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RFID Applications, Issues, Methods and Theory: a Review of the AIS Basket of TOP journals

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Abstract

What is the current level of knowledge development on RFID technology, the technology at the core of the “Internet of Things” within the AIS basket of top journals? And what are the potential future research directions on RFID technology within this outlet? To answer these questions, we conducted a comprehensive review of articles published between 2000 and 2011 in journals within the AIS basket of top journals. A total of 25 relevant papers were found and analyzed by publication year, application areas, topics, approaches, and theories used. Finally, a list of potential research directions is discussed.

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1. Introduction

Radio frequency identification (RFID) is a “wireless automatic identification and data capture (AIDC)” technology (p. 615) that allows end-to-end supply chain item level tracking and tracing. The technology is considered by scholars and practitioners as at the core of the so-called “Internet of Things”, which refers to the “possibility of discovering information about a tagged object by browsing an Internet address or database entry that corresponds to a particular RFID” (p. 2) [1]. However, a basic RFID system is not that complex; it is made of three important components: (i) a tag, which can be embedded in or attached to a physical product to be tracked and traced; (ii) a reader and its antennas, which interact with the tag without requiring a line of sight; and (iii) a host computer or middleware, which is in charge of managing the entire

system by aggregating RFID data, filtering RFID data, and interacting with other supply chain information systems (e.g. enterprise resource planning, warehouse management systems, and transport management systems) to support intra- and interorganizational business transactions.

RFID technology has recently captured the imagination of scholars and practitioners because of its high operational and strategic potential in transforming supply chain operations. Some scholars even suggest that RFID technology is “the next revolution in supply chain” (p. 1) [2]. Indeed, RFID technology is expected to transform many of the supply chain operations and strategies including the real-time data collection and sharing among supply chain stakeholders, the establishment of innovative business models and practices such as the build-to-order supply chain management [3], products anticounterfeiting strategies, enhanced product recall, reverse logistics, and total inventory management [4]. Furthermore, RFID technology allows the redesign of inter- and intraorganizational business processes that could lead to the emergence of the so-called “smart processes,” which are processes that can initiate business transactions without any human interventions and, therefore, ease the integration of inter- and intraorganizational information systems. It is probably for these reasons that [5] state that: “RFID essentially allows the tagged entity to become a mobile, intelligent, communicating component of the organization’s overall information internal infrastructure. In addition, the combination of the tagged mobile entity, the reader, and the infrastructure of hardware and software that processes the transmitted data, makes RFID systems a new type of interorganizational system (IOS) that crosses company boundaries, resulting in new opportunities to transform the supply chain for real-time optimization” (p. 88). All these expected benefits from RFID technology have triggered adoption mandates from major firms including Wal-Mart (in 2003), Metro group, and the United States Department of Defense as well as series of call for papers from journals from various fields of research (e.g. operations, information technology, marketing, and healthcare). Recently, we started seeing literature reviews on RFID technology [6], RFID technology in the supply chain [7], and RFID technology in the healthcare in order to assess the level of knowledge development on the topic and therefore lay down some future research directions. However, to the best of our knowledge, there is no paper dealing exclusively with the review of articles on RFID technology within the AIS basket of top journals.

This basket contains a list of journals that are considered to be the premier journals in the IS field [8]. This study therefore represents an initial attempt to bridge this knowledge gap, by answering the following research questions:

*What is the current level of knowledge development on RFID technology within AIS basket of top journals?
What are the potential future research directions on RFID technology?*

The rest of this paper is structured as follows. Section 2 presents the research methodology and the classification framework. Section 3 presents the results and discussion. Finally, Section 4 provides the conclusion including limitations and future research directions.

