UNIVERSIDADE DE SÃO PAULO
FACULDADE DE ECONOMIA, ADMINISTRAÇÃO, CONTABILIDADE E ATUÁRIA
DEPARTAMENTO DE CONTABILIDADE E ATUÁRIA
PROGRAMA DE PÓS-GRADUAÇÃO EM CONTROLADORIA E CONTABILIDADE

MARCIO KAWAHARA IGUMA

# THE POST-ADOPTION OF RADIO-FREQUENCY IDENTIFICATION TECHNOLOGY IN OMNICHANNEL RETAIL, MANUFACTURING, AND SUPPLY CHAIN: ESSAYS ON THE ACCOUNTING INFORMATION IMPROVEMENT FOR CORPORATE REPORTS

# A PÓS-ADOÇÃO DA TECNOLOGIA DE IDENTIFICAÇÃO DE RADIOFREQUÊNCIA NO VAREJO OMNICANAL, INDÚSTRIA E CADEIA DE SUPRIMENTOS: ENSAIOS SOBRE A MELHORIA DA INFORMAÇÃO CONTÁBIL PARA RELATÓRIOS CORPORATIVOS

São Paulo

2024

Prof. Dr. Carlos Gilberto Carlotti Júnior
Reitor da Universidade de São Paulo

Profa. Dra. Maria Dolores Montoya Diaz
Diretora da Faculdade de Economia, Administração, Contabilidade e Atuária

Profa. Dra. Mara Jane Contrera Malacrida
Chefe do Departamento de Contabilidade e Atuária

Prof. Dr. Renê Coppe Pimentel
Coordenador do Programa de Pós-Graduação em Controladoria e Contabilidade

MARCIO KAWAHARA IGUMA

# THE POST-ADOPTION OF RADIO-FREQUENCY IDENTIFICATION TECHNOLOGY IN OMNICHANNEL RETAIL, MANUFACTURING, AND SUPPLY CHAIN: ESSAYS ON THE ACCOUNTING INFORMATION IMPROVEMENT FOR CORPORATE REPORTS

# A PÓS-ADOÇÃO DA TECNOLOGIA DE IDENTIFICAÇÃO DE RADIOFREQUÊNCIA NO VAREJO OMNICANAL, INDÚSTRIA E CADEIA DE SUPRIMENTOS: ENSAIOS SOBRE A MELHORIA DA INFORMAÇÃO CONTÁBIL PARA RELATÓRIOS CORPORATIVOS

Tese apresentada ao Programa de Pós-Graduação em Controladoria e Contabilidade do Departamento de Contabilidade e Atuária da Faculdade de Economia, Administração e Contabilidade e Atuária da Universidade de São Paulo, como requisito parcial para a obtenção do título de Doutor em Ciências.

Área de concentração: Controladoria e Contabilidade

Orientador: Prof. Dr. Joshua Onome Imoniana

Versão corrigida

(versão original disponível na Biblioteca da Faculdade de Economia, Administração, Contabilidade e Atuária)

São Paulo

2024

Catalogação na Publicação (CIP)
Ficha Catalográfica com dados inseridos pelo autor

Iguma, Marcio Kawahara.
The Post-Adoption of Radio-Frequency Identification Technology in Omnichannel Retail, Manufacturing, and Supply Chain: Essays on the Accounting Information improvement for corporate reports. / Marcio Kawahara Iguma. - São Paulo, 2024.
138 p.

Tese (Doutorado) - Universidade de São Paulo, 2024.
Orientador: Joshua Onome Imoniana.

1. RFID. 2. Omnichannel retailing. 3. Supply chain. 4. Accounting information quality. 5. Internet of Things. I. Universidade de São Paulo. Faculdade de Economia, Administração, Contabilidade e Atuária. II. Título.

O presente trabalho foi realizado com apoio da Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Código de Financiamento 001.

This work was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001.

**ACKNOWLEDGMENTS**

First and foremost, I would like to express my gratitude to the Supreme and faithful God, because of him, and through him, and to him are all things. To Him all honor, all glory, and all praise.

I would like to dedicate this doctoral dissertation to my beloved wife Adriana for her unconditional support, companionship, and understanding since I decided to face the challenge of the academic world. To our little princesses Anne Yuri and Nina Miho, gifts from God. To my parents Taeko and Takeo for their support, care, and example. To my in-laws Nair and Osvaldo (*in memoriam*), and to Michele for their support and encouragement.

This dissertation is the result of four years of hard work. I would not have gotten here without the support of the faculty, professors, family, friends, colleagues, and market professionals.

In particular, I would like to thank Professor Joshua Onome Imoniana, for accepting my invitation to supervise me, and for his company and support during my doctoral journey. I would also like to express my gratitude to the members of my dissertation committee: Professor Napoleão Galegale, Professor Edson Luiz Riccio, Professor Adilson Yoshikumi, and Professor Washington Lopes da Silva for their precious contributions to my research.

I am extremely grateful to the professors at FEA/USP for all their teachings. In particular, Professor Daniel Magalhães Mucci, Professor Edgard Bruno Cornacchione Junior, Professor Gilberto de Andrade Martins (*in memoriam*), Professor Andson Braga de Aguiar, and Professor Silvia Casa Nova, for their essential contributions to the development and improvement of my work.

I would also like to extend my sincere thanks to all my friends and colleagues at FEA/USP, especially Robson Queiroz Pereira, Flavio Riberi, Rafael Vieira, Luiz Guilherme Rodrigues Antunes, Carlos Elder Maciel de Aquino, and Mauro Soares Viana who contributed greatly to my research.

My deepest thanks also go to FEA/USP for the environment and resources made available to students and researchers. To Professor Renê Coppe Pimentel and the team at the Department of Accounting and Actuarial Sciences. I would also like to thank Ana Paula and Luigi Medori at the FEA/USP Postgraduate Service for their promptness and concern.

I would like to give special thanks to the academic and market professionals who generously devoted their precious time to contribute to my research: Professor Mário Duarte Machado, Professor Renata Rampim, Professor Miriam Nemoto, Sueli Pieri, Rafael Lemos, Cristina Lobo, Rafael Pinto, Felipe Mendonça, Francisco Roberto Pereira, Guilherme Salles, João Pedro Flecha de Lima, Laercio Wasques, Marcos Honda, Michel, Danilo Felix More, Carlos Eduardo Padula, Everton Antonio da Silva, Ray da Costa, Renato Steinkirch, Ricardo Verza, Diego Henrique Pereira, Denis Rodrigo de Oliveira, José Francisco, Francisco Roberto Pereira, and Roger Davanso. Due to the terms of the research confidentiality agreement, I could not mention the names of respondents from the three studies here.

To conclude these acknowledgments, I would like to thank the Coordination for the Improvement of Higher Education Personnel - Brazil (CAPES) for the financial support for my academic journey and the development of this doctoral dissertation.

“But the wisdom that is from above is first pure, then peaceable, gentle, and easy to be intreated, full of mercy and good fruits, without partiality, and without hypocrisy.”

(James 3:17)

**RESUMO**

Iguma, M. K. (2024). The Post-Adoption of Radio-Frequency Identification Technology in Omnichannel Retail, Manufacturing, and Supply Chain: Essays on the Accounting Information improvement for corporate reports. (Tese de Doutorado, Universidade de São Paulo, São Paulo).

A identificação por radiofrequência (RFID) é uma técnica de identificação e captura de dados automática que representa uma das principais tecnologias para a Internet das Coisas e a Indústria 4.0. Os sistemas de RFID fornecem grandes volumes de dados em tempo real para análises em aplicações de big data, inteligência artificial, computação em nuvem e blockchain. Apesar de sua relevância, faltam estudos empíricos sobre as influências das tecnologias digitais no varejo omnicanal, na indústria, na cadeia de suprimentos e na Contabilidade. Esta tese está organizada em três ensaios que contribuem conjuntamente para o propósito de examinar os fatores contextuais (antecedentes) e os benefícios (consequentes) do processo de assimilação de RFID nas organizações. O primeiro ensaio é estudo exploratório de casos múltiplos com três grandes empresas do varejo omnicanal do setor de moda listadas na B3, enquanto que o caso piloto é um fabricante de porcelanas. As descobertas revelaram que RFID permite contagens completas de inventário com agilidade, segurança e precisão, com maior frequência do que as contagens cíclicas tradicionais. A mudança mais relevante nas práticas contábeis refere-se ao reconhecimento e provisão de perdas que melhoraram a qualidade da informação contábil. O segundo ensaio é um estudo de caso único em profundidade com uma fabricante de vestuário na cadeia de fornecimento omnicanal de varejistas de moda. Este é um dos poucos fabricantes de vestuário que adotaram com sucesso RFID em nível de item para controlar suas operações internas na linha de montagem. Os resultados mostram que RFID aperfeiçoou o compartilhamento de informações em três níveis de integração na cadeia de suprimentos: interno, fornecedor e cliente. RFID contribuiu com as práticas contábeis relacionadas aos estoques de produtos em elaboração e acabados, à contabilidade de custos e ao reconhecimento de perdas, melhorando assim a mensuração dos itens em estoque, o custo dos produtos vendidos e os resultados nos relatórios financeiros. O terceiro ensaio é uma pesquisa quantitativa que utiliza um levantamento transversal para investigar a assimilação de RFID por empresas de diferentes setores no Brasil. A população-alvo deste estudo consiste em gestores e tomadores de decisão com experiência em aplicações RFID nas áreas de cadeia de suprimentos, logística e gestão de estoques. Os fatores contextuais influenciaram os três estágios da assimilação do RFID (iniciação, adoção e rotinização) de diferentes maneiras, enquanto as influências no compartilhamento de informações e na qualidade da informação contábil variaram ao longo desses estágios. Apresentamos evidências de que o modelo de três estágios fornece informações valiosas em comparação com um modelo dicotômico de adoção/não adoção. Por fim, esta tese contribui com a teoria apresentando um modelo teórico interdisciplinar que integra conceitos de sistemas de informação, cadeia de suprimentos e Contabilidade. Esta pesquisa identificou um fenômeno recente e ainda não pesquisado: a assimilação do RFID por varejistas, fabricantes e outros setores no Brasil. Assim, contribui também para a prática, oferecendo orientações e insights sobre o sucesso da adoção e uso da tecnologia RFID nas organizações.

**Palavras-chave:** RFID. Varejo Omnicanal. Cadeia de Suprimentos. Qualidade da Informação Contábil. Internet das Coisas.

**ABSTRACT**

Iguma, M. K. (2024). The Post-Adoption of Radio-Frequency Identification Technology in Omnichannel Retail, Manufacturing, and Supply Chain: Essays on the Accounting Information improvement for corporate reports. (PhD dissertation, University of São Paulo, São Paulo).

Radio-frequency identification (RFID) is an automatic identification and data capture technique that represents one of the core technologies for the Internet of Things and Industry 4.0. RFID systems provide amounts of real-time data for more accurate analysis in big data, artificial intelligence, cloud computing, and blockchain applications. Despite the relevance of RFID technology, there is a lack of empirical studies on the influences of digital technologies on omnichannel retailing, manufacturing, supply chain, and accounting. This doctoral dissertation is organized into three essays that jointly contribute to the general purpose of examining not only the contextual factors (antecedents) but also the benefits (consequences) of the RFID assimilation process in organizations. The first essay uses an exploratory multiple case study design based on qualitative research with three large omnichannel retailers of the fashion industry, that are listed companies in B3 (Brazil's stock exchange), while the pilot case is a porcelain manufacturer. The findings revealed that the RFID system allows full inventory counts with agility, safety, and accuracy, much more frequently than traditional cyclical counts. The most relevant change in accounting practices refers to the recognition and provision of losses that enhance the accounting information quality. The second essay is an in-depth single case study with a garment manufacturing company in the omnichannel supply chain of fashion retailers. The case is one of the few garment manufacturers in the country that successfully adopted item-level RFID in the assembly line to control its internal operations. The results show that RFID improved information sharing in three levels of integration in the supply chain: internal, supplier, and customer. RFID contributed to the accounting practices related to work-in-progress and finished goods inventories, cost accounting, and loss recognition, thus improving the measurement of items in stock, the cost of goods sold, and, consequently, the results in financial reports. The third essay is quantitative research using a cross-sectional survey to investigate RFID assimilation by companies from different industry sectors in Brazil. The target population of this study consists of managers and decision-makers with expertise in RFID applications in the supply chain, logistics, and inventory management areas. The contextual factors influenced the three stages of RFID assimilation (initiation, adoption, and routinization) in different ways, while the influences on information sharing and the quality of accounting information varied through these stages. We found evidence that the three-stage model provides valuable insights compared to a dichotomous adoption/non-adoption model. Finally, this study contributes to theory by proposing an interdisciplinary theoretical framework that integrates information systems, supply chain management, and accounting concepts. We hope our dissertation opens new paths in different research areas, especially in financial and management accounting fields. This research identified a recent and not yet researched phenomenon: the assimilation of RFID by retailers, manufacturers, and other sectors in Brazil. Thus, it also contributes to practice, offering guidance and insights into the successful adoption and use of RFID technology in organizations.

**Keywords:** RFID. Omnichannel retailing. Supply chain. Accounting information quality. Internet of Things.

## LISTA OF FIGURES

## LIST OF TABLES

## ACRONYMS

| | |
|---|---|
| AD | Adoption stage |
| AIDC | Automatic Identification and Data Capture |
| AIQ | Accounting Information Quality |
| AVE | Average Variance Extracted |
| B3 | Brazilian stock exchange and over-the-counter market |
| BCT | Blockchain Technology |
| BD | Big Data |
| BDA | Big Data Analytics |
| BI | Business Inteligence |
| BOPS | Buy online, pick up in-store |
| CMB | Common Method Bias |
| COGS | Cost of Goods Sold |
| CR | Consistency Reliability |
| CV | Convergent Validity |
| DC | Distribution Center |
| DMT | Digital Manufacturing Technologies |
| DOI | Diffusion of Innovation Theory |
| DV | Discriminant Validity |
| ECP | Competitive Pressure |
| EPC | Electronic Product Code |
| ERP | Enterprise Resource Planning |
| FASB | Financial Accounting Standards Board |
| FG | Finished Goods |
| HTMT | Heterotrait-Monotrait |
| IASB | International Accounting Standard Board |
| IFRS | International Financial Reporting Standards |
| IN | Initiation stage |
| IoT | Internet of Things |
| IS | Information Systems |
| ISH | Information Sharing |
| IT | Information Technology |
| OTS | Top management support |

| | |
|---|---|
| PLS-PM | Partial Least Squares - Path Modeling |
| PPC | Production Planning and Control |
| RFID | Radio Frequency Identification |
| RM | Raw Materials |
| RO | Routinization stage |
| ROI | Return on Investment |
| SC | Supply Chain |
| SCI | Supply Chain Integration |
| SCM | Supply Chain Management |
| SCV | Supply Chain Visibility |
| SEM | Structural Equation Modeling |
| SKU | Stock-keeping Unit |
| TOE | Technology–organization–environment framework |
| TPC | Perceived Costs |
| TRA | Relative advantage |
| VIF | Variance Inflation Factors |
| WIP | Work-in-progress |

## SUMMARY

# 1 INTRODUCTION

Radio-frequency identification (RFID) is a wireless communication method that uses radio waves to remotely access data stored in electronic tags, and automatically identify objects and living beings attached to them (Kgobe & Ozor, 2021). RFID enables physical tracking and monitoring of the progress of individual inventory items in production and throughout the supply chain (Liukkonen, 2015; Munoz-Ausecha, Ruiz-Rosero, & Ramirez-Gonzalez, 2021).

RFID, as an automatic identification and data capture (AIDC) technique (Katoch, 2022), has become one of the core technologies for the Internet of Things (IoT) (Ben-Daya, Hassini, & Bahroun, 2019; Munoz-Ausecha et al., 2021) and Industry 4.0 (I4) (Gladysz, Corti, & Montini, 2021). RFID systems provide amounts of more accurate real-time data for big data, artificial intelligence, machine learning (Hauser, Flath, & Thiesse, 2021), cloud computing, and blockchain applications. (Rejeb et al., 2020; Yang, Fu, & Zhang, 2021).

The literature reports RFID improvements over barcode and image recognition technologies. RFID offers a non-line-of-sight, contactless, high-volume, simultaneous reading of RFID tags (Munoz-Ausecha et al., 2021). This technology enables the detection of items hidden behind other items automatically without the need for manual data entry (Green et al., 2017).

On the contrary, a barcode system requires a direct line of sight for inventory counting. The barcode scanning is a serial process that requires physical proximity to the scanner and is more vulnerable to human error (Goyal et al., 2016). A system of image recognition is challenged by poor lighting conditions and partial hiding of products (Hauser et al., 2021).

The estimated size of the world RFID market is USD 15.8 billion in 2023 and it is expected to reach USD 40.9 billion by 2032, according to Markets and Markets (2023). The growth of the RFID market is related to the increasing demand for RFID technologies in manufacturing, logistics, supply chain, and omnichannel retail applications (Markets and Markets, 2023). This phenomenon is also explained by academic research reports (Caro & Sadr, 2019; Hauser et al., 2021; Munoz-Ausecha et al., 2021; Ovezmyradov & Kurata, 2022).

Our study identified the recent phenomenon of RFID adoption in Brazil. Over the last five years, large retail companies in the fashion industry have developed RFID applications aligned with their omnichannel strategies, such as C&A, Centauro/SBF Group, Pernambucanas, Riachuelo, and Lojas Renner.

This finding resulted from our extensive research in technical publications such as the RFID Journal, GS1 Brasil, and IoP Journal. We also extracted information from press releases and public financial and sustainability reports. In addition, we interviewed numerous RFID service providers and end-users from different sectors.

The Web of Science (WoS) and Scopus databases contain 10,520 and 16,625 articles on the RFID topic, respectively. Engineering and Computer Science are the most prominent research areas in both databases. The Business, Management, and Accounting category presents 1,624 papers in the Scopus database. Additionally, papers of systematic literature review and bibliometric analysis were identified: Manavalan and Jayakrishna (2019), Rejeb et al. (2020), Yang et al. (2021), Munoz-Ausecha et al. (2021); Kgobe and Ozor (2021), Valentinetti and Munoz (2021) and Raza (2022). The work of literature review revealed the growing interest of academic researchers in RFID and IoT, and also a series of research gaps.

In the information systems (IS) literature, studies generally consider the dichotomy between adoption and non-adoption of technology, including RFID, as a single stage (Mabad et al., 2021; Mahdaly & Adeinat, 2022). Many studies investigate the intention or decision to adopt RFID, rather than its actual utilization. However, the successful adoption of a technology does not always result in its dissemination at the enterprise level. For this reason, research must move towards RFID's post-adoption and its benefits to the company (Zhu, Kraemer, & Xu, 2006).

Therefore, this study followed the concepts of the three-stage process of technology assimilation presented by Zhu et al. (2006):

- First, the pre-adoption (initiation) stage consists of the initial assessment of the potential benefits of RFID technology;
- Secondly, the adoption phase refers to deciding to use RFID in the company's value chain; and
- Finally, large-scale deployment for widespread use of RFID refers to the post-adoption (routinization) stage.

The literature review indicates the need for empirical studies on the post-adoption of item-level RFID in omnichannel retailing (Ovezmyradov & Kurata, 2022), manufacturing

(Alonso-Garcia et al., 2021; Ailawadi, 2020), and supply chains (Rejeb et al., 2020). Moreover, it is necessary to examine not only the antecedents (contextual factors) but also the consequences (Yang et al., 2021) of the RFID assimilation process.

The three independent essays jointly contribute to the main purpose of this dissertation regarding the investigation of the contextual factors (technological, organizational, and environmental) that influence the assimilation process of RFID in organizations. In addition, it examines the extent to which this innovation improves the levels of information sharing in supply chains and the accounting information quality for corporate reporting (Agrawal et al., 2022).

The integration of new technologies into accounting and auditing generally occurs after their adoption and incorporation into business (Warren, Moffitt, & Byrnes, 2015). Accountants are end-users of business information who collaborate with information technology (IT) specialists in developing information systems, as they support internal and external areas of the company (Kroon, Alves, & Martins, 2021).

Accountants interact directly with ERP, business intelligence (BI), and data analytics tools. However, the task of investigating RFID and IoT systems is more complex. The aspects of the utilization of these technologies in operational environments are not easily perceived by end-users.

Accounting studies provide insights into the contributions of RFID and IoT to generating accurate and real-time accounting information for decision-making. These contributions mainly relate to specific-unit costing methods and inventory valuation (Davis, 2004; Stambaugh & Carpenter, 2009; Krahel et al., 2015; Vasarhelyi et al., 2015).

However, the literature indicates a lack of empirical studies on the impacts of digital technologies on the daily work of accountants, traditional accounting practices, and the qualitative characteristics of accounting information (Kroon et al., 2021; Valentinetti, & Muñoz, 2021). Therefore, the present study assumes that improving the quality of accounting information is also a consequence of the RFID assimilation process.

This work examines the item-level post-adoption of RFID technology in three relevant environments reported by researchers and practitioners: the fashion retail industry, manufacturing, and supply chains. The three independent essays that make up this doctoral dissertation jointly contribute to its main objective of investigating the contextual factors (technological, organizational, and environmental) that influence the process of assimilating RFID in organizations. In addition, the extent to which this innovation improves the levels of information sharing in supply chains and the quality of accounting information for corporate reporting is examined.

The first essay uses an exploratory multiple case study design based on qualitative research with three large omnichannel retailers in the fashion industry, which are listed companies in B3 (Brazilian stock exchange and over-the-counter market). These retailers were awarded in RFID publications, representing the most advanced cases of RFID adoption among competitors. The pilot case is a porcelain manufacturer in this study.

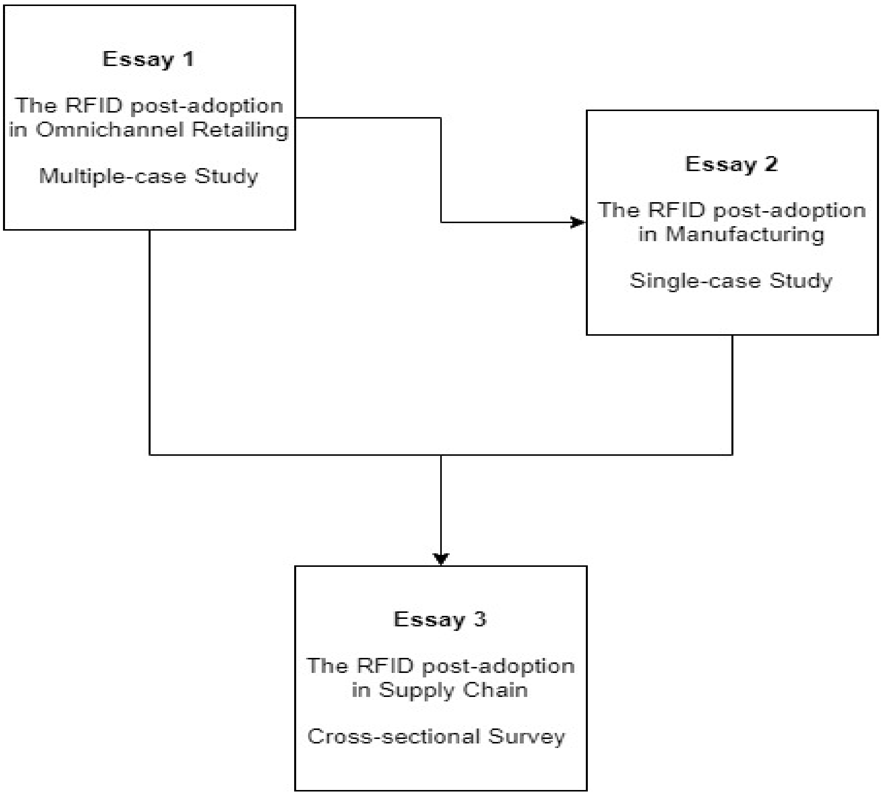
The second essay is an in-depth single case study with a garment manufacturing company in the omnichannel supply chain of fashion retailers. The case is one of the few garment manufacturers in the country that successfully adopted item-level RFID in the assembly line to control its internal operations.

The third essay is quantitative research using a cross-sectional survey to investigate the current scenario of RFID adoption by companies from different industry sectors in Brazil. The target population of this study consists of managers and decision-makers with expertise in RFID applications in supply chain management (SCM), logistics, and inventory management areas.

The first and second essays contribute to theory and practice by providing theoretical frameworks, propositions, and findings related to a phenomenon that has not been researched yet: the RFID assimilation by omnichannel retail and other sectors in Brazil. Their results also contribute to each other and the development of the third essay, as illustrated in Figure 1.1.

Finally, the third essay provides an interdisciplinary theoretical framework, integrating IS, SCM, and accounting concepts. To our knowledge, this is the first study to examine the different effects of antecedents and consequences related to each of the three stages of RFID assimilation.

Figure 1.1. The three essays




Source: the author

**References**

Agrawal, T. K., Kalaiarasan, R., Olhager, J., & Wiktorsson, M. (2022). Supply chain visibility: A Delphi study on managerial perspectives and priorities. *International Journal of Production Research*. https://doi.org/10.1080/00207543.2022.2098873.

Ailawadi, K. L. (2021). Commentary: Omnichannel from a Manufacturer's Perspective. *Journal of Marketing*, 85(1), 121-125. https://doi.org/10.1177/0022242920972639.

Alonso-Garcia, J., Pablo-Martí, F., & Nunez-Barriopedro, E. (2021). Omnichannel management in B2B. Complexity-based model, empirical evidence from a panel of experts based on fuzzy cognitive maps. *Industrial Marketing Management*, 95, 99-113. https://doi.org/10.1016/j.indmarman.2021.03.009.

Ben-Daya M., Hassini, E., & Bahroun, Z. (2017): Internet of things and supply chain management: a literature review. *International Journal of Production Research*. https://doi.org/10.1080/00207543.2017.1402140.

Caro, F., & Sadr, R. (2019). The Internet of Things (IoT) in retail: Bridging supply and demand. *Business Horizons, Elsevier*, 62(1), 47-54. https://doi.org/10.1016/j.bushor.2018.08.002.

Davis, H. E. (2004). Technology - Radio frequency identification: the wave of the future - Because RFID use still is in its infancy, CPAs have a unique opportunity to help their clients and employers understand how it will change inventory and supply chain management -- And its inevitable effect on accounting and auditing methodologies.

*Journal of accountancy: publication of the American Institute of Certified Public Accountants*, 198(5).

Gladysz, B., Corti, D., & Montini, E. (2023). Forecasting the Development of RFID Technology. *Management and Production Engineering Review*. https://doi.org/10.24425/MPER.2021.136870.

Goyal, S., Hardgrave, B.C., Aloysius, J.A., & DeHoratius, N. (2016). The effectiveness of RFID in the backroom and sales floor inventory management. *The International Journal of Logistics Management*, 27, 795-815. https://doi.org/10.1108/IJLM-03-2015-0051.

Green Jr., Pamela J. Zelbst, Victor E. Sower & Jeremy C. Bellah (2017) Impact of Radio Frequency Identification Technology on Environmental Sustainability. *Journal of Computer Information Systems*, 57:3, 269-277. https://doi.org/10.1080/08874417.2016.1184029.

Hauser, M., & Flath, C.M., & Thiesse, F. (2021). Catch me if you can: Data-driven prescriptive modeling for smart store environments. European Journal of Operational Research, Elsevier, 294(3), 860-873. https://doi.org/10.1016/j.ejor.2020.12.047.

Katoch, R. (2022). IoT research in supply chain management and logistics: A bibliometric analysis using vosviewer software. *Materials Today: Proceedings*, 56, 2505-2515. https://doi.org/10.1016/j.matpr.2021.08.272.

Kgobe, P., & Ozor, P. (2021). Integration of Radio Frequency Identification Technology in Supply Chain Management: A Critical Review. *Operations and Supply Chain Management: An International Journal*, 14(3), 289-300. http://doi.org/10.31387/oscm0460303.

Krahel, J. P., & Titera, W. (2015). Consequences of Big Data and Formalization on Accounting and Auditing Standards. *Accounting Horizons*, 29(2), 409–422. https://doi.org/10.2308/acch-51065.

Kroon, N., Alves, M. G., & Martins, I. (2021). The Impacts of Emerging Technologies on Accountants' Role and Skills: Connecting to Open Innovation—A Systematic Literature Review. *Journal of Open Innovation: Technology, Market, and Complexity*, 7(3):163. https://doi.org/10.3390/joitmc7030163.

Liukkonen, M. (2015). RFID technology in manufacturing and supply chain. International *Journal of Computer Integrated Manufacturing*, 28:8, 861-880. https://doi.org/10.1080/0951192X.2014.941406.

Mabad, T., Ali, O., Ally, M., Wamba, S. F., & Chan, K. C. (2021). Making Investment Decisions on RFID Technology: An Evaluation of Key Adoption Factors in Construction Firms. *IEEE Access*, 9, 36937–36954. https://doi.org/10.1109/access.2021.3063301.

Mahdaly, K., & Adeinat, I. (2022). Factors that affect the adoption of RFID in the Saudi logistics industry: an empirical investigation. *The International Journal of Logistics Management*, 33(3), 1017-1039. https://doi.org/10.1108/IJLM-11-2020-0456.

Manavalan, E., & Jayakrishna, K. (2019). A review of Internet of Things (IoT) embedded sustainable supply chain for industry 4.0 requirements. *Comput. Ind. Eng*., 127, 925-953. https://doi.org/10.1016/j.cie.2018.11.030.

Markets and Markets. (2023). RFID Market by Offering (Tags, Readers, and Software and Services) - Global Forecast to 2032. Retrieved from https://www.marketsandmarkets.com/Market-Reports/rfid-market-446.html.

Munoz-Ausecha, C., Ruiz-Rosero, J., & Ramirez-Gonzalez, G. (2021). RFID Applications and Security Review. Computation, 9, 69. https://doi.org/10.3390/computation9060069.

Ovezmyradov, B., & Kurata, H. (2022). Omnichannel fulfillment and item-level RFID tracking in fashion retailing. *Comput Ind Eng*, 168, 108108. https://doi.org/10.1016/j.cie.2022.108108.

Raza, S.A. (2022). A systematic literature review of RFID in supply chain management. *Journal of Enterprise Information Management*, 35(2), 617-649. https://doi.org/10.1108/JEIM-08-2020-0322.

Rejeb, A., Simske, S. J., Rejeb, K., Treiblmaier, H., & Zailani, S. (2020). Internet of Things research in supply chain management and logistics: A bibliometric analysis. *Internet Things*, 12, 100318. https://doi.org/10.1016/j.iot.2020.100318.

Stambaugh, C. & Carpenter, F. (2009). RFID: Wireless innovations in inventory monitoring and accounting. *Strategic Finance*, 91(6), 35-40.

Valentinetti, D., & Munoz, F. F. (2021). Internet of things: Emerging impacts on digital reporting. *Journal of Business Research*. Elsevier Inc., 131, 549–562. https://doi.org/10.1016/j.jbusres.2021.01.056.

Vasarhelyi, M., Kogan, A., & Tuttle, B. (2015). Big Data in Accounting: An Overview. *Accounting Horizons*, 29 (2), 381–396. https://doi.org/10.2308/acch-51071.

Warren, D. R., Moffitt, K. C., & Byrnes, P. E. (2015). How Big Data Will Change Accounting. *Accounting Horizons*, 29, 397-407. https://doi.org/10.2308/acch-51069.

Yang, M., Fu, M. & Zhang, Z. (2021). The adoption of digital technologies in supply chains: Drivers, process and impact. *Technological Forecasting and Social Change, Elsevier*, 169(C). https://doi.org/10.1016/j.techfore.2021.120795.

Zhu, K., Kraemer, K. L., & Xu, S. (2006). The process of innovation assimilation by firms in different countries: a technology diffusion perspective on e-business. *Management Science*, 52(10), 1557-1576. https://doi.org/10.1287/mnsc.1050.0487.

## 2 OMNICHANNEL RETAILING: AN EXPLORATORY STUDY OF THE POSTADOPTION OF RADIO-FREQUENCY IDENTIFICATION TECHNOLOGY CONTRIBUTING TO THE QUALITY OF FINANCIAL INFORMATION[1]

**Abstract**
This paper aims to examine the factors affecting the postadoption of RFID technology as part of omnichannel strategies in the retail industry. In addition, it evaluates how this innovation contributed to the improvement of the quality of corporate financial information. We employed an exploratory multiple-case study design based on qualitative research, by using semi-structured interviews, and public financial and sustainability reports as sources of evidence. The data collection and analysis were performed in 2022 for the pilot case of a manufacturer and the formal cases of three retailers. The results reveal that RFID postadoption is influenced by technological factors (relative advantage, observability, trialability, and perceived costs), organizational factors (top management support and firm size), and environmental factors (competitive pressure and external support). Surprisingly, loss recognition and loss provision are the most affected accounting practices, differently from what has been suggested by the accounting literature. We also found that item-level RFID enables increased frequencies of full inventory counts, providing inventory accuracy of records and real-time inventory visibility. This results in the improvement of accounting information quality in terms of relevance, faithful representation, timeliness, comparability, understandability, verifiability, and value-added. Our findings may contribute to both research and practice, as well as IS and accounting fields. We identified and investigated the phenomenon of the recent movement of RFID adoption by large retail companies listed in B3 during the COVID-19 pandemic in Brazil. Finally, we provide a theoretical model based on the TOE framework integrated to a construct of accounting information quality specifically developed for the RFID postadoption context.

**Keywords:** Omnichannel retailing. RFID. Technology adoption. Accounting information quality. Inventory management.

---

[1] A version of this paper was published in the International Journal of Finance & Banking Studies in 2023.
Title: Omnichannel Retailing: An exploratory study of the postadoption of Radio-Frequency Identification Technology contributing to the Quality of Financial Information.
Author: Iguma, Marcio Kawahara
Co-author: Imoniana, Joshua Onome
https://doi.org/10.20525/ijfbs.v12i1.2519

## 2.1 Introduction

The emergence of new digital channels has led retail companies worldwide to develop omnichannel strategies to integrate digital and physical channels into a single customer experience (Liu et al., 2022). The omnichannel strategy rests on craving an indulgence of avenues for customers to fetch products online from a desktop or mobile device or in a brick-and-mortar store, fostering convenience to address consumer needs in an integrated format. COVID-19 has accelerated the growth of omnichannel adoption as this crisis modified firms and consumer behaviors due to social distancing policies, the closing of physical stores, and limited access to goods and services (Trabucco & De Giovanni, 2021).

Retailers face challenges in the omnichannel environment to meet consumer demands for shorter lead times and higher product availability with lower costs (Park, Dayarian, Montreuil, 2021). These companies seek to reduce stockouts by maintaining accurate inventory data in the company's systems (Bixler & Honhon, 2021). Inventory discrepancies are mainly caused by system transaction errors, theft of products, inventory shrinkage, and inventory misplacement that cause financial and operational impacts on the entire supply chain (Dai & Tseng, 2012).

A growing number of retail companies worldwide are implementing item-level RFID in their supply chains, especially in apparel industries (Zhang, Li, & Fan, 2018; Li et al., 2018; Cilloni et al., 2019). Radio Frequency Identification (RFID) became one of the most important technologies utilized in the Internet of Things (IoT) applications (Škiljo et al., 2020) providing means to achieve inventory accuracy, real-time inventory visibility, channel integration, and supply and demand alignment for omnichannel environments (Caro & Sadr, 2019).

In addition, RFID adoption contributes to customer-oriented services such as 'buy online, pick up in store' (BOPS) (Caro & Sadr, 2019), smart shelves, and smart fitting rooms (Hauser, Flath, & Thiesse, 2021). Thus, the resulting RFID benefits for retailers may include improved inventory ratios, increased operational performance and flexibility, reduced operational risks and costs, and enhanced sales efficiency and profitability (Shin & Eksioglu, 2015; Rejeb et al., 2020).

Academics and industry professionals consider RFID as an evolution of traditional barcode technology (Cilloni et al., 2019) due to its capabilities to encode, identify, trace, and track unique objects across manufacturing, inventory, and retail environments. The RFID system makes it possible to read multiple tagged objects simultaneously at high speed, as its reading range does not require physical or visual contact between the tag and the RFID reader (Goyal et al., 2016; Khayyam et al., 2022).

The industry growth of the global RFID market is expected to reach USD 17.4 billion by 2026 (Markets and Markets, 2021). In Brazil, the largest competing companies in the retail industry have been investing in omnichannel strategies. Retailers such as Lojas Renner, C&A, Centauro (Grupo SBF S.A.), Pernambucanas, Riachuelo, and Hering have recently disclosed information about their RFID projects as part of omnichannel initiatives in their annual financial and sustainability reports.

