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Article

Dynamic acceleration: Service robots in retail

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MANAGEMENT | RESEARCH ARTICLE

Dynamic acceleration: Service robots in retail

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Abstract: Robotics and automation are of the most prominent technologies that will probably define how retail operates in the future. This statement is especially relevant in today's industry conditions characterized by rising wages, severe increases in energy costs and smaller consumer spending across the world. Digitalization accelerated by the pandemic also forces retailers to turn towards technology to keep pace with their competitors. These businesses build on their dynamic capabilities to succeed. The purpose of this article is to analyse successful implementation of robotics in retail in the context of these dynamic capabilities. A key proposition we lay the foundation upon is that investing in dynamic capabilities has an overall positive impact on the implementation of robotic technologies to sustain the digital competitiveness of retail companies. Our document analysis focuses on 190 retail-based news articles about the application of service robots at retail companies from the complete news archives. Findings highlight the importance of enhancing customer experience, regardless of front-end or back-end activities all work towards this one outcome. The implementation examples also reveal that retailers rely heavily on robots in their effort to harmonize digital and physical environment. Looking at geographical differences, Asia is way ahead in front-end application of robots that contribute more directly to customer experience. Retailers in Europe and the United States follow a more balanced approach with many backend service robot applications. Having adopted a global research view, our findings are not only applicable for the whole sector but can be interpreted in a local context.

Subjects: Marketing; Production, Operations & Information Management; Strategic Management; Management of Technology & Innovation;

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Keywords: digital transformation; retail; dynamic capabilities; robots; digitalization

JEL classification: M20

1. Introduction

The most difficult phase of the COVID-19 pandemic is hopefully behind us, and just when the time for economic recovery was about to come, a new threat emerged in the form of the Russia-Ukraine conflict. Both are threats to the global economy and are pushing economies toward crisis. Amid such global events, a sharp decline was forecasted for 2023 by the United Nations (2023) and although economic activity has slowed at a lighter pace, a turn for the better is far off. Supply chain disruptions, and labour market uncertainties still challenge companies to stay competitive in today's business environment. As a global sector, the current situation of retail is also heavily hit by volatile energy costs, contracting market demand as consumers are spending less and wages are also rising due to inflation.

In this uncertain context, it is important to look at several options that can help companies sustain their competitive advantage, the key to which can be automation and digitalization. Digital development in Europe has been undoubtedly boosted by the pandemic. A publication by the European Investment Bank (2021), among others, draws several important conclusions to build on. The report highlights that digital infrastructure is a major barrier to investment. Businesses that have made efforts to digitalize their operations have managed to adopt better governance practices and are generally more productive; therefore, they are more likely to export their goods and services. Also, those companies that had already been using digital technologies prior to the pandemic are likely to have increased their digitalization activities in response to the COVID-19 crisis. To successfully integrate digital solutions into their processes, businesses need to adopt digital transformation strategies. After the pandemic, several retail businesses saw their traditional business models collapse, and as consumers rapidly had to adapt to digital solutions, businesses also executed digital transformation to fit into this new environment (Gouveia & São Mamede, 2022).

In the digital transformation process, digital technologies give organizations the impetus to gain or sustain a competitive advantage in conducting strategic actions. For these actions, the question is how companies will react to the various disruptive events and how they will adapt their business models accordingly. To understand this, we looked at the theory of dynamic capabilities, as the mechanisms linking digital transformation to strategic renewal can be explored through this aspect (Vial, 2019). In this article, we examine the impact of dynamic capabilities in the context of digital transformation using a specific technology, service robots, in retail. We chose service robots because of their ability to integrate multiple technologies (e.g., the Internet of Things (IoT) and artificial intelligence). Thus, it gives us a comprehensive picture of the dynamic capabilities required for successful implementation of advanced technologies and a more comprehensive starting point for further research. Moreover, several studies suggest that dynamic capabilities are key to building on when facing turbulent market conditions. Not only is the possession of dynamic capabilities important to ensure local embeddedness for retailers (Cao, 2011), businesses will only be able to survive the hardships they have experienced if they master these capabilities (Rashid & Ratten, 2021). Dynamic capabilities are also able to steer innovation projects towards feasible outcomes and, by doing so, greatly improve the market success of companies (Chatterjee et al., 2023). Consequently, it is clear that dynamic capabilities strengthen the ability of a business to experiment, which is inevitable in times of crisis (Clampit et al., 2022). If all key elements of dynamic capabilities are perfectly combined, companies may achieve a faster pace of value creation, even in turbulent market conditions (Handoko & Tjaturpriono, 2023).

Our research motivation stems from the observation that digital dynamic capabilities are rich in literature, but this literature has not yet focused on retail robotics, although retailers have already adopted the technology in both back-end and front-end processes.

To summarize, our research examines the importance of service robots in retail operations and places a strong emphasis on the role of dynamic capabilities. Robotic technology has gained significant momentum in retail this decade, but little literature coverage was found in the context of digital dynamic capabilities. Our research proposition is that investing in dynamic capabilities will have an overall positive impact on the implementation of robotic technologies, which will sustain the digital competitiveness of retail companies, and we formulate the following research question: Which types of dynamic capabilities influence the application of service robots in retail, and how can these capabilities contribute towards sustaining competitive advantage in the sector? By using two different models of digital dynamic capabilities, a thorough understanding of this phenomenon will be achieved, and the research question can be answered.

In Section 1, we present the impact of dynamic capabilities on digital transformation and then the role of digital capabilities in shaping retail omnichannel strategies. Sections 2 and 3 review the literature, with Section 2 defining robots and Section 3 examining their different applications in a retail setting. Section 4 introduces our methodology. We have chosen a mixed approach consisting of a full document analysis of three news portals. We included a validation process as well, consisting of articles from the literature review of this paper and other articles selected from the ScienceDirect database after a thorough search. Section 5 interprets robots in retail within the dynamic capabilities framework. Finally, Section 6 discusses validity and research limitations.

2. Dynamic capabilities and digital transformation

According to O'Reilly and Tushman (2008), dynamic capabilities are defined as the capabilities of a company to reconfigure assets and existing capabilities to ensure a long-term competitive advantage. Teece (2007) defined dynamic capabilities as the ability to (a) sense opportunities and threats, (b) seize opportunities, and (c) maintain competitiveness by improving, combining, protecting, and, when necessary, reconfiguring the tangible and intangible assets of the business.

