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A BIBLIOMETRIC STUDY ON THE USE OF RFID TECHNOLOGY IN MARKETING

Nebi Seren[1] & Fatih Bilici[2]

Abstract

RFID (radio frequency identification) is a structure in which objects are labeled and subjected to various processes at the radio frequency level. Although alternative technologies exist, RFID technology interests consumers for some reasons. When businesses want to identify their products and make the necessary transactions through these identities, RFID technology is one of the most challenging choices to give up.

This study was carried out to determine the preference for RFID technology and the intensity levels of the studies on RFID technology by making a detailed examination of RFID technology. This study aims to determine whether businesses choose RFID instead of other network systems where they can categorize their products and observe the degree of interest in the technology.

The data used were taken from studies in the Web of Science (WoS) database between 2020 and 2024, with the title "RFID," and all fields filtered with the words "marketing." In the study, co-authorship analysis, keywords analysis, country citation analysis, author citation analysis, source citation analysis, bibliographic matching analysis, and co-citation analysis are performed. In Web of Science index, Conference Proceedings Citation Index - Science (CPCI-S) 480, Science Citation Index Extended (SCI-EXPANDED) 343, Social Sciences Citation Index (SSCI) 148, Emerging Sources Citation Index (ESCI) 108, Studies published in different categories such as Conference Proceedings Citation Index - Social Sciences and Humanities (CPCI-SSH) 56, Book Citation Index - Science (BKCI-S) 21, using the English language are observed to be included in the bibliometric analysis. The data set is created with the data collected within these constraints.

Finally, the study examines the academic studies in the WoS database not only to determine the demand for the technology but also to examine this technology in terms of business and other usage advantages. As a result, by revealing the current status of RFID technology and the reasons for its preference, it is tried to provide information to help businesses that want to use it.

Keywords: RFID, Radio Frequency Identification, Tagging, Computer Networks, Communication Networks, Network-Enabled Marketing.

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1. Introduction

The bibliometric study is an analytical method that can provide researchers with accelerating and effective summaries. It allows them to look at past studies on the subject from different angles and express quantitative data visually. The goal of bibliometric analysis can be summarized as providing a guiding infrastructure for the desired study by providing visual summaries of studies conducted from many different perspectives. It is a type of study frequently preferred to provide researchers with a guiding summary before a comprehensive literature review and has many examples in different fields.

Although it is stated in many sources that the earliest use of RFID technology was in aircraft identification systems and radar structures in the Second World War, especially the acceptance and rapid development of its standards was observed in the early 2000s. Although RFID technologies are primarily encountered in electronic and technological fields in the literature, it is possible to find many studies in social sciences in terms of their use in product identification systems of enterprises today.

Want's (2006) study, one of the primary studies in this field comprehensively deals with the basic principles and application areas of RFID technology. This study defines the components of RFID systems as tags, readers, and software and explains how these components work. Another study in the field is the research on chipless RFID tags by Herrojo et al. (2018). This study examines the design and applications of chipless RFID tags developed to reduce the costs of traditional RFID systems. This study provides essential information regarding electronic engineering by detailing the potential and application areas of chipless RFID technology. Chipless RFID tags are tags that do not contain integrated circuits (ICs) and are, therefore, more cost-effective (Herrojo et al., 2018). The work of Chin and Klair (2011) focuses on developing an energy-efficient MAC (Medium Access Control) protocol for RFID-enabled wireless sensor networks. This study presents a new approach to improve the energy efficiency of RFID systems and provides recommendations to improve the performance of such systems. Wang et al. (2011) examine the applicability of RFID-based systems in automated storage systems. The study performs a cost analysis for a modular automated storage system that can replace traditional automated storage systems. This study reveals the potential of RFID-based systems to increase cost-effectiveness and efficiency. Other studies examine the effects of RFID technology on improving location awareness in indoor spaces. For example, the study emphasizes the role of RFID systems in location identification and tracking applications. It is recommended that this technology be used more effectively in indoor spaces (Tesoriero et al., 2010). Many studies exemplify the use of RFID technologies in different engineering fields. Textile (Li et al., 2011), civil engineering (Ko et al., 2010), and structural health monitoring (Liu, 2023) are some examples.

