CORVINUS UNIVERSITY
of BUDAPEST

THESIS COLLECTION

Pistrui Bence László
Effective implementation of Industry 4.0 technologies in the retail sector through the example of service robots
for his Ph.D. thesis

Thesis Supervisors

Dr. Czakó Erzsébet
professor
Dr. Matyusz Zsolt
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Tartalom

I. Research background and rationale for the topic

Throughout my research, minor and major environmental changes have influenced the final form and direction of the dissertation and the outcome of this research. The raging COVID-19 pandemic in our world has put my original research in a different light. Initially, my research was intended to primarily examine the widespread adoption of industrial robots within the context of Industry 4.0 and their significance in the world of business. Accordingly, at the beginning of my research, together with my supervisor, Erzsébet Czakó, I participated in the "5th AIB-CEE Chapter Annual Conference on International Entrepreneurship as the Bridge between International Economics and International Business" in 2018 with a paper analyzing the readiness of the Visegrad Four countries for Industry 4.0. The aforementioned work has significantly influenced my perspective, leading to my maintaining Industry 4.0 as an essential concept. Moreover, it has served as a catalyst for technological advancements, enabling the widespread integration of

robots in many global industries. In the same year, I joined a research group on the impact of Industry 4.0 on industry and continued my research with a focus on retail. Thanks to this research and the unfortunate pandemic, my initial ideas were shaped and changed. Due to COVID-19, the retail industry, among others, has undergone significant changes and has been forced to invest significant resources in digitalization. In recent years, there has been a notable trend toward the adoption of robots. The ongoing COVID-19 pandemic has further emphasized this shift, as there is now a greater focus on maintaining distance between humans. Additionally, the emergence of various digital platforms, such as Foodpanda and Walmart's GoLocal service, has facilitated the connection between smaller retail establishments and large multinational retailers. As a result of these external factors, my research has shifted from a general global quantitative focus to an industry-specific qualitative research direction.

In the context of my doctoral thesis, I aim to address the following research question: What is the influence of digitalization, specifically in relation to service robots, on

the worldwide value chain of retail companies? In order to achieve this goal, an analysis will be conducted on the effects exerted on the front-end and back-end operations of retail establishments, as well as the necessity for the presence of strategic support functions to facilitate these operations. In order to carry out this research in sufficient detail, I will first introduce and define service robots and examine the framework and the way in which digitalization is taking place in retailing, based on the Porter value chain model.

II. Methodology

The main methods chosen for my thesis is a systematic literature review, case studies, and interviews with companies and experts. However, for my third article, content analysis is also used as a methodology.

II.1 Systematic literature review

This part based on three main academic papers (Crawford et al., 2015; Erfani & Abedin, 2018; Machi & McEvoy, 2016).

Systematic literature review is a literature review methodology that uses systematic methods to collect secondary data, critically review studies, synthesize qualitative or quantitative results, and help to explore a particular issue from multiple perspectives. The practice of reducing the influence of study errors and biases, identifying areas for potential research gaps, and assuming new results through the synthesis of findings from many studies is beneficial.

There are eight steps to systematic literature processing:

1. Defining the research question

2. Developing an audit protocol: how we will select the literature

3. Identification of relevant studies

4. Pre-selection of studies

5. Evaluation of studies

6. Data retrieval

7. Synthesising and interpreting results

8. Publication and dissemination of results

 Due to the many different approaches and researches that exist for both Industry 4.0, digitalization, and robots, a systematic literature review is a suitable method to summarize these researches and thus lay the foundation for exploring the potential applications of robots beyond manufacturing. After all, several studies have already looked at the applications of robots in other sectors, but their synthesis has been limited or nonexistent.

II.2 Case studies

I was a member of a research project, which was the **EFOP-3.6.2-16-2017-00007, "Aspects of the development of a smart, sustainable, and inclusive society: social, technological, and innovation networks in employment and the digital economy,".**

Within the EFOP project, we investigated the meaning and implementation of Industry 4.0 in different industries. A

case study methodology was chosen to present these. The different industries have been examined in pairs, for example, FMCG, SSC, retail, and others, to show the impact of Industry 4.0. I was part of the team that studied the retail sector, which actually had a big influence on the outcome of my current dissertation.

