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Implementation of RFID Technology in Managing Health Information in a Hospital

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ABSTRACT

Objective: This paper identifies the necessity for an RFID based technology that increases the management in hospitals.

Problem: The following paper discusses the current issues faced by hospitals with traditionally based system and shows the effectiveness of implementing RFID systems in hospitals. Similar systems that utilize RFID in hospitals are explored and analyzed on their efficiency in managing health information systems. Data was also collected from various government and private hospitals to further understand the current state of technology being used to manage systems.

Key Words: RFID, Hospitals, Healthcare, AIDC, Patient, Information System

INTRODUCTION

With the increasing number of population and patients worldwide, patient safety and record management have become a peak in public health concern, according to a research done, it is estimated around 42.7 million events out of 421 million hospitalizations with medical errors^{1,2}. With the statistics from the World Health Organization, it is stated that patients being harmed due to medical errors are within 1 out of 300. With the ongoing development in health care, doctors in health care facilities are seeking ways to serve patient's needs cost-effectively and securely. Based on the research conducted by Omar et al., applications and systems to track patient's data has been developed and implemented into the operations of hospitals³. The main problem that arises from this is the lack of features within the patient management system that retrieves data from the patient's information and history. With the high number of patients being admitted in hospitals this day, it is a hassle for staffs to manage and record details of patients⁴.

In this research, a better understanding of how Radio Frequency Identification (RFID) technologies can be used to build organized and smarter healthcare by reducing human errors.

The second section of the paper will explore the data that was collected from hospitals to better understand the current

system being used in hospitals. The results of the data will be discussed further to better understand the reasonings.

Literature Review

Introduction to Radio Frequency Identification (RFID)

The researcher has read over 10 books and research papers that are heavily focused on the areas of RFID and Hospital management system to get a better overview on the concept of implementing a health management system with RFID into hospitals.

Based on the papers researched, RFID is a technology that could interconnect between a range of multidimensional applications to reduce the complexity of today's life. According to Turcu et al., RFID is wireless Automatic Identification and Data Capture (AIDC) that enables the identification of living and nonliving entities⁵. This concept of identification could be applied to a wide range of tasks in everyday life to increase the efficiency of reading and retrieving information. When compared to barcode scanners, RFID is effective due to factors such as the proximity of the RFID chip and the scanner. RFID requires a close range and does not require a scanner which has a laser. Furthermore, RFID chips could contain more information compared to the barcode. This is due to the architecture of RFID chips which allows informa-

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tion to be stored. RFID could also allow the use of reading more than one item at once. This increases the efficiency in retrieving information and saves time for users.

RFID systems exist by breaking it down to 3 separate components. The first component is the RFID chip or tag. RFID tags consist of 2 types which are passive and active, depending on the type of the RFID tag it functions differently from the other¹. Passive RFID tags have no internal power source as described by Moutaz et al. These tags are dependent on readers which contributes to it being the power source. The RFID readers that comes along with passive tags contains a power source. Active tags are the direct opposite of passive tags. Active tags contain a power source which is embedded within the RFID chip. These tags emit their signal and have a higher range when compared to passive tags. This tag is considered as a suitable tag used for real-time reading and tracking^{6,7}. Table 1 below shows the types of RFID. The next component that exists within an RFID system is the RFID reader.

Table 1: Differences in types of RFID chips

Type of RFID Chips	Power Source
Passive	Dependent on the reader
Active	Battery Powered

The RFID reader is crucial as it allows the contact points between the RFID chip to be communicated with the entire RFID system. Readers allow records to be read and written onto. Readers function as a wireless mechanism to contact with the RFID chip, chips must be placed on top of the pad which allows the process of communication. The final component of an RFID system is the middleware. Middleware could be considered as a database which stores information regarding the RFID chip. This acts as a hub that fetches information to be displayed to the user^{6,7}.

