RFID TAGGING SYSTEM
FOR
NEWBORN BABIES

By

MOHD SYAZWAN BIN MOHD SAKRI

FINAL PROJECT REPORT

Submitted to the Electrical & Electronics Engineering Programme
in Partial Fulfillment of the Requirements
for the Degree
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CERTIFICATION OF APPROVAL

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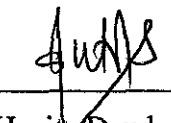
Approved:



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June 2009

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

Mohd Syazwan bin Mohd Sakri

ABSTRACT

Two infants are bathed and each accidentally returned to the incorrect bassinet. A mother picks up her child according to the bassinet label, unaware that a swap has taken place. This problem will eventually happen if there is no proper method to identify the baby. Maternity wards are handling more and more births. Keeping track of the growing number of babies has become challenging for even the most modern hospitals. The main objective of this project is to develop a RFID Infant Protection System prototype to prevent infant abductions and inadvertent child mismatching. The system should be able to protect against mismatching events by affixing matching RFID tags to mother and child. If the mother is given the wrong child, the RFID tag detects the mismatch and activates an audible alarm. The advantage of RFID over other technologies like bar code will be stressed out by the author in this report. The author will detail the method approached to carry this project up until it become successful.

ACKNOWLEDGEMENTS

Firstly, I would like to thank the Almighty God for giving me the strength and time to complete this project. To my mother and my family, thank you for your love and support while I am facing the hardship in the project. I also would like to give my most gratitude to my supervisors, Puan Hanita Daud and Mr Azizuddin Abdul Aziz for giving me support and were always understanding despite all the errors and delays that I made during the completion of the project. I also would like to give a thousand thanks to all my friends especially to Tuan Mohd Irwan, Ahmad Loqman Zainal Abidin, Mohd Qamar Rusydi Ramlan and Amirul Anuar Ibaharin for their cooperation, knowledge sharing, endless guidance and continuous support on the work in order to complete the project successfully.

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LIST OF ABBREVIATIONS

RTSNB	RFID TAGGING SYSTEM FOR NEWBORN BABIES
RFID	RADIO FREQUENCY IDENTIFICATION
GUI	GRAPHICAL USER INTERFACE
PC	PERSONAL COMPUTER
LOS	LINE OF SIGHT
VB	VISUAL BASIC
GSM	GLOBAL SYSTEM FOR MODEM
SMS	SHORT MESSAGING SERVICES
GPS	GLOBAL POSITIONING SYSTEM
IP	INTERNET PROTOCOL

CHAPTER 1
INTRODUCTION

1.1 Background of Study

The RTSNB is basically a design of RFID tagging system for newborn babies for hospital use or specifically for maternity ward. RTNSB can monitor, match babies with their mothers and also embedded with security system which is temper proof strap. The strap will be attached to baby's ankle right after he or she was born. If the tag is lifted from the baby's skin or if the ankle strap is compromised, the system immediately triggers an alarm, alerting hospital security to the situation. The RTNSB use RFID system to achieve the objective of this project since this technology has many advantages over the other technology.

1.1.1 RFID VS Other Technologies

There are many different ways to identify objects, animals, and people. Why use RFID? People have been counting inventories and tracking shipments since the Sumerians invented the lost package. Even some of the earliest uses of writing grew from the need to identify shipments and define contracts for goods shipped between two persons who might never meet. Written tags and name badges work fine for identifying a few items or a few people, but to identify and direct hundreds of packages an hour, some automation is required. [7]

The bar code is probably the most familiar computer-readable tag, but the light used to scan a laser over a bar code imposes some limitations. Most importantly, it requires a direct "line of sight," so the item has to be right side up and facing in the right direction, with nothing blocking the beam between the laser and the bar code. Most other forms of ID, such as magnetic strips on credit cards, also must line up

correctly with the card reader or be inserted into the card reader in a particular way. Whether you are tracking boxes on a conveyor or children on a ski trip, lining things up costs time. Biometrics can work for identifying people, but optical and fingerprint recognition each require careful alignment, similar to magnetic strips. Facial capillary scans require you to at least face the camera, and even voice recognition works better if you aren't calling your passphrase over your shoulder. [3] RFID tags provide a mechanism for identifying an item at a distance, with much less sensitivity to the orientation of the item and reader. A reader can "see" through the item to the tag even if the tag is facing away from the reader. [8]

RFID has additional qualities that make it better suited than other technologies (such as bar codes or magnetic strips) for creating the predicted "Internet of Things."[3] One cannot, for instance, easily add information to a bar code after it is printed, whereas some types of RFID tags can be written and rewritten many times. Also, because RFID eliminates the need to align objects for tracking, it is less obtrusive. It "just works" behind the scenes, enabling data about the relationships between objects, location, and time to quietly aggregate without overt intervention by the user or operator. [3]

To summarize, some of the benefits of RFID includes alignment is not necessary. A scan does not require line of sight. This can save time in processing that would otherwise be spent lining up items. [4]RFID technology also enables to increase the inventory speeds. Multiple items can be scanned at the same time. As a result, the time taken to count items drops substantially. [4] RFID tags also can be made into variety of form factors. RFID tags range in size from blast-proof tags the size of lunch boxes to tiny passive tags smaller than a grain of rice. These different form factors allow RFID technologies to be used in a wide variety of environments. [4] Rewritability capability can enhance the usability of RFID technologies. Some types of tags can be written and rewritten many times. In the case of a reusable container, this can be a big advantage. For an item on a store shelf, however, this type of tag might be a security liability, so write-once tags are also available. [4]

1.2 Problem Statement

1.2.1 Problem Identification

How can I be sure that my baby will not be mixed up in that big nursery?" The question is inevitable and none should be answered with greater care, sympathy and understanding than this of the incoming maternity patient. Upon the care with which it is answered, and the technique of the identification procedure explained, hangs the peace of mind of the mother until such time as the child shows unmistakable evidences of its parentage. There are many method of baby identification. For example the Columbia Hospital of Milwaukee has a triple method of identification consisting of the necklace, the baby's footprints, one impression made on the chart and a duplicate on a special slip which is given to the mother, and an X-ray of the baby which is made before it is taken to the nursery. The X-ray is done, primarily, to ascertain if there is a deformity, a fracture, or an enlarged thymus, but it also serves as a means of identification. But all these methods still cannot ascertain that the baby will not be mixed up since there is a case at Long Island College Hospital where a nurse forgotten to put on the necklace but luckily that omission was immediately noted by the nursery head nurse. There is also cost issue involved since every necklace must be sterilized and made from material that won't harm the baby. The cost for X-ray procedure is also very expensive. The current tagging method is using paper strap that is attached to baby's ankle. The method is still widely used in Malaysia. There are still several problem persist by using this method. The paper strap itself is made from a normal paper and can be easily compromised. If it is compromised, there will be no other way to trace to identify the babies and their mother.