This study is evaluated to emphasize the use of RFID technologies in marketing, especially in tracking and managing supply chains. Although RFID technology is primarily considered the subject of engineering and has been examined in many studies in this field, it is a technology that has been examined from different angles due to its intensive use in marketing.

2. Conceptual Framework

From a social science perspective, research on the role of RFID technology in the supply chain provides essential findings regarding information visibility and process improvements. For example, in Zhou's (2009) study, RFID's capabilities in object tracking and tracing are emphasized, and it is stated that RFID tags enable the identification of individual products by assigning a unique electronic product code (EPC) for each product. In addition, Delen et al. (2007) state that RFID provides better management and operational efficiency by increasing information visibility in supply chain management. Such studies reveal the importance of integrating RFID with supply chain processes.

Various academic studies have addressed The challenges businesses face when using Radio Frequency Identification (RFID) technology. These challenges are essential regarding technology adoption, implementation processes, and their impact on business efficiency. Studies on the benefits and challenges of RFID also examine the potential impacts of the technology. For example, Jones et al. (2005) examine the benefits, challenges, and impacts of RFID in the retail sector, noting that this technology provides advantages such as better customer service and cost reduction. However, it is emphasized that operational and strategic challenges need to be overcome to achieve these benefits.

Lai et al. (2005) examine the applications of RFID in China and discuss the opportunities provided by this technology and the challenges faced. The study emphasizes the potential of RFID to increase supply chain visibility, reduce costs, and increase efficiency. However, this study also states barriers, such as security and privacy issues (Lai et al., 2005). Ngai and Gunasekaran (2009) examined the technology's advantages and challenges, such as standardization, compatibility, cost, and integration. This study reveals potential barriers to RFID adoption and strategies to overcome these barriers. In addition, this study provides comprehensive information about the role and impacts of RFID in supply chain management (Ngai & Gunasekaran, 2009). Zhang et al. (2010) examined the barriers to widespread adoption by addressing the organizational impacts of RFID technology. The study emphasizes challenges such as lack of standardization, costs, business process reengineering, and integration. In their study, Li and Visich (2006) focused on the benefits of RFID, the problems encountered in adopting the technology, and the strategies that should be implemented to overcome these problems. Similarly, Vijayaraman and Osyk (2006) examined the applications of RFID in the warehousing industry, detailing the challenges experienced in the implementation process and the strategies recommended to overcome these challenges. This study provides insights on how RFID can be used more effectively in warehousing processes.

2. Method

In order to perform the analysis, on 06.10.2024, a search was done in the studies listed in Web of Science by selecting the “RFID” keyword restriction in the title section and “marketing” in the “all fields” section, and 1024 results were reached in the search. When the years in which these studies were conducted were analyzed, 500 papers, 477 articles, 47 review articles, and 28 book chapters were reached from different disciplines, with the oldest study being 1994 and the newest

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study being 2024. When the ten fields with the highest number of studies are examined, it is observed that the publications are distributed as engineering and electrical-electronics 289, computer science information systems 181, telecommunications 171, computer science theory methods 154, management 114, operations research and management science 103, business 96, computer science and artificial intelligence 94, computer science interdisciplinary applications 83, industrial engineering 80.

In the study, the dataset obtained using the Web of Science database was processed using the Vosviewer application as co-authorship analysis, keywords analysis, country citation analysis, author citation analysis, source citation analysis, bibliographic matching analysis, and co-citation analysis, respectively. The maps obtained were interpreted in the relevant fields, and relevant inferences were made.

4. Findings

This section presents the findings from analyzing the data set filtered from the Web of Science database using the VOSviewer application.

4.1 Co-Author Analysis

The primary purpose of the co-author analysis is to reveal the authors who have the most connections with each other and co-published. For this purpose, Vosviewer was given the condition of authors with at least one publication and at least 1 citation to see more authors. In the co-author analysis, 47 names merged in the same cluster are shown in 10 different clusters, and 118 links are seen between them. Each of the 47 most connected authors in the cluster has 149 unit links. It is observed that the most cited authors are (Ni LM) with 1722 citations, (Nau YC) with 1698 citations in second place, (Liu YH) with 1698 citations in third place, and none of these authors are among the most connected authors. The authors with the most studies are Ngai E.W.T. (23 studies), Bendavid Ygal (7 studies), and Karmakar Nemai Chandra (7 studies). Of these authors, only Ngai E.W.T. is among the most connected authors. The Co-Author Analysis Density Map visualization is presented in Figure 1.

