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OMNICHANNEL RETAILING: THE IMPROVEMENT OF ACCOUNTING INFORMATION QUALITY THROUGH RFID/IOT ADOPTION

Marcio Kawahara Iguma ; https://orcid.org/0000-0003-4271-5074
FEA/Universidade de São Paulo

Joshua Onome Imoniana ; https://orcid.org/0000-0002-6535-6863
FEA/Universidade de São Paulo

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ABSTRACT

Purpose – This paper aims to investigate the changes in accounting practices of inventory control, contributing to the improvement of the accounting information quality, based on the factors influencing the radio-frequency identification (RFID) adoption.

Design/methodology/approach – The authors use a qualitative methodology with interpretative analysis through the study of four cases in large companies that implemented RFID technology in Brazil, using semi-structured interviews and financial and sustainability public reports.

Findings – The findings show that Technological, Organizational and Environmental factors influence RFID adoption by retail companies. The greater granularity of the product tracking level chosen in the RFID adoption brings greater benefits in inventory accuracy and real-time inventory visibility. The big deal of the RFID technology in retail is to enable full inventory counts of retailers' stores much more frequent than a traditional physical inventory count, providing timely and accurate inventory information for internal areas of the company. Surprisingly, the main changes in accounting practices regard identification, recognition and provision of losses that impact the financial statements quality.

Originality/value – This paper contributes to the accounting literature by providing evidence on how changes in technology may influence business and accounting practices and, consequently, improve the quality of information, extending the TOE theory.

Keywords: RFID; Accounting Information Quality; Omnichannel

1. Introduction

The increasing adoption of omnichannel strategies in recent years has led retail companies worldwide to fundamentally rethink the future role of their network of brick-and-mortar stores (Hauser, Flath, & Thiesse, 2021) due to profound changes in how retailers and consumers view place and locational choices, which became even more critical during COVID-19. The COVID-19 crisis has strongly influenced consumer behavior, pushing firms and people to use different channels to access to goods and services, due to social immobility and distance, limited access to shops and retailing, and reduced stock availability (Trabucco & De Giovanni, 2021).

Omnichannel retailing differs from the more traditional approach of multichannel retailing in that the electronic channel is not operated in isolation from physical stores, but rather merges the two channels into a coherent whole to create added value for the customer through services that may not be provided by Internet-based competitors who operate only on the digital level (Hauser et al., 2021).

The Internet of Things (IoT) plays a fundamental role in channel integration because it allows companies to rebalance supply and demand, enhancing real-time inventory visibility (Caro & Sadr, 2019). Thus, IoT has a lot to offer and contribute to the retail industry, from the innovations in retail store experience to the increased efficiency in the store management and supply chain optimization (Škiljo et al., 2020).

RFID became the main enabler for the final IoT deployment its real-world applications (Škiljo et al., 2020). The potential of RFID technology for logistics and supply chains includes high-speed reading, simultaneous reading of multiple objects even out of visual range, storage of large amounts of data and direct communication with the product (Nikolicic et al., 2021). RFID supports intelligent supply chains by allowing for container, pallet, or item-level tracking of products (Li, Deng, Zhang, & Liu, 2021). Literature presents many advantages for RFID adoption: (1) cost saving, (2) revenue increase, (3) operational efficiency, and (4) productivity increase. RFID enables the accurate knowledge of the inventory resulting in lower labor cost, simplified business processes, helping avoid stockouts and boost the number of inventory turns, reducing losses and shrinkage, improve loss prevention and minimizing the counterfeiting and theft of tagged products (Khalil et al., 2020). Furthermore, the technology also enables new customer-oriented services in retail, such as smart kiosks, smart shelves and smart changing rooms (Hauser et al., 2021).

In the Information System (IS) literature, most studies focus on the factors that influence the decision to adopt RFID (antecedents) (Reyes et al., 2016; Fosso Wamba et al., 2016), but few analyze the actual use of technology and how it continues to evolve in the organization. However, the adoption does not always result in widespread usage of the technology by a firm. After a new Information Technology (IT) innovation is adopted, it needs to be accepted, adapted, routinized, and institutionalized into the firm (Zhu, Kraemer, & Xu, 2006). Furthermore, most studies present the level of benefits that the organization and supply chains can receive from the RFID adoption, including customer service, productivity, asset management and communication (Reyes et al., 2016), but do not address the quality of accounting information produced for decision making.

Through RFID and IoT technology, it is becoming possible to achieve the real-time transmission and updating of inventory information, thus improving the efficiency and quality of data acquisition (Wu, Xiong, & Li, 2019). IoT furtherly enhances the enterprise accounting information process through business data and financial data synchronization (Dai & Ge, 2015) and the ability to understand and communicate the value of tangible and intangible assets (Moll & Yigitbasioglu, 2019). IoT smart tags allow intelligent traceability

which facilitates high-precision financial reporting and improves management decisions across the organization (Arif et al., 2020).

IoT has the potential to revolutionize the way companies collect data and, in the process, transform many aspects of accounting and auditing, according to AICPA, profoundly changing the accounting environment and promoting the accounting information working process (Qiu, 2016). Although the current literature presents interesting insights on the innovative ways accounting information is co-produced and shared through RFID, including the development of some platforms and conceptual models for corporate reporting (Qiu, 2016; Tsai et al., 2020), such studies are mainly forward oriented and lack evidences on practical use of such solutions in accounting and auditing areas. Therefore, research is needed to assess the quality of information from RFID system in terms of reliability, relevance, timeliness and comparability (Valentinetti & Munoz, 2021).

In the last 5 years, a growing number of large retail companies in Brazil have released RFID deployments with the main focus on omnichannel sales strategy, including Lojas Renner S.A., C&A, Centauro (Grupo SBF S.A.), Pernambucanas, Riachuelo, Hering, Havan and Decathlon. In this way, this recent movement of retail companies can be seen as an opportunity for research, considering that this phenomenon was not examined by previous research. In order to address the previously discussed gap, our study attempts to answer the research questions:

- How does the RFID technology adoption process occur in relation to technological, environmental and organizational aspects in retail companies? What are the critical success factors for adoption?
- Which benefits with real-time, accuracy and identification were achieved in inventory management? If not, what are the challenges to achieve them?
- Which accounting practices (related to accounting information quality) have changed or have the potential to change?

The main contributions of this work are summarized as follows:

- By describing the phenomenon considering the relevant existing knowledge, this study aims to contribute to the research on adoption of technological innovation within organizations by giving new insights into two areas: RFID/IoT and the accounting information fields.
- Although this study is informed by prior literature and the theoretical perspectives of the Technology-Organisation-Environment (TOE) framework, it aims to identify new ways in which traditional TOE factors interact with accounting and new factors that could potentially extend the TOE theory.
- Providing insights on the actual use of RFID and contributing both to retail companies and RFID service providers in Brazil, highlighting the relevant role of accounting in the process of adopting technological innovations.

2. Literature Review

RFID and retail challenges

The discrepancies between warehouse quantities recorded in the system and stocks truly available to customers represent one of the biggest problems retailers face. It has been estimated that, due to inventory misplacement and shrinkage, lost sales and inventory costs will cut profit by more than 10% (Tao et al., 2017). Atali et al. (2005) distinguish between three main sources of inventory discrepancies: (i) shrinkage and (ii) misplacement of

products. (iii) transaction errors: this is related to wrong scanning of products in retail outlets or switches of products in the suppliers warehouse.

Inventory misplacement refers to placement of the product on the wrong shelf by a customer or a salesperson, causing a temporary loss which may be recovered by physical audit; while inventory shrinkage is caused by damage or theft in the store (such as customer shoplifting) so that the product cannot be sold any more, which leads to permanent loss.