1.2.2 Project Significance

The project basically offer extra features over conventional baby tagging that use paper to tag the baby. The RTSNB not only tag babies for mother-matching purpose but also act as a security system. This system could prevent infant abductions and at the same time could also prevent inadvertent child mismatching. The theories learnt in this project should be the base of learning experience and platform for better understanding on security system and engineering principles.

1.3 Project Objectives

The project objectives are as follows:

i. To design RFID infant protection systems to prevent infant abductions and inadvertent child mismatching.
ii. To design RFID system that can protect against mismatching events by affixing matching RFID tags to mother and child. If the mother is given the wrong child, the RFID tag detects the mismatch and activates an audible alarm.
iii. To use a special tamper-proof strap. If the tag is lifted from the baby's skin or if the ankle strap is compromised, the system immediately triggers an alarm, alerting hospital security to the situation.

1.4 Scope of Study

The scopes of study of the system are as below:

i. Data transmission via RFID system.
ii. System database development using Visual Basic(VB)
iii. Selection of suitable RFID tag for babies.

The study is based on the elements above which apparently comprise of mother-baby matching, security and also notification systems. The RFID system offer extra features over the current baby tagging system where it can match the babies and mothers automatically and also embedded with security system to prevent infant abduction. Additionally, the system is designed to communicate with PC which practically improved the data handling and notification action.

CHAPTER 2
LITERATURE REVIEW

2.1 Tracking Systems

2.1.1 Patient Tracking Solutions

Hospitals and Health Care facilities are more concerned these days about having the ability to accurately track and accurately identify their patients. Whether it's dispensing medication or identifying the individual for procedures or pulling up a history of treatment on a patient; RFID technology with the appropriate software is a way to manage the information much more efficiently. [2]

An RFID enabled system is used for accurately locating and tracking people, equipment and objects in a hospital. The system can be designed to track hospital assets, curb excess expenditures, increase safety and ensure security and access control by placing small radio frequency identification devices, or 'RFID tags' on people and objects. [2]

Hospitals and Emergency Medical Services (EMS) are facing daily challenges especially when responding to emergencies. They need to be able to manage a large number of patients during an emergency effectively and efficiently. [2]

The institution is responsible for the care and safety of patients. If a patient is missing from their hospital bed or emergency ward the responsibility rests with the healthcare organization. RFID makes tracking and finding patients easier. Administering bedside care is safer, faster, because of real time and accurate identification and verification of patient. [2]

- RFID bracelets can be worn by patients. An RFID bracelet can be read through bed linens, so patients don't have to be disturbed when sleeping.
- Patients can be geo-fenced by using RFID bracelets and fixed readers in certain doorways and corridors to ensure patients do not stray beyond a predetermined perimeter.
- RFID bracelets can contain some patient information or all the information can reside on a computer database logically linked to the RFID bracelet.

2.1.2 Newborn Baby Tracking Solutions

The Maternity Ward is a place for joy and celebration as new family members are welcomed into the world. The ward staff shares some of this joy by playing their part throughout the labor and the post-partum care of mother and newborn child. However anxiety levels rise for the patients, families and staff when there are complications during the labor and/or when the newborn needs neonatal care. In many of these instances the baby and the mother need to be separated, a scenario that creates anxiety. Anxiety can easily turn to anger and a possible law suit when there is a mother-baby mix up; the wrong baby being sent to the wrong mother for the crucial early bonding period, breast-feeding etc. [6]

RFID technology will help both these difficult and challenging situations. At the time of admittance the mother is provided with a patient's RFID tag that will start the process of tracking all procedures relevant to that labor. Once the child is born, an ankle tag is provided to the baby as well and immediately cross-referenced to the baby's mother and the mother's tag. [6]

According to VeriChip, there have been 233 infant abductions in the US over the last 22 years. Half of these abductions occurred from health care facilities. [11] A January 2003 report from the National Center for Missing and Exploited Children concluding that of approximately 4.2 million births per year at 3,500 birthing centers in the U.S., abductions by non-family members are estimated at between zero and 12 per year. [12] By using RFID technology, abduction problem can be reduced and prevented.

2.1.3 Family Access to Babies in Neonatal Care:

In the case of the newborn needing neonatal care, family members are almost as anxious as the new mother, to greet and bond with the new family member. When the newborn needs to be in an intensive care unit (ICU) this becomes very difficult due to the restricted access in the ICU. RFID solves this problem by making available to families the ability to view on a computer monitor outside of the ICU the key data about the baby, a photograph, the height, weight, skin color and temperature after keying in, for example, the mother's family name and first name. [5]

2.1.4 Mother-Baby Mix-ups Eliminated:

Even when the mix up is uncovered moments after the mistake is made, this can cause heightened levels of anger and dissatisfaction with the services rendered. Any mother-baby mix up is a potential liability to the hospital. This scenario can be eliminated when staff follows a procedure of reading the baby's RFID tag and then reading the mother's RFID tag and re-confirming the match that was initiated at the birth. [6]

2.2 RFID Technology

The RFID system architecture consists of a reader and a tag (also known as a *label* or *chip*).The reader queries the tag, obtains information, and then takes action based on that information. That action may display a number on a hand held device, or it may pass information on to a POS system, an inventory database, or relay it to a backend payment system thousands of miles away. [10]

Let's looks at some of the basic components of a typical RFID system.

