



Virtual Indoor Monitoring Safety System for Mothers and Infants at the Malaysia's Public Hospital

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ABSTRACT

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Healthcare providers around the world are recognizing the benefits of adopting Radio Frequency Identification (RFID) technology into their operations in order to enhance health care service delivery, increase operational efficiencies and improve pandemic outbreak management. The ability to pursue these seemingly opposite objectives can be enhanced by optimizing the use of medical equipment and automating appropriate business processes. Patient tracking using RFID can also identify certain operational processes that can or should be changed or improved. B-Tag&Track® has become the first mother and infant indoor virtual positioning a complete total solution and application adapting the RFID technology implemented to the Malaysia's public hospital. The system utilizes RFID tags for the mother, infant and baby cot. Specially designed hypoallergenic straps with tamper-alert features are used with the infant tags. The RFID tags come pre-matched in a set and are available for both single and multiple births.

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1. Introduction

Traditional methods of matching an infant to its mother require hospital staff to manually check the codes on the infant and mother's wristbands to ensure correct matching. With these methods, mismatch or mix-up can happen anytime because of human error or negligence. Such a mix-up can lead to traumatic events such as the newborn being given the wrong medication, breastfeed by a stranger, or sent home with a wrong mother. For hospitals, such event not only is an embarrassment but also may have legal implications.

Radio frequency identification (RFID) technology became one of the most influential and popular technologies that supports business objectives, where it started as a military tool for spying, and evolved to serve many fields like medical, social, and business. RFID technology uses radio waves to track individuals and objects and collect information about their behavior to help make important business decisions.

RFID is a technology for identifying people and objects automatically. RFID was at first introduced as a "sister" technology to replace barcode system for identifying items [1,2]. It has attracted

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considerable attention in recent years. RFID not only replaces the traditional barcode technology, but also provides additional features and eliminates boundaries that limit the use of previous alternatives [3].

RFID consist of tags, software and reader [4]. RFID tag is a small, microchip devised to transmit wireless data [5]. RFID tag is often formulated by a small chip for storing data and an integrated transmitter antenna [1]. Tags are identified wirelessly by the readers by using some protocol of identification executed by readers and tags [6]. These tags operate at different frequencies and for that there is a need to employ different transmission mechanisms with different read-ranges, capabilities and bandwidths to penetrate sight line barriers. Still most of its use is for proprietary systems with specific use cases.

The technologies proliferation of automatic data acquisition, such as sensor and RFID technologies, aimed at improving the integrated environmental information systems (IEISs), decision support systems (DSSs), and environmental management. Such active and enduring topic for the scientists, engineers, and public administrators, involves broad issues beyond the use of many technologies. Internet of things (IOT) is actuators and sensors mixed with the environment around us seamlessly, and shares information across platforms to develop a common picture for operating (COP).

There are two types of RFID tags: active tag, which has embedded power source within it [1]. The second is passive tags, which doesn't have internal energy source (such as a battery). Passive tags get all the needed energy for functioning from an electromagnetic radiation transmitted by a reader. Communication between tags and reader is based on the "backscattering" principle in which the reader transfers energy to activate the tag, and then the tag replay by backscattering its identification data to the reader [10].

2. B-Tag &Track® System and the Development

In a hospital, incidents of infant being given to an incorrect mother or abducted are traumatic and highly distressing to parents and staff; sometimes even resulting in litigation. Although cases of infant abduction are very low however the trauma to the parents and consequences to the professional reputation of the hospital are incalculable.

Hence, National Space Agency of Malaysia (Agensi Angkasa Negara; ANGKASA) has taken a proactive step in developing and adapting the space spin-off technology currently and still being used as the inventory and location tracking system at the International Space Station (ISS) which is the RFID technology in developing, adapting and operationally operating the invention, B-Tag&Track® system and application to the government hospital. Banting Hospital had been the first pilot project government hospital in the country to fully implement and adapting the application.

The B-Tag&Track® safety system incorporates the use of hardware and software application. The system utilizes RFID tags for the mother, infant and infant cot. Specially designed hypoallergenic straps with tamper-alert features are used with the new-born tags. The RFID tags come pre-matched in a set and are available for both single and multiple births.

When an infant mismatch event takes place, there will be both an audio beep and visual LED alert displayed on either the mother or cot tag; on the spot in real-time. This is triggered wirelessly with no action on the part of the nurses when a mismatch happens. Additionally, a button on the mother/cot tag can be activated manually for on-demand verification by either the mother or caregiver as well. This enhances the patient's stay experience.

