

Innovation in operational processes and adherence to industry 4.0 technologies in a network of supermarket stores

Emerson de Oliveira
Dusan Schreiber
Cristiane Froehlich
Feevale University, Brazil

Keywords

COVID-19 pandemic, industry 4.0, innovation, supermarket retail.

Abstract

The advent of the COVID-19 pandemic triggered changes in the social behavior of individuals and companies, affecting the operations of organizations operating in various economic sectors. Changes in operational processes promoted by retail companies were motivated by changes in consumer purchasing habits. From this perspective, digital technologies belonging to the concept of Industry 4.0 (I4.0) have shown themselves to be promising. Given this scenario, the objective was to identify which operational processes were remodeled, from the perspective of innovation, due to the adoption of new technologies, in particular, Industry 4.0 technologies, in a specific supermarket chain. The method used in the research was a single, exploratory, and qualitative case study. The research results indicated three main changes in operational processes promoted by the company because of the COVID-19 pandemic, namely: the incorporation of remote work for part of the workforce, the implementation of an online sales channel, and the adoption of payment systems via PIX and contactless payments. For such operational changes to be made possible, three types of technologies belonging to the industry 4.0 concept were crucial: cloud computing, big data, and the Internet of Things.

Corresponding author: Dusan Schreiber

Email addresses for the corresponding author: dusan@feevale.br

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Introduction

According to the Brazilian Institute of Geography and Statistics (IBGE), in 2020, the tertiary sector was responsible for more than 60% of GDP and 75% of formal jobs in Brazil, corresponding to the economic sector with the most significant participation in the Brazilian economic and social fields. Among the subsectors that make up the tertiary sector there is the supermarket retail segment. According to information released by the Brazilian Association of Supermarkets (ABRAS), in 2020, Brazilian food retail, through all its sales channels (neighborhood market, supermarket, hypermarket, wholetail, and e-commerce), represented 7.5% of the country's Gross Domestic Product (GDP) and had a professional workforce of approximately three million direct and indirect employees.

Parente and Barki (2014) argue about the importance of the retail segment in Brazil and the gradual progress perceived in the expansion of this business segment, claiming that, as retailers expand their companies, they adopt innovations in information technology and management, enabling the modernization of the distribution system. In the food retail sector, innovation occurs predominantly in infrastructure, such as, for example, in the product display layout, in the mix of products sold, and in the information, technology adopted, with product innovation being less frequent, with the latter type of innovation more restricted to the manufacturing sector (Garrigós & Molina, 2020).

Shankar *et al.* (2021) discusses the transformations that the retail segment has been undergoing due to accelerated technological advances, remodeling the way in which many companies belonging to this segment operates. Furthermore, according to the authors, some of these technologies make use of artificial intelligence (AI) through algorithms applied to programs, systems, and machines that demonstrate

intelligence, representing a set of solutions capable of improving the intelligence of a product, service, or solution.

Application of such technologies in the retail segment may include personalization and recommendation systems, customer relationship systems, customer service management, supply chain optimization, inventory management, and store task creation. The adequate functioning of these technological solutions, however, tends to occur in proportion to the investments spent by retail companies in information and communication technology (ICT) (Shankar *et al.*, 2021).

The use of sensors and controllers, a characteristic of these new digital technologies, made it possible to provide a human-free interface between the real and the digital world, bringing about a significant change. This change came under the title of Industry 4.0 (I4.0), which originated in the German manufacturing industry (Klinc & Turk, 2019). This concept emerged with the purpose of housing a series of nascent technologies and presented itself as a conceptual synthesis with the aim of characterizing the technologies that make up the so-called digital transformation. Among these technologies, the following stand out: the Internet of Things (IoT); communication between machines (M2M); cyber-physical systems (CPS); cloud computing (SaaS); big data (BD); and human-machine interaction (HMI) (Oztemel & Gursev, 2020).

When combined, these new technologies can transform traditional production and commercial environments, changing, for example, business models, production systems, and relationships between companies, even extending to commercial relationships established between retail companies and final consumers of their products (Oztemel & Gursev, 2020; Raj *et al.*, 2020).

After the outbreak of the COVID-19 pandemic, new digital technologies took on a new role in retail, as, due to the restriction of consumer circulation, many retailers operating exclusively in physical format were forced to migrate to sales solutions based on technology, such as online order fulfillment, the so-called “click and collect” purchasing system or even robot-assisted operations (Shankar *et al.*, 2021). Habib and Hamadneh (2021) also argue that the pandemic period caused food retail consumers to have more significant contact with digital technologies, demystifying some prejudices related to insecurity and promoting increased confidence in carrying out online transactions.

This change in purchasing behavior has made food retail companies see new business opportunities. However, changes in the way we interact with consumers also required adaptations in the way retailers conduct their operational activities, making it necessary to reevaluate strategies and seek solutions, mainly technological, to adapt to the needs that the new scenario imposed (Habib & Hamadneh, 2021; Shankar *et al.*, 2021).

In the academic context, as a natural movement in the face of relevant historical periods, such as the COVID-19 pandemic, there has been an increase in the number of research exploring the topic of I4.0 technologies associated with the COVID-19 pandemic. When sizing such research within the context of supermarket retail, we observe the prevalence of research that addresses conceptual models, exploring technological solutions based on I4.0 technologies, and characterized by an approach from the perspective of technology-producing companies (Li *et al.*, 2017; Alipio *et al.*, 2020; Arbula & Ljubic, 2020; López-Matencio *et al.*, 2020; Medina *et al.*, 2020; Bhattacharyya *et al.*, 2020; Gladys Aanisujitha *et al.*, 2020; Shahroz *et al.*, 2020). The importance and high contribution that such research offers to society is understood. However, considering the impact that the adoption of digital technologies related to I4.0 has had on retail operations, it becomes noticeable that there are new studies focused on investigating the perception of retail companies that use them regarding the adoption of these new technologies.

The retail company selected for the case study consists of a privately held SA, which, according to data released by Abras (2021), is listed among the 30 largest supermarket chains in Brazil based on gross revenue. The company is made up of 44 sales units, 33 stores in the supermarket format and 11 stores in the “wholetail” format, operating in both large urban centers and small cities and presenting itself as a representative sample of the Brazilian food retail sector.