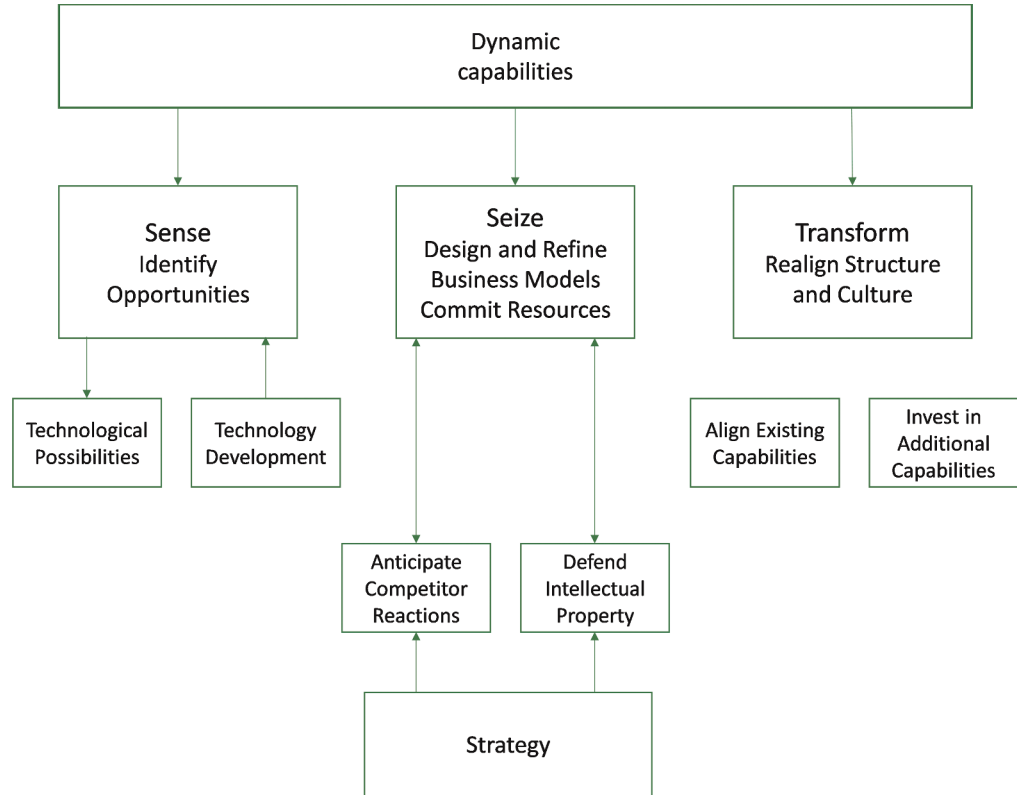
In Teece's (2018) simplified model, the relationship between dynamic capabilities, strategy, and business models can be observed. (Figure 1)

According to the interpretation of the model, the sensing phase involves the identification of opportunities, which are influenced by technological opportunities and can induce technological development processes within the company. The seize phase is where the business model is designed, refined and the resources are allocated. It is the phase most heavily influenced by the company's strategy, through the expected reactions of competitors and the protection of the intellectual property created. These affect the company's business model, in which the strength of its dynamic capabilities plays a key role. The management of a company with strong dynamic capabilities has more freedom to apply business models that involve radical changes in resources or activities. In many cases, corporate strategy dictates the design of the business model. However, the emergence of a new technology that affects most business processes opens up opportunities for radically new business models to which corporate strategy must respond. Based on these, a reconfiguration takes place, where both the structure and culture are refined. It is influenced by the refinement of existing capabilities, and through this, companies invest in acquiring additional capabilities (Teece, 2018).

Dynamic capabilities have an integrational aspect, as they are able to integrate products, resources, capabilities, and business models. For us here, their ability to integrate technologies provided by different parties is key, which enables companies to build successful digital ecosystems and platforms (Helfat & Raubitschek, 2018; Vial, 2019) that can become sources of sustainable competitive advantage. The development of information technology has implications for other types of multilateral platforms for innovation and change as well, including traditional platforms such as shopping malls (Helfat & Raubitschek, 2018).

Figure 1. A simplified model of dynamic capabilities in relation to strategy and business models.

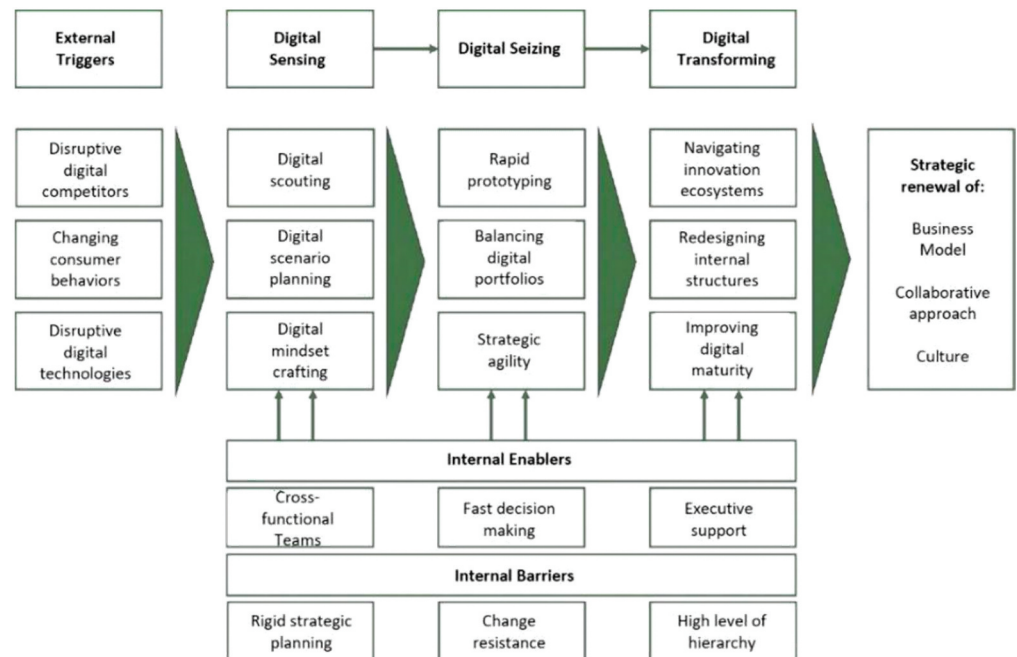
Source: Teece (2018).



Studying dynamic capabilities is particularly important in digital transformation research. Based on Teece's (2018) model, Warner and Wäger (2019) have created a process model for the development of dynamic capabilities for digital transformation (Figure 2). In their article,

Figure 2. Building dynamic capabilities for digital transformation: a process model.

Source: Warner and Wäger (2019).



they investigated how incumbent firms in traditional industries build dynamic capabilities for digital transformation. According to the model, digital sensing, digital seizing, and digital transforming can have external and internal inducers, as well as internal barriers and internal enablers.