2.2.1 Tag/Label

RFID units are in a class of radio devices known as *transponders*. A transponder is a combination transmitter and receiver, which is designed to receive a specific radio signal and automatically transmit a reply. In its simplest implementation, the transponder listens for a radio beacon, and sends a beacon of its own as a reply. More complicated systems may transmit a single letter or digit back to the source, or send multiple strings of letters and numbers.[1] Finally, advanced systems may do a calculation or verification process and include encrypted radio transmissions to prevent eavesdroppers from obtaining the information being transmitted. [1]

Transponders used in RFID are commonly called *tags*, *chips*, or *labels*, which are fairly interchangeable, although "chip" implies a smaller unit, and "tag" is used for larger devices. The designator label is mainly used for the labels that contain an RFID device. [1]

As a general rule, an RFID tag contains the following items:

- Encoding/decoding circuitry
- Memory
- Antenna
- Power supply
- Communications control

Tags fall into two categories: *active* and *passive* [3]

2.2.1.1 Passive vs. Active Tags

Passive RFID tags do not contain a battery or other power source; therefore, they must wait for a signal from a reader. The tag contains a resonant circuit capable of absorbing power from the reader's antenna. Obtaining power from the reader device is done using an electromagnetic property known as the *Near Field.* As the name implies, the device must be relatively near the reader in order to work. The Near Field briefly supplies enough power to the tag so that it can send a response. [3]

In order for passive tags to work, the antenna and the tag must be in close proximity to the reader, because the tags do not have an internal power source, and derive their power to transmit from coupling to the Near Field of the antenna. The Near Field takes advantage of electromagnetic properties and generates a small, short-lived electrical pulse with the passive tag that can power a tag long enough for it to respond. [3]

The alternative to a *passive* tag is an *active* tag. Active tags have their own power source, usually an internal battery. Since they contain a battery to power the radio circuitry, they can actively transmit and receive on their own, without having to be powered by the Near Field of the reader's antenna. [3]

Because they do not have to rely on being powered by the reader, they are not limited to operating within the Near Field. They can be interrogated and respond at further distances away from the reader, which means that active tags (at a minimum) are able to transmit and receive over longer distances[3]

Semi-passive tags have a battery to power the memory circuitry, but rely on the Near Field to power the radio circuits during the receiving and sending of data. [3]

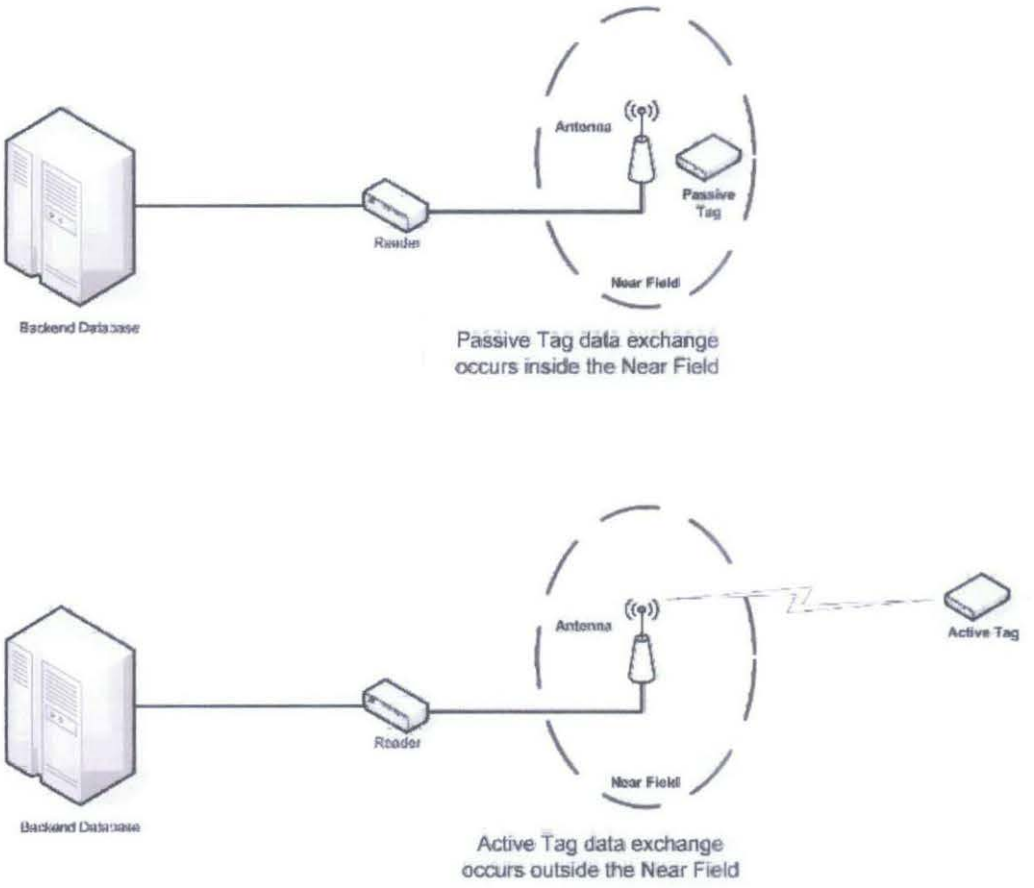

Figure 1 Passive and Active Tag Processes

After gathering data and sites visiting, analysis has be done based on data collected. RFID tags come in a variety of different types according to their functionality. The basic function of an RFID tag is to store data and transmit data to the interrogator. At its most basic, a tag consists of an electronics chip and antenna. Generally, the chip contains memory where data may be store and read from and sometimes written too, in addition to the project.

Table 1 below shows every detail of tags to be chosen. The author decided to choose active tags to be used with this project. An active tag was chosen because it can provide signals over an extended range, typically up to 100 meters. Since the author will use special tamper-proof strap tags for this project, only active tags can support this feature.

	Passive RFID	Active RFID
Power Source	External (Reader provided)	Internal (Battery)
Tag Readability	Only within the area covered by the reader, typically up to 3 meters.	Can provide signals over an extended range, typically up to 100 meters..
Energization	A passive tag is energized only when there is a reader present.	An active tag is always energized.
Magnetic Field Strength	High, since the tag draws power from the electromagnetic field provided by the reader.	Low, since the tag emits signals using internal battery source.
Shelf Life	Very high, ideally does not expire over a life time.	Limited to about 5 years, the life of a battery.
Data storage	Limited data storage, typically 128 bytes.	Can store larger amounts of data.
Cost	Cheap	Expensive
Size	Smaller	Slightly bulky (due to battery)

Table 1 The primary differences between a Passive and Active RFID tags

2.2.2 Reader

The second component in a basic RFID system is the *interrogator* or *reader*. The term "reader" is a misnomer; technically, reader units are *transceivers* (i.e., a combination *transmitter* and *receiver*). But, because their usual role is to query a tag and receive data from it, they are seen as "reading the tag"; hence, the term "reader." Readers can have an integrated antenna, or the antenna can be separate. The antenna can be an integral part of the reader, or it can be a separate device. Handheld units are a combination reader/antenna, while larger systems usually separate the antennas from the reader. [10]

Other parts that a reader typically contains are a system interface such as an RS-232 serial port or Ethernet jack; cryptographic encoding and decoding circuitry; a power supply or battery; and communications control circuits. [10]