In this context, the following was established as a research problem for this study: What type of innovation in operational processes occurred in the supermarket sector company that contributed to the adoption of some Industry 4.0 technologies due to the COVID-19 pandemic? To answer this question, the objective of this research was to identify the innovation of operational processes in the company in the

supermarket sector, which contributed to the adoption of specific Industry 4.0 technologies due to the COVID-19 pandemic.

To academia, this research contributed to carrying out an applied study that addresses the adoption of I4.0 technologies by supermarket retail from the perspective of user institutions. Although the research is limited to a single-case study, it provides a situational overview regarding the adoption of I4.0 technologies for the supermarket sector, offering subsidies to managers working in this segment, and can serve as a parameter for decision-making.

Theoretical framework

Retail contextualization

According to Mattar (2019), retail can be characterized as a business activity that involves the sale of products or the provision of any service to end consumers for personal, family, or residential use or consumption. According to Voratto (2018), since the emergence of supermarkets in Brazil between the 1940s and 1950s, there have been significant transformations in this business model.

In relation to the mix of products sold, the evolution of Brazilian supermarket retail allows the inclusion of the sale of household appliances, clothing, and automotive products, diversifying the portfolio of products offered to the consumer public. Regarding the business model, hypermarket formats and the so-called “wholetails” emerge, a term used to describe stores that sell both products intended for the end consumer and products destined for merchandise transformers, also carrying out wholesale sales (Voratto, 2018). Still, according to Voratto (2018), in this evolutionary path, Brazilian supermarket retail has always been attentive to technological innovations with the potential to add advantages to the sector. According to Voratto (2018), the 1990s marked the adoption of technologies such as EDI (Electronic Data Interchange), ECR (Efficient Consumer Response), and barcode reading technology. At this time, the first virtual stores also began, taking advantage of the emergence of the internet and e-commerce.

Barras (1990) addresses the impact of information technology on innovation processes, especially in retail. Although this study was published more than three decades ago, it already warned of the need to pay attention to technological advances and the possibilities that such advances would bring to the services sector, such as the creation of new IT-based service functions, the popularization of self-service and the incorporation of software into services available to the consumer public.

Barras' (1990) predictions can be easily perceived in current times. According to Mattar (2019), the radical changes that have been occurring in retail and in the customers, it serves have the internet as the primary technological component, which presents itself as an ally that allows retailers to have digital relationships with their customers. On the other hand, this technology allows consumers to take advantage of the information available on the internet, contributing to the development of criticalities capable of influencing consumption habits.

Retail has been undergoing a remarkable transformation caused by recent advances in technology. The advent of the COVID-19 pandemic profoundly impacted consumers' purchasing behavior and, consequently, required retail companies to accelerate the adoption of digital technologies capable of satisfying the immediate needs of these customers during the pandemic period. These modern technologies can influence retail from different perspectives, such as supply, demand, or delivery (Shankar *et al.*, 2021). Table 1 shows the suggested classification for retail technologies.

Classification	Types of Technology	Summary
By Interested Party	Customer facing	Mobile devices, wearables, smart speakers, AR, VR, and MR systems, IoT, chatbots, smart mirrors, and payment technologies. Retailer facilitation and customer value creation are essential to success.
	Aimed at employees	Mobile devices, portable scanners, price scanners, IoT, RFID, and smart mirrors. Technologies that involve employee interactions with customers/buyers need to be managed more carefully.

	Supplier-facing	RFID, IoT, payment, and blockchain technologies. Inventory control, friction reduction, and supply chain resilience and efficiency are fundamental in managing these technologies.
By IT relationship	IT-based	IT-based technologies have a large ecosystem, and new retail technologies may have to fit into this system. Investing in upgrades and migration is the key to success.
	Non-IT-based	Some healthcare technologies are based on biotechnology and are relevant to pharmacies, retail clinics, and fitness centers. Care must be taken to ensure customer security and privacy by managing technologies.
By domain extension By source of origin	Single Domain vs multi-Domain	Some retail technologies may span different types of retail categories (e.g., mobile payment), while others may be category-specific (e.g., magic mirror for apparel).
	Internal versus external	Retailers can benefit from the early implementation of technologies in other domains.
	Outside-in versus inside-out	Some technologies may be in-house, while others are outsourced. In-house retail technologies are expensive, but if they work, they can provide a source of competitive advantage. Suppliers can push new technologies for retailers to adopt. Retailers can pull suppliers to adopt new technologies. Retailers can work with suppliers to introduce new technologies together. Value alignment between retailers and suppliers is fundamental to the success of new technologies.
By news	Incremental versus radical	Newer versions (e.g., 5G telecommunications) constitute incremental changes, while a new solution method (e.g., wireless battery) may be considered radical. Retailers need to plan for more significant efforts, investments, and change management when introducing radical technologies.
By nature of the change	Facilitator versus disruptor	Some technologies enhance current benefits (e.g., Apple Pay). Some technologies upend the system/industry (e.g., Blockchain). Retailers need to constantly be aware of them and pivot their business models sooner if they inevitably must adopt them. Disruptive retail technologies are challenging to develop and predict.
By result	Commoditization versus Value-adding	Some technologies commoditize current offerings (e.g., price comparison via mobile app). Retailers need to be careful about commoditization technologies and have plans to combat them. Retailers should pursue value-added technologies when feasible. Some technologies increase the value of current offerings.

Table 1: Summary of retail technology classifications

Source: Adapted from Shankar *et al.* (2021, p. 6).

In emerging economies, such as Brazil, the retailer's relationship with the customer may present unique characteristics when compared to the relationship characteristics in more stable economies, such as developed countries. Mattar (2019) brings the example of Brazilian retail, which was deeply affected by the economic, political, and moral crisis that occurred in the second half of the last decade, which led to economic stagnation and a reduction in commercial activities. In response to economic instability, consumer behavior also tends to change, showing greater sensitivity to prices, while retailers tend to pay more attention to cost control.