From the consumer's perspective, product stockouts are one of the top three shopping irritations. Beyond immediate lost sales, stockouts can also influence potential future sales since customers who experience a stockout are less likely to purchase products from the same retailer in the future (Goyal et al., 2016). There are two types of stockouts: store stockouts, wherein the product is not available in the backroom or the sales floor; and shelf stockouts, wherein the product is available in the store, but is not on the shelf for the customer to purchase. Replenishments from backroom stock to shelf stock typically happen frequently during the selling season, as retail shelf space is limited. For some fast-moving items, this might happen multiple times during a day (Gaukler, 2011).

RFID adoption is proposed by researchers to meet the ongoing retail challenge. The visibility provided by RFID technology highlights shrinkage problems, ensuring accurate knowledge of actual inventory levels by eliminating the discrepancy between physical and information flows. Periodic monitoring using RFID readers would allow store employees to identify discrepancies. More importantly, store employees can identify these discrepancies quickly as handheld RFID readers only require store employees to walk in the store aisles and do not require scanning of barcodes. Therefore, updating store inventory records based on the RFID reads has the potential to reduce the likelihood of inventory inaccuracy and product out-of-stocks. Tao et al. (2017) find that when RFID technology is adopted, the inventory control policy in the RFID case is much more stable than that of the non-RFID case, as the misplaced inventory can be recovered perfectly and instantly for sale and the inventory shrinkage can be reduced by RFID technology (Tao et al., 2017).

Omnichannel retailing

Accurate product and customer data are imperative to omnichannel retailing in general and the development of "smart stores" in particular, also referred to as "connected stores"), that is, physical stores complemented by digital technologies and services for use by customers on the sales floor (Hauser et al., 2021). In this context, industry experts and scholars highlight the importance of accurate information regarding product availability for the seamless integration of retail channels.

RFID not only provides a means by which to increase inventory accuracy but also enables novel customer-oriented services on the retail sales floor such as smart kiosks, smart shelves, and smart fitting rooms. Self-checkout technology helps shoppers scan, bag, and pay for products without any need to interact with a cashier. Thus, customers gain control and retailers enjoy reduced labor costs from the fewer number of cashiers required (Grewal et al., 2021).

In online shopping, retailers generally have access to large amounts of log files and data-rich customer profiles through tracking cookies and analytics. However, such information is rarely available for physical stores. Instead, the retailer needs to categorize customers based on certain characteristics and serve them accordingly (Landmark, & Sjøbakk, 2017).

RFID can be used to gather data on the sales floor and help close the data void between the goods receipt and the point of sales in the store, thus offering the opportunity to directly observe and analyze physical in-store processes. Landmark and Sjøbakk (2017) demonstrates the use RFID technology to collect customer behavior, illustrated through a case study of fitting rooms in a fashion retail store.

Different customer types most likely require and respond differently to attention from the personnel operating the fitting room area. By identifying such traits, it is possible to devise best practice shop stewardship by creating a more personalized retail experience, and enabling interaction with smart fitting rooms.

The main application of RFID in fashion retail is still within logistics and upstream supply chain management. Only through identification of customer behavior throughout the purchasing process may the retailer determine what the customer needs, and translate this into an offering. Thus, utilizing RFID at the very end of the supply chain can help better understand customer behavior, at a negligible additional cost (Landmark, & Sjøbakk, 2017).

Relative advantage over bar code systems

Both RFID and barcodes use labels (RFID tags vs. printed barcodes) and devices to read the labels (RFID readers vs. scanners), and both rely on the back-end IT infrastructure for cross-referencing the ID number with a database system (Zhang & Yang, 2019).

RFID systems can be considered an evolution of barcodes. It will not be incorrect to say that RFID replaces barcodes, but it offers many additional benefits over Barcode technology (Khayyam et al., 2022 :35). First, no line of sight is required for RFID whereas a clear line of sight is required to read a barcode. RFID does not require immediate physical proximity to a unit of inventory since the read-range of a typical handheld reader is approximately 20 feet (Goyal et al., 2016).

Second, with RFID, multiple parallel reads are possible once RFID tags come in range of the reader. The inventory scanning with RFID is no longer a serial process. There is no need for barcode lines to read. In contrast, a barcode can be read only when the item is physically moved across the scanner, which adds to the time and cost of reading. Third, RFID can capture a wide range of data with minimal human intervention (contactless and remote interrogation). This means that RFID tags and readers do not have to be oriented to or close to each other in order to transmit and receive the radio signals. Finally, a barcode is unchangeable, relatively easy to forge, and cannot carry much data. RFID, on the other hand, offers a wide range of data storage capacities with secure information transfer, especially if the information is encrypted from the product to the product database (Chongwatpol, & Sharda, 2013).

Levels of product tracking

RFID tags are used at different levels. RFID is an effective way to reduce inventory costs because it can support intelligent supply chains by allowing for container, pallet, or item-level tracking of products (Li, Deng, Zhang, & Liu, 2021).

Pallet-level tagging describes the situation where RFID tags are placed on individual pallets. Pallet-level tagging is typically used in full-pallet storage and logistics and transportation applications. In case-level tagging, RFID tags are attached to cases. This level of tagging facilitates mixed-pallet loads.

Prior studies focusing on case-level products and utilizing fixed readers, have two key shortcomings: first, it is difficult to examine store-level processes because items are removed from their case prior to being placed on the shelves and, thus, lose RFID-enabled visibility; and second, some items have little to no inventory in the backroom as all the stock is on the sales floor and are difficult to monitor using RFID technology. Despite the application of RFID mainly at the case level and the pallet level, many researchers have realized its possibility for wider use at the item level as the tag cost descends and given attention to product application.

In item-level tagging, each individual product has its own RFID tag. The ID for an object, the so-called Electronic Product Code (EPC), is constituted of only 96 bits (indicating company name, object type/class, and serial number) allowing relative low data transfer between tag and reader (Duroc, & Tedjini, 2018).

According to Bertolini et al. (2017), important factors that explain the widespread adoption of item-level RFID tagging: (a) the ability to track and trace items from the application of the tag, which may even be at the manufacturing plant, to the point of sale, (b) the high marginality of the fashion and apparel sector, (c) the large number of SKUs (Stock Keeping Unit) that must be managed (i.e. model size, colour, season), (d) ideal environment – absence of liquids and metals, (e) short product lifecycle and (f) the significant developments in information and communication technology that make it possible to manage the massive amount of data generated by item-level tagging. Because of these benefits, item-level RFID had been adopted across retail sectors such as clothing stores (Li, Deng, Zhang, & Liu, 2021). The identification information can then be used to enable complete tracking of an item, thus potentially creating complete visibility of item progress through manufacturing, distribution, storage and inventory, and retail environments. RFID technology can be used to create end-to-end supply chain information visibility to track and trace item-level information through the entire supply chain at any time and at any location (Zhu, Mukhopadhyay, & Kurata, 2012).

RFID Challenges and Barriers

Not all retailers are sure of the benefits of RFID or know how best to realize these benefits as RFID technology is not perfect (Goyal et al., 2016). Many smaller retailers, in particular, remain hesitant to incur the considerable infrastructure and systems costs required to implement, and the ongoing (variable) costs of, tagging.

According to Sarac et al. (2010), there are six components of RFID implementation costs: (1) hardware costs, (2) software costs, including database system, interface system, and middleware system, which extract the data from RFID readers, filter the data, aggregate the information, and route the data to enterprise systems, (3) system integration costs with an existing Enterprise Resource Planning (ERP) system, (4) installation service cost, (5) personnel costs (user training), and (6) business process re-engineering costs.