The reader retrieves the information from the RFID tag. The reader may be self-contained and record the information internally; however, it may also be part of a localized system such as a POS cash register, a large Local Area Network (LAN), or a Wide Area Network (WAN). Readers that send data to a LAN or other system do so using a data interface such as Ethernet or serial RS-232. [10]

Readers, and in particular their antenna arrays, can be different sizes, from postage stamp-sized to large devices with panels that are several feet wide and high. [10]

2.2.3 Middleware

Middleware software manages the readers and the data coming from the tags, and passes it to the backend database system. Middleware sits in the middle of the data flow between the readers and the backend, and manages the flow of information between the readers and the backend. In addition to extracting data from the RFID tags and managing data flow to the backend, middleware performs functions such as basic filtering and reader integration and control. [9]

As RFID matures, middleware will add features such as improved and expanded management capabilities for both readers and devices, and extended data management options. [9]

The backend can be a standard commercial database such as SQL, My SQL, Oracle, Postgres, or similar product. Depending on the application, the backend database can run on a single PC in an office, to multiple mainframes networked together via global communications systems. [9]

2.3 RFID Frequencies Operation

RFID device can be designed to operate in different frequencies depending on the application and specification needed.

Band	LF Low frequency	HF High frequency	UHF Ultra high frequency	Microwave
Frequency	30–300kHz	3–30MHz	300 MHz–3GHz	2–30 GHz
Typical RFID Frequencies	125–134 kHz	13.56 MHz	433 MHz or 865 – 956MHz 2.45 GHz	2.45 GHz
Approximate read range	less than 0.5 metre	Up to 1.5 metres	433 MHz = up to 100 metres 865-956 MHz = 0.5 to 5 metres	Up to 10m
Typical data transfer rate	less than 1 kilobit per second (kbit/s)	Approximately 25 kbit/s	433–956 = 30 kbit/s 2.45 = 100 kbit/s	Up to 100 kbit/s
Characteristics	Short-range, low data transfer rate, penetrates water but not metal.	Higher ranges, reasonable data rate (similar to GSM phone), penetrates water but not metal.	Long ranges, high data transfer rate, concurrent read of <100 items, cannot penetrate water or metals	Long range, high data transfer rate, cannot penetrate water or metal
Typical use	Animal ID Car immobiliser	Smart Labels Contact-less travel cards Access & Security	Specialist animal tracking Logistics	Moving vehicle toll

Table 2 RFID operating frequencies and associated characteristics.

Table 2 shows RFID operating frequencies and all characteristics of it. Each has advantages and disadvantages. The author choose ultra high frequency (UHF) band which suits the best to this project.

CHAPTER 3
METHODOLOGY

For completing the project, there are several methodologies need to be done. The methodologies were summarized in the diagram below. As project has started, study on core features has been done. Software that will be used is Visual Basic for user interface and MS Access for database purpose. The Gantt chart of the project can be found at Appendix A.

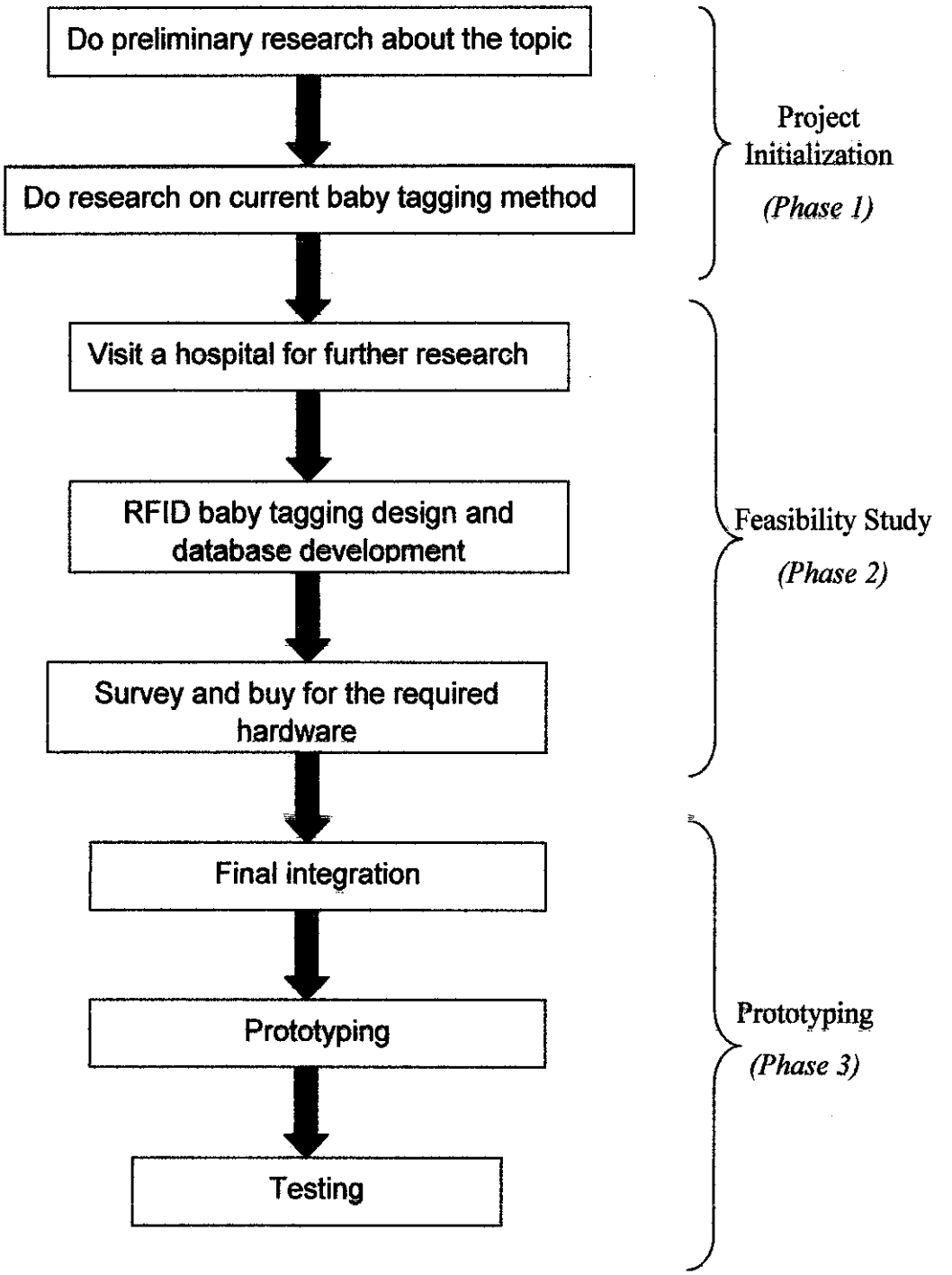

Figure 2 Project Flowchart.

