

Towards Item-Level RFID in the Japanese Publishing Industry

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Abstract

Over the past decade, several industries considered RFID technology to improve supply chain efficiency. In Japan, the national Ministry of Economy, Trade and Industry (METI) initiated and sponsored a number of RFID trials between 2003 and 2006. METI selected the Japanese publishing industry, one of the largest publishing industries in the world, for an early RFID trial on item level to increase industry profitability. This paper examines the 2006 METI RFID trial in the Japanese publishing industry following the case study methodology. The study derives some findings regarding the suitability of item-level RFID to enhance supply chain efficiency and effectiveness and with regard to the effective configuration of the trial in the Japanese publishing industry. It concludes with a summary and an outlook to further research.

Keywords: Radio Frequency Identification (RFID), Publishing, Supply Chain Management, Case Study, Japan

Introduction

Over the past decade Radio Frequency Identification (RFID) technology appeared on the radar screens of several industries. Major publishing associations (Falk 2004; Hicks 1999) increasingly considered RFID for supply chain efficiency improvements on a global scale. Publishers and retailers began to investigate how RFID technology worked and subsequently put it on their strategic agenda (Lichtenberg 2003).

Japan has actively fostered RFID, both in terms of Research & Development (R&D) and practice since the late 1990s (Shirai and Johnson 2006). The Japanese RFID market for tags, other system components, and software is expected to grow from 64 million in 2000 to about 850 million in 2008 and 2.75 billion in 2013 respectively (MIC 2006).

The Japanese publishing industry, one of the largest in the world with about 4,500 publishers, 70 wholesalers, and more than 20,000 retail outlets including bookstores, second-hand bookstores, and libraries (JPO 2005), took a national and even global precursor role in testing RFID technology along the publishing supply chain.

This paper analyzes the RFID related efforts undertaken by the Japanese Ministry of Economy, Trade and Industry (METI) in the Japanese publishing industry. METI undertook initial RFID trials between 2003 and 2005. In 2006, it funded a large-scale RFID project which focused on item-level applications. It involved various players in the publishing context. (For applications on logistic units see for instance Loebbecke (2004) or Loebbecke and Palmer (2006).

The remainder of this paper is structured as follows: After briefly describing the fundamentals of RFID technology and the Japanese publishing industry, this paper analyzes the 2006 METI RFID trial in the Japanese publishing industry following

the case study methodology. Based on the case, the paper offers some findings regarding the suitability of item-level RFID to enhance supply chain efficiency in particular in the Japanese publishing industry. It concludes with a summary and an outlook to further research.

Case Study Methodology

This paper applies the exploratory case study methodology (Yin 2003) to reflect the reality of the Japanese publishing industry trialing RFID technology. The case study methodology is well suited to find answers to 'how' the Japanese publishing industry initially pursued RFID and what implications the required business processes, cost, and turnover have for industry-wide adoption decisions.

We gathered mostly qualitative data from publicly available and organizational sources. The data collection involved repeated formal and informal talks between October 2005 and January 2007 with senior executives and project managers as well as the investigation of meeting minutes. Especially the informal settings facilitated that respondents talked about their personal perceptions and impressions of the project. METI officials reviewed the case paper to exclude factual errors.

Technology and Industry Overview

RFID Technology

RFID technology allows for contact-free reading and saving of data via electromagnetic waves (radio frequency field). It uses RFID transponders, also called Smart Chips, which are tiny computer chips with an antenna. RFID transponders can be integrated into a wafer-thin paper tag or a reusable plastic hard tag. RFID tags are attached to objects, individual items, or logistic units such as cartons, palettes, and containers. Passive or semi-passive tags 'identify' themselves when they detect a signal from a compatible device known as an RFID reader. As an RFID transponder passes through a radio frequency (RF) field generated by a compatible reader, it transmits its stored data to the reader. Thereby, it gives details about the item or logistic unit to which it is attached. No line-of-sight is needed between transponder and reader. The radio signal goes through most materials. With RFID technology, one can read several tags at a time.

From the RFID reader, data is usually transferred to a computer which then may hand the information to other systems, such as Enterprise Resource Planning, Customer Relationship Management, or Electronic Data Interchange to coordinate intra-organizational and inter-organizational supply chain processes (Loebbecke and Palmer 2006; Loebbecke et al. 2006; Shepard 2004).¹

RFID on item-level allows distinguishing every individual item. In the case of the publishing industry, for instance, every copy of the newest Harry Potter book would have a unique RFID code, whereas all of them carry the same International Standardized Book Number (ISBN) and barcode (Lichtenberg 2003). RFID technology enables real-time tracking services and thus facilitates enhanced management of product recalls and returns (Higashino 2006).