The RFID cost has long been identified as a barrier to RFID adoption. However, over the last years, tag and tagging costs have decreased and the availability of cheap and flexible reading equipment, such as hand readers for shop floor and inventory operations, has increased. Consequently, more and more companies find that the benefits of RFID outweigh the associated costs. Although a single RFID tag is cheap, the tagging cost is a significant factor in RFID adoption, because it can cause expensive total spending due to the huge quantity of product items (Zhang, Tian & Ti-Jun, 2018).

Besides, the manufacturers and the retailers often see different benefits from RFID adoption. Further, item-level RFID adoption seems to favour the retailers, but is a costly

solution for the manufacturers who are in the best position to put on the tags (Gaukler et al., 2007). Manufacturers are generally most interested in tracking cases or pallets of their product via the transportation channel up to the retail outlets, which can be done using the much cheaper case and pallet-level tagging (Gaukler, 2011).

RFID/IoT, AIS and Accounting Practices

Information technologies (IT) have forever changed many aspects of business and accounting practices. The impact of IT on accounting systems has evolved from fairly simple general ledger applications to extremely complex ERP systems (Hunton, 2022). Accounting information research found that ERP implementations result in changes in the tasks performed by management accountants and can improve their capability to provide management with access to relevant and real-time operational data in the support of decision making and management control (Appelbaum et al., 2017). These information systems contribute to the dissemination of accounting knowledge throughout the organization and to automatically perform various activities related to management accounting, reporting, consolidated balance sheets, asset and stock management, among others (Martins & Santos, 2021).

The use of sophisticated information technology can affect the manner in which cost data are classified, the frequency and timing of feedback, and the verifiability (credibility) of information. Thus, IT can alter the amount, type, and quality of accounting information available to decision makers and has the potential to significantly influence judgment and decision performance (Sprinkle & Williamson, 2006).

In this way, RFID represents the next technological event in the evolution of technology in accounting and auditing, increasing the frequency of data capture and a large set of managerial, accounting, and assurance process expansions, as well as the addition of multiple sources of audit evidence (Vasarhelyi, Kogan, & Tuttle, 2015).

The accounting literature presents interesting insights on the role of RFID and IoT, including the development of some platforms and conceptual models for corporate reporting. Qiu (2016) proposed a combination of RFID and accounting platform, and the establishment of an intelligent 3D dynamic accounting information platform based on IOT technology to perform the following activities: data acquisition, cost accounting, accounting document generation and report output.

Members in industry may find the use of RFID systems influencing the inventory-costing method their company uses. Typically, it has been impractical for many companies to determine the actual costs of each individual item sold and each one that remains in inventory. As a result, companies have used other cost-flow methods (Davis, & Luehlfing, 2004).

Item-level RFID devices makes the specific identification method of costing inventory practical and cost effective, and it reduces the need for using cost-flow assumptions (Stambaugh, & Carpenter, 2009). FIFO, LIFO, and average costing all aggregate and make simplifying assumptions about the costs of goods, with such assumptions justified by the high cost of tracking an individual item's progress through inventory. RFID enables the reduction of these costs (Krahel & Titera, 2015).

The opportunity to provide real-time inventory costing data portends a significant decline in the cost effectiveness of FIFO, LIFO, average costing, and other aggregated valuation methods (Vasarhelyi 2012). FIFO and LIFO add little value in an era when actual identification, real time measurement, and real-time market prices are available. (Vasarhelyi, 2012).

As companies over the next decade adopt RFID, computer systems will store the cost data associated with each individual inventory item and will be able to more accurately determine ending inventory levels or the cost of goods sold (Davis, & Luehlfing, 2004). The real time updates gathered by IoT in logistic operations traditionally accounted in ERP systems results in improving efficiency and accuracy of stock monitoring and reporting and the optimal asset utilization, for which over- and underutilization of assets improve the depreciation and amortization methods (Mahmud, 2017).

Moving away from traditional balance sheet and income statement disclosures to a more real-time/exception reporting base would lead to a very different set of real-time business reports (Gal, 2008), in addition to more relevant and graphical reporting, and support the analysis and provisioning of management, auditor and stakeholder dashboards. RFID electronic tags can automatically generate the accounting documents in real time, thereby eliminating the need for manual entry and significantly reducing the workload of the accountant.

The real-time data availability could introduce new techniques such as financial ratios analysis, budgeting, profit centers, absorption costs and customer analysis, Activity Based Costing (ABC) and the "target cost" (Martins & Santos, 2021).

Business analytics tools for real-time decisions can take place at the source of data. Accounting data can be tracked from the physical objects they refer to, through ledgers, billings, and other accounting tools that will feed the corporate reports to be externally communicated in real-time (O'Leary, 2013).

Pricing is another activity that can be enhanced by RFID, which allow dynamic pricing decisions (and limited-time discounts) on a daily basis to normalize in-store inventory levels. The retailer can use machine learning algorithms – together with demand forecasting trained on customer shopping data (collected at each store) and real-time visibility of inventory – to adopt dynamic pricing and also to estimate future demand for new products more effectively (Caro & Sadr, 2019).

The awareness of the location of inventory, and its time in storage, would provide knowledge about obsolescence. This information could be used to develop obsolescence trend models that might better inform both management and investors about the quality of inventory (Vasarhelyi, 2012).

RFID promises many improvements in accounting processes and may have a direct impact on generally accepted accounting principles (GAAP) (Stambaugh, & Carpenter, 2009). IoT technology also makes traditional accounting confusing; thus, accounting theory should be immediately reexamined. Corporate CPAs therefore may see a shift to the specific identification method of inventory costing (Davis, & Luehlfing, 2004).

Accounting Information Quality

Accounting information quality is financial information that is useful for decision making, understandable and adequate to the needs of the users for whom it is intended (Hendriksen & Van Breda, 1999). According to Dechow, Ge and Schrand (2010), the quality of the accounting information system adopted by the entity allows greater predictability of future cash earnings by the users of the statements, improving the accounting information quality. In the financial accounting literature, the use of several measures for the quality of accounting information is observed, including: earnings persistence; value relevance; timeliness, which represents how quickly financial

information reaches its users; earnings smoothness; quality of accruals; loss avoidance; conservatism and timely loss recognition (TLR).

Labro and Stice-Lawrence (2020) provide evidence on the determinants and economic outcomes of updates of accounting systems (AS) over a 24-year timespan in a large sample of U.S. hospitals. Hospitals update their AS in response to economic pressures, such as increases in the quality of accounting information driven by vendor rollouts of improved AS.

In the IASB's (2018) conceptual framework applied mainly to the private sector, there are two fundamental qualitative characteristics (relevance and faithful representation) that are supported by four qualitative improvement characteristics (comprehensibility, timeliness, comparability and verifiability). Studies examine the impact of accounting information system on the on the quality of accounting information, using qualitative characteristics as a proxy to measure it, such as relevance, reliability, comparability, understandability, consistency and neutrality (Kanakriyah, 2016), accuracy, timeliness, completeness and consistency (Al-Hiyari et al., 2013).

Following the rapid development and the maturity of blockchain (BC) and the Internet of Things (IoT) technologies, Wu, Xiong and Li (2019) proposes two applications of a BC-IoT transaction model in the accounting field. This paper demonstrates the provision of accounting information in real time and on demand to substantially improve the usefulness of accounting information, the relevance, faithful representation, timeliness, comparability, and other aspects of accounting information quality.