In the IS literature, most studies focus on the intention and decision to adopt RFID, as well as the technological, organizational, and environmental factors affecting the early stages of RFID adoption in organizations (Bhattacharya & Wamba, 2015; Fosso Wamba et al., 2016; Reyes, Li, & Visich, 2016; Tu, 2018; Mabad et al., 2021; Mahdaly & Adeinat, 2022). Nevertheless, a successful adoption does not ensure the achievement of technology diffusion at the enterprise level. For this reason, research must advance toward the next stages of the widespread use of technological innovation in the company (Zhu, Kraemer, & Xu, 2006).

This research gap indicates the need to examine the RFID postadoption in organizational settings in which the technology use is spread throughout the value chain activities. In addition, we also identified the absence of omnichannel issues in most of the RFID studies on the retail industry. Thus, we formulate the first research question of this study:

**RQ1.** How do technological, environmental, and organizational factors impact the postadoption of RFID technology aligned to omnichannel strategies in retail companies?

Moreover, few studies examine the effects of RFID adoption on perceived benefits. For instance, Reyes et al. (2016) findings present positive impacts of RFID implementation on customer service, productivity, asset management, and communication of timely and accurate information to relevant parties. RFID and IoT applications improve enterprise accounting information by combining business data and financial data (Dai & Ge, 2015), and facilitate high-precision financial statements (Arif et al., 2020).

The accounting research field presents new solutions to produce and share accounting information through the RFID adoption, and to provide benefits to corporate digital reporting and disclosure. Studies provide insights regarding the improvement of accounting practices regarding specific-unit costing, real-time inventory costing data, last in first out (LIFO), and other stock valuation methods (Vasarhelyi et al., 2015), dynamic pricing (Caro & Sadr, 2019; Cornacchione et al, 2023), depreciation and amortization methods, fair value accounting, obsolescence trend models and auditing (Krahel & Titera, 2015).

Nevertheless, the existing literature needs more empirical evidence on the practical use of RFID solutions and their implications on accounting (Valentinetti & Munoz, 2021). Considering this second research gap, the present study attempts to address the following research question:

**RQ2.** How do accounting practices change due to RFID postadoption?

Finally, we present the third research question regarding the accounting information quality and its qualitative attributes based on Valentinetti and Munoz (2021) and Wu et al. (2019):

**RQ3.** How does the RFID postadoption significantly enhance the qualitative characteristics of financial information (relevance, faithful representation, understandability, timeliness, comparability, and verifiability)?

This paper contributes to both IS and accounting research fields by proposing an integrated theoretical model that addresses the postadoption of RFID technology and its effects on accounting practices and accounting information quality, thereby extending the TOE framework (Tornatzky & Fleischer, 1990).

Our research identified and examined the recent movement of RFID adoption by large retail companies in Brazil as part of their omnichannel strategies. Considering that this phenomenon has not been investigated, we believe that our findings open up opportunities for further studies and provide insights to industry professionals and organizations regarding the aspects of RFID's actual use and the improvement of the quality of financial reports for decision-making.

This paper is divided into five sections. Following this introductory section, the second section presents a resulting model of the literature review on technology adoption, RFID, and accounting information quality research. The third section describes the research methodology including the pilot and the three formal cases study. Next, the results are discussed by addressing the research questions and developing propositions. Finally, the conclusion section presents implications, contributions, limitations, and suggestions for future research.

## 2.2 Literature Review

### The technology–organization–environment (TOE) framework

The adoption of technological innovations by people and companies is one of the most studied topics in IS research, which resulted in different theoretical models. The unified theory of acceptance and use of Technology (UTAUT) is one example of a widely used framework that focuses on individual behavior in adopting innovations such as big data analytics (Iguma, & Riccio, 2020), influenced by factors of performance expectancy, effort expectancy, social influence, and facilitating conditions (Venkatesh et al., 2003).

Our study focuses on technology adoption at the organizational level. The technology–organization–environment (TOE) framework provides a theory that examines three dimensions of a company's context that influence the decision to adopt a novel technology (Tornatzky & Fleischer, 1990). TOE is considered the most accepted framework by qualitative (Ramanathan et al., 2017), mixed method (Tu, 2018), and quantitative research studies on the adoption of innovative technologies in organizational settings (Lai, Sun, & Ren, 2018). These innovations include m-commerce (Justino, Robertson, & Michael, 2022), blockchain (Kouhizadeh, Saberi, & Sarkis, 2020), big data (Maroufkhani, Iranmanesh, & Ghobakhloo, 2020), and business analytics (Nam, Lee, & Lee, 2019) in different industries including manufacturing, retail, IT, and healthcare (Maroufkhani et al., 2020).

In addition, the accounting literature examines the adoption of generalized audit software (Widuri et al., 2016), audit analytics (Li et al., 2018), and advanced data analytics (Krieger et al, 2021).

The use of the TOE framework has been observed in the RFID adoption in the logistics industry (Mahdaly & Adeinat, 2022), construction firms (Mabad et al., 2021), supply chain management (Tu, 2018), small and mid-sized enterprises (Fosso Wamba et al, 2016), retail industry (Bhattacharya & Wamba, 2015; Tsai, Lee, & Wu, 2010), and manufacturing industry (Wang, Wang, & Yang, 2010).

Although much of the extant literature focuses on the decision-making process to implement new technology, there is an increasing research interest in the long-term and continued evolution of the use of technologies by companies.

Zhu et al. (2006) developed a model that integrates TOE framework dimensions as antecedents of the three-stage assimilation of e-business innovations by firms: initiation is the stage of evaluating the potential benefits of e-business to improve organizational performance (preadoption); adoption is the decision-making stage on the e-business adoption (formal adoption); and routinization refers to the full-scale deployment in which e-business becomes an integral part of the value chain activities (postadoption) (Zhu et al., 2006).

Junior et al. (2019) reported multiple impacts of ERP adoption on farms considering three levels of adoption: evaluation, adoption, and routinization. Nam et al. (2019) use the concept of assimilation rather than routinization as the third stage of IT adoption, which means achieving a more efficient performance of business activities than competitors. Hence, the TOE three-stage model is considered suitable for our scope of study on the actual use of RFID solutions.

Our literature review also revealed that very few studies assess the impacts on the benefits received from RFID adoption by organizations. For instance, Reyes et al. (2016) proposed that customer service, productivity, asset management, and communication are the subconstructs of perceived benefits from RFID. The results show that these benefits increase as a company progress through the three stages of RFID adoption.

The present study focuses on the communication dimension according to Reyes et al. (2016), in terms of the perceived improvement of timely and accurate information produced and disseminated to internal and external users of the company, especially, the accounting information quality (AIQ).

In the financial accounting literature, the study on AIQ encompasses different earning quality proxies: earnings persistence; value relevance; timeliness; earnings smoothness; quality of accruals; loss avoidance; conservatism; and timely loss recognition (TLR) (Dechow et al., 2010; Paananen & Lin, 2007; Okezie et al., 2020).

On the other hand, IS research examines the AIQ produced by accounting information systems (AIS). The AIS enables the potential application of management and financial accounting practices and may be characterized by attributes of the accounting information produced (Daoud, 2013).

Thus, the three-stage TOE model is considered suitable for the scope of this study. We propose a conceptual framework for the actual use of RFID in Omnichannel retailing, integrating it with an AIQ construct developed from the accounting literature specifically for the RFID technology adoption context.

**TOE Technological factors**

The technological factors refer to the characteristics and usefulness of an innovation (Tornatzky & Fleischer, 1990). An increasing number of studies have incorporated the diffusion of innovation (DOI) theory (Rogers, 2003) to assess the technological factors of the TOE framework (Mahdaly & Adeinat, 2022; Mabad et al., 2021). Similarly, the present study considers five characteristics of DOI theory: relative advantage, compatibility, complexity, trialability, and observability.

Relative advantage refers to the extent to which "an innovation is perceived as being better than the idea it supersedes" (Rogers, 2003). RFID offers many advantages over barcode technology in inventory scanning by multiple parallel readings of RFID tags attached to products (Khayyam et al., 2022). Tao et al. (2017) reveal that RFID improves operation performance by mitigating inventory misplacement and shrinkage.

Complexity is the degree to which "an innovation is perceived as relatively difficult to understand and use" (Rogers, 2003). A high level of complexity can influence negatively the adoption of a new technology. RFID implementation is challenging due to a series of issues regarding the diversity of RFID tags and devices, data management, hardware and software integration, and technical expertise (Bhattacharya & Wamba, 2015).

Compatibility is the degree to which "an innovation is perceived as being consistent with the needs of the existing practices of the potential adopters" (Rogers, 2003). RFID is often combined with process innovations and other applications. Thus, companies prevent adopting RFID if they perceive that the innovation cannot be integrated with their existing systems and practices (Mahdaly & Adeinat, 2022).

Trialability can be defined as the extent to which "an innovation may be experimented with on a limited basis" (Rogers, 2003). Trialability can lead to a decrease in the level of uncertainty, offers opportunities for reinvention during the innovation trial, and may accelerate its adoption due to early exposure among businesses (Maroufkhani et al., 2020). Companies conduct RFID pilot projects to experiment with the innovation in a reduced setting, assess its results and decide whether or not to implement it on a full scale (Sarac et al., 2010).

Observability is "the degree to which the results of an innovation are visible to others" (Rogers, 2003; Maroufkhani et al., 2020). The Chiu et al. (2017) study on the adoption of broadband mobile applications reports the visibility of the diversity and growth of technology use and its results in companies.

Perceived costs of innovations include expenses such as hardware, software, system integration, and staff training, and therefore may inhibit their adoption despite the perceived benefits (Tu, 2018). Initiating and financing the innovation costs demand massive financial capital (Lai et al., 2018). Previous literature reveals that the cost of investment and the uncertainty of return on investment are one of the main barriers to RFID adoption (Shin & Eksioglu, 2015).

**TOE Organizational factors**

The organization context refers to the internal aspects such as resources, assets, products, and services (Chiu et al., 2017). Top managers generally make the RFID adoption decision. In addition, they provide direction and promote commitment to creating a suitable environment for innovation (Bhattacharya & Wamba, 2015).

Firm size includes the organizational structure and its slack resources. Larger firms are usually more capable of mobilizing the necessary capital and absorbing risks and costs when making experiments with new technologies (Fosso Wamba et al., 2016). According to Thiesse et al. (2011), large retailers and manufacturers were responsible for the first well-publicized trials of RFID adoption.

**TOE Environmental factors**

The environmental context refers to external issues of the organization regarding suppliers, clients, competitors, and other participants (Chiu et al., 2017).

Competitive pressure refers to the influence of the industry and competitors creating a strong incentive for a company to adopt technological innovations to remain relevant in the market. There are cases where technology deployment is due to corporate mandates or government regulations (Mahdaly & Adeinat, 2022; Tu et al., 2018).

External Support refers to computing and training support provided by RFID manufacturers of tags and devices, service providers, and consultants. This characteristic may influence positively RFID adoption depending on the level of their internal IT expertise and resources (Mabad et al., 2021; Bhattacharya & Wamba, 2015).

**Accounting Information Quality (AIQ)**

AIQ is financial information that is useful for decision-making, understandable, and adequate to the users' specific needs (Hendriksen & Van Breda, 1999). The Conceptual Framework for Financial Reporting proposed by the Financial Accounting Standards Board (FASB) and the International Accounting Standard Board (IASB) presents a descriptive hierarchy with two primary characteristics of financial information (relevance and faithful representation) and their support characteristics (understandability, timeliness, comparability, and verifiability). Our study uses these qualitative characteristics based on IASB (2018):

- Relevance: the ability to significantly influence the achievement of the objectives of accounting information (accountability and decision-making). This significant influence occurs when information has confirmatory value, predictive value, or both.
- Faithful Representation: consists of representing the information in the most possible way of completeness, neutrality, and material error-free.
- Understandability: clear and concise information must be presented in a way that responds to the needs and knowledge base of users and the nature of the information presented.
- Timeliness: information is timely if it is made available to users before it loses its usefulness for decision-making and accountability.
- Comparability: the comparison of similar information between entities or different periods of the same entity, allows identifying similarities and differences between two phenomena.
- Verifiability: implies that different experienced and independent observers can reach a consensus on the information by representing it faithfully.

Kanakriyah (2016) demonstrates the influence of AIS on the improvement of AIQ in terms of relevance, reliability, comparability, understandability, consistency, and neutrality. Ou et al. (2017) assessed the influence of implementing ERP systems on the reliability and relevance of accounting information in Chinese manufacturing companies.

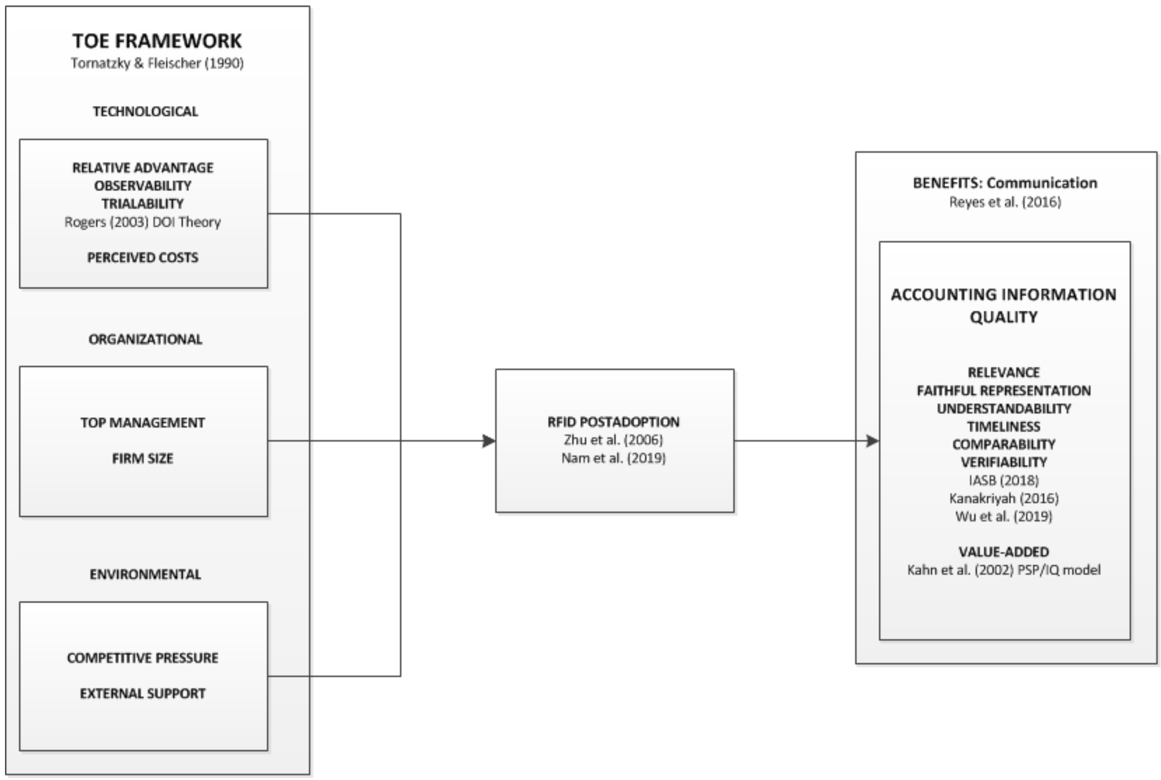
Drum, Pernsteiner, and Revak (2017) investigated the workarounds in an ERP environment and their impacts on AIQ characteristics. Their results show the achievement of completeness, neutrality, and accuracy in the financial information, rather than relevance and faithful representation.

Wu, Xiong, and Li (2019) developed an AIS based on a blockchain (BC) and RFID transaction model, capable of producing personalized financial reports, therefore improving relevance, neutrality, timeliness, and the cost-benefit balance of accounting information.

Additionally, value-added refers to the benefits and advantages provided by the information for those who use it. This is one of the 16 dimensions of the performance model for information quality (PSP/IQ) proposed by Kahn et al. (2002), who combined product and service aspects of information quality.

In the end, the model resulting from the review of theoretical and empirical studies is illustrated in Figure 2.1.

Figure 2.1. Conceptual Model




Source: the author

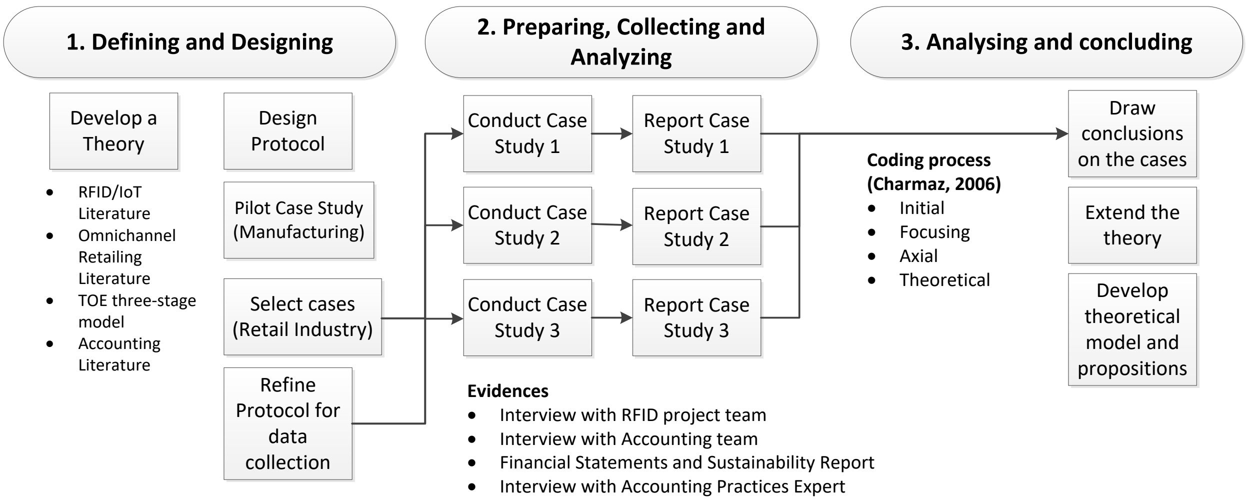
## 2.3 Methodology

Qualitative research is exploratory and useful when the topic is new, when existing theories do not apply to it, or because the population under study has never been addressed before (Creswell, 2013).

In qualitative research, the case study is one of the most used research strategies (Rashid et al., 2019). Multiple-case design is preferred to understand a real-world phenomenon in the context in which it occurs (Yin, 2014). Cases are grouped and rigorously conducted to elaborate conclusions. Researchers undertake in-depth exploration of a program, an event, or a process, and collect detailed information through various data sources on the same topic to be the basis for replicating or confirming the results (Creswell, 2013).

Thus, our study adopts the exploratory multiple-case study design and the replication approach proposed by Yin (2014). The design process begins with theory development, followed by case selection and case study protocol refinement based on the insights obtained from the pilot case study. Each particular case is treated as a complete study, looking for converging evidence concerning the facts and conclusions, which in turn require replication by other individual cases (Yin, 2014), as illustrated in Figure 2.2.

Figure 2.2. Multiple-case study design




Source: Yin (2014) adapted by the author.

The quality of our exploratory design of multiple case studies was assessed through tests of reliability, construct validity, and external validity (Yin, 2014; Treiblmaier, 2019; Rashid et al., 2019).

To maximize reliability, we formulated a case study protocol to provide standardized step-by-step guidance for investigators to follow in all cases (Nuijten et al., 2019). The protocol comprises the overview of the study, the data collection procedures, the interview guide, and the case study reporting guide. In addition, we also created a database (Yin, 2014) to organize all data collected for the case study, including recorded interviews, transcripts, notes, email messages, contacts, and public reports of the companies.

The semi-structured interview guide was elaborated based on the theoretical platform, including the questionnaires developed by previous studies on RFID adoption. This guide is divided into three groups of open-ended questions. The first group focused on the enterprise, the interviewee's functional area, and the chronological events of the RFID project. The second addresses the contextual aspects of RFID adoption. Finally, the third group addresses the changes in accounting practices, AIS and AIQ due to the RFID adoption.

A pilot case study is a preliminary case developed to improve the case study protocol, the interview guide, and the data collection plan that the researcher will follow in the formal case studies (Yin, 2014). The case selected for the pilot study is a large manufacturer (P1) which is considered one of the most successful cases of RFID adoption in the country (Table 2.1). Indeed, the pilot provided important insights that contributed to guiding the final research project through the recent set of empirical observations along with the theories provided by the literature.

The triangulation of multiple data sources can contribute to enhancing the construct validity (Yin, 2014). This can be achieved by providing multiple assessments of the same phenomenon and converging data to determine the consistency of a finding. Furthermore, the collected data can be validated by following the same protocol procedures to interview people from different areas and companies (Khayyam et al., 2022).

We collected data using semi-structured interviews as the main source of evidence. The areas responsible for conducting RFID projects in retail companies are generally supply chain management teams, logistics teams, or loss prevention teams. Controllership and accounting teams not only provide information on accounting and auditing issues, but they also have their point of view on RFID adoption in inventory management.

To increase the reliability of the study, we invited an accounting consultant as an additional source of evidence, who was not related to the three companies of this study. He provided insights about accounting practices and helped classify the qualitative characteristics of accounting information regarding RFID adoption. Furthermore, public documentation such as financial reports and sustainability reports served as an important source of evidence for triangulation.

External validity can be ensured through the generalization of a particular set of results to a broader theory. The analytical generalization method consists of using a previously developed theory to compare with the empirical results of the cases. Case studies are generalizable to theoretical propositions, not to populations (Yin, 2014).

According to the literal replication logic, two or more cases are selected based on the prediction that the cases will produce similar outcomes (Khayyam et al., 2022). Thus, we employed a theoretical sampling rather than a random sampling (Ramanathan et al, 2017), and selected cases that are likely to "replicate previous cases or extend the emergent theory" (Eisenhardt, 1989).

To determine the target population of this study, we researched RFID technical publications such as (RFID Journal, 2023; GS1 Brasil, 2023; IoP Journal, 2023), and also interviewed consultants (RF Consulting, 2023) and RFID technology service providers (Acura, 2023; Beontag, 2023). The results revealed the curious fact that most of the companies that adopted RFID solutions in the last five years in Brazil are retailers, more specifically, seven large apparel retail companies using omnichannel strategies.

Finally, three retail companies were selected for the formal case study (Table 2.1). All these retailers were awarded by RFID technical publications, representing the most advanced cases of RFID adoption among retail competitors. In addition, they are listed companies on the B3 (Brazil stock exchange and over-the-counter market), and their financial reporting is elaborated according to the International Financial Reporting Standards (IFRS). The respondents were chosen according to purposeful sampling guidelines (Khayyam et al., 2022).

For each case in the study (P1, C1, C2, and C3), we contacted and interviewed professionals from the team responsible for the RFID implementation and the accounting team. Ethical considerations were followed to ensure that respondents were fully aware of their participation roles in the study. As requested by all the participants in the consent forms, companies' and people's names were protected and not mentioned in our paper. Due to the small population of large retailers in Brazil, we do not provide detailed descriptions of companies in Table 2.1, as their identities would be easily recognizable (Rashid et al., 2019).

Due to the Covid-19 pandemic, interviews were conducted through online conference platforms in 2022. The recorded interviews were transcribed and imported into the Atlas.ti software for qualitative data analysis (Atlas.ti, 2023).

Table 2.1. Pilot and formal cases, participants, and interviews

| Id | Company | Industry | Team | Job Position | Visits | Duration |
|---|---|---|---|---|---|---|
| **P1** | **Pilot Case:** Large ceramic and porcelain manufacturer in the Americas. Supplier of dining appliances (plates, cups) | Manufacturing | | | | |
| | | | RFID Project | Logistics Manager | 2 | 2 h |
| | | | Accounting practices | (1) Logistics Manager, and (2) Executive of Administration and Finance | 1 | 1 h 25 min |
| **C1** | **Case 1:** Large retail network of sporting goods in Latin America. | Retail | | | | |
| | | | RFID Project | Senior Corporate and Business Development Manager | 1 | 1 h |
| | | | Accounting practices | (1) Controllership Director, and (2) Loss Prevention and Asset Security Planning Manager | 2 | 2 h 30 min |
| **C2** | **Case 2:** Multinational chain of fast-fashion retail clothing stores | Retail | | | | |
| | | | RFID Project | Senior Business Planning Executive | 2 | 2 h |
| | | | Accounting practices | Accounting and Report Manager | 1 | 30 min |
| **C3** | **Case 3:** Large omni retailer in fashion and lifestyle in Brazil | Retail | | | | |
| | | | RFID Project | (1) Risk Director, (2) Project Consultant, and (3) Loss Prevention Manager | 1 | 1 h |
| | | | Accounting practices | Senior Accounting Manager | 1 | 1 h |
| **APC1** | Accounting consultant | Retail | Accounting practices | Accounting Practices Coordinator in Retail Industry | 1 | 2 h 20 min |
| | | | | Total | | 13 h 45 min |

Source: the author

Data collection and data analysis were conducted concurrently as an iterative process, in line with the assumption of the grounded theory method that theory emerges from data. The qualitative coding process allows building the bridge between data collection and theory development to explain these data. This process consists of separating, classifying, and synthesizing data by comparing data segments for data analysis (Charmaz, 2014; Hajdas et al., 2020; Riihimaki & Pekkola, 2021). We followed the four stages of the coding process proposed by Charmaz (2014): initial, focused, axial, and theoretical coding.

In the initial coding, 350 nodes were identified and associated with the respondents' quotes. Then, some nodes were eliminated, therefore preserving the most significant ones. At the end of the focused coding stage, the remaining 285 nodes were grouped in the axial coding stage, resulting in 66 subcategories and 17 categories. Finally, the theoretical coding stage establishes the relationships between categories, and these results will be revealed and discussed in the next section. The resulting model of this analysis was generated with the use of Atlas.ti software (Figure 2.3).

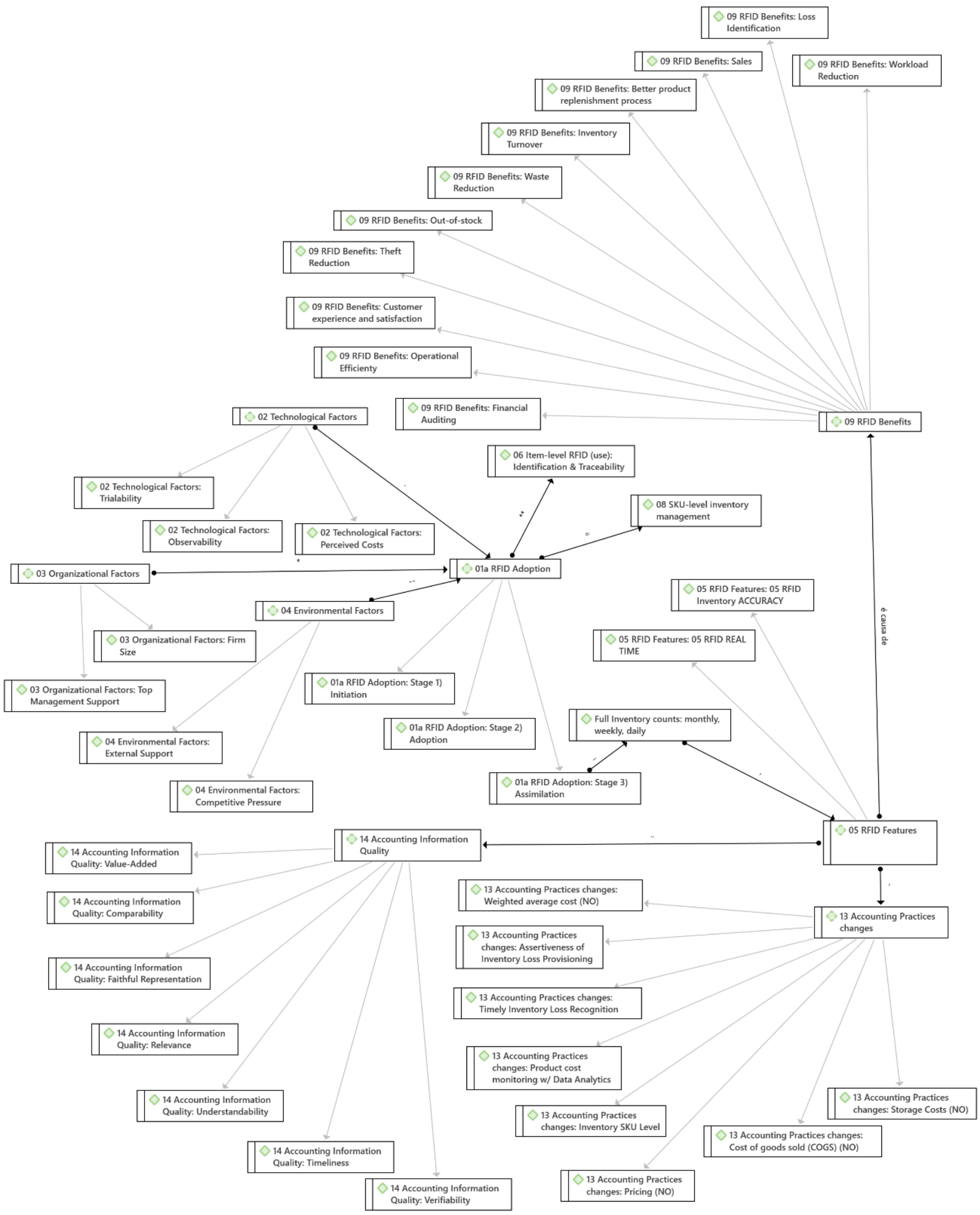
Table 2.2 presents the 17 categories and their related number of nodes by source of evidence of each case: interviews (C1, C2, and C3); financial statements (C1 Fin, C2 Fin, and C3 Fin); sustainability reports (C1 Sust, C2 Sust, and C3 Sust); and interview with accounting consultant (APC1).

Table 2.2. Categories and sources of evidence

| **Categories** | **Sources** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **C1** (99) | **C1 Fin** (3) | **C1 Sust** (4) | **C2** (81) | **C2 Fin** (4) | **C2 Sust** (7) | **C3** (64) | **C3 Fin** (5) | **C3 Sust** (4) | **APC1** (11) |
| Omnichannel (11) | 2 | 1 | 1 | 4 | 0 | 1 | 1 | 1 | 0 | 0 |
| RFID Project Responsible (3) | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| RFID Adoption (23) | 8 | 0 | 0 | 7 | 0 | 0 | 3 | 1 | 0 | 0 |
| Technological Factors (31) | 10 | 1 | 0 | 13 | 1 | 0 | 6 | 0 | 0 | 0 |
| Organizational Factors (12) | 3 | 1 | 0 | 3 | 1 | 0 | 4 | 0 | 0 | 0 |
| Environmental Factors (14) | 5 | 0 | 0 | 5 | 0 | 1 | 3 | 0 | 0 | 0 |
| RFID Features (13) | 5 | 0 | 0 | 4 | 0 | 1 | 2 | 0 | 1 | 0 |
| Item-level RFID (use) (9) | 5 | 0 | 0 | 2 | 0 | 1 | 1 | 0 | 0 | 0 |
| RFID in Retail (10) | 5 | 0 | 0 | 2 | 0 | 0 | 2 | 1 | 0 | 0 |
| SKU-level inventory management (5) | 2 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 |
| RFID Benefits (29) | 11 | 0 | 0 | 6 | 2 | 0 | 9 | 0 | 1 | 0 |
| RFID Benefits: Loss Reduction (6) | 2 | 0 | 1 | 1 | 0 | 0 | 2 | 0 | 0 | 0 |
| RFID Benefited areas (20) | 8 | 0 | 0 | 6 | 0 | 0 | 5 | 1 | 0 | 0 |
| RFID w/ other technologies (20) | 4 | 0 | 0 | 8 | 0 | 2 | 3 | 1 | 2 | 0 |
| Accounting Practices changes (41) | 12 | 0 | 1 | 13 | 0 | 0 | 10 | 1 | 0 | 4 |
| Accounting Information Quality (32) | 11 | 0 | 0 | 3 | 0 | 0 | 10 | 1 | 0 | 7 |
| Full Inventory counts: monthly, weekly, daily (10) | 5 | 0 | 1 | 2 | 0 | 0 | 1 | 1 | 0 | 0 |

Source: the author

Figure 2.3. The Map of relationships




Source: the author

## 2.4 Results and Discussion

In this section, the results are aligned with the theoretical concepts and constructs from the literature review, and discussed along with the development of the resulting propositions and the theoretical model, to address each of the research questions.

***How technological, environmental, and organizational factors impact the postadoption of RFID technology aligned to omnichannel strategies in retail companies***

### Relative advantage

Inventory accuracy and real-time inventory visibility are the RFID main benefits, while operational efficiency is considered a secondary advantage by retailers C1, C2, and C3. They revealed that RFID enables companies to perform an increased frequency of inventory counts, therefore ensuring the accuracy of inventory levels by identifying losses and failures to make timely and appropriate adjustments to inventory.

For example, C1 used to perform inventory cycle counts three times a year. On the other hand, full inventory counts with RFID are performed every week in all physical stores of the retail company. P1 used to scan each one of the products tagged with barcodes. The annual inventory count required shutting down the factory consequently causing a loss of revenue. Nevertheless, the use of RFID enabled the company to read RFID tags without opening the pallets. This improvement in agility and safety made it possible to perform inventory cycle counts throughout the year.

The greater inventory accuracy allows retailers to mitigate the risk of stockouts and to use product stocks of physical stores for omnichannel sales. Thus, customers receive their products more quickly. On the other hand, traditional physical counts are usually challenging and expensive to perform, and therefore infrequent so they are not sufficient to reduce inventory inaccuracy throughout the year (Goyal et al., 2016).

In line with previous studies on RFID adoption intention (Tu, 2018; Mabad et al., 2021; Mahdaly & Adeinat, 2022), the relative advantage is confirmed as the main factor of the actual use of RFID technology.

### Observability

The RFID adoption provided significant improvements in information quality available to diverse internal areas of the companies for decision-making. For example, C1 reported that their loss prevention team can analyze product movements in physical stores much faster, and thus elaborate action plans to mitigate losses for the next week. Supply chain management, financial, accounting, business planning, purchasing, replenishment, and sales areas also benefited from RFID according to respondents.

Although observability was not confirmed by previous studies as a relevant technological factor of RFID adoption intention, our study provides evidence of the increasingly widespread use of the technology across the company, thus reducing uncertainty and motivating both internal areas and competitors to adopt RFID (Maroufkhani et al., 2020).

**Compatibility**

All respondents reported no major occurrences of incompatibility problems with existing processes and technologies in the companies. P1 stated that "the adoption of worldwide standards facilitates deployments". The company already used the GS1 standard for bar codes and then adopted the GS1 EPC standard for RFID implementation. Likewise, the three C1, C2, and C3 have adopted the same standard for RFID smart tags. Thus, none of the respondents reported serious compatibility issues that could threaten the use of the RFID technology. Besides, we found no consensus on the results of previous studies regarding this technological factor.

**Complexity**

All respondents agree that RFID implementation is a complex process that requires great execution capacity and that it must be technically and financially feasible. They revealed that an integrated solution with other systems such as ERP (enterprise resource planning) and WMS (warehousing management system) is crucial to achieving greater benefits and performance from RFID technology.

C1 highlighted the importance of the RFID project design, while C2 and C3 consider the change management process as a critical success factor to overcome technology complexity problems. For example, C1 redesigned all operational processes of stores to meet the RFID project requirements, changing significantly how stores operate and impacting indirectly all company areas and processes.

Similar to previous studies (Mabad et al., 2021; Mahdaly & Adeinat, 2022), we found no confirmation that complexity is a relevant factor for the adoption and use of RFID. This finding may be related to the fact that large companies have the necessary resources and expertise to employ in their projects.

**Trialability**

P1 ran two RFID pilot projects. The first pilot focused on item-level RFID while the second tested a pallet-level RFID system. Due to cost issues, they decided to deploy the second solution. RFID tags are attached to boxes containing sets of 12 or 24 plates, rather than tagging each plate, for example. C1 ran their pilot project in 2018. With the approval of the results by the Board, the implementation of the technology in physical stores and distribution centers was completed in 2019. C2 and C3 reported similar experiences.

Although trialability has not been considered by previous studies on RFID adoption intention, there is evidence of its influence on the actual use of the technology. Pilot projects offer companies the opportunity to test the technology and define specific solutions for their business, or even decide not to implement it (Maroufkhani et al., 2020).

**Perceived Costs**

Respondents reported that tag price and tagging costs have decreased, while the availability of cheaper reading devices has increased over the last few years. According to C1, part of their suppliers delivers their products with RFID tags. In the case of C2, as suppliers produce on demand for the company, they sew the RFID tags on the final products, while additional costs are covered by the retailer. Nevertheless, they warned about the costs involved in the processes of implementing the RFID system infrastructure and maintaining operations, which demand very careful planning by management.

