificial intelligence (AI) in retail and capitalize on the results by developing a conceptual framework for integrating AI technologies with the information systems of retail companies.

In the first step, the eligibility conditions of the sources to be studied were defined. The inclusion criteria set were represented by the year of publication of the research materials (after 2010), the language of publication (English or French) and the field: artificial intelligence or retail. Another criterion was represented by the international databases where the selected papers were indexed: Web of Science, Scopus, Scientific Information Database or EconLit. Also, to capture the concrete results of the implementation of AI solutions in retail, the research area included case studies and reports published by representative actors in this field. Each of the authors independently analysed the identified sources to establish their eligibility as credible and relevant references.

After selecting the research materials, they were studied to identify a set of elements that could generate a competitive advantage for retail organizations. The benefits and challenges of projects for the integration of artificial intelligence in retail have been analysed from the perspective of this set of elements, considered as pillars of the proposed conceptual framework. A flowchart of the steps of the research methodology is depicted in Figure no. 1.

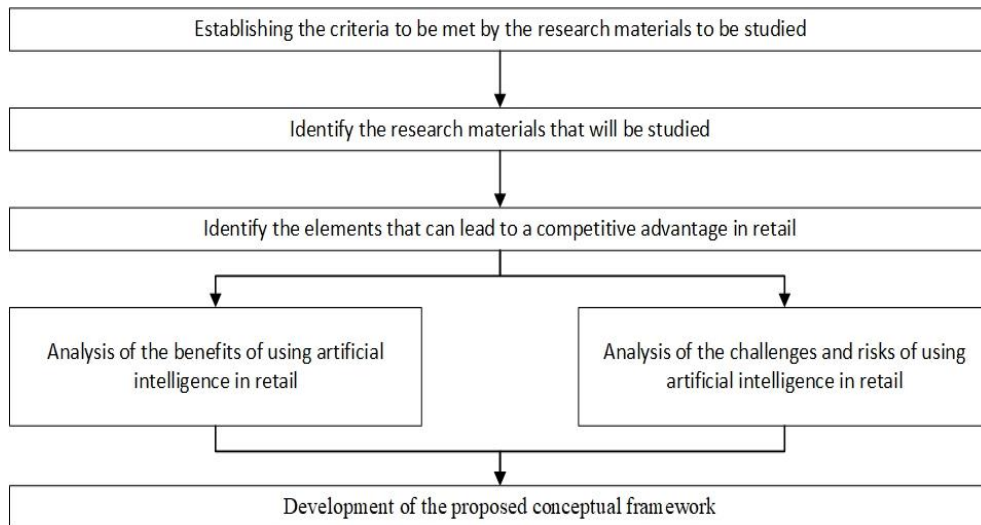


Figure no. 1. Research methodology steps

3. Results and discussions

The current section of the paper introduces a conceptual, customer profile-centred framework, which could be used by retail organizations, to integrate AI techniques and algorithms with their information systems. The goal of this approach to AI adoption consists in generating highly and accurately personalized offers for each customer. On a primary level, the analysis of the advantages enabled by this conceptual framework must take into

account the same business drivers that were used to investigate AI benefits and risks specific to the retail sector: improved customer experience (CE), cost reduction (Co), and increase in sales and revenues (R). The main components of the CECoR framework are described below.

- *General AI integration architecture.* The main structural and functional aspects of this integration architecture that should be managed by the AI implementation team of the retailer are briefly described in the paragraphs below, starting with the key subsystems.

Aggregated customer data subsystem manages sales data and internet data. The sales data is supplied by a data warehouse collecting and organizing data on analysis dimensions which are typical for retail (e.g. time, customer, product, and location). The internet data is aggregated from external sources such as social networks and public forums, using web mining technologies, or it is acquired from various providers; this data must be further integrated with internet data coming from the organization’s own forum.

Individual customer data subsystem manages historical detailed transactional data on each customer (completed sales, cancelled orders, updated orders, etc.). This subsystem also integrates “intelligently” gathered and rapidly processed customer data, resulting from interactions with agents (chatbots, virtual assistants, digital assistants, conversational agents) or from feedback and forum opinions.

The third subsystem of the CECoR integration architecture manages inventory data and information on current promotions for the products on sale.

Figure no. 2 offers a schematic representation of a high-level architecture supporting the AI integration framework.