2. Methodology

As the main objective of this study is to assess the current level of knowledge development on RFID technology within the AIS basket of top journals, we follow a methodology derived from the one used by [9]. More precisely, a comprehensive review of articles published between 2000 and 2011 within each journal of the AIS basket of top journals using the descriptors “RFID technology” or “RFID” is realized followed by a classification of all relevant articles found by the year of publication, application areas, topics, approaches, and theories used. In this study, we use the six journals from the initial list proposed by the AIS senior scholars namely: European Journal of Information Systems (EJIS), Information Systems Journal (ISJ), Information Systems Research (ISR), Journal of AIS (JAIS), Journal of MIS (JMIS), MIS Quarterly (MISQ), as well as the two additional journals suggested by them to be included in the initial list without losing in

quality, namely the Journal of Strategic Information Systems (JSIS) and the Journal of Information Technology (JIT)ⁱ for an overall of eight journals. This deliberate choice is consistent with Viswanath Venkatesh who is using the eight journals to assess IS research rankingsⁱⁱ. This comprehensive review provides a base to understand the current level of knowledge development on RFID technology within the AIS basket of top journals [9]. The preliminary search resulted in 71 articles. After a careful analysis of the content of each paper to assess the fit with our research objectives, a total of 25 papers were finally retained and analyzed for further classification.

3. Results and Discussions

Table 1 presents the distribution of articles by year of publication. We can see that even though RFID has been there from more than two decades, it is only in recent years the publication on RFID is coming into light (2007 onward) for journals within the AIS basket of top journals. In addition, it is noteworthy to see that 40% of articles from our sample were published in the year 2009 and 52% of articles have come from articles published in the EJIS. Surprisingly, the literature review identifies no articles that discuss issues, applications, benefits, and theories related to RFID technology from MISQ, ISJ, JMIS, and ISR.

Table 1. Classification Based on the Year of Publication

Journals	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total	%
EJIS								2	2	7	1	1	13	52
ISJ													0	0
ISR													0	0
JIT										1	2		3	12
JMIS													0	0
JSIS								1		1		3	5	20
JAIS									3	1			4	16
MISQ													0	0
Total	0	0	0	0	0	0	0	3	5	10	3	4	25	
%	0	0	0	0	0	0	0	12	20	40	12	16		100%

Table 2 summarizes the distribution of articles by application areas. It was found that many of the articles covered more than one application area. Clearly, the vast majority of the articles are in the logistics and supply chain (nine papers, 33.3%), followed by the retail industry (five papers, 18.5 %) and manufacturing (four papers, 14.8%). Within application area “others”, we included all papers where we were not able to identify the specific application area.

Table 2. Classification Based on Application Areas

Applications	No. of articles (%)	References
Retail	5 (18.5)	[10]; [11]; [12]; [13]; [14]
Healthcare	2 (7.4)	[15]; [16]
Logistics and SCM	9 (33.3)	[17]; [18]; [19]; [20]; [21]; [22]; [23]; [24]; [25]
Manufacturing	4 (14.8)	[26]; [17]; [27]; [28]
Services	1 (3.7)	[29]
Others	6 (22.2)	[30]; [31]; [32]; [33]; [34]; [35]
Total	27* (100)	

*Some articles are counted more than once because they cover more than one application

Table 3 presents the classification based on topics. Clearly, the most highly published topics are related to “RFID adoption and use/RFID projects” (18 articles, 47.3%), followed by articles that covered topics on RFID infrastructure (eight articles, 21%). Indeed, adoption mandates from major firms have triggered many RFID-enabled organization transformation projects (e.g. trial, pilots, and full implementation). This may be one explanation of this high level of articles related to “RFID adoption and use/RFID projects.” Moreover, because RFID technology is becoming a mature technology, an increasing number of firms are moving from adoption mandates to a more voluntary adoption.

Table 3. Classification Based on Topics

Topics	No. of articles (%)	References
Privacy/Security /Standardization	3 (7.8)	[18]; [32]; [33]
Tags, antennas, readers, middleware	8 (21)	[18]; [17]; [32]; [21]; [23]; [24], [28]; [22]
General introduction /Review	5 (13.1)	[27]; [24]; [20]; [34]; [35]
RFID adoption and use /RFID projects	18 (47.3)	[15]; [30]; [12]; [13]; [17]; [10]; [26]; [23]; [25]; [29]; [24]; [31]; [20]; [21]; [16]; [28]; [33]; [34]
Cost/benefits analysis	4 (10.5)	[18]; [19]; [20]; [17]
Total	38* (100)	

*Some articles are counted more than once because they cover more than one application.

