Utilizing Radio Frequency Identification in Libraries:
The Case of Qatar

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ABSTRACT

Nowadays, RFID technology is widely being used in libraries across the world. This study is in line with global literature pertaining to the implementation of RFID technology in libraries and intends to explore and examine the perceptions of employees from two libraries in Qatar. Data was collected from both staff and managers using two separate surveys. The perceptions of both sets of employees were analyzed and compared to highlight the differences in benefits, drawbacks, and issues concerning the implementation of RFID in contrast to barcode. 'Shelf management of resources,' 'perceived RFID contributions,' and 'workplace efficiency' were the top 3 rated dimensions pertaining to the use of RFID. Additionally, 'increased customer satisfaction' was rated the highest among the reasons as to why RFID is adopted in libraries and the fact that all negative decision determinants were moderately perceived when compared to the positive ones indicates the overall positive attitude of managers in these libraries towards RFID technology. Further conclusions and future work are proposed at the end of the study.

1. INTRODUCTION

The concept of Radio Frequency Identification (RFID) first came into existence in the year 1983 when Charles Walton was awarded the first patent associated with the abbreviation RFID. Since then, the use of RFID technology in modern day business has become highly popular and it is considered to be the newest identification technique among all Internet of Things (IoT) technologies (Kadlec et al. 2014).

RFID, also known as electronic tag (E-Tag) technology, is a non-contact automatic identification technology. Cheng et al. (2016) state three main characteristics of RFID: it is an automated identification and management technology based on non-contact data acquisition; any amount of input can be fed thereby meeting the demands of continuously growing quantity of information and high processing speeds; and it is very fast in recognizing targets. Kantareddy et al. (2017) affirmed

that with its low cost and low maintenance characteristics, RFID has emerged as an important asset tracking tool in a number of industries.

RFID was introduced in libraries as the aftermath of the development of computer technology and microelectronics. The possibility to amalgamate the functions of two widely used systems, viz., the barcode and anti-theft systems, made RFID more enticing for libraries (Timoshenko, 2016). Gupta and Madhusudhan (2017) claimed that RFID implementation in library related services made the processes more efficient and benefited both library professionals and customers, as compared to an accustomed technology such as barcode. For instance, staff can be free from performing manual tasks that are usually time consuming and can be used to enhance user-services instead (Jadhav et al., 2017).

During the period 2002-2014, China, with a contribution of over 17%, was leading in research on "RFID Technology and Libraries" among all other nations globally, followed by USA, Japan, Taiwan and India (Singh, Dhawan & Gupta, 2016). Barely any research was conducted in Qatar regarding the same as RFID was introduced in Qatari libraries only in late 2017. This paper aims to be one of the first research papers on the topic in Qatar that focuses on understanding the application of RFID technology, exploring both its benefits and drawbacks and reporting the success of implementation in the country. As the implementation of such technology is new in Qatar, it is vital to understand its challenges and benefits and direct decision-makers toward the best strategic alignment of such technology.

The paper is divided into two parts: first, introduce the concept of RFID technology and link it with library application, perform extensive literature review to comprehend the advantages and disadvantages of RFID application and identify ethical issues concerning the privacy of customers who use this technology. Second, the perceptions of library employees toward RFID implementation are explored based on empirical analyses and tests. Two sets of surveys were used to collect data from staff and managers in the two libraries that implement RFID in Qatar. In the end, the limitations faced, and recommendations are stated as part of the conclusion.

2. LITERATURE REVIEW

2.1. RFID Overview

RFID is a form of identification technology growing in ubiquity in the library sector. Its ability to identify objects automatically without the need of line-of-sight proximity has helped the technology grow tremendously over the recent past (Mishra et al., 2015). The technology holds notable assurance for ameliorating the experience of library users and staff, and possesses high potential to increase operational efficiency in libraries.

The concept of automatic identification implies the input and recognition of data (could be RFID data, magnetic-cards, bar-codes) automatically through the amalgamation of software and hardware without any human intervention (Fujisaki, 2015). As far as RFID is concerned, identification is done through multiple methods, the most frequently used method being its association with a human or object through the form of a physical tag (Yusof & Saman, 2016).

