Radio Frequency Identification for Efficient Library Management

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Abstract

Auto identification and data collection technology is known as radio frequency identification (RFID) helps to automate business processes and allow identification of large number of tagged objects such as books by means of radio waves. It is used in supply chain management in tracking the movement of inventories, equipments, devices and others. Most libraries automate the tracking of books and documents by utilizing the RFID technology in managing the movements of books from shelves and others. This paper is highlighting the application, requirements, benefits, challenges and other issues by incorporating RFID in university/institution library management.

Key Words: supply chain management, radio frequency identification, library management system, books.

Introduction

The barcodes has been used extensively in supply chain management for decades (Soon et al, 1999; Somuyiwa and Adewoye, 2010; Tajima, 2007), in recent years RFID technology has been increasing and reducing the use of barcodes in most libraries, warehouses and retail outlets in the world (Tajima, 2007). Radio frequency identification technology is a combination of radio frequency based technology and microchip technology by which the information inserted on microchips in the tags affixed to library materials is read via radio frequency technology. This technology being used in most industries in automating its supply chain management, however libraries increasingly starting to use the technology to speed up the self-check in and self-check out processes in controlling inventory and theft in the library (Ferrer et.al, 2010; Ching and Tai, 2009; Coyle, 2005). Even in Bangladesh the university library is migrating to use RFID to increase efficiency as barcodes systems unable to protect library materials from irresponsible patrons, in addition it is more time consuming and costly to use barcodes (Islam and Shuva, 2010). Even so, in Malaysia some of the universities library still using barcodes rather than RFID in tracking books inventory, as such this paper is forwarded to stress on the need of RFID for more efficient library management.

Radio Frequency Identification (RFID)

Radio Frequency Identification (RFID) usually is defined as a small tag containing an integrated chip circuit and an antenna that will respond to radio waves transmitted from the RFID reader that is functioning as a sender, processer, and information storage (Hsu and Yuan, 2011; Jones et al., 2007; Liao et al., 2011;Thornley et al., 2011;Wang, 2011; Wu et al., 2006). Although much studies have been done by earlier researchers until today, due to technology enhancement and advancement, the RFID technology has become cheaper (affordable), effective and efficient in tracking the movement of products or inventories (Ferrer et al., 2010; Lee and Lee, 2010; Ching and Tai, 2009). The first RFID technology was developed by the Los Alamos Scientific Laboratories in 1977 (Wu et al., 2006), since then the evolution of technology for RFID has grown from a simple technology to a more advance technology for the purpose of supply chain management to many industries as shown in Table 1.

In a study conducted at a university library in Hong Kong on the adoption of RFID technology to ensure the efficiency of the library operations has forced them to conduct a pilot test to choose between HF (high frequency) RFID that operates at 13.56MHz and UHF (Ultra High Frequency) RFID that operates at 860 to 960MHz. In RFID technology the frequencies of the electromagnetic waves determines the quality of the read range, the speed of data transfer, immunity to local electrical environments, and performance near metal.

HF RFID has been used for more than 10 years in most of the libraries in the world rather than UHF RFID (refer Table 1). To conduct the pilot test, applications such as EasyCheck units (self-check machine), EasyReturn units (self return machine) and the EasyDetect Gates (security detection gates) must be in place. The advantages of UHF RFID would be the tags are much cheaper, more efficient, and user friendly than HF RFID, as such, a university in Hong Kong had chosen UHF RFID to automate the library management in the university (Ching and Tai, 2009).

Since, the initial investment to set-up RFID system requires substantial amount of money, as such to conduct such test is needed before the system fully adopted by the university library especially if the library is huge and congested with patrons.

