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Digital Technologies and the Future of Retail
A Study of Supply Chain Effectiveness in Portugal

Rui Miguel Pereira Barros

Master Thesis

presented as partial requirement for obtaining the Master Degree in Information Management

NOVA Information Management School
Instituto Superior de Estatística e Gestão de Informação
Universidade Nova de Lisboa

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Digital Technologies and the Future of Retail

A Study of Supply Chain Effectiveness in Portugal

by

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Master Thesis presented as partial requirement for obtaining the Master's degree in Information Management, with a specialization in Information Systems and Technologies Management

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November, 2023

STATEMENT OF INTEGRITY

I hereby declare having conducted this academic work with integrity. I confirm that I have not used plagiarism or any form of undue use of information or falsification of results along the process leading to its elaboration. I further declare that I have fully acknowledged the Rules of Conduct and Code of Honor from the NOVA Information Management School.

Torres Vedras, 02 de Novembro de 2023

DEDICATION

To my devoted wife, Joana, who has been my constant source of courage and encouragement during my academic path. Her unshakable support and unending patience have been the pillars upon which I leaned throughout this academic journey. Your confidence in me has strengthened my resolve and has been a key factor in achieving this goal.

My boys, Gabriel and João, are the joy and inspiration of my life. You both remind me daily why I strive to improve: to build a better future for you.

To my mother for all of their love and support over the years. Her sacrifices have laid the foundation of my persistence and resilience.

To my father and brother, whose memories continue to guide and inspire me daily.

I extend my deepest gratitude to Professor Jorge, my advisor, for his wisdom, mentoring, and knowledge. His extensive expertise and wise criticism were crucial to the successful completion of this work. I appreciate your pushing to do better in my research.

Additionally, I owe a debt of gratitude to all the participants who generously contributed their time and insights to share their experiences for this study.

To all of you, this achievement is equally yours and mine. Thank you all.

ABSTRACT

Given its potential to improve supply chain performance, the adoption of digital technology in retail is a subject of interest that is receiving more and more attention. This study aims to comprehend how digital technologies affect the supply chain effectiveness (SCE) of retail businesses in Portugal. Drawing on the Technology-Organization-Environment (TOE) framework, this research examines how different aspects of technology (such as efficiency, cost savings, and the support for faster, more informed decision-making), organizational factors (such as readiness for digital transformation and organizational structure), and environmental context (including market trends and regulatory environment) interplay to influence digital adoption and supply chain performance. An extensive literature review was conducted, which paved the way for developing a theoretical model and establishing hypotheses. To validate these hypotheses, an online questionnaire was administered to 45 participants. The subsequent quantitative analysis revealed that technology, organizational, and environmental factors have a positive and significant correlation with supply chain performance. The Technological Context exhibits the highest R^2 value, indicating its stronger influence on SCE compared to Organizational and Environmental Contexts. This emphasizes that, while factors related to an organization's readiness and external environmental conditions are significant, the strongest relationship on SCE is predominantly driven by the technology implemented within the supply chain.

KEYWORDS

Digital Technologies; Supply Chain Effectiveness; Retail Industry; Portugal; Technology-Organization-Environment (TOE) Framework; Digital Transformation.

Sustainable Development Goals (SDG):



TABLE OF CONTENTS

Statement of Integrity	i
Dedication	ii
Abstract	iii
List of Figures.....	vi
List of Tables.....	vii
List of Abbreviations and Acronyms	viii
1. Introduction.....	1
2. Literature review.....	3
2.1. DIGITAL TRANSFORMATION: CONCEPTS AND CONTEXT	3
2.2. SUPPLY CHAIN EFFECTIVENESS: DEFINITIONS AND KEY METRICS	4
2.3. DIGITAL TECHNOLOGY’S IMPACT ON SUPPLY CHAIN	4
2.4. DIGITAL TRANSFORMATION IN RETAIL INDUSTRY	5
2.4.1. Evolution, Trends, and Implications	5
2.4.2. Case Studies and Challenges	6
2.5. DIGITAL TRANSFORMATION IN THE PORTUGUESE RETAIL SECTOR	8
2.6. TECHNOLOGY-ORGANIZATION-ENVIRONMENT (TOE) FRAMEWORK	9
2.6.1. Overview and Application	9
2.6.2. Contextual Factors: Technology, Organization, Environment.....	10
2.6.3. Interplay of TOE Factors	12
2.7. SUMMARY AND RESEARCH GAPS	13
3. Methodology	14
3.1. RESEARCH DESIGN AND DATA COLLECTION	14
3.2. POPULATION, SAMPLE, AND QUESTIONNAIRE DESIGN	14
3.3. DATA ANALYSIS: TECHNIQUES AND TOOLS	16
3.4. VALIDITY, RELIABILITY, AND ETHICAL CONSIDERATIONS	16
3.5. LIMITATIONS OF THE STUDY	16
4. Empirical Study	17
4.1. APPLICATION OF TOE FRAMEWORK	17
4.2. DEVELOPMENT OF HYPOTHESIS AND CONCEPTUAL MODEL	17
5. Results and discussion	21
5.1. DESCRIPTIVE ANALYSIS	21
5.2. CORRELATION AND REGRESSION ANALYSIS	33
5.3. DISCUSSION	35
6. Conclusions and future works	39
Bibliographical References.....	40
Appendix A - Questionnaire	47
Appendix B – Ethics Committee Report	53

LIST OF FIGURES

Figure 3.1 – Sample Distribution According to Demographic Profile	15
Figure 4.1 – Conceptual Framework Adopted – Source: Tornatzky and Fleischer (1990)	18
Figure 5.1 – Gender and Age Distribution	21
Figure 5.2 – Educational Qualifications Distribution.....	22
Figure 5.3 – Position in the Organization	23
Figure 5.4 – Division in the Organization	23
Figure 5.5 – Organizational Profile: Headquarters Location, Workforce Size, and Annual Turnover ...	24
Figure 5.6 – Knowledge Proficiency Breakdown of Survey Respondents	25
Figure 5.7 – Technology Characterization of Survey Respondents	26
Figure 5.8 – Organization Characterization of Survey Respondents	27
Figure 5.9 – Environment Characterization of Survey Respondents	29
Figure 5.10 – Supply Chain Effectiveness Characterization of Survey Respondents	30
Figure 5.11 – Customer Service Performance Characterization of Survey Respondents	31
Figure 5.12 – Conclusion Characterization of Survey Respondents	32

LIST OF TABLES

Table 3.1 – Demographic Characteristics	15
Table 4.1 – Hypotheses list	19
Table 4.2 – Items, Constructs, Description and Source – Source: The authors	19
Table 5.1 – Sociodemographic Characteristics.....	22
Table 5.2 – Organizations Headquarters, number of Workers and Annual Turnover	24
Table 5.3 – Descriptive analysis of the variables. Source: Own Elaboration	25
Table 5.4 – Surveyed individuals' Technological Characterization	26
Table 5.5 – Surveyed individuals' Organization Characterization	28
Table 5.6 – Surveyed individuals' External/Environmental Characterization	29
Table 5.7 – Surveyed individuals' Supply Chain Effectiveness Characterization	30
Table 5.8 – Surveyed individuals' Customer Service Performance Characterization	31
Table 5.9 – Surveyed individuals' Conclusion.....	33
Table 5.10 – Correlation Coefficients	34
Table 5.11 – Regression Analysis – Technological Context x Supply Chain Effectiveness	34
Table 5.12 – Regression Analysis – Organizational Context x Supply Chain Effectiveness	35
Table 5.13 – Regression Analysis – Environmental Context x Supply Chain Effectiveness	35

LIST OF ABBREVIATIONS AND ACRONYMS

AI	Artificial Intelligence
AR	Augmented Reality
CRM	Customer Relationship Management
ERP	Enterprise Resource Planning
IoT	The Internet of Things
RFID	Radio-Frequency Identification
SCE	Supply Chain Effectiveness
SCM	Supply Chain Management
TOE	Technology-Organization-Environment
VR	Virtual Reality

1. INTRODUCTION

Despite being in the digital era, with technology gradually taking a relevant place in day-to-day operations, the pandemic surprised the world and its economies. It showed that companies were still not fully prepared for all the changes that COVID-19 brought: the social distancing and confinement reinforced the increase in digital consumers. The retail sector was one of the most affected during this process, as the supply of essential goods to the civilian population depended on it, which forced a rapid and effective change.

Various measures were taken, namely: protective and hygiene improvements, adjustments to distribution and communication channels, and the introduction of new technologies into their operations. There was also a need to use digital payment systems and new methods of selling, distributing, and delivering goods.

The pandemic changed the paradigm of companies, with remote working, e-learning, companies' digital strategy, the use of information and communications technologies, artificial intelligence, big data among others, now being examples of technologies and practices that embed the strategy and conduct of companies.

This transformation is also particularly notable in the realm of supply chain management, where digital innovations are reshaping traditional practices and processes. However, this change is still a long way off, and there are still barriers in the sector, such as culture, training, and leadership. If companies want to survive and stay in the market, they will have to find solutions to overcome these challenges and investing in a digital strategy may be the key.

The pertinence of this inquiry is underscored by data from Pordata, which indicates that there were 1.359.035 companies in 2021, distributed across various economic sectors. The wholesale and retail sector represented about 20% of the total companies in Portugal in 1990 and about 17% in 2021. Since 2008, this number has been decreasing and was one of the most affected by the pandemic, with many companies closing their doors.

Despite the global attention given to digital transformation, there is limited research on the specific impacts on Portugal's retail sector. Given the unique economic and social context of Portugal, it is important to investigate how digital technologies are being adopted by retail businesses and how these technologies impact supply chain effectiveness - a crucial determinant of business performance and customer satisfaction (Daniels, & Jokonya, 2020).

Therefore, the guiding research question for this study is: **How does the adoption of digital technologies impact the supply chain effectiveness of retail businesses in Portugal?**

In this context, the main objective is to explore the relation between digital technologies and supply chain effectiveness in Portuguese retail businesses, utilizing the Technology-Organization-Environment (TOE) framework. This study aims to understand how digital technologies affect supply chain effectiveness in the retail sector of Portugal. This involves investigating how the adoption of digital technologies, organizational and environmental factors affect supply chain operations. The TOE framework, as outlined by Oliveira and Martins (2011), is particularly suited for analyzing the multifaceted nature of technological adoption in the Portuguese retail sector.

The primary contributions of this research will be twofold: enhancing the academic discourse on digital transformation in the retail sector and providing practical insights for Portuguese retail businesses in strategizing digital technology implementation.

Following this introduction, the dissertation is organized into several chapters:

- Chapter 2 provides a comprehensive literature review, establishing the theoretical foundation for the study.
- Chapter 3 details the research methodology, including design, data collection, and analysis techniques.
- Chapter 4 presents the empirical study, applying the TOE framework to analyze data collected.
- Chapter 5 discusses the results, offering interpretations and implications of the findings.
- The final chapter concludes the study, summarizing key insights and suggesting directions for future research.

By exploring the intersection of digital technologies and supply chain management in Portugal's retail sector, this study aims to offer valuable insights and contribute to both academic knowledge and industry practices.

2. LITERATURE REVIEW

In academic research, a literature review serves multiple vital functions. It provides a foundation of knowledge on a subject, identifies seminal and recent works that have shaped the field, and helps to identify gaps in the research where further exploration is needed (Webster, & Watson, 2002). The focus of this literature review is on understanding how the adoption of digital technologies impacts the supply chain effectiveness of retail businesses in Portugal, a topic that is pertinent and important considering the tremendous digital transformation taking place in the global retail industry.

Portugal and many other countries have seen a considerable change in the retail industry in recent years due to digital transformation. New business models, changes in customer behavior, and technological advancements have all helped to speed up this revolution (Kane, Palmer, Phillips, Kiron, & Buckley, 2015). Changes to the supply chain are an essential part of this digital transformation since the use of digital technology frequently plays a critical role in enhancing efficiency, cutting costs, and improving customer experience (Nowicka, 2021).

To understand the implications of digital transformation on supply chain effectiveness in the retail industry, this literature review will explore several key topics. Firstly, we will delve into the concepts and context of digital transformation, followed by a detailed definition and the key metrics of supply chain effectiveness. We will then examine the impact of digital technologies on supply chains and specifically focus on the digital transformation within the retail industry. This includes exploring the evolution, trends, implications, case studies, and challenges faced. Additionally, the review will provide an analysis of the digital transformation in the Portuguese retail sector. The Technology-Organization-Environment (TOE) framework will be explored, including its overview, application, and the interplay of its contextual factors: technology, organization, and environment. Finally, the review will summarize the findings and highlight research gaps, offering a comprehensive overview of the existing body of knowledge on the subject.

2.1. DIGITAL TRANSFORMATION: CONCEPTS AND CONTEXT

A common definition of digital transformation is the integration of digital technology throughout all functional areas of a company, significantly altering how it runs and provides value to consumers (Gebayew et al., 2018). At its core, it signifies a transition away from conventional corporate practices toward new, cutting-edge, and effective ones using digital technology. However, this process goes further than simply incorporating new technologies, it entails a culture shift that necessitates constant experimentation, adaptation to change, and even comfort with failure as a possibility (Kane, Palmer, Phillips, Kiron, & Buckley, 2015).

The process of going digital is fueled by technological developments: Artificial intelligence (AI), the Internet of Things (IoT), cloud computing, big data analytics, and blockchain are examples of cutting-edge technologies needed for digital transformation. These technologies are revolutionizing how organizations operate and connect with their customers, enhancing their efficiency, competitiveness, and customer-centricity (Matt, Hess, & Benlian, 2015).

The retail sector is one industry where the effects of digital change have been particularly noticeable and has been a leader in implementing digital technologies. The purchasing experience has been

completely transformed by e-commerce platforms, mobile apps, and digital payment systems. Additionally, more individualized services have been made possible using data analytics to comprehend customer behavior and preferences (Reinartz, Wiegand, & Imschloss, 2019).