Tu (2017) confirmed that perceived costs have a significant impact on RFID adoption intention, while other studies did not. In this study, the perceived costs are relevant to determine the strategies for expanding the use of technology in the company.

***Proposition 1:*** *Relative advantage, observability, trialability, and perceived costs are technological factors affecting the RFID postadoption in omnichannel retailing.*

**Top management support**

All respondents revealed that their RFID projects received support from top management. For example, the main RFID project sponsor in C1 was the CFO who was personally involved in approving and monitoring its development. In C3, the RFID project was a top-down strategic project. The Board and the main executives were mobilized around the project. In line with the recent studies on RFID adoption intention (Mabad et al., 2021;

Mahdaly & Adeinat, 2022), top management support represents an organizational factor of influence on RFID postadoption.

**Firm size**

The four cases are large companies that have made huge investments in technology including the RFID project. Retailers C1, C2, and C3 have developed major projects aligned with omnichannel, digital transformation, and supply chain modernization strategies, through the integration of artificial intelligence and machine learning applications, blockchain, ERP, and WMS systems. For example, C2 modernized its distribution center and invested in software (WMS and demand forecasting) and hardware for inventory replenishment in physical stores. Thus, similar to Mahdaly and Adeinat (2022) and Mabad et al. (2021), the present study confirms the influence of firm size as an organizational factor on RFID postadoption.

***Proposition 2:*** *Top management support and firm size are organizational factors affecting the RFID postadoption in omnichannel retailing.*

**Competitive Pressure**

The trend of adopting omnichannel strategies by retailers, specifically the largest apparel retailers, has been observed in recent years in the country. The adoption of RFID solutions is associated with this phenomenon as confirmed by respondents.

C1 revealed that the company considered Amazon's case and realized that RFID adoption could contribute to captivating consumers and increasing sales through digital channels, in addition to the benefit of providing inventory accuracy. According to C2, physical fashion retail was one of the most affected economic sectors by the pandemic. In 2020, the company closed all of its physical stores, which forced it to redirect its investments to meet e-commerce needs.

Previous studies presented contrasting results regarding the influence of competitive pressure on RFID adoption intention. In our study, the evidence shows that this is a valid environmental factor that affects technology adoption and use.

**External Support**

According to P1, the selection of an adequate RFID service provider is crucial for the success of the project. Nevertheless, in C1, C2, and C3, the RFID project of software and hardware integration was an in-house solution.

For C2, the RFID market is evolving in Brazil. According to C3, the country has recently received more investment due to the increased demand for RFID tags. For example, companies like Avery Dennyson are installing factories in the country. However, in P1's view, the RFID tag manufacturing sector is still restricted and concentrated in a few players. Despite the growth of companies that provide RFID solutions, many of them do not fully master the technology implementation.

As per previous studies (Tu, 2018; Mabad et al., 2021), external support is confirmed as a relevant environmental factor in RFID adoption and use. The growth of the RFID market in Brazil is likely to offer new solutions for more and more enterprises in different sectors.

***Proposition 3:*** *Competitive pressure and external support are environmental factors affecting the RFID postadoption in omnichannel retailing.*

***How accounting practices change due to RFID postadoption***

In C3, the Controllership area implemented a real-time inventory routine for monitoring the costing process, which accesses the business area's database through a data analytics application. This solution, using item-level RFID information, makes it possible to correct any inappropriate allocation of costs, thus improving the quality of accounting information.

The accounting literature suggests changes in accounting practices regarding aggregated valuation methods such as LIFO and average costing, due to the presence of real-time inventory costing data (Krahel & Titera, 2015) because they are not considered accurate measurements (Vasarhelyi et al., 2015).

Nevertheless, all respondents reported no changes in the use of costing methods. Although retailers C1, C2, and C3 have adopted item-level RFID for product tracking and tracing purposes, they are still assessing information at the stock-keeping unit (SKU) level from ERP systems in their accounting practices.

They can identify an individual product by the electronic product code (EPC) encoded on its RFID tag. However, we are using the SKU level in accounting practices. For example, if I have ten shirts, the RFID system identifies each one of them. But in the end, all that matters to accounting is the existence of ten items of the same SKU (C1).

C3 clarifies that the use of product item-level information is more adequate for business and sales areas: "In accounting, this ends up being a little transparent. Currently, we do not use this level of information directly to the balance sheet preparation". In addition, the weighted average cost is the practice currently adopted in compliance with the international standard for financial statements disclosing (IFRS).

**Losses recognition and losses provision**

All three retailers agree that loss recognition and loss provision are the accounting practices most affected by RFID adoption for AIQ improvement. Surprisingly, among the insights offered by the accounting literature, this topic was not anticipated by previous studies.

For example, C3 used to perform traditional inventory counts annually at brick-and-mortar stores and twice a year at distribution centers. Due to the longer intervals between inventory counts, inaccuracies in the loss provision estimates caused distortions in the financial reporting results.

Nevertheless, the advent of item-level RFID enabled monthly full inventory counts in physical stores, representing a very important evolution. This allowed the effective recognition of inventory losses as well as the elimination of estimates for loss provision. C1 reported similar results through weekly inventory counts in physical stores that improved the quality of accounting information.

***Proposition 4:*** *Loss recognition and loss provision are the most affected accounting practices by item-level RFID postadoption, therefore contributing to the improvement of accounting information quality.*

***How RFID postadoption significantly enhance the qualitative characteristics of financial information (relevance, faithful representation, understandability, timeliness, comparability, and verifiability)***

**Accounting Information Quality**

Based on the information provided by the accounting teams of the three cases C1.E2, C2.E2, and C3.E3, we evaluated the qualitative characteristics of the accounting information improved by the adoption of RFID, with the support of the accounting practices consultant APC1.

- **Relevance:** Inventory visibility ensures the accuracy of inventory records, and consequently both the confirmatory and predictive value (e.g. provision for losses) of accounting information.
- **Faithful Representation:** Due to the mitigation of issues regarding inventory shrinkage, spoilage, misplaced inventories, and transaction errors, the accounting information is improved in completeness, neutrality, and freedom from error.
- **Timeliness:** RFID enables greater accuracy and responsiveness of inventory management through real-time inventory information, in addition to timely recognition of inventory losses minimizing the need for estimating loss provision, for example.
- **Comparability:** The RFID adoption by business partners can help the standardization of inventory management procedures and how accounting information is produced and shared for comparison purposes.
- **Understandability:** The information is presented clearly and concisely so that it can be comprehensible and meet the needs of different types of users for their decision-making. RFID systems have the potential to create vast amounts of data, allowing the analysis of financial and non-financial information using business analytics tools.
- **Verifiability:** The RFID system makes it possible to accurately check inventory values in accounting with product physical items through the integration of company information systems such as ERP and WMS.
- **Value-added:** The benefits of RFID are perceived by internal areas and users of the organization (supply chain, marketing, sales, accounting), external users (financial statements), and customers as well.

***Proposition 5a:*** *The item-level RFID enables full inventory counts on a monthly, weekly, and daily basis, providing greater benefits in inventory accuracy and real-time inventory visibility, and therefore improving the accounting information quality.*

***Proposition 5b:*** *Relevance, Faithful Representation, Timeliness, Comparability, Understandability, Verifiability, and Value-added are the accounting information quality characteristics improved by RFID adoption.*

## 2.5 Conclusion

The present study investigates the recent phenomenon of RFID postadoption by large retail companies in the omnichannel context, including other topics that have not yet been addressed in the literature.

Previous studies have focused on the intention or decision to adopt RFID, and thus their reach is limited to people's perceptions of the early stages of the technology, making it difficult to assess the real benefits of its ongoing utilization in organizations. In this study, we focus on the communication benefits of the RFID postadoption, more specifically, the improvement of accounting information quality.

We used the well-established TOE model from the IS literature and identified the relevant factors and how they affect the RFID post-adoption: technological factors (relative advantage, observability, trialability, and perceived costs); organizational factors (top management support and firm size); and environmental factors (competitive pressure and external support).

We also found which accounting practices were affected by RFID postadoption and how they changed. The accounting literature provides insights concerning RFID and IoT adoption. Nevertheless, respondents did not confirm changes in stock valuation, costing, or pricing methods. Surprisingly, the most relevant finding is related to changes in loss recognition and loss provision, which was not anticipated by previous studies.

The big deal of the RFID technology in retail is to enable full inventory counts much more frequently than traditional partial cycle counts, therefore providing timely and accurate inventory information for internal users across the company, therefore improving the quality of accounting information. Based on the accounting literature, we outline the qualitative characteristics of accounting information specifically for the RFID post-adoption context: relevance, faithful representation, timeliness, comparability, understandability, verifiability, and value-added.

We provide evidence of the influence of TOE contextual factors on RFID post-adoption, which in turn contributes to improving the quality of accounting information. In addition to the theoretical model and propositions, we developed the dimensions of accounting information quality in the specific context of RFID technology. Thus, our study offers contributions to both IS literature and accounting literature.

This exploratory multiple-case study is limited by its focus on a small population of large companies in the apparel retail sector. Concerning future research, we suggest an in-depth case study, for instance, to assess RFID benefits on an entire supply chain of suppliers, retailers, and customers.

Empirical survey research is recommended to study the retail industry more broadly on the RFID postadoption, as well as quantitative research to study this phenomenon using financial accounting measures such as Timely Loss Recognition.

## References


Acura. (2023). Acura: Cases. Online. Available in: https://www.acura.com.br/pt/cases.

Al-Hiyari, A., AL-Mashre, M. H. H., Mat, N. K., & Alekam, J. M. (2013). Factors that affect accounting information system implementation and accounting information quality: A survey in University Utara Malaysia. *American Journal of Economics*, 3(1), 27-31. https://doi.org/10.5923/j.economics.20130301.06

Arif, J., Azzouz, K., Mouzouna, Y., & Jawab, F. (2020). Design on improvement of traceability process in the outsourcing of logistics' activities using the internet of things (IoT) applications. *International Journal of Advanced Science and Technology*, 29 (1), 1093–1108. Retrieved from http://sersc.org/journals/index.php/IJAST/article/view/3602

Atlas.ti. (2023). Atlas.ti: interview analysis tools. Online. Available in: https://atlasti.com/pt/interview-analysis-tools.

Beontag. (2023). Beontag: Cases. Online. Available in: https://beontag.com/pt/nossos-cases/

Bhattacharya, M., & Wamba, S. F. (2015). A Conceptual Framework of RFID Adoption in Retail Using TOE Framework. *International Journal of Technology Diffusion*, 6(1), 1-32. https://doi.org/10.4018/ijtd.2015010101.

Bixler, M.J., & Honhon, D. (2021). Exploring the Connections between Backrooms, Inventory Record Inaccuracies, and Waste. *Sustainability*, 13(17), 9490. https://doi.org/10.3390/su13179490.

Caro, F., & Sadr, R. (2019). The Internet of Things (IoT) in retail: Bridging supply and demand. *Business Horizons, Elsevier*, 62(1), 47-54. https://doi.org/10.1016/j.bushor.2018.08.002.

Charmaz, K. (2014). *Constructing grounded theory (second edition).* Thousand Oaks, CA: Sage.

Chiu, C., Chen, S., & Chen, C. (2017). An integrated perspective of TOE framework and innovation diffusion in broadband mobile applications adoption by enterprises. *International Journal of Management, Economics and Social Sciences (IJMESS),* 6(1), 14-39. Retrieved from https://www.ijmess.com/volumes/volume-VI-2017/issue-I-03-2017/full-2.pdf.

Cilloni, G., Leporati, R., Rizzi, A., & Romagnoli, G. (2019). State of the art of item-level RFID deployments in fashion and apparel retail. *International Journal of RF Technologies*, 10(3-4), 65–88. https://doi.org/10.3233/rft-190174.

Cornacchione, E. B., Reginato, L., Imoniana, J. O. & Souza, M. (2023). Dynamic Pricing Models and Negotiating Agents: Developments in Management Accounting. *Administrative Sciences*, 13 (2), 57. https://doi.org/10.3390/admsci13020057.

Creswell, J. W. (2013). *Research design: Qualitative, quantitative, and mixed methods approaches*. Thousand Oaks, CA: Sage.

Dai, Y. H., & Ge, X. Y. (2015). Optimization of the internal accounting control based on the internet of Things. In H. C. Liu, W. P. Sung, & W. Lao (Eds.), *Management, information and educational engineering* (55–59). Taylor & Francis Group.

Dai, H., & Tseng, M. M. (2012). The impacts of RFID implementation on reducing inventory inaccuracy in a multi-stage supply chain. *International Journal of Production Economics*, 139(2), 634–641. https://doi.org/10.1016/j.ijpe.2012.06.005.

Daoud, H., & Triki, M.A. (2013). Accounting Information Systems in an ERP Environment and Tunisian Firm Performance. *The International Journal of Digital Accounting Research*, 13, 1-35. https://doi.org/10.4192/1577-8517-v13_1.

Dechow, P., Ge, W., & Schrand, C. (2010). Understanding earnings quality: A review of the proxies, their determinants and their consequences. *Journal of Accounting and Economics*, 50(2-3), 344–401. https://doi.org/10.1016/j.jacceco.2010.09.001.

Drum, D., Pernsteiner, A., & Revak, A. (2017). Workarounds in an SAP environment: impacts on accounting information quality. *Journal of Accounting & Organizational Change*, 13(1), 44-64. https://doi.org/10.1108/JAOC-05-2015-0040.

Eisenhardt, K. M. (1989). Building Theories from Case Study Research. *The Academy of Management Review*, 14(4), 532. doi:10.2307/258557.

Fosso Wamba, S., Gunasekaran, A., Bhattacharya, M., & Dubey, R. (2016). Determinants of RFID adoption intention by SMEs: an empirical investigation. *Production Planning & Control*, 27, 979-990. https://doi.org/10.1080/09537287.2016.1167981.

Goyal, S., Hardgrave, B. C., Aloysius, J. A., & DeHoratius, N. (2016). The effectiveness of RFID in backroom and sales floor inventory management. *The International Journal of Logistics Management*, 27(3), 795–815. https://doi.org/10.1108/ijlm-03-2015-0051.

GS1 Brasil. (2023). GS1 Brasil: cases. Online. Available in: https://www.gs1br.org/conteudo/cases.

Hajdas, M., Radomska, J., & Silva, S. C. (2020). The omni-channel approach: A utopia for companies? *Journal of Retailing and Consumer Services*, 102131. https://doi.org/10.1016/j.jretconser.2020.102131.

Hauser, M., & Flath, C.M., & Thiesse, F. (2021). Catch me if you scan: Data-driven prescriptive modeling for smart store environments. *European Journal of Operational Research, Elsevier*, 294(3), 860-873. https://doi.org/10.1016/j.ejor.2020.12.047.

IASB. (2018). Conceptual Framework for Financial Reporting. IFRS Foundation. Retrieved from: https://www.ifrs.org/issued-standards/list-of-standards/

Iguma, M. K., & Riccio, E. L. (2020). Factors influencing Brazilian internal auditors' behavioural intention to adopt big data analytics. *Int. J. Auditing Technology*, 4(3), 217–239. https://doi.org/10.1504/IJAUDIT.2020.10039040.

IoP Journal. (2023). The Internet of Packaging. Online. Available in: https://iopjournal.com.br/category/tecnologias/rfid/

Junior, C. H., Oliveira, T., & Yanaze, M. (2019). The adoption stages (Evaluation, Adoption, and Routinisation) of ERP systems with business analytics functionality in the context of farms. *Computers and Electronics in Agriculture*, 156, 334–348. https://doi.org/10.1016/j.compag.2018.11.028.

Justino, M. V., Robertson K. T., & Michael T-D. (2022). A Revised Technology–Organisation–Environment Framework for Brick-and-Mortar Retailers Adopting M-Commerce. *Journal of Risk and Financial Management*, 15(7), 289. https://doi.org/10.3390/jrfm15070289.

Kahn, B. K., Strong, D. M., & Wang, R. Y. (2002). Information quality benchmarks: Product and service performance. *Communications of the ACM*, 45(4), 184-192. https://doi.org/10.1145/505248.506007.

Kanakriyah, R. (2016). The effect of using accounting information systems on the quality of accounting information according to users perspective in Jordan. *European Journal of Accounting, Auditing and Finance Research*, 4(11), 58-75. Retrieved from: https://www.eajournals.org/wp-content/uploads/The-Effect-of-Using-Accounting-Information-Systems-on-the-Quality-of-Accounting-Information-According-to-Users-Perspective-in-Jordan.pdf.

Khayyam, S., Ramish, A., Rehman, K. U., & Syed, A. R. (2022). Strategizing Radio Frequency Identification (RFID) in the Retail Supply Chains of Pakistan: A Multiple Case Study. *Operations and Supply Chain Management: An International Journal*, 15(1), 27-40. https://doi.org/10.31387/oscm0480328.

Kouhizadeh, M., Saberi, S., & Sarkis, J. (2020). Blockchain technology and the sustainable supply chain: Theoretically exploring adoption barriers. *International Journal of Production Economics*, 107831. https://doi.org/10.1016/j.ijpe.2020.107831.

Krahel, J. P., & Titera, W. (2015). Consequences of Big Data and Formalization on Accounting and Auditing Standards. *Accounting Horizons*, 29(2), 409–422. https://doi.org/10.2308/acch-51065.

Krieger, F., Drews, P., & Velte, P. (2021). Explaining the (non-) adoption of advanced data analytics in auditing: A process theory. *International Journal of Accounting Information Systems*, 41, 100511. https://doi.org/10.1016/j.accinf.2021.100511.

Lai, Y., Sun, H., & Ren, J. (2018). Understanding the determinants of big data analytics (BDA) adoption in logistics and supply chain management: An empirical investigation. *The International Journal of Logistics Management*, 29(2), 676-703. https://doi.org/10.1108/IJLM-06-2017-0153.

Li, H., Dai, J., Gershberg, T., & Vasarhelyi, M. A. (2018). Understanding usage and value of audit analytics for internal auditors: An organizational approach. *International Journal of Accounting Information Systems*, 28, 59–76. https://doi.org/10.1016/j.accinf.2017.12.005

Li, Y., Deng, S., Zhang, Y., & Liu, B. (2018). Coordinating the retail supply chain with item-level RFID and excess inventory under a revenue-cost-sharing contract. *International Transactions in Operational Research*. https://doi.org/10.1111/itor.12591.

Liu F., Fang, M., Cai, L., Su, M., & Wang, X. (2022). Consumer Motivations for Adopting Omnichannel Retailing: A Safety-Driven Perspective in the Context of COVID-19. *Front. Public Health*, 9, 708199. https://doi.org/10.3389/fpubh.2021.708199.

Mabad, T., Ali, O., Ally, M., Wamba, S. F., & Chan, K. C. (2021). Making Investment Decisions on RFID Technology: An Evaluation of Key Adoption Factors in Construction Firms. *IEEE Access*, 9, 36937–36954. https://doi.org/10.1109/access.2021.3063301 .

Mahdaly, K., & Adeinat, I. (2022). Factors that affect the adoption of RFID in the Saudi logistics industry: an empirical investigation. *The International Journal of Logistics Management*, 33(3), 1017-1039. https://doi.org/10.1108/IJLM-11-2020-0456.

Markets and Markets. (2021). RFID Market with COVID-19 Impact Analysis by Product Type (Tags, Readers, and Software and Services) - Global Forecast to 2026. Retrieved from https://www.marketsandmarkets.com/Market-Reports/rfid-market-446.html.

Maroufkhani, P., Iranmanesh, M., & Ghobakhloo, M. (2023). Determinants of big data analytics adoption in small and medium-sized enterprises (SMEs). *Industrial Management & Data Systems*, 123(1), 278-301. https://doi.org/10.1108/IMDS-11-2021-0695.

Nam, D., Lee, J., & Lee, H. (2019). Business analytics adoption process: An innovation diffusion perspective. *International Journal of Information Management*, 49, 411–423. https://doi.org/10.1016/j.ijinfomgt.2019.07.017.

Nuijten, A., Keil, M., Sarens, G., & van Twist, M. (2019). Partners or opponents. *Managerial Auditing Journal*, 34(9), 1073–1100. https://doi.org/10.1108/maj-02-2018-1811.

Okezie, B. N., Imoniana, J. O. & Eze, M. G. (2020). Pre and post IFRS and value relevance of accounting information of money deposit banks in Nigeria. *International Journal of Auditing Technology*, 4(3) 177-194. https://doi.org/10.1504/IJAUDIT.2020.115886.

Ou, P., Zhao, H., & Zhou, Z. (2017). Does the implementation of ERP improve the quality of accounting information? Evidence From Chinese A-Share Listed Manufacturing Firms. *Journal of Applied Business Research (JABR)*, 34(1), 43–54. https://doi.org/10.19030/jabr.v34i1.10090.

Paananen, M., & Lin, C. (2007). The Development of Accounting Quality of IAS and IFRS Over Time: The Case of Germany. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.1066604.

Park, J., Dayarian, I., & Montreuil, B. (2021). Showcasing optimization in omnichannel retailing. *European Journal of Operational Research, Elsevier*, 294(3), 895-905. https://doi.org/10.1016/j.ejor.2020.03.081.

Ramanathan, R., Philpott, E., Duan, Y., & Cao, G. (2017). Adoption of business analytics and impact on performance: a qualitative study in retail. *Production Planning & Control*, 28(11-12), 985-998. https://doi.org/10.1080/09537287.2017.1336800.

Rashid, Y., Rashid, A., Warraich, M. A., Sabir, S. S., & Waseem, A. (2019). Case Study Method: A Step-by-Step Guide for Business Researchers. *International Journal of Qualitative Methods*, 18. https://doi.org/10.1177/1609406919862424.

Rejeb, A., Simske, S., Rejeb, K., Treiblmaier, H., & Zailani, S. (2020). Internet of Things research in supply chain management and logistics: A bibliometric analysis. *Internet of Things*, 12, 100318. https://doi.org/10.1016/j.iot.2020.100318.

Reyes, P. M., Li, S., & Visich, J. K. (2016). Determinants of RFID adoption stage and perceived benefits. *European Journal of Operational Research*, 254(3), 801–812. https://doi.org/10.1016/j.ejor.2016.03.051.

RF Consulting. (2023). RF Consulting: clientes. Online. Available in: https://www.rfconsulting.com.br/clientes.

RFID Journal. (2023). RFID Journal Awards. Online. Available in: https://rfidjournalawards.com/

Riihimäki, E., & Pekkola, S. (2021). Public buyer's concerns influencing the early phases of information system acquisition. *Government Information Quarterly*, 101595. https://doi.org/10.1016/j.giq.2021.101595.

Rogers, E. M. (2003). *The Diffusion of Innovations (fifth edition)*. New York: The Free Press.

Sarac, A., Absi, N., & Dauzère-Pérès, S. (2010). A literature review on the impact of RFID technologies on supply chain management. International *Journal of Production Economics,* 128(1), 77–95. https://doi.org/10.1016/j.ijpe.2010.07.039.

Shin, S., & Eksioglu, B. (2015). An empirical study of RFID productivity in the U.S. retail supply chain. *International Journal of Production Economics*, 163, 89–96. https://doi.org/10.1016/j.ijpe.2015.02.016.

Skiljo, M., Solic, P., Blažević, Z., & Perković, T. (2020). Analysis of Passive RFID Applicability in a Retail Store: What Can We Expect? *Sensors*, 20(7). https://doi.org/10.3390/s20072038.

Tao, F., Fan, T., Lai, K. K., & Li, L. (2017). Impact of RFID technology on inventory control policy. *Journal of the Operational Research Society*, 68(2), 207–220. https://doi.org/10.1057/s41274-016-0030-5.

Thiesse, F., Staake, T., Schmitt, P., & Fleisch, E. (2011). The rise of the "next-generation bar code": an international RFID adoption study. *Supply Chain Management: An International Journal*, 16(5), 328–345. https://doi.org/10.1108/13598541111155848.

Trabucco, M., & De Giovanni, P. (2021). Achieving Resilience and Business Sustainability during COVID-19: The Role of Lean Supply Chain Practices and Digitalization. *Sustainability*, 13(22), 12369. https://doi.org/10.3390/su132212369.

Treiblmaier, H. (2019). Toward More Rigorous Blockchain Research: Recommendations for Writing Blockchain Case Studies. *Frontiers in Blockchain*, 2. https://doi.org/10.3389/fbloc.2019.00003.

Tsai, M.-C., Lee, W., & Wu, H.-C. (2010). Determinants of RFID adoption intention: Evidence from Taiwanese retail chains. *Information & Management*, 47(5-6), 255–261. https://doi.org/10.1016/j.im.2010.05.001.

Tornatzky, L. G., & Fleischer, M. (1990). The processes of technological Innovation. *The Journal of Technology Transfer*, 16(1), 45-46.

Tu, M. (2018). An exploratory study of Internet of Things (IoT) adoption intention in logistics and supply chain management: A mixed research approach. *The International Journal of Logistics Management*, 29(1), 131-151. https://doi.org/10.1108/IJLM-11-2016-0274.

Valentinetti, D., & Munoz, F. F. (2021). Internet of things: Emerging impacts on digital reporting. *Journal of Business Research. Elsevier Inc*., 131, 549–562. https://doi.org/10.1016/j.jbusres.2021.01.056.

Vasarhelyi, M., Kogan, A., & Tuttle, B. (2015). Big Data in Accounting: An Overview. *Accounting Horizons*, 29 (2), 381–396. https://doi.org/10.2308/acch-51071.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, 27(3), 425–478. https://doi.org/10.2307/30036540.

Wang, Y. M., Wang, Y. S., & Yang, Y. F. (2010). Understanding the Determinants of RFID Adoption in the Manufacturing Industry. *Technological Forecasting and Social Change*, 77(5), 803–815. https://doi.org/10.1016/j.techfore.2010.03.006.

Widuri, R., O'Connell, B., & Yapa, P. W. S. (2016). Adopting generalized audit software: an Indonesian perspective. *Managerial Auditing Journal*, 31(8/9), 821–847. https://doi.org/10.1108/maj-10-2015-1247.

Wu J., Xiong, F., & Li, C. (2019). Application of Internet of Things and Blockchain Technologies to Improve Accounting Information Quality. *IEEE Access*, 7, 100090-100098. https://doi.org/10.1109/ACCESS.2019.2930637.

Yin, R. (2014). *Case Study Research: Design and Methods (fifth edition).* Thousand Oaks, CA: Sage Publications, Inc.

Zhang, L., Li, T., & Fan, T. (2018). Radio-frequency identification (RFID) adoption with inventory misplacement under retail competition. *European Journal of Operational Research, Elsevier*, 270(3), 1028-1043. https://doi.org/10.1016/j.ejor.2018.04.038.

Zhu, K., Kraemer, K.L., & Xu, S. (2006). The process of innovation assimilation by firms in different countries: a technology diffusion perspective on e-business. *Management Science*, 52(10), 1557-1576. https://doi.org/10.1287/mnsc.1050.0487.

# 3 THE POSTADOPTION OF RADIO-FREQUENCY IDENTIFICATION TECHNOLOGY BY A MANUFACTURING COMPANY CONTRIBUTING TO THE QUALITY OF FINANCIAL INFORMATION IN OMNICHANNEL RETAILING: AN EXPLORATORY STUDY

**Abstract**
This in-depth case study aims to investigate the item-level RFID post-adoption by an apparel manufacturing company in the omnichannel supply chain of fashion retailers. In addition to understanding the context of technology adoption and use, it reveals how this innovation contributed to the supply chain and the generation of corporate financial information. Empirical data was collected from semi-structured interviews, direct observations, and internal and external documentation, triangulated and analyzed using a grounded theory approach. The results show that RFID post-adoption is determined by three contextual factors: technological (relative advantage, complexity, compatibility, observability, trialability, and perceived costs); organizational (top management support and company size); and environmental (competitive pressure). The technology improves information sharing for the omnichannel supply chain at three levels of integration: internal, supplier, and customer. RFID also benefits the accounting practices of WIP and FG inventories, loss recognition, cost accounting, cost of goods sold, and the results in financial reports. The produced accounting information was improved in terms of relevance, faithful representation, comprehensibility, timeliness, comparability, and verifiability. While most studies focus on the intention and decision to adopt RFID, our work contributes to theory and practice by investigating the actual use and post-adoption of the technology in apparel manufacturing companies. Finally, we provide an interdisciplinary theoretical model based on the TOE framework integrating information systems, SCM, and accounting research concepts, and present related propositions.

**Keywords:** Manufacturing. RFID. Omnichannel retailing. Technology adoption. Accounting information quality.

## 3.1 Introduction

Researchers and practitioners revealed that a growing number of retail companies worldwide, mainly fashion retailers, have invested in item-level radio frequency identification (RFID) applications as their omnichannel strategies (Ovezmyradov & Kurata, 2022; Caro & Sadr, 2019). In Brazil, major retailers such as Lojas Renner, C&A, Centauro (SBF Group), Pernambucanas, Riachuelo, and Hering have recently reported their RFID systems implementation (Iguma & Imoniana, 2023).

Omnichannel retailing refers to the integration of all available channels (i.e., physical stores, online shops, and mobile shops) to optimize the customer shopping experience by decoupling product information and fulfilling product demand (Caro & Sadr, 2019). For instance, buy online, pick up in-store (BOPS) is considered one of the most popular omnichannel services (Li et al., 2022).

The fashion industry is characterized by high impulse purchasing, short product life cycles, volatile demand, low predictability, tremendous product variety, and a complex supply chain (McMaster et al., 2020). The advent of fast fashion presented a new social and cultural meaning to the clothing industry, which was initially focused only on satisfying the consumer's basic needs (Gwozdz, Kristian, & Müller, 2017). The textile and apparel supply chain (SC) consists of four segments of participants: natural or synthetic fiber producers, textile mills, apparel manufacturers, and retailers (Sen, 2008).

The evolution of manufacturing is divided into four phases: mechanical power (Industry 1.0), mass production (Industry 2.0), and digital revolution (Industry 3.0). Industry 4.0 (I4) is based on the Internet of Things (IoT) (Ben-Daya et al., 2017). RFID is one of the core IoT information-sensing devices and technologies in the I4 context (Gladys et al., 2023). I4 includes other technologies such as big data (BD) analytics, artificial intelligence, and cloud manufacturing (Tiwari & Khan, 2020).

RFID systems enable the collection of real-time data associated with workers, machines, materials, and products. In this way, RFID improves production operations and decision-making and contributes to upgrading traditional factories into smart manufacturing ones (Ben-Daya et al., 2017). Thus, RFID supports manufacturing in achieving efficiency by improving internal operations and external supply chain management (SCM) (Liukkonen, 2015).

In the fashion industry, there is a concern regarding the environmental impact through the intense use of chemical products and natural resources, and textile waste generation (Gwozdz et al., 2017). Studies found evidence of RFID contributions to manufacturing organization’s sustainability in terms of social, economic, and environmental dimensions, in building sustainable and green supply chains (Manavalan & Jayakrishna, 2019; Green et al., 2017; Cui et al., 2017).

There is a growing research interest in the challenging process of digital manufacturing technologies (DMT) adoption (Yang et al., 2021). Studies pointed out the need for research on how manufacturing firms strategically adopt these technologies, by investigating their antecedents and consequences in SCM (Tian et al., 2021; Rejeb et al., 2020).

Most studies on Omnichannel strategies concentrate on retail companies (Hauser et al., 2021). Ovezmyradov and Kurata (2022) reported that retailers achieved higher return on investment (ROI) due to the adoption of item-level RFID tracking of fashion products in the omnichannel context. Studies report that retailers and manufacturers in the same supply chain environment perceive different benefits and challenges from RFID adoption (Ailawadi, 2021; Zhang & Yang, 2019). On the other hand, the literature indicates a lack of empirical studies that investigate manufacturing and wholesale companies, considering that these companies are affected by the decisions of omnichannel retailers due to changes in consumer behavior (Alonso-Garcia et al., 2021; Ailawadi, 2020).

Furthermore, most studies focus on the intention and decision to adopt RFID in organizations, rather than the post-adoption of the technology (Zhu et al., 2006; Iguma & Imoniana, 2023). Thus, we address the first research question of this study.

**RQ1.** How do technological, environmental, and organizational factors impact the post-adoption of RFID technology in a manufacturing company aligned with omnichannel strategies of the fashion industry?

RFID and IoT technologies have the potential to promote internal, supplier, and customer integration by tracking and sharing information with improved quality for SCM (Tian et al., 2021). Furthermore, the sharing of high-quality information provided by RFID is also considered the main enabler of supply chain visibility (SCV) (Agrawal et al., 2022). Nevertheless, there is a research gap on why and how manufacturing firms adopt digital technologies, and their impact on supply chains (Yang et al., 2021). We present the second research question:

**RQ2.** How does RFID post-adoption by a manufacturing firm contribute to information sharing in the omnichannel supply chain?

Accounting information with high quality may be useful for managers and shareholders to increase SCV by helping them analyze risks and uncertainties and communicate the financial impact of SC disruption events (Velayutham et al., 2021). Moll and Yigitbasioglu (2019) reported the need for empirical studies of IoT and other Internet-related technologies in the accounting research field. According to Valentinetti and Munõz (2021), accounting literature lacks the understanding of the IoT benefits in producing accounting information with enhanced quality for corporate reporting and disclosure.

The findings of Iguma and Imoniana (2023) reveal the influence of technological, organizational, and environmental factors on the RFID post-adoption by omnichannel retail companies in Brazil. The item-level RFID system affected loss recognition and loss provisioning, thus improving accounting practices and AIQ. However, there is a need to investigate the RFID post-adoption impacts on accounting in manufacturing companies (Alonso-Garcia et al., 2023). Next, the third research question was formulated:

**RQ3.** How does RFID post-adoption by a manufacturing firm in the omnichannel context significantly improve the qualitative characteristics of financial information (relevance, faithful representation, understandability, timeliness, comparability, and verifiability)?

To answer these research questions, we conducted an in-depth single case study on the RFID post-adoption by a leading apparel manufacturing company in the omnichannel retail supply chain. Considering that this phenomenon has not been investigated yet, we believe that our results open opportunities for further studies and provide insights to practitioners into aspects of the real-world use of RFID.

Based on the TOE theoretical framework (Tornatzky & Fleischer, 1990), this work contributes to the information systems (IS) and accounting research fields, proposing an integrated theoretical model that addresses the RFID benefits to the improvement of information sharing in the omnichannel supply chain, accounting practices and AIQ.

The rest of this article is organized as follows. The second section reviews the relevant literature. Next, the third section presents the research methodology, including research design, case selection, data collection, case description, and data analysis. In the fourth section, the results of the analysis are presented and discussed, addressing the research questions and developing propositions. Finally, the conclusion section presents implications, contributions, limitations, and suggestions for future research.

## 3.2 Literature Review

The adoption of omnichannel strategies as SC practices by companies worldwide for business sustainability and resilience was driven by the COVID-19 pandemic outbreak (Trabucco & De Giovanni, 2021). Trabucco and De Giovanni (2021) surveyed professionals from 119 firms of different industry sectors and countries in Europe. The study revealed that production costs and sales (economic sustainability), SCV, and inventory availability (sustainable SC) were preserved during the COVID-19 pandemic due to omnichannel practices. Surprisingly, they also found that digital technologies such as artificial intelligence, big data, and machine learning do not support firms' resilience.

The development of omnichannel strategies by retail companies, more specifically fashion retailers, has been a topic of great interest in academic studies (Alonso-Garcia et al., 2023; Ovezmyradov & Kurata, 2022; Grewal et al., 2021).

Hajdas et al. (2022) conducted a multiple-case study with four European retail companies based in Portugal. Their work revealed two types of barriers faced by firms to successful implementation of omnichannel practices. While internal obstacles include operational and strategic barriers, external obstacles refer to product-related, customer-related, legal, and competitive drivers.

Von Briel (2018) conducted a Delphi study concerning the future of omnichannel retail with eighteen internationally recognized retail experts from Western countries. The research presented four main insights. First, competition in the retail industry focuses on customer experience rather than individual products. Second, the development of human capabilities and a change in the organizational mindset are essential for successful omnichannel retail. Third, physical stores need to be reinvented due to the adoption of digital technologies. Lastly, retailers' productivity will be leveraged through the integration of retail channels. Li and Gong (2022) developed a research model to explain that customer engagement is obtained by omnichannel integration (informational integration, transactional integration, and relational integration) mediated by perceived fluency and flow in the shopping experience.

Omnichannel strategies require the adoption of digital technologies for channel integration, such as RFID and IoT technologies, to enhance consumers' shopping experience (Caro & Sadr, 2019; Shao, 2021; Li & Gong, 2022; Ovezmyradov & Kurata, 2022). Rupasinghe (2017) analyzed an SAP ERP system integrated with RFID technology in the fashion apparel and footwear industry using a mixed-method approach (survey and observations). The availability of relevant real-time information was considered the most important benefit of item-level tagging and inventory management with RFID in the retail supply chain. On the other hand, high costs arising from the complexity of RFID implementation constitute a major challenge. At last, they proposed a conceptual framework to improve inbound and outbound operations.

