

RFID in the Retail sector: A Bibliographic review of the literature

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Abstract— All of the companies in the Retail sector, regardless of their size and age, have suffered different problems related to their stock and one solution is the use of radio frequency identification (RFID). Therefore, tracking and understanding the development of the literature on RFID is a key factor in the improvement of supply chain management (SCM). The general objective of this bibliographic review is to understand the behavior of the researches about the implementation of RFID in the Scopus database. In order to achieve the objective, the database will be filtered and subsequently analyzed using the VOSviewer software and bibliometrix software. In addition, the results shows the countries with the most publication as well as authors, journals and key words

Keywords—Supply Chain, Radio Frequency Identification, Inventory, Retail.

I. INTRODUCTION

Most retail organizations face challenges in terms of traceability and visibility in tracking their items, which is exacerbated by the global spread of the covid-19 pandemic caused by the Coronavirus (SARS-CoV-2) [1]. This is a significant difficulty for cold chain management since it affects all parts of the supply chain, from the farmer to the consumer [2]. Because Covid-19 produces acute respiratory syndrome, droplets from an infected worker could quickly transfer the virus, posing a threat.

Every year, the cold chain market in Indonesia grows significantly, and it is predicted to rise from 4% to 6% to 8% to 10% in the following five years [3]. Indonesia's food supply is supported by the food cold chain system. To extend the shelf life of the food and maintain acceptable nutritional quality, this system employs cold chain temperature management that inhibits microbial development [4].

Because of the problem's intricacy, information traceability systems for items that can track their status along the supply chain are being developed. Given the virus's quick spread, one of the proposed solutions to this problem is the use of RFID technology

II. THEORETICAL FRAMEWORK

RFID (radio frequency identification) is a type of identification that employs radio waves to identify the existence of things via labels. RFID has a number of benefits, including simplicity of use, automatic scanning, fast data rates,

big memory, and the ability to scan several tags at once [5].

In this view, the use of radio frequency identification (RFID) as a tool to collect and disseminate information might lead to successful supply chain management (SCM) [6].

This information is mostly used to control real inventory without requiring direct vision of the product; similarly, RFID technology can improve the traceability and visibility of the chain, as demonstrated by the Metro group in Germany, which reduced product losses in transit by 11-14%, improved in-store product availability by 14%, and reduced the cost of merchandise distribution by 11% by implementing RFID technology in its suppliers [7].

Due to the lack of real-time information that RFID technology can provide, today's gap between inventory and information flow leads excess inventory to cushion demand uncertainties [8]. According to Kull, RFID technology can also alleviate the problem of inventory record inaccuracy (IRI), which is defined as a discrepancy between the amount recorded in a company's inventory management system and the amount physically available [9]. IRI causes substantial issues in the retail industry by creating stockouts and revenue loss due to wasteful replenishment [10]. It can also result in a revenue loss of more than 1% of sales and more than 3% of gross profit, according to DeHoratius and Raman [11]. The authors Kang and Gershwin found mistakes in 51% of a retail company's data and claim that the proportion of improper records in retail establishments ranges from 30% to 80% [12]. Similarly, DeHoratius and Raman looked at 37 businesses and found that 65 % of the 369,567 inventory data they looked at had IRI issues [13]. Improved traceability and visibility of items and processes, greater efficiency and speed of processes, improved information accuracy, reduced inventory loss, and ease of handling information in real time are just a few of the benefits RFID technology may give in SCM [8].

The function of RFID technology entails reading labels using radiofrequency [14]. This means that no physical or visual contact between the tag and the reader is required; however, the distance between them must be kept within a certain range [15]. "RFID systems have three essential components," according to Hingley et al. (2007): "a label or tag, a reader or reader, and a computer with functions and activities already established." The tags have a microchip that stores all of the encrypted information, the readers have a radio frequency antenna that allows them to obtain the information, certain readers can also add information, and finally, the computer where the information is stored and managed [15]. There is

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also a middleware or ERP system that performs data filtering and management as a separate component [15].

RFID technology's components seem to become smaller, less expensive, and more effective. As a result, RFID applications in the supply chain have grown.