Teece’s (2018) model focuses on sensing, seizing, and transforming, but when discussing dynamic capabilities, it must be highlighted that change is induced by external factors. In Warner and Wäger’s (2019) model, the external triggers of digital transformation are the starting point. These external triggers include disruptive digital competitors, changing consumer behavior, and disruptive digital technologies (such as robots), and they influence the company’s market position and force it to react in order to sustain its competitive advantage. The first step is digital sensing. It includes the development of a digital mindset and the exploration and design of digital opportunities. Sensing is followed by the step of digital seizing. Rapid prototyping, creating digital portfolios, and strategic agility fall under this phase. Digital transformation is defined by navigating innovation ecosystems, reconfiguring internal structures, and developing digital maturity. These three stages, which define digital dynamic capabilities, are affected by both internal enablers and internal barriers. Enablers include cross-functional teams, rapid decision-making, and managerial support, while barriers include rigid strategic planning, resistance to change, and hierarchy. This process affects strategic renewal in three different areas: the business model, the collaborative approach (among internal and external actors as well), and the culture.

Dynamic capabilities are key to the success of digital transformation. Teece’s (2018) model examines dynamic capabilities in a general context, while Warner and Wäger’s (2019) model discusses them from the perspective of digital transformation. The latter authors’ model points out that dynamic capabilities should not be assessed in isolation but in the context of the three different organizational levels influenced by digital environmental factors and digital dynamic capabilities.

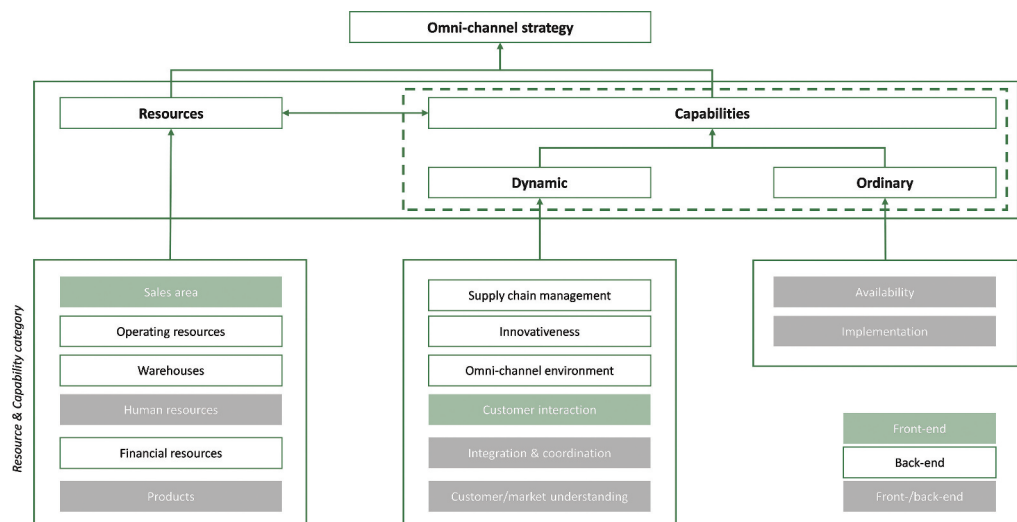
2.1. Dynamic capabilities in creating retail omnichannel strategies

Mrutzek-Hartmann et al. (2022) have built a generic retail model that encompasses the resources and capabilities needed to develop a successful omnichannel strategy (Figure 3).

The framework shows which retail processes (back-end, front-end, or both) are affected by a given resource or capability. It describes six resource categories and six additional categories for dynamic capabilities, alongside two categories for ordinary capabilities. Standard capabilities

Figure 3. A conceptual framework of resources and capabilities for developing a retail omnichannel strategy.

Source: Mrutzek-Hartmann et al. (2022).



include implementation, which is related to omnichannel processes and availability, including both consumer choice and logistics. Dynamic capabilities are responsible for identifying and matching key trends and development areas for the business. This means that both categories belong to both the back-end and front-end processes and are generally responsible for the proper running of the business. The back-end side of dynamic capabilities also includes innovation related to supply chain management and strategy, the creation of an omnichannel environment and the provision of the associated back-end infrastructure. Customer interaction processes are related to the front-end activity. We can discuss integrating a new technology into these processes or the development of a customer relationship management system. Closely linked to this is the coordination of these solutions, which of course, act on both the back-end and the front-end. The final dynamic capability that also works both ways is understanding consumers and the market. The resources affecting the front-end processes include the sales area, while back-end resources include warehouses, financial resources and operational resources. Both back-end and front-end are represented by human resources and products (Mrutzek-Hartmann et al., 2022). Solem et al. (2022) identified eight dynamic capabilities that are necessary to develop an omnichannel strategy and grouped them into four categories. These dynamic capabilities are the following:

1. Capabilities related to back-end technologies

- Capability to develop and implement an integrated digital ERP system.
- Capability to optimize online business, mobile usage, connectivity with social media platforms, and search engine optimization.

2. Capabilities related to optimizing the consumer experience

- Capability to optimize the efficiency of product delivery, return policies, and supply chain management
- Ability to deliver the customer experience in a physical environment, like through showrooms and pop-up stores

3. Capabilities related to external and internal collaboration

- Capability to collaborate across multiple business units and strengthen the core management team
- Capability to collaborate with retail suppliers and partners across different service ecosystems

4. Capabilities related to standard omnichannel operations

- Capability to build and maintain a consumer-oriented retail culture
- Ability to integrate marketing communications and personalization through the use of data

Based on the works of Mrutzek-Hartmann et al. (2022) and Solem et al. (2022), the dynamic capabilities and resources that are essential for a successful omnichannel strategy can be determined. Technologies like the Internet of Things, artificial intelligence, cloud computing, big data, blockchain, augmented reality, advanced robotics, additive manufacturing technologies, simulation, and semantic technologies have attributes that define the digital capabilities of a company, becoming the inducers of digital transformation (Chirumalla, 2021). The impact of these technologies on omnichannel strategies is, therefore, a relevant topic, and better understanding and research are essential to getting acquainted with these technologies. We need to be able to better map their impact on strategy, examine the capabilities and resources required to successfully implement them, and see how they contribute to value creation.

3. Robots

Among the Industry 4.0 technologies identified by Rübmann et al. (2015), advanced robotics stands out. In their interpretation, these industrial robots differ from the mainstream industrial robots that have appeared throughout history in that they are autonomous, flexible, and cooperative. They are autonomous because they can make decisions based on prior algorithms. They are flexible because they are capable of multi-tasking and more mobile than their predecessors were generations ago. And they are cooperative because they can reach and maintain deeper levels of human-robot collaboration. The increasing popularity of industrial robots is also due to the fact that they are now seen as an Industry 4.0 technology and not just an example of industrial automation. Thanks to their exponential technological nature, the cost of industrial robots is constantly decreasing, and their technical capabilities are becoming more versatile, which is also why they are becoming more widespread. Due to cost reduction and versatility of use, SMEs can nowadays afford to invest in such solutions (Strange & Zucchella, 2017).

We can further divide service robots into three different parts: personal, professional, and collaborative service robots (Galín et al., 2020) (Figure 4). Professional service robots, due to their consumer orientation, are regarded as being more prevalent in the front-end domain. Collaborative service robots are usually deployed in the back-end. Industrial robots are excluded from our research in the retail environment because of their primary role in production, and personal service robots are not examined further there either, as they are consumer-use robots.