The receivers and exciters are also installed and mounted strategically at doorway exits in the maternity ward to provide additional patient safety to the infants. Each time an infant tag goes near

to an exciter in the designated monitored area, it will be 'excited' by the exciter. In turn, the tag will transmit its tag ID and the exciter's device ID to a nearby configured receiver. The receiver will transmit the information to the engine application to immediately alert the caregivers by both audio and visual notifications on the PC desktop application and connected speakers. Hence any attempt to remove an infant from the ward without authorization will trigger an alert. Other incidents captured by the B-Tag&Track® system include:

- tampering (cut) of the infant safety band
- infant loose tag (not properly fastened)
- low battery status
- time-out situation (eg. not returned to nursery after a certain period)

Upon receipt of an alert, besides displaying the tag's ID, the B-Tag&Track® engine will also display the location of the tag that originated the alert. The RFID tags and receivers together with the application software encompass an integrated system that provides virtually 100% security for the baby. The system can also be configured to automatically lock a particular door or all doors upon receipt of a high priority alert such as "tamper" alert.

2.1 B-Tag&Track® Function, Feature and Benefit

Among the key features and benefits of B-Tag&Track® develop, implement and adapt for this project include its automatic tag verification which takes place whenever an infant tag is in close proximity to either the mother or cot tag, with on-the-spot audio and visual alerts giving the parents' greater assurance and peace of mind. It also come with on-demand verification button on mother's tag to enhance patient's experience. Its unique RFID cot tag wirelessly alerts when a wrong infant is put into the cot by mistake to provide for real-time infant safety. The cot tag is supplied together with a bracket that is mounted onto the cot. The three coupled tags are re-usable and come with user replaceable lithium-ion batteries. The battery life of the mother and infant tags is up to 12 months depending on usage. For the cot tag, the battery life is up to 6 months.

Another unique feature of the three (3) couple pre-paired tags, it prevent accidental wrong pairing of two physical tags. The tags are identified via the last four (4) alphanumeric digits of each tag. Both the mother and infant tags are waterproof and suitable for frequent dip sterilization. The cot tag is splash proof only. However, the use of alcohol swabs is sufficient in most cases when cleaning the tags. As mentioned before, the infant tags are worn with special tamper-alert straps for extra protection and are capable of detecting loose strap situations. The straps are made of silicon material with a softness ideal for infants. When the tags are used together with the engine associating with the software application, all the alerts will be detectable on the nurses' workstation. Alerts are configurable and can be triggered via sms, email or external beacon.

2.2 Ethical Concern related with B-Tag & Track® RFID

It's very important to judge any technology in terms of its ethical perspective because the compatibility and harmony of technology with morality (ethics) has a significant impact on its acceptance by the individuals and organizations at large. Three types of ethics are identified: computer ethics, information ethics, and cyber ethics. This applies to the all ICT applications. Ethics aims to provide means to help discern what humans should do and how they should behave. It guides us to what is good or bad behavior, and deals with behaviors or actions rather than thoughts or

feelings. It is also realized that what is an acceptable behavior in one culture might not be ethical in another.

Research about ethical issues focused more on Internet security, like data theft and personal information hacking, and especially in business domains. The RFID introduction adds a new dimension to debates over consumer's privacy by allowing tracking of products after the point of sale. The issues at pin depend on two factors: how the item is considered to be personal, and the item mobility.

The RFID technology users can be partitioned into individual, business and government. All of these classes of users can use RFID in a different way that proved beneficial to the generic population. Private sector enterprises can generate revenue from the technology. Also, consumers can benefit from technology by reduced prices and enhanced quality of service. Both of them can make trade-offs between convenience and privacy when it is the time for opt-out options [4]. RFID privacy concerns with misbehaving readers and the problem of harvesting information from tags behaving well.

Receiving an RFID tag is purely a matter of consumer choice, and raises few minor ethical issues. The most important ethical issue is the possibility that the chips might be implied or implanted under real coercion, with the deep aversion or at least unease with many individuals. A more relevant ethical justification was that the RFID device had the ability to reduce the time spent to find lost patients, and lessening the chances that would cause an accident. RFID also can identify patients and improve the accuracy and streamlined delivery of health care, but they may also introduce new ethical, medical and social, risks. In general concerns about implants have been largely theoretical and concentrate on the devices safety, patients' records privacy, and coercion to consent to the devices implantation [5]. A passive RFID tag will not pose any medical risk when applied/wear by an individual, as it doesn't emit any waves while outside of the reader's field. While readers emit waves, they have only a limited range. Therefore, the RFID tag are medically safe for the newborn. Several RFID systems are approved to be used in healthcare applications.

3. Conclusions

Implementation and adaptation of B-Tag&Track® toward the current work flow, process and procedure being applied at the Malaysia's Government Hospital through the intervention of the spin-off space technology, the RFID, B-Tag&Track® has immensely set its own standard to the safety and security landscape in the public health sector to revolutionise and modernise. Even though there are still a long way and challenges to meet ahead of this journey, B-Tag&Track® has making its small step to inculcate and educate alongside with technology transfer package to its successful pioneer pilot implementation end user at Hospital Banting, Selangor.

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