According to Thonemann, after implementing RFID technologies, Procter & Gamble and Wal-Mart simultaneously cut inventory levels by 70%, enhanced service levels from 96% to 100%, and lowered management expenses by revamping their supply chains [16]. The results of interviews with sales employees from numerous organizations regarding how to improve the customer experience with RFID technology were mainly positive, with inventory counting being the best feature they could point to. Second, the feature of discovering a misplaced item and rectifying it was appreciated. Inventory counting for employees has always been a complicated thing to follow and a pain point for managers who prefer the employee to remain serving customers. Secondly, the functionality of identifying a misplaced item and fixing it was appreciated [17].

The purpose of this research is to determine what researches has been carried out about the implementation of RFID on the optimization of storage management in America, Asia and Europe in the last 5 years based on a bibliographic review of the literature.

Based on the given problem, the research questions are presented.

- What is the effect of RFID technology in reducing inventory record inaccuracy?
- Is it possible to have an IRI of 0 using RFID?
- In what types of companies (large, medium or small) has more research been done on the application of RFID?

What is the effect of RFID to reduce IRI?

First, let's go over the most prevalent IRI failures. They may be divided into three categories: transaction mistakes, inaccessible inventory, and provisioning issues.

Shipping problems, delivery errors, scanning errors, and item misidentification are all examples of transaction errors [18].

Shipping errors can be very costly because they occur during the product's arrival or transit to the destination; deliveries of incorrect products or deliveries to an incorrect address are also delivery errors; customers who obtain the incorrect items may demand a refund, or the supplier may be forced to pay double the shipping costs [18].

Scanning errors: To quicken the checkout process, the cashier frequently scans the same item twice as if they were identical, resulting in a mistake in the inventory of both articles [18].

Due to scanning problems, items are misidentified. All types of errors that result in the loss of ready-to-sell products are referred to as shrinkage errors (also known as stock loss) [18].

Inaccessible inventory, according to Lee et al., is defined as products that are not in the correct area and are not available to customers. Inaccessible inventories, sometimes known as lost objects, have been researched by a number of authors.

The literature on supply errors, according to Rekik, is scarce. Inventory accuracy can be influenced by product quality, efficiency, and the supply process (2011). RFID enables supply chain improvements against inventory inaccuracy problems by providing greater product traceability through real-time data collection features. While RFID cannot eliminate all errors, it can detect them fast and handle them effectively if the problem is recognized early in the planning phase.

Is it possible to have an IRI of 0 using RFID?

Today there is no method or technology that can indicate the exact number of units in a warehouse, in the same way, manual counting does not guarantee a procedure without errors [19]. This is because despite the fact that the same RFID technology being in an ideal space, without obstacles, is limited by its chip and antenna generating an inaccurate result [20].

Forrester, on the other hand, saw demand fluctuate and amplify from the downstream to the upstream of the supply chain. He claimed that the bullwhip effect occurs when the variance of consumer demand rises at each level of the supply chain.

The bullwhip effect is a well-known phenomenon in SCM that has been studied for about 50 years. According to studies, eliminating the bullwhip effect can boost revenues by 15 to 30%.

According to Yucesan, the fundamental reason of the bullwhip effect is a lack of information sharing, communication, and collaboration along the SCM, which leads to information failures and delays in information and material flows. According to several writers, automatic identifying technologies such as RFID can lessen the bullwhip effect and increase SCM performance. According to Bottani and Rizzi, an automated information technology such as RFID can increase inventory visibility, reducing safety inventory and the bullwhip effect.

In what types of companies (large, medium or small) has more research been done on the application of RFID?

More research was carried out in large companies than in SMEs and it was possible to conclude that RFID helped SMEs more than large companies with a system already defined in terms of the margin of error of the IRI including in the visibility and traceability of each product with the RFID tag.

III. METHODOLOGY

To have a structured review of the literature regarding RFID technology in the SCM, we must address the design of the present research as a 5 phase Systematic literature review (SLR)

Phase I: Search, filter and improvement of the search of information, the steps carried out to obtain the final selected articles summarized in Figure 1.