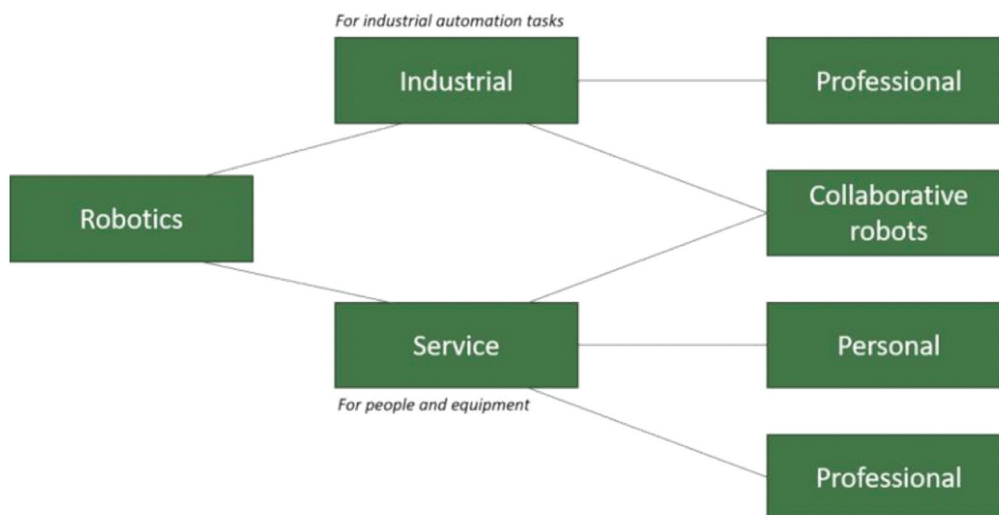
In Pistrui and Harmat (2022), the authors examine how these service robots have spread across multiple industries and how these features are observed in service robots. According to their definition, “physically embodied or software robots with a high level of artificial intelligence and social skills that are different in appearance from industrial robots are called service robots.” (Pistrui & Harmat, 2022, p. 64) This definition builds on Wirtz et al. (2018, p. 909) definition of service robots as “system-based autonomous and adaptable interfaces that interact, communicate, and deliver service to an organization’s customers”.

4. Service robots in retail

In the past decade, the application of robots and other technologies has accelerated the digital transformation of the retail sector. The total value of robots in retail reached \$19 billion in 2015, and at that time, a steady average annual growth rate of 11% was predicted, which would lead to a market size of \$52 billion by 2025. This growth was driven by the proliferation of robots in retail and the steady decrease in the prices of goods (Bloching, 2016). The growing importance of robots in the

Figure 4. Classification of robots.

Source: Galín et al. (2020).



retail sector was so evident that the first conference at Northwestern University in 2018 was held, which focused solely on retail robotics and the potential of artificial intelligence (Bogue, 2019).

Today, the evident growth of the technology's adoption is driven by the implementation of service robots. Sales of these service robots grew by 37% in 2021, indicating the huge potential companies see in such devices (IRF International Federation of Robotics, 2022). Behind this growth, the increasing digitalization of retail plays a role. The World Economic Forum's article cites Mark Shirley, Head of Logistics at Primark, stating that "the sector is already 40% automated, but this could jump to 60–65% over the next three to four years" (World Economic Forum, 2022).

In the retail sector, the biggest companies are leading the way towards innovation. This is the outcome of the constant competition between physical stores (Walmart) and e-commerce (Amazon). This means that they are successfully adapting to the digital revolution in today's competitive environment and developing new strategies to counter the expansion of e-commerce giant Amazon. They exploit the latest technologies and benefit from the resulting synergies (Investopedia, 2019; Makridakis, 2017). The physical stores of larger retailers will remain competitive but will rely heavily on technologies such as artificial intelligence and robotics in the future. This could mean lower employment costs for these retailers. The only advantage for competing smaller firms is that they can build on their personal ties between their employees and their customers (Bertacchini et al., 2017; Shankar, 2018).

4.1. Front-end processes

Regarding front-end activities, two important areas need to be distinguished. The first is the state of the store, its maintenance, and related activities.

The process of cleaning shops and signalling potentially dangerous situations is mentioned in literature in the context of robotization in retail. After the store closes, 20% of employees' time is spent on cleaning, which could be used for other work. This problem is strongly linked to hazardous situations, examples of which range from simple liquid spills to potentially more serious problems that could be detected by sensors attached to robots. These robots, which can clean and detect hazards, are mainly autonomous. In addition to their main function, they can also check stocks, prices, and planogram compliance, supporting both front-end and back-end activities (Bogue, 2019).

The second area of front-end activities is customer-facing activities. Instead of collaborative robots, this field deploys professional robots that can interact with consumers moving around the sales area to enhance the customer experience. This poses the question already raised by Singh et al. (2019): what will be the impact on consumers if a robot performs an activity previously performed by a human? On the customer side, the real issue is trust. The "Uncanny Valley" theory, however, predicts that human-like robots will gain more acceptance from humans than machine-like ones, but this could backfire if they become too similar to humans. Machine-like robots may also gain trust by behaving like humans. Acceptance also depends on customers' experiences with technology (Ben Mimoun et al., 2012; Lu et al., 2019; Wingreen et al., 2019).

A robotic assistant that meets shoppers' expectations can be a great help for shopping by building on the benefits for both the stores and customers. These robotic assistants can also be embodied as robotic shopping trolleys, which can be a great help for elderly or disabled people to carry their belongings or for other shoppers to find the products they need in stores (Bertacchini et al., 2017; Bogue, 2019).

In addition to robotic carts, they can also provide personalized customer service and other value-added services (self-checkout cashiers, avoiding shelf abandonment) (Kumar, 2016). These personalized services are based on data collected by sensor robots. Such data can include the age, gender, behavioral patterns, shopping history, etc. of the customer, and the robot can recommend

products to customers in stores based on the gathered and analyzed data. In conclusion, robotics can be a solution for product personalization, which is highly demanded by consumers today. They can even order a fully customized product through an app, which will be prepared by a complex, cloud-based robotic system (Zhang et al., 2019).

These activities can increase the amount of time shoppers spend in front of shelves, which can lead to an increased customer propensity to purchase (Bertacchini et al., 2017). AI-powered robots can further improve service quality, customer-robot interaction, and AI-assisted decision-making as well (Shankar, 2018). Using machine learning technology, the robots collect data during the customer-robot interaction process and analyze it to gain further insight into possible process failures. In this case, they can warn their owners to buy them new parts or clothes so that they can continue their service and, through that, increase the customers' willingness to buy (Gonzalez-Jimenez, 2018).