Berek (2016) described the three basic elements of an RFID system as the RFID tag (passive, semi-passive or active), RFID reader (read only readers, writer/reader devices or smart/intelligent readers) and anti-theft detection gates. Each element plays a crucial role in the functioning of the system and a defect in any one element could deem system failure. The radio transponder and receiver, commonly called the tag and reader, transmit information over a radio frequency connection and RFID applications that use the transmitted information are hosted on servers connected to the reader via wired or wireless networks (Muthuselvi, 2016).

A passive tag has no battery and operates based on the radio energy transmitted by a reader, while a semi-passive tag is battery-assisted and an active tag is entirely run by an external power source (Jain & Krishna, 2014). Alwadi, Kilby and Gawanmeh (2017) claimed that the most commonly

used RFID tags in library systems are the ultra-high frequency (UHF) passive tags as they present the lowest unit cost and are preferred for bulk applications. The UHF band has a frequency range of 860-930 MHz, a passive read range of 3 metres and is widely used in library book tracking, supply chain tracking and warehouse management.

RFID readers can be categorized as fixed readers such as those mounted on the doors of libraries, or movable readers such as hand readers. Available in various shapes and sizes, these readers have multiple operational frequencies and offer a wide range of features. Certain readers possess their own processing power, internal memory and also provide wireless network connectivity (Ghate & Patil, 2017).

The anti-theft detection gates equipped with electronic article surveillance (EAS) are placed in entrances and are critical in any kind of theft protection system. In the case of libraries, the gate also acts as a reader device that detects EAS armed RFID tags and triggers audio and visual alarms. Like any reader, these gates record patron count, support remote monitoring and parameter settings and support read and write of RFID tag data while passing through (Vishwakarma & Yadav, 2014). Once RFID tags come within a relatively close proximity of the RFID reader, a signal is transmitted by the reader that examines the tags. Upon receiving the signal, the tags respond with unique serial numbers through which they are identified. The reader then captures these signals and transmits it the host computer software system for processing the data (Li et al., 2016). Guo et al. (2014) claimed that as UHF-RFID technology is developing, more and more academic libraries have noticed its development potential and begun implementing it widely. The authors opined that unified data model standards need to be developed by international bodies to standardize operations and help organize the market.

With a growing market for RFID technology in libraries, the International Organization for Standardization (ISO) established a standard (ISO 28560-1:2014) that specifies a model for the use of RFID tags on all type of materials used by libraries, whether national, public, academic, corporate, special or school libraries. The standard offers a framework "to ensure interoperability between libraries that exchange library items with RFID tags, the freedom of the library to acquire or renew equipment or library items from different vendors, and interoperability of a single RFID application from the vendor's perspective".

2.2. RFID's Advantages in Libraries

Before implementing any new technology, it is vital to understand the pros and cons of the technology. Previous researches have resulted in numerous benefits for implementing RFID technology in libraries. These advantages depend on the nature of the library, size in terms of area occupied, amount of staff employed and the average number of customers.

Yusof and Saman (2016) studied the perceived benefits of adopting RFID in libraries and categorized their findings in four categories: fast tracking, efficient shelf management service, efficient shelf service and improved security levels. Fast tracking includes finding books faster, scanning books efficiently, tracking inventory and efficiently locating and managing library material (Kulbhaiyya & Bhuyar, 2016). Efficient shelf management service relates to the ability to handle large volumes of books, automated handling of material and higher speeds in managing inventory (Sahoo & Sharma, 2015). Automation could be accomplished by using robots, conveyors and sorting systems to move materials and categorically sort them, thus reducing the time taken by staff for re-shelving (Hasan, 2014). Self-service for borrowing and returning books (Sigwald, 2016), faster circulation, expedited processes and the ability to support enquiries, reservations and integration with information systems and anti-virus protection are few characteristics of efficient shelf service.

Gopinath (2017) suggested a significant advantage of the self-check system is that library users can drop off books during non-working hours of the library, thus making it more convenient for both parties. Security levels are improved through the use of anti-theft detection gates, thereby eliminating the need of human security personnel and CCTV camera footage. Ali (2017) asserted that technology

systems like RFID render useful in identifying security patterns and ensuring effectiveness of security measures in the protection of library material.