However, omnichannel retail may not favor supply chain partners of the manufacturing industry. Shao (2021) investigated distinct omnichannel scenarios involving one manufacturer distributing products through two competing retailers. The findings revealed that omnichannel strategies adopted by retailers may benefit or hurt the manufacturer in terms of higher/lower demand and more/less profitability. When both retailers adopt an omnichannel strategy, it represents the worst scenario for the manufacturer.

According to Tsai et al. (2010), channel power in supply chains has been transferred from manufacturers to retailers over the years. Large retailers mandated the RFID adoption by their top suppliers and trading partners, such as Walmart in 2003 (Fosso Wamba et al., 2016; Reyes et al., 2016; Tu, 2018).

The literature provides several studies on the adoption of RFID by manufacturing companies unrelated to omnichannel strategies. Ehie and Chilton (2020) developed a research model based on technology, organization, and environment (TOE) (Tornatzky et al.,1990) and diffusion of innovation (DOI) (Rogers, 2003) frameworks using a sample of 239 manufacturing firms in the United States. They found that information technology (IT) infrastructure, IT governance, and interoperability are the main IoT enablers of the convergence of IT and operational technology systems, and their influence on IoT adoption by manufacturers. Similarly, Wang et al. (2010) proposed a research model based on TOE. They analyzed a sample of 133 responses from RFID decision-makers in the manufacturing industry in Taiwan. The study revealed four facilitators (compatibility, firm size, competitive pressure, and trading partner pressure) and two inhibitors information intensity, and complexity) as determinants of RFID adoption.

De Jesus Pacheco et al. (2021) conducted a longitudinal in-depth case study on the development of an Industry 4.0 information system in a footwear manufacturing plant, namely a control system via RFID for online monitoring and optimization of production lines. This system demonstrated the capacity to support the management of bottlenecks in production lines, check the progress of production time, and analyze the factory floor performance through the web platform in real-time.

Tian et al. (2021) conducted survey research with firms in Europe, Asia, and America based on the TOE framework. They found that human resources and digital manufacturing technologies (such as RFID) play significant roles in implementing the three dimensions of SCI. First, the internal integration (sales and purchasing department) involves sales forecasts, production plans, production progress, and stock-level information. Second, supplier integration (key suppliers) refers to sales forecasts, production plans, order tracking and tracing, delivery status, and stock level information. Lastly, customer integration (key customers) includes sales forecasts, production plans, order tracking and tracing, delivery status, and stock level information.

In the accounting field, studies focus on the benefits of RFID/IoT solutions for AIQ in the manufacturing industry. Qiu (2016) proposed a 3D dynamic accounting information platform through RFID technology divided into four main modules: data acquisition, cost accounting, and accounting document generation and report output. This system produced real-time accounting information with transparency that improved enterprise management and decision-making. Wu et al. (2019) presented an accounting information system (AIS) based on blockchain (BC)-IoT transaction model with RFID technology composed of three subsystems: a contract system, a logistics system, and a capital flow system. The system can automatically collect and store data and produce personalized financial reports in real-time and on demand. The improvement of the accounting information was identified by their study in terms of its qualitative characteristics: relevance, neutrality, timeliness, and cost-benefit.

However, the existing research on RFID adoption by manufacturers does not consider it within the omnichannel supply chain context. Most of these studies on omnichannel topics examine the retail point of view (Alonso-Garcia et al., 2023).

The study of Drum et al. (2017) on workarounds in an ERP system showed that AIQ can be compromised by inaccurate or missing entries in the accounting system in terms of relevance and faithful representation.

Most studies on AIQ use the conceptual framework developed by the Financial Accounting Standards Board (FASB) and the International Accounting Standard Board (IASB). This framework presents a descriptive hierarchy with two primary characteristics of financial information (relevance and faithful representation) and their support characteristics (understandability, timeliness, comparability, and verifiability).

Iguma and Imoniana (2023) performed a multiple-case study to investigate the RFID post-adoption by three large retail companies in the fashion industry in the omnichannel context. Based on the TOE framework, their findings revealed the determinants of RFID postadoption: technological factors (relative advantage, observability, trialability, and perceived costs), organizational factors (top management support and firm size), and environmental factors (competitive pressure and external support).

Moreover, their study explained that item-level RFID applications made full inventory counts with greater frequency, thus providing real-time visibility of accurate inventory information. These benefits impacted accounting practices of loss recognition and loss provision, thus resulting in the improvement of qualitative characteristics of accounting information: relevance, faithful representation, timeliness, comparability, understandability, verifiability, and value-added. However, this study did not focus on the supply chain context.

We developed a theoretical model based on the TOE framework (Tornatzky & Fleischer, 1990) to examine the contextual factors that influence the adoption decision and the development of item-level RFID applications in a manufacturing company in the omnichannel retail environment. In turn, it will also investigate how technology provides benefits and contributes to the supply chain in terms of information sharing and AIQ.

The technological factors refer to the characteristics of internal and external technologies relevant to the firm (Tornatzky & Fleischer, 1990). Many studies have also incorporated the diffusion of innovation (DOI) theory (Rogers, 2003) to assess the technological factors of relative advantage, compatibility, complexity, trialability, and observability. Organizational context is characterized in terms of firm size, managerial structure, human resources, and slack resources. Environmental context is the arena in which a firm conducts its business, including its industry, competitors, suppliers, and government.

### 3.3 Methodology

The case study is one of the most used methodologies in qualitative research in exploring a contemporary phenomenon in a human and social context through a variety of lenses. It is useful to analyze current and past data from real-life situations to address "why" and "how" research questions (Riihimäki & Pekkola, 2021, Yin, 2014).

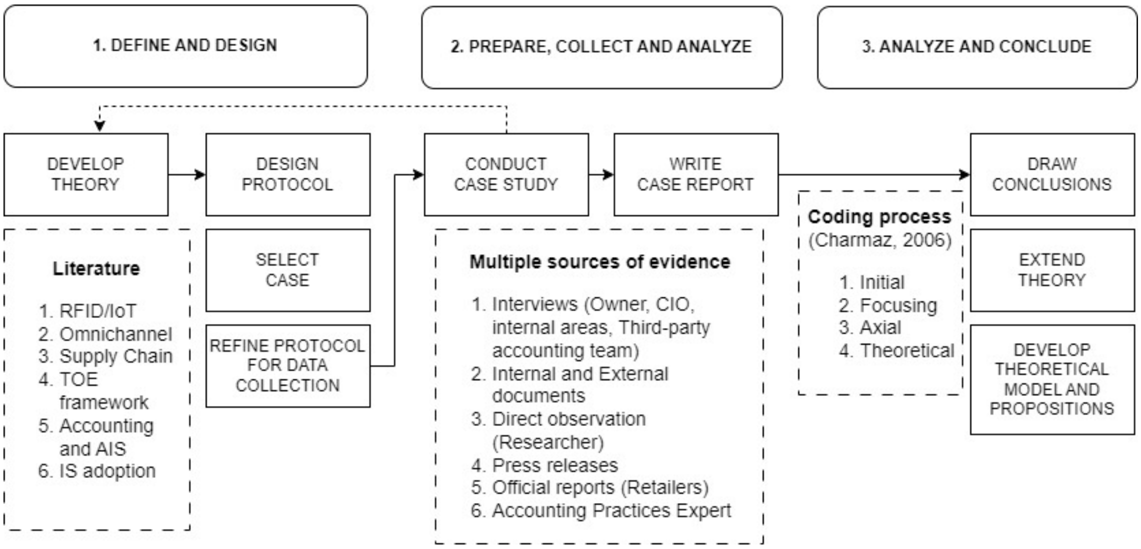
In this exploratory study, we used the single case study design, which is suitable when the case under investigation is rare, unique, and revealing (Yin, 2014). An in-depth analysis of a single case allows for a more detailed understanding of the circumstances surrounding the phenomenon of interest (Arvidsson & Melander, 2020).

Single case studies are carried out to examine technology development and implementation in manufacturing, supply chain, and logistics contexts: RFID, IoT, and Industry 4.0 (de Jesus et al., 2021; Margherita & Braccini, 2021; Dweekat et al., 2017); BDA and IoT (Hopkins & Hawking, 2019); and manufacturing technology (Ahlskog et al., 2017).

### 3.3.1 Research Design

The single-case study design was planned in three phases based on Yin (2014) as illustrated in Figure 3.1. To address research design issues regarding the quality of this single case study, we followed the criteria of reliability, construct validity, and external validity (Yin, 2014; Treiblmaier, 2019; Rashid et al., 2019).

Figure 3.1. Single-case study design




Source: Yin (2014) adapted by the author.

The reliability criterion can be satisfied through the development and use of a series of artifacts. First, the case study protocol documents the study overview and step-by-step guidance for data collection, and reporting processes. Second, we built a case study database to organize all research data, including interviewee information, email messages, signed consent forms, obtained evidence and interview transcripts, public and private documentation, memos of researchers' on-site observations, coded data, and mindmaps (Kahkonen, 2014; Myrelid & Jonsson, 2019). Third, the semi-structured interview guide was designed based on theoretical frameworks and data collection instruments validated by previous empirical studies (Iguma & Imoniana, 2023).

Construct validity can be strengthened by employing different data collection techniques to triangulate data from multiple sources and establishing a chain of evidence (Yin, 2014). In this study, empirical data were collected from semi-structured interviews, direct observations, and internal and external documentation. The use of research informants from different areas allows us to capture different perceptions about the same phenomenon, thus contributing to the richness of the data collected and the reduction of bias.

In qualitative case studies, external validity relies on analytic generalization rather than statistical generalization. This method is performed by comparing theory with the resulting empirical results of cases. In this way, cases are generalizable to theoretical propositions, not to populations (Yin, 2014). In single case studies, generalizability is limited by the context studied (Scheller et al., 2021; Margherita & Braccini, 2021; Ahlskog et al., 2017). To enhance external validity, it is recommended that both data coding and analysis should be aligned with theory (Kähkönen, 2014).

### 3.3.2 Case Selection

Although many manufacturing companies have been investing in technologies for digital transformation, few have succeeded in delivering business value (Yang et al., 2021). The case selected for this research is one of the main supply chain partners of the largest fashion retailers that use the technology in their omnichannel strategies.

The case is one of the few garment manufacturers in the country that successfully adopted item-level RFID in the assembly line to control its internal operations. Moreover, 100% of its finished products are attached with RFID tags and shipped to its customers, even those retailers that do not use the technology.

This manufacturer is one of the main supply chain partners of the largest fashion retailers that use the technology in their omnichannel strategies. On the other hand, most garment manufacturers only attach RFID tags to finished products just before shipping them to clients (omnichannel retailers) (Liukkonen, 2015).

RFID allows companies to adopt different strategies for tagging objects. The identification and traceability of individual products present many advantages over traditional pallet and case-level RFID solutions (Iguma & Imoniana, 2023; de Jesus et al., 2021; Choy et al., 2017). Thus, item-level RFID tagging has the potential to increase the granularity of inventory data, thereby contributing to SCV improvement and omnichannel fulfillment of fashion products (Katoch, 2022; Ovezmyradov & Kurata, 2022).

In this case, we observed the progress of RFID adoption towards its assimilation and widespread use within the company (post-adoption). According to Zhu et al. (2006), for a successful adoption of a technology, it needs to be accepted, adapted, routinized, and institutionalized into the firm.

To protect its identity, the manufacturer will be known as “XPTO” in our study. XPTO is considered by a large fashion retailer, namely “ACME”, as one of the main garment manufacturers of its supply chain. ACME reported that approximately 30% of their apparel suppliers use RFID systems as a tool to control their internal processes. In this way, they were able to reduce return rates due to errors in counting or model selection, or even in the size of the pieces ordered (TI Inside, 2022a).

### 3.3.3 Data collection

This study resorted to data collection from primary and secondary sources of evidence from January to November 2023.

Our interview guide is composed of three groups of open-ended questions. The first one refers to the interviewee's professional experience, the functional area he/she is responsible for, and its relationship with other internal areas. The second group includes aspects of RFID adoption in XPTO such as challenges, benefits, and changes in the company's internal processes. Moreover, his/her perceptions as a user of the enterprise information systems integrated with RFID applications. Lastly, the third group focuses on XPTO's interaction with other supply chain partners, such as raw material suppliers, sewing contractors, and retailers.

The interviews were conducted through online conference platforms, video recorded, and transcribed. In total they lasted around ten hours, varying between 30 and 60 minutes. The Chief Information Officer (CIO) is responsible for the RFID project in XPTO and the main contact for the case study. He facilitated all the interviews with the company's owner, managers of internal teams (fabric sourcing, trim sourcing, after-sales, PPC, quality control, finance, and finishing section), and third-party accounting firms (Table 3.1). Under ethical considerations, interviewees were fully aware of their roles in the study. Furthermore, the identities of participants were protected and not published in our work.

Table 3.1. Interviews and respondents

| Code | Functional Area | Respondent | Date | Duration (in minutes) |
|---|---|---|---|---|
| CIO | Chief Information Officer | Male | 2023-01-11 | 50 |
| CIO | Chief Information Officer | Male | 2023-03-16 | 50 |
| CIO | Chief Information Officer | Male | 2023-05-19 | 60 |
| FBS | Fabric Sourcing | Male | 2023-06-22 | 30 |
| TRS | Trim Sourcing | Female | 2023-06-22 | 30 |
| AFS | After-sales | Female | 2023-06-26 | 40 |
| FIN | Finance | Male | 2023-06-26 | 60 |
| PPC | Production Planning and Control | Female | 2023-06-27 | 45 |
| QLC | Quality Control | Female | 2023-07-11 | 30 |
| FNS | Finishing | Female | 2023-07-03 | 30 |
| ACC | Accounting (Third-party) | Female | 2023-07-03 | 60 |
| OWN | Owner | Female | 2023-07-11 | 30 |
| CIO | Chief Information Officer | Male | 2023-05-19 | 60 |
| | | | | 575 |

Source: the author.

The direct observation may reveal certain environmental conditions and behaviors (Yin, 2014). In this way, we carried out on-site observations guided by the CIO and took field notes (Scheller et al., 2021; Ahlskog et al., 2017). The goal was to observe the assembly line involving sewing machines, non-sewing equipment, and workstations for manual processes. In addition to interviews, observations allowed us to understand the flow of work from start to end, and how the RFID system operates at each stage of the assembly line, from raw materials to finished products.

As secondary data sources, we made use of documentation provided by XPTO including organizational structure and the description of the production management system (SGP). We also collected organizational information from the XPTO website and the company's official page on the LinkedIn social network.

Furthermore, our work of direct observation extended to the retailer ACME's store network. In this way, we identified how the XPTO products attached with RFID tags traveled across the omnichannel supply chain until ACME stores, and how technology is used by the fashion retailer there.

The researchers also extracted data from press releases and official reports published by fashion retailers listed on B3 (Brasil, Bolsa de Valores, Balcão), such as C&A, Centauro/Grupo SBF, Lojas Renner, and Riachuelo (C&A, 2021; C&A, 2023; Centauro, 2020; Renner, 2020; Renner, 2023; TI Inside, 2022a; TI Inside, 2022b; Riachuelo, 2023). This provided us with information about the omnichannel retailing environment, including all the required conditions and information from manufacturers as their supply chain partners.

Finally, we invited a consultant on accounting standards as an additional source of evidence. He provided insights on accounting practices and contributed to categorizing the qualitative characteristics of accounting information related to RFID adoption and use in manufacturing.

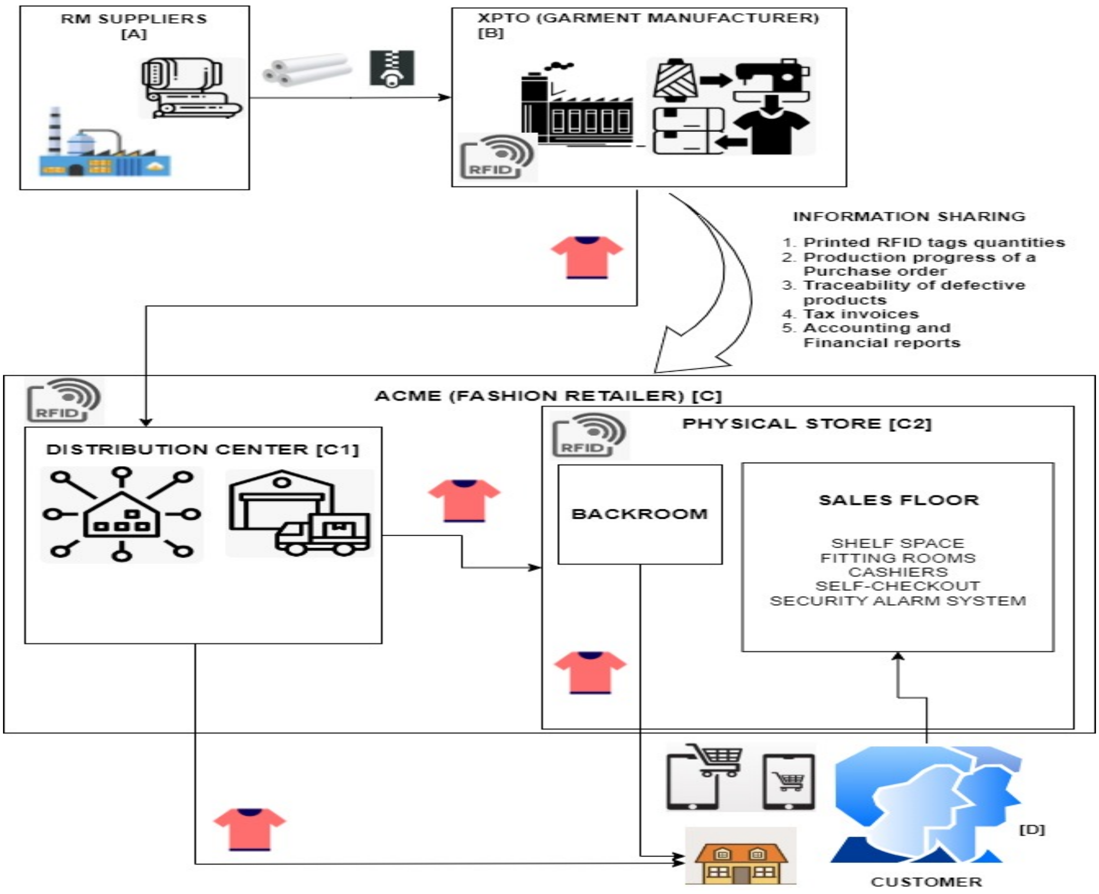
### 3.3.4 Case description

XPTO is a private family company with approximately 500 employees, annual revenue between 1.2 and 12 million BRL, and has been operating for more than 40 years in Brazil. In 2021, the company introduced a digital transformation process that involved the in-house development and implementation of an RFID system on the assembly line, as well as its integration into the new production management system, namely SGP.

XPTO is a third-party garment manufacturer that delivers private-label products based on retailers' specifications and demands. A private label is any brand exclusively owned and sold by a retailer (Perez-Santamaría & Martos-Partal, 2021). This business relationship allows retailers to make joint decisions with manufacturers on materials and components selection, product development and quality, production rate, costs, and prices.

Nevertheless, fashion retailers require rigorous criteria for the selection and maintenance of their supply chain partners, such as garment manufacturers and raw materials suppliers. Quality certifications are required for manufacturers, such as the Brazilian Association of Textile Retail (ABVTEX), as well as compliance with social, environmental, and sustainability practices. In addition, retailers also require periodic inspections and audits in factories, and production and accounting-financial reports (C&A, 2023; Riachuelo, 2023; Renner, 2023).

Figure 3.2. The omnichannel supply chain




Source: the author.

In Figure 3.2, the omnichannel supply chain consists of three categories of participants until the end consumer: raw material suppliers, garment manufacturers, and retailers (Green et al., 2017). First, 3.2A represents the suppliers at the top of the supply chain. Fiber producers convert natural and synthetic fibers into yarn. Next, the yarn is transformed into fabric by textile mills. In addition, we include the suppliers of trim and accessories (e.g., zipper, button, and embroidery) in this category.

In group 3.2B, manufacturers like XPTO transform raw materials into apparel (e.g., t-shirts, tops, and trousers) through product design, material sourcing, production, marketing, and shipping of finished products. It is also common for manufacturers to outsource contractors to assemble the cut fabric and label the garments (Sen, 2008).

Group 3.2C consists of fashion retailers that offer apparel products for sale to end consumers. First, garments are received from manufacturers, checked, sorted, and stored at the retailer's distribution center (3.2C1). Then, products are distributed directly to customers or retail stores (Caro & Sadr, 2019).

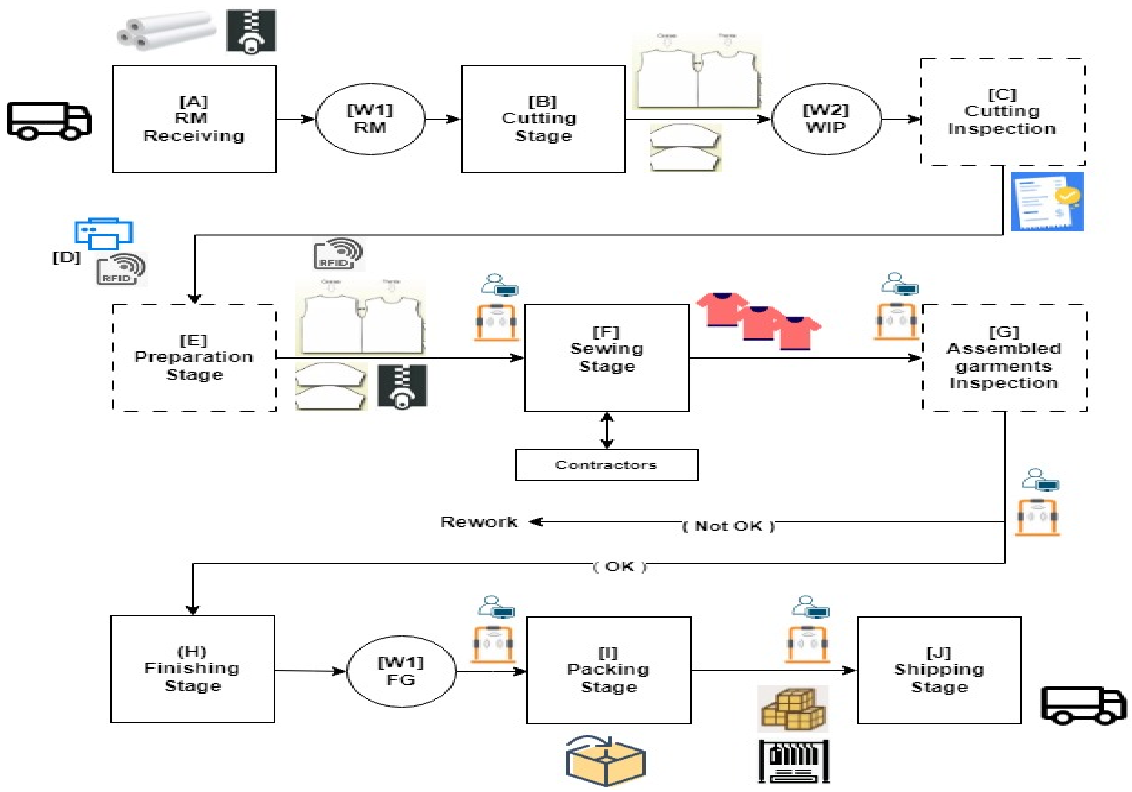
A physical store is commonly divided into two main areas: the sales floor and the backroom (Goyal et al., 2016). The sales floor is the main selling area accessible to customers, while the backroom houses the overflow of goods for sale (3.2C2).

In the omnichannel context, products are attached with RFID tags by garment manufacturers or at the retailer's distribution center (DC). Retailers use item-level RFID applications to reduce inventory record inaccuracy and out-of-stock in distribution centers, backrooms, and sales floors, thus benefiting from real-time inventory visibility (Goyal et al., 2016). Moreover, the consumer experience (3.2D) is maximized through online and offline channel integration.

Buy online, pick up in-store (BOPS), and ship from store are two popular omnichannel services. Consumers shop and place orders through the retailer's website or mobile app, but pick up their purchases in a physical store. They can also choose to receive their products from the nearest physical store rather than the DC (Caro & Sadr, 2019; Xu et al., 2022).

On-site observations performed at the XPTO factory and ACME physical stores gave us an understanding of the flow of products through the omnichannel supply chain. At the retail store, we purchased a product manufactured by XPTO. This customer experience allowed us to observe the technology used on the sales floor, including the RFID sensors in the fitting rooms, handheld RFID readers used by employees, traditional cashiers, self-checkout systems, and the security alarm system.

Figure 3.3. The assembly line with RFID system




Source: the author.

Apparel production is an organized and sequential process of activities integrating materials handling, production processes, personnel, and equipment (Figure 3.3). In the XPTO factory, raw materials (RM) (e.g., fabric rolls and zippers) are received (3.3A) and stored (W1) according to the retailer's purchase order specifications. Quality control is performed through a series of inspections in the pre-production and production stages.

The manufacturing process begins with the cutting stage (3.3B). In bulk cutting, several fabric layers are cut together using an arrangement of pattern pieces: a marker. The outcomes of this stage are the separate garment components. For instance, a t-shirt is composed of a front panel, a back panel, two sleeves, and neck piping.

After the cutting inspection (3.3C), work-in-progress (WIP) items are stored (W2). Then, a production order is issued with instructions for producing the merchandise within a given period. Then, RFID tags are printed on demand at the bureau service maintained by XPTO (3.3D). In this preparation stage (3.3E), all cut components are grouped in the form of individual t-shirt kits for subsequent assembly. Each t-shirt kit includes trims, accessories, and an RFID tag.

From this moment on, WIP items begin to be tracked and traced by the RFID system. RFID portal readers are installed at all stages of the assembly line with specific counting strategies by capturing data from RFID tags: individual items, stacked items, boxes, and hangers with items.

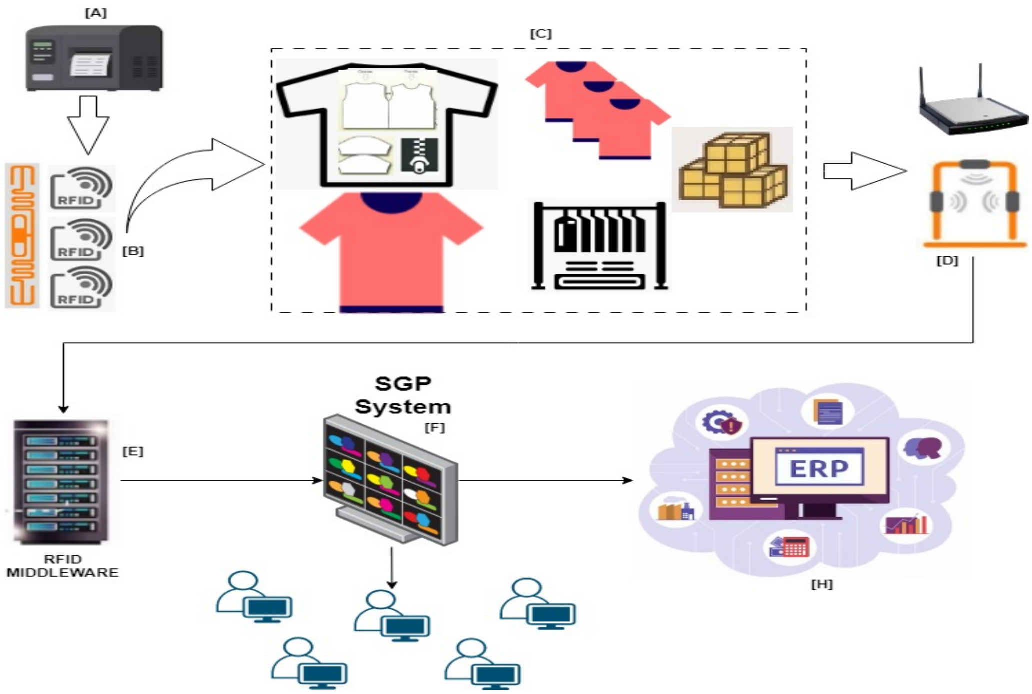
Next, the sewing stage (3.3F) refers to the mass-producing a wide range of garments. The sewing department receives all the garment kits. For instance, a single t-shirt is assembled from components of a garment kit and then attached with a textile composition label and RFID tag. Depending on the characteristics of the production order, this stage can be executed in-house or outsourced to contractors. Contractors send the assembled garments in boxes back to XPTO for inspection (3.3G) and finishing.

The finishing stage (3.3H) covers all the operations required to complete a garment, adding to its aesthetic and technical qualities through chemical, physical, and mechanical treatments such as printing, drying, washing, spotting, and steaming processes.

A final inspection is performed on finished garments for performance, overall appearance, size, and fit requirements. Finally, after being packaged (3.3I), the pieces are stored in boxes or hangers in the finished products (FG) warehouse to ensure timely delivery of the shipment to the retailers' distribution centers (3.3J).

RFID applications benefit manufacturing companies by enabling the tracking of RM, WIP, and FG inventories, as well as fixed assets (e.g. equipment, tools, and instruments) (Green et al., 2017; Liukkonen, 2015; Chongwatpol & Sharda, 2013). Nevertheless, RM and fixed assets are not traced using RFID technology in XPTO.

Figure 3.4. The components of the RFID system




Source: the author.

An RFID system is made up of three main components: an electronic tag, a reader, and middleware (Figure 3.4). First, RFID tags are printed, encoded, and tested in XPTO's service bureau (3.4A). An RFID tag contains a microchip and an antenna. Each tag needs to be encoded with a unique sequential identification (RFID ID) (3.4B) before it can be attached and used to identify a specific WIP item or finished product (3.4C).

An RFID reader (3.4D) emits a radio signal and captures data from the RFID tag, transmitting its information to be stored in a centralized database (Raza, 2022) through the RFID middleware (3.4E). Thus, all data from RFID tags may be accessed by decision-makers through the production management system applications, namely the SGP (3.4F).

SGP consists of several features used by managers from all areas of the company and also by assembly line workers through user-friendly interfaces (Liukkonen, 2015):

- Warehouse management (real-time monitoring of stock status; control and error checking of material flows; and inventory/product tracking);
- Process management (real-time monitoring and reporting of assembly status; quality control, assurance, and monitoring of WIP; automated real-time schedule management; automated identification of WIP and components);

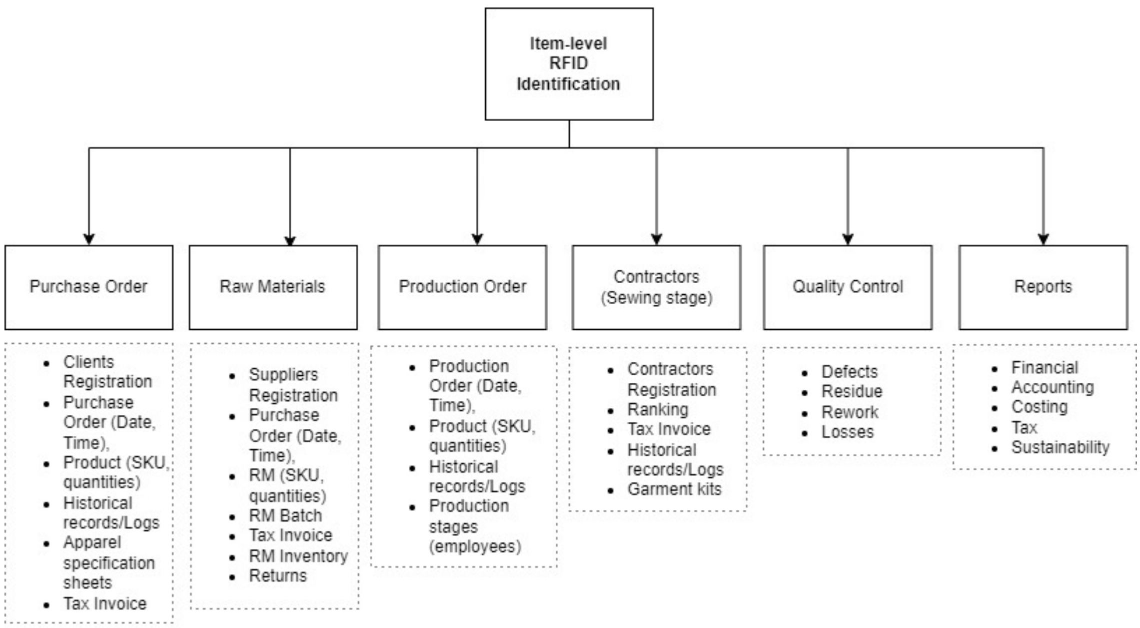
- Life cycle management (location of items at different production stages; storing production-related information and product history for service units; monitoring of processes, operations, and costs; identification of returned and repaired products; and record-keeping and updating of product history);
- SCM (maintaining records of the manufacturer, selling company, and contractors).

For instance, sourcing areas use SGP information about retailers' purchase orders, apparel specification sheets, supplier records, and also RM inventory. After-sales monitors production progress to check whether the order is subject to delivery risks. The quality control team analyzes the root cause of defects in work performed by contractors.

Synchronization was established between the SGP and ERP (Enterprise Resource Planning) systems (3.4H). SGP item-level data is aggregated at the stock-keeping unit (SKU) level and uploaded daily to the ERP via APIs (Application Programming Interface). Access to the ERP is restricted to a limited number of users such as the CIO, owners, finance department, and outsourced accounting team.

Figure 3.5 illustrates the information stored in SGP. This information is available for sharing with internal and external users. It also offers countless possibilities for obtaining insights through the integrated analysis of production, accounting, financial, and sustainability data through business intelligence and data analysis tools.

Figure 3.5. The data collected in the SGP system




Source: the author.

## 3.4 Data analysis

We collected and analyzed qualitative data from the case study database in an interactive way to develop a grounded theory from the single case study, according to Glaser and Strauss (1967). The grounded theory method is considered a tool for "understanding invisible things" (Star, 2011) and posits that theory emerges from data (Krieger et al., 2021; Riihimäki & Pekkola, 2021, Tu, 2017). The coding process of transcribed data was performed in four stages based on Charmaz (2014): initial, focused, axial, and theoretical coding.

The initial coding resulted in 503 concept nodes related to interviewees' quotes from the transcribed data. Then, after eliminating non-significant nodes, the focus coding step presented 478 concept nodes. In the axial coding stage, these remaining nodes were grouped into 11 categories and 67 subcategories. Table 3.2 shows the categories, subcategories, and their respective number of nodes per responding area.