So far, the main inhibitors to large scale RFID diffusion have been (1) the price of individual tags, (2) the development and integration of software, (3) the management and analysis of the vast amount of data gathered, and (4) a lack of industry specific technical standards (Loebbecke and Palmer 2006).

Japanese Publishing Industry Basics

The Japanese publishing industry reaches approximately 6% of the size of the Japanese automotive or the electronic sector, each with a 2004 turnover of about 365 billion. It comprises three levels of players, publishers, wholesalers, and retailers. Together, the three levels employ about 100,000 people.

The top five publishers account for approximately 25% of the total sales (Japan Society of Publishing Studies 2004). Two of the 70 wholesalers, Nippan and Tohan, control 80% of the market (Matthews et al. 2002; Miyamoto and Whittaker 2005). The top three retailers control about 10% of the publishing retail market (Miyamoto and Whittaker 2005). Japan counts 18,000 retail outlets for publishing products, i.e., twice as many as the UK and the US together.

¹ Regarding RFID applications on unit-level along the supply chain, see for example Angeles (2005), Kaerkkainen and Holmstroem (2002), or Loebbecke (2006).

With almost 10 billion revenue from book sales in 2005, books account for more than 40% of the Japanese publishing market. Despite the availability of several distribution channels for books, book publishers sell roughly 70% of books to wholesalers, who in turn sell about 65% to retail bookstores (Miyamoto and Whittaker 2005). Traditionally, the cooperation among publishers, wholesalers, and retailers in the Japanese publishing industry has been strong, including the exchange of human capital, cash infusion, and IT network building (Kornicki 1998).

Annually, Japanese publishers issue more than 75,000 new books and sell about 1.3 billion books with a variety of 1.2 million titles (JPO 2006a; Miyamoto and Whittaker 2005). Japanese book retailers either buy books or make consignment deals. The latter allow them to return unsold issues to publishers. More than a third of the books delivered on consignment are returned.

In the 1990s, the Japanese publishing market faced a major decline, the first ever as far as industry representatives could remember. Main reasons for the decline were (1) decreasing personal income during recession, (2) spreading of the Internet and mobile phones, and (3) emerging library services as well as the newly introduced second hand book shops (Hanajiri 2003). Especially the book sector was hit by cheaper electronic forms of distribution (METI 2002).² Only in the new millennium, the Japanese publishing industry could stop the downtrend. In 2004, it grew for the first time in more than a decade (Miyamoto and Whittaker 2005).

The 2006 METI RFID Trial

Motivation

In 2003/2004, the Japanese publishing industry undertook METI-funded performance evaluations. The evaluations included all supply chain processes, paying special attention to (1) store operations and redesign, (2) spotting and preventing book theft, and (3) illegal book trade in second-hand bookstores and libraries (Hada et al. 2004). The evaluations indicated ongoing challenges regarding RFID technology leading the Japanese publishing industry to further investigate (1) distribution inefficiency, not only because the Internet offered distribution costs far lower than the traditional multi-tier channel involving publishers, wholesalers, and local retail bookstores, (2) increasing book returns on consignment deals, and (3) large amounts of paper waste contaminated with plastic and silicon from RFID tags.

METI together with the Japan Publishing Organization for Information Infrastructure Development (JPO), who aims at improving book distribution using modern technologies, took up the issues and at the same time reacted to economic difficulties when they proclaimed faster and better inter-organizational coordination of all business processes along the publishing supply chain.

METI and the JPO calculated an RFID business case for the Japanese publishing industry. Altogether, they projected the impact of RFID on the Japanese publishing sector to reach about 2.5 billion in combined sales increases and cost reductions (JPO 2006a). Specifically, they anticipated sales of new books to increase by about 1.2 billion per year resulting from better managing release dates and improving customer relationship management, costs from returned books to be reduced by about 200 million per year, and book theft³ to decrease by about 290 million per year (JPO 2006a). Further, they expected book inspection time to be reduced by 90% with RFID applications (JPO 2004) and business processes together with distribution and tracing systems to be generally improved (JPO 2006a).