Phase II: Information processing

Phase III: Bibliometric Analysis, performed to analyze the existence of trends in authors, journals, countries and years of publication regarding RFID in SCM.

Phase IV: Results and Conclusions

Phase I: Search, filter and improvement of the search

The keywords to be used are defined and related to scientific articles and analyzed in Table 1, Figure 1 graphically shows the literature review describing the steps, objectives, methods, tools and software used for their analysis.

About the article collection methodology, the Scopus database was used because this platform provides tools capable of segmenting articles related to the research topic. Additionally, it has publishers such as Elsevier, Springer and InderScience, among others.

TABLE 1
PUBLICATIONS IN RFID ON RETAIL

Search terms	Query applied	Search result (number of articles)
RFID and Retail	RFID AND Retail AND PUBYEAR > 2016 AND PUBYEAR < 2022	3002
RFID and Retail and Supply Chain or Supply	RFID AND Retail PUBYEAR > 2016 AND PUBYEAR < 2022 AND (LIMIT-TO EXACTKEYWORD, "Supply Chains") OR LIMIT-TO (EXACTKEYWORD, "Supply Chain")	1993
RFID and Retail and Inventory	RFID AND Retail AND (PUBYEAR > 2017 AND PUBYEAR < 2021) AND (LIMIT-TO EXACTKEYWORD, "inventory")	1008

The period considered in the bibliometric review was from 2017 to 2021, only the articles containing the keywords "RFID" and "Retail" were selected. In addition, the secondary keywords "Inventory" and "Supply Chain" were used (See in table 1). The first results of the search for articles based on keywords for the period 2017 to 2021 were 3002, of which only 1993 (66.39%) were related to the supply chain and only 1008 (33.58%) were related to inventory.

It is important to highlight that the only articles that were taken into consideration were those published, in their final version, in academic journals and written in English.

By conducting an in-depth review of the 3002 articles, duplication was identified among them. The main reason was the reuse of keywords in the search such as "RFID" with "Supply Chain" and "RFID" with "Inventory." Therefore, the articles were carefully reviewed in order to avoid duplication and present significant relevance.

As a result, the search results were fine-tuned to extract unique, relevant items while eliminating redundancies and duplications. In addition, extra restrictions were added to the search query in order to narrow down the results and find articles that contained exact terms. Table 2 displays the results.

TABLE 2:
APPLICATION OF THE REFINED QUERY

Search terms	Query applied	Search result (number of articles)
RFID AND Retail AND "Supply chain" OR "Supply chain management"	RFID AND Retail AND PUBYEAR > 2016 AND PUBYEAR < 2022 AND (LIMIT-TO (SCRTYPE, "J")) AND (LIMIT-TO (PUBSTAGE, "final")) AND (LANGUAGE, "English") AND (LIMIT-TO (EXACTKEYWORD, "Supply Chains") OR LIMIT-TO (EXACTKEYWORD, "Inventory"))	188

Phase II: Information Processing

Once the database was delimited, a statistical analysis of the 188 selected articles was carried out in order to identify and demonstrate the existence of trends in authors, journals, countries and years of publication (2017-2021). Figure 2 shows the number of articles created in different countries, the number of articles being proportional to the color saturation of the country. Table 3 indicates the number of articles per country with China being the country with the largest number of articles, followed by the United States and India.

TABLE 3:
DATA FROM FIGURE 2

Country	CHINA	USA	INDIA	UK	FRANCE	IRAN	ITALY	SPAIN
Number of articles	139	61	47	45	31	24	23	19