Slone (2006) investigated the dependency relationship between organizational benefits and information quality dimensions using the Product-Service-Performance Model for Information Quality (PSP/IQ) model (Kahn, Strong, & Wang, 2002). In the accounting field, Antonelli et al. (2021) developed a critical factors model to assess the success of accounting information systems in accounting service providers in Brazil and the influence on the quality of accounting information as a subgroup of the net benefit factor produced by the systems.

Technology-Organisation-Environment (TOE) framework

Information System (IS) research has long studied how and why individuals and companies adopt new information technologies. The Technology-Organisation-Environment (TOE) framework identifies three aspects of a firm’s context that influence its assimilation of a technological innovation: (a) Technological context describes both the existing technologies in use and new technologies relevant to the firm. (b) Organizational context refers to descriptive measures about the organization such as scope, size, and managerial structure. (c) Environmental context is the arena in which a firm conducts its business—its industry, competitors, and dealings with government (Tornatzky & Fleischer, 1990).

The choice of the TOE framework was based on its applicability on the purpose of this study in comparison to other theories in the area of technological adoption on a firm level. Other models such as UTAUT (Venkatesh et al., 2003) view the individual level of technological adoption and were not applicable to this study. Besides, TOE has been applied in numerous previous researches on adoption of technological innovation: GAS adoption by external auditors (Widuri et al., 2016), CAATTs adoption by audit firms (Siew, Rosli, & Yeowa, 2020), audit analytics for internal auditors (Li, Dai, Gershberg & Vasarhelyi, 2018), RFID adoption intention by SMEs (Fosso Wamba et al., 2016).

2.1. Technology-Organization-Environment (TOE) Literature

2.1.1. Technological factors

All technological attributes that affect the company, both internal and external, must be considered. This part mentions that the current technology used in a company has an impact on the decision to adopt a new technology. One aspect on the technology side is therefore availability. The company's current technology must adjust to the new technology being considered for an implementation to take place, and therefore this new technology must be able to replace or integrate with existing technology. Another aspect is characteristics, which means that technological innovations have different characteristics and not all characteristics are suitable for all industries (Tornatzky & Fleischer, 1990). These include complexity of technologies, compatibility with practices already existing in a firm, perceived benefits, emergence of computing platforms, and technologies that help increase the security of technology (Ramanathan et al., 2017).

2.1.2. Organizational factors

The organizational part of the structure deals with the internal context of the organization, which concerns the internal life of the organization. As such, this part of the framework consists primarily of formal and informal liaison structures, describing how employees and departments within the organization are structured and linked to each other. In addition, companies with a hierarchical structure are less associated with the regular adoption of innovations, as normally only the top management of the organization knows about the organization's purpose, results, tasks and current situation, which makes this structure centralized and specialized, leading to less influence from other parts of the organization, where the need for technological innovation might originate (Tornatzky & Fleischer, 1990). For example, business strategy, company structure, processes and culture are important organizational factors (Ramanathan et al., 2017).

2.1.3. Environmental factors

This part of the structure consists, first of all, of the characteristics of the industry and the structure of the market. Some industries are more eager to adopt new technologies, while others are less eager, depending on technological importance as a competitive advantage. In addition, the external task environment affects decision making due to market variations and growth, and the tendency for companies in the same industry to share the same problems and opportunities. If, however, there are differences between companies in the same industry and they do not share the same problems and opportunities, this is likely due to company-specific organizational or market attributes (Tornatzky & Fleischer, 1990). This includes business pressure, environmental munificence, complexity, and, dealings with business partners, competitors and the and the government (Ramanathan et al., 2017).

2.1.4. Three stages of technology assimilation

Zhu, Kraemer and Xu (2006) developed a model that integrates technological, organizational and environmental (TOE) dimensions as prominent antecedents of the three-stage assimilation process: initiation, adoption and routinization. The initiation stage

begins with the perception and evaluation of an innovation to measure the performance improvement and potential benefits of a company's value chain activities, such as cost reduction, market expansion, and supply chain coordination. In the adoption stage, decisions are made to formally allocate the resources needed to fully implement the innovation (resource allocation and physically acquire the technology). Finally, in the routinization stage, the innovation must be accepted by the company's members and widely used as an integral part of a company's value chain activities. Furthermore, in the IS literature, routinization has been proposed as a significant dimension of success (Zhu et al., 2006).

3. Research Methodology

A qualitative research approach is suitable when studying complex research problems in a human and social context (Creswell, 2013). This study adopts the exploratory approach using the qualitative methodology multiple case studies. Thus, the focus is on developing propositions for further investigation and allowing for in-depth investigation of the contemporary phenomenon in its real-world context (Yin, 2015).

Case study protocol is a formal document capturing the entire set of procedures involved in the collection of empirical material (Yin, 2015). It extends direction to researchers for gathering evidences, empirical material analysis, and case study reporting (Yin, 1994). Case study protocol should include (i) research question, (ii) research method, (iii) permission seeking, (iv) ethical considerations, (v) interpretation process, and (vi) criteria for assessment.

The interview guide is composed of three groups of questions and was developed based on the theoretical platform of the study, including data collection instruments adapted from previous studies that used TOE framework, in addition to information provided by professionals of retail, RFID and accounting areas, as well as RFID market publications. The first group contains questions about the interviewee. The second group of questions addresses the contextual aspects of the RFID technology adoption process in the organization. The third group addresses specific issues in the accounting area.

The company selection is based on the following characteristics:

a) Large retail companies listed on the B3 (Brazil Stock Exchange and Over-the-Counter Market).
b) Companies currently in the process of RFID adoption, between the second and third stages of assimilation of the technology (Zhu et al., 2006).
c) Requirement that the interviewee had participated in the RFID implementation process, exercising managerial or operational functions.

A pilot case study is a preliminary case aimed at developing, testing, or refining the planned research questions and procedures that will later be used in the formal case study. The pilot case helps to develop relevant lines of questions, even providing conceptual clarification for the research design. In general, convenience, access and geographic proximity can be the main criteria for selecting one or several cases (Yin, 2015). Thus, for the pilot case study, the company must present a mature stage of use of the RFID technology (third stage), not necessarily from the retail industry.

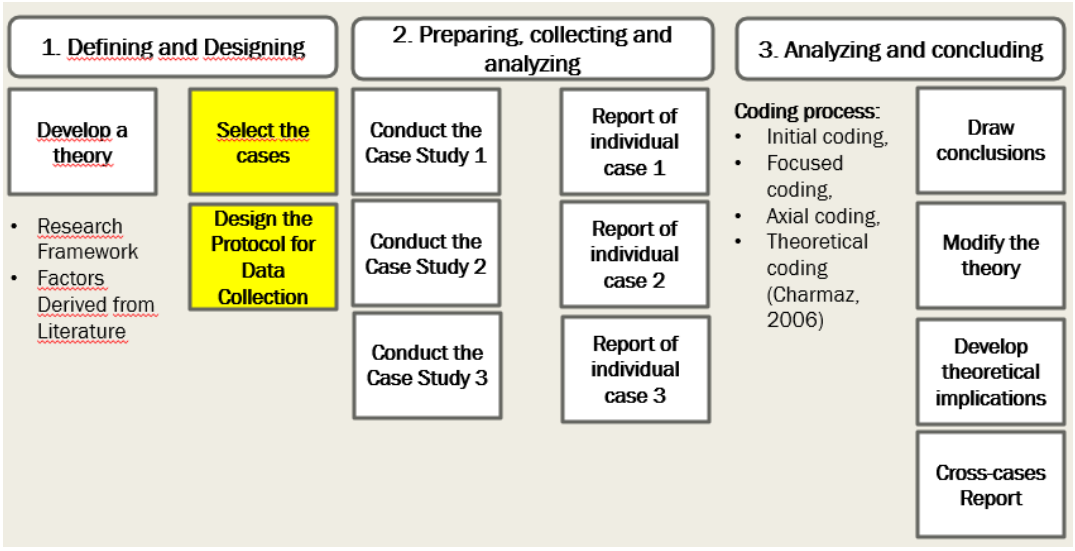

Figure 1. Multiple case study steps. Adapted from Yin (2014)

The evidence from the multiple cases is considered stronger than the single case study. Each case must be selected carefully so that it can predict similar results (literal replication) or produce contrasting results for predictable reasons (theoretical replication) (Yin, 2015). In this study, the following sources of evidence were used:

a) Interviews with representatives of the areas that participated in the RFID implementation project.
b) Interviews with the Controllership and Accounting areas
c) Interviews with an accounting practices coordinator in retailing.
d) Quarterly earnings reports and sustainability annual public reports.