This transformation has not only changed the retail landscape but has also necessitated changes in related areas such as supply chain management. The integration of digital technologies into retail supply chains is altering the dynamics of the retail industry, influencing its efficiency, resilience, and overall performance (Daniels, & Jokonya, 2020). The subsequent sections will provide a more in-depth exploration of digital transformation within the context of the retail industry, specifically focusing on its impact on supply chain effectiveness and the interplay of technological, organizational, and environmental factors as per the TOE framework.

2.2. SUPPLY CHAIN EFFECTIVENESS: DEFINITIONS AND KEY METRICS

Due to its critical role in boosting operational effectiveness, expanding customer service, and establishing competitive advantage, supply chain management (SCM) has grown in popularity. The performance of retail firms is now significantly influenced by the efficiency of supply chain operations, sometimes known as "supply chain effectiveness" (Li et al., 2006).

Defining supply chain effectiveness can be complex because it encompasses various interconnected elements and processes within the supply chain. Generally, it can be viewed as the extent to which a supply chain accomplishes its intended purpose or goals (Flynn, Huo, & Zhao, 2010). These goals usually involve the timely delivery of products, the minimization of costs, maintaining the quality of products, and ensuring customer satisfaction. Consequently, supply chain effectiveness implies the optimal functioning of these aspects leading to overall operational efficiency and customer service performance (Negi, 2021).

Measuring supply chain effectiveness can involve multiple dimensions. Typically, it involves indicators such as on-time delivery performance, fill rate, order cycle time, inventory turnover, and customer satisfaction (Gunasekaran, Patel, & McGaughey, 2004). More recently, with the advent of digital technologies, data-driven metrics, including real-time visibility of inventory and demand forecasting accuracy, are also being incorporated into the measurement of supply chain effectiveness (Wang, Gunasekaran, Ngai, & Papadopoulos, 2016).

2.3. DIGITAL TECHNOLOGY'S IMPACT ON SUPPLY CHAIN

Digital technologies are fundamentally transforming supply chain management (SCM), marked by a shift from traditional methods to systems characterized by real-time tracking, seamless communication, and data-driven decision-making. These advancements are not only enhancing efficiency and effectiveness but also improving transparency, reducing delays, and increasing speed, which fosters better coordination among supply chain participants (Chen, Preston, & Swink, 2015; Büyüközkan & Göçer, 2018).

The adoption of AI and machine learning is a key factor in this transformation, significantly enhancing forecasting and demand planning. This leads to a reduction in excess inventory and fewer out-of-stock situations, streamlining operations for businesses (Pallathadka et al., 2023). Similarly, IoT technology

has been instrumental in providing real-time visibility into the supply chain, allowing for more informed and timely decision-making (De Vass, Shee, & Miah, 2021).

The potential of blockchain technology is being recognized for its ability to increase security, reduce fraud, and improve traceability in SCM. Its contribution to increasing transparency not only promotes consumer confidence but also elevates the overall efficiency of supply chains (Saber et al., 2019). Moreover, the integration of big data analytics into SCM processes enables the analysis of large volumes of data, leading to insights that enhance operational effectiveness and customer service (Lehrer et al., 2018).

Cloud computing has emerged as a pivotal technology in SCM, enhancing coordination and responsiveness by enabling real-time communication and collaboration between supply chain partners (Giannakis, Spanaki, & Dubey, 2019). The digitalization of SCM, therefore, is marked by a significant increase in the sector's visibility, agility, and operational speed (Kiel, Müller, Arnold, & Voigt, 2017).

As SCM continues to evolve, emerging technologies such as Augmented Reality (AR) and Virtual Reality (VR) are finding their applications, particularly in improving warehouse operations and facilitating immersive training programs for supply chain employees (Boletsis & Karahasanovic, 2020). Additionally, advanced analytics powered by big data and AI enable companies to gain valuable insights from the vast amount of data generated within the supply chain, thereby enhancing forecasting accuracy and optimizing inventory management (Kamble, Gunasekaran, & Arha, 2019).

Despite these advancements, integrating digital technologies into SCM is not without its challenges. These include data security concerns, interoperability of systems, and the need for substantial capital and human resource investments. Overcoming resistance from employees accustomed to traditional SCM processes remains a significant hurdle (Cichosz, Wallenburg, & Knemeyer, 2020) and cybersecurity also remains a critical concern due to the increased connectivity and digitalization of SCM processes (Vaidya, Ambad, & Bhosle, 2018).

For successful adoption, organizations need a clear digital strategy, a culture of innovation, and capabilities in strategic planning and change management. These elements are crucial to navigating the digital transformation journey effectively (Singh et al., 2021). In conclusion, while digital technologies present challenges, their adoption is transforming SCM in significant ways, enhancing efficiency, visibility, and decision-making capabilities, requiring careful planning, risk assessment, and change management (Kshetri, 2017).

2.4. DIGITAL TRANSFORMATION IN RETAIL INDUSTRY

2.4.1. Evolution, Trends, and Implications

The retail industry's digital transformation has been dramatic, beginning with the advent of e-commerce, which introduced the convenience of shopping from home, and evolving into a multi-channel strategy for customer engagement (Ferreira et al., 2020). This shift has been further accelerated by the development of mobile technologies, leading to mobile applications that offer personalized shopping experiences with features like personalized suggestions, loyalty programs, and mobile payments (Pantano, Pizzi, Scarpi, & Dennis, 2020).

As mentioned before, modern technologies like AI, machine learning, IoT, and big data analytics have become increasingly prevalent in the retail sector. They are employed for a variety of purposes, such as improving operational efficiency, enhancing customer service, and creating personalized client experiences (Musso & Adam, 2020). AI and machine learning, for instance, are instrumental in analyzing consumer behavior for tailored marketing recommendations (Pantano et al., 2020) and IoT devices like smart shelves and RFID tags facilitate real-time inventory tracking, thus improving supply chain effectiveness (Borgia, 2014; Queiroz, Telles, & Bonilla, 2020).

Digital technologies have also transformed the retail landscape by providing unprecedented opportunities to enhance operations and customer experiences. Notably, e-commerce platforms have enabled retailers to reach global clients and offer a broader range of products (Huang & Rust, 2018).

In physical retail environments, digital technologies like augmented reality (AR) and virtual reality (VR) are being applied to enhance the shopping experience. AR apps add more product information or simulate product use, while VR offers immersive shopping experiences (Pantano, Rese, & Baier, 2017). Payment processes have also been transformed with the development of mobile wallets, contactless payments, and cryptocurrencies, improving transaction ease and security (Liébana-Cabanillas, Marinković, & Kalinić, 2017).

Retailers leverage AI and machine learning algorithms extensively for strategic decision-making by analyzing customer data to forecast consumer behavior. This can lead to predictions of future sales patterns or improvements in store layouts based on customer path analysis (Huang & Rust, 2018). Additionally, digital technologies enhance the efficiency, transparency, and responsiveness of retail supply chains through real-time inventory management and product traceability (Queiroz et al., 2020).

Despite the advantages, the use of digital technologies in the retail sector, involves challenges, including concerns about data security and privacy, the cost of technological investments, and the requirement for digital skills. Retailers face the need to create strategies to mitigate these risks for successful digital transformation (Huang & Rust, 2018; Oliveira et al., 2016).

The digital age has increased competition and innovation within the retail sector. Retailers must innovate to differentiate themselves, which can include creating unique digital products or services, employing innovative digital strategies, or utilizing technology for new business models (Ferreira et al., 2020). The platform business model is one such innovation where retailers connect buyers and sellers on their digital platforms, benefiting from technologies like cloud computing and AI (Van Alstyne, & Parker, 2017).

However, digital transformation can also exacerbate inequalities, particularly between large and small retailers, leading to a digital divide. Policymakers need to ensure equitable access to digital transformation benefits for all retailers (Kim, Choi, & Lew, 2021). In conclusion, digital transformation has reshaped the retail industry, shifting the competitive advantage towards data-driven insights and personalized experiences, though it requires careful integration and substantial investment (Ferreira et al., 2020).

2.4.2. Case Studies and Challenges

Digital technologies have dramatically transformed supply chain management (SCM) across various industries, enhancing efficiency, visibility, and agility. In the retail sector, Amazon and Walmart stand

as prime examples of this transformation. Amazon's integration of advanced data analytics and machine learning has revolutionized demand forecasting and inventory management (Bharadwaj, 2019), while Walmart's adoption of a robust data analytics system and AI-powered forecasting tools has similarly streamlined its supply chain operations, leading to improved inventory management and customer satisfaction (Heller, 2017).

In manufacturing, we have several examples. Siemens has effectively implemented Industry 4.0 technologies such as IoT and AI to create a fully automated supply chain (Annanth, Abinash, & Rao, 2021) and John Deere has also embraced digital technologies, incorporating IoT, AI, and predictive analytics to optimize product delivery (Vyas et al., 2023). The shipping industry has seen innovative applications of these technologies as well. Maersk and IBM's development of the blockchain-based platform TradeLens has significantly improved shipping efficiency (Jovanovic et al., 2022), while DHL has leveraged AI, IoT, and cloud computing to enhance its logistical operations (Erceg & Damoska-Sekulowska, 2019).

In the automotive sector, Tesla's use of AI and machine learning for predictive maintenance illustrates the potential for digital technologies to enhance customer satisfaction (Jain & Kulkarni, 2022). The fashion and technology sectors have also witnessed significant transformations. Zara and Cisco Systems have both employed data analytics and other digital tools to manage their supply chains efficiently (Villa, & Dalvi, 2022; Trebilcock, 2015; DFreight, 2023). In healthcare, Medtronic has utilized AI and data analytics to streamline supply chain efficiency and risk management (Chaudhuri, Boer, & Taran, 2018), and Pfizer has used blockchain technology to ensure traceability and authenticity in its supply chain (Ghadge et al., 2022).

The sports apparel industry, represented by Nike, has adopted 3D printing technology for responsive manufacturing and AI for forecasting and inventory management, showcasing the broad applicability of digital technologies in SCM (Ekren et al, 2023; Ahmad et al., 2020; Ivanov, Dolgui, & Sokolov, 2019).

Despite these numerous success stories, the implementation of digital technologies in SCM is accompanied by significant challenges. Retail businesses, particularly SMEs, often struggle with technological complexity, cybersecurity risks, and data privacy issues. The substantial initial investments required for digital transformation, including hardware, software, system upgrades, and staff training, can be daunting, especially for smaller enterprises (Kache & Seuring, 2017; Priyono, Moin, & Putri, 2020; Ghadge et al., 2020).

Moreover, interoperability between different systems remains a critical hurdle, requiring strategic planning and a strong change management framework. In Portugal, the predominance of SMEs in the retail sector introduces unique challenges, including limited technological expertise and resources, cultural resistance to change, and regulatory constraints (Santos, 2022; Teles, 2023).

In addition to these challenges, the regulatory environment in Portugal can significantly impact the adoption of digital technologies in SCM. Regulatory constraints can either enable or obstruct digital transformation efforts, highlighting the importance of understanding their impact (Teles, 2023).

Recognizing and addressing these challenges is crucial for businesses and policymakers. By aligning digital transformation efforts with strategic goals, businesses can significantly improve supply chain effectiveness and gain a competitive advantage (Tsipoulanidis, & Nanos, 2022). The potential benefits

of digitized SCM, such as improved efficiency, visibility, and flexibility, offer significant incentives for retail businesses, underscoring the importance of overcoming these challenges for the future success and sustainability of the industry.

2.5. DIGITAL TRANSFORMATION IN THE PORTUGUESE RETAIL SECTOR

Portugal's retail industry is experiencing a paradigm shift, driven by the need to embrace digital transformation in an ever-changing market. This urgency has been highlighted by the challenges of the COVID-19 pandemic, as noted by Carujo et al. (2021). Retailers, regardless of their size, are investing in technological options like online selling platforms and advanced stock control systems to enhance efficiency and customer satisfaction. Durão et al. (2019) emphasize the commitment of Portuguese organizations to digital efforts, envisioning a future where digital mastery is key to success.

The evolution towards digital practices varies across the sector, influenced by factors such as business size, market scope, and resource availability. Eiriz et al. (2019) observed the agility of small independent food retailers in adopting digital tools to improve process efficiency and customer interactions. These retailers have adeptly used technology to navigate the tumultuous retail landscape marked by pandemic disruptions (Lopes, 2021).

The pandemic has acted as a catalyst for digital adoption. Retailers reevaluated and reinvented their business models and customer engagement strategies to thrive in an evolving economic environment. The shift towards digital avenues has been partly propelled by the need for social distancing, leading to a surge in e-commerce and online shopping, necessitating a pivot towards digital-centric business models (Lopes, 2021).

Larger entities, including conglomerates and editorial groups, have not been bypassed by this digital wave. They have leveraged robust digital infrastructures to advance their supply chain management capabilities. Carujo et al. (2021) notes that these organizations have implemented advanced digital strategies incorporating real-time inventory management and sophisticated analytics for demand prediction, along with digital platforms to manage supplier and distributor networks efficiently.

However, the journey to a fully digital retail sector faces challenges. Retail businesses grapple with digital literacy within their staff, the economic burdens of new technology adoption, and general resistance to change often accompanying significant organizational transformations (Teles, 2023). Overcoming these obstacles requires strategic planning, investment in workforce training, and fostering a culture receptive to innovation and technological adoption.

The current state of digital transformation in Portugal's retail industry is a dynamic mix of advancement and challenges. The rapidly changing economic landscape has sparked widespread motivation for greater efficiency and progress. The future trajectory of the sector depends on its ability to integrate digital innovations, cultivate a culture of ongoing improvement, and navigate the complexities of such a significant paradigm shift in operations and corporate ethos.

The Portuguese retail industry is witnessing a shift in supply chain management efficacy due to digital technology advancements. The implementation of innovative systems and tools has been critical in refining operational capabilities, particularly for small independent food retailers Eiriz et al. (2019) illuminate how these businesses have embraced technology to enhance their operational functions. Key technological advancements, such as Warehouse Management Systems and AI-driven forecasting

tools, have been instrumental in increasing inventory accuracy, reducing lead times, and fostering overall supply chain transparency (Carujo et al., 2021). The strategic integration of these technologies has increased productivity and become a necessary component of retail firms' viability, considering shifting market dynamics.