In addition to the positive effects, some researchers are concerned about the possible impact of the technologies. For example, as human interpersonal relationships are affected by human-machine interaction (Priporas et al., 2017), even the return on investment in robot technology is questioned by some (they focus mainly on the two sides of investment, maintenance, and employee wages, but many completely neglect to gauge the positive returns regarding the impact on the customer experience).

4.2. Back-end processes

The use of robotics in back-end activities has the same broad potential as in front-end activities, especially in replacing human labour. In back-end activities, collaborative robots can replace personnel, reducing costs and increasing warehousing performance (Bertacchini et al., 2017). These benefits are mainly driven by the technological background of customized products, back-office administrative activities in warehousing and inventory management, autonomous delivery options, and last-mile delivery systems.

The replacement of back-end tasks is particularly important, as sales assistants spend around 30% of their time on back-office tasks. Much of this work can be easily automated, freeing up some time for employees to do more and better sales work so that they can deal with customers instead of administrative tasks (Bloching, 2016). By freeing up time for sales assistants to do value-added work and focus on integral parts of everyday work, compassion and customer-orientation mechanisms will also have a greater effect on businesses being successful, which are proven to be essential in how customers are served (Zoghbi-Manrique de Lara et al., 2023). Through working in a compassion-driven and ethical environment, employees are motivated to adopt an honest approach and stay engaged in a store's sales setting (Ruiz-Palomino et al., 2023).

Inventory management and stocking will be significantly more efficient with AI-powered robotics. Based on the data collected and analyzed, experts can develop predictive models for robots, which can then manage the stocking, inventory, and ordering processes all on their own. Thus, these robots can ensure that customers have access to the desired products when they want them (Shankar, 2018). Robots can be useful not only in store warehouses but also in large logistics centers. With minimal human or automated intervention, they can achieve higher levels of efficiency (Vallandingham et al., 2018). Robots in warehouse environments can perform a wide range of tasks. Robots moving along shelves are just the beginning (Boysen et al., 2019). Exotec Solution, a French robotics company, has developed a machine that can climb onto racks, pick up orders, and even deliver them to the specified location (Mahroof, 2019). In addition, wearable robotics with various exoskeletons are key to helping human workers avoid injuries from heavy lifting during warehouse operations while also increasing efficiency (Tang & Veelenturf, 2019). There are also many examples of fully automated warehouses that operate with minimal human labour but maximize space utilization, working 24 hours a day for all seven days of the week

(Bloching, 2016; KPMG, 2018). The first fully operational, fully automated warehouse was installed by JD.com in Shanghai in 2019 (Tang & Veelenturf, 2019), but other major retailers are also experimenting with the technology.

Connected to retail, there are several experiments in the transportation industry, including a wave started in 2013 by Amazon with the intention of introducing a drone delivery system. As a result, retailers such as Walmart and delivery businesses such as UPS and FedEx have sought partnerships and launched autonomous delivery projects using drones and vans. Some companies have even ventured into developing their own automated retail stores (Bogue, 2019). The aim of autonomous last-mile delivery systems is simple but difficult to achieve. The customer simply places an order for the desired product, and the order is processed through an autonomous system that is linked to the autonomous warehouse mentioned above. Then, the system delivers the order with autonomous delivery within a few hours of the order (Bogue, 2019; Deloitte, 2018).

4.3. Key enablers

Any company that wants to achieve results from robotics must meet certain requirements. The first factor is the organization, which must support the implementation of robotic technology. Employees must see the positive side and not be afraid of technology that could take their jobs away (Bagdasarov et al., 2018; Priporas et al., 2017). Frey & Osborne (2017) calculated the potential for automation in a total of 702 occupations. According to their calculation, the sales job in retail is at the highest risk. In a retail environment, humans need to supervise and support robots during their interactions with customers. The question is: what level of automation is needed to maximize value creation? In turn, robots can assist employees by performing automated, repetitive work instead of them (Daniela, 2015). Advances in sensing and communication technologies ensure that robots and humans can work together safely (Tang & Veelenturf, 2019).

On the other hand, a company needs to invest not only in robotics but also in technology and infrastructure support. Data can play an enabling role in robotics in a technology-rich retail environment (Bertacchini et al., 2017; Colangelo & Maggolino, 2019). To maximize synergies, companies must also consider integrated technologies and continuously improve their IT infrastructure. With the right combination of big data, AI, drone technology, machine learning, and cloud computing, company-tailored robotics can serve as the key to success in today's competitive retail market.

5. Methodology

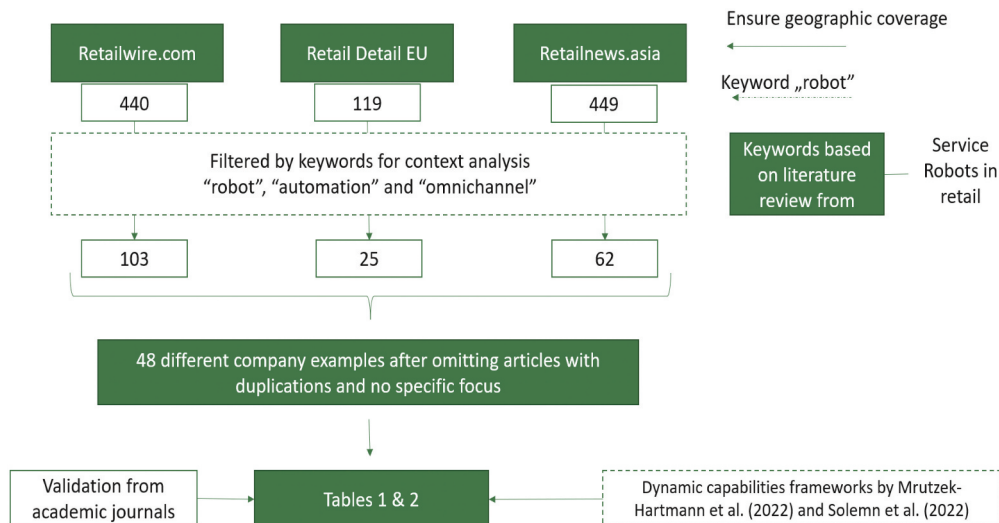
Our research is based on the document analysis of articles from three news portals with a focus on retail. Corbin and Strauss (2008) define document analysis as “a systematic process for reviewing or evaluating documents, both print and electronic (computer-based and Internet-delivered).” Such documents include, but are not limited to, advertisements, handbooks, background documentation, brochures, diaries, journals, event programs, letters and memos, maps, charts, newspaper press releases, organizational or institutional reports, and questionnaire data (Bowen, 2009). The choice of this method is essential for the study of the uptake of robots since fieldwork and observation are not feasible, as the basis of the presented research is analyzing the global context of robotic technology. By examining materials from large companies and press articles, a comprehensive picture can be obtained.

To maintain a geographically diverse pool of the analyzed companies, we present retail examples from three different sites that cover retail operations in the United States, Asia, and Europe.