Based on those numbers, the Japanese publishing industry opted for an RFID implementation trial and prepared to organize the first real-life test of supply chain wide item-level RFID implementation (Higashino 2006). Soon after, they proceeded with a large consortium consisting of industry associations and players, governmental institutions, and technology vendors, even though RFID regulation was still rudimental and RFID technology under continuous development.

Consortium Composition and Objectives

The JPO took a leading role in organizing to the consortium for the 2006 METI RFID trial. Several JPO member companies, paper manufacturers, printing companies and book manufacturers, publishers including the three major players

2 In Europe and North America, music and newspaper markets suffered the most from newly available electronic distribution opportunities (Rao 1999; Picard 2003).

3 Book theft accounted annually for 13,375 per bookstore in Japan, calculating to an average theft / sales ratio of 24% (JPO 2006b).

Kodansha⁴, Shogakukan⁵, and Shueisha⁶, and bookstores participated. METI also invited technology vendor Hitachi, in charge of the RFID developments in Japan, to supervise the technological aspects of the trial.

The consortium members formulated a catalog of trial objectives focusing on seamless sharing of information through RFID. Building international standardization trends, the three main goals were to promote (1) fundamental R&D for inter-organizational coordination and information exchange on a global scale, (2) common cross-sector problem solving regarding the social acceptability of RFID technology, and (3) the acceleration of RFID adoption and diffusion along the publishing supply chain as a role model for other industries (Higashino 2006). Further, the consortium aimed at creating new RFID-based business models and at exploiting newly available information for publishers' marketing purposes (Fujita 2007).

Technological Context

RFID Infrastructure in Japan

Implementing RFID in the publishing industry required a commonly accepted product numbering scheme and an assigned frequency range for RFID systems.

Product numbering scheme: The development of a common product numbering scheme began long before considerations to implement RFID technology. In 1977, the Japanese Distribution Systems Research Institute⁷ founded the Distribution Code Centre - Japan (DCC-Japan) as national authority for product number coding. In 1978, envisioning the global scope of product numbering, the DCC-Japan joined the European Article Numbering (EAN) Association. In January 2004, the former European Article Numbering Association migrated to GS1.

Succeeding the EAN Association, GS1 considered mature and standardized product number coding inevitable for the identification of products on item-level along the entire supply chain. With a special focus on RFID applications, in 2003 GS1 together with international research institutions founded EPCglobal. In January 2004, EPCglobal set up a Japanese unit, EPCglobal Japan, which promoted specific product numbering codes for use with RFID technology (Shirai and Johnson 2006).

Frequency range: Available frequency ranges were scarce when commercial RFID use came into play during the 1990s. In Japan, Ultra High Frequency (UHF) was mainly allocated to cell phone services. Only the frequencies 13.56 MHz (HF) and 2.45 GHz (UHF) were available for RFID. In April 2005, understanding the need for a globally harmonized RFID frequency allocation, the Japanese Ministry of Internal Affairs and Communications released the 950 MHz to 956 MHz frequency range in the UHF band for RFID use (Hara 2003). As the frequency range lay within 860 MHz to 960 MHz specified by EPCglobal, Japanese RFID implementations were compatible with other industrial nations.

Hibiki RFID Tag

To tackle RFID technology challenges, in 2004 Hitachi took a central role to form the Hibiki Tag Development Consortium with the cooperation of Dai Nippon Printing, Toppan Printing, NEC, and Fujitsu. Funded with about 92 million from METI between 2004 and 2006, the so-called Hibiki project aimed at developing and testing Hibiki RFID tags. They were supposed to be low-cost, high-quality, multi-standard, re-writable, and designed for item-level use (Ishikawa et al. 2003).

The resulting Hibiki RFID tag coding scheme complies with ISO and EPCglobal standards, even though it only serves one data encoding and transmission type (instead of two specified by EPCglobal). The Hibiki RFID tag offers a 512 bit memory. It is compatible with EPCglobal Gen II devices (Hara 2003). Assuming an output volume of 100 million tags, production cost per Hibiki tag amount to 0.05 compared to 0.10 to 0.15 for European or American tags.

Overall, METI was satisfied with the Hibiki project results, and therefore solely promoted Hibiki tags for further RFID trials in the publishing industry.

4 Kodansha is one of Japan's largest publishing companies. In 2006, the company achieved revenues of more than 1.3 billion. It has a major joint venture with Walt Disney Company.