Barki *et al.* (2013) addresses the characteristics of retail in emerging markets, such as Brazil, arguing about the particularities that differentiate the same business segment, such as supermarkets, and about the prospects for operating in developed economies in contrast to operating in developing countries. One of the main determinants for the concept of a developing economy is GDP per capita, which tends to be low for most of the population in underdeveloped countries, directly impacting consumption habits. In this vein, Barki *et al.* (2013) highlights the importance of retailers understanding consumer needs and creating or adapting strategies to act in this reality, which will not always be ideal but necessary to sustain the segment.

Given this context, which imposes on the Brazilian retailer some business variables over which it has no management, such as economic instability, characteristic of a developing country, the need for an optimized operation is evident, with well-defined processes aimed at operational efficiency, enabling the generation of competitive advantage in a highly competitive market. One of the possible alternatives to achieve operational efficiency is to invest in technological products that are designed to promote greater integration with the supply chain.

To Wollenburg *et al.* (2019), the expansion of the range of online offers has caused a radical change in traditional retail structures, imposing on retailers the need to create business models that serve both customers in physical spaces and customers in online channels. Still, according to Wollenburg *et al.* (2019), to talk about diversification of sales channels, there is a need for some basic concepts, such as, for example, distinguishing between multichannel and omnichannel, as non-differentiation can generate misinterpretations. Wollenburg *et al.* (2019) explain that, in multichannel mode, there is total separation between operations in physical spaces and online operations. The units are segregated, and marketing is autonomous for each channel, thus resulting in the total separation of operations and technological systems. In the omnichannel model, physical and online operations merge, with no distinction between the customers' and the retailers' perceptions. This last model requires channel integration in marketing and services as well as mastery of information technologies (IT), operational areas, information exchange, joint operations, and inventories.

Industry 4.0 technologies

Over time, technological advancement has gone through four distinct phases. Each of them was characterized by a meaningful change, having a decisive impact on the social organization of the time. According to Klinc and Turk (2019), the first transformation, known as the era of mechanization, or Industry 1.0, comprises the transition from an agricultural society to an industrial society. The second phase, or Industry 2.0, was led by the discovery of electricity as a new energy source, guaranteeing a leap in productive infrastructure through the evolution of mass production systems. The third industrial revolution, or Industry 3.0, had the automation of industrial processes as its main characteristic, a fact made possible by the emergence of electronic equipment, telecommunications, and computers.

The advent of the fourth industrial revolution, also called Industry 4.0 (I4.0), has received special attention from academia and professionals from the corporate world in recent years. A more comprehensive definition for the term Industry 4.0 was expressed by Oztemel and Gursev (2020, p. 166), who, after reviewing the literature that deals with the technologies that make up the term Industry 4.0, coined the following definition:

Industry 4.0 is a manufacturing philosophy that includes modern automation systems with a certain level of autonomy, flexible and effective data exchanges encompassing the implementation of next-generation production technologies, innovation in design, and more personal and more agile in production as well as customized products.

Oztemel and Gursev (2020) further argue that the concept of Industry 4.0 is not exactly new. However, the term "Industry 4.0" seems to have been accepted and well-received by both the academic community and economic agents. While the academic community focuses on understanding and defining the concept of Industry 4.0, companies focus mainly on understanding and mastering the technological innovations that emerge from Industry 4.0. In the current context, there is a predominance of machine-based manufacturing. However, with the advent of Industry 4.0 technologies, there is a tendency to migrate towards digital domination through the prevalence of more customized processes, aiming to satisfy customers who are increasingly integrated into new digital technologies. These customers have access to a lot of information available on the internet, developing unique criticalities, perceptions, and consumer desires (Oztemel & Gursev, 2020),

In the academic context, there is a growing interest in the topic I4.0. Kipper *et al.* (2020) carried out a bibliometric analysis of publications from the Scopus database between 2011 and 2018. Over the eight years analyzed, this study showed a significant growth in the number of publications that deal with topics inherent to Industry 4.0, especially regarding topics such as cyber-physical systems (CPS), Internet of Things (IoT), and big data.

The definition of some of these terms is presented by Gottge *et al.* (2020), for whom big data (BD) refers to high-volume, high-speed, and high-variability data, characteristics that make it difficult to analyze through traditional data processing methods. Therefore, technology is used to analyze big data, called business intelligence (BI). This technology uses intelligent algorithms based on probability calculations, allowing decision-making that aims to improve the visibility, flexibility, and integration of processes. Subsequently, this process generates patterns that are identified and related to generate new knowledge. IoT is characterized as a network that offers a structure for integration between the physical world and computerized systems, making things self-controlled.

The study carried out by Kipper *et al.* (2020) demonstrated that the countries that invest the most in research on the topic of Industry 4.0, taking the number of publications as a parameter, are, in order, Germany, China, the United States, Italy, and South Korea. Germany is considered a precursor in inserting the concept of Industry 4.0 into the business environment. In 2013, approximately 20% of German companies were already involved in Industry 4.0.

However, Oztemel and Gursev (2020) warn of the importance of companies understanding the resources and content of Industry 4.0, which will transform the current machine-based manufacturing system to digital manufacturing, review their current position in this scenario and then develop strategies to face the transformations that Industry 4.0 will bring to their activity. Still, according to the authors, there is an expectation that the transformations of Industry 4.0 will have a substantial impact on social organization. In the field of manufacturing, it is anticipated that robots will be more dominant in manufacturing, in deployed technologies, in the cooperation and coordination of machines, in self-decision systems, autonomous problem solvers, machine learning, and 3D printing, among others, resulting in the dominance of manufacturing processes. In the social field, innovations such as the wearable internet, big data analysis, sensor-based life, smart cities, and smart applications will give rise to new demands for consumption and relationships between companies and customers, requiring organizations to adapt and optimize their processes to maintain a competitive advantage.