Our research model can be seen in Figure 5. For the first filtering steps, we used only the keyword “robot” to determine the main pool of articles to examine (440, 119, and 449 articles, respectively). To continue with the document analysis of the articles, we have chosen three keywords, including “robot”, “automation,” and “omnichannel,” to filter for the type of technology and sector, so only relevant articles will be included in the document analysis. We used the

Figure 5. Research design.

Source: own work.



term “omnichannel” to include companies that are successful in integrating front-end and back-end technologies, as they are likely to have already adopted several digital technologies in their operation.

The online retail news site “Retailwire.com” was chosen because the sources of its articles are large multinational retail sites and popular business magazines (e.g., Forbes, Business Insider). The site also has a state-of-the-art search engine ideal for systematic keyword searches. The unique feature of the site is that it only allows authorized retail industry experts to open a discussion, which helps us to ensure the validity of the article pool. On this page, we found 440 articles based on keyword searches, of which 103 were selected for our research after filtering them.

The other two sites chosen were “Retailnews.asia” and “Retail Detail.Eu”. The reasons for our choice are very similar to those already presented for “Retailwire.com”, as they are suitable for keyword searches and aggregated documents from typical retail news portals. Using the three sites combined, we created a pool of continent-based retail articles, which helped us target the selection process for certain geographical areas. On “Retailnews.asia”, where retail articles were included relevant to the Asian market, 449 relevant articles were identified, of which 62 were selected. On “Retail Detail.Eu,” which collects retail articles based on the European retail market, 25 out of 119 were selected. To determine the final pool of retail articles that describe how certain companies apply robotic technology in their operations, we only kept articles describing solutions that were already implemented at the time this paper was finalized. We also filtered out duplicated company cases and articles without a specific focus; hence, a final number of 48 company examples was reached and is being presented here.

To frame our research, Section 4.3 analyzes the role of robotic technology in retail by using two digital transformation models of dynamic capabilities, introduced by Mrutzek-Hartmann et al. (2022) and Solem et al. (2022) and explained in Section 1. By examining the service robots of retail companies in the context of both models, key dynamic capabilities were identified that enable retailers to sustain their advantage in the ever-intensifying competition of the retail sector.

These key dynamic capabilities are shown in the first column of Tables 1 and 2, structured by the two previously mentioned digital transformation models. The 48 chosen company examples were placed in the “geographical breakdown of companies” columns of Tables 1 and 2, according to their retail database source.

Table 1. Service robots and dynamic capabilities at retail companies based on the categorization of Mrutzek-Hartmann et al. (2022)

	Examples from academic literature	Geographical breakdown of companies		
		Retailwire examples	Retail Detail EU examples	Retailnews.asia examples
Dynamic capabilities (Mrutzek et al, 2020)		Company (Name of robot/ Manufacturer)	Company (Name of robot/ Manufacturer)	Company (Name of robot/ Manufacturer)
Supply chain management	Wolpert and Roth (2020), Hanninen et al (2020), Bäckström and Johansson (2017), Ye et al. (2022), Moradi and Dass (2022)	Carnegie Mellon University bookstore (AndyVision), Walmart (Auto-S), Kroger & Sobey's (Ocado), Schnucks (Tally), Sam's Club (Brian Corporation), Amazon (Kiva), Lord & Taylor fulfillment center, Walmart fulfillment center, GreyOrange Butler fulfillment center	Casino, Morrison's, ICA(Ocado), Colruyt (Scallog), Tesco (Mini-repository)	
Innovativity	Vakulenko et al. (2019), Morenzanos et al. (2019)	Kroger (Nuro), Google patented self-driving truck, H-E-B self-driving delivery vehicle		
Omnichannel environment	Hanninen et al (2020)	Hointer, Zara, Walmart (Robo-cart	Ochama (pick-up point), Carrefour (pick-up-point), Rituals, Zara Stratford store	Funan shopping mall (Click-and-Collect), JD Mall shopping centre
Customer interactions	Bertacchini et al. (2017), Song and Kim (2022)	Lowe's (LoweBot), Toys "R" Us (MyKeepon), Macy's (Marty)	Solebox (Solebot), Media Markt Eindhoven (Pepper), Auchan (WiiGo), Carrefour-Pepsi Co marketing robot, Lenta (Promobot)	Mitsukochi (Aiko Chihira), Aqua City (Chihira Junco), Aircart bookstore, Tokinomo, SmarTone (NAO), SM Group-SM Megamall (Sam), Center Food Hall (UV-C), Nudaku (The Probe), Pricerite (Pepper)
Integration and coordination	Solti et al (2018)	Giant Food's, Stop Shop ésMartin's (Marty)		FamilyMart Funan shopping mall (M1), CLOi

(Continued)

		Geographical breakdown of companies		
	Examples from academic literature	Retailwire examples	Retail Detail EU examples	Retailnews.asia examples
Dynamic capabilities (Mrutzek et al, 2020)		Company (Name of robot/ Manufacturer)	Company (Name of robot/ Manufacturer)	Company (Name of robot/ Manufacturer)
Understanding consumers and markets	Song & Kim (2020), Bäckström and Johansson (2017), Hoekstra and Leeflang (2022)	Lowe's (LoweBot), Toys "R" Us (MyKeepon), Macy's (Marty)	Solebox (Solebot), Media Markt Eindhoven (Pepper), Auchan (WiiGo), Carrefour-Pepsi Co marketing robot, Lenta (Promobot)	Mitsukochi (Aiko Chihira), Aqua City (Chihira Junco), Aircart bookstore, Tokinomo, SmarTone (NAO), SM Group-SM Megamall (Sam), Center Food Hall (UV-C), Nudaku (The Probe), Pricerite (Pepper)

Source: Own editing based on „retailwire.com”, „Retail Detail.Eu” and „Retailnews.asia” articles.

Lastly, we conducted a two-step validation of our research. Firstly, we took the publications presented in Section 3. Secondly, an additional keyword and context search was carried out in journals within the ScienceDirect database. To select relevant journals and articles to enhance the quality of the validation, we used “retail AND robots” AND “dynamic capabilities” in the logic of Boolean operators to filter for the applicable articles in the database. These articles were placed in the second column of Tables 1 and 2 (“Examples from academic literature”), matching the respective dynamic capabilities.

6. Dynamic capabilities and robots in retail

In Teece's (2018) simplified model, the three main stages of dynamic capabilities are sensing, seizing, and transforming. Warner and Wäger (2019) interpret dynamic capabilities in the digital environment. Digital sensing is about exploring business opportunities, while digital seizing is about designing the right elements of the business model. Lastly, digital transformation is about reconfiguring internal processes, shaping the business model, and developing digital maturity. We identified retail robots as tools for digital transformation, so our research focuses on the third phase.

We can evaluate business examples in retail through dynamic capabilities using the categories defined by both Mrutzek-Hartmann et al. (2022) and Solem et al. (2022), described earlier in Section 1, and organizing the selected academic and news portal articles (see Section 3) within these categories. Tables 1 and 2 below summarize these practical examples according to the related literature and geographical breakdown.