Digital technologies have significantly improved communication and collaboration across the supply chain. Carujo et al. (2021) highlights that larger editorial groups in Portugal have led in adopting digital platforms that bolster coordination with suppliers and distributors, ensuring a more efficient flow of information, reducing delays, and accelerating market delivery.

Due to e-commerce growth, supply chains now need to be more flexible and agile. The increasing use of Artificial Intelligence (AI) and machine learning algorithms provides predictive insights, allowing retailers to swiftly respond to evolving market trends (Ribeiro et al., 2022). AI is improving logistics processes, from route planning for deliveries to managing returns, increasing the overall effectiveness of the supply chain.

Furthermore, real-time monitoring capabilities, made possible by the integration of the Internet of Things (IoT) into supply chain activities, are improving process transparency and traceability. This is particularly important for the food retail industry, as product safety and quality are critical. IoT devices are deployed to monitor storage conditions, manage product expiration dates, and ensure adherence to health regulations, thus upholding consumer confidence (Santos, 2022).

In summary, digital technologies are radically reshaping Portuguese retailers' supply chains and giving them the tools, they need to run more effectively, quickly, and with a customer-centered mindset. This ongoing digital transformation is a complete revamp of operations, preparing the retail industry for a business environment focused on the future rather than just small, incremental changes.

2.6. TECHNOLOGY-ORGANIZATION-ENVIRONMENT (TOE) FRAMEWORK

2.6.1. Overview and Application

The study is rooted in the technology-organization-environment (TOE) framework. This theoretical perspective posits that the adoption of technological innovations in organizations is shaped by three contexts: the technological context, the organizational context, and the environmental context (Baker, 2012). In the context of this study, the TOE framework will be employed to systematically analyze the interplay between digital technology adoption and supply chain effectiveness in Portuguese retail businesses.

The TOE framework, originally proposed by Tornatzky and Fleischer (1990), has been widely applied in research investigating the adoption of technological innovations in organizations. Its three contexts offer a comprehensive lens to understand the complexities of technology adoption:

1. **Technological Context:** This refers to the internal and external technologies relevant to the organization, including the presence and use of digital technologies, their sophistication, and their compatibility with existing operations (Baker, 2012).

2. **Organizational Context:** This pertains to the attributes of the organization that can affect the adoption process. These attributes can include the size of the organization, its readiness for change, managerial structure, and resources (Baker, 2012).
3. **Environmental Context:** This encompasses the broader business environment in which the organization operates. Factors such as industry characteristics, competition, regulatory environment, and external support or pressures can influence technology adoption (Baker, 2012).

Applying the TOE framework in the context of this study will allow a nuanced exploration of how digital technologies are impacting the effectiveness of supply chains in the retail sector in Portugal.

2.6.2. Contextual Factors: Technology, Organization, Environment

a) Technological Context:

In an era of rapid digitalization, various technologies are playing instrumental roles in transforming supply chain operations in the retail sector (Kache & Seuring, 2017).

The adoption of digital technologies in supply chains largely depends on the technology readiness and acceptance of retail businesses. Factors such as perceived usefulness, ease of use, and perceived risk can affect technology acceptance and subsequently, the extent of technology integration in SCM (Breckon et al., 2019).

Adopting these technologies presents difficulties despite the potential advantages. Issues related to cost, lack of technical knowledge, worries about data protection, and resistance to change are a few examples (Dwivedi et al., 2021).

There is substantial evidence demonstrating that the adoption of digital technologies can enhance supply chain effectiveness (Ivanov, Dolgui, & Sokolov, 2019). Nevertheless, several variables, such as organizational preparation, technological compatibility, and the external business environment, can affect how technology affects supply chain effectiveness.

b) Organization Context

Organizational readiness is a critical determinant of successful digital transformation. It encompasses the alignment of strategy, infrastructure, processes, and people to facilitate digital adoption (Cichosz, Wallenburg, & Knemeyer, 2020). The preparedness of an organization to embrace digital technologies is highly dependent on its technological and human resource capabilities, leadership vision, and flexibility to adapt to change.

The structure and culture of an organization can significantly impact its digital transformation journey. A structure that promotes open communication, collaboration, and innovation can foster the successful implementation of digital technologies. Moreover, a culture that encourages learning, risk-taking, and acceptance of new technologies can expedite the digital transformation process (Leso, Cortimiglia & Ghezzi, 2023).

An organization's resources and capabilities, including technological infrastructure, financial resources, and human capital, are critical enablers of digital transformation. Adequate investment in

infrastructure and skilled personnel can greatly facilitate the adoption of digital technologies (Schallmo et al., 2017). Furthermore, an organization's ability to manage and leverage these resources effectively can significantly enhance the effectiveness of its supply chain (Wu et al., 2006).

A clear and coherent strategy and vision for digital adoption can guide an organization's digital transformation efforts. Leadership plays a critical role in articulating this vision, setting strategic goals, and driving digital initiatives (Ismail, Khater, & Zaki, 2017). Furthermore, aligning digital transformation with overall business strategy can maximize its impact on supply chain effectiveness (Bharadwaj et al., 2013).

Without top management's direct support, an organization cannot effectively promote a digital transformation supply chain. Executive management would convey the transformation's vision and how it aligns with departmental strategic objectives (Daniels, & Jokonya, 2020). According to Nguyen et al. (2022), the level of top management support indicates how much managers understand and accept an innovation's technological potential. To speed up the adoption process, it seeks to concurrently create a workable environment, guarantee resource mobilization, and provide proactive support. It is a crucial consideration for managers when choosing whether to implement an invention. Having the backing of upper management is essential when implementing innovations.

Organizational factors, including readiness for digital transformation, organizational structure and culture, resources and capabilities, and strategy and vision, collectively impact the effectiveness of the supply chain. Their alignment and management can determine the success of digital adoption and its impact on supply chain effectiveness (Cichosz, Wallenburg, & Knemeyer, 2020).

c) Environment Context

The effectiveness of retail supply chains in Portugal is influenced by various environmental factors, including the retail market landscape, regulatory environment, market trends, consumer behaviors, and the competitive environment. Navigating these factors while adopting digital technologies can enhance supply chain effectiveness and foster sustainable growth in the retail sector (Santos, 2022).

The retail market in Portugal presents unique characteristics, shaped by a diverse mix of international and local businesses and a significant presence of small and medium-sized enterprises (SMEs). With increasing consumer demand for e-commerce and omnichannel shopping experiences, the adoption of digital technologies in retail supply chains has become more relevant (Santos, 2022).

The regulatory environment in Portugal plays a vital role in digital adoption by retail businesses. Policies and regulations concerning data protection, cybersecurity, and technological standards can either enable or hinder the incorporation of digital technologies in supply chains (Santos, 2022). Understanding these regulatory factors is pivotal to successfully navigating the digital transformation journey in the retail sector. The legal framework, according to Nguyen et al. (2022), reflects the rules, regulations, and specifications that a firm needs to obey. Laws and policies pertaining to Online Retailing may influence a company's decision to use Online Retailing to improve business performance. Hiran et al. (2020) demonstrated how an important aspect of the environmental setting that encourages cloud computing adoption is the legal framework. In the same way, Maroufkhani et al. (2023) showed that companies are more inclined to use big data when they face a high degree of

restrictions and government pressure. Similarly, a significant enabler of the spread of big data was the legal system.

Market trends and consumer behaviors in Portugal are also influential in shaping the retail sector's digital transformation. The increasing demand for online shopping, the expectation for quick deliveries, and the growing concern for product authenticity and sustainability are significant factors driving the adoption of digital technologies in retail supply chains (Santos, 2022).

The competitive environment in Portugal's retail sector necessitates the adoption of digital technologies for retailers to maintain or gain a competitive edge. Retail businesses are increasingly leveraging digital technologies to improve supply chain efficiency, reduce costs, enhance customer experience, and consequently, differentiate themselves in the market (Santos, 2022). According to Nguyen et al. (2022), competitive pressure is equivalent to pressure from rivals operating in the same sector. It is widely acknowledged that one of the most important factors influencing the adoption of innovation is competitive pressure. Businesses will engage in innovation in reaction to perceived increases in industry competitiveness. The adoption of innovations in cloud computing, mobile payments, and CRM is facilitated by competitive pressure, according to previous research. Technological advances are strategically vital for enterprises to compete in the market when competition forces them to raise quality standards. This is especially true since the competition is driven by these innovations.

2.6.3. Interplay of TOE Factors

The adoption of digital technologies in retail supply chains is not an isolated process but a synergistic interaction of technology, organization, and environment (TOE) factors. Technological factors such as readiness and acceptance, organizational elements like culture and resources, and environmental aspects such as market trends and regulatory environment collectively influence the effectiveness of digital transformation (Oliveira, Thomas, & Espadanal, 2014). In the context of Portugal's retail sector, understanding the intricate interplay of these TOE factors can provide valuable insights into the process and outcomes of digital adoption in supply chains.

While the synergy of TOE factors presents numerous opportunities for enhancing supply chain effectiveness, it also brings forth significant challenges. Technological challenges include managing the complexity of advanced technologies and ensuring data security (Kache, & Seuring, 2017). Organizational challenges involve building digital capabilities, fostering a digital culture, and aligning digital strategies with business objectives (Serpa, Sá, & Ferreira, 2022). Environmental challenges include adapting to rapidly changing market trends, complying with regulatory requirements, and maintaining competitiveness (Santos, 2022).

On the other hand, the TOE context also offers exciting opportunities for retail businesses. Technological advancements allow real-time tracking, predictive analysis, and enhanced transparency in supply chains. Organizational readiness for digital transformation can foster innovation, enhance efficiency, and improve customer experience. The changing environmental context, characterized by the growth of e-commerce and changing consumer preferences, creates new avenues for growth and differentiation (Santos, 2022).

In conclusion, understanding the complex interplay of TOE factors is critical for successfully navigating the digital transformation journey in retail supply chains, enhancing their effectiveness, and ultimately contributing to the sustainability and competitiveness of retail businesses in Portugal.

2.7. SUMMARY AND RESEARCH GAPS

The advent of digital technologies, such as the Internet of Things (IoT), Artificial Intelligence (AI), Big Data Analytics, and Blockchain, has been transforming various business sectors globally, including the retail industry (Queiroz et al., 2022). Previous studies indicate that these digital technologies can substantially enhance supply chain effectiveness through improved visibility, coordination, and efficiency (Wang, Gunasekaran, Ngai, & Papadopoulos, 2016). However, the adoption of these technologies is not uniform across different markets and organizations (Büchi, Just, & Latzer, 2016).

In the context of Portugal, research on the adoption of digital technologies in retail businesses and their impact on supply chain effectiveness is still relatively limited. Some studies have explored the relationship between technology adoption and supply chain effectiveness (Kamble, Gunasekaran, & Arha, 2020), but the specific role of digital technologies in the retail sector in Portugal has not been thoroughly examined.

Additionally, while the TOE framework has been utilized in several studies to study technology adoption (Baker, 2012; Oliveira, & Martins, 2011; Oliveira, Thomas, & Espadanal, 2014), very few have done so to examine the adoption of digital technologies in the context of the retail supply chain. This reveals a sizable study void and justifies additional research into how the interaction of organizational, technological, and environmental elements affects the efficacy of supply chains in Portugal's retail industry.

Moreover, organizational, and environmental contexts, despite being significant in technology adoption, are not sufficiently explored in existing literature (Oliveira, Thomas, Baptista, & Campos, 2016). This research gap points to the need for a more detailed analysis of how factors such as organizational readiness, culture, strategy, and market conditions affect the adoption of digital technologies in the retail industry in Portugal.

Finally, there is a lack of literature addressing the complex interplay and synergies among technology, organization, and environmental contexts in influencing supply chain effectiveness (Bell, & Sherlock, 2020). Unpacking these relationships would provide valuable insights into the challenges and opportunities in digital adoption in retail supply chains.

In summary, this study aims to address these research gaps by utilizing the TOE framework to explore the adoption of digital technologies and their impact on supply chain effectiveness in Portugal's retail industry.

3. METHODOLOGY

In this chapter, we delve into the methodology applied to investigate the relationship between digital technologies and the effectiveness of the supply chain in the Portuguese retail sector. The investigation is a crucial tool, playing a pivotal role in propelling various disciplines forward and laying the groundwork for a unique body of knowledge essential for recognizing professions. However, understanding the multifaceted nature of our world doesn't rely on singular approaches. This realization necessitates the use of diverse methods by researchers, which are essential in addressing challenges and thereby enhancing the scientific foundation of various domains (Polit et al., 2004).

Building upon this, our methodology, as described by Fortin (2009), encompasses the various methods employed during this investigation. We began by establishing the type of study, opting for a quantitatively structured design, which serves as the backbone for collecting objective data. This is followed by the stages of data collection, and the population and sample. In addition, we will shed light on the design of our questionnaire, highlighting aspects of its validity and reliability. The chapter concludes with ethical considerations and potential limitations.

3.1. RESEARCH DESIGN AND DATA COLLECTION

In this research, we have chosen a quantitative approach to systematically collect and statistically analyze data. This decision was motivated by the aspiration to gather measurable data on the adoption of digital technologies and their consequent influence on supply chain effectiveness.

Our investigation is characterized as quantitative, descriptive, and correlational. This is primarily because it entails the methodical acquisition of numerical data, often under controlled circumstances, followed by statistical evaluation. As outlined by Fortin (2009), the descriptive aspect of our approach seeks to depict and interconnect features and variables within a given population. Concurrently, its correlational facet examines the interrelations between variables to comprehend the nature of their associations. Typically, in such studies, hypotheses are formulated, and quantitative data is amassed using instruments like scales and questionnaires. A significant advantage of this method is its ability to account for multiple variables simultaneously and probe the interrelations among them.

An online questionnaire was employed as the primary data collection tool. This method was chosen due to its efficiency in collecting responses from a wide geographical area and the convenience it offers respondents. Using Qualtrics, an online survey platform, participants provided insights into the current state of digital technology adoption in their organizations and its implications on their supply chains.