Table 3.2. The categories and subcategories resulting from the coding process

| | CIO Gr=194 | OWN Gr=9 | FBS Gr=25 | TRS Gr=25 | PPC Gr=68 | FIN Gr=50 | AFS Gr=26 | QLC Gr=27 | FNS Gr=25 | ACC Gr=29 |
|---|---|---|---|---|---|---|---|---|---|---|
| **1. XPTO Manufacturer** | | | | | | | | | | |
| **XPTO_Characteristics Gr=9** | 4 | 0 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 1 |
| **XPTO_Contractors_Sewing Gr=12** | 2 | 0 | 0 | 0 | 3 | 1 | 0 | 3 | 3 | 0 |
| **XPTO_Private_Label Gr=7** | 3 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 |
| **XPTO_Products Gr=5** | 2 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| **XPTO_RFID_Project Gr=3** | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| **2. Retailers** | | | | | | | | | | |
| **Retailers_Clients Gr=7** | 4 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| **Retailers_Requirements Gr=11** | 2 | 0 | 1 | 1 | 0 | 1 | 3 | 3 | 0 | 0 |
| **Sustainability Gr=8** | 4 | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 |
| **Purchase_Order_Retailer Gr=8** | 0 | 0 | 1 | 1 | 2 | 0 | 4 | 0 | 0 | 0 |
| **Fashion_Market Gr=5** | 0 | 0 | 1 | 0 | 2 | 0 | 1 | 0 | 0 | 1 |
| **3. RFID Post-Adoption** | | | | | | | | | | |
| **RFID_ItemLevel_EPC Gr=14** | 7 | 0 | 0 | 1 | 3 | 1 | 0 | 1 | 1 | 2 |
| **RFID_Accuracy Gr=10** | 3 | 1 | 1 | 0 | 2 | 2 | 0 | 0 | 1 | 0 |
| **RFID_Traceability Gr=18** | 8 | 0 | 1 | 0 | 5 | 1 | 1 | 2 | 0 | 0 |
| **RFID_Online_Realtime Gr=10** | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **4. TOE-Technical Factors** | | | | | | | | | | |
| **TOE_T_Relative Advantage Gr=19** | 6 | 2 | 1 | 0 | 6 | 3 | 0 | 1 | 0 | 0 |

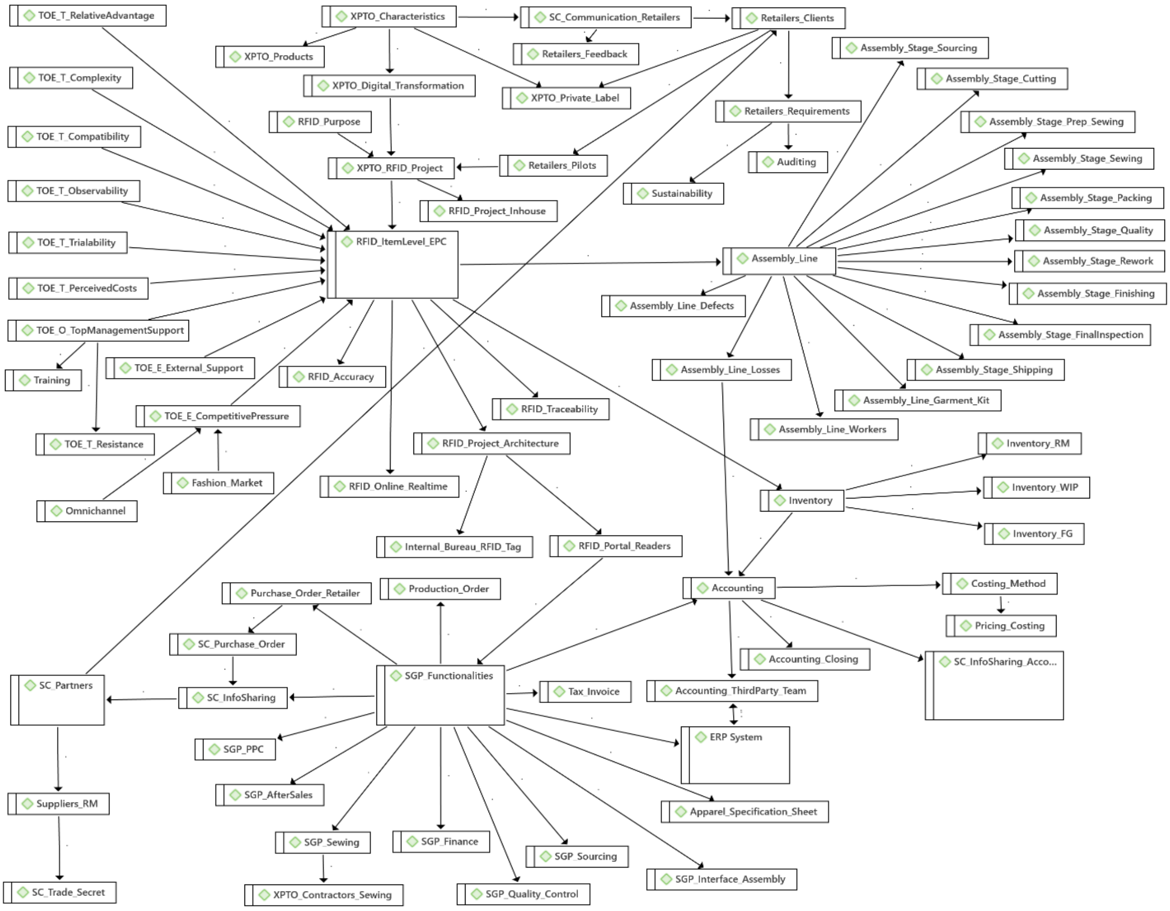
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **TOE_T_Compatibility Gr=3** | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **TOE_T_Complexity Gr=5** | 3 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| **TOE_T_Observability Gr=8** | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |
| **TOE_T_Trialability Gr=3** | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **TOE_T_PerceivedCosts Gr=11** | 7 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| **TOE_O_ TopManagementSupport Gr=5** | 4 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 1 |
| **5. TOE-Environmental Factors** | | | | | | | | | | |
| **TOE_E_CompetitivePressure Gr=6** | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 1 |
| **6. RFID Project Architecture** | | | | | | | | | | |
| **RFID_Project_Architecture Gr=1** | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **RFID_Portal_Readers Gr=13** | 8 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 3 | 0 |
| **RFID_Project_Inhouse Gr=4** | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Internal_Bureau_RFID_Tag Gr=18** | 11 | 1 | 0 | 2 | 2 | 0 | 0 | 0 | 1 | 1 |
| **7. Assembly Line** | | | | | | | | | | |
| **Assembly_Line Gr=8** | 3 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 |
| **Production_Order Gr=9** | 5 | 0 | 1 | 0 | 2 | 0 | 1 | 0 | 0 | 0 |
| **Assembly_Stage_Sourcing Gr=3** | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Assembly_Stage_Cutting Gr=6** | 2 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 |
| **Assembly_Stage_Prep_Sewing Gr=2** | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| **Assembly_Line_Garment_Kit Gr=5** | 3 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| **Assembly_Stage_Sewing Gr=5** | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| **Assembly_Stage_Quality Gr=1** | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| **Assembly_Stage_Rework Gr=5** | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 1 |
| **Assembly_Line_Defects Gr=3** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 1 |
| **Assembly_Line_Losses Gr=8** | 5 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 |
| **Assembly_Stage_Finishing Gr=2** | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| **Assembly_Stage_Packing Gr=2** | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| **Assembly_Stage_FinalInspection Gr=4** | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 |
| **Assembly_Stage_Shipping Gr=3** | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 0 |
| **Assembly_Line_ Workers Gr=4** | 3 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| **8. Inventory** | | | | | | | | | | |
| **Inventory Gr=9** | 1 | 0 | 2 | 0 | 2 | 0 | 1 | 0 | 0 | 3 |
| **Inventory_FG Gr=6** | 2 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 1 | 0 |
| **Inventory_RM Gr=10** | 2 | 0 | 0 | 2 | 2 | 1 | 1 | 0 | 1 | 1 |
| **Inventory_WIP Gr=4** | 2 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| **9. Accounting** | | | | | | | | | | |
| **Accounting Gr=8** | 0 | 0 | 0 | 0 | 0 | 7 | 1 | 0 | 0 | 0 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Accounting_Closing Gr=6** | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| **Accounting_ThirdParty_Team Gr=2** | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| **Costing_Method Gr=16** | 5 | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 0 | 2 |
| **Pricing_Costing Gr=7** | 2 | 0 | 2 | 1 | 0 | 1 | 1 | 0 | 0 | 0 |
| **Tax_Invoice Gr=15** | 5 | 0 | 0 | 1 | 2 | 3 | 0 | 0 | 1 | 3 |
| **ERP System Gr=12** | 8 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 1 |
| **10. SGP System** | | | | | | | | | | |
| **SGP_Functionalities Gr=15** | 13 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| **SGP_AfterSales Gr=2** | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| **SGP_Finance Gr=4** | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 |
| **SGP_PPC Gr=3** | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 |
| **SGP_Quality_Control Gr=4** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 |
| **SGP_Sewing Gr=2** | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| **SGP_Sourcing Gr=5** | 0 | 0 | 1 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| **SGP_Interface_Assembly Gr=6** | 5 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| **11. Omnichannel Supply Chain** | | | | | | | | | | |
| **SC_Partners Gr=9** | 1 | 0 | 3 | 3 | 1 | 0 | 0 | 0 | 1 | 0 |
| **SC_Communication_ Retailers Gr=6** | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| **SC_InfoSharing Gr=10** | 7 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 1 | 0 |
| **SC_InfoSharing_ Accounting Gr=10** | 1 | 0 | 0 | 0 | 0 | 5 | 2 | 0 | 0 | 2 |
| **SC_Purchase_Order Gr=2** | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| **Suppliers_RM Gr=7** | 2 | 0 | 1 | 1 | 0 | 1 | 2 | 0 | 0 | 0 |

Source: the author.

The relationships between the categories and subcategories were established as illustrated by the map generated in the Atlas.ti software (Figure 3.6).

Figure 3.6. The map of relationships




Source: the author.

## 3.5 Results and Discussion

In this section, the data analysis results are aligned with the theoretical concepts and constructs provided by the literature review, presenting the theoretical model (Figure 3.7) and propositions to address the research questions.

**RQ1.** How do technological, environmental, and organizational factors impact the post-adoption of RFID technology in a manufacturing company aligned with omnichannel strategies of the fashion industry?

### TOE: Technological Factors

### Relative advantage

The advantages of RFID technology concerning other technologies, such as the identification of individual garments, the simultaneous reading of a large number of items

(WIP and FG inventories), and the real-time update of the SGP system, have provided several benefits to the company XPTO.

The counting of WIP and FG inventories performed manually by one worker, which was 16,000 units per day, increased to 80,000 units with the RFID use. Moreover, there was a reduction in the number of operational errors, such as errors in apparel size labeling.

Thus, workers no longer need to enter data into the SGP system on the assembly line. When garments are passed through the RFID portal readers, each item is identified in the production stage, automatically generating data in SGP. Then, the worker can check the garments' records that are displayed on the system interface screen.

Furthermore, the use of RFID portals reduced the number of garment quality checkpoints, resulting in the elimination of duplicated labor efforts and costs at each stage of production and making it more dynamic. There was also an improvement in controlling the garments assembled by sewing contracting companies. RFID allows XPTO to identify and check how many and which apparel items must be delivered by each contractor.

The RFID system contributed to reducing the number of product returns by retailers caused by errors in the quantity and quality of garments produced by XPTO, in addition to improving the accuracy of delivering products on time. Consequently, there was a reduction in fines for late orders from retailers. In this way, customer relationships were also improved.

Accurate accounting of garments at each stage of production allows for reliable data-based analysis and more assertive decision-making at the strategic, tactical, and operational levels (Stambaugh & Carpenter, 2009). Before RFID adoption, investigating a problem (e.g., product defect) required exhaustive and time-consuming work for managers to gather information from physical documents spread across the company's areas, and from supplier and contractor contacts.

Thus, the accuracy, agility, and visibility provided by the RFID system allowed the generation and sharing of higher-quality information with supply chain partners (Kgobe & Ozor, 2021; Raza, 2022). For example, XPTO not only reports failures in its production line to retailers but also analyzes and presents them with solutions in advance.

Each apparel item is identified by a unique serial number encoded on an RFID tag microchip (RFID ID). This identification code allows access to all related information available in the SGP, including historical production records, tracks of clothing components' origin (raw materials), costs and prices, and accounting-financial, tax, and quality control information (Figure 3.5). The SGP system maintains historical records of each garment, from receipt of raw materials to shipment of finished goods, aggregating information at each stage of production. Thus, it is possible to identify each worker who handled the product and account for the time consumed by the assembly line processes.

Traceability can be expanded across the entire omnichannel supply chain (Kgobe & Ozor, 2021). For example, a customer purchased a defective t-shirt through ACME's BOPS channel. The ID recorded on the RFID tag attached to the t-shirt provides knowledge of the garment's journey through the supply chain, from the sales floor and backroom of retail stores, distribution centers, and apparel manufacturers, tracing it back to the source of raw materials.

In line with previous studies on RFID adoption in manufacturing (Iguma & Imoniana, 2023; Mabad et al., 2021; Fosso Wamba et al., 2016), relative advantage is confirmed as the main driver of the actual use of RFID technology in an omnichannel context.

**Complexity**

XPTO faced a series of challenges to implement and operationalize the RFID system in the company's production line. Electromagnetic fields, humidity, and temperature problems have been solved. Depending on the factory's electrical configuration, the reading of RFID tags may be compromised by electromagnetic interference.

RFID tags can be damaged if they are bent or exposed to certain levels of humidity and temperature. Therefore, XPTO trained production line workers to avoid waste and rework when handling RFID tags. The most difficult part of the training was making employees aware of the importance of the RFID tag as the “heart” of the garment. Another challenge was building the in-house bureau service by bringing together different printing equipment technologies and encryption methods used by retailers.

Previous studies do not support Complexity as a determining factor for RFID adoption (Mahdaly & Adeinat, 2022; Mabad et al., 2021). However, our results show that several challenges arise when implementing RFID. If not adequately addressed, these challenges could compromise the successful adoption and widespread use of RFID in the enterprise.

**Compatibility**

From the technological point of view, the factory's digital transformation process combined different projects, including the development of the SGP system followed by the implementation of the RFID system. The integration of these new systems with the ERP system went smoothly and did not present any compatibility problems.

On the other hand, the biggest challenge was integrating the RFID system with offline manufacturing, as the work of counting WIP and FG inventories was carried out manually by the assembly line staff. For this reason, the company's project team developed user-friendly interface screens connected to the SGP system, providing high levels of usability and facilitating the training and rapid introduction of new workers into the RFID-based manufacturing process.

Mahdaly and Adeinat (2022) and Fosso Wamba et al. (2016) provided evidence on the relevance of Compatibility on RFID adoption, while Mabad et al. (2021) did not. Our results revealed that compatibility aspects regarding the current system, organizational culture, and business practices must be considered in the RFID adoption process.

**Trialability**

The participation of XPTO in ACME pilot projects provides the manufacturer with support for the first experience with RFID. Subsequently, creating an in-house bureau for coding and printing RFID tags allowed XPTO to try and learn about technologies (e.g., RFID tag components, RFID readers, encryption techniques) widely used by large retailers, leading XPTO to develop its solution.

This solution involved the integration, testing, and adjustment of different types of RFID printers, tags, reading devices, and middleware. This experience provided the company with the opportunity to address several issues that arose from the RFID system operating on the assembly line. Likewise, trialability was a relevant factor in determining the post-adoption of RFID by omnichannel retail. Iguma and Imoniana (2023) found that three large retailers benefited from running RFID pilot projects in their stores.

**Observability**

The results of using RFID in the company's day-to-day activities were noticed by managers in internal areas (sourcing, PPC, after-sales, quality control, and finance) and by the third-party accounting team. There is a growing demand for new functionalities for analyzing data captured from RFID integrated with other types of data (e.g., purchase order, raw material stock, production order, invoice) in SGP, assisting decision-makers at all levels of the company.

At the supply chain level, retailers have identified apparel manufacturers that control their internal production processes with RFID and have managed to reduce errors in counting and shipping finished products (TI Inside, 2022a). Furthermore, the accuracy of production data, traceability, and visibility of products contributed to improving the quality of information shared with supply chain partners (for example, order fulfillment and accounting financial reports).

Observability was not supported by Mabad et al. (2021) as a relevant technological factor. However, like the research on omnichannel retailers (Iguma & Imoniana, 2023), our study provides evidence of the increasingly widespread use of RFID and its benefits inside and outside the apparel manufacturing company.

**Perceived Costs**

RFID technology demands an expensive investment for companies (Lai et al., 2018; Bhattacharya & Wamba, 2015). The perceived costs of innovations may inhibit their adoption despite the perceived benefits. The cost of investment and uncertainty of return on investment represent barriers to RFID adoption (Shin & Eksioglu, 2015).

The high investment required to adopt RFID makes it unfeasible for most companies in the garment industry compared to large retail companies. When RFID technology was first introduced to XPTO, there was no technical support and resources available to implement it. Years later, the adoption of RFID became economically and technically viable for XPTO when the RFID pilot project was proposed by ACME.

Retailers typically print and ship RFID tags to their supply chain partners. In contrast, XPTO maintains clients' RFID label printers in its internal bureau service, establishing a printer lease contract with them. Additionally, these retailers are kept up to date on all label quantities printed at the XPTO bureau service.

This solution benefited the company by gaining autonomy and agility. It also helped to avoid excessive label printing and waste, as XPTO only prints the number of labels according to the number of pieces produced in the cutting phase.

Regarding the internal processes of the production line, there were no extra costs for attaching RFID tags to apparel items. RFID tags are sewn together with textile composition tags. Furthermore, all projects related to digital transformation at XPTO were planned and carried out internally by the CIO and his IT team. The company did not use external RFID service providers or consulting.

Thus, perceived costs are closely related to the RFID solutions developed by the company. Previous studies also found evidence of a perceived cost's negative influence on RFID adoption (Iguma & Imoniana, 2023; Tu, 2018).

***Proposition 1:*** *Relative advantage (+), complexity (-), compatibility (+), observability (+), trialability (+), and perceived costs (-) are technological factors that influence the post-adoption of RFID by an apparel manufacturing company in the omnichannel context.*

## TOE: Organizational Factors

### Top Management Support

Top managers provide direction and promote commitment to creating an environment suitable for innovation, process reengineering, and overcoming employee resistance to change (Bhattacharya & Wamba, 2015).

In this case, the owners' vision of innovation, technology, and sustainability led XPTO to participate in several strategic pilot projects for its clients (e.g., Product Lifecycle Management, RFID, 3D modeling). XPTO's owners decided to launch the factory's digital transformation process based on the business plan presented by the CIO to develop the RFID project internally.

The company promoted intense work to raise awareness among assembly line personnel regarding the digital transformation process, training workers to properly handle RFID tags and counting WIP and FG items with RFID. All of these initiatives helped to reduce employees' resistance to changes resulting from the digital transformation process.

Most studies agree with top management support as an organizational factor influencing the post-adoption of RFID (Iguma & Imoniana, 2023; Mabad et al., 2021; Mahdaly & Adeinat, 2022).

### Firm size

Firm size refers to the organization's structure and available resources. Thus, larger companies are considered more capable of mobilizing the necessary capital and absorbing risks and costs when experimenting with new technologies (Fosso Wamba et al., 2016).

XPTO's characteristics as a garment manufacturing company are different from that of its large retail clients. XPTO has a lean organizational structure in terms of the number of business areas and employees. According to those interviewed, the adoption of RFID at XPTO was made possible by the partnership with retail companies that widely use the technology in their network of stores and distribution centers spread across the country. Thus, firm size is an organizational factor in RFID post-adoption in line with previous research (Iguma & Imoniana, 2023; Mahdaly & Adeinat, 2022; Mabad et al., 2021).

***Proposition 2:*** *Top management support (+) and firm size (+) are organizational factors that influence the post-adoption of RFID by an apparel manufacturing company in the omnichannel context.*

## TOE: Environmental Factors

### Competitive Pressure

A more competitive environment can encourage companies to quickly adopt new technological trends that others are beginning to adopt or are already using (Zhu et al., 2006). In addition to competitors, supply chain partners and customers are other external sources of pressure considered by previous studies (Tu, 2018).

Competing manufacturers did not influence the adoption of the technology at XPTO. In the national context, apparel manufacturers rarely use RFID technology in their internal production operations. However, successful cases of RFID adoption from other industry sectors contributed to the development of the RFID system at XPTO.

Large retail companies require their supply chain suppliers to deliver finished products attached to RFID tags, such as Wal-Mart in 2003 (Liukkonen, 2015). Therefore, the RFID adoption by XPTO is associated with its relationship with its clients. Previous studies have presented contrasting results regarding the influence of competitive pressure on RFID adoption (Mahdaly & Adeinat, 2022; Tu, 2018).

***Proposition 3:*** *Competitive pressure is the environmental factor that positively influences the post-adoption of RFID by an apparel manufacturing company in the omnichannel context.*

***RQ2.*** *How does RFID post-adoption by a manufacturing firm contribute to information sharing in the omnichannel supply chain?*

**Information Sharing**

Chongwatpol & Sharda (2013) developed a simulation model to evaluate the impact of RFID visibility on specific waste in shop floor operations in manufacturing and supply chains. Their results show that information visibility through RFID reduces inventory waste resulting from excess WIP production.

Information sharing refers to the extent to which a firm makes strategic, tactical, critical, or proprietary information available promptly to its supply chain partners (Tian et al., 2021; Liu et al., 2016). Tian et al. (2021) reported that digital manufacturing technologies (e.g., RFID) influence the three levels of supply chain integration based on information sharing: internal, supplier, and customer integrations. DMTs include RFID and other digital technologies such as three-dimensional (3D) printing, automated processes, and robotics.

The RFID application developed by XPTO provided a series of benefits to improve information sharing in the omnichannel retail supply chain, mainly in terms of SC visibility and integration (Figure 3.2). First, the internal bureau of XPTO is connected to its clients' systems. In this way, retailers are automatically informed about the quantities of RFID tags printed and encoded by XPTO.

XPTO provides its clients with the most accurate and current status of production progress related to each retailer's purchase order. The manufacturer can report in advance the occurrence of failures on the production line, diagnose the problem, and propose a solution to the client. The SGP system allows the management of contracted partners in the sewing phase, to obtain more precise information to control the assembled products and the performance of the work carried out by them.

Identifying each item allows XPTO to quickly detect product defects and losses by tracking them along the supply chain, from the retailer's store to raw material suppliers. In this way, information about the source of the problem is identified, analyzed, and shared to correct supply chain processes.

Finally, the outsourced accounting team accesses the ERP system to check all updated daily entries from the SGP system. They assist the company in generating regular financial statements (e.g., balance sheets) and eventually customized financial reports on demand for the clients and banks. Manufacturers need to demonstrate their operational, financial, and sustainable capabilities to meet the demands of their clients. Improving the quality of information also contributes to the issuance of invoices for tax obligations.

***Proposition 4:*** *The RFID post-adoption by an apparel manufacturing company positively influences the three levels of information sharing in an omnichannel supply chain: internal, supplier, and customer.*

***RQ3.*** *How does RFID post-adoption by a manufacturing firm in the omnichannel context significantly improve the qualitative characteristics of financial information (relevance, faithful representation, understandability, timeliness, comparability, and verifiability)?*

**Inventory**

In the apparel industry, merchandise is usually categorized into two groups: basic products and fashion products. Basic products have longer selling seasons, while fashion products have shorter life cycles (Sen, 2008).

Retail companies manage inventories of a wide variety of product types and SKUs in high volumes. In this context, inventory counts are used to adjusting records and identify losses in inventories held for sale (Iguma & Imoniana, 2023).

In contrast, inventory levels in XPTO are generally low and maintained at levels necessary to meet retailers' purchase orders, as well as to prevent production disruptions. While RM is subject to spoilage, WIPs are used in the production line, and FG are immediately shipped to customers upon completion of the production order.

Changes in the omnichannel retail market impact product demands for manufacturers and, consequently, their internal operational processes (Ailawadi, 2021). XPTO used to produce 70% of basic products and 30% of fashion products. Basic products are those supplied to customers regularly, while fashion products are limited to seasonal fashion collections. In recent years, XPTO's production has radically changed to 5% of basic products and 95% of fashion products, making production planning and inventory management of raw materials and WIP items more challenging due to the less predictable scenario.

**Accounting practices: Cost Accounting and Loss recognition**

RFID and IoT technologies allow the tracking of accounting data from physical objects, through accounting books, invoicing, and other accounting tools that will feed corporate reports for internal and external users (Valentinetti & Munoz, 2021).

Management accounting encompasses cost accounting, cost reporting and analysis, and decision support with cost planning, aiming to provide accurate, timely, and relevant information to assist management in planning and decision-making (Appelbaum et al., 2017). These decisions in manufacturing companies refer to pricing, offering new products or discontinuing products, make versus buy, in-house versus outsourcing, selection of contractors, plant expansion or contraction, and equipment purchases (Boyd & Cox III, 2002).

The XPTO factory utilizes three warehouses (W1, W2, and W3). W1 is used to store both RM received from fabric and trim suppliers and finished products for shipment to retailers (Figure 3.3). When the manufacturing process begins with the cutting stage, RM items are moved to W2. A03 is the warehouse to store defective raw materials for further return to suppliers. In this way, W2 is used by all of the WIP production stages aggregating costs as production advances to finished products (Liukkonen, 2015).

In accounting practice, RM, WIP, and FG inventories are considered current assets on the balance sheet. WIP refers to unfinished products currently in development or assembly. It helps monitor production progress and manage the flow of manufacturing costs from one production area to another. When the product is finished, it switches from WIP to being categorized as FG. Finally, when FG are sold, it moves to the cost of goods sold (COGS) which is reported on the company's income statement.

Drum et al. (2017) study on workarounds in an ERP system revealed that AIQ can be compromised by inaccurate or missing entries in the accounting system. In this case, it compromises the inventory valuation, cost of goods sold (COGS) or other expense items, accounts payable, and sales tax payable. Davis (2004) predicted the potential use of RFID to generate cost data associated with each inventory item and to determine inventory levels and the cost of goods sold more accurately.

In XPTO, the unique identification of a garment with RFID allows counting the labor and machine time consumed in each completed production stage, as well as which workers were involved (Stambaugh & Carpenter, 2009). Cost is also measured differently whether a garment was assembled by an in-house team or a contractor. RFID application provides accuracy of WIP and FG inventory counts. Although raw materials (RM) are not controlled with RFID technology, the SGP system enables the integration of a finished garment with the respective production batch of raw materials consumed in the assembly line.

In traditional cost accounting, product costs consist of direct labor, raw materials, and overhead. Profit per unit is the decision-making criterion in this accounting system and refers to the sales price minus the cost of the product (Boyd & Cox III, 2002). Conley et al. (2019) show that the financial performance of a company changes for the same operational performance based on the inventory costing method adopted, and how these methods influence COGS, value of items in inventory, and therefore profits.

Losses refer to goods or services consumed abnormally and involuntarily. The material losses produced by apparel industries impact the environment. They refer to different types of waste, including overproduction, waiting, transporting, inappropriate processing, unnecessary inventory, and unnecessary motions in production (Dechampai et al., 2021). Bixler and Honhon (2021) identified other types of waste in the retail industry in the form of time, labor, cash flow, and product obsolescence.

According to Iguma and Imoniana (2023), three retail companies agree that loss recognition and loss provision are the accounting practices most affected by the adoption of RFID, which in turn improves AIQ. In XPTO, the use of RFID allows the real-time identification of losses that occurred in each assembly line stage. Loss rates were found higher in the sewing stage, mainly when completed by contractors and in the inspection stage conducted by the quality control team. The most common losses refer to damaged FG due to tears, holes, incorrect cuts, and oil contamination.

Dechampai et al. (2021) identified production losses in the lingerie industry in Thailand using material flow cost accounting (MFCA). Likewise, they found larger losses in the cutting section, followed by the sewing section and the quality control section.

***Proposition 5:*** *The Post-adoption of RFID positively influences cost accounting practices, valuation of WIP and finished products inventories, recognition of losses, and consequently to the quality of accounting information.*

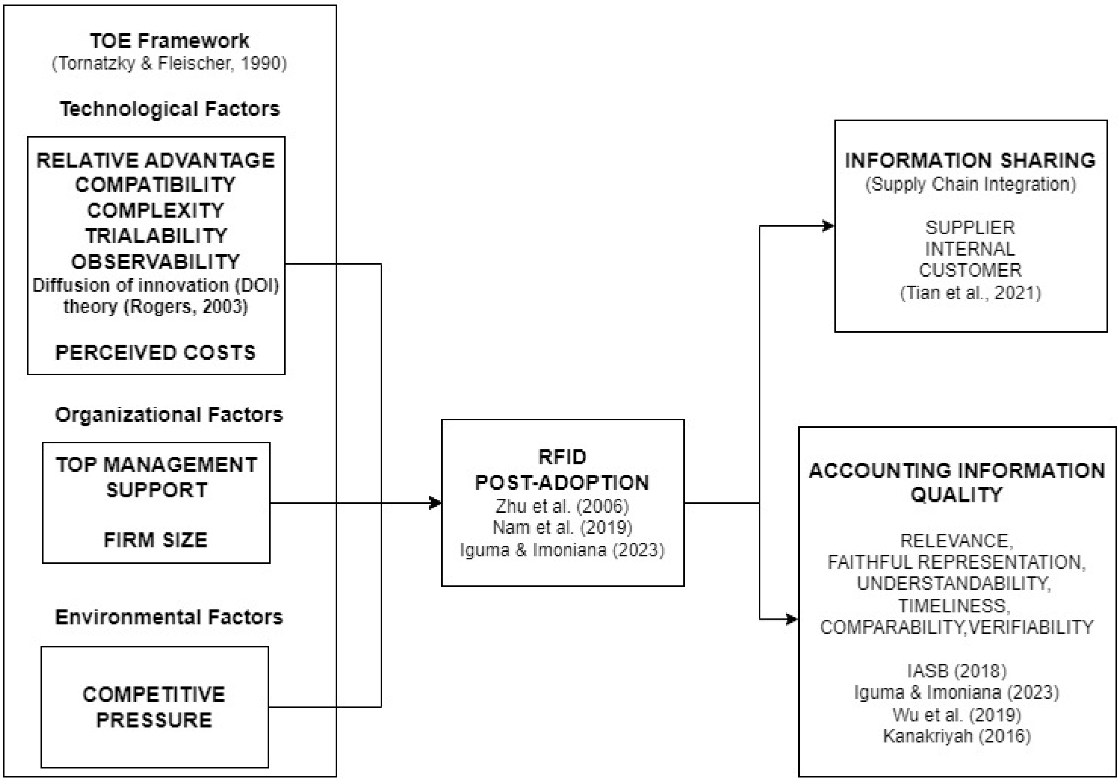
**Accounting Information Quality (AIQ)**

As RFID post-adoption contributes to accounting practice, we evaluated the qualitative characteristics of accounting information (IASB, 2018; Iguma & Imoniana, 2023; Wu et al., 2019; Kanakriyah, 2016) with the support of the accounting practices consultant to associate them with RFID features.

- Relevance: visibility in the production line and accuracy of inventory records of WIP and FG through the RFID system contribute to the confirmatory and predictive value of accounting information, accountability, and decision-making.
- Faithful representation: accuracy in garment counts with RFID at each stage of the production line, loss identification, and the mitigation of record errors contribute to the improvement of accounting information in terms of integrity, neutrality, and absence of errors.
- Timeliness: updating accurate stock and real-time production data in the SGP and ERP systems for generating accounting and financial reports allows for more assertive decision-making for internal and external users.
- Comparability: automation of inventory counting with RFID has contributed to the standardization of processes in the production line and garment quality checkpoints.
- Understandability: The RFID system has the potential to create large amounts of accurate data on inventory and production line progress, enabling integrated analysis of financial and non-financial information using business intelligence tools.
- Verifiability: The RFID system allows the creation of historical data for each garment throughout the supply chain, from raw material suppliers to retail stores. It also enables its association with accounting, financial, tax, and cost information.

***Proposition 6:*** *Relevance, faithful representation, timeliness, comparability, understandability, and verifiability are the quality of the accounting information dimensions positively influenced by the RFID post-adoption.*

Figure 3.7. The theoretical model




Source: the author.

### 3.6 Conclusion

We present an in-depth single case study to investigate how a manufacturing company develops item-level RFID applications and how their post-adoption impacts the areas of accounting and omnichannel supply chain, contributing to filling the research gaps presented. Our findings revealed that RFID post-adoption is influenced by three contextual factors and their respective dimensions: technological (relative advantage, complexity, compatibility, observability, trialability, and perceived costs); organizational (top management support and firm size); and environmental (competitive pressure).

The post-adoption of RFID in XPTO is characterized by the wide use of RFID in all internal areas of the company. More and more new functionalities are developed in the SGP system for integrated analysis of data captured by the RFID system with operational, business, accounting, financial, tax, and sustainability data.

The results of the analysis also show that post-adoption of RFID contributes to improved information sharing for the omnichannel supply chain at three levels of integration: internal, supplier, and customer. The information shared included quantities of printed RFID tags, production progress of a purchase order, assembly progress by contracted partners in the sewing phase, traceability of defective products throughout the supply chain, tax invoices, accounting, and financial information.

RFID also contributed to the accounting practices of WIP and FG inventories, cost accounting, and loss recognition, thus influencing the measurement of items in stock, the cost of goods sold (COGS), and, therefore, results in the financial reports. We present how AIQ was improved with the post-adoption of RFID, associating the technology features with each AIQ dimension: relevance, faithful representation, comprehensibility, timeliness, comparability, and verifiability.

The present study contributes to theory by presenting six propositions and an interdisciplinary theoretical framework based on the TOE model, by integrating IS, SCM, and accounting research fields. While most studies focus on the intention and decision to adopt RFID, our work investigates the increasing use of the technology in apparel manufacturing companies.

In the manufacturing industry, the adoption of advanced digital technologies such as item-level RFID is considered insipient. In this way, our work can contribute to practice, by providing insights for companies planning to develop their own RFID implementation projects.

Although a single case study can richly describe a phenomenon, it has some limitations related to the generalization of results. To increase external validity, we conducted coding and data analysis aligned with theory and validated conceptual models provided by previous research on RFID adoption in manufacturing and supply chain contexts.

Finally, we hope our exploratory study opens new research avenues. First, item-level RFID can facilitate the shift to the specific identification method of inventory costing. Therefore, further investigation into this implication for accounting practices and standards is necessary. Secondly, we suggest studying external audit work that can be impacted by the adoption of RFID by manufacturers and retailers. Third, a survey is recommended to examine different industries more broadly on the post-adoption of RFID in the supply chain environment.

**References**

Agrawal, T. K., Kalaiarasan, R., Olhager, J., & Wiktorsson, M. (2022). Supply chain visibility: A Delphi study on managerial perspectives and priorities. *International Journal of Production Research*. https://doi.org/10.1080/00207543.2022.2098873.

Ahlskog, M., Bruch, J., & Jackson, M. (2017). Knowledge integration in manufacturing technology development. *Journal of Manufacturing Technology Management*, 28(8), 1035-1054. https://doi.org/10.1108/JMTM-03-2017-0051.

Ailawadi, K. L. (2021). Commentary: Omnichannel from a Manufacturer's Perspective. *Journal of Marketing*, 85(1), 121-125. https://doi.org/10.1177/0022242920972639.

Alonso-Garcia, J., Pablo-Martí, F., & Nunez-Barriopedro, E. (2021). Omnichannel management in B2B. Complexity-based model, empirical evidence from a panel of experts based on fuzzy cognitive maps. *Industrial Marketing Management*, 95, 99-113. https://doi.org/10.1016/j.indmarman.2021.03.009.

Alonso-Garcia, J., Pablo-Marti, F., Núñez-Barriopedro, E., & Cuesta-Valiño, P. (2023). Digitalization in B2B marketing: omnichannel management from a PLS-SEM approach. *Journal of Business & Industrial Marketing*, 38(2), 317-336. https://doi.org/10.1108/JBIM-09-2021-0421.

Appelbaum, D., Kogan, A., Vasarhelyi, M. A., & Yan, Z. (2017). Impact of business analytics and enterprise systems on managerial accounting. *Int. J. Account. Inf. Syst.*, 25, 29-44. https://doi.org/10.2308/ajpt-51684.

Arvidsson, A., & Melander, L. (2020). The multiple levels of trust when selecting suppliers – Insights from an automobile manufacturer. *Industrial Marketing Management*, 87, 138–149. https://doi.org/10.1016/j.indmarman.2020.02.011.

Ben-Daya M., Hassini, E., & Bahroun, Z. (2017): Internet of things and supply chain management: a literature review. *International Journal of Production Research*. https://doi.org/10.1080/00207543.2017.1402140.

Bhattacharya, M., & Wamba, S. F. (2015). A Conceptual Framework of RFID Adoption in Retail Using TOE Framework. *International Journal of Technology Diffusion*, 6(1), 1-32. https://doi.org/10.4018/ijtd.2015010101.

Bixler, M. J., & Honhon, D. (2021). Exploring the Connections between Backrooms, Inventory Record Inaccuracies, and Waste. *Sustainability*, 13(17), 9490. https://doi.org/10.3390/su13179490.

Boyd, L. H., & Cox III, J. F. (2002). Optimal decision-making using cost accounting information. *International Journal of Production Research*, 40(8), 1879-1898. https://doi.org/10.1080/00207540210122239.

Caro, F., & Sadr, R. (2019). The Internet of Things (IoT) in retail: Bridging supply and demand. *Business Horizons, Elsevier*, 62(1), 47-54. https://doi.org/10.1016/j.bushor.2018.08.002.

C&A (2021). Sustainability Annual Report 2021. Available in https://sustentabilidade.cea.com.br/pt-br/Documents/C%26A_RA_2021_ENG-V8.pdf

C&A (2023). Processo de monitoramento da nossa rede de fornecimento. Available in https://sustentabilidade.cea.com.br/pt-br/Paginas/Monitoramento.aspx.

Centauro (2020). Relatório anual de sustentabilidade 2020. Available in https://ri.gruposbf.com.br/a-companhia/relatorio-anual-esg/

Charmaz, K. (2014). *Constructing grounded theory (second edition)*. Thousand Oaks, CA: Sage.

Chongwatpol, J., & Sharda, R. (2013). Achieving Lean Objectives through RFID: A Simulation-Based Assessment. *Decis. Sci.*, 44, 239-266. https://doi.org/10.1111/deci.12007.