Company / Interviewes	Company Description / Job Position	Sector	Listed B3	Theme	Frequency of visits	Duration of Interviews
P1 (Pilot Case)	Large ceramic and porcelain manufacturer in the Americas. Supplier of dining appliances (plates, cups)	Manufacturing	No			
P1.E1	Logistics Manager			RFID Project	2	2 hours
P1.E2	Logistics Manager, Executive of Administration and Finance			Accounting practices	1	1 hour 25 minutes
C1 (Case 1)	Large retail network of sporting goods in Latin America.	Retail	Yes			
C1.E1	Senior Corporate and Business Development Manager			RFID Project	1	1 hour
C1.E2	Controllership Director, Loss Prevention and Asset Security Planning Manager			Accounting practices	2	2 hours 30 minutes
C2 (Case 2)	Multinational chain of fast-fashion retail clothing stores	Retail	Yes			
C2.E1	Senior Business Planning Executive			RFID Project	2	2 hours
C2.E2	Accounting and Report Manager			Accounting practices	1	30 minutes
C3 (Case 3)	Large omni retailer specialized in fashion and lifestyle in Brazil	Retail	Yes			
C3.E1	Risk Director; Project Consultant; Loss Prevention Manager			RFID Project	1	1 hour
C3.E2	Senior Accounting Manager			Accounting practices	1	1 hour
APC1	Accounting Practices Coordinator	Retail		Accounting practices	1	2 hours 20 minutes
						13 hours 45 minutes

Figure 2. Companies and interviews

First, each recorded interview was first transcribed verbatim into words in a document. Then, these verbatim transcripts were revised to improve the readability of the transcripts. Finally, they can be analyzed and encoded during the qualitative data coding process. Data collection and data analysis proceed concurrently in an iterative process, moving back and forth between the data and emerging analysis, and thus helping the theory-building of the analysis.

The analysis of the interviews was carried out based on Charmaz (2006) practical guide "Grounded Theory Practice". Charmaz (2006) suggests a four-step data coding process: initial coding, focused coding and axial coding, with the exception of theoretical coding. In the initial coding, the data is labeled strictly according to the sources, and the texts can be fragmented word by word, line by line or incident by incident. The researcher's analytical eye and knowledge lead him or her to look at participants' statements and actions in ways that may not have occurred to them. Then, focused coding consists of selecting the most significant and/or frequent code, label, to filter a large amount of data in order to determine the adequacy of codes. Axial coding "relates categories to subcategories, specifies the properties and dimensions of a category, and reassembles data that was fractured during initial coding for consistency with the emerging analysis" (Charmaz, 2006).

4. Results

4.1. Factors influencing RFID adoption

4.1.1. Technological factors

Perceived benefits/Relative advantage

Relative advantage over barcode system: the manufacturer P1 used to perform one inventory count annually by scanning all products with barcodes contained in each pallet, shutting down factory's operations for ten days and causing the loss of revenue at the company's five sites. This problem was solved with RFID technology by performing rotating inventories throughout the year, reading the smart tags without opening the pallets.

Inventory accuracy and real-time inventory visibility are the main features of RFID adoption reported by respondents (P1, C1, C2 and C3), thanks to the increased frequency of inventory counts provided by the RFID technology especially in physical stores, generating several benefits for companies. For example, the retailer C1 used to perform rotating inventories three times a year. It took 4 months to count the entire company's stock, demanding 8 hours and 15 employees in each physical store. Subsequently, with the RFID adoption, at least one inventory is performed per week in all stores, with only two employees in 3 or 4 hours.

In this way, the RFID adoption allows companies to increase the frequency of physical counts of inventory and ensure the accuracy of product stock levels, by identifying losses and qualitative problems of products, and then making appropriate adjustments. For retailers C1, C2 and C3, the greater inventory accuracy allows them to solve issues of stockouts and to use stocks of physical stores for e-commerce sales (omnichannel strategy). With this evolution, customers receive their orders more quickly, from the nearest physical store, and the companies reduce expenses with freight and transportation.

Observability can be interpreted as "the degree to which the results of an innovation are visible to others" (Fosso Wamba et al., 2016). Retailer C3 concluded the implementation of a system for the management, control, replenishment and security of inventories with RFID identification, which resulted in a 64% improvement in the accuracy of inventories. The stockout had a general drop of 87% thanks to automatic alerts issued to mobile devices used by employees in stores.

Item-level tracing and tracking

Each product item has a unique identity due to the use of smart tag with EPC. From the moment the products arrive at the distribution centers, retail companies C1, C2, C3 are able to track products. Retailer C1 reported the ability to identify divergences at the entrance of the product in the chain, whether the product left the distribution center and arrived at the physical store, allowing the control of all the steps of the process, as well as helping identify problems "outside the store" related to transportation error or picking error in the warehouse shipment. Retailer C3 stated that "the product item identification is unitary by EPC, so we have the traceability of each product by EPC from when it arrives at the physical store, when it goes from the store's stock to the sales area, whether it is taken to the fitting room, whether it is sold (...) we have this product lifecycle management at the EPC level".

Real-time inventory visibility

All companies reported the real-time visibility of inventory. "Today, when we need to go into a physical store and perform the inventory counting to know the stock level, including the accounting information, we can do it whenever we want" (C1).
Another example is the manufacturer P1. The company maintains a structure to produce and ship 7,000 boxes of products daily, enabling the real time monitoring of production, as well as the real time position of the stock-levels from all the company's sites. As soon as the products leave the Production area, all enterprise operational and accounting information systems are updated in real time.

Information Quality for decision making

Inventory accuracy and real-time inventory visibility brought improvements in the quality of information in different internal areas of the company for decision making. In retailer C1, for example, the lost prevention team can analyze store movements much faster for action plans creation and mitigate next week's losses. The commercial planning team knows where the stock is allocated and can plan better which store to send products to. The supply area in general. Store teams benefited from the operational part. The financial areas in general, because the accounting inventory and the managerial inventory are now aligned, bringing greater value to the closing of the balance sheet and the publication of the financial statements. In the case of company C3, "product management has improved a lot because today it is possible to know the products available in each store and obtain a clear picture of what we have in the sales area and in stock". The management of product replenishment, of which products need to be available to the customer, the complete range, is much easier.

Compatibility

All respondents reported no major occurrences of incompatibility problems with existing processes and technologies in the companies. Manufacturer 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 retailers C1, C2, C3 have adopted the GS1 standard for RFID smart tags. Thus, the adoption of standards such as GS1 allows RFID tags to be leveraged by all the supply chain participants.