Table 4 summarizes the distribution of articles based on the approach used within each article. The results from our study obviously showed that case studies (12 articles, 41.3%) was the most common approach employed by the authors, followed by survey studies (five articles, 17.2%), review articles (four articles, 13.8%), and data analysis (three articles, 10.3%). Only one article (3.4%) is using action research as the primary research method, while two articles (6.8%) used experiment. This situation may be due to the fact that RFID technology is in its early adoption stage, and in this context case study approach is widely recognized by scholars as the most appropriate research approach to study the technology [36] as an emerging phenomena to ultimately induce theories [37].

Table 4. Classification Based On Approached Used By Each Article (Adapted From Wareham Et Al., (2005))

Approaches	No. of articles (%)	References
Conceptual	2 (6.8)	[25]; [21]
Review	4 (13.8)	[18]; [31]; [32]; [34]
Data analysis	3 (10.3)	[13]; [30]; [35]
Survey	5 (17.2)	[15]; [10]; [11]; [33]; [29]
Experiment	2 (6.8)	[12]; [20]
Case study	12 (41.3)	[17]; [19]; [12]; [13]; [20]; [27]; [24]; [16]; [22]; [29]; [23]; [28]
Action research	1 (3.4)	[26]
Total	29* (100)	

*Some articles are counted more than once because they cover more than one application.

Drawing on the list of theories used in IS research available on the Association for Information Systems web siteⁱⁱⁱ, a classification of articles based on the theory/assessment approach used was realized (Table 5). We can see that a range of theories/assessment approaches have been used to study RFID technology. The most popular ones being the “Diffusion of innovation theory” (five papers, 15%) followed by “Stakeholder theory” (three papers, 9%) and “Coordination theory,” “Delone and McLean IS success model,” “Game theory,” “Technological acceptance model,” and “Unified theory of acceptance and use of technology” with two papers (6%) each.

4. Conclusion, Limits and Future Research Directions

In this paper, the results of comprehensive review of RFID papers within the AIS basket of top journals were presented and discussed. Our results showed that, even if RFID technology has been around for more than two decades, the publication of articles dealing with the topic within the AIS basket of top journals is recent. The first publications can be traced back to 2007. Interestingly, almost 40% of articles were published in the year 2009 and 52% of articles are from one journal namely the EJIS. Surprisingly, the literature review identifies no articles that discuss issues, applications, benefits, and theories related to RFID technology from MISQ, ISJ, JMIS, and ISR. Therefore, the AIS basket of top journals should increase its level of publication of articles on RFID technology. This can be done for example through the organization of special issues on RFID technology by considering various dimensions such as issues, applications, theories, and models related to the technology. It is worthy to highlight the fact that the EJIS has already organized a special issue on RFID technology entitled: “managing RFID projects in organizations.” The rest of journals of the AIS basket of top journals should follow this example.

Our review also showed that the vast majority articles were in the logistics and supply chain (nine papers, 33.3%), followed by the retail industry (five papers, 18.5 %) and manufacturing (four papers, 14.8%). Clearly, more studies need to be done on critical areas such as healthcare and services. Indeed, the healthcare sector is a big burden for many western economies and IT including RFID technology has been recognized as a key tool to alleviate this burden. For example, looking at how RFID technology may allow key healthcare stakeholders to improve outcomes while lowering cost [38] could be an interesting research area. Looking at how RFID technology can facilitate the digitalization of healthcare processes for better patient service should also be included in future research.

Furthermore, our review highlighted the fact that the most highly published topics are related to “RFID adoption and use/RFID projects” (18 articles, 47.3%), followed by articles that covered topics on RFID infrastructure (eight articles, 21%). Also, case studies (12 articles, 41.3%) was the most common approach employed by the authors, followed by survey studies (five articles, 17.2%), review articles (four articles, 13.8%), and data analysis (three articles, 10.3%). With regard to theories used in IS research, our review showed that the most popular ones used when studying RFID technology are the “Diffusion of innovation theory” (five papers, 15%) followed by “Stakeholder theory” (three papers, 9%) and “Coordination theory,” “Delone and McLean IS success model,” “Game theory,” “Technological acceptance model,” and “Unified theory of acceptance and use of technology” with two papers (6%) each.