Choy, K. L., Ho, G. T. S., & Lee, C. K. H. (2017). A RFID-based storage assignment system for enhancing the efficiency of order picking. *Journal of Intelligent Manufacturing*, 28(1), 111–129. https:// doi. org/ 10. 1007/ s10845- 014- 0965-9.

Conley, K., Natarajarathinam, M., Lu, W., & Rangan, S. (2019). Effect of Accounting Policies on Effectiveness of Inventory Management Strategies. *Engineering Management Journal*, 31(4), 246-256, https://doi.org/10.1080/10429247.2019.1652056.

Cui, L., Deng, J., Liu, F., Zhang, Y., & Xu, M. (2017). Investigation of RFID investment in a single retailer two-supplier supply chain with random demand to decrease inventory inaccuracy. *Journal of Cleaner Production*, 142, 2028-2044. https://doi.org/10.1016/j.jclepro.2016.11.081.

Davis, H. E. (2004). Technology - Radio frequency identification: the wave of the future - Because RFID use still is in its infancy, CPAs have a unique opportunity to help their clients and employers understand how it will change inventory and supply chain management -- And its inevitable effect on accounting and auditing methodologies. Journal of accountancy: publication of the American Institute of Certified Public Accountants, 198(5).

Dechampai, D., Homrossukon, S., Wongthatsanekorn, W., & Ekkachai, K. (2021). Applying Material Flow Cost Accounting and Two-Dimensional, Irregularly Shaped Cutting Stock Problems in the Lingerie Manufacturing Industry. *Appl. Sci.*, 11, 3142. https://doi.org/10.3390/app11073142.

Drum, D., Pernsteiner, A., & Revak, A. (2017). Workarounds in an SAP environment: impacts on accounting information quality. *Journal of Accounting & Organizational Change*, 13(1), 44-64. https://doi.org/10.1108/JAOC-05-2015-0040.

Dweekat, A. J., Hwang, G., & Park, J. (2017). A supply chain performance measurement approach using the internet of things: Toward more practical SCPMS. *Industrial Management & Data Systems*, 117(2), 267-286. https://doi.org/10.1108/IMDS-03-2016-0096.

Ehie, I. C., & Chilton, M. A. (2020). Understanding the influence of IT/OT Convergence on the adoption of Internet of Things (IoT) in manufacturing organizations: An empirical investigation. *Comput. Ind.*, 115, 103166. https://doi.org/10.1016/j.compind.2019.103166.

Fosso Wamba, S., Gunasekaran, A., Bhattacharya M., & Dubey, R. (2016). Determinants of RFID adoption intention by SMEs: an empirical investigation. *Production Planning & Control*, 27(12), 979-990, https://doi.org/10.1080/09537287.2016.1167981.

Gladysz, B., Corti, D., & Montini, E. (2023). Forecasting the Development of RFID Technology. *Management and Production Engineering Review*. https://doi.org/10.24425/MPER.2021.136870.

Glaser, B. G., Strauss, A. L., (1967). *The Discovery of Grounded Theory: Strategies for Qualitative Research*. Aldine de Gruyter, Hawthorne, NY.

Goyal, S., Hardgrave, B.C., Aloysius, J.A., & DeHoratius, N. (2016). The effectiveness of RFID in backroom and sales floor inventory management. *The International Journal of Logistics Management*, 27, 795-815. https://doi.org/10.1108/IJLM-03-2015-0051.

Green Jr., K. W., Zelbst, P. J., Sower, V. E., & Bellah, J. C. (2017). Impact of Radio Frequency Identification Technology on Environmental Sustainability. *Journal of Computer Information Systems*, 57(3), 269-277. https://doi.org/10.1080/08874417.2016.1184029.

Grewal, D., Gauri, D. K., Das, G., Agarwal, J., & Spence, M. T. (2021). Retailing and emergent technologies. *Journal of Business Research*, 134, 198-202. https://doi.org/10.1016/j.jbusres.2021.05.004.

Gwozdz, W., Kristian, S. N., & Müller, T. (2017). An Environmental Perspective on Clothing Consumption: Consumer Segments and Their Behavioral Patterns. *Sustainability*, 9(5), 1-27. https://doi.org/10.3390/su9050762.

Hajdas, M., Radomska, J., & Silva, S. C. (2020). The omni-channel approach: A utopia for companies? *Journal of Retailing and Consumer Services*, 102131. https://doi.org/10.1016/j.jretconser.2020.102131.

Hauser, M., & Flath, C.M., & Thiesse, F. (2021). Catch me if you scan: Data-driven prescriptive modeling for smart store environments. *European Journal of Operational Research, Elsevier*, 294(3), 860-873. https://doi.org/10.1016/j.ejor.2020.12.047.

Hopkins, J., & Hawking, P. (2018). Big Data Analytics and IoT in logistics: a case study. *The International Journal of Logistics Management*, 29(2), 575–591. doi:10.1108/ijlm-05-2017-0109.

IASB. (2018). Conceptual Framework for Financial Reporting. IFRS Foundation. Retrieved from: https://www.ifrs.org/issued-standards/list-of-standards/

Iguma, M. K., & Imoniana, J. O. (2023). Omnichannel Retailing: An Exploratory Study of the Postadoption of Radio-Frequency Identification Technology contributing to the Quality of Financial Information. *International Journal of Finance & Banking Studies*, 12(1), 48–62. https://doi.org/10.20525/ijfbs.v12i1.2519.

Kahkonen, A. (2014). Conducting a Case Study in Supply Management. *Operations and Supply Chain Management: An International Journal*, 4(1), 31-41. http://doi.org/10.31387/oscm090054.

Kanakriyah, R. (2016). The effect of using accounting information systems on the quality of accounting information according to users perspective in Jordan. *European Journal of Accounting, Auditing and Finance Research*, 4(11), 58-75. Retrieved from: https://www.eajournals.org/wp-content/uploads/The-Effect-of-Using-Accounting-Information-Systems-on-the-Quality-of-Accounting-Information-According-to-Users-Perspective-in-Jordan.pdf.

Kgobe, P., & Ozor, P. (2021). Integration of Radio Frequency Identification Technology in Supply Chain Management: A Critical Review. *Operations and Supply Chain Management: An International Journal*, 14(3), 289-300. http://doi.org/10.31387/oscm0460303.

Krieger, F., Drews, P., & Velte, P. (2021). Explaining the (non-) adoption of advanced data analytics in auditing: A process theory. *International Journal of Accounting Information Systems, Elsevier*, 41(C). https://doi.org/10.1016/j.accinf.2021.100511.

Lai, Y., Sun, H., & Ren, J. (2018). Understanding the determinants of big data analytics (BDA) adoption in logistics and supply chain management: An empirical investigation. *The International Journal of Logistics Management*, 29(2), 676-703. https://doi.org/10.1108/IJLM-06-2017-0153.

Li, Y., & Gong, X. (2022). What Drives Customer Engagement in Omnichannel Retailing? The Role of Omnichannel Integration, Perceived Fluency, and Perceived Flow. *IEEE Transactions on Engineering Management*, 1-13. https://doi.org/10.1109/TEM.2021.3138443.

Li, Z., Yang, W., Liu, X., & Li, S. (2022). Coupon strategies for competitive products in an omnichannel supply chain. *Electronic Commerce Research and Applications*, 55, 101189. https://doi.org/10.1016/j.elerap.2022.101189.

Liu, Z., Prajogo, D., & Oke A. (2016). Supply Chain Technologies: Linking Adoption, Utilization, and Performance. *Journal of Supply Chain Management*, 52(4). https://doi.org/10.1111/jscm.12117.

Liukkonen, M. (2015). RFID technology in manufacturing and supply chain. *International Journal of Computer Integrated Manufacturing,* 28(8), 861-880. https://doi.org/10.1080/0951192X.2014.941406.

Mabad, T., Ali, O., Ally, M., Wamba, S. F., & Chan, K. C. (2021). Making Investment Decisions on RFID Technology: An Evaluation of Key Adoption Factors in Construction Firms. *IEEE Access*, 9, 36937–36954. https://doi.org/10.1109/access.2021.3063301.

Mahdaly, K., & Adeinat, I. (2022). Factors that affect the adoption of RFID in the Saudi logistics industry: an empirical investigation. *The International Journal of Logistics Management*, 33(3), 1017-1039. https://doi.org/10.1108/IJLM-11-2020-0456.

Manavalan, E., & Jayakrishna, K. (2019). A review of Internet of Things (IoT) embedded sustainable supply chain for industry 4.0 requirements. *Comput. Ind. Eng*., 127, 925-953. https://doi.org/10.1016/j.cie.2018.11.030.

Margherita, E. G., & Braccini, A. M. (2021). Managing industry 4.0 automation for fair ethical business development: A single case study. *Technological Forecasting and Social Change*, 172, 121048. https://doi.org/10.1016/j.techfore.2021.121048.

McMaster, M., Nettleton, C., Tom, C., Xu, B., Cao, C., & Qiao, P. (2020). Risk Management: Rethinking Fashion Supply Chain Management for Multinational Corporations in Light of the COVID-19 Outbreak. *Journal of Risk and Financial Management*, 13(8), 173. https://doi.org/10.3390/jrfm13080173.

Myrelid, P., & Jonsson, P. (2019). Determinants of information quality in dyadic supply chain relationships. *The International Journal of Logistics Management*, 30(1), 356-380. https://doi.org/10.1108/IJLM-12-2017-0343.

Moll, J., & Yigitbasioglu, O. (2019). The role of internet-related technologies in shaping the work of accountants: New directions for accounting research. *The British Accounting Review*. https://doi.org/10.1016/j.bar.2019.04.002.

Ovezmyradov, B., & Kurata, H. (2022). Omnichannel fulfillment and item-level RFID tracking in fashion retailing. *Comput Ind Eng*, 168, 108108. https://doi.org/10.1016/j.cie.2022.108108.

Pérez-Santamaría, S., Martos-Partal, M. (2021). Analyzing the effects of private-label supplier disclosure on retailer image[J]. *Journal of Retailing and Consumer Services*, 62:102666. https://doi.org/10.1016/j.jretconser.2021.102666.

Qiu, F. (2016). Overall framework design of an intelligent dynamic accounting information platform based on the internet of things. *International Journal of Online Engineering*, 12(5), p. 14–16. https://doi.org/10.3991/ijoe.v12i05.5728.

Rashid, Y., Rashid, A., Warraich, M. A., Sabir, S. S., & Waseem, A. (2019). Case Study Method: A Step-by-Step Guide for Business Researchers. *International Journal of Qualitative Methods*, 18. https://doi.org/10.1177/1609406919862424.

Raza, S.A. (2022). A systematic literature review of RFID in supply chain management. *Journal of Enterprise Information Management*, 35(2), 617-649. https://doi.org/10.1108/JEIM-08-2020-0322.

Rejeb, A., Simske, S. J., Rejeb, K., Treiblmaier, H., & Zailani, S. (2020). Internet of Things research in supply chain management and logistics: A bibliometric analysis. *Internet Things*, 12, 100318. https://doi.org/10.1016/j.iot.2020.100318.

Renner (2020). Relatório anual de sustentabilidade. Available in https://api.mziq.com/mzfilemanager/v2/d/13154776-9416-4fce-8c46-3e54d45b03a3/9147136a-16d1-963d-4039-0a576654ac02?origin=1

Renner (2023). Guia para novos fornecedores. Available in https://www.lojasrennersa.com.br/wp-content/uploads/2023/05/guia_novos_fornecedores-2023.pdf

Reyes, P. M., & Li, S., & Visich, J. K. (2016). Determinants of RFID adoption stage and perceived benefits. *European Journal of Operational Research, Elsevier*, 254(3), 801-812. https://doi.org/10.1016/j.ejor.2016.03.051.

Riachuelo (2023). Cartilha de Fornecimento. Available in https://midia.fotos-riachuelo.com.br/fotos/hotsites/moda-que-transforma-sustentabilidade/cadeia/25-06-21/Cartilha%20de%20Fornecimento.pdf

Riihimäki, E., & Pekkola, S. (2021). Public buyer's concerns influencing the early phases of information system acquisition. *Government Information Quarterly*, 38(4), [101595]. https://doi.org/10.1016/j.giq.2021.101595.

Rogers, E. M. (2003). *Diffusion of Innovations, 5th Edition* (5th ed.): Simon and Schuster.

Rupasinghe, T. (2017). Internet of Things (IoT) Embedded future supply chains for industry 4.0: An assessment from an ERP-based fashion apparel and footwear industry. *Journal of Supply Chain Management,* 6(1), 25–40. https://doi.org/10.59160/ijscm.v6i1.1395.

Scheller, A. C., Sousa-Zomer, T. T., & Cauchick-Miguel, P. A. (2021). Lean Six Sigma in developing countries: evidence from a large Brazilian manufacturing firm. *International Journal of Lean Six Sigma*, 12(1), 3-22. https://doi.org/10.1108/IJLSS-09-2016-0047.

Şen, A. (2008). The US Fashion Industry: A Supply Chain Review. *International Journal of Production Economics*, 114, 571-593. https://doi.org/10.1016/j.ijpe.2007.05.022.

Shao, X. (2021). Omnichannel retail move in a dual-channel supply chain. *European Journal of Operational Research, Elsevier,* 294(3), 936-950. https://doi.org/10.1016/j.ejor.2020.12.008.

Shin, S., & Eksioglu, B. (2015). An empirical study of RFID productivity in the U.S. retail supply chain. *International Journal of Production Economics*, 163, 89–96. https://doi.org/10.1016/j.ijpe.2015.02.016.

Star, S. L. (2011). *Living grounded theory: Cognitive and emotional forms of pragmatism. In A. Bryant, & K. Charmaz (Eds.),* The SAGE Handbook of Grounded Theory (pp. 75–93). SAGE Publications Ltd.. https://doi.org/10.4135/9781848607941.n3.

TI Inside (2022a). TI Inside Online. Available in https://tiinside.com.br/?s=RFID

TI Inside (2022b). Riachuelo acelera gestão de estoques com tecnologia RFID. Available in https://tiinside.com.br/20/01/2022/riachuelo-acelera-gestao-de-estoques-com-tecnologia-rfid/

Tian, M. (2019). Turning a technology into many solutions: A case study of embedding an information system, *Journal of Business Research*, 23-39. https://doi.org/10.1016/j.jbusres.2019.03.053.

Tian, M., Huo, B., Park, Y., & Kang, M. (2021). Enablers of supply chain integration: a technology-organization-environment view. *Industrial Management & Data Systems,* 121(8), 1871-1895. https://doi.org/10.1108/IMDS-09-2020-0564.

Tiwari K. Khan M. S. (2020). Sustainability Accounting and Reporting in the Industry 4.0. *Journal of Cleaner Production*, 258, 1–14. 10.1016/j.jclepro.2020.120783

Tornatzky, L. G., & Fleischer, M. (1990). The processes of technological Innovation. *The Journal of Technology Transfer*, 16(1), 45-46.

Trabucco, M., & De Giovanni, P. (2021). Achieving Resilience and Business Sustainability during COVID-19: The Role of Lean Supply Chain Practices and Digitalization. *Sustainability*, 13(22), 12369. https://doi.org/10.3390/su132212369.

Treiblmaier, H. (2019). Toward More Rigorous Blockchain Research: Recommendations for Writing Blockchain Case Studies. *Front. Blockchain*, 2(3). https://doi.org/10.3389/fbloc.2019.00003.

Tsai, M. C., Wen, L., & Wu, H. C. (2010). Determinants of REID adoption intention: evidence from Taiwanese retail chains. *Information & Management*, 47, 255-261. https://doi.org/10.1016/j.im.2010.05.001.

Tu, M. (2018). An exploratory study of Internet of Things (IoT) adoption intention in logistics and supply chain management: A mixed research approach. *The International Journal of Logistics Management*, 29(1), 131-151. https://doi.org/10.1108/IJLM-11-2016-0274.

Valentinetti, D., & Munoz, F. F. (2021). Internet of things: Emerging impacts on digital reporting. *Journal of Business Research. Elsevier Inc*., 131, 549–562. https://doi.org/10.1016/j.jbusres.2021.01.056.

Velayutham, A., Rahman, A. R., Narayan, A. & Wang, M. (2021). Pandemic turned into pandemonium: the effect on supply chains and the role of accounting information. *Accounting, Auditing and Accountability Journal*, 34(6), 1404-1415. https://doi.org/10.1108/AAAJ-08-2020-4800.

Von Briel, F. (2018). The future of omnichannel retail: a four-stage Delphi study. *Technol. Forecast. Soc. Change*, 132, 217–229. https://doi.org/10.1016/j.techfore.2018.02.004.

Wang, Y. M., Wang, Y. S., & Yang, Y. F. (2010). Understanding the Determinants of RFID Adoption in the Manufacturing Industry. *Technological Forecasting and Social Change*, 77(5), 803–815. https://doi.org/10.1016/j.techfore.2010.03.006.

Wu J., Xiong, F., & Li, C. (2019). Application of Internet of Things and Blockchain Technologies to Improve Accounting Information Quality. *IEEE Access*, 7, 100090-100098. https://doi.org/10.1109/ACCESS.2019.2930637.

Xu, G., Kang, K., & Lu, M. (2022). Optimal Pricing and Customer Experience Investment Strategy in an Omnichannel Supply Chain Under BOPS. *IEEE Access*, 10, 133219-133231. https://doi.org/10.1109/ACCESS.2022.3231482.

Yang, M., Fu, M. & Zhang, Z. (2021). The adoption of digital technologies in supply chains: Drivers, process and impact. *Technological Forecasting and Social Change, Elsevier*, 169(C). https://doi.org/10.1016/j.techfore.2021.120795.

Zhang, L., & Yang, H. (2019). Incentives for RFID adoption with imperfect read rates: Wholesale price premium versus cost sharing. *Journal of the Operational Research Society*. https://doi.org/10.1080/01605682.2018.1506252.

Zhu, K., Kraemer, K.L., & Xu, S. (2006). The process of innovation assimilation by firms in different countries: a technology diffusion perspective on e-business. *Management Science*, 52(10), 1557-1576. https://doi.org/10.1287/mnsc.1050.0487.

# 4 ASSESSING THE THREE-STAGE ASSIMILATION PROCESS OF RADIO-FREQUENCY IDENTIFICATION TECHNOLOGY: THE ANTECEDENTS AND CONSEQUENCES IN SUPPLY CHAIN MANAGEMENT AND ACCOUNTING INFORMATION QUALITY

**Abstract**

The present study aimed to explore the contextual factors that influence the process of assimilation of radio frequency identification (RFID) by organizations. Furthermore, this work examines the effects of improving the level of information sharing in supply chains and the quality of accounting information. We proposed a research model based on the Technology-Organization-Environment (TOE) framework and the Innovation Diffusion Theory, conceptualizing the technological, organizational, and environmental dimensions as antecedents of RFID assimilation in three stages: initiation (IN), adoption (AD), and routinization (RO). An online survey questionnaire was used to collect data from decision-makers in manufacturing, retail, technology, and other sectors. The data sample of 165 valid responses was analyzed with Partial Least Squares Structural Equation Modeling (PLS-SEM). The findings revealed that similar to the antecedents, the effects on consequences varied across the three stages of RFID assimilation. Top management support and competitive pressure had significant effects on all three stages. Surprisingly, relative advantage and perceived costs influenced the IN and RO stages, respectively. Although information sharing was positively affected by RO, the quality of accounting information was impacted by both the IN and RO stages. Firm size and industrial sector were not statistically significant as control variables. This study contributes to theory by offering an interdisciplinary theoretical framework by integrating information systems, supply chain management, and accounting concepts. In addition to presenting the current scenario of RFID adoption in the national context, it also provides some guidance and insights into the successful process of assimilation of the technology by organizations.

**Keywords:** Supply chain. RFID. Innovation assimilation. Accounting information quality.

## 4.1 Introduction

In the last years, the process of business digitization has changed supply chain management (SCM) with the advent of innovative technologies such as the Internet of Things (IoT), big data, blockchain, cloud computing, and artificial intelligence (Rejeb et al., 2020; Kgobe & Ozor, 2021; Khayyam et al., 2022).

In this scenario, organizations have invested in digital technologies for stakeholders' integration, providing efficiency, sustainability, and flexibility in their supply chains. They seek to improve lead times, costs, and product availability for customer satisfaction (Shousong, Xiaoguang, & Yuanjun, 2018) to survive in an ever-changing environment (Ben-Daya, Hassini, & Bahroun, 2017).

The Radio Frequency Identification Device (RFID) is one of the main technologies in an IoT-enabled supply chain (Tu, 2018). The integration of RFID in SCM has attracted considerable attention from both academics and practitioners, according to a series of literature review papers covering the topic (Manavalan & Jayakrishna, 2019; Rejeb et al., 2020; Roy, 2021; Yang et al., 2021; Munoz-Ausecha, Ruiz-Rosero, & Ramirez-Gonzalez, 2021; Kgobe & Ozor, 2021; Raza, 2022).

RFID contributes to SCM by improving inventory flows and traceability of products as they move upstream and downstream throughout the supply chain (Sodhi & Tang, 2019; Green et al., 2017).

RFID utilization enables supply chain visibility (SCV) by capturing more accurate data and generating real-time information for more effective decision-making (Agrawal et al., 2022; Ben-Daya et al., 2017). A poor SCV may cause forecast errors, bullwhip effects, inventory waste, and supply chain disruptions, and consequently impact lead times, productivity, and revenue for supply chain partners, from first-tier suppliers to end customers (Cui et al., 2017; Agrawal et al., 2022).

RFID is also relevant for supply chain integration (SCI), which refers to the strategic collaboration between an organization and its business partners to achieve SCV at low cost and high speed (Tian et al., 2021). Nevertheless, research on the adoption of IoT technologies by companies in the supply chain context is still incipient (Rejeb et al., 2020).

Previous studies showed contrasting findings regarding the contextual factors influencing RFID adoption in SC contexts (Fosso Wamba et al., 2016; Reyes et al., 2016; Ehie & Chilton, 2020; Mabad et al., 2021; Mahdaly & Adeinat, 2022). RFID adoption in SCM is even more challenging for companies in developing economies (Ehie & Chilton, 2020).

Over the last five years, large retail companies in the fashion sector in Brazil have adopted RFID technology in line with their omnichannel strategies. Iguma and Imoniana (2023) conducted a multiple-case study with three of these fashion retailers. They found that the RFID post-adoption enables full inventory counts with agility, safety, and accuracy, much more frequently than traditional cyclical counts. The most relevant change in accounting practices refers to the recognition and provision of losses, enhancing the accounting information quality.

Iguma and Imoniana (2024) presented an in-depth single case study with a garment manufacturing company in the omnichannel supply chain of fashion retailers. The case company is one of the few garment manufacturers in the country that successfully adopted item-level RFID in the assembly line to control its internal operations. Results show that RFID improved information sharing in three levels of integration in the supply chain: internal, supplier, and customer. RFID contributed to the accounting practices related to WIP and FG inventories, cost accounting, and loss recognition, thus improving the measurement of items in stock, the cost of goods sold (COGS), and, consequently, the results in financial reports.

However, little is known about the current status of RFID post-adoption in supply chains by different industry sectors in a broader national context. Thus, we present the first research question of this study:

**RQ1.** What contextual factors influence the RFID post-adoption by companies of different sectors in Brazil?

Most studies on RFID adoption consider the dichotomy between adoption and non-adoption of technology as a single stage (Fosso Wamba et al., 2016; Mabad et al., 2021; Mahdaly & Adeinat, 2022).

However, the success of a technology adoption does not always result in its dissemination at the enterprise level. For this reason, research must move towards RFID's post-adoption and its benefits to the company (Zhu, Kraemer, & Xu, 2006; Nam, Lee, & Lee, 2019). Therefore, this study followed the concepts of the three-stage process of technology assimilation presented by Zhu et al. (2006): pre-adoption (initiation), adoption, and post-adoption (routinization).

Previous studies developed three-stage research models for the adoption of business analytics (Nam et al., 2019), ERP systems (Junior et al., 2019), and mobile applications (Chiu et al., 2017). They found that contextual factors influenced the three stages of technology assimilation in different ways. Next, we formulate the second research question:

**RQ2.** How would these factors vary at different stages of the RFID assimilation process?

Information sharing and information quality are two leading factors for increased levels of SCV and SCI, boosting supply chain performance, social and environmental sustainability, and profitability (Agrawal et al., 2022).

Gunasekaran et al. (2017) reported that big data and predictive analytics are positively associated with supply chain performance in India, while Tian et al. (2021) revealed the positive influence of digital manufacturing technologies (DMTs) on SCI in different countries.

Tambuskar et al. (2023) reported that green practices and environmental performance are critical factors for big data analytics (BDA) implementation in SCM. Liu et al. (2016) found support for the positive relationship between supply chain technologies (SCT) and firm performance and, in turn, their influence on the level of information sharing between supply chain partners. Despite the relevance of understanding the benefits of emerging technologies in SCM, specific studies on RFID and IoT are scarce (Tian et al., 2021).

Wu, Xiong, and Li (2019) developed an IoT-BC accounting system that provided accounting information with improved qualitative characteristics. Accounting information with high quality may be useful for managers and shareholders to increase SCV through the analysis of risks and uncertainties and the communication of the financial impact of SC critical events (Velayutham et al., 2021).

Retailers request financial statements from their supply chain partners in the manufacturing industry to analyze their capacity to fulfill their production orders (Iguma & Imoniana, 2024). In the accounting field, there is a need to address research gaps regarding the benefits of the diffusion of IoT for corporate digital reporting practices to improve the qualitative characteristics of financial information (Valentinetti, & Munoz, 2021).

RFID/IoT research rarely considers the influence of the three-stage assimilation process on supply chain processes, specifically the benefits to companies related to information sharing and accounting information quality (AIQ). Finally, we develop the third research question:

**RQ3.** How would the effects on information sharing and the quality of accounting information vary due to the influence of each of the three stages of the RFID assimilation process?

The purpose of this study is to investigate the contextual factors that influence the three stages of RFID assimilation (initiation, adoption, and routinization), as well as their impacts on the information sharing between supply chain partners and the improvement of accounting information quality.

To address the research questions, we develop an interdisciplinary theoretical model based on the technology-organization-environment (TOE) framework (Tornatzky & Fleischer, 1990) and the Innovation Diffusion theory (Rogers, 1995), by integrating information systems (IS), SCM, and accounting concepts.

We employed quantitative research using a cross-sectional survey to collect 165 valid responses about the current scenario of RFID adoption by companies from different industry sectors in Brazil. This study also contributes to practitioners by providing some guidance and insights on the technology's successful assimilation process for enterprises.

The remainder of this paper is structured in the following way. In Section 4.2, the literature is reviewed. The theoretical framework and the research hypotheses are developed. Section 4.3 explains the research method, sampling, and data collection procedures. Section 4.4 presents the data analysis and assessment of the measurement model and the structural model. In Section 4.5, the data analysis results are discussed. Theoretical and practical contributions, limitations, and future research directions are shared. Finally, the conclusions are presented in Section 4.6.

## 4.2 Literature Review

RFID technologies have the potential to track and share high-quality information for SCI (Tian et al., 2021) and SCV (Agrawal et al., 2022).

Agrawal et al. (2022) revealed the three groups of information for visibility in supply chains in a prioritized order: deliveries and deviations (customer information); inventory levels, capacity, and lead time (internal information); and purchasing plans and supplier capabilities (supplier information). They concluded that real-time data with enhanced quality may be shared with supply chain partners to manage SC deviations to meet customer demands.

Tornatzky and Fleischer (1990) proposed the technology-organization-environment (TOE) theoretical framework to explain three contexts that influence the adoption of technological innovations in organizations, rather than the adoption by individual users of the technology.

The technological context includes characteristics from both the existing technologies in use and the innovative technology usefulness to the firm; the organization context describes the internal issues within the company and the slack resources available internally; and the environmental context involves the external characteristics of the business field which a firm is embedded (Justino, Robertson, & Michael, 2022; Chiu, Chen, & Chen, 2017).

TOE is the most used framework in studies on technology adoption by companies. Such studies involve RFID/IoT adoption research in the logistics industry (Mahdaly & Adeinat, 2022), construction firms (Mabad et al., 2021), SCM (Tu, 2018), small and mid-sized enterprises (Fosso Wamba et al, 2016), retail industry (Bhattacharya & Wamba, 2015; Tsai, Wen, & Wu, 2010), different sectors (Thiesse et al., 2011), and manufacturing industry (Wang, Wang, & Yang, 2010).

Much of the extant literature focuses on the intention and the decision to adopt new technologies in organizations (Iguma & Imoniana, 2023). However, the simple introduction of a new technology cannot be considered successful if the technology does not progress towards its assimilation and widespread use within the company. The adopted technology must be institutionalized in the firm (Zhu et al., 2006).

Other studies extended the TOE framework by developing three stages of the technology assimilation process based on the Innovation Diffusion theory (Rogers, 1995): ERP systems (Junior, Oliveira, & Yanaze, 2019), business analytics (Nam et al., 2019), broadband mobile applications (Chiu et al., 2017), e-collaboration (Chan, Chong, & Zhou, 2012), and e-business (Zhu et al., 2006). However, previous studies on RFID adoption have not utilized this three-stage model.

This study followed the concept of the three different stages of RFID assimilation: first, the preadoption stage (initiation) is the initial evaluation of RFID technology's potential benefits; second, the adoption refers to the decision-making to use it for value chain activities; and finally, the postadoption stage refers to the full-scale deployment for widespread usage of the technology be the organization (routinization) (Zhu et al., 2006).

Each one of the TOE factors plays a different role according to each adoption stage: technology (relative advantage and perceived costs); organization (top management support); and environment (competitive pressure) (Tornatzky & Fleischer, 1990).

**TOE Technological factors**

Relative advantage (TRA) is the extent to which the benefits of adopting RFID are superior compared to those offered by competing technologies or those currently in use by the company (Mabad et al., 2021; Lutfi et al., 2023).

RFID readers capture information from RFID tags using radio waves, allowing batch scanning of tagged products without the need for line of sight, thus reducing the chances of manual error and increasing agility and accuracy in identifying items in the system (Green et al., 2017; Tu, 2018).

Mabad et al. (2021) revealed that the relative advantage of RFID services positively affects their adoption in Australian construction companies. Therefore, we present the following hypotheses for the study:

**H1a(+):** The technology factor of Relative advantage (TRA) has a positive influence on RFID Initiation (IN) in supply chain management.

**H1b(+):** The technology factor of Relative advantage (TRA) has a positive influence on RFID Adoption (AD) in supply chain management.

**H1c(+):** The technology factor of Relative advantage (TRA) has a positive influence on RFID Routinization (RO) in supply chain management.

The perceived cost (TPC) comprises all types of expenses necessary for the implementation of RFID, such as hardware equipment, software and systems integration, infrastructure development, storage capacity, data management, business process reengineering, external consultancy, and training employees (Mahdaly & Adeinat, 2022; Tu, 2018).

The benefits must outweigh the perceived costs of RFID. Otherwise, high costs may inhibit its adoption by companies (Bhattacharya & Fosso Wamba, 2015). Tu (2018) found that the perceived costs adversely influence the intention to adopt IoT technologies in logistics and SCM in Taiwan.

**H2a(-):** The technology factor of Perceived cost (TPC) has a negative influence on RFID Initiation (IN) in supply chain management.

**H2b(-):** The technology factor of Perceived cost (TPC) has a negative influence on RFID Adoption (AD) in supply chain management.

**H2c(-):** The technology factor of Perceived cost (TPC) has a negative influence on RFID Routinization (RO) in supply chain management.

**TOE Organizational factors**

Top management support (OTS) is critical for RFID adoption to provide the necessary resources to implement the technology, create a favorable environment for innovation, and overcome employee resistance to change (Bhattacharya & Fosso Wamba, 2015). Previous studies have reported that OTS is a driver of RFID adoption success (Mahdaly & Adeinat, 2022; Mabad et al., 2021).

Top management support is one of the factors that influence whether or not a company adopts RFID technology in the logistics services industry (Mahdaly & Adeinat, 2022). Mahdaly and Adeinat (2022) concluded that the strong commitment of top management contributes to the communication, coordination, and collaboration of internal departments and partners through the supply chain for RFID implementation.

**H3a(+):** The organizational factor of Top management support (OTS) has a positive influence on RFID Initiation (IN) in supply chain management.

**H3b(+):** The organizational factor of Top management support (OTS) has a positive influence on RFID Adoption (AD) in supply chain management.

**H3c(+):** The organizational factor of Top management support (OTS) has a positive influence on RFID Routinization (RO) in supply chain management.

**TOE Environmental factors**

Competitive pressure (ECP) is the level of influence of competitors within the same industry on the decision to adopt RFID. ECP refers to the environment in which a firm operates, when more competitors adopt it to attain a competitive advantage (Mahdaly & Adeinat, 2022; Bhattacharya & Fosso Wamba, 2015).

A more competitive environment can incentivize companies to quickly jump on new technology trends that others are beginning to adopt or are already using (Zhu et al., 2006). In addition to competitors, supply chain partners and customers are other sources of external pressure considered by previous studies.

Tu (2018) found that these external motivating forces outside of the firm are significant determinants of IoT adoption intention in Taiwanese firms from different industries.

**H4a(+):** The environmental factor of Competitive pressure (ECP) has a positive influence on RFID Initiation (IN) in supply chain management.

**H4b(+):** The environmental factor of Competitive pressure (ECP) has a positive influence on RFID Adoption (AD) in supply chain management.

**H4c(+):** The environmental factor of Competitive pressure (ECP) has a positive influence on RFID Routinization (RO) in supply chain management.

**Three stages of RFID assimilation**

In the first stage of the RFID assimilation process (initiation), the technological solution is evaluated according to the degree to which it fits the company's needs, improves its performance, and produces benefits in value chain activities (Zhu et al., 2006).

In Junior et al. (2019), pilot tests were conducted to evaluate ERP systems on farms in Brazil. The results influence the company's decision to deploy the technology or not. In the adoption stage, decisions are made to allocate all the resources to implement the technology in the company. This is considered a necessary step toward the routinization stage (Zhu et al., 2006).

Finally, the last stage is characterized by the acceptance of the technology by employees, the expansion of its use across business areas, and its integration into the activities of a company's value chain. These achievements constitute successful technology assimilation (Nam et al., 2019; Chiu et al., 2017).

However, these studies do not test hypotheses of the relationships between the three stages of the technology assimilation process, except for Junior et al. (2019). Therefore, we present the following hypotheses:

**H5(+):** Initiation (IN) has a positive influence on Adoption (AD).

**H6(+):** Adoption (AD) has a positive influence on Routinization (RO).

**Information sharing and Accounting Information**

SCV refers to the capability of collecting and sharing timely and accurate information about operations upstream and downstream throughout the supply chains, such as inventory, transport, and logistics activities (Agrawal et al., 2022).

Trabucco and De Giovanni (2021) revealed that firms adopting a lean omnichannel strategy can preserve and ensure SCV, as a performance indicator of business sustainability during the COVID-19 pandemic.

Information sharing and information quality are the top enablers for SCV (Agrawal et al., 2022; Manavalan & Jayakrishna, 2019), and refers to two distinct concepts addressed differently by literature. While the first concept represents the quantitative aspect of information exchange, the second one describes the type of information shared through the supply chain (Chavez et al., 2017).

Somapa et al. (2016) argue that the assessment of SCV involves three characteristics of information: accessibility, high quality, and usefulness. Accessibility is associated with the ability to capture, transfer, or integrate information, while high-quality information is accurate, timely, complete, adequate, reliable, and usable forms (Li et al., 2006).

Information sharing (ISH) refers to the extent to which a firm makes strategic, tactical, critical, or proprietary information available on time to its supply chain partners (Tian et al., 2021; Liu et al., 2016).

Williams et al. (2013) classify SC partner-level types of information as downstream (demand-related) or upstream (supply-related). While the first type includes point-of-sale data, demand forecasts, and customer inventory levels, the second type comprises supplier inventory levels, supplier lead time and delivery dates, and advanced shipment notices.

Furthermore, ISH is one of seven supply chain collaboration (SCC) components. Cao and Zhang (2011) found that SCC improves collaborative advantage in U.S. manufacturing firms in various industries. ISH is also one of the main elements of the three dimensions of SCI: internal, supplier, and customer integration.

Tian et al. (2021) conducted a survey with manufacturing firms from Europe, Asia, and America, concerning the adoption of emerging technologies in Industry 4.0. Based on the TOE framework, they found that human resources and digital manufacturing technologies (DMTs), including RFID, have significant positive effects on three dimensions of SCI.

**H7a(+):** RFID Initiation (IN) has a positive influence on Information sharing (ISH) in the supply chain.

**H7b(+):** RFID Adoption (AD) has a positive influence on Information sharing (ISH) in the supply chain.

**H7c(+):** RFID Routinization (RO) has a positive influence on Information sharing (ISH) in the supply chain.

Accounting information affects not only the decision-making of the company's internal managers, but also of stakeholders such as investors, shareholders, creditors, bankers, regulatory agencies, employees, consumers, and supply chain partners (Tian et al., 2021).