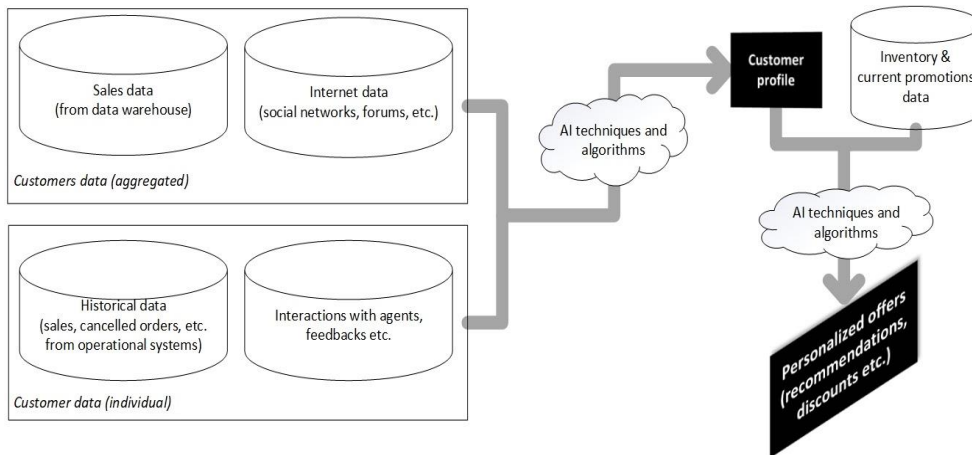


Figure no. 2. CECoR framework: high-level AI-based integration architecture

- *AI-enabled customer profile management.* The processing logic of the integration architecture introduced here relies on the customer profile construct, with the following specializations: generic customer profile, individual customer profile, and contextual customer profile. This section elaborates on the rationale of this profile typology and its role in an AI-enabled retail information system.

Generic customer profiles. Despite the aspects that individualize each client, there are certain transactional and behavioural patterns that, when identified and combined with different descriptive elements (gender, age, location, etc.), allow segmentation of company's customers into relatively homogeneous groups. Each of the resulting clusters corresponds to a generic profile that covers the defining elements for a subset of customers, allowing a uniform treatment of interactions with them.

Individual customer profiles. While generic profiles abstract common features of a certain cluster of a company's customers, individual profiles are the result of the reverse process, allowing a generic profile to be adapted to each customer's particularities. Individual profiles define preferences and buying patterns that cannot be adequately managed in general terms, so they are directed at distinct treatment of interactions with customers sharing the same generic profile. Therefore, an individual profile is obtained by refining and extending the transactional and behavioural attributes of a generic profile, with elements determined by each customer's identity and transactions.

Contextual customer profiles. They represent particular views on individual profiles, conveying the perception of a specific customer relative to certain elements that the company is planning to use in order to influence the current operational context. For example, contextual profiles could be used to identify the customers most likely to be interested in a new product to be offered for sale, or the customers interested in out of stock or understocked products, to be presented with alternative options. The resulting profiles are temporary, as their relevance is limited to a particular business context, with a specific time frame (e.g. a certain inventory situation, new product launches, social media campaigns for brand support, etc.).

Figure no. 3 shows the AI-enabled sequence of profiles as a gradual transition from generic to particular in relation to a company's customers, i.e. the derivation of fine-grained profiles out of coarse-grained profiles. The key functions of an AI-enabled customer profile management include: (1) automatic update or reconfiguration of generic and individual profiles, enabled by a continuous flow of new data from internal and external sources; (2) generation of contextual profiles well adapted to situations that justify their use (for example, better configured and targeted promotional campaigns).