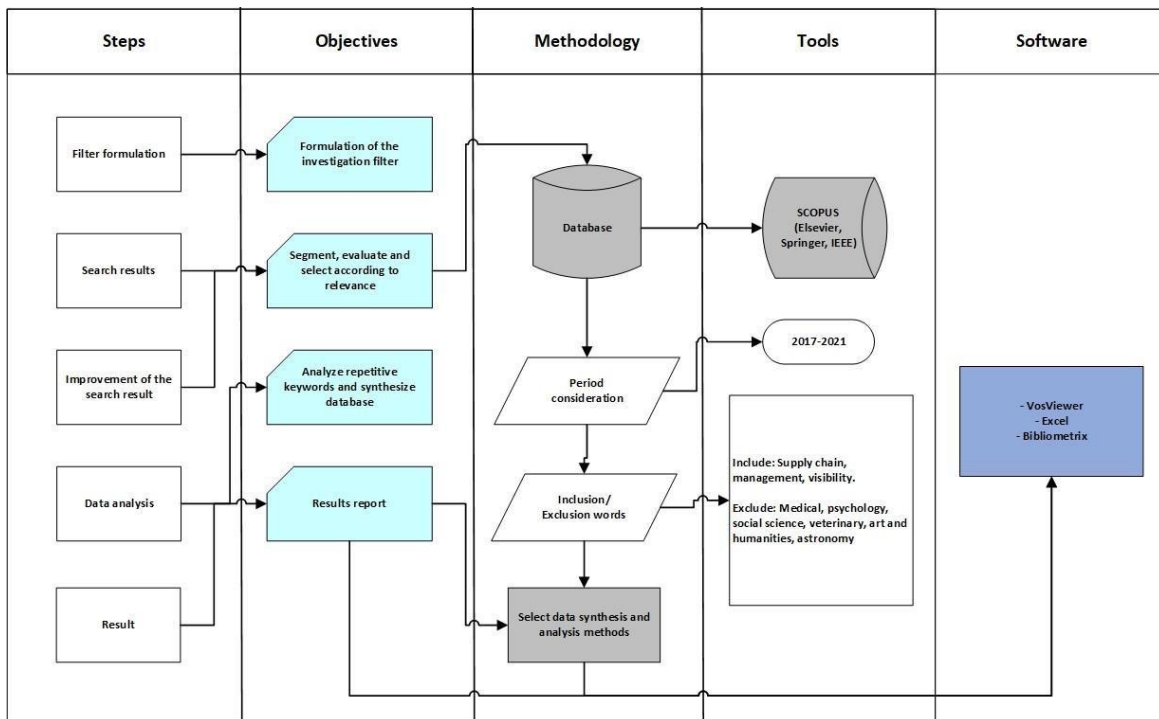


Figure 1: Steps, objectives, methods, tools, and programs/software

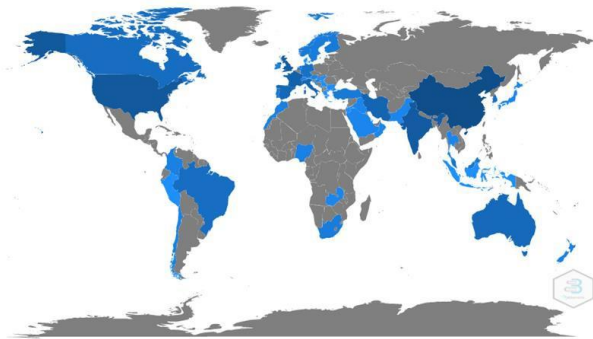


Figure 2: Graphical representation of the creation of articles by country (elaborated in bibliometrix software)

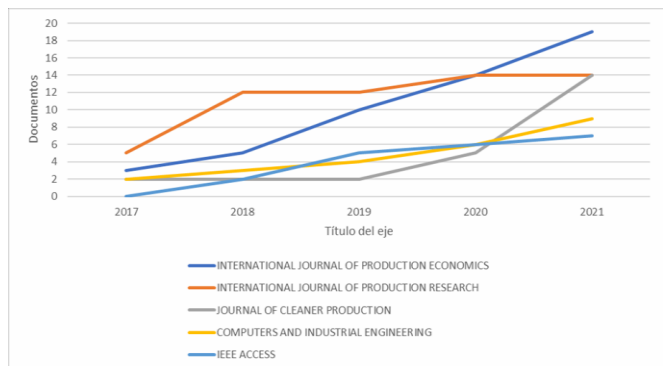


Figure 3: Articles per year by journal

Additionally, Figure 3 shows the distribution of articles by year and by journals, of which 5 were the most representative being in quartile 1 and of which the largest number of articles were collected. As a result, "International Journal of Production Economics" was where we obtained the largest number of articles, the Journal focuses on topics that deal with the interface between engineering and management.