Two companies were selected, and a case study was written about them. These case studies were used to write the main part of the second article.

According to Harling (2012), "a case study is a holistic study that examines a contemporary phenomenon in its natural context. A phenomenon can be any problem, event, action, or even individual. By natural environment, he means the context of the event, the circumstances in which the phenomenon takes place. This is important when examining a phenomenon because either the environment affects it or they cannot be clearly separated from each other and are therefore highly relevant to the researcher. Holistic analysis ensures the versatility and detail of the data. In collecting data, researchers can rely on

observation, interviews, documentary analysis, and audiovisual materials, among others.

In Simmon's (2014) definition, "a case study is an in-depth exploration of the complexity and uniqueness of a project, policy, institution, program, or system from multiple perspectives in a'real life' context."

The case-study method is the right choice when the questions of how and why are to be answered or when the boundaries between the phenomenon under study and the context are not fully separable. Additionally, this method is particularly suitable where there exists an inherent interdependence between the subject of research and its surrounding context, rendering a complete separation of the two entities unattainable. It is imperative that the researcher remain impartial and refrain from exerting any influence on the study's outcome, irrespective of the unfolding events. (Starman, 2013).

Because of its versatility, the case study method is now increasingly referred to as a distinct research concept that

can encompass more than just a single method (Starman, 2013; Simmon, 2014).

II.3 Document analysis

Bowen (2009, p. 27) 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 advantages of document analysis include that it is an efficient and less time-consuming method, much of the material is freely available, it is cost-effective, the research process does not change the content, it covers a broad spectrum, and it is accurate. The disadvantages are that, as they are not produced for research purposes, they may

leave out some details that may be relevant to the research. Furthermore, they are difficult to retrieve, as they may have been provided for research purposes only or they may have been deliberately blocked from access. Other drawbacks may be that the selection of data included is subjective, as they have different purposes, so the choice of data may reflect the perspective and purpose of the content producer. These drawbacks can be easily mitigated by introducing other methods, and the advantages make their use widespread among researchers (Bowen, 2009).

The choice of this method is essential for the study of the uptake of robots since fieldwork and observation are out of the question as the technology is less widespread in our country. However, by analyzing materials from large companies and press articles, a comprehensive picture can be obtained.

III. Results:

I base my dissertation on three articles. I will provide a brief summary of the interconnections and logical

associations among the articles, clarifying their relevance to the primary research question by using the sub-questions from the articles and their corresponding answers. Table 6 provides a summary of the publications, organized by research topics, content, and place of publication. Additionally, it acknowledges and emphasizes the contributions of my co-authors, whose involvement was important in conducting this research.

Figure 1: Articles used as part of my article-based dissertation

| Main research question	The evolution of digitalisation with a focus on service robots, how does it enable the successful implementation of technologies in a business environment?					
Article No	Authors	Title	Sub Questions	Answers	Journal	Classification
1	Pistrui Bence, Harmat Vanda	A szolgáltató robotok definiálása és alkalmazási lehetőségei az üzleti szervezetekben- szisztematikus irodalmi áttekintés	What is the definition of service robots, how do they participate in the value creation of companies and where do they fit within the typology of	Providing a definition for service robots Typology of robots and their occurrence within industries The emergence of effects on retail trade: - Attitude - Distancing - Consumer experience	Budapest Management Review	B
2	Matyusz Zsolt, Pistrui Bence	Digitalisation projects in the Hungarian retail sector - comparison of two key segments through	What are the digitalisation trends in retail, how can these trends be framed, and how are companies trying to respond to these	Impact of digitalisation on value chains Validation and use of a model to demonstrate integrative robot technology	Budapest Management Review	B
3	Pistrui Bence, Kostyal Dániel Stephen, Matyusz Zsolt	Dynamic acceleration: service robots in retail	Which types of dynamic capabilities influence the application of service robots in retail, and how can these	The importance of investing in dynamic capabilities for the successful use of robots Detecting geographical differences in the use of robots	Cogent Business & Management	Q2