While these early results help to fill the current knowledge gap in the literature [5], we need to move from technology focus studies to a better assessment of RFID-enabled end-to-end supply chain business value. For example, future research topics may include an exploration of end-to-end supply chain business value generated by the item level tracking and tracing enabled by RFID technology. Also, a better assessment of cost/benefits of RFID-enabled supply chain projects (e.g. who is paying more for the RFID infrastructure, who is benefiting the most) should be included in future research. Other expectations from further research are the use of alternative methods such as living laboratory and virtual reality to engage supply chain stakeholders during the adoption process of RFID technology. Indeed, these approaches are relevant when assessing the co-creation of business value from network technologies such as RFID technology [17]. Also,

applying other theories, including social network theory and design theory, may be useful to understand the selection/design process of different components of RFID infrastructure at the firm and supply chain levels as well as the importance of the position of each firm within the supply chain during all decisions related to the said decision process. Finally, even if our review offers a starting point to scholars and practitioners working on RFID technology, it is limited to only one dataset: AIS basket of top journals.

Table 5. Sample of Theories Used To Study RFID Technology

Theory/assessment approach	Number of articles (%)	Sample references
Activity theory	1 (3)	[26]
Argumentation theory	1 (3)	[18]+
Business value of IT	1 (3)	[34]
Contingency theory	1 (3)	[17]
Coordination theory	2 (6)	[22]; [16]
Critical realism theory	1 (1)	[13]+
Delone and McLean IS success model	2 (6)	[29]; [31]+
Diffusion of innovation theory	5 (15)	[35]; [17]; [15]; [11]; [33]
Expectancy theory	1 (3)	[33]
Game theory	2 (6)	[19]++; [25]+
Grey theory	1 (3)	[11]
Organizational information processing theory	1 (3)	[21]+
Organizational learning theory	1 (3)	[17]
Process theory	1 (3)	[12]+
Push–pull theory	1 (3)	[15]
Resource-based view theory	1 (3)	[16]
Sensemaking theory	1 (3)	[30]
Stakeholder theory	3 (9)	[23]; [28]++; [24]+
Technological acceptance model	2 (6)	[11]; [32]
Theory of understanding	1 (3)	[29]
Theory of reasoned action	1 (3)	[33]
Unified theory of acceptance and use of technology	2 (6)	[10]; [11]
Total	33* (100)	

+Not explicit in the paper.

*Some articles are counted more than once because they cover more than one theory/assessment approach.

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ⁱⁱⁱ Theories used in IS research: http://istheory.byu.edu/wiki/Main_Page

Appendix A. Reasons for Not Including Some Articles In Our Review

<i>Reasons for not including some articles in our review</i>	<i>Articles</i>
Editorial/Introduction	[39]; [40]; [41]; [42]; [43]; [44]; [45]; [46]; [47]; [14]; [48]
Papers not related to RFID: study on pervasive technologies with little or no mention of RFID	[49]; [50]
Papers not related to RFID: study on developing a unified framework of the business model concept with little or no mention of RFID	[51]
Papers not related to RFID: study on enterprise/business transformation with little or no mention of RFID	[52]
Papers not related to RFID: study on collaborative e-government or no mention of RFID	[53]
Papers not related to RFID: study on topics related to IT/IS/Enterprise System/IOS with little or no mention of RFID	[54]; [55]; [56]; [57]; [58]; [59]; [60]; [61]; [62]; [63]; [64]; [65]; [66]; [67]; [68]; [69]; [70]; [71]; [72]
Papers not related to RFID: study on business value of IT with little or no mention of RFID	[73]; [74]; [75] [76], [77],
Papers not related to RFID: study on information intensity, skills, and global service disaggregation with little or no mention of RFID	[78]
Papers not related to RFID: study on IT in the context of management and marketing with little or no mention of RFID	[79]
Papers not related to RFID: study on supply chain with little or no mention of RFID	[80]; [81]; [82]
Papers not related to RFID: study on Green IT with little or no mention of RFID	[83]; [84]