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. According to P1, the selection of the RFID service provider, the company responsible for providing the technology and designing the project, is crucial for the success of the project. In the case of C1, C2 and C3 retailers, the RFID project of software and hardware integration was developed in-house. C1 highlighted the RFID project design as a crucial factor of success, while C2 and C3 consider the Change Management process as such. For example, C1 redesigned all operational processes of stores to meet the RFID project requirements, fundamentally changing how stores operate and indirectly impacting all company areas and processes.

An important point revealed by all respondents is the role of the WMS (warehousing management system). In order to achieve the perceived benefits, the RFID project must consider that the technology does not work in isolation. On the contrary, it is an integrated solution with other technologies such as ERP and WMS systems, BI and artificial intelligence applications, for example.

For P1 manufacturer, RFID was needed for a quick reverse logistics solution, securing everything in and out. However, the loss of productivity due to rework was only resolved with the implementation of the WMS, for addressing and improving the accuracy of product location. “RFID by itself makes it possible to carry out the general inventory blindly, which would be a drag on the internal stock. But operationally I need to say 'where' the Inventory is. To do this I need the WMS” (P1).

“RFID does not depend on WMS and neither does the opposite (...) It would be more the opposite, that is, how WMS benefits from RFID. (...) WMS promotes digital and real-time control of the entire logistical operation of the distribution center via machine learning and other technologies” (C2).

Trialability

Trialability is defined as “the degree to which an innovation may be experimented with” (Fosso Wamba et al., 2016: 10). Company P1 ran two pilots proposed by its RFID service provider. In the first pilot, each of the pieces (plates, cups) was tagged, allowing traceability from the Factory. Thus, P1 identified that the costs of the first pilot would make the project unfeasible and, for this reason, they opted for the second approach, in which boxes of pre-configured sets with 12 pieces or 24 pieces were tagged.

Retailer C1 started the pilot project at the end of 2017 until the end of 2018. The results of the pilot were presented to the Board, which approved the project. Suppliers were defined (tags, hardware and software), involving planning, procurement and the implementation of the technology started at the end of 2018. The turn of the stores and distribution centers and the implementation of the label bureau in 2019.

Costs

The cost associated with RFID has traditionally been considered a barrier to implementation of such technology. However, over the last years, tag and tagging costs have decreased and the availability of cheap and flexible reading equipment, such as hand

readers for shop floor and inventory operations, has increased. The issue of tag and equipment costs was the main point that P1 was very careful about when determining the size of the RFID project.

As manufacturer P1 has always adopted the technology to solve an internal problem, the company considers that the tagging cost of products has already been absorbed by its operation. “So, for the retailers, it's just one more benefit offered by P1 for their logistical operation. I don't see this issue of sharing tag costs with customers in the future”.

In the case of C1, part of their suppliers has already delivered their products with RFID tags. For those suppliers that did not adopt the technology, the C1 retailer itself performs the tagging of the products at its distribution centers. Thus, unlike Walmart, C1 did not mandate its suppliers to implement RFID. C1 considers that suppliers will naturally move to RFID at some point. In the case of C2, as the suppliers produce on demand for the company, they produce and sew the RFID tag into the product without additional effort. The cost of the tag goes into the cost of the product and C2 retailer pay more for that price.

Proposition 1: *Perceived benefits, observability, compatibility, complexity, trialability and costs are Technological factors that influence RFID adoption by retail companies.*

4.1.2. Organizational factors

Business Strategy

Company P1 stated as the main purpose of its RFID project the resolution of internal issues, aiming to eliminate packaging and shipping operational failures, and reducing reverse logistics costs. On the other hand, in the case of the three retailers C1, C2 and C3, the focus was on Omnichannel strategy and customer experience, with operational efficiency improvement in distribution centers and physical stores as a secondary target. In these companies, the RFID project integrated an enterprise strategic umbrella along with other initiatives related to digital transformation and supply chain modernization. For C1, “More than a tool, RFID represents a transformation in management and operation”. C2 and C3 consider RFID technology as an enabler of Omnichannel. “In the omnichannel game, inventory accuracy is critical because you can't sell the customer something you don't have, consequently generating customer disenchantment.” (C2)

Top management support

In P1, when the RFID project proposal was submitted to the Board that the ROI would be 12 months, they had no difficulty in approving the project. In C1, the main sponsor of the project was the CFO who was personally involved in approving the project and monitoring its development, along with the CEO. It also had support from the VP of physical stores and the VP of supply chain. It was essential to have buy-in from these people. In the case of C3, it was a “top down” strategic project. It was defined in the Board and all the main executives were already mobilized around the project.

Firm size

The four companies are large companies that have made major investments in technology along with RFID. Manufacturer P1 acquired new ERP and WMS systems, along with RFID, in its automation project to improve its product dispatch control. The three retailers have developed major strategic projects aimed at omnichannel, digital

transformation and supply chain modernization, with the implementation of artificial intelligence and machine learning applications, blockchain and ERP and WMS systems.
"We modernized our distribution center in São Paulo, investing in software (WMS and the system for forecasting demand, planning and supply for physical stores) and hardware (sorters) to adopt the push-pull model of supply of stores by SKU (Stock Keeping Unit)" (C2).

Proposition 2: *Business strategy, top management support and firm size are Organizational factors that influence RFID adoption by retail companies.*

4.1.3. Environmental factors

External Pressure

The trend of adoption of omnichannel strategies by retail companies, specifically the largest clothing retailers in the country, has been observed in recent years. And the adoption of RFID technology solutions is associated with this phenomenon. In C3, the RFID project was approved in 2016 by the Board, deciding that RFID would be an enabler for Omnichannel, for operational efficiency, as well as for other projects. C1's respondent stated: "We were already using Omnichannel long before the COVID-19 pandemic. And a lot of people adapted to multichannel in the pandemic". For C2, the RFID project was already on the roadmap and the company decided to pursue the expansion of the Omnichannel sale in April 2020.

External Support

According to C3, more investments have now started to come to Brazil, because the consumption of smart labels has increased. Companies like Avery Dennyson are setting up factories in the country. For C2, the RFID market is evolving, and the pandemic has accelerated, bringing Omnichannel to the game in a different way. However, according to P1, the market of RFID tag manufacturers is still restricted with the concentration on a few players. In terms of companies that provide integration solutions, there has been growth, but many of these companies do not master the technology.

Proposition 3: *External pressure and external support are Environmental factors that influence RFID adoption by retail companies.*

4.2 Accounting practices

4.2.1 Specific identification of cost

For C1 and C2, despite they adopted RFID item-level tracking of products, Accounting still works with SKU level in their ERP systems. "In the end, when we are looking at the item (EPC), we are considering the SKU in Accounting. Today each product has its own identity, that is, I can have 10 shirts with different identities. But for Accounting, there are 10 shirts" (C1).

However, both recognize the benefits of managing information at the item level. "The ability to identify a product individually today has much more to do with the quality of information than in the use cases we have today" (C2). For C1, "it will provide much more information and we will be able to be much more assertive within the company" (C1).

For C3, product stratification by item (item-level) is much more used in the commercial and sales areas, for example. “For Accounting, this ends up being a little transparent. We do not need this information for balance sheet position and monthly closing purposes” (C3). Thus, RFID did not change either the inventory-costing method or the item recognition process in C3. COGS (costs of goods sold) is still calculated using the same variables as it was before RFID. In a procurement process, the items are identified in the invoice according to the purchase area's order. Then the allocation of costs related to that order is apportioned to all those items. C3 adopts only the weighted average cost for IFRS purpose. This average cost increases over time as new purchases are made at different prices. Nonetheless, this control is already done individually, without obtaining the average cost for an arrival count, taking all purchases and carrying out a costing process. Our process is individualized by SKU.