RFID has several advantages over barcode. For instance, in the case of barcodes, a direct line of sight is required along with human intervention to scan the barcode, which is not the same in the case of RFID (Khor et al., 2015). Barcodes do not possess read/write memory, scanning and reading is time consuming as it happens one by one, direct visibility is important, it has a lesser read range and can accommodate limited data, the presence of an obstacle in the line of sight or external factors such as moisture, dirt and abrasion can impair the readability of the barcode (Vimalraj et al., 2015). RFID technology easily overcomes all these issues and enhances the efficiency of the system to a great extent. Other advantages identified by Roper et al. (2015) include high data capacity, the option of reusing tags, higher durability, continuous tracking and automatic data recording, inventory counting and inventory reordering. In terms of non-technical advantages, Hassan and Hussein (2017) claimed that RFID is more reliable and economical, and it reduces the cost and effort required in carrying out day-to-day operations in the library.

2.3. RFID's Disadvantages in Libraries

Albeit RFID has several advantages, the technology comes with certain drawbacks. These downsides to the technology could avert libraries from implementing it regardless the benefits it offers. Along with the advantages of RFID, Yusof and Saman (2016) also studied the perceived disadvantages of adopting RFID in libraries. The authors defined six main barriers: ineffectiveness, interference, standardization, cost, privacy & security and technology integration.

Along with the advantages of RFID, Yusof and Saman (2016) also studied the perceived disadvantages of adopting RFID in libraries. The authors defined six main barriers: ineffectiveness, interference, standardization, cost, privacy & security and technology integration. Ineffectiveness attributes to compatibility issues between the tags and readers, the availability of adequate hardware and frequency ranges. Interference refers to environmental and situational factors such as disturbances caused due to the presence of metal or mist, high moisture levels in the atmosphere, incorrect antenna positioning, or when there is more distance between the tag and reader (Abu-Shanab & Yamin, 2014). Reader collision due to coverage overlap and the possibility of other electronic items getting affected due to transmission from the reader/security gates also result in interference problems. For example, if two users are checking out at the same time and are standing very close to each other the reader might detect the tags of books of the wrong person (Mehrjerdi, 2011).

Standardization is difficult because library materials and equipment need to be aligned with RFID systems depending on the varying operational standards and regulations in each country (Singh & Mahajan, 2014a). A major challenge with implementing RFID in libraries is the high cost associated with it (Singh & Mahajan, 2014b). In comparison to its counterpart barcodes, setting up an RFID system is much costlier and hence good quality tags must be used to avoid frequent removal of exposed tags. Another major concern is privacy since RFID readers are capable of detecting all kinds of customer and employee activities including browsing, reading and other actions. Other disadvantages include difficulty in integrating existing library systems with RFID and the lack of knowledge among employees in dealing with operational problems during day-to-day activities.

Vulnerability to compromise is a major concern. RFID systems can be compromised by either placing two items against each other in such a way that one tag overlays the other, or wrapping the tag with household foil to block the radio signal transmission (Singh & Mahajan, 2014a; Sahoo & Sharma, 2015). Moreover, RFID tags are typically affixed to the inner side of the back cover of books which can be removed easily (Rathee & Kaushik, 2011).

Chelliah, Sood, and Scholfield (2015) claimed that a risk associated to the implementation of RFID in an academic library is the costly indigenization or customization of existing technology to suit the academic context. University officials will have to work on various customization initiatives

to ensure effectiveness. However not all academic institutions may have the high-caliber technical staff required for this to happen, thereby increasing costs through outsourced technical assistance.

RFID integrated self-service stations enable users to save time by skipping long queues at the manually operated service desks. However, if these service terminals are complicated to use and take longer to process requests, it might have a negative impact on the attitude of users thereby adversely affecting user experience (Kapoor et al., 2014). Lack of awareness about the system as it is relatively new in the country could affect the comfort levels of users. Thus at least for the first few times existing users should be encouraged to involve and understand the functions of the new system.

2.4. The Ethical Aspect of RFID Usage

During the past decade, the implementation of RFID technologies by numerous kinds of organizations in different sectors, particularly in the case of libraries, has raised many ethical issues. The adoption of RFID led interest groups, professional associations and related legislative entities to confront these issues by creating alternate solutions in order to protect rights of individuals and organizations, as well as the environment.

As discussed in the previous section, a negative aspect of this technology is the issue concerning privacy of individuals. Hu and Harris (2016) claimed that economic benefits may be sidelined due to social, security and privacy concerns as some customers referred to RFID technology as a "spyware." The authors also discussed concerns related to the environment such as electromagnetic radiation in the workplace and contamination of RFID tags.