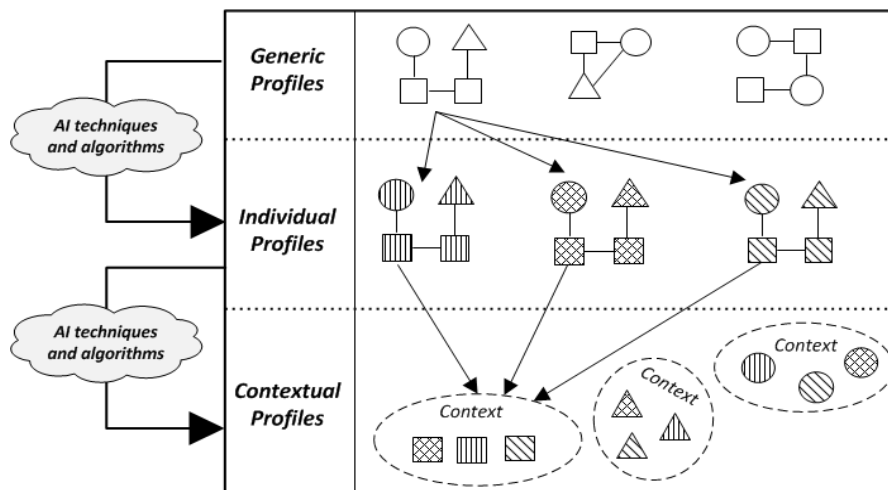


Figure no. 3. Customer profile layers

• *Main expected AI integration outcomes, by stages and CECoR business drivers.* The integration logic involving the subsystems described above and the corresponding data flows could be represented as a three-step process. In the first step, AI learning algorithms are used on sales data, adjusted with internet data, to produce generic customer profiles. Subsequently, individual customer data is used to fine tune the profile of a specific person. Once available, the individual profile of a customer is used by the offers' subsystem to match it with data on inventory and current promotions; in this final phase, AI techniques and algorithms are used, once more, to generate contextual *customer profiles* and corresponding *personalized offers* (e.g., product recommendations, discounts, etc.) for each customer.

The business case for the AI integration solution using a layered approach to customer profile derives from positive effects that could be easily mapped to the same business drivers that were used to investigate AI impact on the retail: improved customer experience – each customer feels important and valued, as offers are tailored specifically for his/her needs and tastes, which are being continuously monitored thanks to dynamically generated customer data; increased sales revenues – this is a direct consequence of personalized product offerings and enhanced customer experience; reduced costs – offers rely on real-time inventory data, which supports cost reduction for both expired products and lost sales.

• *An explanatory scenario.* For a better understanding of the CECoR integration architecture introduced above, we are going to illustrate its underlying functional logic with a descriptive example of a hypothetical shopping experience.

On each Wednesday, a customer (John) buys two milk cans from a specific producer (Classic Milk). In the past few months, customers with similar characteristics as John have given, on various internet platforms, many positive ratings and feedbacks for milk products of other two brands (New Milk and Best Milk). Today is Wednesday, and the inventories of milk from New Milk and Best Milk that will expire tomorrow are quite high, while the milk from Classic Milk is out of stock. According to the aggregate data from company's sales and internet sources, the customer profile corresponding to John indicates preference for Best Milk (first option) and New Milk (second option). On the other hand, the individual data of John collected from the company's forum reveals that his posts on Best Milk contain words showing he does not like Best Milk. In this case, even if the customer profile based on aggregate data will place John in the category that prefers Best Milk, the customer profile adjusted with individual data will include him in the category that prefers New Milk; hence the system will inform John that he could buy milk from New Milk, with a discount. This is how the retailer prevents lost sales for milk and avoids having a large quantity of milk that can no longer be sold past the expiration date. Similarly, from the customer's perspective, this is a no less rewarding experience: the customer feels special because the retailer "knows" that he needs milk, while also getting a discount for a product of a brand he has been tempted to buy. Moreover, the retailer no longer risks potential negative consequences due to unpleasant customer experience; for example, if product recommendations will only be based on aggregated data, as it happens with retail systems currently in use, the offer could be either ignored by the target customer, or he might very well think "I don't like Best Milk, why did they send me this offer?"

• *Practical and technical issues.* The proposed CECoR AI integration model introduced by this paper is a highly generic solution that could be used in multiple business contexts. Naturally, this means that the architecture described here must be further developed to accommodate the information systems currently in use and the IA technologies of a specific

retail company. For example, in case of traditional physical stores, the customer needs to “register” using the phone when he enters the store; alternatively, he could be automatically registered by the system, provided that face recognition technology is available in the store. Moreover, the system must be able to “associate” distinct customers: when a couple goes shopping, it is necessary that the persons in question are treated as a single customer entity, with specific characteristics.