RFID In Healthcare

Based on the study conducted, medical and human errors could potentially cause 42.7 million medical events every year¹. This translates to the need for an alternative system to greatly reduce these events to prevent any great problems from arising that could harm the patient's health and safety. With the technology of RFID, it has the potential to ease the tasks of medical professionals in departments. The application of RFID in healthcare will be explored in the next section.

Patient Identification

According to a study done by Yao and Aguilar, misidentification of patients is one of the main factors that causes medical errors in hospitals and imposes a huge risk to patient's safety⁸. With the help of RFID technology, patient identification

systems could be directly embedded into a form of a wristband or a badge that could be pinned onto the patient's robe. Passive RFID chips could be used as it would prevent any sensitivity issues with the usage of batteries within the RFID tag. As suggested by Moutaz Haddara et al., RFID tags could contain relevant information for medical staff to obtain such as blood type, date of birth, allergies and medications¹. Several studies suggested this could reduce the amount of time required for medical staff to search through records^{2,3,9}. This would ultimately save time and issues fetching wrong records. Based on a specific study conducted, patient identification using RFID tags could reduce issues relating to mismatching between the baby and the mother⁵. This concludes that RFID tags could be provided to certain wards depending on the volume of patients. Some studies also suggest that this data could also be used to build a real-time patient identification system. This will allow medical professionals to monitor the location and admission status of patients in hospital wards^{3, 6, 10}. Real-time systems with patient identification would also assist doctors to keep track of special medication of patients.

Inventory and Patient Tracking

Based on a short study done by Bridge Project, RFID could be associated with the usage of tracking assets and inventory inside hospitals. Table 2 shows more than 200 million tags would be needed for use in the healthcare and pharmaceutical industry by 2022. This could provide a great overview of tasks such as monitoring medical supplies, logistical tracking and tracing of patients. Without needing features such as barcodes, RFID could assist in notifying medical staff on quantities of drugs stored in inventory. This improves inventory management and decreases the amount of time needed to manage inventory. Likewise, using RFID for inventory management also could prevent issues such as theft of drugs in hospitals. According to a case study done in a Romanian Medical sector, issues relating to theft and counterfeiting are an all-time high and with the implementation of (Internet of Things) IoT devices would pose a solution to fix this problems⁵. The case study also proposed a system called VITAL-IS (Internet of Things based Health Information System). This system would allow real-time monitoring and information management of objects, patients and staffs.

Table 2: Projected adoption rate of RFID tags in medical facilities

	2007	2012	2017	2022
Total RFID tags (in Millions)	8	352	1720	6740
-on Hospital assets	2	98	190	320
-on laboratory Supplies	1	8	30	40

Table 2: (Continued)

	2007	2012	2017	2022
-on drugs	5	246	1500	6380
Location with RFID Readers	110	2770	11.900	40.600
Total number of RFID readers	180	12.600	70.200	208.000

VITALIS fixes the issues by proposing solutions in 2 separate approaches. A first approach is a referential approach which acts as a confirmation node between health care records. Medical Staff could use RFID based systems to get health information of patients instantly without accessing the electronic health record system located elsewhere. This could save time for doctors or medical staff to get confirmation of records. VITALIS could be extended with a non-referential approach by placing specialized agents that acts as a hub to access records between hospitals. Patients who get transferred to different departments or hospitals could still carry their record forward with the hospital's specialized system¹. Likewise, the proposed solutions act to attach RFID tags to objects such as medical assets, laboratory items and sensors that store some information regarding the objects. This would allow professionals to access detailed information. For example, RFID tags could be used for temperature monitoring where data of patients or objects could be recorded seamlessly.