5 Shogakukan has a market share of about 8% in the Japanese publishing market, specializing in schoolbooks, books for children, and encyclopedia. With about 69 magazines, 7,500 book titles, 10,900 comic book titles, 900 magazine books, and 3,000 DVD and video titles, it achieves a turnover of about 1.25 billion.

6 Shueisha specializes in Manga comics and other magazines.

7 The Japanese Distribution Systems Research Institute was founded in 1972 to investigate the potential of supply chain enhancements in many industries.

Customer Privacy Context

When RFID became a mainstream topic at the beginning of the millennium, customer privacy organizations and civil rights activists emphasized the danger of customer data being gathered, processed, and exploited without the customer even being aware. RFID technology raised concerns that personally relevant data was stored on RFID tags and then transferred from the tag without customer permission. Customer data stored on an RFID tag containing an ISBN code, would allow drawing conclusions on customers' shopping behavior and possibly on political and philosophical attitude.

In June 2004, as the privacy topic gained public attention, METI and the Ministry of Internal Affairs and Communications (MIC) jointly established and released *Guidelines for Privacy Protection with Regard to RFID Tags* facing the consumer. The policy regulated to make attached RFID tags transparent to the user. It set restrictions for gathering and using personal customer information and gave consumers the rights to nullify or remove RFID tags. Finally the policy ruled the accountability of RFID tag issuers (Shirai and Johnson 2006).

In the 2006 METI RFID trial, project participants specified and even extended the overall privacy policy concerning two aspects. They required that information stored on RFID tags should only include arbitrary numbers and letters needed for the distribution process and exclude any personal customer data. Also, they required that any information stored on the RFID tags should be deleted and the tags should be destroyed before product delivery to the customer.

METI RFID Sub-Trials

The 2006 METI RFID trial in the publishing industry consisted of five sub-trials: (1) the *Customer Order Tracking* sub-trial, (2) the *Sales Management System* sub-trial, (3) the *Store Operation and Customer Service* sub-trial, (4) the *Code System and Privacy Protection* sub-trial, and the (5) *Paper Recycling* sub-trial.

Ad (1) The *Customer Order Tracking* sub-trial (see Figure 1) involved printing and book binding companies, publishers, wholesalers, bookstores, and consumers. It denoted the tracking of customer orders of comic books. Hibiki RFID tags were attached to 100,000 comic books during the manufacturing process. Following ID issuance and code writing on the tag, publisher personnel inspected the comic books and assorted them in the distribution system. To fix and maintain delivery dates based on RFID across supply chain members, the printing and book binding company set a delivery date for the book to reach the wholesaler. The wholesaler then set a date when the book would reach the retailer; and finally, the retailer fixed a date for the book to be available to customers. Along the entire process from printing to customer purchase, the Customer Order Tracking sub-trial investigated the cost per customer order, the cost per retail service, and the cost for design and store layout of next generation bookstores.

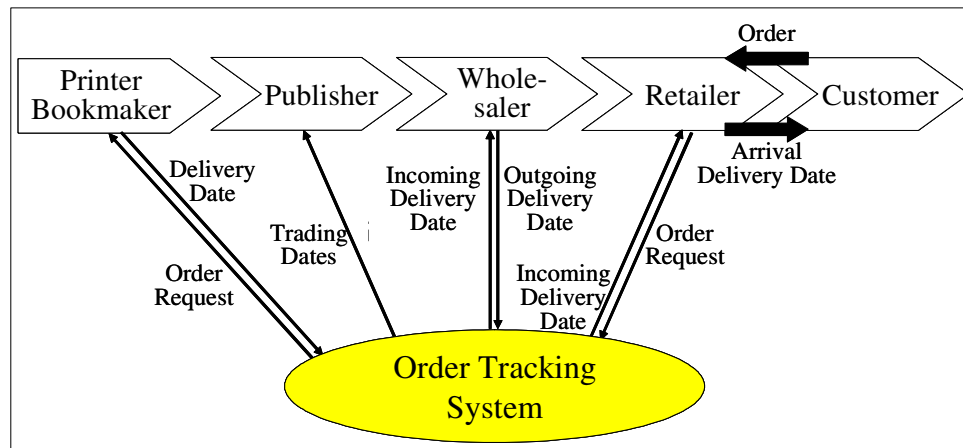


Figure 1: Customer Order Tracking (After JPO 2006b)