In general, the issue of invading individuals' privacy can adversely affect library users' decisions if they feel that their location can be tracked or information regarding the various activities performed by them is under the possession of library authorities, or even worse, a third party. Ferguson et al. (2015) recommended in particular that libraries adopt the 'Precautionary Principle' laid out by the Library Technology and Privacy Advisory Committee of San Francisco Public Library in order to tackle this issue.

With respect to a third-party collecting data illegally, Al-Sebae and Abu-Shanab (2015) suggested that libraries could use random numbers or timestamps to prevent tracking of user's location information, and produce changing values to prevent attackers from accessing significant data even if they acquired it. Pratt & Zhong (2016) further asserted that denying third parties' access to data is not the only way data can be secured. Data confidentiality can be maintained if transmission occurs without a third party being able to interpret the data, such as through the use of encryption.

According to Turri, Smith, and Kopp (2017), regulatory efforts were carried out by various consortiums to manage privacy issues in the United States, Canada, Japan and the European Union. For instance, these efforts resulted in developing the guidelines and laws that derived from the FIP (Fair Information Practices) to protect individuals privacy through several practices like consumer education, limiting data collection, preventing tracking behavior without consent, ensuring anonymity and providing timeline for data expiration.

Assessing benefits and ethical challenges of implementing RFID technology becomes significant in many fields. There is no doubt that decision makers should consider trade-offs, because there is no fixed formula to solve ethical dilemma optimally. In a general case, citizens cannot refuse to provide data if required by the government, and the data collected by a government agency would offer serious threats if shared among third parties (Hossain & Dwivedi, 2014). Therefore, ethical issues need to be evaluated carefully from different aspects to guide organizational behaviors toward morally accepted actions. To address ethical issues, worldwide legislative organizations and professional association like the International Federation of Library Association (IFLA) played a major role to in formulating rules and standards to protect patrons' privacy and to enable organizations to utilize from such technologies in an appropriate way.

3. RESEARCH METHODOLOGY

This paper is focused on outlining the environment of RFID technology and the issues faced with its implementation in libraries. With an extensive literature review to solidify the understanding of RFID implementation in libraries along with its advantages, disadvantages and ethical implications, the study aims to explore the views of employees and managers who utilize this technology on a daily basis. This will be accomplished by answering the following questions:

- What are the pros and cons of utilizing RFID technology in libraries?
- What are the drivers that influence the decision to adopt such technology?
- Is there a difference in opinion between the perceptions of employees and managers with regards to RFID implementation in libraries?

Through this type of exploratory research, the research methodology focusses on answering the research questions in a descriptive manner without having to test specific hypotheses.

3.1. Context of the Study

The research focused on data collected from two libraries in Qatar: the Qatar National Library (QNL) and the library at Qatar University (QU Library). Qatar National Library's primary purpose is to collect and preserve the country's national heritage through recorded history and make this information available for all who seek to learn more about the country. Apart from being a prominent figure in exhibiting the country's heritage through books and other full-text online resources, QNL also fosters and promotes global insight into the culture and history of the Gulf region. The library has more than one million books, more than 500,000 e-books, newspapers, periodicals and special collections available to all Qatari residents with equal access. Being a public library, QNL seeks to empower individuals and promote life-long learning and knowledge transfer by providing support to students, researches and the general public.

Qatar University (QU) library is part of the university that provides high quality information to all members of the QU community. The university comprises of 9 schools all located within the same campus in Doha. The library has an extensive collection of books in both print and digital format. In addition to the vast collection available, the library subscribes to scholarly databases in all relevant areas of study within the different schools in the university so as to equip students and staff with the required information to conduct in depth research and self-development.

3.2. Survey Used

This study utilized a survey that was distributed to employees of the two libraries as respondents. These libraries have been selected since they are the only two libraries within the country that have implemented RFID technology. Two separate surveys addressing key aspects of RFID implementation were developed and distributed to employees of the aforementioned libraries, both staff and managers, in order to collect data. The first survey addressed the perceptions of employees regarding RFID utilization and the second survey addressed specific issues related to RFID implementation in addition to exploring perceptions of managers with respect to RFID utilization in libraries. The data collected from both sets of surveys were compared and analyzed to address the research questions stated above. The survey was developed by the researchers based on extensive review of literature. The first survey was distributed to employees (non-managerial) in both libraries, and the second survey was distributed only to managers in both libraries.