Although the adoption of RFID did not change the inventory measurement from weighted average cost to specific cost, C3 revealed that the Controllership area implemented in accounting a real time inventory monitoring routine for the costing process. It is a data analytics routine that accesses the Commercial area database, considering the product hierarchy and performing the analysis by item-level, from parameterization of analysis and critical conditions, and identifying exceptions that may represent deviations from process. In this way, this monitoring routine makes it possible to know “whether the costing being practiced is adequate, whether it had any kind of interference in the receipt process due to an incorrect cost allocation, or due to an incorrect allocation of taxes that could distort this cost.

According to APC1, the possibility of specific identification costing, different from FIFO and average cost, does have an impact on accounting practice. “Considering the opportunity to work by item (not by SKU), we can think of an example of selling 10 iPhones for $1,000 and 10 iPhones for $1,200.00. What was the cost that this iPhone specifically was registered? If I know how much the product cost, I will write off the sale neither by the average cost nor by the cost of the first item that is in my inventory. That way, I can recognize the COGS exactly how much it cost. This can have a significant impact. But maybe from the point of view of the faithful representation of the information, maybe it's better than these two methodologies (FIFO and average cost), because I take into my result the specific cost of that item”.

4.2.2 Loss recognition and provision

In C3, the inventory physical counting processes were either annual (in the case of stores), or biannual for critical cases such as distribution centers. How did C3 mitigate eventual losses, for example, of Inventories? With provisions that, like any estimate. However, as you have margins of difference, over the period you were provisioning, you had an impact on the balance sheet, which did not reflect exactly what happened. With the advent of RFID, physical counts became monthly, mainly in stores, representing a very important evolution. “For this reason, we were able to stop making estimates and ended up recognizing month by month what is actually counted. A line was replaced in the Balance Sheet that does not capture exactly what happened, but ‘what approximately may have happened (provision)’, by something that actually happened, which is the Effective Inventory Loss”.

C1: Inventory losses are effectively recognized in accounting in the inventory counts that are carried out weekly in stores. In this way, it was possible to reduce the provision for losses and improve its assertiveness in accounting. For example, if the

inventory is taken on the 27th and the close is on the 30th, the company tries to project these 3 days based on the history of inventory losses. C2 reported that the loss reduction was not yet noticeable. In fact, there was a side effect of the first round of RFID implementation. Inventory losses apparently 'increased' because, as RFID is much more accurate than traditional physical counting, this increase was due to the recognition of losses that had not been identified before.

Proposition 3: *The greater granularity of the product tracking level chosen in the RFID adoption provides greater benefits in inventory accuracy and real-time inventory visibility, and accounting information quality.*

4.2.3. Accounting Information Quality

Basic Quality Characteristics
Relevance: The visibility provided by RFID technology, ensuring accurate knowledge of actual inventory, provides both confirmatory value and predictive value (e.g loss provision) of accounting information.
Faithful Representation: Due to the reduction of shrinkage, spoilage, misplaced inventories, and transaction errors, the accounting information is improved in characteristics of completeness, neutrality and free from error.

Quality improvement characteristics
Timeliness: RFID enables greater accuracy and responsiveness of inventory management through real-time inventory information, in addition to timely recognition of inventory losses without the need for provisions, for example.
Comparability: The RFID adoption by the supply chain companies can help standardize inventory procedures and the way in which accounting information is produced for comparison purposes.
Comprehensibility: Classifying, characterizing and presenting information clearly and concisely makes it understandable. 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: With RFID it is possible to verify the values of the stocks in the accounting with the product items of the inventory through the integration of the company's information systems such as ERP and WMS.
Value-Added (Kahn et al., 2002): The benefits of RFID are perceived by internal areas and users of the organization (supply chain, marketing, sales, accounting) and by external users (financial statements), as well as customers.

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

4.2.4. Conceptual model of RFID adoption by retail companies

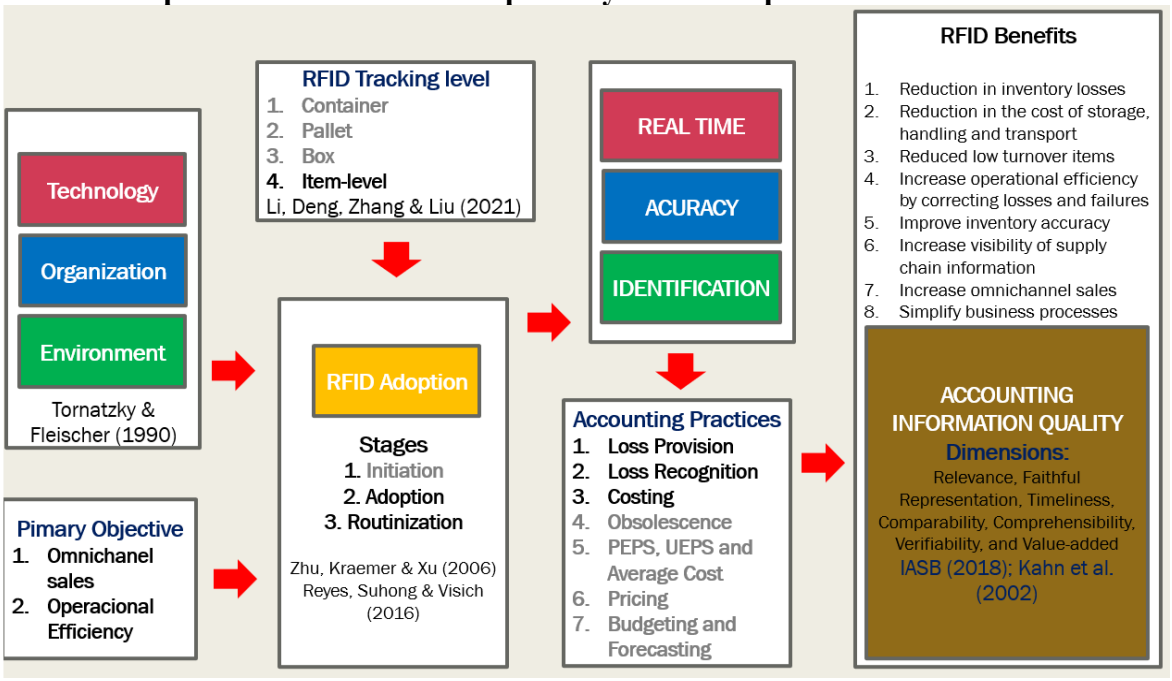

Figure 3. Conceptual model

5. Discussion

Proposition 1: *Perceived benefits, observability, compatibility, complexity, trialability and costs are Technological factors that influence RFID adoption by retail companies.*

The big deal of the RFID technology is to enable full inventory counts of retailers' stores much more frequent than a traditional physical inventory count, which may only happen once or twice a year. Infrequent counts are often not very effective at reducing inventory inaccuracy throughout the year (Goyal et al., 2016). Actually, RFID makes it possible to complete monthly, weekly, and even daily inventories to identify and rectify any inventory record discrepancies, and addressing issues related to shrinkage, misplacement of products, transaction errors, and stockouts. Internal areas of the company may access timely and accurate inventory information for decision making with business analytic tools, and develop plans of action to address inventory issues (Hauser et al., 2021).

In this study, the benefits from supply chain visibility, provided by RFID usage in retail sector, are restricted to the so-called "micro supply chain level" (Delen et al., 2007), which is constituted by retailers' distribution centers and physical stores.

Companies C1, C2, and C3 understand the importance of creating end-to-end supply chain information visibility, enabling suppliers, manufacturers, logistics providers, and retailers to track item-level information across the entire supply chain (Zhu et al., 2012). However, they have not yet implemented the technology at the end of the supply chain to analyze the customer behavior (Landmark, & Sjøbakk, 2017).