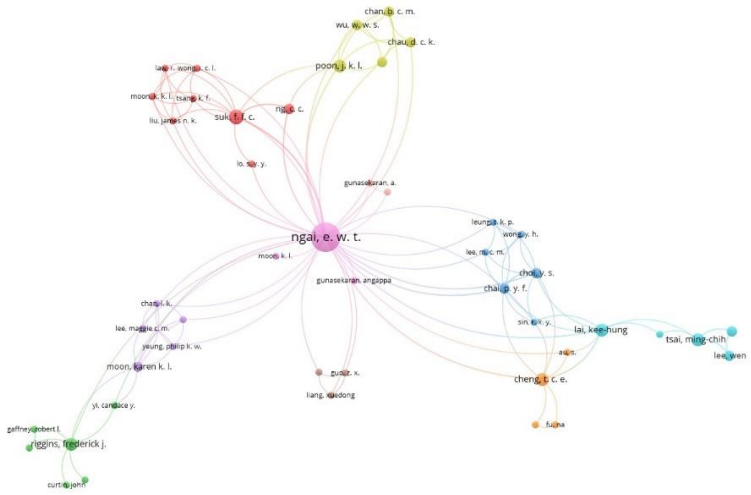

Figure 1: Co-author Analysis Density Map

4.2 Keywords Analysis

When we look at the data set created with the words "RFID" and "marketing," the words RFID and radio frequency identification are shown by Vos viewer with separate numbers. When these two words are combined to obtain more accurate results, they give the highest value due to word analysis with a total of 377 repetitions. In second place is the word Internet of Things with 47 repetitions, and in third place is the word supply chain with 34 repetitions, supporting the desired result in our study. RFID and radio frequency identification appear as the most potent expression of total link strength with 1692 total links; the word Internet of Things takes second place with 248 total links, and the word sensors takes third place with 155 total links. Figure 2 shows the keywords analysis density map.

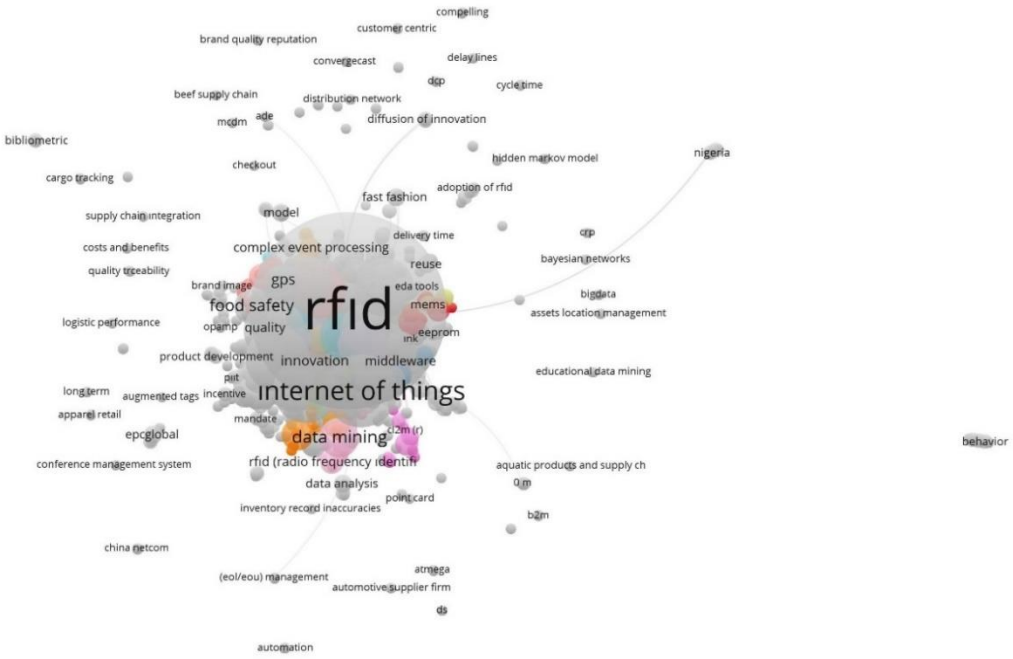

Figure 2: Keywords Analysis Density Map

4.3 Country Citation Analysis

In the country citation analysis, which is used to create a network map in the context of the citations and countries that the publications have received, the analysis was conducted on 73 different countries that have a relationship with each other, with the condition that a country has conducted at least one study and that this study has received at least one citation. These countries formed 15 clusters over the dataset, with 205 links and 797 total links. The most cited countries are the United States of America 7410 citations, the People's Republic of China 4835 citations, the United Kingdom 1214 citations, Canada 1182 citations, and Germany 970 citations. Regarding the studies produced, only the People's Republic of China ranks first with 200 publications, followed by the United States of America with 164 publications and South Korea with 67 publications. The density map of country citation analysis is shown in Figure 3.