According to Figure 4, the most representative author with 9 articles produced on RFID was Choi, Tsan Ming (Choi, TM) who is currently a professor at the National Taiwan University, specialized in operations management followed by Shen Bin (Shen, B) and Gunasekaran Angappa (Gunasekaran A) both with 5 articles on RFID



Figure 4: Articles per author

Phase III: Bibliometric Analysis

In this study, the software used for bibliometric analysis were VOSviewer and bibliometrix. Both programs have information analysis and visualization tools, allowing the evolution of the indicators to be identified.

As previously stated, chosen pieces were published in their final form in academic publications in the English language. There are more than 2,600 writers and more than 10,000 keywords in the 188 articles that resulted. Figure 5 further depicts the link between terms.

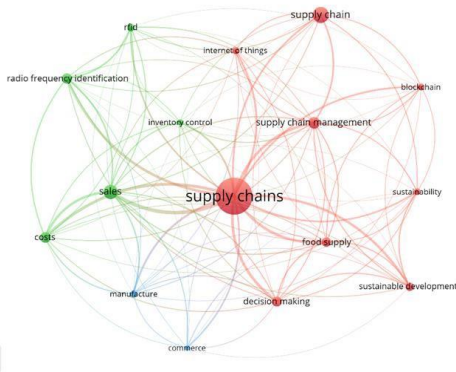


Figure 5: Keyword Match (elaborated in VOSviewer)

Clusters represent a group of keywords that are mentioned more frequently by authors and for that reason can determine a greater search for articles. The criteria in the formation of the clusters were keywords with at least 15 occurrences which resulted in 16 more repeated keywords, 5 being the most representative, the information is presented in Table 4.

TABLE 4:
TOP 5 KEYWORDS OCCURRENCES

Keyword	Ocurrences	Total %
Supply chains	175	28%
Supply chain	59	9%
Sales	52	8%
Supply chain management	40	6%
Costs	36	6%

Phase IV: Results and Conclusions

The findings reveal the interaction between the many elements of RFID technology in the retail industry, as well as fresh research in the field and its connection to the supply chain. For a better understanding of the state of the art around the topic provided, the bibliometric analysis displays the major nations, authors, and fundamental journals.

Researchers will be able to discover research areas based on the structure, links in efficiency, and cost reduction in the supply chain using bibliometric analysis. Finally, the findings of this study can be applied to future efforts to understand the important indicators of RFID technology in the retail industry, as well as other inventory and supply chain management indicators.

Implications for practice

This study highlights that companies are faced with the challenge of quantifying the cost-benefit of implementing RFID. Similarly, it was identified that the implementation of RFID is mainly related to the SCM and inventory management. Therefore, the strategies to be applied must focus on identifying the benefits obtained in order to have an indicator.

Finally, the concept of RFID and its uses in the retail sector are presented, which can be used as a guide by managers to devise and implement strategies in inventory management to reduce costs and increase efficiency. Consequently, understanding the key RFID indicators regarding inventory management provides a valuable insider when making decisions.

Limitations

The research in question has some drawbacks. One of the first constraints is connected to the database selection; because we employ the Scopus and Proquest databases, other materials from various authors from other databases will all be lost. Because they diverge from the main purpose, different forms of publishing as complementary techniques in papers, books, and journals were not explored to contribute to this bibliometric study. Furthermore, the result of the co-citation cluster analysis may bring only the most common characteristics among the obtained base and will keep improving some more relevant knowledge on the investigated topic, but other conclusions may be reached during the review of the extensive database (over 10,000 articles about RFID).

Other parts of analysis, such as co-occurrence analysis or bibliography coupling, can provide additional data; however, because these investigations were not important to this study, publishing the results may be of limited utility.