Velayutham et al. (2021) conducted a case study of Fisher and Paykel Healthcare to investigate the role of accounting information in SCM to address the challenges of the disruptive effects of the COVID-19 pandemic. The findings revealed that accounting information ensures SCV at different locations in the supply chain.

Extant studies represented accounting information quality (AIQ) dimensions in terms of the qualitative characteristics informed by the Conceptual framework for financial reporting (IASB, 2018).

According to Bonsón and Bednárová (2019), different dimensions of AIQ (e.g. relevance, comparability, and timeliness) might be improved as a result of the blockchain technology (BCT) adoption.

Palazuelos et al. (2018) surveyed bank loan officers in Spain. They revealed a positive influence on the decision of credit agents to facilitate access to credit due to their general perception of the AIQ (timely, accurate, complete, relevant, and reliable information) of the audited financial statements.

Wu et al. (2019) developed an accounting information system (AIS) based on blockchain (BC) and RFID technologies focusing on sales and procurement applications in the manufacturing industry. This system improved relevance, neutrality, timeliness, and the cost-benefit balance of accounting information.

In the study, we hypothesize that the three stages of the RFID assimilation process affect the quality of accounting information for internal and external decision-making:

**H8a(+):** RFID Initiation (IN) has a positive influence on Accounting information quality (AIQ) in the supply chain.

**H8b(+):** RFID Adoption (AD) has a positive influence on Accounting information quality (AIQ) in the supply chain.

**H8c(+):** RFID Routinization (RO) has a positive influence on Accounting information quality (AIQ) in the supply chain.

We also consider firm size and industry sector relevant as control variables presuming that different attitudes may occur in organizations of different sizes and types (Chiu et al., 2017).

First, firm size is measured by the number of employees. Reyes et al. (2016) found that larger firms are associated with a higher RFID adoption stage. These firms are usually expected to have more resources as a competitive advantage to adopt IoT than smaller ones (Ehie & Chilton, 2020).

Second, firms within different industries are supposed to have different needs and perceptions regarding technology use (Seifian et al., 2023). Chiu et al. (2017) investigated the broadband mobile applications adoption by enterprises. Their analysis showed different results in various stages of assimilation for both control variables.

In summary, all constructs and their measurement items were adapted from research instruments tested and validated by previous studies:

- Technological factors: relative advantage (TRA) (Tsai et al., 2010; Wang et al., 2010; Bhattacharya & Fosso Wamba, 2015; Lutfi et al., 2023; Iguma & Imoniana, 2023) and perceived cost (TPC) (Thiesse et al., 2011; Bhattacharya & Fosso Wamba, 2015; Iguma & Imoniana, 2023);
- The organizational factor: top management support (OTS) (Tsai et al., 2010; Wang et al., 2010; Thiesse et al., 2011; Bhattacharya & Fosso Wamba, 2015; Lai et al., 2018; Justino et al., 2022; Mahdaly & Adeinat, 2022; Lutfi et al., 2023);
- Environmental factor: competitive pressure (ECP) (Wang et al., 2010; Thiesse et al., 2011; Bhattacharya & Fosso Wamba, 2015; Reyes et al., 2016);
- RFID assimilation is a threefold process involving initiation, adoption, and routinization (Chan & Chong, 2013; Gunasekaran et al., 2017; Junior et al., 2019; Nam et al., 2019);
- Information sharing (ISH) (Tsai et al., 2010; Cao & Zhang, 2011; Chan et al., 2012; Reyes et al., 2016; Tian et al., 2021); and
- Accounting information quality (AIQ) (Xu et al., 2003; Li et al., 2006; Palazuelos et al., 2018; Bonsón & Bednárová, 2019; Al-Okaily et al., 2021; Al-Hattami & Kabra, 2022; Iguma & Imoniana, 2023). AIQ is represented by six dimensions that may be

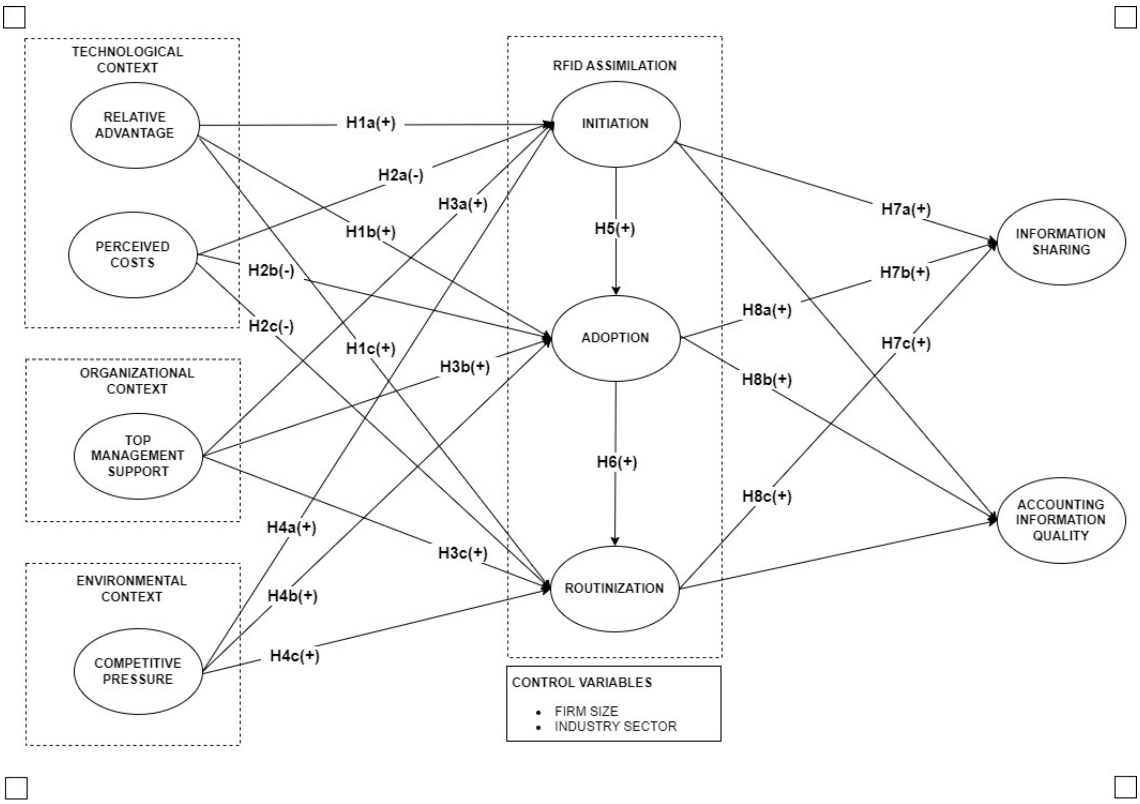
influenced by the three stages of RFID assimilation: two primary characteristics (relevance and faithful representation), and support characteristics (understandability, timeliness, comparability, and verifiability) (IASB, 2018).

In the proposed model (Figure 4.1), we define three stages of RFID assimilation (initiation, adoption, and routinization) as dependent variables that are influenced by TOE framework dimensions: technology (relative advantage and perceived costs), organization (top management support) and environment (competitive pressure).

Regarding the consequences, the model explains the impact of benefits provided by RFID assimilation on gaining higher information sharing and AIQ in supply chains. Furthermore, we also consider that the initial stage has a direct effect on the adoption stage, which in turn influences the routinization stage.

Lastly, we present firm size and industry type as control variables. They may influence the three stages of RFID assimilation and their relationship between information sharing and AIQ.

Figure 4.1. The research model




Source: the author

## 4.3 Methodology

This quantitative research uses a cross-sectional study design and employs a closed-ended questionnaire as the main instrument for data collection. All constructs were measured by multiple items using a five-point Likert-type scale ranging from 1 ("strongly disagree") to 5 ("strongly agree") (Table 4.1). A series of demographic questions on gender, age, job position, field of work, firm size, annual revenue, geographical location, and industry sector were also included.

Table 4.1. Measurement items of constructs

Please indicate the degree of agreement with each statement as follows: 1-totally disagree, 2-disagree, 3-neither agree nor disagree, 4-agree, and 5-totally agree.

| Construct | Item | Statement | Source |
|---|---|---|---|
| Relative Advantage (TRA) | TRA1 | The RFID system allows you to reduce various company costs (e.g.: inventory costs, logistics costs, production costs). | Tsai et al. (2010), Wang et al. (2010), Bhattacharya & Fosso Wamba (2015), Iguma & Imoniana (2023) |
| | TRA2 | The RFID system allows you to identify and track individual products as they move through the supply chain. | |
| | TRA3 | The RFID system can mitigate inventory losses (e.g., loss and theft of products) and waste in the supply chain. | |
| | TRA4 | The RFID system makes it possible to carry out physical stock counts with greater speed and security, allowing the frequency of inventories to be increased throughout the year. | |
| | TRA5 | The RFID system allows more accurate information on products in stock to be made available in real-time. | |
| Perceived Costs (TPC) | TPC1 | The costs of adopting RFID technology are greater than the benefits. | Thiesse et al. (2011), Bhattacharya & Fosso Wamba (2015), Tu (2018), Iguma & Imoniana (2023) |
| | TPC2 | Staff training costs in RFID are high. | |
| | TPC3 | The costs of reengineering processes and work practices are high. | |
| | TPC4 | Maintenance and support costs for RFID technology are high. | |
| | TPC5 | The costs of integrating RFID system components with an organization's IT infrastructure are high. | |
| Top Management Support (OTS) | OTS1 | Top management is willing to assume the costs and risks involved in the RFID adoption process. | Tsai et al. (2010), Wang et al. (2010), Thiesse et al. (2011), Bhattacharya & Fosso Wamba (2015), Reyes et al. (2016), Lai et al. (2018), Lutfi et al. (2023); Justino et al. (2022); Mahdaly & Adeinat (2022) |
| | OTS2 | Senior management considers the adoption of RFID to be strategically important for the company. Examples: operational efficiency, digital acceleration, omnichannel, business, and environmental sustainability. | |
| | OTS3 | Top management considers RFID solutions to gain a competitive advantage. | |
| | OTS4 | Top management promotes the creation of a suitable environment for RFID adoption (e.g., employee training). | |
| | OTS5 | Senior management recognizes the benefits and advantages of adopting RFID. | |
| Competitive Pressure (ECP) | ECP1 | The adoption of RFID by major customers influenced the decision to implement the technology in the company. | Wang et al. (2010), Thiesse et al. (2011), Bhattacharya & Fosso Wamba (2015), Reyes et al. (2016) |
| | ECP2 | The use of RFID by competing companies influenced the adoption of the technology in my company. | |
| | ECP3 | Positive experiences from companies in other sectors and industries influenced the adoption of RFID in my company. | |
| | ECP4 | Pressure from customers to improve service quality and reduce order delivery times influenced the adoption of RFID. | |
| | ECP5 | The company believes that the adoption of the RFID system could avoid a competitive disadvantage shortly. | |

| | | | |
|---|---|---|---|
| Initiation Stage (IN) | IN1 | The company evaluated the potential benefits of RFID to improve its performance in value chain activities. | Sarac et al. (2010), Chan et al. (2012), Junior et al. (2019), Iguma & Imoniana (2023) |
| | IN2 | The company collected market information and success stories to evaluate the use of RFID technology. | |
| | IN3 | The company conducted tests with pilot project(s) to evaluate RFID technology. | |
| | IN4 | The company used external technical support services to design the initial RFID project. | |
| Adoption Stage (AD) | AD1 | The company decided to purchase RFID hardware and software to implement the technology. | Zhu et al. (2006), Chiu et al. (2017), Junior et al. (2019), Iguma & Imoniana (2023) |
| | AD2 | The company decided to implement RFID in its value chain activities. | |
| | AD3 | The company decided to allocate the necessary resources to implement the RFID solution. | |
| | AD4 | The company decided to hire external RFID services to support the implementation and integration of the technology. | |
| Routinization Stage (RO) | RO1 | The functionalities of the RFID system were integrated into the company's value chain activities. | Chan et al. (2012), Nam et al. (2019), Junior et al. (2019), Iguma & Imoniana (2023) |
| | RO2 | A growing number of internal areas of the company use the information generated by the RFID system for decision-making. | |
| | RO3 | The company continues to expand the use of RFID as part of the development of new business strategies. | |
| | RO4 | The RFID system is used widely and constantly in the company, making it suitable for our organizational culture. | |
| Information Sharing (ISH) | ISH1 | The RFID system allows the company to share accurate, real-time product information with supply chain partners. | Li et al. (2006), Tsai et al. (2010), Cao & Zhang (2011), Liu et al. (2016), Reyes et al. (2016), Gunasekaran et al. (2017), Tian et al. (2021), Agrawal et al. (2022), Tambuskar et al. (2023) |
| | ISH2 | The use of the RFID system can increase the level of information sharing between internal areas of the company. Example: the purchasing department (about sales forecast, production plans, production progress, and stock level). | |
| | ISH3 | The use of the RFID system can increase the level of information sharing with the main suppliers in the supply chain. Example: order tracking and tracking, delivery status, stock level. | |
| | ISH4 | The use of the RFID system can increase the level of information sharing with key customers in the supply chain. Example: about product and service design/modifications, process design/modifications. | |
| Accounting Information Quality (AIQ) | AIQ1 | The RFID system provides the accuracy of the stock position in the information system (e.g.: ERP) producing relevant accounting information, that is, with confirmatory value and predictive value (e.g.: immediate recognition of losses and the provision of inventory). | Xu et al. (2003), Palazuelos et al. (2018), Bonsón & Bednárová (2019), Wu et al. (2019), Al-Okaily et al. (2021), Al-Hattami & Kabra (2022) |
| | AIQ2 | The RFID system provides the accuracy of the stock position in the information system (e.g.: ERP), producing accounting information with greater reliability, that is, in a complete, neutral, and error-free manner. | |
| | AIQ3 | The RFID system provides data capture, analysis, and provision of real-time inventory information, producing timely accounting information for decision-makers. | |
| | AIQ4 | The adoption of RFID by suppliers, customers, and competitors can contribute to the standardization of inventory procedures, making it possible to achieve comparability of accounting information between different entities and periods. | |
| | AIQ5 | The analysis of large amounts of business data and financial data generated by the RFID system makes it possible to produce more concise and understandable accounting information, meeting the needs of different types of users. | |
| | AIQ6 | The RFID system contributes to the verifiability of accounting information, by allowing physical inventory items to be counted with greater precision and timeliness, through integration with other company systems (e.g.: ERP and WMS-warehousing management system) | |

Source: the author

The draft version of the questionnaire was pretested by six experienced researchers and six supply chain experts from the industry. The researchers reviewed the questionnaire for clarity and appropriateness of the measures used to operationalize each construct, while the experts assessed its structure, readability, and ambiguity (Gunasekaran et al., 2017). Their feedback contributed to enhancing the final version of the online questionnaire.

The target population of this study consists of managers and decision-makers from different industries in Brazil with expertise in RFID applications in SCM, logistics, and inventory areas. Other RFID applications, such as fixed asset tracking (e.g. equipment and tools), tracking of returnable packaging, and personnel access control, were not considered in the scope of our study. Finally, we sent a survey link to 800 potential respondents through the LinkedIn networking platform.

Data from a sample of 165 valid responses were collected between June and September 2023, accounting for a 20.6% response rate. Thus, the sample size surpassed the minimum of 148 observations calculated using the G*Power 3.1.9.4 software with a statistical power of 0.95, a 0.05 significance level, and an effect size of 0.15 (Hayat et al., 2022), by considering the maximum number of six predictors pointing at one construct (IN, AD or RO) in the research model (Hair et al., 2014). Table 4.2 presents the demographics of the sample.

Table 4.2. Descriptive statistics of respondents and companies

**Sample Characteristics (N = 165)**

| | Freq | Percent | | Freq | Percent |
|---|---|---|---|---|---|
| **Age group** | | | **Company Type** | | |
| 18-24 | 1 | 0,61 | Publicly listed company | 41 | 24,85 |
| 25-34 | 29 | 17,58 | Private company | 117 | 70,91 |
| 35-44 | 65 | 39,39 | Others | 7 | 4,25 |
| 45-54 | 49 | 29,70 | **Industry Sector** | | |
| >55 | 21 | 12,73 | Retailing | 36 | 21,82 |
| **Gender** | | | Manufacturing | 31 | 18,79 |
| Female | 16 | 9,70 | Technology | 55 | 33,33 |
| Male | 149 | 90,30 | Others | 43 | 26,06 |
| **Field of work** | | | **Firm Size/Number of employees** | | |
| Supply Chain Management | 33 | 20,00 | <100 | 52 | 31,52 |
| Operations and Logistics | 36 | 21,82 | 100-499 | 29 | 17,58 |
| Information Technology | 54 | 32,73 | 500-999 | 18 | 10,91 |
| Sales | 19 | 11,52 | 1.000-4.999 | 23 | 13,94 |
| Others | 23 | 13,94 | >5.000 | 43 | 26,06 |
| **Job position** | | | **Geographical location (Brazil)** | | |
| C-Level and Board | 48 | 29,09 | SP | 121 | 73,33 |
| Coordination or Supervision | 32 | 19,39 | PR | 13 | 7,88 |
| Management | 62 | 37,58 | RS | 9 | 5,45 |
| Specialist | 23 | 13,94 | SC | 6 | 3,64 |
| | | | MG | 5 | 3,03 |
| | | | Others | 11 | 6,67 |

Source: the author

We tested non-response bias by comparing early and late responses, considering that respondents who reply late are similar to non-respondents (Armstrong and Overton, 1977).

First, independent sample t-tests were performed in IBM SPSS Statistics 29.0.1.0 software on the first and last 40 responses. The comparison test between the two groups, concerning the demographic characteristics (job position and field of work) and dependent variables, revealed that there are no statistical differences between them. Furthermore, we performed paired samples t-tests and obtained similar results (Chaudhuri et al., 2021). Thus, nonresponse bias is unlikely to be an issue in this study.

We also found that common method bias (CMB) does not impact this research (Podsakoff et al., 2003). First, the analysis of Harmon's single-factor in SPSS revealed eight factors with eigenvalues above 1, explaining 68.9% total variance. The first factor explained 32.6% of the variance (Palazuelos et al., 2018).

In addition, a full collinearity assessment was performed in SmartPLS 4.0 software as recommended by Kock (2015). The variance inflation factors (VIFs) of the latent variables are lower than 3.3, indicating that our model is not contaminated by CMB (Seifian et al., 2023). In addition, VIF values are lower than the critical threshold of 5. This result suggests that multicollinearity is not a problem in our data in Figure 4.3 (Hair et al., 2016).

Table 4.3. Collinearity statistics/Variance inflation factor (VIF)

| Construct | IN | AD | RO | AIQ | ISH |
|---|---|---|---|---|---|
| **TPC** | 1,081 | 1,093 | 1,083 | | |
| **TRA** | 1,192 | 1,254 | 1,236 | | |
| **OTS** | 1,395 | 1,595 | 1,585 | | |
| **ECP** | 1,473 | 1,523 | 1,559 | | |
| **IN** | | 1,751 | | 2,851 | 2,851 |
| **AD** | | | 1,672 | 3,002 | 3,002 |
| **RO** | | | | 2,264 | 2,264 |
| **Firm Size** | 1,053 | 1,177 | 1,110 | 1,125 | 1,125 |
| **Industry Sector** | 1,117 | 1,123 | 1,123 | 1,093 | 1,093 |

Source: the author

### 4.4 Analysis and Results

This study adopted partial least squares (PLS), a nonparametric statistical method for structural equation modeling (SEM), to test the proposed hypotheses using SmartPLS 4.0 software.

PLS-SEM allows for analyzing interrelationships between latent and observed variables of complex models, small samples, and data with non-normal distribution, easily dealing with both reflective and formative measurement models (Hair et al., 2014). In this research, all constructs are reflective except for the control variables firm size and industry sector, which are formative as recommended by Henseler et al. (2016).

The data analysis follows a two-step process: first, we assessed the measurement model in terms of internal consistency reliability (CR), convergent validity (CV), and discriminant validity (DV). Next, we assessed the structural model in the second step, including the hypotheses and their relationship with the theory being tested (Hair et al., 2014; Lai et al., 2018; Iguma & Riccio, 2020).

#### 4.4.1 Assessment of the measurement model

For internal consistency reliability, both measures of Cronbach's alpha and Composite reliability (CR) exceed the threshold value of 0.70 for all constructs (Table 4.4). Cronbach's alpha assesses the intercorrelations of the observed indicator variables. On the other hand, CR does not assume equal indicator loadings. It indicates a high level of reliability when it presents values closer to 1 (Hair et al., 2014).

The average variance extracted (AVE) values provided evidence of convergent validity (CV) (Table 4.4), which refers to the extent to which a set of individual indicators is related to the same construct (Hair et al., 2016). All AVE values surpass 0.50 indicating that each construct explains more than 50% of the variance of its indicators (Ehie & Chilton, 2020; Seifian et al., 2023).

An indicator's outer loading represents the contribution of this indicator to its assigned construct. In Table 4.4, outer loadings are supposed to be acceptable when higher than 0.70. Those between 0.40 and 0.70 may be accepted when they contribute to content validity and the assessment of CR and AVE (Hair et al., 2016).

Table 4.4. Reliability and Validity

| Construct | Cronbach's alpha | Composite reliability (CR) | Average variance extracted (AVE) | Indicator | Loading |
|---|---|---|---|---|---|
| Relative advantage (TRA) | 0,770 | 0,844 | 0,520 | TRA1 | 0,740 |
| | | | | TRA2 | 0,717 |
| | | | | TRA3 | 0,742 |
| | | | | TRA4 | 0,765 |
| | | | | TRA5 | 0,640 |
| Perceived cost (TPC) | 0,751 | 0,826 | 0,548 | TPC1 | 0,785 |
| | | | | TPC2 | 0,610 |
| | | | | TPC3 | 0,660 |
| | | | | TPC4 | 0,882 |
| Top management support (OTS) | 0,894 | 0,922 | 0,703 | OTS1 | 0,768 |
| | | | | OTS2 | 0,875 |
| | | | | OTS3 | 0,872 |
| | | | | OTS4 | 0,858 |
| | | | | OTS5 | 0,816 |
| Competitive pressure (ECP) | 0,816 | 0,871 | 0,574 | ECP1 | 0,806 |
| | | | | ECP2 | 0,713 |
| | | | | ECP3 | 0,782 |
| | | | | ECP4 | 0,729 |
| | | | | ECP5 | 0,755 |
| Initiation (IN) | 0,850 | 0,899 | 0,691 | IN1 | 0,877 |
| | | | | IN2 | 0,858 |
| | | | | IN3 | 0,850 |
| | | | | IN4 | 0,734 |
| Adoption (AD) | 0,882 | 0,919 | 0,740 | AD1 | 0,877 |
| | | | | AD2 | 0,912 |
| | | | | AD3 | 0,889 |
| | | | | AD4 | 0,755 |
| Routinization (RO) | 0,901 | 0,931 | 0,772 | RO1 | 0,830 |
| | | | | RO2 | 0,913 |
| | | | | RO3 | 0,886 |
| | | | | RO4 | 0,883 |
| Information sharing (ISH) | 0,868 | 0,910 | 0,716 | ISH1 | 0,834 |
| | | | | ISH2 | 0,874 |
| | | | | ISH3 | 0,883 |
| | | | | ISH4 | 0,791 |
| Accounting information quality (AIQ) | 0,933 | 0,947 | 0,748 | AIQ1 | 0,840 |
| | | | | AIQ2 | 0,844 |
| | | | | AIQ3 | 0,875 |
| | | | | AIQ4 | 0,831 |

| | |
|---|---|
| AIQ5 | 0,909 |
| AIQ1 | 0,885 |

Source: the author

Discriminant validity (DV) posits that a construct is unique and captures phenomena differently from those captured by other constructs in the model. In this study, DC was established with the use of three criteria.

The first criterion is the assessment of cross-loadings of the indicators. In Table 4.5, the outer loading of each indicator is higher than its cross-loadings with other variables (Hair et al., 2014).

Table 4.5. Discriminant validity: cross-loadings

| | **IN** | **AD** | **RO** | **ECP** | **OTS** | **AIQ** | **TPC** | **TRA** | **ISH** |
|---|---|---|---|---|---|---|---|---|---|
| **IN1** | **0,877** | 0,632 | 0,610 | 0,412 | 0,535 | 0,407 | -0,229 | 0,294 | 0,379 |
| **IN2** | **0,858** | 0,597 | 0,530 | 0,457 | 0,488 | 0,436 | -0,124 | 0,420 | 0,377 |
| **IN3** | **0,850** | 0,706 | 0,651 | 0,350 | 0,432 | 0,354 | -0,200 | 0,233 | 0,287 |
| **IN4** | **0,734** | 0,667 | 0,403 | 0,264 | 0,302 | 0,227 | -0,048 | 0,177 | 0,136 |
| **AD1** | 0,699 | **0,877** | 0,558 | 0,430 | 0,430 | 0,274 | -0,060 | 0,278 | 0,242 |
| **AD2** | 0,690 | **0,912** | 0,719 | 0,442 | 0,523 | 0,393 | -0,165 | 0,391 | 0,394 |
| **AD3** | 0,710 | **0,889** | 0,653 | 0,425 | 0,507 | 0,339 | -0,179 | 0,255 | 0,288 |
| **AD4** | 0,567 | **0,755** | 0,457 | 0,365 | 0,353 | 0,260 | -0,071 | 0,203 | 0,253 |
| **RO1** | 0,614 | 0,643 | **0,830** | 0,385 | 0,475 | 0,379 | -0,189 | 0,302 | 0,411 |
| **RO2** | 0,590 | 0,635 | **0,913** | 0,514 | 0,477 | 0,375 | -0,245 | 0,277 | 0,380 |
| **RO3** | 0,567 | 0,587 | **0,886** | 0,465 | 0,471 | 0,305 | -0,298 | 0,246 | 0,298 |
| **RO4** | 0,564 | 0,603 | **0,883** | 0,462 | 0,474 | 0,370 | -0,246 | 0,224 | 0,372 |
| **ECP1** | 0,282 | 0,296 | 0,423 | **0,806** | 0,290 | 0,324 | -0,117 | 0,299 | 0,293 |
| **ECP2** | 0,249 | 0,260 | 0,388 | **0,713** | 0,264 | 0,187 | -0,109 | 0,145 | 0,095 |
| **ECP3** | 0,454 | 0,440 | 0,418 | **0,782** | 0,430 | 0,340 | -0,108 | 0,293 | 0,310 |
| **ECP4** | 0,283 | 0,335 | 0,370 | **0,729** | 0,307 | 0,229 | -0,016 | 0,096 | 0,262 |
| **ECP5** | 0,393 | 0,455 | 0,374 | **0,755** | 0,487 | 0,353 | -0,139 | 0,374 | 0,309 |
| **OTS1** | 0,363 | 0,351 | 0,377 | 0,291 | **0,768** | 0,322 | -0,100 | 0,195 | 0,214 |
| **OTS2** | 0,498 | 0,474 | 0,464 | 0,471 | **0,875** | 0,411 | -0,219 | 0,349 | 0,291 |
| **OTS3** | 0,470 | 0,463 | 0,467 | 0,473 | **0,872** | 0,392 | -0,149 | 0,363 | 0,311 |
| **OTS4** | 0,418 | 0,444 | 0,456 | 0,349 | **0,858** | 0,245 | -0,153 | 0,117 | 0,217 |
| **OTS5** | 0,478 | 0,488 | 0,488 | 0,415 | **0,816** | 0,297 | -0,208 | 0,241 | 0,183 |
| **AIQ1** | 0,356 | 0,279 | 0,338 | 0,285 | 0,334 | **0,840** | -0,161 | 0,486 | 0,632 |
| **AIQ2** | 0,295 | 0,252 | 0,269 | 0,271 | 0,251 | **0,844** | -0,132 | 0,427 | 0,492 |
| **AIQ3** | 0,399 | 0,342 | 0,397 | 0,337 | 0,394 | **0,875** | -0,098 | 0,529 | 0,574 |
| **AIQ4** | 0,357 | 0,305 | 0,301 | 0,390 | 0,292 | **0,831** | -0,198 | 0,502 | 0,521 |
| **AIQ5** | 0,400 | 0,359 | 0,404 | 0,378 | 0,394 | **0,909** | -0,243 | 0,546 | 0,620 |
| **AIQ6** | 0,426 | 0,370 | 0,375 | 0,341 | 0,367 | **0,885** | -0,243 | 0,524 | 0,572 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **TPC1** | -0,169 | -0,170 | -0,178 | -0,082 | -0,226 | -0,216 | **0,785** | -0,148 | -0,196 |
| **TPC2** | -0,076 | -0,009 | -0,123 | 0,016 | -0,195 | -0,063 | **0,606** | 0,023 | -0,134 |
| **TPC3** | 0,037 | 0,039 | -0,131 | -0,009 | -0,028 | -0,015 | **0,656** | 0,075 | -0,063 |
| **TPC4** | -0,189 | -0,134 | -0,299 | -0,181 | -0,118 | -0,188 | **0,882** | -0,121 | -0,251 |
| **TRA1** | 0,294 | 0,271 | 0,277 | 0,292 | 0,260 | 0,447 | -0,129 | **0,740** | 0,395 |
| **TRA2** | 0,236 | 0,232 | 0,235 | 0,218 | 0,204 | 0,400 | -0,085 | **0,717** | 0,354 |
| **TRA3** | 0,243 | 0,219 | 0,123 | 0,203 | 0,177 | 0,418 | 0,064 | **0,742** | 0,290 |
| **TRA4** | 0,258 | 0,268 | 0,216 | 0,254 | 0,242 | 0,488 | -0,099 | **0,765** | 0,282 |
| **TRA5** | 0,194 | 0,203 | 0,204 | 0,209 | 0,208 | 0,338 | -0,153 | **0,636** | 0,203 |
| **ISH1** | 0,329 | 0,283 | 0,384 | 0,349 | 0,269 | 0,629 | -0,230 | 0,488 | **0,834** |
| **ISH2** | 0,373 | 0,382 | 0,395 | 0,300 | 0,237 | 0,505 | -0,231 | 0,347 | **0,874** |
| **ISH3** | 0,302 | 0,243 | 0,306 | 0,276 | 0,271 | 0,621 | -0,241 | 0,381 | **0,883** |
| **ISH4** | 0,200 | 0,241 | 0,314 | 0,231 | 0,207 | 0,484 | -0,143 | 0,218 | **0,791** |

Source: the author

Second, the Fornell-Larcker criterion compares the square root of the AVE values with the latent variable correlations (Fornell & Larcker, 1981). In Table 4.6, the AVEs exceed the squared correlation with any other construct (Hair et al., 2014), supporting DV.

Table 4.6. Discriminant validity: the Fornell-Larcker criterion

| | IN | AD | RO | ECP | OTS | AIQ | TPC | TRA | ISH |
|---|---|---|---|---|---|---|---|---|---|
| **IN** | **0,832** | | | | | | | | |
| **AD** | 0,777 | **0,860** | | | | | | | |
| **RO** | 0,666 | 0,704 | **0,878** | | | | | | |
| **ECP** | 0,452 | 0,484 | 0,520 | **0,758** | | | | | |
| **OTS** | 0,536 | 0,534 | 0,540 | 0,483 | **0,839** | | | | |
| **AIQ** | 0,436 | 0,373 | 0,408 | 0,387 | 0,399 | **0,865** | | | |
| **TPC** | -0,187 | -0,144 | -0,277 | -0,132 | -0,202 | -0,209 | **0,740** | | |
| **TRA** | 0,344 | 0,334 | 0,300 | 0,331 | 0,307 | 0,585 | -0,118 | **0,721** | |
| **ISH** | 0,364 | 0,347 | 0,418 | 0,345 | 0,291 | 0,661 | -0,253 | 0,431 | **0,846** |

Source: the author

The third criterion of DV is the Heterotrait-Monotrait (HTMT) ratio by Henseler, Ringle, and Sarstedt (2015). HTMT values lower than 0.85 indicate that the model's constructs are conceptually different from one another (Hair et al, 2019). In Table 4.7, all results were below 0.90, except AD related to IN (0.904).

According to Henseler et al. (2015), 0.90 is recommended for conceptually similar constructs, such as loyalty, cognitive satisfaction, and affective satisfaction (Rizun & Strzelecki, 2020). In our study, we assume that IN and AD are similar as they both represent stages of RFID assimilation.

Table 4.7. Discriminant validity: Hetrotrait-Monotrait (HTMT)

| | IN | AD | RO | ECP | OTS | AIQ | TPC | TRA |
|---|---|---|---|---|---|---|---|---|
| **IN** | | | | | | | | |
| **AD** | **0,904** | | | | | | | |
| **RO** | 0,754 | **0,778** | | | | | | |
| **ECP** | 0,519 | 0,555 | **0,606** | | | | | |
| **OTS** | 0,602 | 0,590 | 0,598 | **0,542** | | | | |
| **AIQ** | 0,476 | 0,401 | 0,436 | 0,431 | **0,428** | | | |
| **TPC** | 0,203 | 0,170 | 0,295 | 0,181 | 0,231 | **0,203** | | |
| **TRA** | 0,413 | 0,394 | 0,350 | 0,399 | 0,359 | 0,680 | **0,198** | |
| **ISH** | 0,403 | 0,383 | 0,465 | 0,393 | 0,329 | 0,731 | 0,259 | **0,508** |

Source: the author

Thus, this established the measurement model's validity before the interpretation of the structural relationships.

### 4.4.2 Assessment of the structural model

The structural model is assessed by examining the coefficients of determination ($R^2$), the predictive relevance ($Q^2$) of the path model, the $f^2$ effect size, and the path coefficients in the structural model (Hair et al., 2014).

$R^2$ measures the amount of variance in the dependent variable that is explained by the independent variables in the structural model, ranging from 0 to 1. In this study, TPC, TRA, OTS, and ECP in combination explained 63.7% of AD variance, 59% of RO variance, and 42.9% of IN. In turn, IN, AD, and RO combined explained 22% of ISH variance and 22.8% of AIQ variance.

$Q^2$ is estimated by the blindfolding procedure, measuring how well the path model can predict the observed values. The predictive relevance is indicated by a $Q^2$ value greater than zero for a particular construct. All the dependent variables obtained above-zero values of $Q^2$, indicating a satisfactory fit of the model: IN ($Q^2$=0.328), AD ($Q^2$=0.307), RO ($Q^2$=0.355), ISH ($Q^2$=0.162), and AIQ ($Q^2$=0.225).

The effect size $f^2$ is a measure to examine the level of contribution of an independent variable to a dependent variable's $R^2$ value. The higher estimated $f^2$ values were presented by IN →AD ($f^2$ = 0.649), AD →RO ($f^2$=0.374), and OOA→IN ($f^2$=0.143).

Finally, a bootstrapping procedure with 5,000 resamples was used to evaluate path coefficients and their statistical significance (Figure 4.2), as recommended by Hair et al. (2019). The results of the structural model in Table 4.8 show that thirteen of twenty hypotheses were supported. Nevertheless, control variables' impacts (firm size and industry type), were not significant in this model.