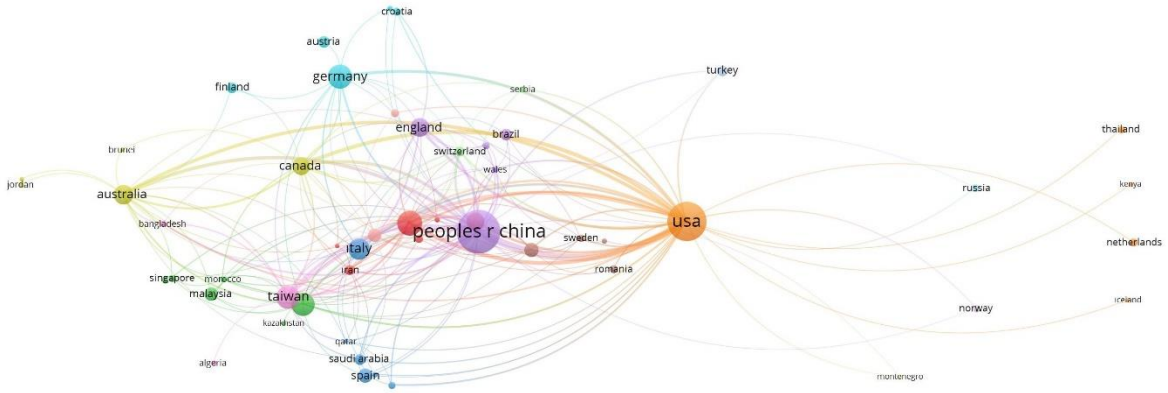

Figure 3: Country Citation Analysis Density Map

4.4 Source Citation Analysis

In order to determine the networks to be created based on the number of citations to the sources, when the network map for the author citation analysis was produced by restricting the authors who have at least one publication and the sources that have received at least 1 citation, 26 clusters, 410 connections and a total connection strength of 488 were observed in the analysis made on 184 sources that were found to be connected. International Journal of Production Economics appears to be the most published source, with Supply Chain Management International Journal in second place and Production and Operations Management in third place. The source citation analysis density map visualization is shown in Figure 4.

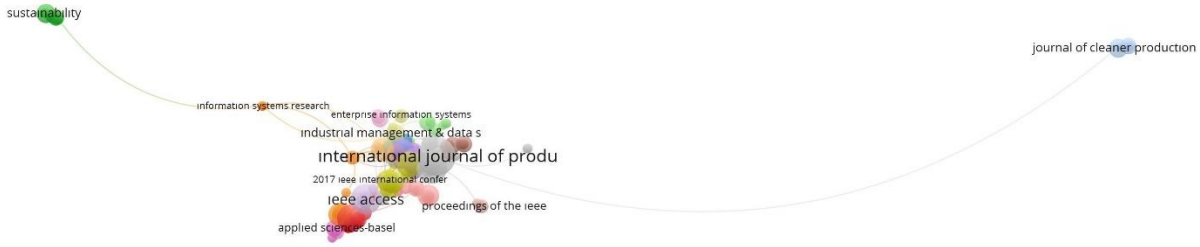

Figure 4: Source Citation Analysis Density Map

4.5 Bibliographic Matching Analysis

Bibliographic matching is a type of analysis that indicates the citation of a joint study from two independent (unrelated) sources. At this point, 27 clusters, 8292 links, and 3224 total link strengths are observed according to the analysis of 575 studies with at least 1 citation as a restriction. The publications with the highest number of bibliographic matches are Ni (2004), with 973 citations, Ni (2003), with 725 citations, and Wang (2006), with 626 citations. The studies with the highest

total link strength are Hossain (2016), Ngai (2008) and Osmolska (2022). The Bibliographic Matching Analysis is shown in Figure 5.