METHODOLOGY

This study was conducted among a group of medical practitioners across hospitals in Malaysia. The objective of this research is to understand the issues and perspective of users on the current system in managing medical records at the Pediatric Departments in hospitals. This survey will provide an overview of the areas to be improved and implemented. In the end, the project aims to create an RFID Bracelet to manage and store medical records of patients. The pediatric ward is selected as the focus area for this research as there is a huge case of medical errors regarding mismatching between babies and their parents. This survey was conducted via google forms where questions were carefully designed to ensure data collected was relevant and kept about matter. Online survey method was selected as it would be easier for respondents to answer with the comfort of their time. This would also allow respondents to pass the survey to other nurses in the departments as well. The responses obtained from this survey are used for academic purposes only. The anonymity of the respondents will be de-identified. All records will be encrypted and stored for confidentiality purposes. After each response from respondents, data is then used to compare with current studies made regarding using

RFID in the healthcare line. This would provide a clear relevancy for future studies to be done.

Data Analysis

To retrieve a better clarity on the current situation of hospitals in Malaysia utilizing RFID technology in their wards, an exploratory study is conducted in the pediatric ward. The survey is done through google forms and is sent to a small group of nurses and doctors. The objective of this research is to understand the issues and perspective of users on the current system in managing medical records at the pediatric departments in hospital as this survey conducted would provide an overview on areas to be improved and to implement RFID technologies. Data collection is conducted through carefully curated questions to understand the difference in perspective of nurses and doctors in the department. The survey constructed is segregated to 4 sections, the first section aims to understand the demographic profile of the medical staff in the department. This is also to gain an overview on the experience of staff in the medical field being familiar with a new system being implemented. Next, the second section is aimed to understand the current system being utilized in the pediatric hospital in managing medical records of patients. To get a better understanding of the human errors faced by the hospitals, questions regarding misfiling of records were also asked. The next section is to understand the level of security faced by the current system being used in the department. Informational Breaches are common in hospitals. Breaches include patients' medical records being leaked out to the public unintentionally. External threats could also play a role in causing situations that circle information breaches. User satisfaction with the current system was also measured using a Likert scale. The final section of the survey aims to understand the knowledge of participants in implementing an RFID based system into the department of hospitals. Questions in this section compromises on providing a perspective for participants on the implementation of RFID technology within areas where it is suitable.

Findings

The flexibility of the data collected is kept by ensuring the survey was sent to respondents to answer over 1 month. The first section of the survey is to collect the demographic profile. The questions that were asked were the role of respondents and the range of years inexperience. Based on the survey that was received, Figure 1 and Figure 2 shows the results.

Based on the results gathered, the demographic profile states that a total of 7 doctors and 3 nurses was participating in this survey. The survey was sent to a group of doctors and nurses in Malaysia who serves in the pediatric ward. It is also gathered that 40 percent of the respondents were experienced with the ranges of 1 to 3 years in the medical field. Data collected with these demographics is useful as it achieves the

aim of conducting this survey by setting the focus area on medical practitioners.

Employment in the Medical Field?

10 responses

Figure 1: Chart on the Employment of respondents.

Experience in the Medical Field
10 responses

Figure 2: Chart on the experience of respondents.

The next section of analysis was conducted to collect data on the current system that is being used in the ward. Data regarding frequency of medical practitioners access medical records were recorded. The data is then tabulated below *Table 3*.

Table 3: Query issuing on the frequency of accessing medical records

Queries on frequency of accessing medical records	Nurse	Percentage of Nurses accessing records	Doctors	Percentage of Doctors accessing records	Total	Average	Max	Min
Number of respondents	7		3		10			
Respondents accessing Daily	5	50%	2	20%	7	0.7	5	2
Respondents accessing Occasionally	2	20%	1	10%	3	0.3	2	1

Based on Table 4, it is shown that data is captured among 10 respondents ranging from 7 nurses and 3 doctors. The data shows that 7 respondents access medical records daily. A breakdown shows that 5 nurses and 2 doctors are dependent on checking and taking down patient's information every day. Towards respondents accessing data occasionally, a to-

tal of 3 respondents accesses medical records at least 5 times a week. This could be done just to give a quick glance on patient's information in hospitals. With these data, we could conclude that 70% of the respondents need access to medical files every day and the highest level of user accessing records are nurses.