Table 4.8. Structural model: Path Analysis

| **Control variables** | **Path Coefficient** | **P-value** |
|---|---|---|
| **Firm Size → IN** | -0,725 | 0,299 |
| **Firm Size → AD** | -0,038 | 0,818 |
| **Firm Size → RO** | -0,026 | 0,884 |
| **Firm Size → AIQ** | 0,329 | 0,393 |
| **Firm Size → ISH** | 0,430 | 0,308 |
| **Industry Sector → IN** | -0,135 | 0,567 |
| **Industry Sector → AD** | -0,053 | 0,713 |
| **Industry Sector → RO** | -0,279 | 0,345 |
| **Industry Sector → AIQ** | 0,059 | 0,805 |
| **Industry Sector → ISH** | -0,226 | 0,421 |

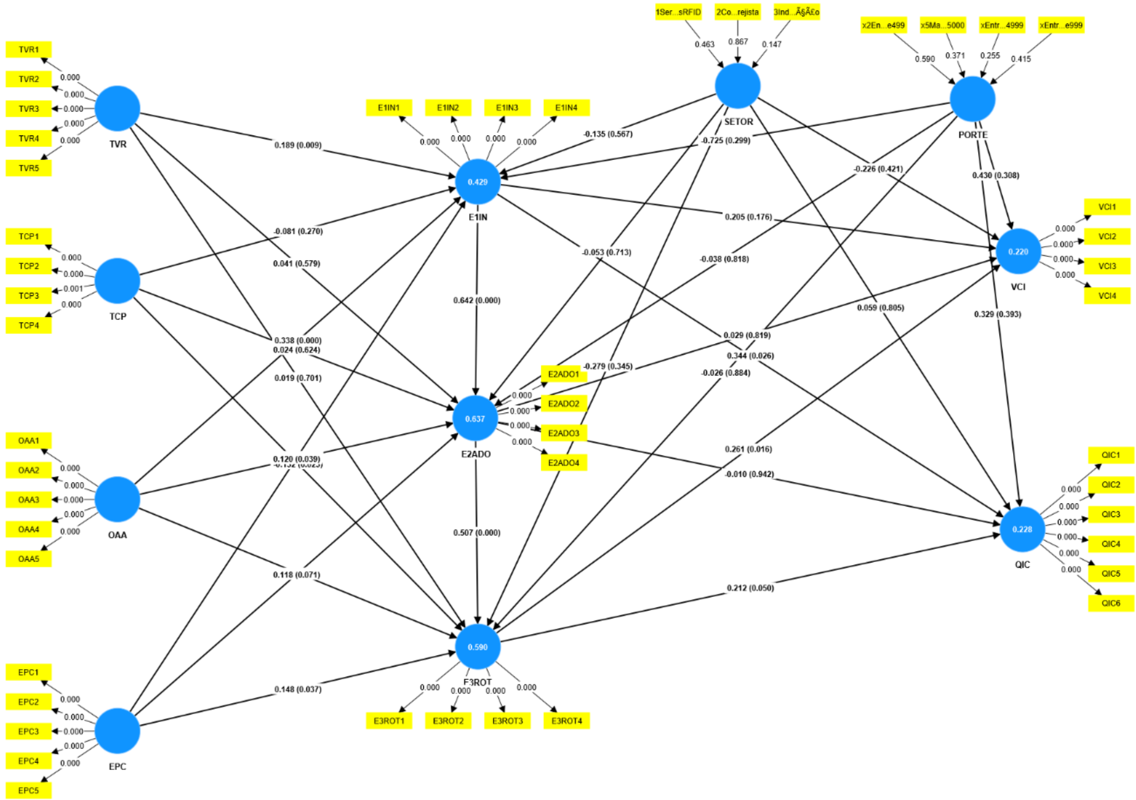
**Hypotheses**

| | **INITIATION** ($R^2$=42.9%) | | | **ADOPTION** ($R^2$=63.7%) | | | **ROUTINIZATION** ($R^2$=59%) | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Hyp** | **Path** | **P-value** | **Hyp** | **Path** | **P-value** | **Hyp** | **Path** | **P-value** |
| **TRA →** | **H1a** | 0,189 | 0.009*** | H1b | 0,041 | 0.579 | H1c | 0,019 | 0.700 |
| **TPC →** | H2a | -0,081 | 0.270 | H2b | 0,024 | 0.624 | **H2c** | -0,132 | 0.022** |
| **OTS →** | **H3a** | 0,338 | 0.000*** | **H3b** | 0,120 | 0.039** | **H3c** | 0,150 | 0.045** |
| **ECP →** | **H4a** | 0,168 | 0.036** | **H4b** | 0,118 | 0.071* | **H4c** | 0,148 | 0.037** |
| **IN →** | | | | **H5** | 0,642 | 0.000*** | | | |
| **AD →** | | | | | | | **H6** | 0,507 | 0.000*** |
| **ISH** ($R^2$=22%) ← | H7a | 0,205 | 0,176 | H7b | 0,029 | 0.818 | **H7c** | 0,261 | 0.016** |
| **AIQ** ($R^2$=22.8%) ← | **H8a** | 0,344 | 0,026** | H8b | -0,010 | 0.941 | **H8c** | 0,212 | 0.050* |

Note: Significant at * $p < 0.10$, **$p < 0.05$, and ***$p < 0.01$ (one-tailed test).

Source: the author

Figure 4.2. PLS-SEM results obtained from Bootstrapping (SmartPLS 4.0)




Source: the author

### 4.5 Discussion

The results show that organizational top management support (OTS) is the most important facilitator among the contextual factors, as it shows significant and the strongest effects on all three stages of the RFID assimilation process: IN (β=0.338; p<0.01), AD (β=0.120; p <0.05), and RO (β=0.150; p<0.05).

Next, the significance of the path of environmental competitive pressure (ECP) is lower than OTS: IN (β=0.168; p<0.05), AD (β=0.118; p<0.10), and RO (β=0.148; p <0.05). Thus, the hypotheses related to the organizational and environmental contexts, Hypotheses 3 (a, b, and c) and 4 (a, b and c), are supported.

**Top Management Support (OTS)**

OTS path to IN has the highest magnitude (0.338), followed by RO and AD with 0.150 and 0.120, respectively. This is consistent with previous studies of RFID adoption decision (Mahdaly & Adeinat, 2022), BDA adoption (Maroufkhani et al., 2020), and m-commerce adoption decision (Justino et al., 2022). Chiu et al. (2017) also revealed that OTS is significant in the assimilation of broadband mobile applications.

**Competitive Pressure (ECP)**

The influence of ECP is stable across the three stages of RFID assimilation, but slightly higher in the initiation stage (β=0.168; $p < 0.05$). This suggests that firms adopt and implement RFID due to their competition, the influence of major customers, and the inspiration of successful cases from other industries. In recent years, large fashion retail companies have been adopting, one after another, RFID solutions as a competitive advantage in their omnichannel strategies (Iguma & Imoniana, 2023), while manufacturing companies are driven to adopt the technology by these retailers in Brazil (Iguma & Imoniana, 2024).

Bhattacharya et al. (2015) found that ECP is a significant variable to discriminate RFID adopters from non-adopters. ECP is significant in the context of the adoption of broadband mobile applications in three stages (Chiu et al., 2017).

Nevertheless, while Nam et al. (2019) revealed that competitive intensity is significant only in the initiation stage, Zhu et al. (2006) found that ECP positively affects e-business initiation and adoption, but negatively impacts routinization.

**Relative Advantage (TRA)**

Literature reports a series of RFID advantages and benefits, including cost reduction (e.g.: inventory costs, logistics costs, production costs), mitigation of inventory losses and waste in the supply chain, and agility and accuracy of real-time inventory counts.

TRA also shows a significant result in the three-stage adoption process of broadband mobile applications (Chiu et al., 2017). On the other hand, Junior et al. (2019) report that TRA does not influence RO, but has a positive influence on evaluation (EV) and AD of ERP system.

In this study, TRA is significant in IN (β= 0.189; $p<0.01$), but insignificant in AD (H1b) and RO (H1c) stages. In the end, only H1a was supported. This suggests that recognizing the RFID advantages and contributions to the company is important for evaluating the technology at an early stage. However, once this understanding is established, TRA ceases to be a driving force in the next stages of RFID assimilation.

**Perceived Costs (TPC)**

TPC displays a significant negative effect on the RO as previously hypothesized (H2c). Nevertheless, hypotheses H2a and H2b were not supported.

In general, the perception of RFID costs is supposed to inhibit its adoption decision. They involve costs arising from staff training, processes, and work practices re-engineering technological support, and systems integration. Tu (2018) found that TPC hurts a firm's IoT adoption intention in logistics and SCM in Taiwan.

Many companies conduct pilot projects to test RFID technology in a reduced environment and then decide whether or not to proceed with a full-scale implementation (Sarac et al., 2010; Raza, 2022).

This period of evaluation is the opportunity to observe the difficulties and benefits of RFID integration and analyze return on investment (ROI), costs, and profits. For instance, a large porcelain manufacturer decided to implement a case-level RFID rather than an item-level RFID system due to cost issues, after conducting pilot projects to test both solutions (Iguma & Imoniana, 2023).

Thus, the costs of implementing RFID are known by the company at the initiation stage, after a period of studies, evaluations, and adjustments of the proposed solution. These costs identified in IN are already expected at the adoption stage. For this reason, TPC is not a relevant factor to affect the first two stages of RFID assimilation (IN and AD).

However, many issues may arise in the RO stage as RFID is implemented on a large scale and its applications expand to all business areas of the company. For instance, technical problems might lead to losses of data, due to reading several tags at the same time and collecting huge amounts of data (Zhang & Yang, 2019).

The necessary measuring procedures to overcome these challenges will require additional efforts and costs that may even put the technology assimilation process at risk. Therefore, TPC can negatively affect RFID routinization.

**Information Sharing (ISH)**

H7c was supported ($\beta=0.261$; $p<0.05$) considering that RO positively influences ISH, while IN (H7a) and AD (H7b) did not show significant effects.

Tian et al. (2021) found that DMTs have significant positive effects on three dimensions of SCI, but the moderating effect of competition in these relationships was insignificant. DMTs include RFID and other digital technologies such as three-dimensional (3D) printing, and automated processes and robotics.

In our specific context of RFID technology, information sharing in the supply chain is achieved in the routinization stage. This result indicates that only the widespread use of RFID in the company's daily operations makes its effects visible to internal areas, customers, and business partners.

**Accounting Information Quality (AIQ)**

Ou et al. (2017) found support for the influence of ERP adoption in AIQ improvement in terms of reliability and relevance in Chinese manufacturing companies, obtaining different results depending on the size and type of companies.

In this study, RFID routinization (RO) has a significant and positive path to AIQ ($\beta$=0.261; p=0.05) supporting H8c, while the effect of AD was insignificant (H8b).

Similar to ISH results, the quality improvement in corporate financial information is perceived by internal and external users for decision-making as the RFID routinization stage advances. For instance, RFID applications allow large retailers to perform their inventory counts, and identify and correct failures with agility and safety. However, the period for integrating RFID into inventory management must be considered until gains in accuracy and real-time data are observed in the company's information systems.

Furthermore, IN is also significant ($\beta$=0.344; $p<0.05$) and H8a is supported. This result can be explained by the expectation of AIQ improvement by RFID in the assessment period, as well as by the positive results provided by pilot projects.

**Initiation (IN), Adoption (AD), and Routinization (RO)**

Finally, H5 and H6 are supported as IN presents a significant and positive influence on AD ($\beta$=0.642; $p<0.01$), as well as AD has a significant effect on RO ($\beta$=0.507; $p<0.01$). The relationships between the three stages are strong.

Therefore, we assume that the model has been validated, as each stage is a necessary step toward the next in the technology assimilation process. Junior et al. (2019) also reported similar results in their research on ERP systems adoption in the context of farms in Brazil.

### 4.5.1 Theoretical contributions and implications

Recent studies employed the TOE framework to understand the contextual factors influencing RFID/IoT diffusion in organizations, focusing on a single stage of technology adoption (Tu, 2018, Mahdaly & Adeinat, 2022; Mabad et al., 2021).

In contrast, our approach examines TOE dimensions along the three stages of the RFID assimilation process as suggested by Zhu et al. (2006): initiation, adoption, and routinization.

As stated by the literature, routinization represents the success of technology assimilation in companies (Zhu et al., 2006). In this way, we go beyond the intention and decision to adopt technology. In addition, our results reveal that several contextual factors had differential effects at each one of the three stages, providing support to the relevance of this approach.

Our results also show strong significant effects of the relationships between the three stages (H5 and H6) as did previous studies (Chiu et al., 2017; Junior et al., 2019). Thus, we recommend this criterion for future studies to validate the three-stage-based research model, as one stage is necessary for the next one toward technology assimilation.

Furthermore, our research investigated not only the antecedents but also the consequences of RFID assimilation in SCM (Tian et al., 2021): information sharing (ISH) and accounting information quality (AIQ). Similar to the contextual factors (antecedents), the effects on the consequences varied across the three stages of RFID assimilation. To the best of the authors' knowledge, this approach has not been employed by extant literature (Valentinetti & Munoz, 2021).

Finally, our study contributes to the accounting field as there is sparse literature exploring the benefits of technological innovations to improve accounting information for decision-making.

We developed an AIQ construct measured by items that combine the qualitative characteristics of accounting information (IASB, 2018) with the RFID features and application benefits (Wu et al., 2019; Iguma & Imoniana, 2023).

### 4.5.2 Implications for practice

This study investigated the recent scenario of RFID adoption by companies from different industry sectors (retailing, manufacturing, and technology) in Brazil. Our results provide some guidance and insights into the successful RFID assimilation process for enterprises.

The role of top management is essential for ensuring a high level of RFID assimilation (H3a, H3b, H3c) by promoting it as a strategic priority of the firm and providing resources to create an environment of innovation. OTS must go beyond the decision to adopt RFID (AD), in an ongoing effort to support the company all the way to fully integrating the technology into their daily routines (RO).

However, OTS was revealed to be more important in the initial stage (IN) for evaluation of potential RFID benefits, conduction of pilot projects, and use of technical support services. Furthermore, top management must understand and recognize the technological capabilities of RFID and its benefits for business at an early stage (H1a).

Our results show that IN is a necessary stage for AD (H5), just as AD precedes RO (H6). Therefore, the decision to adopt RFID cannot be made without an adequate assessment of the technology at the initial phase. The company must resist the temptation to rush the implementation of RFID, by skipping necessary steps to assimilate the technology, even in the presence of higher market competitive pressure (H4a, H4b, H4c). Top management must be especially careful with unforeseen costs at the routinization stage (H2c), which may be related to technical issues that arise in the process of expanding RFID use on a large scale in the company's daily operations.

Finally, our findings also support the benefits to SCM provided by RFID routinization regarding the enhancement of information sharing between SC partners (H7c) and accounting information quality for decision-making (H8c).

### 4.5.3 Limitations and future research direction

In addition to presenting the contributions for researchers and practitioners, we also present the limitations of the study and directions for future research.

First, our sample is limited to companies in Brazil. To enhance the generalizability of the results, future studies can employ our research framework to investigate RFID assimilation in other emergent markets and compare their outcomes.

Second, this study used cross-sectional data collected at a particular point in time using a questionnaire survey. This approach presents constraints to establish the causality of relationships among variables. This way, future works can collect longitudinal data to address this issue for more accurate findings.

Lastly, further research may extend our conceptual framework by proposing other relevant variables. For instance, Tian et al. (2021) explored the effects on SCI influenced by DMTs. In addition to these technical resources, they also used the human resources construct (soft resources) to investigate this influence.

### 4.6 Conclusion

The present study examined the antecedents and consequences of the three-stage-based assimilation process of RFID technology by companies from different industry sectors in Brazil.

TOE framework factors influenced the RFID assimilation in different ways. Top management support (OTS) and competitive pressure (ECP) had significant effects in all three stages: initiation (IN), adoption (AD), and routinization (RO).

Surprisingly, relative advantage (TRA) and perceived costs (TPC) influenced only the IN and RO stages, respectively. The impacts of firm size and industry sector were not statistically significant as control variables in this model.

Finally, information sharing (ISH) and quality of accounting information (AIQ) were confirmed as consequences of RFID assimilation. While ISH was positively affected by RO, AIQ was impacted by both the IN and RO stages.

As revealed by the results, the contextual factors influenced the three stages (initiation, adoption, and routinization) in different ways. The impacts on information sharing and quality of accounting information varied through the stages of RFID assimilation. We found evidence that using a three-stage model can provide valuable insights compared to a dichotomous adoption/non-adoption model.

This study contributes to theory by offering an interdisciplinary theoretical framework, by integrating IS, SCM, and accounting concepts. To the best of the authors' knowledge, this is the first study to examine the different effects of antecedents and consequences related to each one of the three stages of RFID assimilation.

In addition to presenting the current scenario of RFID adoption in the national context, we contribute to practicians by offering guidance and insights on the technology's successful assimilation process for enterprises.

**References**

Agrawal, T. K., Kalaiarasan, R., Olhager, J., & Wiktorsson, M. (2022). Supply chain visibility: A Delphi study on managerial perspectives and priorities. *International Journal of Production Research*. https://doi.org/10.1080/00207543.2022.2098873.

Al-Hattami, H. M., & Kabra, J. D. (2022). The influence of accounting information system on management control effectiveness: The perspective of SMEs in Yemen. *Information Development*, 0(0). https://doi.org/10.1177/02666669221087184.

Al-Okaily, M. (2021). Assessing the effectiveness of accounting information systems in the era of the COVID-19 pandemic. *VINE Journal of Information and Knowledge Management Systems*. https://doi.org/10.1108/VJIKMS-08-2021-0148.

Ben-Daya M., Hassini, E., & Bahroun, Z. (2017): Internet of things and supply chain management: a literature review. *International Journal of Production Research*. https://doi.org/10.1080/00207543.2017.1402140.

Bhattacharya, M., & Wamba, S. F. (2015). A Conceptual Framework of RFID Adoption in Retail Using TOE Framework. *International Journal of Technology Diffusion*, 6(1), 1-32. https://doi.org/10.4018/ijtd.2015010101.

Bonsón, E., & Bednárová, M. (2019). Blockchain and its implications for accounting and auditing. *Meditari Accountancy Research*, 27(5), 725-740. https://doi.org/10.1108/MEDAR-11-2018-0406.

Cao, M., & Zhang, Q. (2011). Supply chain collaboration: Impact on collaborative advantage and firm performance. *Journal of Operations Management*, 29(3), 163–180. https://doi.org/10.1016/j.jom.2010.12.008.

Chan, F. T. S., Chong, A. Y., & Zhou, L. (2012). An empirical investigation of factors affecting e-collaboration diffusion in SMEs. *International Journal of Production Economics*, 138(2), 329–344. https://doi.org/10.1016/j.ijpe.2012.04.004.

Chaudhuri, R., Chatterjee, S., Vrontis, D. et al. (2021). Adoption of robust business analytics for product innovation and organizational performance: the mediating role of organizational data-driven culture. *Ann Oper Res*. https://doi.org/10.1007/s10479-021-04407-3.

Chavez, R., Wu, Y., Jacobs, M. A., & Feng, M. (2017). Data-driven supply chains, manufacturing capability and customer satisfaction. *Production Planning & Control*, 28(11-12), 906-918, https://doi.org/10.1080/09537287.2017.1336788.

Chiu, C., Chen, S., & Chen, C. (2017). An integrated perspective of TOE framework and innovation diffusion in broadband mobile applications adoption by enterprises. *International Journal of Management, Economics and Social Sciences (IJMESS),* 6(1), 14-39. Retrieved from https://www.ijmess.com/volumes/volume-VI-2017/issue-I-03-2017/full-2.pdf.

Cui, L., Deng, J., Liu, F., Zhang, Y., & Xu, M. (2017). Investigation of RFID investment in a single retailer two-supplier supply chain with random demand to decrease inventory inaccuracy. *Journal of Cleaner Production*, 142, 2028-2044. https://doi.org/10.1016/j.jclepro.2016.11.081.

Ehie, I. C., & Chilton, M. A. (2020). Understanding the influence of IT/OT Convergence on the adoption of Internet of Things (IoT) in manufacturing organizations: An empirical investigation. *Comput. Ind.*, 115, 103166. https://doi.org/10.1016/j.compind.2019.103166.

Fornell, C., & Larcker, D. F. (1981). Structural Equation Models with Unobservable Variables and Measurement Error: Algebra and Statistics. *Journal of Marketing Research*, 18(3), 382–388. https://doi.org/10.2307/3150980.

Fosso Wamba, S., Gunasekaran, A., Bhattacharya M., & Dubey, R. (2016). Determinants of RFID adoption intention by SMEs: an empirical investigation. *Production Planning & Control,* 27(12), 979-990, https://doi.org/10.1080/09537287.2016.1167981.

Green Jr., K. W., Zelbst, P. J., Sower, V. E., & Bellah, J. C. (2017). Impact of Radio Frequency Identification Technology on Environmental Sustainability. Journal of Computer *Information Systems,* 57(3), 269-277. https://doi.org/10.1080/08874417.2016.1184029.

Gunasekaran, A., Papadopoulos, T., Dubey, R., Wamba, S.F., Childe, S.J., Hazen, B.T., & Akter, S. (2017). Big data and predictive analytics for supply chain and organizational performance. *Journal of Business Research*, 70, 308-317. https://doi.org/10.1016/j.jbusres.2016.08.004.

Hair, J. F., Jr., Hult, G. T. M., Ringle, C., & Sarstedt, M. (2016). *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM).* Sage publications, Thousand Oaks.

Hair, J. F., Jr., Ringle, C. M., & Sarstedt, M. (2014). *Partial least squares structural equation modeling: Rigorous applications, better results and higher acceptance*. Long Range Planning - Prentice-Hall.

Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to Use and How to Report the Results of PLS-SEM. *European Business Review*, 31(1), 2-24. https://doi.org/10.1108/EBR-11-2018-0203.

Hayat, N., Zainol, N. R., Salameh, A. A., Al Mamun, A., Yang, Q., & Md Salleh, M. F. (2022). How health motivation moderates the effect of intention and usage of wearable medical devices? An empirical study in Malaysia. *Front. Public Health.* https://doi.org/10.3389/fpubh.2022.931557.

Henseler, J., Hubona, G., & Ray, P. A. (2016). Using PLS path modeling in new technology research: updated guidelines. *Industrial Management & Data Systems*, 116(1), 2-20. https://doi.org/10.1108/IMDS-09-2015-0382.

Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *J. of the Acad. Mark. Sci*., 43, 115–135. https://doi.org/10.1007/s11747-014-0403-8.

IASB. (2018). Conceptual Framework for Financial Reporting. IFRS Foundation. Retrieved from: https://www.ifrs.org/issued-standards/list-of-standards/

Iguma, M. K., & Imoniana, J. O. (2023). Omnichannel Retailing: An Exploratory Study of the Postadoption of Radio-Frequency Identification Technology contributing to the Quality of Financial Information. *International Journal of Finance & Banking Studies*, 12(1), 48–62. https://doi.org/10.20525/ijfbs.v12i1.2519.

Iguma, M. K., & Imoniana, J. O. (2024). The Postadoption of Radio-Frequency Identification Technology by a Manufacturing Company contributing to the Quality of Financial Information in Omnichannel Retailing: An Exploratory Study. Working Paper. Department of Accounting and Actuarial Sciences, University of São Paulo, São Paulo, Brazil.

Iguma, M. K., & Riccio, E. L. (2020). Factors influencing Brazilian internal auditors' behavioural intention to adopt big data analytics. *Int. J. Auditing Technology,* 4(3), 217–239. https://doi.org/10.1504/IJAUDIT.2020.10039040.

Junior, C. H., Oliveira, T., & Yanaze, M. (2019). The adoption stages (Evaluation, Adoption, and Routinization) of ERP systems with business analytics functionality in the context of farms. *Computers and Electronics in Agriculture*, 156, 334–348. https://doi.org/10.1016/j.compag.2018.11.028.

Justino, M. V., Robertson K. T., & Michael T-D. (2022). A Revised Technology–Organisation–Environment Framework for Brick-and-Mortar Retailers Adopting M-Commerce. *Journal of Risk and Financial Management*, 15(7), 289. https://doi.org/10.3390/jrfm15070289.

Kahkonen, A. (2014). Conducting a Case Study in Supply Management. *Operations and Supply Chain Management: An International Journal*, 4(1), 31-41. http://doi.org/10.31387/oscm090054.

Kanakriyah, R. (2016). The effect of using accounting information systems on the quality of accounting information according to users perspective in Jordan. *European Journal of Accounting, Auditing and Finance Research*, 4(11), 58-75. Retrieved from: https://www.eajournals.org/wp-content/uploads/The-Effect-of-Using-Accounting-Information-Systems-on-the-Quality-of-Accounting-Information-According-to-Users-Perspective-in-Jordan.pdf.

Kgobe, P., & Ozor, P. (2021). Integration of Radio Frequency Identification Technology in Supply Chain Management: A Critical Review. *Operations and Supply Chain Management: An International Journal*, 14(3), 289-300. http://doi.org/10.31387/oscm0460303.

Khayyam, S., Ramish, A., Rehman, K. U., & Syed, A. R. (2022). Strategizing Radio Frequency Identification (RFID) in the Retail Supply Chains of Pakistan: A Multiple Case Study. *Operations and Supply Chain Management: An International Journal*, 15(1), 27-40. https://doi.org/10.31387/oscm0480328.

Kock, N. (2015). Common method bias in PLS-SEM: a full collinearity assessment approach. *International Journal of E-Collaboration (ijec),* 11(4), 1-10. https://doi.org/10.4018/ijec.2015100101.

Krieger, F., Drews, P., & Velte, P. (2021). Explaining the (non-) adoption of advanced data analytics in auditing: A process theory. *International Journal of Accounting Information Systems, Elsevier*, 41(C). https://doi.org/10.1016/j.accinf.2021.100511.

Lai, Y., Sun, H., & Ren, J. (2018). Understanding the determinants of big data analytics (BDA) adoption in logistics and supply chain management: An empirical investigation. *The International Journal of Logistics Management*, 29(2), 676-703. https://doi.org/10.1108/IJLM-06-2017-0153.

Li, Z., Yang, W., Liu, X., & Li, S. (2022). Coupon strategies for competitive products in an omnichannel supply chain. *Electronic Commerce Research and Applications*, 55, 101189. https://doi.org/10.1016/j.elerap.2022.101189.

Liu, Z., Prajogo, D., & Oke A. (2016). Supply Chain Technologies: Linking Adoption, Utilization, and Performance. *Journal of Supply Chain Management*, 52(4). https://doi.org/10.1111/jscm.12117.

Lutfi, A., Alrawad, M., Alsyouf, A., Almaiah, M. A., Al-Khasawneh, A., Al-Khasawneh, A. L., Alshira'h, A. F. & Alshirah, M. H., Saad, M., & Ibrahim. (2023). Drivers and impact of big data analytic adoption in the retail industry: A quantitative investigation applying structural equation modeling. *Journal of Retailing and Consumer Services*, 70(C). https://doi.org/10.1016/j.jretconser.2022.103129.

Mabad, T., Ali, O., Ally, M., Wamba, S. F., & Chan, K. C. (2021). Making Investment Decisions on RFID Technology: An Evaluation of Key Adoption Factors in Construction Firms. *IEEE Access*, 9, 36937–36954. https://doi.org/10.1109/access.2021.3063301.

Mahdaly, K., & Adeinat, I. (2022). Factors that affect the adoption of RFID in the Saudi logistics industry: an empirical investigation. *The International Journal of Logistics Management,* 33(3), 1017-1039. https://doi.org/10.1108/IJLM-11-2020-0456.

Manavalan, E., & Jayakrishna, K. (2019). A review of Internet of Things (IoT) embedded sustainable supply chain for industry 4.0 requirements. *Comput. Ind. Eng.,* 127, 925-953. https://doi.org/10.1016/j.cie.2018.11.030.

Munoz-Ausecha, C., Ruiz-Rosero, J., & Ramirez-Gonzalez, G. (2021). RFID Applications and Security Review. *Computation*, 9, 69. https://doi.org/10.3390/computation9060069.

Nam, D., Lee, J., & Lee, H. (2019). Business analytics adoption process: An innovation diffusion perspective. *International Journal of Information Management*, 49, 411–423. https://doi.org/10.1016/j.ijinfomgt.2019.07.017.

Ou, P., Zhao, H., & Zhou, Z. (2017). Does The Implementation of ERP Improve The Quality Of Accounting Information? Evidence From Chinese A-Share Listed Manufacturing Firms. *Journal of Applied Business Research (JABR),* 34(1), 43–54. https://doi.org/10.19030/jabr.v34i1.10090.

Palazuelos, E., Crespo, Á. H., & del Corte, J. M. (2018). Accounting information quality and trust as determinants of credit granting to SMEs: the role of external audit. *Small Bus Econ,* 51, 861–877. https://doi.org/10.1007/s11187-017-9966-3.

Podsakoff, P. M., & Organ, D. W. (1986). Self-reports in organizational research: problems and prospects. Journal of Management, 12(4), 531-544.

Raza, S.A. (2022). A systematic literature review of RFID in supply chain management. *Journal of Enterprise Information Management*, 35(2), 617-649. https://doi.org/10.1108/JEIM-08-2020-0322.

Rejeb, A., Simske, S. J., Rejeb, K., Treiblmaier, H., & Zailani, S. (2020). Internet of Things research in supply chain management and logistics: A bibliometric analysis. *Internet Things*, 12, 100318. https://doi.org/10.1016/j.iot.2020.100318.

Reyes, P. M., & Li, S., & Visich, J. K. (2016). Determinants of RFID adoption stage and perceived benefits. *European Journal of Operational Research, Elsevier*, 254(3), 801-812. https://doi.org/10.1016/j.ejor.2016.03.051

Rizun, M.; Strzelecki, A. (2020). Students' Acceptance of the COVID-19 Impact on Shifting Higher Education to Distance Learning in Poland. *Int. J. Environ. Res. Public Health*, 17, 6468. https://doi.org/10.3390/ijerph17186468.

Rogers, E. M. (1995). *Diffusion of Innovations, 4th ed*. Free Press, New York.

Roy, V. (2021). Contrasting supply chain traceability and supply chain visibility: are they interchangeable? *The International Journal of Logistics Management*, 32(3), 942-972. https://doi.org/10.1108/IJLM-05-2020-0214.

Sarac, A., Absi, N., & Dauzère-Pérès, S. (2010). A literature review on the impact of RFID technologies on supply chain management. *International Journal of Production Economics*, 128(1), 77–95. https://doi.org/10.1016/j.ijpe.2010.07.039.

Seifian, A., Bahrami, M., Shokouhyar, S., & Shokoohyar, S. (2023). Data-based drivers of big data analytics utilization: moderating role of IT proactive climate. *Benchmarking: An International Journal,* 30(10), 4461-4486. https://doi.org/10.1108/BIJ-11-2021-0670.

Shousong, C., Xiaoguang, W., & Yuanjun, Z. (2019). Revenue Model of Supply Chain by Internet of Things Technology. *IEEE Access*, 7, 4091-4100. https://doi.org/10.1109/ACCESS.2018.2888952.

Sodhi, M. S., & Tang, C. S. (2019). Research Opportunities in Supply Chain Transparency. *Production and Operations Management*, 28, 2946–59. https://doi.org/10.1111/poms.13115.

Somapa, S., Cools, M., & Dullaert, W. (2016). Characterizing supply chain visibility - a literature review. *International Journal of Logistics Management*. https://doi.org/10.1108/IJLM-06-2016-0150.

Tambuskar, D. P., Jain, P., & Narwane, V. S. (2023). An exploration into the factors influencing the implementation of big data analytics in sustainable supply chain management. *Kybernetes*. https://doi.org/10.1108/K-07-2022-1057.

Thiesse., F., Staake., T., Schmitt., P., & Fleisch., E. (2011). The rise of the "next-generation bar code": an international RFID adoption study. *Supply Chain Management*, 16(5), 328-345. https://doi.org/10.1108/13598541111155848.

Tian, M. (2019). Turning a technology into many solutions: A case study of embedding an information system. *Journal of Business Research*, 23-39. https://doi.org/10.1016/j.jbusres.2019.03.053.

Tian, M., Huo, B., Park, Y., & Kang, M. (2021). Enablers of supply chain integration: a technology-organization-environment view. Industrial Management & Data Systems, 121(8), 1871-1895. https://doi.org/10.1108/IMDS-09-2020-0564.

Tornatzky, L. G. and Fleischer, M. (1990) *The Processes of Technological Innovation*. Lexington Books, Lexington.

Trabucco, M., & De Giovanni, P. (2021). Achieving Resilience and Business Sustainability during COVID-19: The Role of Lean Supply Chain Practices and Digitalization. *Sustainability,* 13(22), 12369. https://doi.org/10.3390/su132212369.

Tsai, M. C., Wen, L., & Wu, H. C. (2010). Determinants of REID adoption intention: evidence from Taiwanese retail chains. *Information & Management*, 47, 255-261. https://doi.org/10.1016/j.im.2010.05.001.

Tu, M. (2018). An exploratory study of Internet of Things (IoT) adoption intention in logistics and supply chain management: A mixed research approach. *The International Journal of Logistics Management*, 29(1), 131-151. https://doi.org/10.1108/IJLM-11-2016-0274.

Valentinetti, D., & Munoz, F. F. (2021). Internet of things: Emerging impacts on digital reporting. *Journal of Business Research. Elsevier Inc.*, 131, 549–562. https://doi.org/10.1016/j.jbusres.2021.01.056.

Velayutham, A., Rahman, A. R., Narayan, A. & Wang, M. (2021). Pandemic turned into pandemonium: the effect on supply chains and the role of accounting information. *Accounting, Auditing and Accountability Journal*, 34(6), 1404-1415. https://doi.org/10.1108/AAAJ-08-2020-4800.

Wang, Y. M., Wang, Y. S., & Yang, Y. F. (2010). Understanding the Determinants of RFID Adoption in the Manufacturing Industry. *Technological Forecasting and Social Change*, 77(5), 803–815. https://doi.org/10.1016/j.techfore.2010.03.006.

Williams, B. D., Roh, J., Tokar, T., & Swink, M. (2013). Leveraging supply chain visibility for responsiveness: The moderating role of internal integration. *Journal of Operations Management*, 31(7-8), 543–554. https://doi.org/10.1016/j.jom.2013.09.003.

Wu J., Xiong, F., & Li, C. (2019). Application of Internet of Things and Blockchain Technologies to Improve Accounting Information Quality. *IEEE Access*, 7, 100090-100098. https://doi.org/10.1109/ACCESS.2019.2930637.

Xu, H., Horn Nord, J., Daryl Nord, G., & Lin, B. (2003). Key issues of accounting information quality management: Australian case studies. *Industrial Management & Data Systems,* 103(7), 461-470. https://doi.org/10.1108/02635570310489160.

Yang, M., Fu, M. & Zhang, Z. (2021). The adoption of digital technologies in supply chains: Drivers, process and impact. *Technological Forecasting and Social Change, Elsevier*, 169(C). https://doi.org/10.1016/j.techfore.2021.120795.

Zhang, L., & Yang, H. (2019). Incentives for RFID adoption with imperfect read rates: Wholesale price premium versus cost sharing. *Journal of the Operational Research Society*. https://doi.org/10.1080/01605682.2018.1506252.

Zhu, K., Kraemer, K.L., & Xu, S. (2006). The process of innovation assimilation by firms in different countries: a technology diffusion perspective on e-business. *Management Science*, 52(10), 1557-1576. https://doi.org/10.1287/mnsc.1050.0487.

## 5 CONCLUDING REMARKS

The present research investigated the antecedents and consequences of item-level RFID post-adoption in three distinct settings: omnichannel retailing, manufacturing, and supply chains. Three essays together provide evidence of how the RFID assimilation process is influenced by contextual factors (technical, organizational, and environmental) and, in turn, generates benefits for companies differently in each setting. These benefits are related to improvements in accounting practices, quality of accounting information, and sharing of information in the supply chain.

Our findings contribute to practice by offering guidance and insights into the successful adoption and use of RFID technology in organizations. The benefits of RFID for organizations' sustainable practices were addressed in some environmental, social, and governance aspects implicitly in this study. However, new empirical studies of RFID may investigate the topic more deeply using theories focused on ESG performance.

The first essay revealed which accounting practices were affected by the post-adoption of RFID in omnichannel retail and how they changed. The RFID system allows full inventory counts much more frequently than traditional cyclical counts with agility, safety, and accuracy. The most relevant change refers to the practices of recognition and provision of losses, enhancing the accounting information quality.

In the second essay, the post-adoption of RFID in a garment manufacturer improved information sharing at three levels of SCI: internal, supplier, and customer. RFID contributed to the accounting practices related to WIP and FG inventories, cost accounting, and loss recognition, thus improving the measurement of items in stock, the cost of goods sold (COGS), and, consequently, the results in financial reports.

The third essay examined the antecedents and consequences of the three-stage-based assimilation process of RFID technology by companies from different industry sectors in Brazil. As revealed by the results, the contextual factors influenced the three stages (initiation, adoption, and routinization) in different ways. The impacts on information sharing and quality of accounting information varied through the stages of RFID assimilation. We found evidence that using a three-stage model can provide valuable insights compared to a dichotomous adoption/non-adoption model.

In addition to the limitations presented in each of the studies, we must consider that the case study and survey research strategies capture the perceptions of respondents through the use of interviews and online questionnaires, respectively. Regarding the construct of quality of accounting information, the present study focuses on capturing RFID data and its path through the company's information systems to the ERP system available for access by accountants and managers.

Future studies may adopt other quantitative research strategies on RFID post-adoption with the use of earning quality proxies (e.g., earnings persistence, value relevance, asymmetric timeliness, earnings smoothness, quality of accruals, loss avoidance, and timely loss recognition) related to earnings manipulation issues, which are generally applied in Financial Accounting studies.

In general, this dissertation focused on the current scenario of item-level RFID post-adoption in different settings of the national context. This study contributes to theory by proposing an interdisciplinary theoretical framework that integrates information systems, supply chain management, and accounting concepts. We hope our dissertation opens new paths in different research areas, especially in financial and management accounting, and auditing fields.