The employees' survey consisted of three sections; an introduction, demographics of the sample and a total of 31 items measuring the 5 main variables related to the perceptions of employees with respect to the contributions of RFID technology in libraries. The managers' survey included the same

three sections used in the employees' survey, and a fourth section which measured 10 positive and 5 negative factors that influence the decision to implement RFID in libraries.

Section 3 in both surveys which included the items measuring the 5 main variables concerning contribution of RFID was measured using a 5-point Likert scale (1 = strongly disagree, 2 = somewhat disagree, 3 = neither agree nor disagree, 4 = somewhat agree, 5 = strongly agree). Section 4 of the managers' survey which included positive and negative factors influencing decisions to implement RFID was also measured using a 5-point Likert scale, but with different interpretations (1 = not at all important, 2 = slightly important, 3 = moderately important, 4 = very important, 5 = extremely important). Finally, the common practice in social sciences for the 5-point Likert scales considers a mean ranging between 1-2.33 as low mean, 2.33-3.66 as moderate, and 3.66-5 as high.

3.3. Sample of the Study

In order to collect information for the study, the surveys were distributed to all employees and managers who work directly or indirectly with the RFID technology installed in the two libraries. A total of 17 surveys (12 employees and 5 managers) were collected from Qatar National Library and a total of 11 surveys (9 employees and 2 managers) were collected from Qatar University Library. The demographics of the sample are shown in Table 1.

4. DATA ANALYSIS AND DISCUSSION

Our literature review reached a set of factors that demonstrate the overall status of the use of RFID in libraries. The items used in the survey represents the factors contributing to five major dimensions that describe the status of the study. This study tried to answer the research question using a set of statements that describe how subjects perceived the use of RFID in libraries. It is important to first estimate the means and standard deviations of the set of items constituting the five dimensions. The following tables depict that. In the discussion around the status of a scale value, social sciences research adopted the following classification to evaluate the agreement/disagreement with the item when using a 5-point Likert scale: values from 1-2.333 are considered low, values from 2.333-3.666 are considered moderate, and values from 3.666 and 5 are considered high (Hammouri & Abu-Shanab, 2018).

Table 1. Sample demographics

Demographic Factor	Qatar National Library		Qatar University Library		Total
	Employees	**Managers**	**Employees**	**Managers**	
Gender:					
• Male	7	2	1	1	11
• Female	5	3	7	1	16
Age:					
• Less than 20 years	0	0	0	0	0
• 20 – 40 years	7	2	6	0	15
• More than 40 years	5	3	2	2	12
Work Experience:					
• Less than 5 years	1	0	1	0	2
• 5 - 15 years	7	1	7	1	16
• More than 15 years	4	4	0	1	9

Note: Only one survey did not include demographic information

4.1. RFID Use Dimensions

The data in Table 2 indicates that all statements were perceived highly except the last three (negative ones). The high value supports the utility of RFID use in tracking and maintaining security of articles and users. Still, when inspecting the negative items, we can see that subjects did not extremely object, but did not agree. Considering that such mean is an accurate consensus of subjects around the items, they proclaimed that their perceptions of privacy, interruptions, and coverage might be doubtful. The last three items can be secured by raising awareness regarding such issue and demonstrating to users the techniques used to protect privacy, and prevent such interruptions to happen.

To accommodate the negatively stated items, we recoded them to estimate the total mean of the dimension. The values were replaced according to the following scheme: $1 \rightarrow 5$, $2 \rightarrow 4$, $3 \rightarrow 3$, $4 \rightarrow 2$, and $5 \rightarrow 1$. The highest item mean was 4.36 (TS4 - with the highest consensus among subjects (based on the standard deviation value, 0.687). Subjects asserted the high security contained in the RFID systems. On the other hand, the lowest item was TS5 (Mean = 2.82, negative, and a high standard deviation). Such standard deviation might indicate a limitation regarding the mix of negative/ positive items.

After this step, we estimated the total mean of the items included in the survey under each dimension (example, the mean of TS dimension included the mean of the following items: TS1-TS7). The estimates are shown in Table 7, where the first-dimension mean was in the top moderate category (TS mean = 3.648). Table 7 estimates of the standard deviation show that all of them were low in value, which makes sense after recoding the negative values and estimating the total means (reducing the effect of mixing +ve/-ve items).