3.1 Preliminary Research about the Topic.

First of all, understanding the basic theory of RFID technology is very important. Paper works, journal, engineering books or anything relevant to the project are reviewed.

3.2 Do Research on Current Baby Tagging Method.

After understanding the concept, current baby tagging methods from various hospitals were reviewed. This includes using necklace, the baby's footprints, one impression made on the chart and a duplicate on a special slip which is given to the mother, and an X-ray of the baby which is made before it is taken to the nursery.

3.3 Visit a Hospital for Further Research.

A visit to Hospital Sungai Buloh has been conducted by the author accompanied the Project Supervisor, Puan Hanita Daud. The visit was done successfully and the author now able to see how a maternity handle the infants using current tagging method. This gave the author the brief idea on how the system will be developed.

3.4 Graphical User Interface (GUI) Using Visual Basic.

The author has decided to use Visual Basic as the main platform to create an interface between tag and reader. In this project, Visual Basic creates a graphical user interface, linking information on different locations within the computer, so that the software built can interpret all the information and send it to other computer. Information on Visual Basic were obtained from various written sources, which includes lecture notes from Information Technology students, as well as books that provide users with guidelines to use Visual Basic. Some development is shown result and discussion.

3.5 Survey Questionnaire

A survey questionnaire has been conducted in order determine the feasibility of the project. A set of survey questionnaire has been formed and distributed to those who are concerned such as parents and future parents. The result of the survey is shown in the result and discussion with this report.

3.6 Tools

3.6.1 ActiveWave RFID Kit.

Figure 3 ActiveWave RFID Kit.

RFID Kit Components:

- 1 Activewave Reader and Power Supply
- 1 Activewave Reader RS-232 Connector Cable
- 1 ActiveWave Reader RJ-45 Cable
- 6 Activewave Wristband Tags
- 2 ActiveWave Jumbo Tags
- 2 Activewave Card Tags
- 1 Programming Station Software Application
- 1 Tracker Program Software Application (Demo Version)
- 1 API with Documentation and Example Software Application

3.6.2 Specification

- Tags – Several ActiveWave tag model are available, each one transmitting at either 916 MHz, 868 MHz or 927 MHz. Tags may be electronically enabled or disabled, so they can be "seen" or "unseen" by ActiveWave Readers. All ActiveWave tags have anti-collision circuitry that assures each tag's information is received when more than one tag is transmitting. An on-board temperature sensor can also be included the fit the customer's requirements.
- Readers – Readers interface the Host applications to the rest of the ActiveWave system. Readers transmit data at 433 MHz and receive data at 916 MHz, 868MHz or 927 MHz. Readers communicate to the Host computer via an RS-232 cable or via an Ethernet network connection. Readers are used to read the tags and transmit the received data to the Host computer. Readers are also used to enable, disable, wake up and program tags.

3.6.3 Basic ActiveWave System

The basic ActiveWave System consists only three components- the Host (PC running any ActiveWave application), the Reader and at least one tag. Configuration of the Reader and tag are done via either an RS-232 connection or Ethernet connection. All monitoring and tracking of the tag done via the same connection from the Host to the Reader. The basic operation of the ActiveWave system is shown in the simplified diagram below.

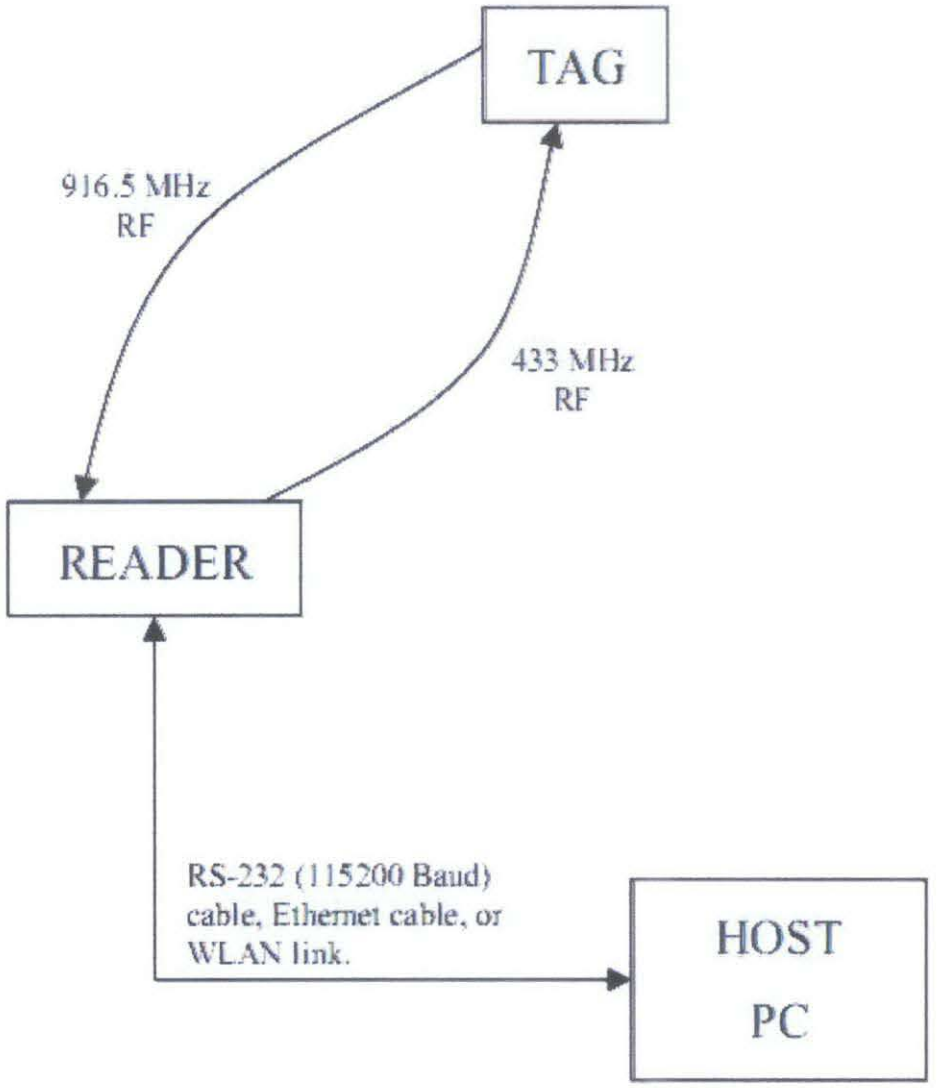

Figure 4 Basic ActiveWave System.