The coverage of retail robots in literature is extensive, such as their place in the lives and business models of companies, as shown in both Tables 1 and 2. While supply chain integration was the key factor in the 1990s, from the late 2000s onwards, consumer adaptation of digital devices and emerging technologies came to the spotlight for retail. Today, this includes, among other things, the introduction of artificial intelligence-based solutions and retail robots. They provide a strong foundation for the digital maturity of companies (Hanninen et al., 2020), while the alignment of back-end and front-end processes is necessary for seamless operations, to which

Table 2. Service robots and dynamic capabilities at retail companies based on the categorization of Solem et al. (2022)

	Examples from academic literature	Geographical breakdown of companies		
		Retailwire examples	Retail Detail EU examples	Retailnews.asia examples
Dynamic capabilities (Solem et al, 2020)		Company (Name of robot/ Manufacturer)	Company (Name of robot/ Manufacturer)	Company (Name of robot/ Manufacturer)
Capabilities related to back-end technologies		Giant Food's, Stop Shop és Martin's (Marty), Amazon (Kiva), Carnegie Mellon University bookstore (AndyVision), Walmart (Auto-S), Kroger & Sobeys (Ocado), Schnucks (Tally), Sam's Club (Brian Corporation), Amazon (Kiva)	Casino, Morrison's, ICA (Ocado), Colruyt (Scallog), Tesco (Mini-repository)	Funan shopping mall (M1), CLOi
Capabilities related to optimizing consumer experience	Lavoye et al. (2021), De Gauquier et al. (2021), Leroi-Werelds et al. (2021)	Toys "R" Us (MyKeepon), Lord & Taylor fulfillment center, Walmart fulfillment center, GreyOrange Butler fulfillment center, Lowe's (LoweBot), Macy's (Marty), Kroger (Nuro), Google patented self-driving truck, H-E-B self-driving delivery vehicle	Solebox (Solebot), Media Markt Eindhoven (Pepper), Auchan (WiiGo), Carrefour-Pepsi Co marketing robot, Lenta (Promobot)	Mitsukochi (Aiko Chihira), Aqua City (Chihira Junco), Aircart bookstore, Tokinomo, SmarTone (NAO), SM Group-SM Megamall (Sam), Center Food Hall (UV-C), Nudaku (The Probe), Pricerite (Pepper)
Capabilities related to external and internal collaboration				
Capabilities related to standard omnichannel operations	Hänninen et al. (2021), Akter et al. (2023)	Hointer, Zara, Walmart (Robo-cart)	Ochama (pick-up point), Carrefour (pick-up-point), Rituals, Zara Stratford store	Funan shopping mall (Click-and-Collect), JD Mall shopping centre

Source: Own editing based on „retailwire.com”, „Retail Detail.Eu” and „Retailnews.asia” articles.

a comprehensive digital technology portfolio serves as a great enhancement (Ye et al., 2022). Many authors argue that to become technology pioneers and market leaders, businesses must invest in capabilities that involve robotics and artificial intelligence that will support the value proposition for the consumer (Leroi-Werelds et al., 2021) and that the COVID-19 pandemic has only accelerated the adoption of such technologies after social distancing practices had been in place for a long time (Hoekstra & Leeftang, 2022). The ability to integrate business processes is a key to success for retailers, which is fostered by AI-enabled service innovations such as robots (Akter et al., 2023).

In addition to research on omnichannel environments and consumer experience, the use of retail robots in supply chain management is the most studied area in the literature. In retail, the monitoring of both product availability on the shelves in the sales area and the stock levels in the warehouse area is considered feasible (Morenza-Cinos et al., 2019). On the front end, Carnegie Mellon University's bookstore, Schnucks, Sam's Club, and Walmart supermarket chains successfully use professional robots to scan products on the shelf. These robots monitor and check the availability and stock levels of products in the sales area. The application of retail robots for this purpose can also filter misplaced products, even if they did not receive product placement information beforehand (Solti et al., 2018). A significant advantage of such applications is that AI-enabled shelf-scanning robots can enhance the efficiency of sales assistants (Moradi & Dass, 2022). On the back-end, companies are using robots to run automated warehouses. Robots developed by Ocado can be found in retail chains around the world, from Kroger in the US and Sobeys in Canada to French retailers Casino, Morrison's in the UK, and ICA in Sweden, where they contribute to back-end process efficiency. Similarly, Scallog robots and Tesco mini-repositories support back-end operations too.

The establishment of fulfillment centers is also a prominent practice at many large retail companies. In 2012, Amazon acquired Kiva, which allows them to use robots to move stock in their warehouses. Hudson Bay Company (HBC) has also opted for fulfillment centers, which they claim make their operations three times more efficient. In addition to these, GreyOrange's widespread Butler robotics system, Walmart and Lord & Taylor are also successful examples of fulfillment centers. As for the stage of the supply chain management closest to the consumer, retailers are embracing innovative ways of going the "last mile". This is of paramount importance, as the „last mile" experience has a significant impact on consumer satisfaction (Vakulenko et al., 2019). The challenge of this stage can be overcome by using self-driving cars, as demonstrated by the use of Nuro self-driving cars in the delivery of retail giant Kroger, or the self-driving truck patented by Google. This same solution is chosen by supermarket H-E-B too.

The satisfaction and in-store experience of the "new consumer" are influenced by multiple elements, to which technological support contributes significantly (Bäckström & Johansson, 2017). In line with this, the shift in literature and retail business models towards omnichannel strategies is undeniable (Hanninen et al., 2020). The robots that create and maintain this environment are typically located in the retail sales area in a highly visible way, as they are at the heart of the omnichannel model of companies. An example of this can be seen in Zara's stores in North America and Europe. Robots in the out-of-store fitting rooms allow customers to collect their online orders in the store. At Hointer, on the other hand, an app makes shopping easier in the in-store space: products placed in the virtual shopping cart are delivered to the in-store fitting room, so the robots are working outside the consumer's field of vision, "in the background". Walmart has patented its self-driving shopping trolleys as an innovation to simplify the shopping process. Consumers can call the trolleys equipped with sensors and cameras using their smartphone apps. This way, the chain not only enhances the omnichannel experience for consumers but also makes in-store service more efficient. A similar innovation is the Aircart bookstore's smart robotic shopping trolley, which amplifies the customer's pushing power, making in-store navigation easier. In addition to corporate examples, shopping malls with retail outlets are also using robots to engage shoppers: click-and-collect robots at Funan in Singapore and the full omnichannel architecture at JD Mall in China can integrate different stores to

maximize the customer experience. In Europe, order dispatch and pick-up are seen to be managed by robots; the robotic pick-up points at Ochama and Carrefour are pioneer examples of this. The cosmetics company Rituals uses QR codes to receive orders from queuing customers, which can be picked up by them after they have entered the store.