3.2. POPULATION, SAMPLE, AND QUESTIONNAIRE DESIGN

Participants were selected using non-probabilistic convenience sampling, focusing on professionals with direct experience or knowledge about the convergence of digital technologies and supply chain processes in the Portuguese retail sector. According to Saunders, Lewis, & Thornhill (2009), convenience sampling of this nature has limited representativeness and is characterized by its unknown parameters. As a result, it is crucial to approach the analysis of this study with heightened care and attention to ensure that the findings closely reflect reality.

During September 2023, out of the 220 professionals in the Portuguese retail sector who were contacted via LinkedIn, 45 responded to the online questionnaire, resulting in a response rate of 20.5%. The sample demographic characteristics are illustrated in Figure 3.1 and detailed in Table 3.1. Males are the most represented at 66.7%. Regarding age, the age group that comprises the largest number of individuals is the age group between 35 and 44 years old, with a percentage of 35.6%, followed by individuals whose age is between 45 and 54 years old (31.1%) and individuals between 25 and 34 years old (28.9%).

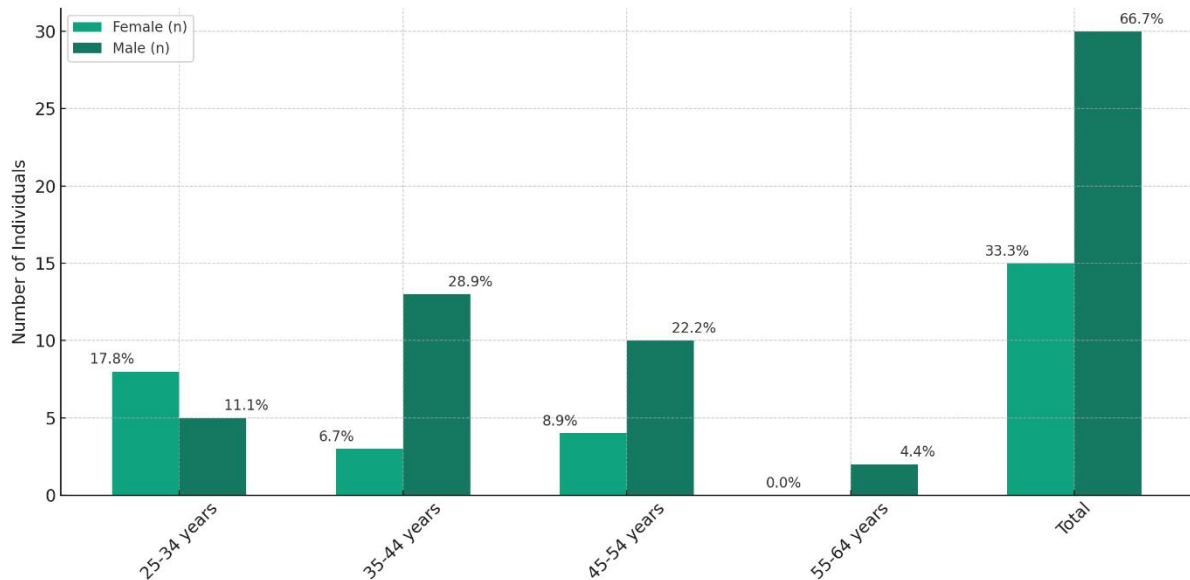


Figure 3.1 – Sample Distribution According to Demographic Profile

Table 3.1 – Demographic Characteristics

Age	Gender					
	Female		Male		Total	
	n	%	n	%	n	%
25-34 years	8	17,8	5	11,1	13	28,9
35-44 years	3	6,7	13	28,9	16	35,6
45-54 years	4	8,9	10	22,2	14	31,1
55-64 years	0	0,0	2	4,4	2	4,4
Total	15	33,3	30	66,7	45	100,0

The questionnaire was structured using a Likert scale to gauge the level of agreement or disagreement with specific statements related to digital technology and supply chain effectiveness. The sections began with demographics (3 questions), followed by statements that are aligned with the Technology-Organization-Environment (TOE) framework. These sections specifically addressed technological (3

questions), organizational (6 questions), and environmental (3 questions) aspects of their respective businesses. Followed by supply chain effectiveness (2 questions), customer service performance (2 questions), and organizational characterization (5 questions). The questionnaire concluded with a final section (6 questions) – refer to Appendix A.

3.3. DATA ANALYSIS: TECHNIQUES AND TOOLS

The collected data was processed and analyzed using the IBM SPSS Statistics software. Descriptive statistics will provide an overview of the sample characteristics. Inferential statistics, such as regression analysis, will be used to determine relationships and impacts between variables.

3.4. VALIDITY, RELIABILITY, AND ETHICAL CONSIDERATIONS

As previously mentioned, the questionnaire is structured using the Likert scale. According to Fortin (2009), whenever a scale is utilized, Cronbach's alpha should be determined, which indicates the degree of homogeneity of a measurement instrument. The coefficient's value ranges from 0.00 to 1.00. The higher the coefficient value, the greater the internal consistency. In the sample under study, the internal consistency and reliability yielded a Cronbach's alpha of 0.861 for the 14 items examined (TOE and Supply Chain Effectiveness). Regarding the Cronbach's alpha for each of the components studied, the results were as follows: Technology: 0.824; Organization: 0.840; Environment: 0.579; Supply Chain Effectiveness: 0.727.

After constructing the questionnaire, a pre-test was carried out, which according to Fortin (2009), consists of filling out the questionnaire by a small part of the sample (in this case 4 individuals, experts in the field), to verify their understanding of the questions, the effectiveness and relevance of the questionnaire, checking the clarity of the terms used (semantic understanding), whether the questions allow collecting the desired information, whether the questionnaire is not too long and whether the questions are not ambiguous, to correct or modify the questionnaire.

The Likert scale, which is well-established in academic research, was used to ensure consistent interpretation of responses.

This study abides by moral standards such as gaining informed consent, maintaining participant anonymity, and assuring confidentiality. Participants were made aware of the goals of the study, their rights, and their ability to discontinue participation at any time. The data will be safely preserved, and their identities and private information will remain anonymous.

3.5. LIMITATIONS OF THE STUDY

While the study was designed to ensure maximum reliability, it still has certain limitations. Although the sample size reflects the willingness of the participants, it may not encompass the entire opinion of the retail sector in Portugal. The use of self-reported data could introduce biases, and the cross-sectional nature of the data restricts the study's capacity to record changes over time.

Even though the sample size, regarding its distribution, we can apply the Central Limit Theorem. This mathematical principle states that in samples where $N \geq 30$, the distribution naturally tends towards normality (Maroco, & Bispo, 2005).

4. EMPIRICAL STUDY

4.1. APPLICATION OF TOE FRAMEWORK

Drawing on the insights gained from the literature review, this section synthesizes the application of the TOE framework to the study of digital transformation and supply chain effectiveness in Portugal's retail sector.

A comprehensive analysis of digital transformation from the TOE perspective shows that the interplay of technology, organization, and environmental factors greatly influences the adoption of digital technologies and their impact on supply chain effectiveness in the retail sector (Baker, 2012; Nguyen, Le, & Vu, 2022).

Technological factors, such as the selection of digital technologies, their compatibility with supply chain processes, and their usability are crucial (Chen, Preston, & Swink, 2015). Organizational factors such as leadership commitment, resources, culture, and readiness for change also significantly affect the adoption process and its outcomes (Cichosz, Wallenburg, & Knemeyer, 2020). Furthermore, environmental factors such as regulatory support, market trends, consumer behaviors, and competition dynamics shape the broader context within which these transformations occur (Oliveira, Thomas, & Espadanal, 2014).

These insights from the TOE framework provide a holistic understanding of digital transformation in the retail sector, highlighting the need for a balanced and integrated approach to leveraging digital technologies for enhancing supply chain effectiveness.

4.2. DEVELOPMENT OF HYPOTHESIS AND CONCEPTUAL MODEL

In using the Technology-Organization-Environment (TOE) framework as our theoretical backdrop, we make a series of assumptions. These underpin our research and guide our hypothesis formulation.

a) Theoretical Assumptions

- 1. Adoption of Digital Technologies is Multidimensional:** This research assumes that the adoption of digital technologies isn't a single-faceted phenomenon. It involves complex interactions among various technological, organizational, and environmental factors (Baker, 2012).
- 2. Positive Impact of Digital Technologies on Supply Chain Effectiveness:** The study assumes that the successful adoption and use of digital technologies will positively impact supply chain effectiveness in the retail sector (Yang, Fu, & Zhang, 2021).

b) Hypotheses

Given these assumptions, we propose the following hypotheses:

- **H1:** Higher levels of digital technology readiness and acceptance in the retail sector will lead to greater supply chain effectiveness.

- **H2:** Organizational readiness for digital transformation, including the structure and culture, resources and capabilities, and strategic vision for digital adoption, positively influence supply chain effectiveness.
- **H3:** Environmental factors such as the regulatory environment, market trends, consumer behaviors, and competitive dynamics in the Portuguese retail market significantly impact the effectiveness of the supply chain.

These hypotheses pave the way for the empirical investigation of our research question using the TOE framework.

c) Linking Digital Transformation and Supply Chain Effectiveness: Proposed Conceptual Model

A crucial part of modern corporate strategies is now digital transformation, particularly as it relates to supply chain management. Innovative technologies like artificial intelligence, big data analytics, the Internet of Things (IoT), and blockchain are frequently what's driving this revolution (Ghadge et al., 2020; Queiroz et al., 2022). These technological advancements can fundamentally alter how the supply chain operates and increase its efficiency.

Building on the Technology-Organization-Environment (TOE) framework, our conceptual model posits that the effectiveness of a retail business's supply chain in Portugal is largely influenced by three broad factors: technological, organizational, and environmental contexts (Baker, 2012).

In the **technology context**, factors such as efficiency, cost savings, support for faster and better decision-making, and the overall advancement of digital technologies are considered crucial. Our model suggests that a more advanced technology context will lead to greater supply chain effectiveness (**H1**).

In the **organizational context**, aspects like organizational readiness for digital transformation, supportive structure and culture, available resources and capabilities, strategic vision for digital adoption, and investment in training are pivotal. Our model proposes that these organizational factors positively influence supply chain effectiveness (**H2**).

Lastly, the **environmental context** includes factors such as the market landscape, market trends, consumer behaviors, competitive environment, and the regulatory environment. The model hypothesizes that these environmental factors significantly impact supply chain effectiveness (**H3**).

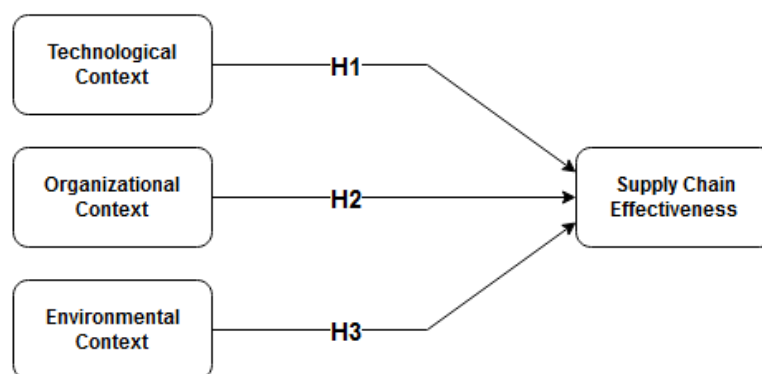


Figure 4.1 – Conceptual Framework Adopted – Source: Tornatzky and Fleischer (1990)

Table 4.1 – Hypotheses list

Hypothesis	Description
H1	The more advanced the Technology Context of a retail business (in terms of efficiency, cost savings, and support faster and better decision-making), the higher the Supply Chain Effectiveness.
H2	The more favorable the Organizational Context of a retail business (in terms of organization readiness for digital transformation, supportive structure and culture, resources and capabilities, strategic vision for digital adoption, and invests in training), the higher the Supply Chain Effectiveness.
H3	The more conducive the Environmental Context (in terms of the market landscape, market trends, consumer behaviors, competitive environment, and regulatory environment), the higher the Supply Chain Effectiveness.

Table 4.2 – Items, Constructs, Description and Source – Source: The authors

Items	Construct	Description	Source
- Technology improve efficiency	Technological Context	Measures the level of digital technology impact to improve efficiency, cost savings, and support for faster and better decision-making in a retail organization.	Park & Kim (2021); Kumar, Singh, & Swain (2022)
- Technology helps in cost saving			
- Perceived benefits from big data			
- Data quality and integration			
- Readiness for digital transformation	Organizational Context	Captures the degree of organizational readiness for digital transformation, the existing structure and culture, resources and capabilities, the strategic vision for digital adoption, and invests in training.	Baker, J. (2012); Kumar, Singh, & Swain (2022); Dadhich & Hiran (2022); Park & Kim (2021)
- Organizational structure			
- Organizational culture			
- Resources			
- Capabilities			
- Strategy and vision for digital adoption			
- Top management allocated sufficient resources for the technology deployment at the post-implementation stage			

Items	Construct	Description	Source
- Organization's readiness to embrace the new technology			
- Optimum resource allocation mechanism			
- Learning in my organization is seen as a key commodity necessary to guarantee organizational survival			
- Retail market landscape			
- Regulatory environment			
- Market trends			
- Consumer behaviors	Environmental Context	Assesses the retail market landscape, the regulatory environment, market trends, consumer behaviors, and competitive dynamics in Portugal.	Baker, J. (2012); Park & Kim (2021); Kumar, Singh, & Swain (2022)
- Competitive dynamics			
- Retailers will lose customers to competitors if they do not adopt technology			
- Competitor adoption			
- Government support and policy			
- Service Delivery			
- Customer response time	Supply Chain Effectiveness	Dependent variable in the study, measuring the effectiveness of supply chain processes in a retail organization.	Kamble & Gunasekaran (2020)
- Customer service quality			
- Customer satisfaction			

This proposed conceptual model provides a thorough understanding of the different elements influencing supply chain effectiveness in the retail industry and digital transformation. This study intends to advance knowledge about how to improve supply chain operations in the digital era by examining these aspects and how they interact.