The second dimension analyzed was the shelf management of resources (SM, shown in Table 3), where all items demonstrated a high agreement with the statement posted. All mean values were above 4.2, with small standard deviation (more consensus on the agreement). The overall dimension mean was 4.405, which indicates the extreme agreement with the item statements and the contribution of RFID to the resource management.

Using RFID is known for managing resources, while previous research indicated that it improves efficiency based on its contribution toward less load on staff because of self-lending, faster transaction, and book drop-off. Our data indicated a high perception regarding all items except for decreasing the number of employees (WE4 - moderate). On the other hand, the only negative item (WE7) yielded a low estimate, which means a disagreement but in a moderate level. It is important to realize that both items (WE4 & WE7) are related to job loss. It looks like employees are not feeling threatened by the implementation of RFID, but not to the extent of perceiving it highly safe on their jobs.

Table 4 shows the data described. It is also important to comment on standard deviation, where for the third factor, moderately perceived items are associated with the highest standard deviations,

Table 2. Item descriptive statistics for the Tracking and Security (TS)

Code	Item Description	Min	Max	Mean	Std. Dev.
TS1	RFID tags on books, DVDs etc. can be tracked easily	1	5	4.14	1.008
TS2	A direct line of sight is not required to detect RFID tags	1	5	3.86	1.145
TS3	Protect library material from theft and damage	2	5	4.14	0.891
TS4	Information security is better with RFID	3	5	4.36	0.678
TS5	RFID risks privacy of customers*	1	5	2.82	1.156
TS6	Presence of metals can cause interference*	1	5	3.11	1.066
TS7	Reader collision due to coverage overlap*	1	5	3.04	1.319

*. Statement in negative direction N=28

Table 3. Item descriptive statistics for the Shelf Management of resources (SM)

Code	Item Description	Min	Max	Mean	Std. Dev.
SM1	Better inventory control	3	5	4.61	0.567
SM2	Managing material on shelves more efficiently	3	5	4.54	0.576
SM3	Reduce percentage of material loss	3	5	4.32	0.723
SM4	Make more information available	2	5	4.21	0.876
SM5	Ability to support enquiries, reservations and integration with information systems	3	5	4.25	0.752
SM6	RFID enhances automation within the library	3	5	4.50	0.745

N=28

Table 4. Item descriptive statistics for the Workplace Efficiency (WE)

Code	Item Description	Min	Max	Mean	Std. Dev.
WE1	RFID enables self-service for borrowing and returning books	2	5	4.50	0.694
WE2	Book drop-off during non-working hours of library	2	5	4.32	0.819
WE3	Reduced workload (repetitive tasks) of library staff	2	5	4.36	0.826
WE4	Decrease the number of employees needed	2	5	3.57	0.920
WE5	Can lend more than one item with RFID	3	5	4.46	0.744
WE6	With RFID, borrowing and returning is faster and more accurate	3	5	4.61	0.567
WE7	RFID implementation can lead to loss of job for employees*	1	5	2.64	1.367

*. Statement in negative direction N=28

which indicates a dispute among our sample. The overall mean of the dimension (WE mean = 4.168) indicates that the study subjects highly perceived the contributions of RFID to the workplace efficiency (with a low standard deviation = 0.507).

The cost of RFID tags prevented many industries from using them. It is important to realize a value from using RFID tags as it is not logical to tag an item worth less than a dollar with a tag similar to its monetary value, especially when you cannot in many cases collect back the tags and reuse them. Tags longevity represents such concept, where the more you use the tag, the more it become cost-effective. Table 5 shows our selected items for this dimension, where means values are lower than expected and all in the moderate level except for PL3 (data capacity related). It looks like our subjects perceive RFID tags to be reusable, durable, and healthy but in a moderate level. All standard deviations were above 1, which aligns with our previous claim. The overall mean of PL was 3.336 (readers need to note that this is a transformed mean, which corresponds to a positive perspective).