Table 1: Cases on RFID

Case	Tagged Item	Customer	Service Provider	Tag Type	Frequency
Container yard management	Containers	Shippers	Shipping company	RTLS	433 MHz
Automobile distribution yard	Automobiles	Dealers	Automobile distributor	RTLS	433 MHz
Highway and city toll collection	Registered automobiles	Drivers	Transit authority	Passive	2.45GHz
McDonald's cashless payment	Customers	Consumers	Fast food outlet	Passive	13.56MHz
Public library customer service	**Books**	**Readers**	**Library**	**Passive**	**13.56MHz**
Industrial laundry management	Bedding and uniforms	Hospitals and hotels	Industrial laundry	Passive	13.56MHz
ATM cash transfer	Cash securing boxes	Banks	Security transportation company	Active	125kHz
Beer keg distribution control	Beer kegs	Breweries	Keg supplier	Passive	13.56MHz
Lab supply vendor-managed inventory	Lab supplies	Research labs	Laboratory supplier	Passive	2.45GHz
Railcar tracking	Railcars	Shipper	Railroads	Passive	915MHz
Prison inmate tracking	Prison inmates	Government	Prison management company	RTLS	915MHz
Ocean going container tracking	Ocean going containers	Shipper	Port authority	Active	433MHz
Airline luggage tracking	Luggage	Air traveler	Airline	Passive	915MHz
Hospital patient identification	Patients	Patients	Hospital	Passive	13.56MHz
Specialty container identification	Intermediate and bulk containers	Container lessors	Chemical and pharmaceutical company	RTLS	433MHz
Fashion boutique management	Clothes and accessories	Consumer	Fashion boutique	Passive	13.56MHz
Refrigerated cargo control	Containers	Frozen goods manufacturer	Shipping company	Semi passive	2.45GHz
MREs(Meals Ready to eat) control	Pallets	Military personnel	US Department of Defense	Semi passive	2.45GHz
Theme park visitor location	Children and family members	Park visitors	Theme park	RTLS	433MHz
Student location	Students	Students	College or school	Passive	13.56MHz
Mine worker identification	Mine workers	Mine workers	Mine company	RTLS	433MHz

Source: Ferrer, C., Dew, N., and Apte, U. (2010). When is RFID right for your service? International Journal Production Economics. 124, pp. 417.

RFID Implementation Process

There are three factors to be taken into considerations before the evaluation, adoption and integration of RFID by any companies, organisations or institutions. Those factors are organizational needs, perceived factors, and organizational readiness, after the information gathered from all these three factors the evaluation process started whether it is feasible to adopt the technology, and if it is highly needed and relevant to the library management, the integration of RFID technology into the supply chain should be carried out as illustrated in Figure 1.
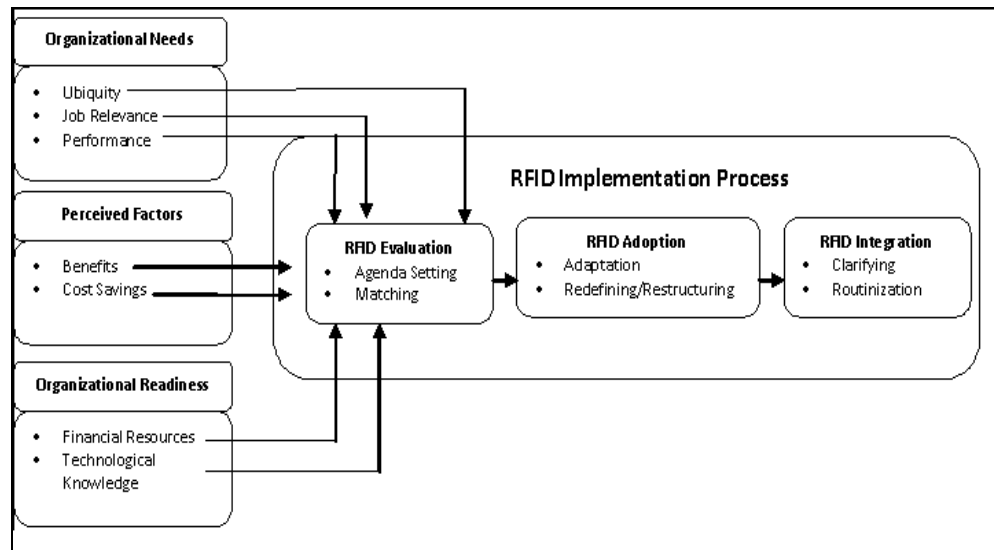

Figure 1. Determinants for the implementation of RFID

Source: Kim, S., and Garrison, G. (2010). Understanding users' behaviors regarding supply chain technology: Determinants impacting the adoption and implementation of RFID technology in South Korea. International Journal of Information Management. 30, pp. 391.