Implementation of AI-enriched solutions and the adoption of the CECoR integration framework presented here and pose multiple technical challenges, as this involves a technology mix which is not easily accessible to all retail companies: cloud computing, big data, deep learning, machine learning, neuro-linguistic programming, etc. However, continuous progress in AI research and development, as well as already proven business benefits of AI adoption are likely to pave the way for more affordable AI technologies in the years to come, with significant impact in all industries, including retail.

- *A brief review of risks.* As AI implementations have implications that move beyond the technical realm of learning algorithms and big data processing, the CECoR conceptual framework also involves consistent risk management. This requires a top-down view on the AI context specific to each retailer in order to decide on key principles relative to IT, but also to business and ethical issues, e.g. what is acceptable or not in terms of use of learning algorithms for customer profiling, customer privacy, etc. In fact, all ethical concerns that were reviewed in section 1.2 are of immediate interest for any retail system using AI-driven customer profiling. As companies collect, track and analyse so much about their customers, they also have the means to use the profiles to exploit customers’ likes and dislikes and to manipulate their buying decisions to the extreme extents allowed by formal regulation. Though apparently justifiable from a business perspective, such practices pose a significant reputational risk that could jeopardize the very business benefits promised by AI technologies. In fact, the key business drivers of AI integration investigated by this paper – improved customer experience, increased sales revenues, cost reduction – could also be perceived as indicators of effective (or ineffective) AI risk management.

Conclusions

While the fourth industrial revolution is in full swing, the huge wave of technological changes is pushing companies to adapt quickly to remain competitive. The current research contributes to the support of retail organizations nowadays when artificial intelligence seems to become a pervasive and slowly inserted enhancement in almost every commercial activity. The authors took a cross-disciplinary approach, bringing into the research field a triadic contribution.

Firstly, in order to help retail specialists looking to adopt AI in their organisations have real insights, an analysis of AI benefits identified in current practice was performed, structured on the business drivers provided by Hetu (2020): customer experience (CE) enhancement, cost (Co) decrease and revenue (R) growth. Among other findings, we have observed that there are many AI emerging tools with positive influences on not only one, but two or even all three CECoR drivers. For example, the query-based AI systems, like Macy’s On Call, Alexa on Amazon’s Echo, Cortana on Microsoft, or Siri on the Apple phone, in both online and physical stores, answer customers’ questions about specific goods, provide suggestions on possible combination with complementary products, or offer directions about where to

find the goods within a store (Grewal, Roggeveen and Nordfält, 2017). Thus, the business impact of those AI systems is significant, manifesting itself simultaneously on all three CECoR levels: customer experience improvement, sales volume increase and to labour costs cut. On smart shelves with integrated digital tags, it was noted it can perform remote price updates almost instantly (Inman and Nikolova, 2017), not needing human intervention; as a result, both staff and stock keeping costs savings and increased customer satisfaction are possible.

Secondly, in relation to the CECoR pillars, the risks that practitioners associate with the AI implementation in retail were revealed. Based on the performed analysis, it can be stated that the positive impact of AI implementation depends on an efficient management of risks associated with this type of technologies. Particular attention should be paid to ethical issues, such as the possibility of manipulating customers through AI. The abusive exploitation of data can cause contrary effects to those initially expected, at the time of implementation of AI solutions for capturing and processing this data. For example, one of the risks that can cause major negative effects is reputational risk, especially important in the context of the specific way the CECoR framework approached customer profiles definition.

The third contribution of the paper is the CECoR conceptual framework, designed to enable implementation teams to align AI initiatives with business priorities aiming at fully leveraging these improvement opportunities and obtaining a meaningful impact and significant competitive advantages for their companies. The elaborated framework was substantiated by capitalizing on the CECoR cognitive acquis, its application having two important purposes: refining customer profiles and optimizing the personalization of offers. This dichotomous vision – CECoR oriented and customer profiles-focused – differentiates this article from previous studies in the same area of research.

Though it could be seen a research limitation, confining the set of analysed resources by using methodological criteria to filter scientifically validated and recent papers makes this study relevant and up-to-date, while guiding the research efforts towards the conceptual framework introduced here.

The pragmatic analysis of the digital change generated by AI in retail and the elaborated conceptual framework can be documentary resources for futures studies on possible sustainable implementations of AI in retail. Further developments in this research could also aim at deepening and expanding the application scenarios of the CECoR framework, as well as analysing trends in the maturation of artificial intelligence technologies and the effects on retail and other areas of activity.

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