Ad (2) The *Sales Management System* sub-trial aimed at reducing stocks, returned books and faster reacting to customer orders. It also encouraged management to reintegrate returned books into the supply chain at the earliest possible stage. For the sub-trial, 10,000 copies of the 'Encyclopedia of Health and Medicine' published by Kodansha Ltd. were printed, tagged, and distributed along the supply chain. Information gathered from Hibiki RFID tags affixed to the Encyclopedia books was passed to and processed by the sales management system. The information let publishers, wholesalers, and bookstores track returnable and non-returnable books and their respective status. To provide advantages for printing companies, the Sales Management System offered fast and precise sales feedback and thus fostered a reduction of book overproduction.

Ad (3) The main objective of the *Store Operation and Customer Service* sub-trial was to achieve more detailed and objectified, even if qualitative, assessments of customer demand and to transform them into quantitative information for better customer services. The sub-trial focused on retail bookstores and the interaction between retail personnel and customers (see Figure 2). The sub-trial examined the introduction of flatbed smart shelves, which displayed information to consumers and retail personnel. Offering an inventory management system for RFID-tagged books on the shelves, the sub-trial gave retail personnel the opportunity to observe daily and weekly book rankings in real-time and to analyze the relationship between customers' book browsing and buying. It enabled retail personnel to send instant messages concerning growth rates, hit ratios, inventory levels, and out-of-stocks to the employees in charge of inventory management. Finally, it also provided customers with book rankings, summaries, and reviews as additional service.

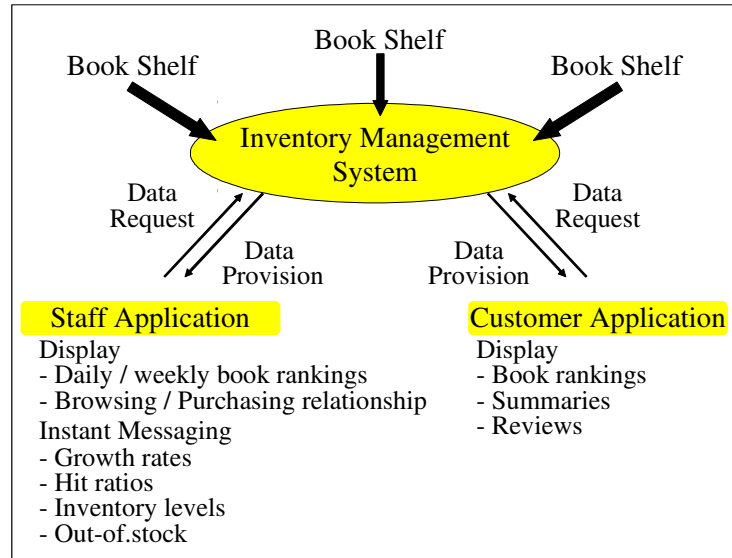


Figure 2: Store Operations and Customer Service (After JPO 2006b)

Ad (4) The *Code System and Privacy Protection* sub-trial involved all supply chain participants. It was built on a newly developed common coding system for publishing products. The sub-trial required printing and book binding companies to attach the Hibiki RFID tags to books and assigned publishers, wholesalers, and retailers to implement software for reading and interpreting the information stored on the tag. The Code System and Privacy Protection sub-trial analyzed the trade-off between providing appropriate and reliable information on the one hand and securing customers' private data on the other hand. By setting up flatbed smart shelves, the sub-trial offered information on customer behavior in the retail store prior to purchase. For instance, it provided information that allowed tracking a customer route through the store after he had picked a book from a shelf. However, the sub-trial requested retail stores to preserve customer anonymity by neither storing customer data on the tags nor matching purchase data to customer information upon checkout.

Ad (5) The *Paper Recycling* sub-trial concentrated on paper manufacturers, printing companies, and book binding companies. Based on a full-scale RFID roll-out in one paper manufacturing plant, it experimented with various ways of attaching RFID tags to books considering environmental concerns. The sub-trial examined the efforts needed to detach RFID tags automatically when separating pieces for recycling.

Findings

This section first offers findings from each of the five sub-trials included in the 2006 METI RFID trial.