Stage 1: RFID Evaluation
Need: Ubiquity, job relevance and performance
The perception of an organization or institution on the ability of RFID to provide personalize and uninterrupt connection and communication throughout the organization is called ubiquity. In the context of a library, the information pertaining movements of books and the accuracy of the information captured on the patrons and books from the RFID technology is highly crucial in the supply chain management of a library. The job relevance is referring to the extent the technology is significant towards the user. The usefulness of RFID to library patrons will be less time needed to check out books because the tag can be read immediately and staff is not required to be at the circulation desk. Usually, long queue at the circulation desk will lead to less books could be checked out from the library, as such with the adoption of RFID technology more books could be checked out in short time (Ching and Tai, 2009; Kim and Garrison, 2010). It is crucial for university library to adopt and implement RFID as it will significantly increases performance and reduces operating cost of the library (Ching and Tai, 2009; Ferrer et al., 2010; Kim and Garrison, 2010).

Perceived factors: Benefits and cost savings
The ability of RFID to provide cost effective communications, information exchanges, and business operations can be considered as cost savings (Chen et al., 2007; Fazel et al., 2011; Karkainen, 2003; Lee and Lee, 2010; Wang, 2011). As in the case of a university in Hong Kong decision to adopt UHF RFID as the tools to automate the library management due to the results from the pilot test showed that the UHF RFID as the most preferred technology by library patrons and staffs in the university. In addition, it is cheaper, more efficient and user friendly than HF RFID (Ching and Tai, 2009; Kim and Garrison, 2010).

Organizational readiness: Financial and technological knowledge
It is crucial for a university to have sufficient budget, and knowledge on the RFID technology before adopting the technology (Ching and Tai, 2009; Ferrer, Dew and Apte, 2010; Kim and Garrison, 2010).

Stage 2: RFID Adoption: Adaptation and redefining/restructuring

The RFID technology has to be customized to suit the needs and structures of the library or else, the library has to change in order to adopt the technology requirements and applications (Fazel et al., 2011; Kim and Garrison, 2010). As in the case of a university in Hong Kong, the university library has installed EasyCheck units (self-check machine), EasyReturn units (self return machine) and the EasyDetect Gates (security detection gates) to ensure the success of the adaptation and refining process (Ching and Tai, 2009).

Stage 3: RFID Integration: Clarifying and routinization

The RFID technology has to be fully integrated and immersed into the library needs, by which all parties able to use the technology easily (Fazel et al., 2011; Kim and Garrison, 2010). In the case of a university in Hong Kong, the university conducted pilot study to evaluate the RFID technology before adopting it in the university library, whereby librarians and library patrons able to be familiar with the RFID technology application (Ching and Tai, 2009).

Application of RFID in Library:

RFID is actively replacing barcodes not only in retail stores but also libraries. The needs to apply RFID in library operations especially in terms of supply chain management of books to patrons are highly relevant, due to the nature of the library operations. This technology is beneficial for a wide variety of inventory tracking situation, as such it allows "micro payment" for books overdue by the patrons (Coyle, 2005). There are four main benefits which are quality, speed, flexibility and costs, these benefits are discussed further in the following paragraph (refer Figure 2).
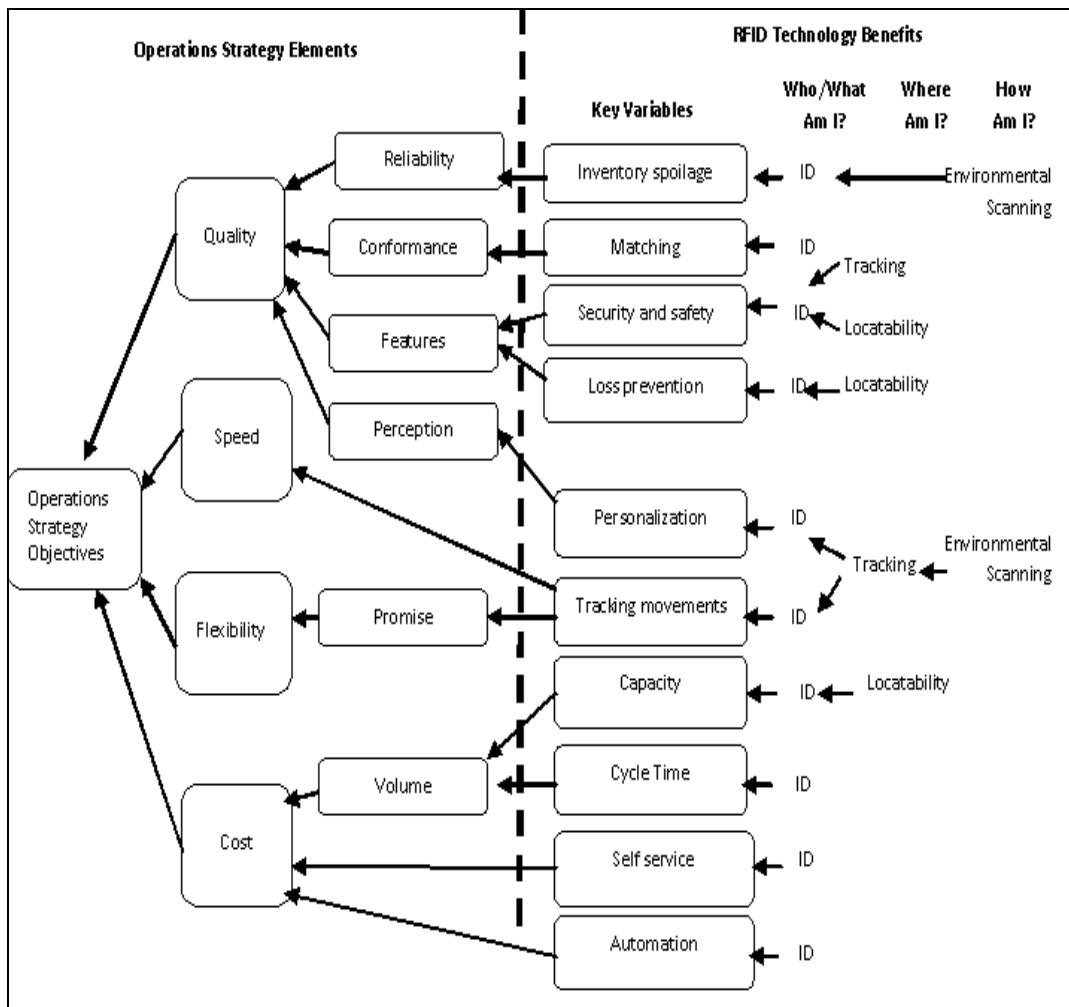

Figure 2. RFID benefits

Source: Ferrer, C., Dew, N., and Apte, U. (2010). When is RFID right for your service? International Journal Production Economics. 124, pp. 414-425.

Quality

The main function of RFID technology is as security tool whereby the tag is used as a "security bit" that allows switching from "checked-in" to "checked-out". A library must install an exit gates that will read each tag as the patrons walk through it the alarms will sound if the tag is not in a "checked-out" mode. The books information can be personalized to the need of the library into the RFID tag such as damages or spoilage of the books (Ching and Tai, 2009; Coyle, 2005; Lee et al., 2008; Thornley et al., 2011; Zhao et al., 2011).

Speed: Tracking movements

RFID will detect the location of a book either on shelf or elsewhere so it is more efficient and faster in tracking book inventories, however it only allows the presence of an object to be detected within an area rather than providing a specific location (Coyle, 2005; Gibb et al., 2011; Tajima, 2007). A normal barcodes system unable to detect books if it is mis-shelves as a result time wasted for locating the books (Li, 2009). Other than that, patrons information such as types of book loan by them also stored in the system and can be extracted by the librarian anytime (Thornley et al., 2011; Zhao et al., 2011).

Flexibility

Promise: Tracking movements

Librarian able to assist patrons in locating the movements of books and documents in the library, as such it increases the efficiency of customer service in the library. Also, the 'checked-out' books and documents information are stored in the computer database that allows the patrons to check the availability of the books on-line (Ching and Tai, 2009; Coyle, 2005; Gibb et al., 2011; Yoon et al., 2008).