3.7 Basic Overview of BabyTraxx System

Basically the main components of the system are tamper-proof tags, readers and controller PC. For this project, two readers will be used. One reader will be located in the maternity ward to monitor the tamper-proof tags. Another reader will be located at the entrance to monitor exit from the safe area. This reader will also be used to match baby and mother. The controller PC will be located in a special room. Only authorized personnel have access to this room and the controller PC. This controller PC contains the system software and control the operation of the entire system. The tags incorporate a tamper mechanism that is enabled as soon as the tag is attached with the tamper-proof strap. The basic BabyTraxx system will look like figure 4 below.

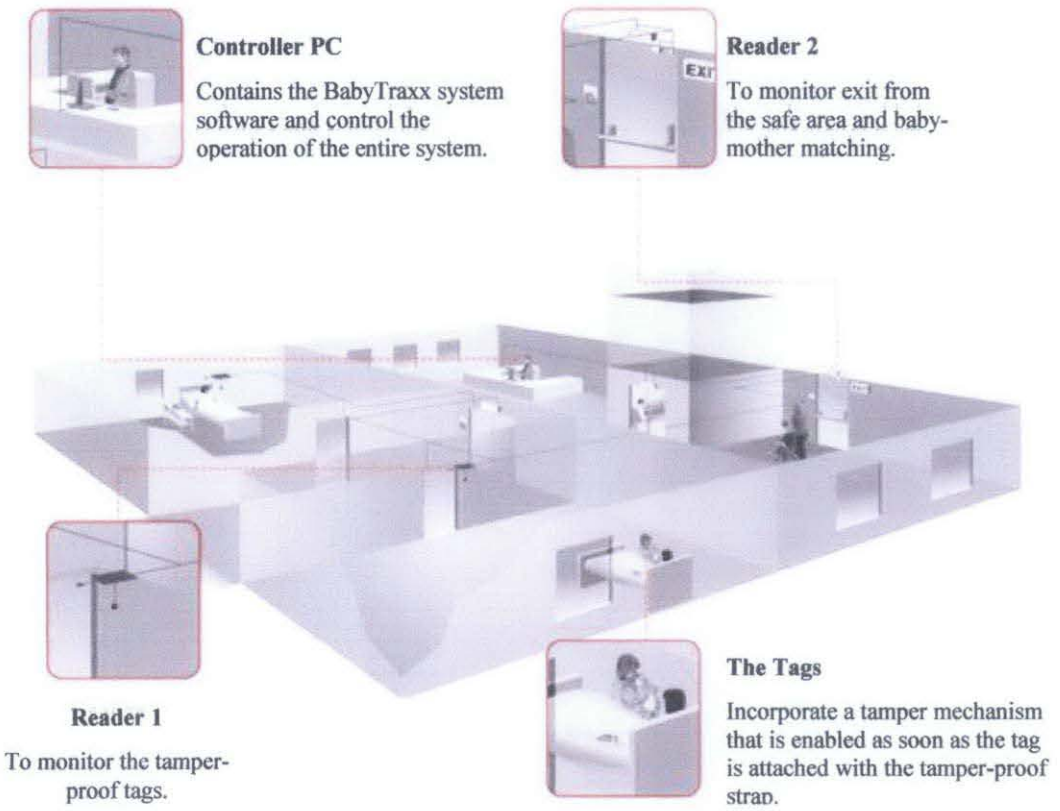

Figure 5 Basic System Overview.

CHAPTER 4
RESULT AND DISCUSSION

4.1 Result

4.1.1 Survey Questionnaire

The result for the survey questionnaire has been obtained. There are about 50 respondent have participated in this survey. From the result of the survey, it is shown that this project is feasible to be implemented to replace current baby tagging method. The result and analysis for each question is shown in the Appendices.

4.1.2 BabyTraxx System

This developed system is called BabyTraxx. The development of the system and how the system works will be shown below.

4.1.2.1 How The System Works?

To make the system works, the right sequence of process must be followed. This is to ensure that the system to works perfectly.

1. Right after the baby is born, the RFID (radio frequency identification) bracelet is attached to their ankle, usually in the delivery room.
2. The bracelet is monitored by a network of sensors wired into the maternity department ceiling and linked to a central computer.
3. If the tag is out of range, alarms will sound, doors will lock and elevators will be shut off.
4. If anyone tries to tamper with the tag, like trying to cut it off the baby, staff and security will be notified through their pagers and overhead speakers.

5. To match the baby with the mother, place the baby and the mother in a designated zone (usually at the entrance) and the matching process will take place.