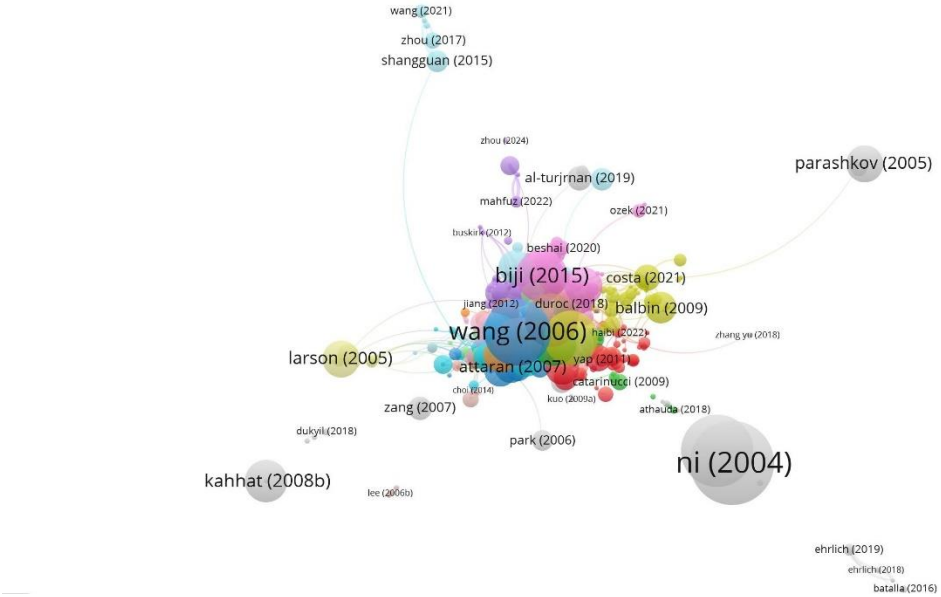

Figure 5: Bibliographic Matching Analysis Density Map

4.6 Common Source Citation Analysis

Co-citation analysis indicates the common citations in different sources cited in a publication. According to the analysis performed on 1469 sources by selecting at least three citations, 15 clusters, 85546 links, and 8248 total link strength were identified and shown in the co-citation analysis map in Figure 6. The most co-cited sources are International Production Economics (484), Lecture Notes Computer Sciences (293), and Production Operational Management (266).



Figure 6: Common Source Citation Analysis Density Map

5. Conclusion

As a result, RFID technologies are an auxiliary technology used effectively in product tracking, especially for businesses. Thanks to this technology, businesses can facilitate their processes by keeping the data of their products in the structural form they want and carrying out different tracking and analysis processes through them. There have been many studies on this technology in the marketing literature. These studies point out the convenience of RFID technology, the obstacles observed during use, and the disadvantages of this technology.

RFID technologies offer significant advantages for businesses and revolutionize various areas of use. RFID enables businesses to optimize production processes, reduce costs, and increase efficiency by providing wireless communication for automatic identification and tracking of objects (Ryu et al., 2011; Mosashvili, 2023). RFID tags, especially in supply chain management, allow products to be tracked from supplier to retail, significantly improving stock management and inventory control (Li & Li, 2011; Duong et al., 2016). This technology gives businesses better decision-making processes and information flow thanks to its ability to collect real-time data (Zhang et al., 2010).

Another advantage observed from the study is its high resilience to environmental conditions and fast data processing capability. Compared to traditional barcode systems, RFID tags can be read without line-of-sight, and many tags can be processed simultaneously (Chen & Pan, 2018; Kaur et al., 2011). These features are critical for improving operational efficiency, especially in large-scale enterprises (Wang, 2015). Moreover, the integration of RFID technology with IoT contributes to the digital transformation processes of enterprises by further strengthening data collection and analysis processes (Xu et al., 2018; Wang et al., 2018).

Adopting RFID technology gives businesses a competitive advantage and helps processes become smarter. However, some barriers, such as high initial costs and implementation difficulties, must be overcome (Jakkhupan et al., 2011; Arunachalam et al., 2017). As a result of the analysis, it is observed that there are more studies on RFID, especially in the sources of developed countries in the field of technology. Countries with fewer studies on these technologies are underdeveloped or developing countries.

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