Cost

Self-service and automation

It allows the patrons to check-out all books at once, because the reader can read multiple tags at once in a single transaction (Ching and Tai, 2009; Coyle, 2005; Liao et al., 2011; Wang 2011). Another investment is automating sorting machine that enable to sort books into bins in accordance to its call number that allows the librarian to do the re-shelving faster (Coyle, 2005). RFID allows the library patrons to do self check out and in for books, thus less time spend to queue and less staff needed at the circulation desk (Gibb et al., 2011).

Volume: Capacity and cycle time

Although the cost per item for RFID is more, however the libraries items are taken out and returned many times, due to this the RFID tag is re-used many times as such it is more cost efficient and has a longer cycle time (Ching and Tai, 2009; Coyle, 2005).

Challenges on RFID Adoption

Technology challenges

In RFID technology, the antenna plays an important role for communication between tag and reader, whereby the strength of radio wave is reflected or refracted by different materials (Ngai et al., 2008). The types of materials might affect the antenna power, and radio wave reception. Since the tag can be read at once, collision could happen due to simultaneous radio transmission. In addition, lack of unified and complete RFID standard for UHF and HF is a challenge for the adoption of the technology (Chao et al., 2007; Wu et al., 2006).

Regulatory challenges

RFIDs augmented with consumer data raises issues, whereby they should be aware of their data being captured for profiling purposes. Privacy on patrons stored in the database such as types of books and also personal information can be extracted by librarian as such it highlighted privacy issues for the library patrons (Tajima, 2007). As such notice and consent (aware of the RFID being used), choice (to deactivate data automatically, unless the patrons demand otherwise) and control (patrons should have the right to kept personal information detached from the object/book) should be given to the library patrons (Gibb et al., 2011; Ngai et al., 2008; Thornley et al., 2011). Other than that, the patent challenges for manufacturing and customizing RFID due to high patent royalty payment is one of the obstacle to further develop RFID (Chao et al., 2007; Wu et al., 2006).

Cost challenges

The infrastructure for system design, customization and configuration would be a challenge due to high set-up cost or infrastructure for the RFID implementation process.

ROI will be one of the main challenges, due to high initial investment in setting up the RFID technology for the premise or library (Tajima, 2007). During the migration from barcode to RFID, the cost is double due to maintenance of dual systems for the operation (Chao et al., 2007; Wu et al., 2006). Not only that, RFID also have recurring costs for hardware (upgrading, maintaining, moving, changing), software (upgrading, maintaining, moving, changing, system integration costs with existing systems), development (internal technical staff, incorporating overhead costs, collaboration with external partners, tagging labor costs, communication costs), training (on-going training, change management) and service (on-going third party services, professional services) (Lee and Lee, 2010).

RFID Threats

RFID allows automation of information collections on individual's locations and actions, the data collected and stored can be abused by hackers, retailers and government by means of sniffing, tracking, spoofing, replay attacks and denial of service (Rieback et al., 2006; Ngai et al., 2008). The reason why RFID attracts abuser is due to lots of source code, generic protocols and facilities, back-end databases, high-value data, and false sense of security. There are three types of malware identified which are RFID exploits, RFID worms, and RFID viruses (Rieback et al., 2006).

Table 2: RFID Malware

	Where the attacks start?	How they attack?	What being attack?
RFID exploits	Abuser could write data on a RFID tag, once read the information corrupts reader's back-end software.	Low cost RFID tags or contactless smartcards	Attack back end software
RFID worms	Program self-multiply across a network	FRID tags, e-mail, files and etc	Exploit security flaws online for RFID service
RFID viruses	Infected tag is required to spread the viral attack	Normal objects with a infected tag	Attacks database

Managerial Implications

The decision whether to adopt RFID in managing the library supply chain, the manager should evaluate the feasibility for adopting RFID by utilising the 3 steps analysis that analyse the technology, infrastructure and financial capacity to support the adoption or migration process from barcode to RFID.

Conclusion

Institutional libraries in Malaysia and also other parts of the world should reap the benefits for adopting RFID in managing movement of books and documents efficiently. Benefits of RFID are substantial that include increasing the effectiveness of the customer service, inventory tracking and cost center management for the library. However, the challenges and threats of RFID technology have to be considered before adopting the technology into the supply chain management of any institutional libraries. Training and prevention mechanism have to be in placed in order to protect the technology before any attacks from exploiters, worms and viruses.

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