Following this line of analysis of the impact that Industry 4.0 transformations have on traditional production models, Rosin *et al.* (2020) address the relationship between Industry 4.0 transformations and the principles and tools of the lean management approach, popularized since the Toyota production system in the 1950s. According to Rosin *et al.* (2020), the set of lean management principles aims to increase productivity, customer satisfaction, and business profitability. With the new paradigm proposed as a function of Industry 4.0, new tools emerge, mainly related to technological interactivity, which changes the traditional production scenario, such as, for example, the interconnectivity of products, machines, the supply chain, and customers, combined with growing decision-making resources based on intelligent systems, which allow companies to improve their production variability in an agile way, which can result in greater profitability.

Through the Internet of Things, cyber-physical systems, cloud computing, and other tools from Industry 4.0, companies can achieve levels of organizational performance that were previously unattainable. Furthermore, it is in this context that manufacturing companies find themselves forced to revisit their strategies, which frequently need to be adapted or reconsidered to prioritize the implementation of Industry 4.0 technologies. The contrast between production based on lean management and Industry 4.0 is the fact that the former pushes for stability in production levels and little variability. At the same time, Industry 4.0 is characterized by encouraging control of production levels and product variability, making the process more dynamic (Rosin *et al.*, 2020).

To be successful, Industry 4.0 must be implemented on an already optimized basis, with standardized processes, eliminating waste, and constantly focusing on generating value for the customer. In this way, the importance of prior preparation of companies for the adoption of Industry 4.0 technologies is evident, as a lean operation has the potential to reduce the risk of failures in the experience of organizational change (Rosin *et al.*, 2020).

According to Hahn (2020), three distinct types of business architectures can coexist: product-centric, service-centric, and platform-centric. The product-centric business model is characterized by the transfer of ownership through sale. Service-centric is characterized as continuous value exchange, in which the provider commits to delivering a predefined result to the customer for a product over a certain period.

According to Hahn (2020), these two models follow a traditional line of business activity. The third approach, platform-centric, allows for the creation of collaborative value, exploiting network effects and allowing external interaction. This type of business architecture differs from the other two traditional models (centered on products or services) in that it is more dynamic and complex.

Bringing this model to the supermarket retail environment, one can cite as an example of integration between traditional models and digital platforms the applications that make home deliveries, the so-called "Delivery Apps", such as the iFood, Rappi, and Uber Eats, which had a large following among consumers after 2019, because of the COVID-19 pandemic, which has led most food retailers to include third-party platforms in their sales channels.

Both Oztemel and Gursev (2020) and Hahn (2020) are emphatic in stating that there is an awareness among organizations of the need to understand and thus be part of the transformations originating in Industry 4.0. However, there are barriers to its adoption, and these barriers come in different forms. According to Raj *et al.* (2020), barriers to the adoption of Industry 4.0 technologies occur differently in the economies of developing countries compared to what happens in countries with already consolidated economies.

Raj *et al.* (2020) state that developed countries usually have well-defined strategies for development. On the other hand, in developing countries, there is a noticeable lack of a national coordination policy that encourages the adoption of technologies from Industry 4.0, resulting in isolated investments by individual companies, which end up facing difficulties in implementing technological products due to incompatibilities of local infrastructure. The same authors point to two prominent factors in terms of barriers to the adoption of Industry 4.0 technologies: the lack of a digital strategy and the scarcity of resources.

Given this scenario, which imposes numerous barriers to the adoption of Industry 4.0 technologies, especially for organizations operating in developing economies, Raj *et al.* (2020) contribute some suggestions, such as, for example, the formulation of appropriate strategies to achieve greater success in the implementation of these technologies. They suggest that managers encourage the increase of companies' internal capabilities to overcome the challenges of implementing Industry 4.0. To this end, it is necessary to construct appropriate roadmaps and create strategic planning that includes resource training.

As demonstrated, due to the social and economic impact that the topic imposes, several studies have dedicated efforts to advancing knowledge about the range of technologies that characterize the concept of Industry 4.0. Furthermore, the previously discussed literature also states that these technologies are not restricted to specific economic segments. However, this study focuses on a single economic segment, the services sector, more specifically, the supermarket retail segment.

Methodology

The research is classified as an exploratory and qualitative case study. Exploratory research seeks more information about the subject being investigated, enabling its definition and outlining, thus delimiting the theme, setting the objectives, and discovering a new approach to the subject being researched (Prodanov & Freitas, 2013). The definition of a single-case study was based on Yin (2015), who argues about the importance of this study method and the motivators for its use in research in the field of administration. To Yin (2015), the main reason for choosing the case study method is its ability to elucidate complex social phenomena, allowing researchers to focus on a particular case and retain a more comprehensive perspective of the real world.

This single-case study was applied to a supermarket chain. The justification for choosing the unit of analysis, a supermarket chain operating in the southern region of Brazil, was due to the representativeness it has within the national supermarket sector. The company is characterized as a large, privately held company with broad geographic operations, which, according to Abras (2021), is among the 30 largest Brazilian supermarket chains. It has 44 sales units, which are in both large urban centers and small cities. Administration, however, is centralized, and decision-making regarding investments in modern technologies is restricted to a single administrative unit, with sales units and distribution centers only being left with operational execution using previously determined technological tools.

For data collection, two questionnaires were prepared, with open and closed questions on the topic investigated. These questionnaires were created using Microsoft Word text editor. The objective questions remained the same in both questionnaires, with distinctions only in the essay questions. The differentiation used in the essay questions aimed to extract additional specific perceptions according to the work functions performed by the respondents. In this sense, Questionnaire 1, which was applied exclusively to members of the organization's strategic level, aimed to identify the strategy adopted by the company's senior management in facing the pandemic period. Moreover, Questionnaire 2, which was applied to company employees working at tactical and operational levels, aimed to identify the perceptions of respondents who work directly in customer service in relation to operational changes and the adoption of digital technologies belonging to the industry 4.0 concept as a result of the COVID-19 pandemic.

The objective questions took the form of statements arranged on a 5-point Likert scale, offering the respondents the option of choosing the alternative they deemed most appropriate for each of the proposed statements. The five response options available to respondents were: (1) disagree entirely; (2) partially disagree; (3) neither disagree nor agree; (4) partially agree; (5) agree entirely.