Source: own editing

III.1 Defining and applying service robots in business organisations - a systematic literature review

In the first article, my co-author and I defined service robots, described their main characteristics and identified the industries in which they are present. The discussion

highlighted the phenomenon of robots possessing many functionalities, which arise from diverse advancements in digitalization technology. These robots integrate various technologies to enable their versatility in doing multiple tasks. While the focus of the research is on the tourism and hospitality industry (one of the main sufferers of COVID-19, which is why research in this direction started earlier), several other industries using service robots are mentioned, including retail. From the perspective of my research, the impact of COVID-19 highlights the fact that developments and research on robots have accelerated as a result of the pandemic, as they have provided greater opportunities to provide higher-quality hygiene, reduce human-human interactions, and provide distance control. This acceleration was also true for their use in other industries such as consulting, fintech, manufacturing, and retail. In these areas, their use and research directions have included increasing customer experience, trust, perceived usefulness, improving customer attitudes towards robots, and increasing the intensity of research into human-robot interactions to increase the social skills of robots. Therefore, the primary inquiry revolves around identifying

the digitized attributes that hold the highest utility for a retail chain. Specifically, we aim to ascertain which of these features, if integrated into a service robot, can effectively contribute to the aforementioned objectives. Additionally, we seek to understand the impact of ongoing digitization advancements within the retail industry, as these factors play a crucial role in shaping the capabilities of present and future robots operating within retail environments.

Figure 2: Results of the first article
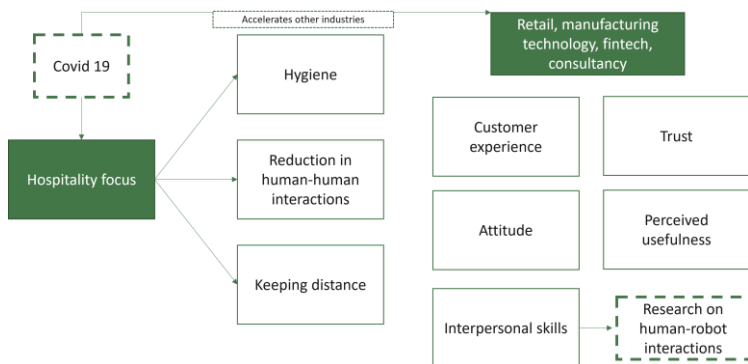
Source: own editing

III.2 Digitalisation projects in the Hungarian retail sector - comparison of two key segments through empirical examples

In the second article, we examined the digitalization situation in the Hungarian retail sector with one of my supervisors. For this purpose, we chose semi-structured interviews as methodology and selected two companies as interview targets. The criterion for selecting the companies was to have one company from each of the two leading sub-sectors within the Hungarian retail industry. Thus, we chose a fashion retailer and a sports retailer. Through the examples of these two companies, our aim was to show how these companies use digitalization solutions within the value chain theory, what the main reasons are for this, and what their biggest challenges are. As a result of our research, we found that digitalization solutions have an impact on the entire corporate value chain and fundamentally change the way companies approach certain issues. Examples include the choice of appropriate technology and financing, the selection of human resource and training issues with a particular focus

on digitalization skills and development areas, and the rethinking of senior management positions to increase the technology focus. For the core activities, we have also shown that both back-end and front-end processes are affected by digitization solutions. As the establishment of improved working conditions for employees is implemented, the efficiency of corporate management is enhanced. Digitalization tools have proven to be crucial in enhancing the customer experience and generating greater value for customers.