5. RESULTS AND DISCUSSION

This chapter presents the results derived from the quantitative analysis, as described in Chapter 3. These results will provide detailed insights into the research question: "How does the adoption of digital technologies impact the supply chain effectiveness of retail businesses in Portugal?". To understand these findings in the broader context of the retail industry's digital transition, the discussion will rely on the Technological, Organizational, and Environmental (TOE) framework.

The subsequent sections in this chapter will provide the analysis and discussion of the data collected. The "Descriptive Analysis" and "Correlation and Regression Analysis" sections will detail the findings from the questionnaires, while the "Discussion" section will link these findings with existing literature and elaborate on their implications.

5.1. DESCRIPTIVE ANALYSIS

The sample for this study comprises 45 individuals. Of these, 33.3% are female and 66.7% are male. Age-wise, 35.6% are between 35 and 44 years old, 31.1% are between 45 and 54 years old, 28.9% are between 25 and 34 years old, and the remaining 4.4% are between 55 and 64 years old.

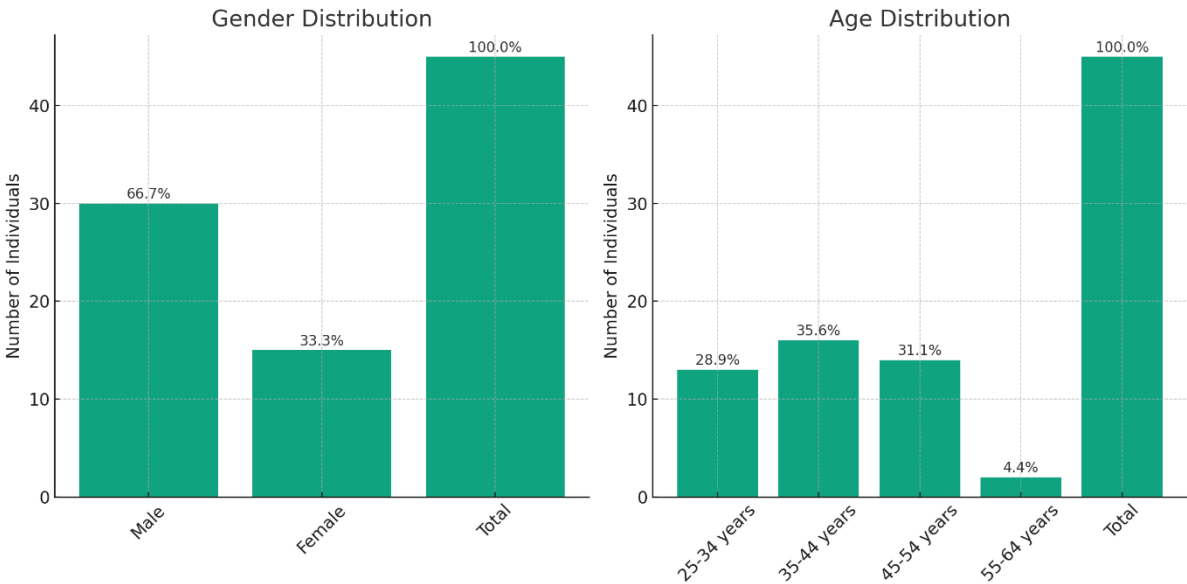


Figure 5.1 – Gender and Age Distribution

Regarding educational qualifications, 53.3% of the participants hold a degree or bachelor's degree, while 42.2% have a master's degree.

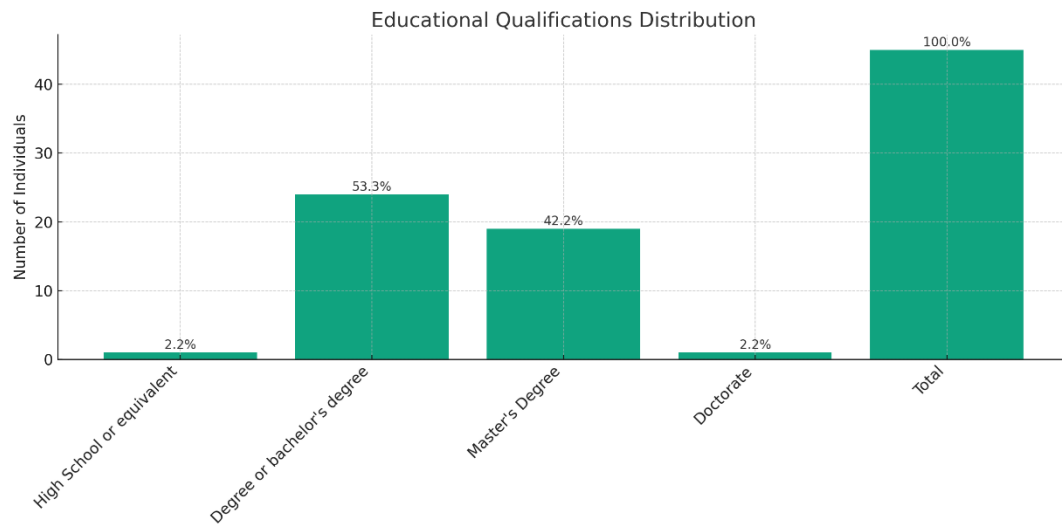


Figure 5.2 – Educational Qualifications Distribution

For a more concise characterization of the sample studied, a descriptive table follows, from which the previously mentioned data was extracted.

Table 5.1 – Sociodemographic Characteristics

		n	%
Gender	Male	30	66,7
	Female	15	33,3
	Total	45	100,0
Age	25-34 years	13	28,9
	35-44 years	16	35,6
	45-54 years	14	31,1
	55-64 years	2	4,4
	Total	45	100,0
Educational Qualifications	High School or equivalent	1	2,2
	Degree ou bachelor's degree	24	53,3
	Master's Degree	19	42,2
	Doctorate	1	2,2
	Total	45	100,0

Regarding the position held by the surveyed individuals, 26.7% are Manager/Division Managers, followed by individuals who are Supply Chain Managers or Director and IT Manager or Director with an equal percentage of 20.0%. As for the division in which they work, 40.0% work in Information Technology/Information Systems and 35.6% work in Logistics.

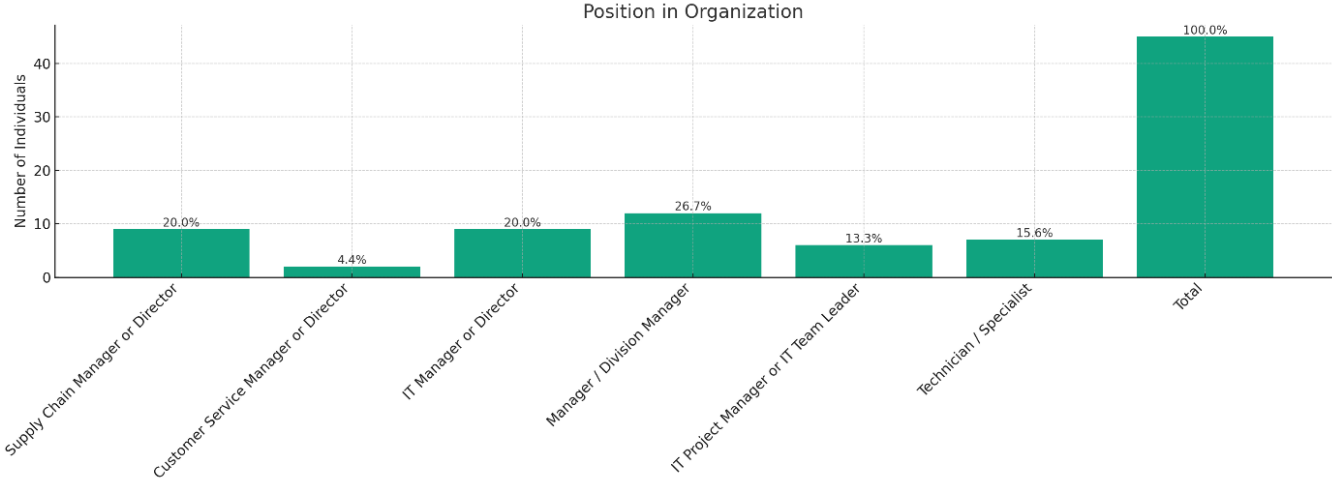


Figure 5.3 – Position in the Organization

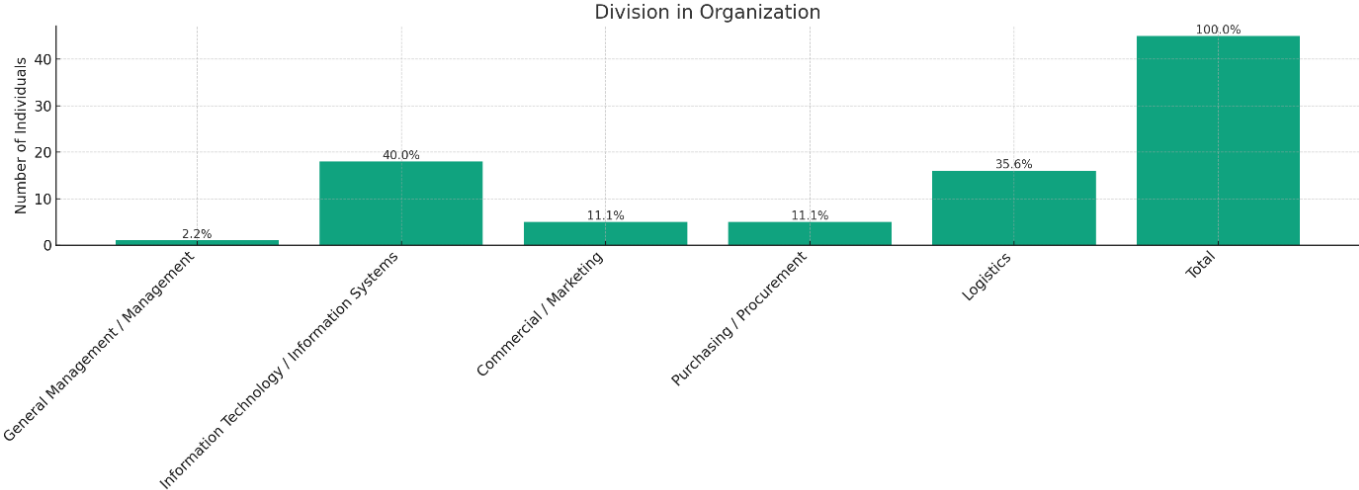


Figure 5.4 – Division in the Organization

The surveyed individuals are predominantly (82.2%) from organizations headquartered in Lisbon, with 500 or more employees (97.8%) and with an annual turnover exceeding 50 million (91.1%).

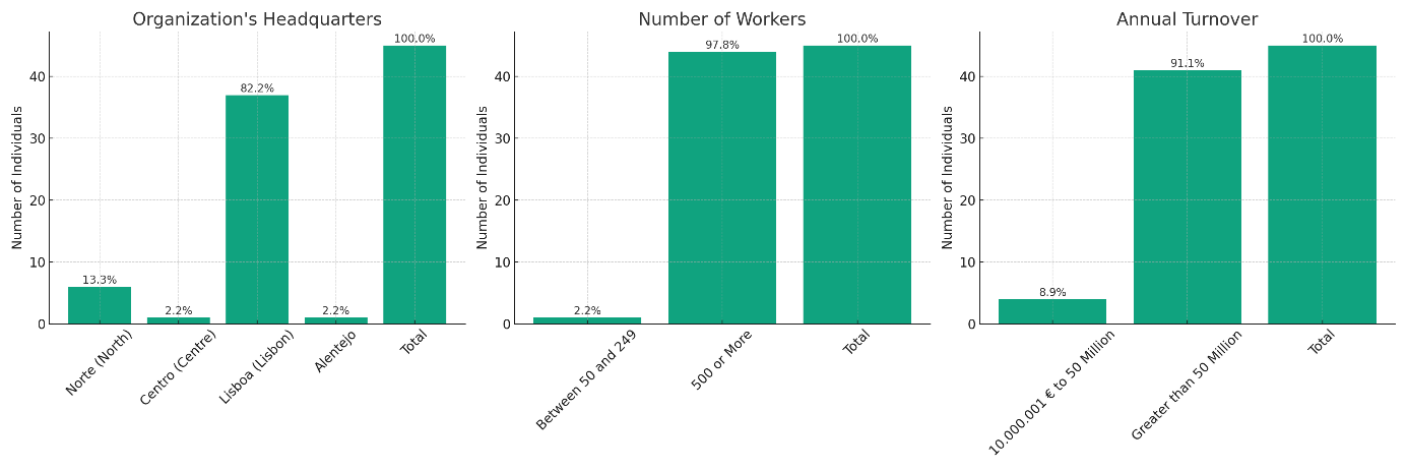


Figure 5.5 – Organizational Profile: Headquarters Location, Workforce Size, and Annual Turnover

Table 5.2 – Organizations Headquarters, number of Workers and Annual Turnover

		n	%
Organization's headquarters located?	Norte (North)	6	13,3
	Centro (Centre)	1	2,2
	Lisboa (Lisbon)	37	82,2
	Alentejo	1	2,2
	Total	45	100,0
Number of workers in the organization	Between 50 and 249	1	2,2
	500 or More	44	97,8
	Total	45	100,0
Organization's annual turnover	10.000.001 € to 50 Million	4	8,9
	Greater than 50 Million	41	91,1
	Total	45	100,0

The individuals surveyed were asked about their level of knowledge regarding the subject of this questionnaire. The majority said their knowledge was Good 55.6%, and 37.8% said Very Good. In this sense, I present the obtained results.