Table 4: Query on issues of misfiling of documents

Queries on issues of misfiling documents	Nurse	Doctors	Total	Average	Max	Min	Percentage of misfiling issues
Number of respondents	7	3	10				
Respondents encountered issues	6	3	9	0.9	6	3	90%
Respondents without issues	0	1	1	0.1	1	0	

Furthermore, data on issues of misfiling of documents shows that nurses perform most of the document tasks compared to doctors. This could be seen with the number of issues faced by respondents with nurses having issues higher than doctors. Overall, 90% of the respondents have issues faced with misfiling medical records of patients. Misfiling patient re-

ords occurs commonly as doctors require nurses to search through countless medical records that store patient's data. With the ongoing study on medical errors, issues in the medical field could potentially cause 42.7 million medical events or emergencies every year¹.

Do you feel that the current way of filing data in your system, may cause information breaches?
10 responses

Figure 3: Chart on the perspective of users on information breaches.

Respondents were also asked on the perspective of traditionally based filing system on the confidentiality of patient's medical records from being leaked out, Figure 3. Informational Breaches are common in hospitals. Breaches include patients' medical records being leaked out to the public unintentionally. External threats could also play a role in causing situations that circle information breaches. Based on the data collected, 90% of the respondents agree with the current filing of data in their hospitals may cause information/data breaches. This data is summed up from respondents that answered "Maybe" and "Yes" where is taken account to agree with current systems causing data breaches. Respondents stated that there is little to no security features in place on the current system that stores files and important information on staff and patients. Possibility of unauthorized users from breaching in and stealing data could occur. Furthermore, it is stated that some hospital systems are used by respondents to be outdated and old. Outdated systems are harmful to be used by hospitals or corporations as there could be issues of zero-day exploits or vulnerability that has yet to be patched. This could result in massive damage to the hospital's integrity and patient's data from being leaked.

Are you familiar with RFID technology?

10 responses

Figure 4: Chart on the familiarity of users with RFID Technology.

Before implementing a new system, it is important to understand the adoption rate and the general understanding of users regarding a specific technology. Based on Figure 4, it is stated that 70% of respondents are familiar with the technology of RFID. This would make adoption and implementation of RFID systems into hospitals easier as it cuts the time for users to fully understand the operation behind the technology, Figure 5.

If given an opportunity, Would you be interested in using a RFID based system to improve the management of medical records of patients?

10 responses

Figure 5: Chart on the interest of respondents on RFID Technology.

Data regarding RFID based technology to be implemented into hospitals were also collected from respondents. Data suggests that 90% of respondents would like to use an RFID based system to improved management of files and records of patients. As the adoption of RFID increases, this would open opportunity for other areas in hospitals to benefit RFID technologies. Respondents also suggested enhancements to RFID based systems to be implemented in hospitals. One respondent suggests the implementation of Artificial Intelligence and Machine Learning that would assist in managing hospital patients during high traffic cases. Other respondents also suggested improving the security of storing and reading patient's records which would reduce risks associated with the data breach.

DATA DISCUSSION

From the data collected in this study, it is concluded that there is a huge hassle in medical practitioners in managing and organizing medical-related files in hospitals. This survey conducted proved that there is a difficulty in reading and writing information regarding patients in hospitals. Concerns of respondents were also during high traffic cases in hospitals where it is time-consuming to record patient's data and could cause errors in the long run. Medical errors could also impose a huge risk that could even impact the wellbeing of patients being admitted in hospitals. Based on previous studies done, medical practitioners face a similar issue as compared to this study done. This could be seen in a study done by Moutaz, where it is said that the implementation of RFID