Before discussing how libraries decide on adopting RFID or not, and the factors influencing such decision, we need to focus more on the contribution of RFID. Table 6 lists six major contributions to RFID related to operations, and customer interactions. It was important to ask subjects about the contributions of RFID tags regardless of the reasons that influenced their decision to adopt such technology. All items were highly perceived with mean values more than 3.93, and varying standard deviations. The highest value for standard deviation was not the lowest mean (PC4-related to the balance between benefits and drawbacks.) The highly perceived items were close to each

Table 5. Item descriptive statistics for the Perceived Longevity (PL)

Code	Item Description	Min	Max	Mean	Std. Dev.
PL1	RFID tags are reusable	1	5	2.64	1.367
PL2	High durability	1	5	3.46	1.105
PL3	High data capacity	1	5	3.75	1.206
PL4	RFID can cause health problems*	1	5	2.32	1.188
PL5	Varying operational standards and regulations in each country make standardization difficult*	1	5	2.86	1.008

*. Statement in negative direction N=28

Table 6. Item descriptive statistics for the Perceived RFID Contributions (PC)

Code	Item Description	Min	Max	Mean	Std. Dev.
PC1	RFID positively contributes to the library operations	3	5	4.32	0.723
PC2	RFID technology added great value to our operations	3	5	4.29	0.713
PC3	Work is more easier and better with the implementation of RFID	3	5	4.36	0.731
PC4	RFID benefits exceed its drawbacks	1	5	4.00	1.122
PC5	RFID implementation has enhanced effective customer interaction	1	5	3.93	0.858
PC6	Overall, I am satisfied with the usage of RFID in the library	2	5	4.36	0.951

N=28

other in mean values (PC1, PC2, PC3, PC6 (ranged from 4.29-4.36)). The overall contributions of RFID technology in libraries are highly perceived by subjects, where the mean value was 4.208 (standard deviation = 0.707).

4.2. Why Adopt RFID Technology

The previous section discussed how our sample reacted towards the major dimensions of RFID use in libraries. The decision to adopt such technology is related to library managers more than employees. Based on that we used an extended survey for managers, where two extra sections targeted the positive and negative influencers of RFID. The first section included 10 positive drivers that influenced managers when deciding to adopt RFID technology. Managers' perceptions also followed a 5-point

Table 7. Variable descriptive statistics (means of all included items)

Code	Variable Description	Minimum	Maximum	Mean	Std. Dev.
TS	Tracking & Security (TS)	2.286	4.571	3.648	0.527
SM	Shelf Management of Resources (SM)	3.167	5	4.405	0.573
WE	Workplace Efficiency (WE)	3	5	4.168	0.507
PL	Perceived Longevity (PL)	1.6	4.6	3.336	0.673
PC	Perceived RFID Contributions (PC)	2.167	5	4.208	0.707

Likert scale but ranging from "not at all important" to "extremely important". Table 8 shows the results of the positive decision determinants (PDD).

Al items showed high perceptions, where subjects indicated that all items were extremely important when deciding to adopt RFID technology. The responses were collected from the managers' survey (only 7 in total), which makes the variation between responses more difficult to capture. Thus, we can see that Table 8 included more than one similar mean value. Still, ranking them might demonstrate a better image of such decision. Four graduated colors were used in the table to demonstrate the differences.

The most influential item was related to customer satisfaction, while two items were the lowest (PDD2-to stay updated with the latest technology & PDD5- to improve work efficiency and accuracy). It is also important to note that all items possessed a minimum value of 3, and a maximum value of 5. Finally, we can see that all standard deviations are less than one.

The last segment of our data collection is the negative set of items that would influence the decision to adopt RFID technology. Table 8 indicates that all items were moderately perceived (moderately important in the decision). Such result indicates (when compared to the positive ones) the overall positive attitude towards RFID technology. Table 9 depicts the data related to NDD.

Table 8. Item descriptive statistics for the Positive Decision Determinants (PDD)

Code	Item Description	Min	Max	Mean	Std. Dev.
PDD1	Wide international use	3	5	4.00	0.816
PDD2	To stay updated with latest technology in the market	3	5	3.86	0.900
PDD3	Solve problems related to customer service	3	5	4.00	0.816
PDD4	Save time and effort of employees	3	5	4.00	0.577
PDD5	Improved work efficiency and accuracy	3	5	3.86	0.690
PDD6	Improved decision making	3	5	4.00	0.577
PDD7	Protect library material from damage and misuse	3	5	4.14	0.690
PDD8	Increased safety and security	3	5	4.14	0.900
PDD9	Implementation and usage are relatively easy	3	5	4.14	0.900
PDD10	Increased customer satisfaction	3	5	4.29	0.756
PDD	**Overall - Positive Decision determinants (PDD)**	**3**	**4.8**	**4.043**	**0.665**