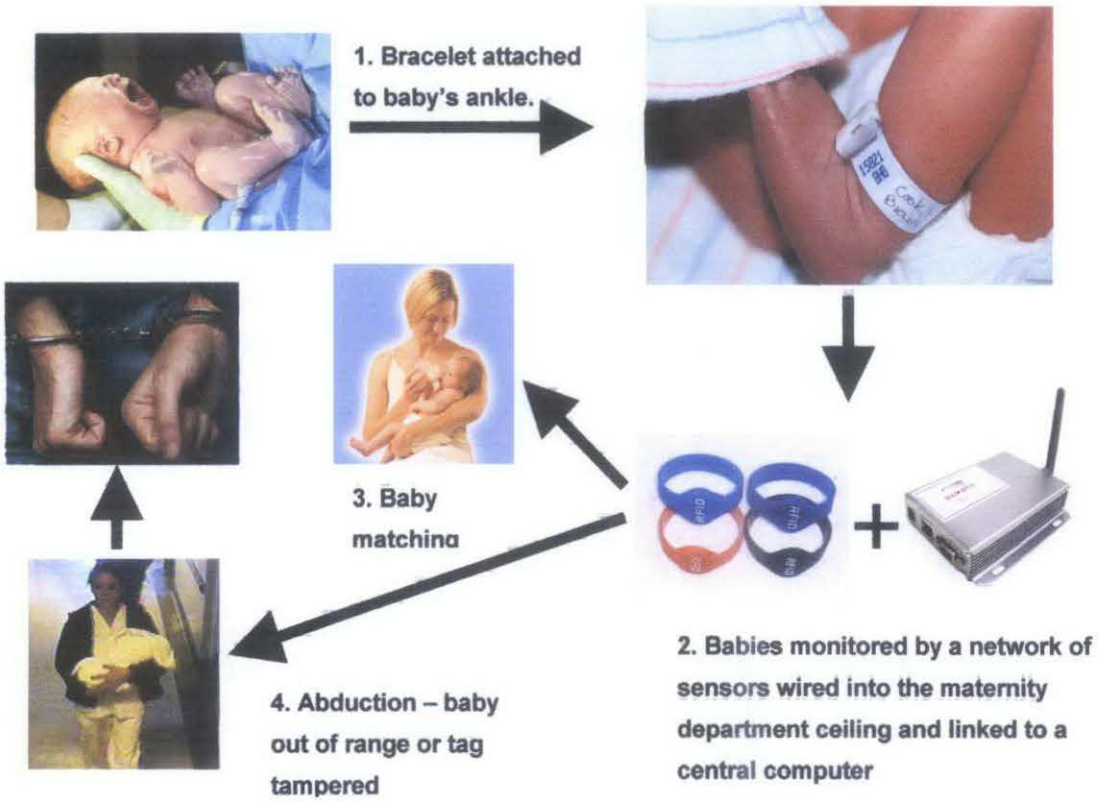

Figure 6 How the System Works

4.1.2.2 Graphical User Interface (GUI) of BabyTraxx.

The GUI for this system has been developed. Firstly, the authorized user has to login to the system using the "Login" screen. The "Login" screen is shown below:

Figure 7 Login Screen

After the authorized user successfully login to the system, he/she will be brought to the "Main Manu" screen. The "Main Menu" screen is shown below:

Figure 8 Main Menu Screen

From the "Main Menu" screen, there are many buttons for the user to choose. There are "Connect" button, "Start" button, "Configure" button, "Add Personnel" button, "Add Baby" button, "Alert History" button, "Baby List" button, "Personnel List" button and lastly "Log Out" button.

Firstly, user has to configure the IP of the reader(s). To do that, the user has to click "Configuration" button and the "Configuration" screen will pop up. The "Configuration" screen is shown below:

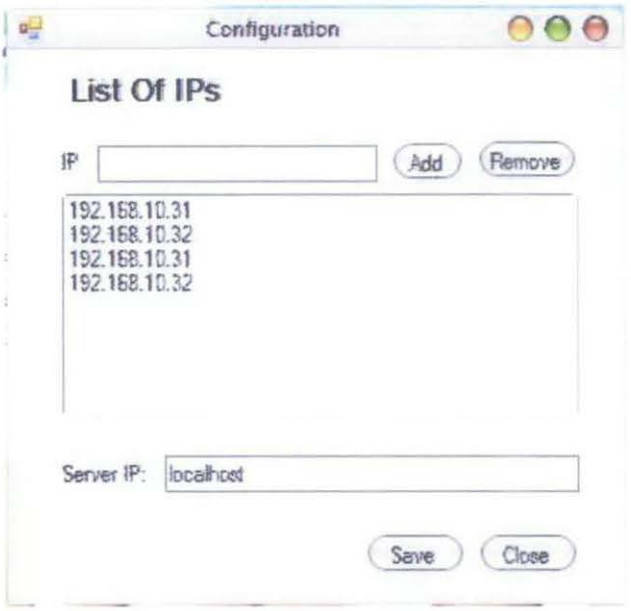

Figure 9 Configuration Screen

The configure the IP of the reader(s), user has to key in the IP number of the reader and click Add. If the is more than one reader involved, key in another IP number and click Add again. To remove a reader, just click on any IP number involved and click Remove. To add new personnel, firstly the authorized user has to click "Add Personnel" button from the Main Menu and the "Add New Personnel" screen will pop up. The "Add Personnel" screen is shown below:

Figure 10 Add New Personnel.

Next, user has to fill up all the details of the personnel. After completed the form, the user has to click "Confirm" to add the information of the new personnel to database.

To add new baby, firstly the authorized user has to click "Add Baby" button from the Main Menu and the "Add Baby" screen will pop up. The "Add Baby" screen is shown below:

Figure 11 Add New Baby.

Next, the authorized user has to fill up all the details of the baby and the mother and also the tag IDs. The purpose of having both baby's and mother's tag ID filled in the form is for mother-baby matching process later on. After completed the form, the user has to click "Submit" to add the information of the new baby to database.

To check the alert history, the user has to click "Alert History" button from the Main Menu and the "Alert History" screen will pop up. The "Alert History" screen is shown below:

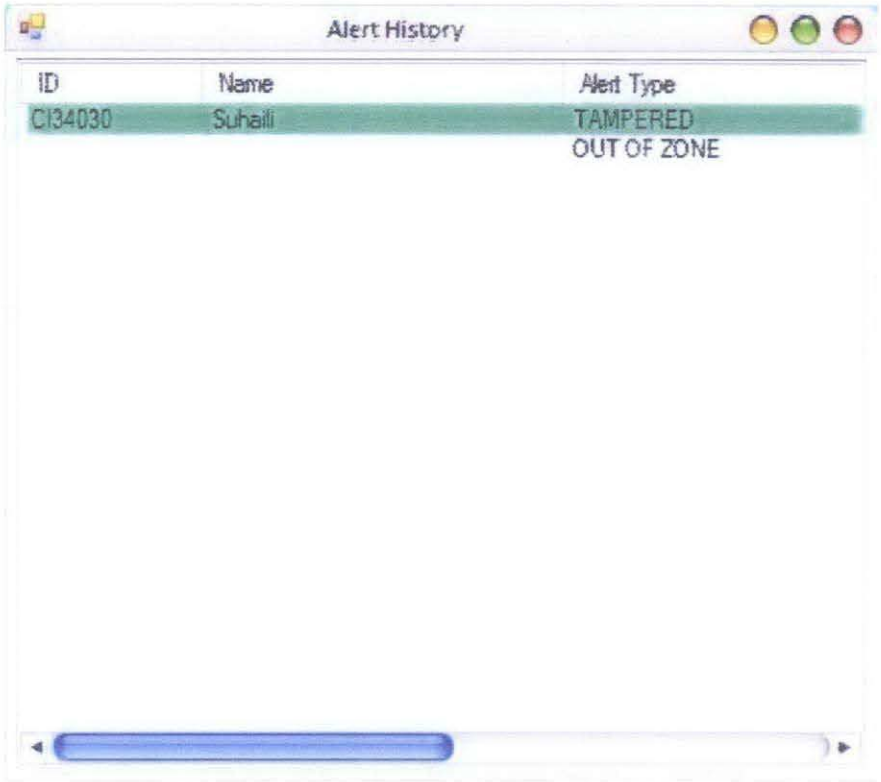

Figure 12 Alert History.