based technology could assist in cutting downtime and effort on track and store patient's data¹. The survey also measured the level of confidentiality of the current system being used in hospitals. Results stated that respondents were not confident with the level of security that is placed within their system. As cyber-attacks are rising around, it is common for data stored in health information systems to be stolen. A recent study conducted in 2015 regarding cyber-attacks in hospitals states approximately 4.5 million records were stolen which resulted in major financial repercussions to the hospital in United States¹¹. Adoption and understanding of users were also measured, it was stated that almost 90% of medical practitioners fully understand the technology behind RFID. This is essential as it allows the technology to be implemented easily. It was also recorded that 80% of the respondents trust in the system of RFID where it would assist in lessening the risk and issues relating to managing records. Current RFID systems that were proposed^{1,3,8,9}, we're focusing on capturing the general tasks such as patient identification, tracking and inventory management. This could further be improved by embedding into other areas in the hospital management where suitable. Artificial intelligence is also an emerging technology that would assist in organizing data captured².

CONCLUSION

The research proved that there is a huge need in implementing an RFID based system into hospitals in Malaysia. This would greatly improve the general management of patients and operations in different wards. An RFID system in health-care is proven to be efficient and could increase its effectiveness in the future by implementing technologies such as machine learning and artificial intelligence. With other countries implementing RFID systems as an early adoption stage, results are satisfactory and are shown to reduce workload in managing during high traffic cases in hospitals.

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Conflict of Interest

The authors involved in the current study does not declare any competing conflict of interest.

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REFERENCES

1. M. Haddara and A. Staaby, "RFID Applications and Adoptions in Healthcare: A Review on Patient Safety," *Procedia Computer Science*, vol. 138, pp. 80-88, 2018.
2. P.-J. Che, Y.-F. Chen, S.-K. Chai and Y.-F. Huang, "Implementation of an RFID-Based Management System for Operation Room," in *International Conference on Machine Learning and Cybernetics*, Hebei, 2009.
3. H. Q. Omar, A. Khoshnaw and W. Monnet, "Smart Patient Management, Monitoring and Tracking System Using Radio-Frequency Identification (RFID) Technology," in *IEEE EMBS Conference on Biomedical Engineering and Sciences (IECBES)*, Hewler, 2016.
4. S. F. Khan, "Health Care Monitoring System in the Internet of Things (IoT) by Using RFID," *International Conference on Industrial Technology and Management*, pp. 198-204, 2017.
5. C. Turcu and C. Turcu, "RFID-based Solutions for Smarter Healthcare," *International Workshop Fostering Innovation in Healthcare Services*, 2017.
6. D. Uppala, "RFID Based Electronic Health Record System," *International Journal of Pure and Applied Mathematics*, vol. 117, no. 10, pp. 79-82, 2017.
7. K. Srivastava, A. K. Awasthi and S. D. Kaul, "A Hash-Based Mutual RFID Tag Authentication Protocol in Telecare Medicine Information System," *Journal of medical systems*, vol. 1, no. 39, p. 153, 2015.
8. A. Aguilar, W. v. d. Putten and G. Maguire, "Positive Patient Identification using RFID and Wireless Networks," 2006.
9. E. & P. Ngai and F. & N. C. J. & Suk, "Design of an RFID-based Healthcare Management System using an Information System Design Theory," *Information Systems Frontiers*, vol. 11, pp. 405-417, 2009.
10. R. S. Sangwan, R. G. Qiu and D. Jessen, "Using RFID Tags for Tracking Patients, Charts and Medical Equipment within an Integrated Health Delivery Network," in *IEEE Networking, Sensing and Control*, Tucson, AZ, 2005.
11. T. Floyd, M. Grieco and E. F. Reid, "Mining Hospital Data Breach Records," *2016 IEEE Conference on Intelligence and Security Informatics (ISI)*, pp. 43-48, 2016.
12. P.-C. Liao, L. Liu, F. Kuo and M.-H. Jin, "Developing a Patient Safety Based RFID Information System --An Empirical Study in Taiwan," in *International Conference on Management of Innovation and Technology*, Singapore, 2006.