The *Customer Order Tracking* sub-trial illustrates the shortening of the product delivery process. It points to the necessity of precise information entering and the appropriate protection of private customer data as main problems. It successfully identifies the main challenges of a large scale RFID adoption on item level and offers sufficient cost and profitability information to prepare for the industry-wide roll-out.

The *Sales Management System* sub-trial shows that available real-time information on retail inventories and book returns allows publishers and book printers to enhance the quality of future demand estimates and thus to better allocate production capacities.

The *Store Operation and Customer Service* sub-trial indicates that customers readily adopt the customer service applications. It illustrates that customers are willing to give away information to be passed upstream along the publishing supply chain in exchange for better service. Further it outlines how retail personnel can survey future demand and future trends based on objectified customer data.

The *Code System and Privacy Protection* sub-trial indicates that bookstores need appropriate installations to void the tags before passing books to customers in order to fully comply with the privacy protection guidelines. It thereby identifies an important cost component with regard to a large scale RFID adoption.

The *Paper Recycling* sub-trial demonstrates that RFID tags can easily be attached to and also removed from various types of book covers as to not disturb the recycling process.

Further, the study allows for insights regarding three configuration aspects of the 2006 METI RFID trial, i.e., the *general trial context*, the *trial composition*, and the *competencies and resources*. *General trial context*: From an intra-industry perspective, the economic situation of the Japanese publishing industry fuels the industry's willingness and readiness to engage in the METI 2006 RFID trial. The technological progress made by foreign companies from various industries, e.g., pharmaceuticals, fashion, and automotives, and foreign technology vendors, provides the necessary encouragement and technological competition. The internal and the external context encourages METI as governmental institution to initiate and support the RFID trial in order to strengthen the competitive position of the Japanese publishing industry and maintain the image of Japan as a technology powerhouse.

Trial composition: Government involvement has stimulated participation from private companies that perceive to be part of the regulation and lawmaking process. By involving companies from the entire publishing supply chain, METI enabled trials covering supply-chain-spanning systems. Incorporating technology vendors in the trial fosters new technological development to fit the specific needs of the publishing industry.

Competencies and resources: In the heterogeneous trial consortium, each participant offers different competencies and resources. METI and MIC as state agencies can adapt the regulatory context. It could reallocate frequency bands and define a binding privacy policy that make the trial technically feasible and enhance the social acceptability of RFID. Public project funding also eases companies' willingness to participate. The large publishers and wholesalers selected for the 2006 METI RFID trial contribute their expertise concerning the relevant business process reconfigurations in global publishing. Technology vendors' engineering skills play an important role in developing the high-tech RFID systems and their large scale production facilities allow for producing low cost RFID tags.

Finally, the research leads to some general findings concerning the suitability of RFID to improve efficiency and effectiveness in the Japanese publishing industry.

Overall, the 2006 METI RFID trial in the Japanese publishing industry indicates the technical feasibility of RFID item-level tagging to enhance order fulfillment and book tracking on their way to customers. It demonstrates that RFID technology contributes to accelerating numerous supply chain processes, such as delivery, order tracking, and inventory takes. Thus it delivers arguments for accelerated RFID adoption and diffusion by industry players. The 2006 METI RFID trial points to the required business process adaptations, identifies cost components, and allows for early profitability assessments. It illustrates the opportunity of an conducting innovative marketing campaigns and raises overall RFID awareness. Ultimately, the positive results of the 2006 METI RFID trial in the Japanese publishing industry has encouraged other industries to consider deployment of item-level RFID.

Whereas the 2006 METI RFID trial illustrated the overall suitability of RFID on item-level in the Japanese publishing industry, it could not offer generalizable and quantified profitability statements. Economies of scale involved in a large scale roll-out and learning effects associated with extended project duration may change profitability assessments substantially.

Summary and Outlook to Future Research

The paper shortly described RFID technology and the Japanese publishing industry to build a foundation for the case of the 2006 METI RFID trial in the Japanese publishing industry. It offered findings per sub-trial, the trial configuration in terms of context, composition, and competencies and resources, and the overall suitability of RFID for enhancing the efficiency of the Japanese publishing supply chain.

Building on this research, we plan to investigate RFID technology trials on item-level in other media industries to validate our findings across products and possibly countries. To better understand the RFID opportunities in the publishing industry, we suggest to also analyze whether industry-wide trials without state funding lead to similar results. However, due to the limited number of item-level RFID implementations expected to be available in the near future, comparative quantitative studies will have to remain limited.

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