The high frequency and regular inventory counts are performed in all store inventory holding positions – that is, backroom or sales floor inventory (Delen et al., 2007). On the other hand, distribution centers (DC) are equipped with fixed readers placed at strategic points (portals), and it is still performed the traditional inventory count. C1 stated that "We rely on other technologies to track goods movements within the DC and we use RFID at the entrance and exit points. Compared to the stores, the DC is a much

more controlled environment and it sustains losses at a lower level". According to C2: "As most part of my inventory is in stores and everything on the DC goes to stores at some point, I guarantee my inventory there (in the stores)". C3 is implementing a new DC and that's why the strategy was to "focus on stores where we had the fastest gains, with greater results".

Proposition 2: *Business strategy, top management support and firm size are Organizational factors that influence RFID adoption by retail companies.*

The differences between the strategies of the manufacturing company (P1) and the retail companies were evident. The manufacturer focuses on B2B, focusing the RFID project to specifically solve operational problems by tracking boxes with porcelain pieces. In this way, the individual pieces were not tagged with smart tags. On the other hand, retailers adopted omnichannel strategies focused especially on physical store inventories. For this reason, all product items have been tagged. In addition, retailers showed a greater appreciation for data-driven decision making, based on the data generated by the RFID system. According to Zhang and Yang (2019), the manufacturers and the retailers often see different benefits from RFID adoption. Manufacturers are generally most interested in tracking cases or pallets of their product via the transportation channel up to the retail outlets, whereas retailers typically are expected to gain most benefit from individual-product tracking on their shelves (Gaukler et al., 2007).

"[Firm] size is probably a surrogate measure of several dimensions that lead to innovation: total resources, slack resources, technical expertise of employees" (Rogers 1995, p. 379). According to the literature, large-size firms are expected to facilitate innovation initiation and adoption because they tend to enjoy resource advantages while many smaller retailers remain hesitant to incur the considerable infrastructure and systems costs required to implement, and the ongoing (variable) costs of, tagging (Goyal et al., 2016). However, it is necessary to consider the complexity of the RFID project, which can affect all areas of the company, its suppliers and customers as well. Thus, making large investments in technology and having resources at their disposal may not be sufficient for the project success. There are reports of large companies that are facing difficulties in implementing RFID, while there are companies that have given up on the technology. Respondents identified as critical success factors the proper selection of RFID service providers, the RFID project design and the Change Management process.

Proposition 3: *External pressure and external support are Environmental factors that influence RFID adoption by retail companies.*

Khayyam et al. (2022 :35) highlight the importance of the external environment, despite it is not controllable by the organization. The external environment includes external pressure (from the environment of buyer or supplier or competitors), external support (technology providers), and external uncertainty.

The largest competing retailers in the country, most of them apparel retailers, have been investing in omnichannel strategies, in which accurate inventory management has become essential. Many of these companies, such as Lojas Renner S.A., C&A, Centauro (Grupo SBF S.A.), Pernambucanas, Riachuelo, and Hering, have reported RFID technology implementations in their quarterly earnings reports and sustainability annual reports. Thus, it seems nobody wants to lag behind in the omnichannel retailing race.

According to Markets and Markets (2022), the global RFID market is estimated to be USD 10.7 billion in 2021 and projected to reach USD 17.4 billion by 2026, at a CAGR of 10.2%. Major factors driving the growth of the RFID market include growing market competitiveness leading to availability of cost-effective RFID solutions, high returns on investment, increasing regulations and government initiatives for various industries, and increasing installation of RFID systems in manufacturing units to improve productivity due to COVID-19 (Markets and Markets, 2022). In the last 10 years there has been an expansion of the RFID market in Brazil and its maturation has increasingly encouraged the adoption of technology by manufacturing and retailing companies in the country.

Proposition 4: *The greater granularity of the product tracking level chosen in the RFID adoption provides greater benefits in inventory accuracy and real-time inventory visibility, and accounting information quality.*

Item-level tagging provides the most detailed tracking capability and is primarily envisioned to assist retail operations within-store, as well as visibility into within-store location of inventory at a finer degree of granularity (i.e. backroom or sales floor) (Gaukler, 2011). In line with the literature, our findings confirmed the benefits of RFID item-level tagging in the agility in performing inventory counts, inventory accuracy and real-time inventory visibility, cost reduction and sales increase, improvement in operational efficiency, self-checkout, improvement of informational quality, including information accounting.

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

Since RFID can eliminate inventory inaccuracy, Dai and Tseng (2012) quantified the extent of savings from timely information and reduction in information distortion, including the accounting information. Gelbcke et al. (2018) highlight the importance of inventories for industrial and commercial companies, in the way that their correct determination is essential to determine the net income for the year. With regard to inventory, the physical quantities of inventories are as important as a good valuation and cost criterion, to avoid significant distortions in the financial statements.

Although the accounting literature has suggested that item-level RFID devices make specific inventory costing identification practical and cost-effective, reducing the need to use cost flow assumptions (Vasarhelyi 2012; Krahel & Titera, 2015), companies interviewed did not change the use of the weighted average method. There were also no changes in pricing and budgeting practices due to the availability of real-time data, according to the perception of the respondents. Surprisingly, the most relevant findings are related to changes in accounting practices for identification, recognition and provision of losses that impact the financial statements that were not mentioned in the accounting literature.

6. Conclusion

RFID technology demonstrates great potential for reducing shrinkage, preventing stockouts and excess stocks, allowing improved inventory management accuracy and responsiveness through real-time inventory information, contributing to accounting

information systems to provide transparent, credible, real-time accounting information (Wu, Xiong, & Li, 2019).

In this paper, we present a study to investigate how changes in technology may influence business and accounting practices and, consequently, improve the quality of information that is produced and made available to internal and external users for decision making. We used a qualitative methodology with interpretative analysis through the study of four cases in large companies that implemented RFID in Brazil: one manufacturer and three apparel retailers. All four companies were awarded by specialized RFID associations. All four companies were awarded by RFID specialized associations. The manufacturer offers the most mature use of the technology, thus chosen for the pilot case. The three retailers represent the most advanced cases of RFID adoption among retail competitors. In addition, they are listed on the B3 and disclosure their financial statements in accordance with IRFS standards.

Findings show that the big deal of the RFID technology in retail is to enable full inventory counts of retailers' stores much more frequent than a traditional physical inventory count. RFID makes it possible to complete monthly, weekly, and even daily inventories, providing timely and accurate inventory information for internal areas of the company. Although companies did not change the use of the weighted average method, surprisingly, the most relevant findings are related to changes in accounting practices for identification, recognition and provision of losses that impact the financial statements that were not mentioned in the accounting literature.

Theoretically, this study extends the TOE framework by enhancing our understanding on the actual RFID use by large companies in Brazil, identifying the factors influencing the technology adoption: Technology (perceived benefits, observability, compatibility, complexity, trialability, and costs); Organization (business strategy, top management support, and firm size); and Environment (external pressure and external support). Above all, our theoretical framework proposes the association of qualitative characteristics of the accounting information with RFID applications and benefits in the real world. Our study has some limitations. Retail companies reported that they are still in a maturing phase of using RFID and there are many possibilities to explore the technology. Likewise, it is possible that many of the benefits and opportunities have not yet been perceived by the interviewees, especially in the accounting area. The study opens new research avenues. further in-depth longitudinal case studies are recommended, for instance, to analyse an entire supply chain constituted by suppliers, retailers and customers; and quantitative research using scale surveys are needed to offer further validation of our framework.

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