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III.3 Dynamic acceleration: service robots in retail

In the third article, I looked at the potential for the use of robots in the retail environment and the types of robots that can be successfully implemented in a retail environment. This study examine the possible application of robots in the retail sector, as well as the many types of robots that can be effectively used within this environment. The utilization of robots was employed as a demonstration example to analyze the overall influence of a particular

technological advancement on retail businesses. The selection of robots is motivated by their ability to include many technologies including as artificial intelligence, drones, sensors, cloud computing, and the Internet of Things (IoT). Moreover, robots find utility in both back-end and front-end operations, encompassing tasks like warehousing, inventory management, and customer information management. The classifications of robots as defined and differentiated in the first paper were used alongside additional research findings that have been since published. It was observed that dynamic capabilities possess an integrational aspect, which facilitates the integration of various elements such as products, resources, capabilities, and business models within firms. The integration of many components facilitates the development of digital ecosystems and platforms that have the potential to yield sustainable competitive advantage. This study examines the impact of robotic technology on the retail industry through the application of two digital transformation models that incorporate dynamic capabilities. Through an analysis of service robots employed by retail organizations, this study aims to

identify the essential dynamic characteristics that allow retailers to maintain their competitive advantage in the increasingly competitive retail market. The retail sector's largest companies are at the forefront of innovation, as they navigate the digital revolution and formulate novel ways to combat the growing dominance of Amazon, a major player in the e-commerce industry. The implementation of robotic technology in the retail industry has major potential for transforming both front-end and back-end operations. The utilization of retail robots and developing technology provides a deeper understanding of customer behavior, requiring robots to possess improved social competency, human-like personality features, and adaptability. The significance of anthropomorphism and social features of robots is more pronounced in the retail industry compared to other sectors, given that an excessive degree of anthropomorphism has the potential to generate unfavorable perceptions. The effective deployment of service robots has the potential to improve dynamic capabilities and improve digital sensing capabilities. Asian retail stores have demonstrated an important lead in front-end usage of service robots, as the companies in the region

have already implemented them in that field. The utilization of robots in both front-end and back-end operations is more evenly distributed in the United States. While, in Europe back-end procedures are predominantly observed in sales-associated warehouses.

Conclusion

I would like to answer explicitly to my research question, which was: What is the influence of digitalization, specifically in relation to service robots, on the worldwide value chain of retail companies?

Due to technological advancements, improved accessibility, and the influence of the COVID-19 epidemic, robots have experienced a notable increase in their availability to businesses and have expanded their presence across all sectors in order to perform a diverse array of functions. The definition of service robots was imperative in enhancing comprehension of the proliferation of robots beyond industrial applications.

In general, the fourth industrial revolution's effects and the growth of digitalization have had an impact on the retail industry. The integration of digital assets has had a profound impact on every aspect of a company's value chain. The retail business is currently facing new strategic problems, which have required decision-makers to prioritize IT strategy, and IT infrastructure development. Additionally, there is a need to provide sales and human resource management with the necessary skills to train and develop personnel in the area of digital capabilities. The integration of digitalization has been prevalent in various aspects of both back-end and front-end operations, leading to the emergence of numerous technical advancements, such as the utilization of robots within the retail industry.

The introduction of service robots in the retail sector has demonstrated differences throughout different regions of the world. In the European context, these technologies are predominantly employed in backend operations, encompassing tasks such as warehouse automation, inventory automation, and security services. In the Asian region, particularly within the domain of front-end

solutions, there has been a notable proliferation aimed at enhancing the whole customer experience. In the United States, their use has been mixed in both back-end and front-end processes. The adaption of dynamic capabilities is expected to enhance the probability of effective integration of robotic technologies into organizational processes, thereby leading to an increased competitive advantage.

Further areas of research could encompass a comprehensive exploration of technologies beyond robotics, in order to enhance the credibility of a broader research that bolsters the connection between technologies and dynamic capacities.

However, the extent to which robots will become commonplace companions in the retail industry is yet to be determined, while the possibility for such integration exists.

In conclusion, it is essential for the successful implementation of digital tools that the right infrastructure is in place and that companies have the resources to ensure that it is up-to-date. Robotic technology is only one of a

number of possible advanced technologies that can provide a competitive advantage over competitors today, but it can quickly become a prerequisite for staying competitive. They are having an impact on both back-end and front-end processes and are having an impact on the entire enterprise value chain. The importance of their role in back-end processes will presumably remain, but an interesting further research question may be: how sustainable is their role in the front-end in the long term? To what extent can they be a means of creating a long-term customer experience, or are they just one-off hype that, once seen, can no longer have an impact?

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