Validation of the data collection instrument was made possible through a pre-test with one member from the strategic level, two members from the tactical level, and one member from the operational level. In this pre-test, respondents were asked about the clarity of the information requested as well as their complete understanding of the propositions. Respondents were also asked to describe any issues not covered in the data collection instrument and which they considered relevant to the research. Once we had the four assessments from the pre-test participants, the necessary adjustments were made, and the final versions of the questionnaires were then applied. It is worth highlighting that the option for the format of questionnaires instead of interviews was taken due to the demands of the respondents and the organization.

The company's internal electronic mail was primarily used for communication between respondents and researchers. In addition, some specific doubts were resolved in face-to-face conversations or via telephone calls. The questionnaires were sent to ten employees (Table 2). The data collection period took place between June 13th and 20th, 2022. The ten employees who participated in the research provided a comprehensive analysis with perspectives from different organizational levels.

Organizational Level	Position of respondents	Education	Company time (years)	Age (years)	Gender (M/F)
Strategic	Director	Postgraduate	16	56	Male
	Director	Graduated	30	47	Male
Tactical	Regional Supervisor	Graduated	30	44	Male
	Branch Manager A	Complete High School	19	42	Male
	Branch Manager B	Incomplete High School	20	39	Male
Operational	Branch Manager C	Complete High School	20	40	Male
	Grocery Manager	Complete High School	17	39	Male
	Branch A Cash Inspector	Complete High School	5	21	Female
	Branch B Cash Inspector	Graduated	10	43	Female
	Branch C Cash Inspector	Incomplete higher education	10	28	Female

Table 2: Profile of respondents

For this study, data triangulation was used with the purpose of comparing the evidence obtained through research questionnaires with the previously revisited theory, with the documentary survey, and

with participant observation. According to Yin (2015), the use of multiple sources of evidence can provide more relevant results, as it allows the researcher a broader approach to historical and behavioral aspects.

The data were organized according to the analysis categories previously identified in the literature for content analysis in accordance with the guidelines of Bardin (2016), namely, changes that occurred in the company due to the COVID-19 pandemic, innovation in the company, and adoption of Industry 4.0 technologies in the company because of the COVID-19 pandemic. Within each analysis category, the statements proposed to the respondents are presented individually. The responses obtained considering each of the three hierarchical levels, strategic, tactical, and operational, are also analyzed. Next, the respondents' dissertation responses are presented, thus providing more consistent material for comparison with the previously carried out literature review. To conclude, data obtained through participant observation are presented. Thus, there are different sources of evidence for the interpretation and analysis of research data.

Results

The first category of analysis investigated had the prerogative of identifying what changes were made by the company because of the COVID-19 pandemic. The evidence observed from the data collected from the first category of analysis made it possible to identify the intensity with which the COVID-19 pandemic impacted the company's traditional operating model, imposing the need for adaptations that would enable the maintenance of operations during the adverse scenario. These findings are in line with the statements of Habib and Hamadneh (2021), who claim that the COVID-19 pandemic resulted in considerable changes in business operations worldwide.

Moreover, according to Habib and Hamadneh (2021), the pandemic also generated a change in the perception of supermarket customers, who are accustomed to making their purchases in traditional physical stores. The pandemic caused customers of this type of retail to have more significant contact with digital technologies, generating experimentation with the purchase of non-durable goods via e-commerce, resulting in the demystification of prejudices related to insecurity and, consequently, reflecting increased confidence for carrying out online transactions. This change in consumer purchasing behavior has sparked the interest of retail companies in new business opportunities. However, such changes in the way we interact with consumers also required adaptations in the way these retailers conduct their operational activities, making it necessary to reevaluate strategies and seek solutions, mainly technological, to adapt to the needs that the new scenario imposed (Habib & Hamadneh, 2021; Shankar *et al.*, 2021).

A summary of the evidence identified in this category is presented: a) As a result of the COVID-19 pandemic, changes occurred in operational and management processes; b) The availability of labor was affected because of the pandemic; c) During the pandemic period, changes occurred in management processes, with the aim of allowing remote work and social distancing; d) Adaptations to physical structures were necessary, aiming to comply with rules and regulations imposed by public authorities; e) The pandemic resulted in greater demand from the chain's customers for non-face-to-face shopping alternatives, which increased online sales; f) Based on the new circumstances triggered by the pandemic, the company established partnerships with other companies, such as the online sales platform iFood, seeking to improve customer service; g) No structural adjustments were made to reduce costs, such as the dismissal of employees, due to the pandemic period.

Therefore, we found that during the pandemic period, the company made changes to management and operational processes. According to the financial administrative director's report,

We had to review our Strategic Planning and redefine priorities due to the pandemic. Online sales to individuals were still a long-term plan for the company and were not within the short-term priorities. With mass isolation due to COVID-19 and, consequently, the adoption of 'home office', there was an immediate need to implement e-commerce to serve the population that needed to receive their groceries at home.

Mention of changes in operational processes can be seen, and the financial administrative director stated that the company implemented e-commerce. In contrast, the other two respondents, the manager of branch A and the cash inspector of branch A, stated that the company entered a partnership with the iFood platform. These actions are characterized as changes to operational processes. In this sense, due to

the COVID-19 pandemic, we noticed that changes occurred in the company's operational and management processes, which are in line with the statement of Habib and Hamadneh (2021), who state that the COVID-19 pandemic has resulted in considerable changes to the operation of businesses across the world. They also state that, in the supermarket sector, traditionally used to the face-to-face shopping format, in physical stores, a barrier has been broken in relation to consumers' skepticism in purchasing non-durable goods through the non-face-to-face format.

Furthermore, respondents consider that the availability of labor was affected because of the COVID-19 pandemic, requiring the company to promote adaptations, both administrative and commercial. The regional supervisor revealed that the shortage of labor was a significant factor in the company making adaptations, both in the company's core activities, such as the sales front, and in ancillary activities, such as the administrative sectors. The empirical data obtained from the application of the questionnaires corroborate the statements made by Costa Dias *et al.* (2020), who state that, at the beginning of the pandemic, there was a significant shortage of labor in the supermarket sector. Moreover, although this shortage was dissipated with the reduction in contagion peaks, the lack of labor in the supermarket sector remained compared to the period before the pandemic.