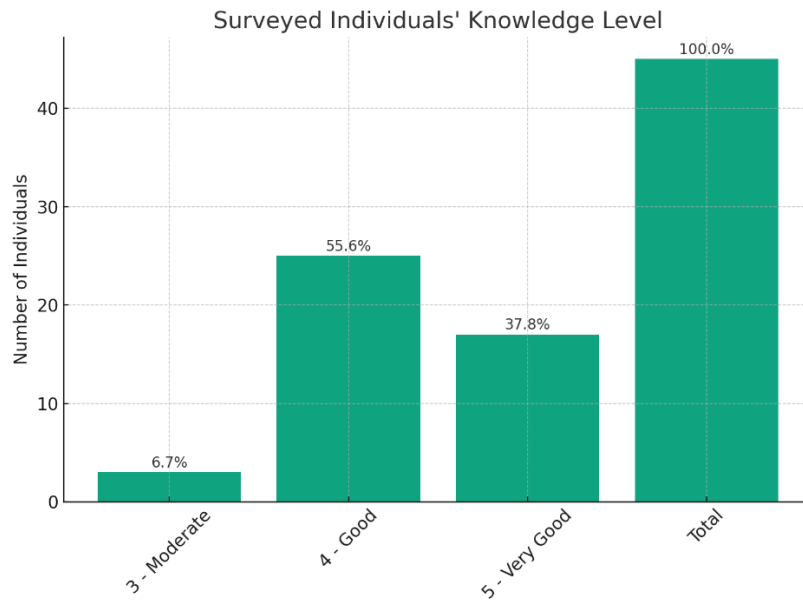


Figure 5.6 – Knowledge Proficiency Breakdown of Survey Respondents

The table of descriptive statistics is presented, where the minimum, maximum, and average values responded to for each variable are observed. It has a 5-point Likert scale (from 1 - Strongly disagree to 5 - Strongly agree), where the average for each of the studied variables was 4 – Agree. The variable with the highest average value is the Technological Context (M=4.44). On the other hand, the dimension with the lowest average responses corresponds to the Organizational Context (M=3.68). Regarding the standard deviation, the variable with the highest standard deviation is the Organizational Context ($\sigma = 0.75$), and the variable with the lowest standard deviation is the Supply Chain Effectiveness ($\sigma = 0.52$). This means that the Supply Chain Effectiveness is the variable with a more homogeneous value and closer to the expected value.

Table 5.3 – Descriptive analysis of the variables. Source: Own Elaboration

	N	Minimum	Maximum	Mean	Std. Deviation
Technological Context	45	1,67	5,00	4,4370	,59383
Organizational Context	45	2,00	5,00	3,6778	,74654
Environmental Context	45	2,33	5,00	3,9333	,56676
Supply Chain Effectiveness	45	3,00	5,00	4,1778	,52392
Valid N (listwise)	45				

The subsequent sections will present an analysis of the collected data, detailing findings from the questionnaires. These findings will focus on various aspects such as technology, organization, environment, supply chain effectiveness, customer service performance, and conclusion characterization:

a) Technology characterization

From the observation of the following figure and table, most of the surveyed individuals strongly agree (66.7%) with the statement, "In our organization, the digital technologies implemented have significantly improved our supply chain operations efficiency." Similarly, 53.3% agree and 37.8% strongly agree that the implementation of digital technologies has helped reduce costs, as well as support a faster and more efficient decision-making process with 51.1% of the surveyed individuals strongly agree and 46.7% agree.

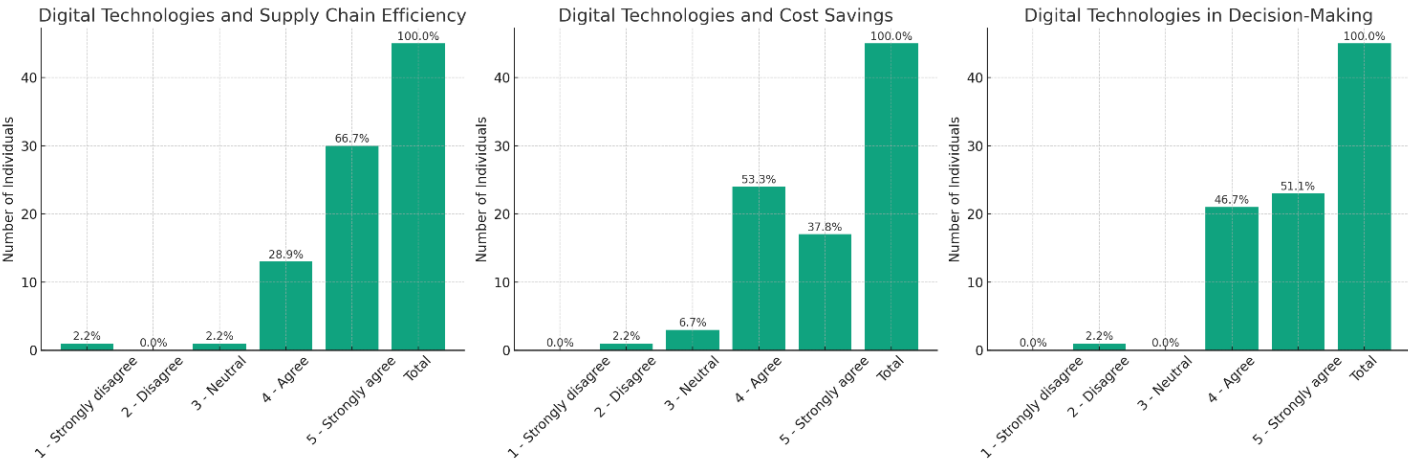


Figure 5.7 – Technology Characterization of Survey Respondents

Table 5.4 – Surveyed individuals' Technological Characterization

		1 Strongly disagree	2 disagree	3 Neutral	4 Agree	5 Strongly agree	Total
In our organization, the digital technologies implemented have significantly improved our supply chain operations efficiency.	n	1	0	1	13	30	45
	%	2,2	0,0	2,2	28,9	66,7	100
In our organization, the digital technologies implemented help to get cost savings.	n	0	1	3	24	17	45
	%	0,0	2,2	6,7	53.3	37,8	100
In our organization, the digital technologies implemented support faster and better decision-making.	n	0	1	0	21	23	45
	%	0,0	2,2	0,0	46,7	51,1	100

b) Organization characterization

Regarding the question of whether the organization was prepared for digital transformation in its operations, the surveyed individuals had different answers, with 40.0% agreeing, but 26.7% disagreeing. Similarly, when the question is about whether the organization is well-prepared for the implementation of digital technologies in their supply chain processes, opinions were divided, but 48.9% agree and 24.4% disagree. Many of the surveyed individuals (55.6%) agree that the structure, culture, resources, and capabilities of their organization have positively influenced the adoption of digital technologies. If the question pertains to the resources and capabilities of the organization, 42.2% of the surveyed individuals agree that these were critical to the successful implementation of digital processes. Regarding the organization's strategy and vision for digital adoption, 40.0% of the surveyed individuals agree and 31.1% strongly agree that it is clear. Most respondents, 53.3%, agree, and 24.4% strongly agree that their organization invests in training its employees to maximize the use of digital technologies.

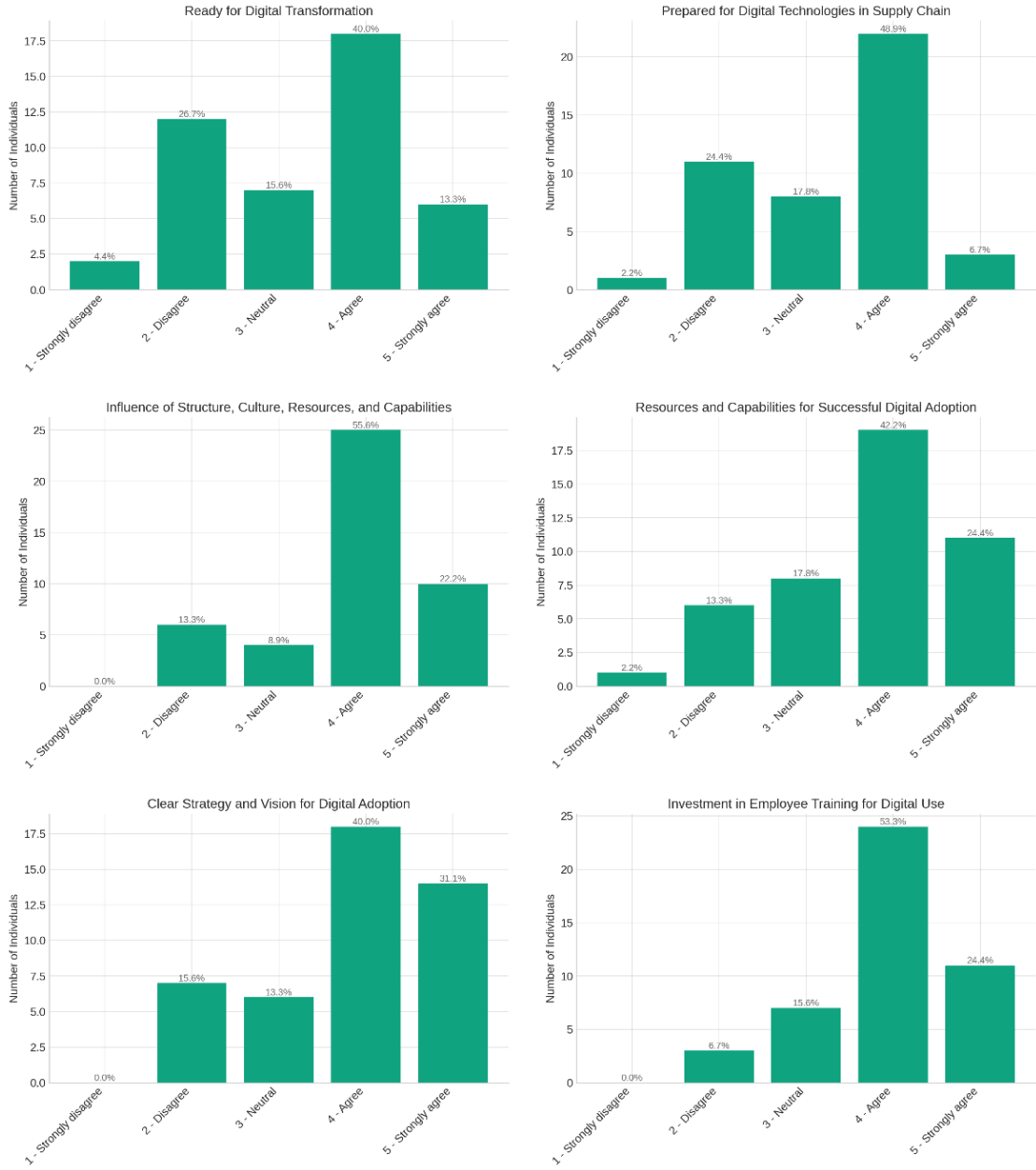


Figure 5.8 – Organization Characterization of Survey Respondents

Table 5.5 – Surveyed individuals' Organization Characterization

		1 Strongly disagree	2 disagree	3 Neutral	4 Agree	5 Strongly agree	Total
My organization was ready for a digital transformation in its operations.	n	2	12	7	18	6	45
	%	4,4	26,7	15,6	40,0	13,3	100
My organization was well-prepared for the implementation of digital technologies in our supply chain processes.	n	1	11	8	22	3	45
	%	2,2	24,4	17,8	48,9	6,7	100
My organization: the structure, culture, resources, and capabilities of my organization have positively influenced the adoption of digital technologies.	n	0	6	4	25	10	45
	%	0,0	13,3	8,9	55,6	22,2	100
My organization has resources and capabilities that are critical to a successful digital adoption process.	n	1	6	8	19	11	45
	%	2,2	13,3	17,8	42,2	24,2	100
My organization has a clear strategy and vision for digital adoption.	n	0	7	6	18	14	45
	%	0,0	15,6	13,3	40,0	31,1	100
My organization invests in employee training to make the best use of digital technologies.	n	0	3	7	24	11	45
	%	0,0	6,7	15,6	53,3	24,4	100

c) Environment characterization

Of the individuals surveyed, 48.9% agree and 31.1% strongly agree with the statement, "The current Retail market landscape in Portugal significantly influenced my organization's approach to digital technology adoption." Similarly, 57.8% agree and 37.8% strongly agree that current market trends, consumer behaviors, and the competitive environment have largely influenced their digital adoption strategy.

However, when the question is about the current regulatory environment, even though 48.9% of the surveyed individuals agree, 33.3% of individuals have a neutral opinion.

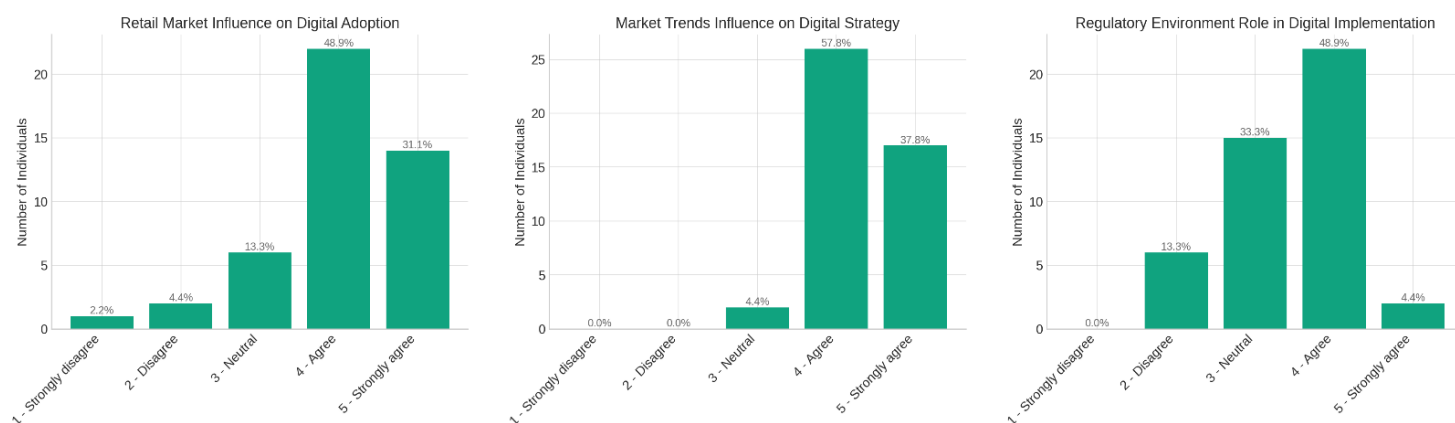


Figure 5.9 – Environment Characterization of Survey Respondents

Table 5.6 – Surveyed individuals' External/Environmental Characterization

		1 Strongly disagree	2 disagree	3 Neutral	4 Agree	5 Strongly agree	Total
The current Retail market landscape in Portugal significantly influenced my organization's approach to digital technology adoption.	n	1	2	6	22	14	45
	%	2,2	4,4	13,3	48,9	31,1	100
Current market trends, consumer behaviors, and the competitive environment have largely influenced our digital adoption strategy.	n	0	0	2	26	17	45
	%	0,0	0,0	4,4	57,8	37,8	100
The current regulatory environment plays a substantial role in our decision-making and implementation processes for digital technologies.	n	0	6	15	22	2	45
	%	0,0	13,3	33,3	48,9	4,4	100

d) Supply Chain Effectiveness characterization

More clear was the position of the surveyed individuals regarding the impact of digital technologies on supply chain effectiveness, where the majority (66.7%) agree that it has improved and also agree (64.4%) that there were substantial changes in the supply chain. It should be noted that 62.2% of individuals agree that there was a considerable improvement in the speed, quality, or customization of the service since these technologies were adopted.