By deploying retail robots, which can access business databases or social media in the store area, one can also provide consumers with a personalized experience by filtering their preferences (Bertacchini et al., 2017). There are many examples of robot customer service. Leading the way are Toshiba's Aiko Chichira service robot and assistant robots at Lowe's and Macy's, which can answer consumer questions and guide them to the product they are looking for. Media Markt's Pepper robot in Eindhoven can also guide and serve customers in-store, while WiiGo robots assist shoppers at Auchan in Western Europe.

A similar function is performed by robots placed in shopping malls, such as the Chichira Junco robot at AquaCity and the Sam robot at SM Megamall. Robots placed to attract attention also rely on interacting with consumers and are effective in luring potential customers to the store (De Gauquier et al., 2021). Greeting robots can be found in several Macy's stores and in Lenta stores in the Russian capital. Also, Toys R Us toy stores have successfully used their My Keepon robots as an attraction. The Pepsi Co. advertising robots tested in Carrefour stores in Poland are also building on their power to attract attention. What all these robots have in common is that they rely on interaction with the consumer.

It is important to distinguish between two types of interaction between robots and humans: direct and indirect. Greeting robots and customer engagement robots target consumers in a direct way, creating a lasting customer experience. The Tokinomo marketing robot and the playful NAO robots of SmarTone aim to enhance the customer experience. The Probe robot at the Gentle Monster store in Shanghai features a digital creature resembling a six-legged being that embodies the essence of the brand. UV disinfection robots have also emerged because of the coronavirus pandemic, which, unlike the previous examples, interacts with consumers indirectly. The robots can also take over the tasks of the shop assistants (Wolpert & Roth, 2020). Supermarket chain Giant Foods uses its robotic assistants, called Marty, primarily to predict in-store emergencies. Through this, store employees can pay more attention to serving customers. There are also many examples of fully automated stores; the Solebox store in Berlin operates without a human workforce. Although 100% automation is not yet common in the sales area, more and more practices are emerging around the world to replace human resources: kangaroo-shaped robots at FamilyMart in Thailand can even do shelf sorting. A very different concept from the previous ones is the CLOi wearable robot, a piece of equipment that helps business salespeople work more efficiently.

Along with improving the customer experience, a deeper understanding of consumers is an important benefit of using retail robots and emerging technologies (Lavoye et al., 2021). Examples from our research also support the idea that this requires outsourced robots to have higher social competence, human personality traits, and to be adaptive. These make the consumer-robot relationship easier to establish (Song & Kim, 2022). Anthropomorphism and the social traits of robots are more important to discuss in retail than in other sectors. Although consumers are encouraged to approach these robots as service providers, excessive anthropomorphism may create a negative impression on consumers (Lu et al., 2019).

7. Validity and limitations

In order to ensure validity, we matched our research results based on information collected from retail news sites with the articles used in Section 3 and further strengthened this process by including additional articles in Tables 1 and 2 as described in Section 4. Validity can be further increased by a systematic search based on articles from the major retail journals, by processing more articles with the relaxed keyword search rule already described in Section 4, and by conducting interviews with experts in retail digital transformation.

Reproduction of the research might be a bit more tedious due to the fact that one of the used retail news portals, „Retailwire.com,” modified its search engine some time ago, requiring more effort to access their older articles.

One limitation of our research is that we did not conduct a complete survey of all available retail news sites; we just focused on some geographically important and relevant major ones. A complete survey could further strengthen our results by finding and including more company examples. We also did not dive into analyzing possible regional differences in detail, as this would have been beyond the scope of this article. This extension could be the start of a new research direction, as well as the inclusion of other, so far not covered geographical regions.

8. Conclusion

Our research investigated the dynamic capabilities required for the successful implementation and integration of service robots into business processes in retail. Mrutzek-Hartmann et al. (2022) and Solem et al. (2022) both defined the dynamic capabilities that retail companies can build on to develop a successful omnichannel strategy. The example of robotic technologies can be extended to other digital technologies because of their technology-integrating complexity. With our research, we would like to provide a new perspective for academics working on the digitalization of retail. An analysis of dynamic capabilities and technology implementation can provide further support for a better understanding of the ongoing digital transformation in retail, which is still a work in progress.

The level and focus of implementation of robot technology vary across the markets researched. In general, retail companies are largely using service robots to enhance the customer experience. In this regard, it is noteworthy that companies are using robots to harmonize their physical and digital environments, leveraging the dynamic capabilities of consumer interactions and maintaining an omnichannel environment. Asian retailers are well ahead in this area, with the vast majority of the surveyed companies already having deployed service robots. In comparison, Europe and the US are more balanced in terms of using robots in their front-end and back-end activities. As far as back-end processes are concerned, service robots are most common in the warehouses linked to the sales area. Companies can successfully implement robots by building on their dynamic capabilities in supply chain management and back-end process integration.

The successful implementation of service robots could have a strengthening effect on dynamic capabilities, potentially enhancing the digital sensing capabilities of retail companies. It is possible through gaining a deeper understanding of consumers, which also outlines further research directions. Further research could include in-depth interviews with experts and case study-like research with companies at the forefront of digital transformation in retail. The selected news portals have great potential for document analysis since only academic and industry experts can add posts and write articles on them. The focus of research would be on consumer and company-level adoption of robotic technologies and the impact of robotic technologies on the consumer experience. Questions that could be raised may target different areas. Firstly, can the adoption of robot technology help improve the efficiency of retail companies in both front-end and back-end operations? Also, is it a temporary positive effect due to novelty, or can the use of robots on the front-end be a source of sustainable competitive advantage? As an additional research direction reflecting on the positive effect of servant leadership in strategic differentiation (Ruiz-Palomino et al., 2021), it could be examined whether service robots could take a facilitative role between managers and subordinates and how they can encourage collaboration and social interactions between different business functions. Connected to this, it is interesting to analyze how service robots can contribute to building social capital at firms and, by doing so, yield a competitive edge for the business (Zoghbi-Manrique de Lara & Ruiz-Palomino, 2019).

The widespread adoption of service robots in retail is still a long way from maturity. Through analyzing various company examples, we have seen that retailers are using robots in both their front-end and back-end operations, primarily to enhance the customer experience. Companies can

leverage their dynamic capabilities to successfully introduce and integrate service robots into their operations. By analyzing the 48 company examples presented in our paper, several practical conclusions can be derived for business owners and managers. Robotics work most efficiently when used to enhance the customer experience and integrate both front-end and back-end operations. These technologies provide invaluable benefits when retailers would like to get insights from customer interactions, thus improving the sensing and dynamic capabilities of the business.

To conclude, our research can provide companies with a clear focus on the dynamic capabilities and business areas in which they can successfully implement service robots. Our results can also provide the research community with potential new opportunities to conduct future research.

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Data availability statement

The data that support the findings of this study are available from the corresponding author, M. Zs., upon reasonable request.

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