As a result of the COVID-19 pandemic, the company made changes to management processes, aiming to allow remote work and social distancing. However, during the pandemic period, the economic activity carried out by companies belonging to the supermarket sector was considered essential, characterizing itself as one of the few economic activities that was not prevented from maintaining face-to-face customer service. Given this condition and using the participant observation technique, we noticed that the adoption of remote work for the company's employees was restricted to administrative sectors, as physical stores maintained face-to-face activities. This limiting condition of remote work, excluding employees working in physical stores, may indicate the motivations for the partial agreement indicated by the two respondents.

This evidence supports the statements made by Shankar *et al.* (2021), who state that the COVID-19 pandemic resulted in changes in consumer purchasing behavior, causing food retail companies to envision new business opportunities. However, Shankar *et al.* (2021) is emphatic in stating that the feasibility of such opportunities required adaptations in the way these companies conduct their operational activities, making it necessary to reevaluate strategies and seek solutions, mainly technological, to adapt to the needs that the new scenario imposed.

The evidence from the commercial director's report indicates that, during the pandemic period, it was possible to notice an increase in sales through e-commerce. These findings corroborate the research by Carvalho and Tavares (2021), who state that, in relation to the increase in online sales, it is estimated that e-commerce grew between two and three times in Brazil during the first four weeks after the closure of the trade must be established. They also highlight that online sales in supermarkets showed peaks of up to 270% daily growth between the weeks of March 15th and 28th, 2020, gradually slowing down in the following weeks.

During the pandemic, the company established partnerships with other institutions, seeking to promote changes capable of improving service and management processes. Respondents stated that they perceived the pandemic period as a stimulus for the company to seek to establish new commercial partnerships, establishing relationships with companies that provide auxiliary services capable of promoting improvements in service and management processes. Given the data and based on the new circumstances, the company established partnerships with other companies, such as the online sales platform iFood, thus seeking to improve the service provided to the customer. This finding corroborates statements by Shankar *et al.* (2021), to whom, after the outbreak of the COVID-19 pandemic, the role of new digital technologies in retail took on a new level, given that, due to the restriction of consumer circulation, many retailers operating exclusively in physical format were forced to migrate to technology-based sales solutions, such as online order fulfillment, the so-called "click and collect" purchasing system or even robot-assisted operations.

Finally, from the participants' opinions, we identified that the company did not make structural adjustments, aiming to reduce costs, due to the pandemic period. Such evidence aligns with statements by Costa Dias *et al.* (2020), to whom, at the beginning of the pandemic, there was a significant shortage of

labor in the supermarket sector. Furthermore, although this shortage was dissipated with the reduction in contagion peaks, the lack of labor in the supermarket sector remained high considering the period before the pandemic.

The second category of analysis used in the investigation aimed to identify the behavior of the company concerning innovation. From this perspective, statements were prepared, which sought to obtain the perception of each of the respondents, distributed at different organizational levels.

The first four statements aimed to identify the types of innovations promoted by the company, addressing innovation in processes, innovation in human resources management, innovation in the computerization of records/controls, and innovation to improve customer service. The last four statements aimed to identify the company's environment for promoting innovation, verifying the involvement of the company's senior management in innovation, encouraging innovative initiatives, the existence of specific processes that aim to collect ideas for improving processes, and the existence of employee training focusing on innovation.

The evidence from the data collected in the second category of analysis is listed below: a) Over the last five years, the company has intensively promoted process innovation; b) Over the last five years, the company has worked to promote innovation in the way of leading people; c) Over the last five years, the company has promoted innovations focused on the computerization of records and controls; d) Over the last five years, the company has promoted innovations focused on improving the service provided to its customers; e) The company's senior management is aware of the importance of innovation for the business and works to promote an innovative environment within the organization; f) The company promotes an innovative environment by encouraging employees to innovate; g) Although there is an internal tool that allows employees to send suggestions, there is no specific process focused on collecting suggestions and ideas aimed at promoting improvements in organizational processes; h) The company offers training to its employees with a focus on innovation.

From the analyses that make up the second category of analysis, which aimed to identify how innovation occurs in the company, it was possible to identify that most participants understand that, in the last five years, the company has made changes to processes, changes in the way of leading people promoted, changes aimed at computerizing records and controls as well as promoting changes focused on improving the service provided to its customers.

I believe that we live in a new technological era in which information reaches us faster and faster, and that is why we have become increasingly demanding to be served in the shortest possible time and with the quality we expect. The company has been engaged in the search for this efficiency, as it believes that only companies that have this perception will survive in the future much closer than we imagine (Financial Administrative Director, strategic level).

We need to be aware of the new model of consumer understanding and desire, which is to access products more quickly, safely, and comfortably. Also, pay attention to the new demands of employees, who are now more interested in producing in remote environments without the usual model of a defined physical location (Commercial Director, strategic level).

The reports show that the company's top management understands the need to have processes aligned with market needs, adapting the company's processes to customers' consumption desires and new formats of work relationships, such as remote work, made available to part of the company's staff due to the pandemic period.

The concern with keeping processes up-to-date with the new demands caused by technological innovations confirms the statements of Mattar (2019), who says that the radical changes that have been occurring in retail and in the customers that are served by it have the internet as the primary technological component, which presents itself as an ally that enables retailers to establish digital relationships with their customers. From this same perspective, Shankar *et al.* (2021) state that, in recent years, retail has been undergoing a notable transformation caused by recent advances in technology. Both Mattar (2019) and Shankar *et al.* (2021) argue that those retailers who wish to remain active in this scenario of constant technological evolution must be attentive and prone to constant changes in their processes, promoting an innovative environment.

It was possible to identify that, in the last five years, the company promoted innovations focused on improving the service provided to its customers through the implementation of a new sales channel. This initiative confirms the statements of Wollenburg *et al.* (2019), who state that the expansion of the range of online offers has caused a radical change in traditional retail structures, imposing on retailers the need to create business models that serve both customers in physical spaces and customers in online channels.