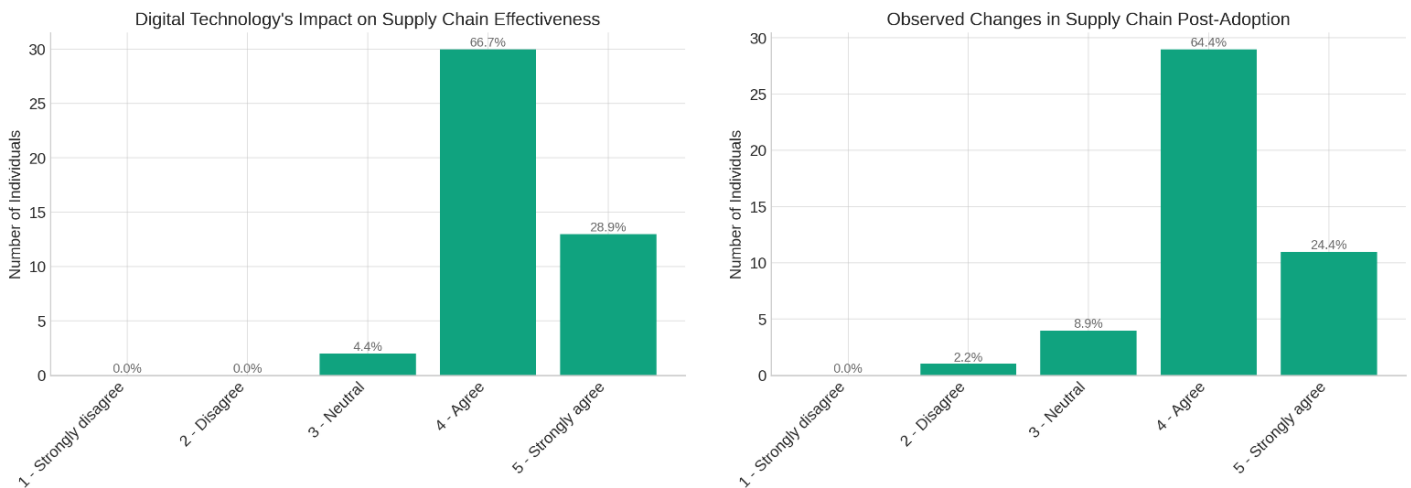


Figure 5.10 – Supply Chain Effectiveness Characterization of Survey Respondents

Table 5.7 – Surveyed individuals' Supply Chain Effectiveness Characterization

		1 Strongly disagree	2 disagree	3 Neutral	4 Agree	5 Strongly agree	Total
The adoption of digital technologies has significantly improved our supply chain effectiveness.	n	0	0	2	30	13	45
	%	0,0	0,0	4,4	66,7	28,9	100
We have observed substantial changes in our supply chain since adopting these technologies.	n	0	1	4	29	11	45
	%	0,0	2,2	8,9	64,4	24,4	100

e) Customer Service Performance characterization

No less important, 66.7% of the individuals agree that customer satisfaction has also significantly improved with the adoption of digital technologies.

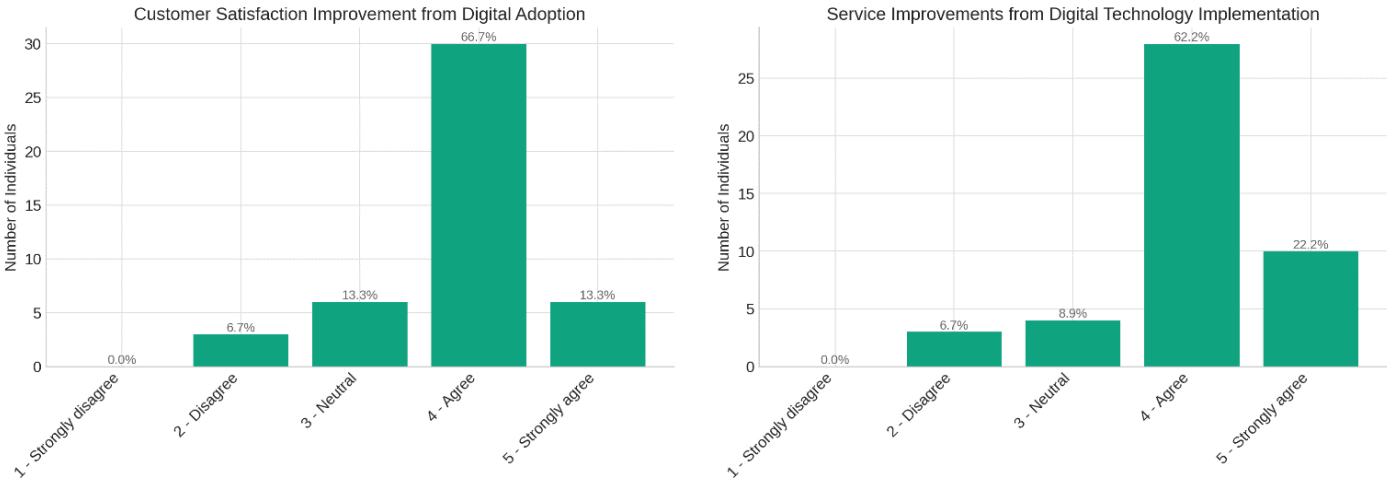


Figure 5.11 – Customer Service Performance Characterization of Survey Respondents

Table 5.8 – Surveyed individuals' Customer Service Performance Characterization

		1 Strongly disagree	2 disagree	3 Neutral	4 Agree	5 Strongly agree	Total
Customer satisfaction has significantly improved due to changes in our supply chain from digital technology adoption.	n	0	3	6	30	6	45
	%	0,0	6,7	13,3	66,7	13,3	100
We have noticed a considerable improvement in the speed, quality, or personalization of service since implementing these technologies.	n	0	3	4	28	10	45
	%	0,0	6,7	8,9	62,2	22,2	100

f) Conclusion characterization

However, when asked if they have extensive experience with supply chain management and digital technologies in their role at this organization, 44.4% of individuals agree, but 35.6% have a neutral opinion.

Regarding the question of whether their organization has widely adopted digital technology in the context of supply chain management, 62.2% of individuals agree. Similarly, the vast majority (71.1%) agree that there have been significant challenges, successes, and insights gained from their experience with digital transformation.

Lastly, of the 45 individuals surveyed, 51.1% agree, and 48.9% strongly agree with the statement, "*I am optimistic about the future of digital technology in retail supply chain management.*"



Figure 5.12 – Conclusion Characterization of Survey Respondents

Table 5.9 – Surveyed individuals' Conclusion

		1 Strongly disagree	2 disagree	3 Neutral	4 Agree	5 Strongly agree	Total
I have extensive experience with supply chain management and digital technologies in my role at this organization.	n	0	5	16	20	4	45
	%	0,0	11,1	35,6	44,4	8,9	100
My company has widely adopted digital technology in the context of supply chain management.	n	0	4	5	28	8	45
	%	0,0	8,9	11,1	62,2	17,8	100
There were significant challenges, successes, and insights gained from our experience with digital transformation.	n	0	1	2	32	10	45
	%	0,0	2,2	4,4	71,1	22,2	100
I am optimistic about the future of digital technology in retail supply chain management.	n	0	0	0	23	22	45
	%	0,0	0,0	0,0	51,1	48,9	100

5.2. CORRELATION AND REGRESSION ANALYSIS

a) Correlation Analysis

In the present study, it was possible to examine the correlation between the variables, that is, the level of intensity between them. To do so, the Pearson correlation coefficient was employed, as it allows measuring the correlation between the variables.

As shown in the following table, the variables are correlated, since R is never equal to 0. Similarly, it can also be observed that the variation does not occur in opposite directions, as R never reaches negative values ($R < 0$). Thus, the studied variables are not negatively correlated. Therefore, the variables are positively related, meaning they vary in the same direction ($R > 0$). When the correlation is positive, it can be: Weak, when $0 < R < 0.5$, Moderate, when $0.5 \leq R < 0.8$, and Strong, when $0.8 \leq R < 1$.

Thus, by analyzing the studied variables, we can conclude that:

- The Technological Context positively correlates with Supply Chain Effectiveness at a moderate and significant scale.
- The Organizational Context positively correlates with Supply Chain Effectiveness at a moderate and significant scale.
- The Environmental Context positively correlates with Supply Chain Effectiveness at a weak and significant scale.

Table 5.10 – Correlation Coefficients

	Technological Context	Organizational Context	Environmental Context
Supply Chain Effectiveness	R = 0,670 ** p = 0,000	R = 0,527 ** p = 0,000	R = 0,398 ** p = 0,007

** . Correlation is significant at the 0,01 level.

Thus, it is concluded that the variable with the highest correlation with Supply Chain Effectiveness is the Technological Context, followed by the Organizational Context variable.

b) Regression Analysis

To estimate the model, a simple linear regression analysis was used to study the relationship between the dependent variable – Supply Chain Effectiveness – and each of the independent variables – Technological Context, Organizational Context, and Environmental Context, represented by Hypotheses 1, 2, and 3:

1. H1 – Technological Context x Supply Chain Effectiveness (T x S)

H1 - The more advanced the Technology Context of a retail business (in terms of efficiency, cost savings, and support faster and better decision-making), the higher the Supply Chain Effectiveness.

The hypothesis is accepted.

This is because there is a moderate, positive, and significant correlation between the Technological Context and Supply Chain Effectiveness variables (R=0.670, p-value=0.000). In the Linear Regression, where the dependent variable is Supply Chain Effectiveness and the independent one is Technological Context, a $R^2=0.449$ was obtained.

Table 5.11 – Regression Analysis – Technological Context x Supply Chain Effectiveness

R	0,670
R Square	0,449
Sig. F Change	0,000

2. H2 – Organizational Context x Supply Chain Effectiveness (O x S)

H2 - The more favorable the Organizational Context of a retail business (in terms of organization readiness for digital transformation, supportive structure and culture, resource and capabilities, strategic vision for digital adoption, and invests in training), the higher the Supply Chain Effectiveness.

The hypothesis is accepted.

This is because there is a moderate, positive, and significant correlation between the Organizational Context and Supply Chain Effectiveness variables ($R=0.527$, $p\text{-value}=0.000$). In the Linear Regression, where the dependent variable is Supply Chain Effectiveness and the independent one is Organizational Context, a $R^2=0.278$ was obtained.

Table 5.12 – Regression Analysis – Organizational Context x Supply Chain Effectiveness

R	0,527
R Square	0,278
Sig. F Change	0,000

3. H3 – Environmental Context x Supply Chain Effectiveness (E x S)

H3 - The more conducive the Environmental Context (in terms of the market landscape, market trends, consumer behaviors, competitive environment, and regulatory environment), the higher the Supply Chain Effectiveness.

The hypothesis is accepted.

This is because there is a weak, positive, and significant correlation between the Environmental Context and Supply Chain Effectiveness variables ($R=0.398$, $p\text{-value}=0.003$). In the Linear Regression, where the dependent variable is Supply Chain Effectiveness and the independent one is Environmental Context, a $R^2=0.158$ was obtained.

Table 5.13 – Regression Analysis – Environmental Context x Supply Chain Effectiveness

R	0,398
R Square	0,158
Sig. F Change	0,003

5.3. DISCUSSION

The findings from the simple linear regression analyses have provided empirical support for the proposed hypotheses regarding the determinants of Supply Chain Effectiveness (SCE) in the retail sector. These determinants were examined in terms of Technological Context (T), Organizational Context (O), and Environmental Context (E):

a) Technological Context (H1)

The hypothesis that an advanced Technological Context would be positively correlated with higher SCE was strongly supported ($R=0.670$, $p\text{-value}=0.000$), explaining 44.9% of the variance in SCE ($R^2=0.449$).

This result aligns with current literature which suggests that technology is a critical enabler for supply chain cost savings, efficiency, and supports faster and better decision-making. In a systematic literature review conducted by Mamhiyo and Jokonya (2020), cost savings were the most mentioned at 81%, as influencers when adopting digital technology in the supply chain, which coincides with what was found in our study, where 91.1% of respondents strongly agree or agree. Daniels and Jokonya (2020) found similar results, stating that cost savings were one of the most cited technological factors that influence digital technology supply chain adoption (69%).

On the other hand, Dudukalov et al. (2020) conducted a study on Industry 4.0 readiness and found statistically significant evidence between Industry 4.0 technologies and supply chain performance, it has been shown to provide an efficient contribution to enhancing business efficiency and productivity. They mention that "*readiness for these revolutionary innovations is significant as it leads to better consistency of choices and enhanced efficiency of supply chain*" (Dudukalov et al., 2020, p. 2). This corroborates the high percentage (95.6%) of individuals who agree or strongly agree with the influence of digital technologies on supply chain operations efficiency found in the current study.