N=7

Table 9. Item descriptive statistics for the Negative Decision Determinants (NDD)

Code	Item Description	Min	Max	Mean	Std. Dev.
NDD1	RFID technology has bad health influence*	2	5	3.14	1.069
NDD2	High cost compared to other methods*	3	4	3.29	0.488
NDD3	Negative influence on privacy of information*	2	4	2.71	0.756
NDD4	RFID technology increases unemployment rates*	2	3	2.71	0.488
NDD5	Vulnerability to compromise RFID tags*	2	3	2.57	0.535
NDD	**Negative Decision determinants (PDD)**	**2.2**	**3.6**	**2.886**	**0.540**

*. Statement in negative direction N=7

4.3. Different Perceptions

This study tried to utilize the data collected and try to explore if any differences are accounted to certain category. The differences can be estimated for similar items/variables. Such argument is valid only on the employees' survey sections. We conducted an ANOVA test to compare the means of different categories of respondents. The ANOVA test was first done on three categories (position, gender and age) to see if any differences exist. The results shown in Table 10 indicate that all mean comparisons yielded insignificant results except in one case (TS mean difference with respect to position). The estimated mean for employees = 3.597, and managers = 3.625, indicate higher perceptions of security and tracking dimensions for managers than employees. Such means represent moderate perceptions but at the upper edge. A similar test was done for experience in addition to the three categories and no significant results were estimated. The test results did not require extra post hoc analysis as all results were insignificant.

5. CONCLUSION AND FUTURE WORK

This study utilized a survey as the major tool to answer three research questions related to the use of RFID in libraries in Qatar. The survey probed perceptions of managers and employees working in QNL and the library of QU. Their opinions and reflections on the survey formulated our image of such experience (using RFID technology in libraries). The first research question is related to the pros and cons of using RFID technology in libraries. The answer to this question comes from analyzing five dimensions of RFID use, namely – Tracking & Security (TS), Shelf Management of Resources (SM), Workplace Efficiency (WE), Perceived Longevity (PL) and Perceived RFID Contributions (PC). While TS and PL were rated moderately, the remaining three SM, WE and PC were given a high rating pertaining to the use of RFID.

The second research question focused on the drivers that managers feel important when adopting RFID technologies in the libraries. This part utilized only managers' sample and listed 10 positive drivers and 5 negative drivers. All drivers listed were considered to be highly important with 'Increased Customer Satisfaction' being rated the most influential of them all. Moreover, each of the 5 negative drivers were perceived to be moderately important in the deciding whether or not to adopt RFID. This shows an overall positive attitude towards RFID technology. Results also indicated a support for the list by our sample and indicated differential importance (as shown in Tables 8 and 9).

The third research question contrasted the opinions of employees against managers in relation to the dimensions of this study. Except for the tracking and security dimension, results indicated no differences in all conducted comparisons (even for gender, age, and experience).

Table 10. ANOVA test for means comparison for position, gender, age and experience

		Position		Gender		Age*		Experience	
		F	Sig.	F	Sig.	F	Sig.	F	Sig.
TS	Tracking & Security (TS)	5.08	0.03	0.02	0.89	0.00	0.95	0.28	0.76
SM	Shelf Management of Resources (SM)	2.45	0.13	0.52	0.48	0.20	0.66	0.02	0.98
WE	Workplace Efficiency (WE)	0.07	0.79	0.06	0.80	0.20	0.66	3.06	0.07
PL	Perceived Longevity (PL)	0.12	0.73	0.25	0.62	0.19	0.67	1.56	0.23
PC	Perceived RFID Contributions (PC)	0.00	0.98	0.06	0.80	0.18	0.68	3.17	0.06

*Only two categories N=27

This study suffered from a limitation related to the sample size. The researchers would recommend conducting a larger scale study that would confirm the results of this study and improve our understanding of such technology. Even though our comprehensive and thorough literature review formulated the foundation of the survey used and the set of factors comprising it, we believe that future research will bring more issues related to RFID technology and its use in different industries and in libraries in specific.

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