Research participants also understand that the company's management is committed to promoting innovation, employees are encouraged to innovate, and the company carries out training focused on innovation. However, we identified that although there is a tool for collecting suggestions, the company's management understands that there is no specific tool for collecting ideas and suggestions for improving organizational processes.

The evidence observed from the study allows us to establish relationships between the innovative behavior identified in the company and the literature that deals with innovative companies. From this perspective, the Oecd (2018) states that an innovative company reports one or more innovations within the observation period. On the other hand, a firm active in innovation is involved at some point during the observation period in one or more activities to develop or implement new or improved products or business processes for an intended use.

The third category of analysis used in the investigation aimed to analyze the company's adoption of Industry 4.0 technologies because of the COVID-19 pandemic. The evidence collected is presented below: a) Over the last five years, the company has made investments aimed at implementing technologies focused on facilitating the registration and control of products in the chain's stores; b) Over the last five years, the company has promoted investments aimed at implementing technologies focused on improving customer service at sales units; c) Over the last five years, the company has invested in the implementation of technologies focused on generating data on the movement of goods in stores; d) Over the past five years, the company has made investments in technologies focused on supporting the electronic commerce of goods; e) The company carries out some types of experiments with digital technologies. However, it has not yet taken advantage of the full range of resources that these technologies already make available to the supermarket retail sector, such as self-service at checkouts; f) The company uses software based on artificial intelligence to monitor sales, both physical and online channels. However, due to the limitations present in the company's current ERP system, the company is unable to take advantage of all the possibilities that current sales analysis tools based on artificial intelligence can provide; g) The company invests in management software to improve the operational control system; h) The company invests in digital technologies for inventory control and management, aiming to subsidize the purchasing sector.

From the data, it was possible to identify that the company frequently promotes investments aimed at acquiring technologies belonging to the industry 4.0 concept. However, it does not take advantage of all the technological innovations already made available by technology-producing industries. From this perspective, the responses made it possible to identify that the pandemic impacted the way in which the company's agents, or the strategic decision makers, perceive the importance of adhering to I4.0 digital technologies.

The adoption of technological solutions, such as the implementation of payment via PIX and contactless payment, shows that the company promoted the adoption of I4.0 technologies, aiming to facilitate the registration and control of products in the store. Regarding the adoption of the contactless payment system by retailers, Shankar *et al.* (2021) state that the pandemic period accelerated the incorporation of this type of technology, mainly aimed at the safety and well-being of customers, reducing physical contact in stores.

Relating these two technological solutions with the literature that addresses Industry 4.0 technologies, we observed that the contactless payment system is based on IoT, a technology that allows communication between computerized systems and the physical world. To Gottge *et al.* (2020), IoT can be characterized as a network that offers a structure for integration between the physical world and computerized systems and can make things self-controlled.

The payment system via PIX makes use of cloud computing, allowing the interface between the supermarket network software and the banking network software. Oztemel and Gursev (2020) define

cloud computing as storage systems for all applications, programs, and data on a virtual server. Also, according to Oztemel and Gursev (2020), systems based on virtual servers provide some radical changes to traditional autonomous models, being able to provide cost reduction, elimination of local equipment and infrastructure complexities, more excellent data protection, and provision access to information in a more agile and interactive way.

We identified that the company has a customer relationship program materialized through a cellphone application. With the registration data of the supermarket chain's customers, this application offers financial advantages, such as discounts on products that are part of a given consumer's shopping basket. To identify the purchasing preferences of consumers registered in the loyalty application, data from tax coupons is collected, enabling the system to manage and create a consumption profile for each customer, mapping consumption habits and suggesting products that this consumer is likely to buy. Modern literature has assigned a term to this type of technology, which is part of the technologies that form the concept of Industry 4.0. This term is called data mining.

Data mining was the type of I4.0 technology that returned the most studies in the systematic review presented in Chapter 4. Regarding data mining, Oztemel and Gursev (2020) state that in any process in which digital interaction occurs, data is generated, which is transmitted by systems, sensors, and mobile devices. They also state that, currently, the volume and speed with which this data is generated and transmitted is alarming. However, for this data to be transformed into useful information, high processing power, analysis resources, and mental skills are required.

Given the evidence collected, we can infer that, during the last five years, the company promoted the adoption of I4.0 technologies aimed at generating data on the movement of goods in the store, exemplified by the implementation of an application for relationship and consumer loyalty, making use of data mining to draw consumption profiles.

Concerning data processing with the aid of artificial intelligence, we found, through participant observation and document analysis, that the company uses a system for graphical data analysis called business intelligence. This system is used to perform big data (BD) analysis, which, according to Gottge *et al.* (2020), refers to high-volume, high-speed, and high-variability data, characteristics that make them challenging to analyze using traditional data processing methods. For this, technology is used for big data analysis, called business intelligence (BI), which makes use of intelligent algorithms based on probability calculations, allowing decision-making that aims to improve visibility, flexibility, and integration of the processes.

Corroborating the responses, participant observation, and documentary survey, we identified that, in the last five years, the company has promoted automated processes to mitigate operational errors related to stocks. Examples include the development of automated management reports to measure the levels of stockouts in warehouses and points of sale, thus aiming to promote preventive actions and improve operational efficiency. Another type of technology promoted by the company was the intensification of digital integration between the retail network and the supply chain, materialized mainly through Electronic Data Interchange (EDI), thus ensuring greater assertiveness in the exchange of information between the retail network and merchandise suppliers. Campos *et al.* (2019) observe that supply chain management represents an essential factor in determining the success of organizations, comprising a critical factor in achieving competitiveness and superior performance.

The perceptions of members at the strategic level of the organization allow us to verify the influence that consumers' purchasing habits have on the company's strategic decisions. This evidence aligns with the Service-Dominant Logic (SDL) theory, initially proposed by Vargo and Lusch (2004), in which the consumer is part of a creation ecosystem composed of several actors, including the industries that produce the goods/services. According to Teece (2010), the consumer's participation as an active agent in the business environment had as a significant driver of the dissemination of technological tools, especially computing and communication, which, combined with more open global trade regimes, made it possible to reduce the cost of access to such information, covering a massive number of users of these new digital technologies.