According to the study, Procter & Gamble and Wal-Mart simultaneously lowered inventory levels by 70% and raised quality of service from 96% to 99% after implementing RFID. Although Walmart obtained these benefits over a long period of time, at the beginning of this implementation it had many inconveniences with suppliers, since the cost of implementing RFID at that time was very expensive and the cost was mostly borne by suppliers, but the beneficiaries were retailers, many studies were done to encourage suppliers to assume these expenses, however there was a contract model called Revenue Cost Sharing (RCS) which presented incredible results. For example, Once RFID is used at the item level, the numerical findings reveal that the RCS contract is more effective than the wholesale pricing contract (WP) in coordinating the vendors SCM. Small and medium-sized businesses (SMEs) gain the most, because the margin of error in inventory registration is substantially higher for SMEs without adequate inventory control than for large businesses with an inventory system in place [21].

IV. CONCLUSIONS

A wide range of crucial data has been documented and used based on the findings of journals and references, statistical analysis, and bibliometric mapping. The current state of the research has been assessed by looking at the methodology, fields, quality of study, and design of this with contributions, main concepts, tools, and software. Furthermore, a complete analysis of the data acquired provided amazing results, which are detailed below.

RFID is a technology capable to improve SCM by tracking each product that has been labeled and as a result is able to reduce IRI, which improve visibility in all the SCM. Additionally, RFID has the most impact in SME.

Inventory and supply chain optimization

Initial numerical data on search outcomes related to costs incurred in implementing the RFID system and not doing it, after refinement and excluding repetitive or irrelevant elements, yielded 188 full articles related to efficiency, effectiveness and cost reduction. In addition, the research initially shows that the concepts of optimization in the inventory (1008 articles) and Supply Chain (2018 articles) are very dominant since together they add up to 3026 articles (counting the repeated ones) so we can conclude that the RFID focuses in these 2 concepts.

Knowledge about Journals

According to an analysis of the top five newspapers in the SCM, International Journal of Production Economics,

International Journal of Production Research, Journal of Cleaner Production, Computers and Industrial Engineering, and IEEE Access, the top five articles on efficiency and cost reduction received the most citations. It's worth noting that these publications accounted for 63 articles, or 33.51% of the total.

Analysis of the influence of authors and citations

According to the bibliometric investigation, Weihua Liu (eight publications) from the University of Taijinn in China and Shawn Brown (six articles) from the Technological University of Montreal in Canada contributed the majority of the articles on logistics costs in the SCM.

In the topic of optimization studies, authors like Nidhal Rezg (4 papers) from the University of Lorraine and Eric Ballot (3 articles) from the Center for Scientific Management, both in France, had far more articles with a high number of citations. The most publications (5) were linked to the problem of mobility studies based on the logistics cost approach by Mohamad Jaber of Ryerson University in Toronto, Canada. On the other hand, Cathy Macharis of the University of Brussels in Belgium had 4. Reliable database archives like Scopus have enough high-quality published materials in a range of subject areas to provide online access to the current body of knowledge for scholars and practitioners.

Bibliometric studies are a valuable way to comprehend and investigate the state and quality of prior research by analyzing publications and citations and offering a comprehensive description.

This document will assist scholars and practitioners working with SCM methods in recognizing the limitation of academic research and publications in three major areas: "Supply Chain," "Optimization," and "Transportation," all of which are SCM-centric ideas. The results of this bibliometric study can also be used to suggest subject areas, journals, and subjects to aid in the discovery of new research prospects. The research approach used in this study, however, is limited; the results can also be evaluated from numerous angles.

Including more terms in the search parameters could result in a larger number of results. This, however, would necessitate a more advanced bibliometric analysis.

This study employed the VOSviewer and Bibliometrix to map the bibliometric statistics results and present the most current and comprehensive overview data possible.

Finally, the citation analysis demonstrates that communication is a common theme, particularly in a management science research community. In addition, the results of this study reveal that strategic management accounting methods have a significant positive relationship with SCM outcomes, and SCM results have a large positive relationship with logistics firm profitability. Citation networks reflect research flows in the formal and analytical SCM that are linked to empirical obstacles of collaboration / cooperation in the SCM or coordination issues. SCM's boundaries are broadened by the ability to create value for customers while looking for cost-cutting opportunities.

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