The same author states that the development of Industry 4.0 companies also leads to quicker and more effective decision-making. In our study, 97.8% of individuals agreed or strongly agreed that digital technologies implemented support faster and better decision-making. The results suggest that investments in technology not only support operational processes but also lead to substantial improvements in overall supply chain performance.

b) Organizational Context (H2)

Similarly, the Organizational Context's favorable conditions, encompassing readiness for digital transformation, supportive structure and culture, resource capability, and strategic vision for digital adoption, were found to significantly influence SCE ($R=0.527$, $p\text{-value}=0.000$). This variable accounted for 27.8% of the variance in SCE ($R^2=0.278$). The finding underscores the importance of the internal capabilities and culture of an organization in leveraging technology for supply chain success.

Dudukalov et al (2020), as mentioned in the previous point, asserts that readiness for revolutionary innovations is significant as it enhances the efficiency of the supply chain. In the current study, many individuals (53.3%) also agree or strongly agree that readiness for digital transformation has an influence on the supply chain.

The effective adoption of technologies depends on the employees and their learning, as well as top management support, as noted by Kumar, Singh, & Swain (2022). They also emphasize that top management is considered the strongest driver for adopting new technologies. In the current study, 77.8% of individuals believe that a supportive structure and culture positively influence the adoption of digital technologies.

Daniels and Jokonya (2020) assert that resource capabilities have high influence on digital supply chain adoption within retail industries. They also state that they may have a direct influence on technological factors, such as cost and security. In our study, 66.4% of participants agree or strongly agree that resource capabilities were critical to a successful digital adoption process. Similarly, Mamhiyo and Jokonya (2020) report that 53% of the articles they consulted cite top management support as an organizational factor.

The companies' strategic vision was explored by the same authors in a systematic literature review, where it was identified as a dominant (73%) organizational factor that retailers must consider when adopting a digital supply chain. These findings resonate with our study, where 71.1% of respondents agree or strongly agree with this factor.

c) Environmental Context (H3)

The Environmental Context, characterized by market landscape, regulatory environment, market trends, consumer behaviours, and competitive dynamics, also showed a positive relationship with SCE ($R=0.398$, $p\text{-value}=0.003$), but with a lower R^2 of 0.158. While this context explained less of the variance compared to technological and organizational contexts, its significance cannot be dismissed. This relationship emphasizes that external factors also play a critical role in shaping the effectiveness of supply chains. It resonates with the viewpoint that supply chains do not operate in isolation and are continually influenced by external market forces and trends.

In their systematic review, Daniels and Jokonya (2020) found that market structure was one of the most referenced environmental factors (66%). This suggests that organizations are more likely to adopt digital supply chains if they are considered suitable to the current market structure, especially in mature markets. These findings agree with our study, where 80% of individuals agree or strongly agree that the market landscape influences the adoption of digital technologies in the supply chain.

Mamhiyo and Jokonya (2020) state that 38% of the articles considered legislation to be important in the adoption of the digital supply chain. Other authors, such as Nguyen et al. (2022), also corroborate our findings. They state that in their study, a legal framework was found to positively impact online retailing. Organizations are willing to integrate online retailing into their business processes when they strongly believe that the legal framework facilitates and creates business transparency in digital transformation. In our study, 53.3% agree or strongly agree that the regulatory environment played a substantial role in the implementation processes for digital technologies.

In our study, market trends, consumer behaviors, and competitive environment were considered by 95.6% to largely influence digital adoption. Similarly, Dudukalov et al. (2020) corroborate the findings, stating that businesses are attempting to improve service, pertinence, and usability through the development of Industry 4.0 technology and expanding customer data access. They work to improve supply chain performance to establish a long-term relationship with each client. The formation and maintenance of long-lasting customer relationships with the majority of businesses benefit greatly from the use of consumer knowledge. According to Prasad & Venkatesham (2021) the utilization of big data analytics enables retailers to analyze vast amounts of data for insights into customer behavior and market trends, which aids in informed decision-making and strategic planning. Other authors, such as Huang & Rust (2018) state that retailers leverage AI and machine learning algorithms extensively for strategic decision-making by analyzing customer data to forecast consumer behavior which can lead to predictions of future sales patterns or improvements in store layouts based on customer path analysis.

Competitive dynamics is one of the environmental factors explored in the study by Putra and Santoso (2020). They state that online retailing provides a competitive advantage to companies compared to their competitors who do not utilize these technologies. Nguyen et al. (2022), have the same opinion, he states that one of the most important factors influencing the adoption of innovation is competitive

pressure. Technological advances are strategically vital for enterprises to compete in the market when competition forces them to raise quality standards.

d) Comparative Analysis

A comparative analysis of the R^2 values reveal the differential impact of each context on SCE. Technological Context, with the highest R^2 , suggests a stronger impact on SCE compared to Organizational and Environmental Contexts. This indicates that while the organizational and environmental factors of a retail business are important, the technology employed within the supply chain has the strongest relationship on its effectiveness.

This conclusion is aligned with the findings of Daniels & Jokonya (2020), who observed a similar trend in the adoption of digital supply chains within retail industries. Their study highlights that technological factors predominantly steer the adoption process, overshadowing organizational and environmental factors. This alignment suggests a common thread in the retail sector's digital transformation journey: the central role of technology in enhancing supply chain efficiency and effectiveness.

Therefore, this comparative analysis underscores the primary influence of technological advancements in shaping the future of retail supply chains. It suggests that, for businesses aiming to improve their supply chain operations, a greater emphasis should be placed on integrating and advancing technological aspects, with organizational and environmental factors playing supportive but less dominant roles in this digital evolution.

6. CONCLUSIONS AND FUTURE WORKS

The conclusions drawn from this study indicate that all three contexts (Technological, Organizational, and Environmental) have a positive correlation with Supply Chain Effectiveness, albeit to different extents. Technological Context has the strongest relationship with Supply Chain Effectiveness, followed by Organizational and Environmental Contexts. These findings suggest that retail businesses looking to enhance their Supply Chain Effectiveness should prioritize technological advancements and organizational improvements. Although the Environmental Context is also important, it has a relatively smaller influence on the effectiveness of the supply chain.

The study's findings have several implications for retail industry practitioners. To enhance SCE, retailers should prioritize the advancement of their technological capabilities. However, it is not enough to solely focus on technology; organizational readiness and adaptability are also key. Moreover, environmental factors should be monitored continuously to ensure that the supply chain can adapt to external changes effectively.

One limitation of this study is its focus on linear relationships between the contexts and SCE. Future research could explore more complex models that account for interactions between these variables. Additionally, a longitudinal study design could provide insights into how these relationships evolve over time. Specifically, in the context of technological advancements, future investigations must pinpoint which technologies—such as Enterprise Resource Planning (ERP), Internet of Things (IoT), Artificial Intelligence (AI), Big Data Analytics, and Blockchain—are pivotal in transforming supply chain operations, thereby guiding strategic technological integration within the supply chain sector.

In conclusion, the current research adds to the body of knowledge by quantitatively confirming the importance of technological, organizational, and environmental contexts in enhancing SCE in the retail sector. Future strategies should be holistic, combining technology implementation with organizational and environmental awareness to develop robust and effective supply chains.

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APPENDIX A - QUESTIONNAIRE



Digital Technologies and the Future of Retail: a study of the effectiveness of the supply chain in Portugal

1. Introduction

Good morning,

This survey takes place within the scope of a master's thesis at NOVA IMS - Information Management School, with the main objective of studying the impact of digital technologies on the effectiveness of the supply chain of retail companies in Portugal. Your participation will contribute to the development of research areas on this topic, as well as to the completion of my master's work.

Informed consent

If the option "I agree to participate" is selected, the participant affirms to be over 18 years old and to be aware of the purpose of this investigation, being also aware that it is possible to withdraw at any time without suffering any type of consequence. The data collected through this questionnaire will only be used for academic research purposes. In this way, the anonymity and confidentiality of your responses will be respected.

Thank you in advance for your collaboration, time spent, and honesty in participating in this survey/study.

If you have any questions, comments, or suggestions, you can contact me at the following e-mail address: m20211350@novaims.unl.pt

Would you like to participate in this study? Please choose one of the options below:

- I agree to participate
- I do not accept to participate

Digital Technologies and the Future of Retail: a study of the effectiveness of the supply chain in Portugal

2. Demographic Characterization

1. How old are you?
 - 18-24 years
 - 25-34 years
 - 35-44 years
 - 45-54 years
 - 55-64 years
 - Above 65 years

2. What is your gender?
 - Male
 - Female
 - Other
 - Prefer not to say

3. What is your education level?
 - Less than High School
 - High School or equivalent
 - Degree or bachelor's degree
 - Master's Degree
 - Doctorate
 - Prefer not to say

Digital Technologies and the Future of Retail: a study of the effectiveness of the supply chain in Portugal

3. Technological Characterization

4. On a scale of 1-5 indicate how 1 (strongly disagree) – 5 (strongly agree) with the following statements.

	1 – strongly disagree	2	3	4	5 – strongly agree
In our organization, the digital technologies implemented have significantly improved our supply chain operations efficiency.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
In our organization, the digital technologies implemented help to get cost savings.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
In our organization, the digital technologies implemented support faster and better decision-making.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Digital Technologies and the Future of Retail: a study of the effectiveness of the supply chain in Portugal

4. Organizational Characterization

5. On a scale of 1-5 indicate how 1 (strongly disagree) – 5 (strongly agree) with the following statements.

	1 – strongly disagree	2	3	4	5 – strongly agree
My organization was ready for a digital transformation in its operations.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My organization was well-prepared for the implementation of digital technologies in our supply chain processes.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My organization: the structure, culture, resources, and capabilities of my organization have positively influenced the adoption of digital technologies.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My organization has resources and capabilities that were critical to a successful digital adoption process.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My organization has a clear strategy and vision for digital adoption.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My organization invests in employee training to make the best use of digital technologies.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Digital Technologies and the Future of Retail: a study of the effectiveness of the supply chain in Portugal

5. External/Environmental Characterization

6. On a scale of 1-5 indicate how 1 (strongly disagree) – 5 (strongly agree) with the following statements.

	1 – strongly disagree	2	3	4	5 – strongly agree
The current Retail market landscape in Portugal significantly influenced my organization's approach to digital technology adoption.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Current market trends, consumer behaviors, and the competitive environment have largely influenced our digital adoption strategy.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The current regulatory environment played a substantial role in our decision-making and implementation processes for digital technologies.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Digital Technologies and the Future of Retail: a study of the effectiveness of the supply chain in Portugal

6. Supply Chain Effectiveness Characterization

7. On a scale of 1-5 indicate how 1 (strongly disagree) – 5 (strongly agree) with the following statements.

	1 – strongly disagree	2	3	4	5 – strongly agree
The adoption of digital technologies has significantly improved our supply chain effectiveness.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
We have observed substantial changes in our supply chain since adopting these technologies.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Digital Technologies and the Future of Retail: a study of the effectiveness of the supply chain in Portugal

7. Customer Service Performance Characterization

8. On a scale of 1-5 indicate how 1 (strongly disagree) – 5 (strongly agree) with the following statements.

	1 – strongly disagree	2	3	4	5 – strongly agree
Customer satisfaction has significantly improved due to changes in our supply chain from digital technology adoption.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
We have noticed a considerable improvement in the speed, quality, or personalization of service since implementing these technologies.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Digital Technologies and the Future of Retail: a study of the effectiveness of the supply chain in Portugal

8. Organization Characterization

9. In which of the following regions of Portugal is your organization's headquarters located?

- Norte (North)
- Centro (Centre)
- Lisboa (Lisbon)
- Alentejo
- Algarve
- Açores (Azores)
- Madeira

10. What is the number of workers in the organization?

- Less than 49
- Between 50 and 249
- Between 250 and 499
- 500 or More

11. What is the organization's annual turnover?

- Up to 2 Million €
- 2.000.001 € to 10 Million
- 10.000.001 € to 50 Million
- Greater than 50 Million

12. What is your position in the organization? [in case of doubt indicate the one that is closest]

- Chief Executive Officer (CEO) / General Director / Manager / Administrator
- Chief Information Officer (CIO) or Chief Technology Officer (CTO)
- Chief Operations Officer (COO)
- Supply Chain Manager or Director
- Customer Service Manager or Director
- IT Manager or Director
- Manager / Division Manager
- IT Project Manager or IT Team Leader
- Technician / Specialist

13. What division do you work in?

- General Management / Management
- Information Technology / Information Systems
- Commercial / Marketing
- Purchasing / Procurement
- Production
- Logistics
- Other (specify):

Digital Technologies and the Future of Retail: a study of the effectiveness of the supply chain in Portugal

9. Conclusion

14. Please indicate:

	1 – strongly disagree	2	3	4	5 – strongly agree
I have extensive experience with supply chain management and digital technologies in my role at this organization.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My company has widely adopted digital technology in the context of supply chain management.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
There were significant challenges, successes, and insights gained from our experience with digital transformation.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am optimistic about the future of digital technology in retail supply chain management.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

15. Please indicate:

	1 – very limited	2	3	4	5 – very good
What is your level of knowledge regarding the questions in this survey ?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
What is your level of knowledge regarding NOVA IMS ?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

16. Thank you very much! I appreciate your cooperation.

APPENDIX B – ETHICS COMMITTEE REPORT



This is to certify that

Project No.: **INFSYS2023-11-24080**

Project Title: **Digital Technologies and the Future of Retail: A Study of Supply Chain Effectiveness in Portugal**

Principal Researcher: **Rui Barros**

according to the regulations of the Ethics Committee of NOVA IMS and MagIC Research Center this project was considered to meet the requirements of the NOVA IMS Internal Review Board, being considered **APPROVED** on 11/2/2023.

It is the Principal Researcher's responsibility to ensure that all researchers and stakeholders associated with this project are aware of the conditions of approval and which documents have been approved.

The Principal Researcher is required to notify the Ethics Committee, via amendment or progress report, of

- Any significant change to the project and the reason for that change;
- Any unforeseen events or unexpected developments that merit notification;
- The inability of the Principal Researcher to continue in that role or any other change in research personnel involved in the project.

Lisbon, 11/2/2023

NOVA IMS Ethics Committee
ethicscommittee@novaims.unl.pt