Concluding the presentation and analysis section, it is worth highlighting that the review of the company's investment priorities was aimed at programs focused on e-commerce and adaptations that

would allow remote work for some company departments. Also, due to the uncertainty generated by the pandemic period, some expansion and renovation plans in physical stores were suspended. In the IT area, the pandemic period caused the suspension of some ongoing, less urgent projects to allocate resources to other more urgent demands, such as electronic commerce, for example.

Through reports from research participants, it was possible to determine the main factors that motivated the company to seek technological solutions capable of meeting the demands imposed by the new pandemic scenario. Among these factors, the scarcity of labor to carry out the company's operational tasks stands out, as well as the search by customers for shopping alternatives that would make it possible to reduce or inhibit physical contact when purchasing goods from the retail chain.

In addition to the reasons that led the company to adopt modern technologies due to the pandemic period, some types of technologies were adopted by the company due to the pandemic period. Highlights include adherence to home office work for some of the company's activities, mainly administrative tasks; the establishment of partnerships with other companies to diversify sales channels, such as the partnership established with the iFood platform; adherence to the payment format via PIX, aiming to reduce physical contact between customers and employees; and adherence to the contactless payment system, also aiming to reduce physical contact at points of sale.

When relating such technological innovations promoted by the company with the previously discussed literature, an intersection with the statements of Hahn (2020) is noticeable, which argues about the disruptive potential unleashed by technologies related to Industry 4.0, enabling the emergence of innovative business models. Hahn (2020), however, states that already established companies can take advantage of new digital technologies to transform their operational model in the supply chain, implementing and integrating these new functionalities into their business model, providing greater recognition of value by the customer. The incorporation of the iFood delivery platform, carried out by the company, exemplifies this incorporation cited by Hahn (2020) and, according to the statements of the company's research participants, has been offering satisfactory results, arousing interest in expanding such a partnership.

Demand increased a lot, and our e-commerce sales in partnership with iFood soared. This partnership with iFood allowed the company to incorporate the online sales system in six of the chain's stores in a short space of time, all with great acceptance from our customers (Regional Supervisor, belonging to the tactical level).

The diversification of the company's sales channels, which, during the pandemic period, adopted the online sales modality, materialized through the partnership with the iFood company, corroborates the statements of Wollenburg *et al.* (2019), who warn of the need for retailers to be aware of the omnichannel reality, a term used to describe the different sales channels, whether online or physical. To Wollenburg *et al.* (2019), the expansion of the range of online offers has caused a radical change in traditional retail structures, imposing on retailers the need to create business models that serve both customers in physical spaces and customers in online channels.

The technological solutions incorporated into the company's business model, such as electronic commerce of goods and contactless or PIX payment systems, make use of some of the industry 4.0 technologies already detailed in the literature review. Electronic commerce of goods, for example, makes use of cloud computing and big data. The contactless payment system is based on IoT, and the payment system via PIX makes use of cloud computing to allow the interface between the supermarket network software and the banking network software.

Conclusion

The study aimed to identify which operational processes were remodeled, from the perspective of innovation, due to the adoption of modern technologies, in particular, Industry 4.0 technologies, in a specific supermarket chain. Field research allowed us to identify that the COVID-19 pandemic accelerated the adoption of Industry 4.0 technologies aimed at digitizing processes in the company. Such technologies acted on three main fronts of change.

The first front of changes highlights the permission for remote work. Cloud computing proved to be an indispensable tool, as employees began to use corporate software from remote locations, making use of

the internet. Given this finding, it was possible to identify that cloud computing, a type of technology belonging to the industry 4.0 concept, proved to be of fundamental importance for maintaining work activities in the company during the pandemic period, allowing a considerable contingent of employees to continue to perform their tasks from remote workstations.

The second front of changes promoted by the company during the pandemic period consisted of developing the online sales channel, which was made possible through a partnership signed with the iFood company. This company specializes in promoting the interface between retailers and the final consumer of goods. To make this partnership possible, technologies belonging to the industry 4.0 concept were once again present, namely cloud computing and big data.

The third front of changes aimed at incorporating technologies designed to avoid physical contact when paying for goods. To this end, field research identified that, due to the pandemic period, two new payment methods were implemented in the supermarket chain: contactless payment and payment via PIX. The functionality of these two payment methods depends on more than one type of technology belonging to the industry 4.0 concept. Contactless payment makes use of the Internet of Things concept, while payment via PIX makes use of cloud computing and big data. We identified that the company makes use of other Industry 4.0 technologies, such as data mining, augmented reality, and business intelligence. However, the adoption of these technologies was not related to the advent of the COVID-19 pandemic, having already been in use prior to the pandemic period. This research also identified that the primary motivators for the company's adoption of Industry 4.0 technologies due to the pandemic were related to two factors: the need for social isolation of its employees and the change in the purchasing behavior of its customers.

For the technological changes promoted in the company to be made viable, a review of the company's strategic planning was necessary, impacting mainly on the anticipation of budgetary steps scheduled for the information and communication technology department, aiming at the acquisition of equipment and software capable of supporting the demands imposed by the new pandemic scenario. To this end, the IT department received additional financial contributions relocated from other departments with demands deemed less urgent at that time.

The limitation of this study is highlighted, which did not aim to exhaust the discussions on the topic at hand but to provide a specific focus within a unique business context portrayed in the case study presented here. As this is a single-case study, it is limited to events that occurred in the only scenario researched. Another limitation concerns the data collection period, called the "pandemic period". The pandemic caused by COVID-19, recognized by the WHO on March 11, 2020, was still in force until the conclusion of this research, and there was effectively no time limit for its completion.

Finally, this research exposed a gap identified in the literature: the lack of scientific studies relating Industry 4.0 technologies to supermarket retail from the perspective of companies using these technologies. From this perspective, new studies are suggested that investigate the vision of user companies in relation to the availability, use, and measurement of results in relation to the adoption of I4.0 technologies by supermarket retailers. There are also promising scientific studies that seek to list the vision of end users of I4.0 technologies in supermarkets, both employees and customers of food retail companies. New comparative studies and the use of new methodologies are suggested to increase the depth and applicability of the investigation.

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