From the "Alert History" screen, the user can check the history of any alert occurred before. To check the baby list, the user has to click "Baby List" button from the Main Menu and the "Baby List" screen will pop up. The "Baby List" screen is shown below:

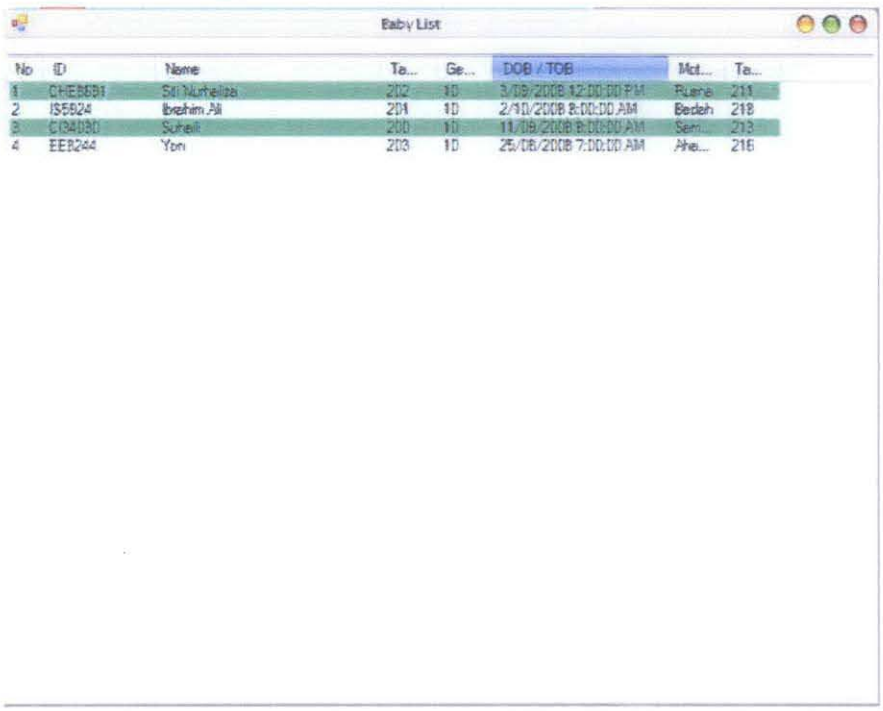

Figure 13 Baby List.

From the "Baby List" screen, the user can check the details for each baby such as Name, ID, Gender, Tag Number, Date of Birth/Time of Birth, Mother's Name and Mother's Tag Number. To check the personnel list, the user has to click "Personnel List" button from the Main Menu and the "Personnel List" screen will pop up. The "Personnel List" screen is shown below:

Figure 14 Personnel List.

From the "Baby List" screen, the user can check the details for each authorized personnel who can access BabyTraxx system. All the information is saved in MySQL database. The Personnel List database is shown below:

	id	name	Password
	PE4321	Ismi Ismayatim	4321
	PE8723	Zulkarnain Mustapha	8723
	KP7777	Mohd Amirul Anwar	7777
	KE2834	Al-Ashraf Ibaharin	2834
	8797	Djamal	mourir
	6825	Mohd Syazwan	6825

Figure 15 Personnel List Database.

The remaining databases are shown in Appendices. To connect the BabyTraxx system to reader, user just simply clicks the Connect button. If system is successfully connected to hardware, the indicator of the reader will change from "Off" to "On". The indicator is shown below:

Figure 16 Hardware Successfully Connected.

To activate the BabyTraxx monitoring system, user just simply clicks the "Start" button. After the system is activated, it will warn the user if the tag approaching the exit/entrance indicating someone try to abduct the children and take it out from the maternity ward. The "Out of Zone" warning is shown below:

Figure 17 Out of Zone Warning.

The alarm will also trigger if someone try to remove the tag from the baby indicating someone try to compromise with the BabyTraxx system. The "Tag Tampered" warning is shown below:

Figure 18 Tag Tampered Warning.

To use the babymatch function, just make sure tag of the mother and baby are in the reader zone. The tag ID will be crosschecked to make sure the baby belong to the mother. If the matching process is successful, dialog box will pop up indicating the process is successful. The dialog box is shown below:

Figure 19 Tags successfully matched.

If you want to log out from the system, just click the "Log Out" screen from the Main Menu. Finally if you want to quit the program, just click "Exit" button and a confirmation message will appear. Click "Yes" if you really want to quit.

4.2 Discussion

The result for the survey questionnaire has been obtained. There are about 50 respondent have participated in this survey. From the result of the survey, it is shown that this project is feasible to be implemented to replace current baby tagging method.

From the result, we can see that about 40 % respondents went to maternity ward for 1-2 times and 43% went there for 3-4 times. We can see that most of the respondents are parents that already have experience delivering the babies in hospitals. Most of them have been in maternity ward and they know how their baby was handled by the nurses. About 60% respondents agree that the current environment is not safe for their babies.

Most of the respondent that answer stated that the current method is not reliable because the conventional paper strap can be compromised easily. About 57% respondents feel that their babies are not safe from abduction in maternity ward. It shows that most parents have doubt on the security of current method. The security of the maternity must be improved so that there is no chance for abduction cases to happen.

About 60 % respondents very concern about the safety of their child and willing to pay a little bit more for the safety of their child. Here we can see that safety of the children is more important than money for the respondents. About 50% respondents said that they prefer to go to hospitals that offer RFID tagging system. It shows that most of the respondents more confidents in this more advanced RFID technology over the conventional baby tagging method.

For the conclusion, most of the respondents agree that this system has to be implemented in the hospitals to replace the current baby tagging method. It is also can be concluded that this project is feasible to be implemented to replace current baby tagging method.

The BabyTraxx system has been developed using Visual Basic for GUI and MySQL for database. There are some difficulties faced by author during the system development. The main problem faced is the limited access to the hardware. Due to limited budget and cost of RFID device is very high, the supervisor of the project only managed to buy 2 units of RFID development kit. There are quite a number of students working on projects involving the hardware. So, the author has to share the device with other students and access to the hardware is very limited. The late arrivals of the hardware from the manufacturer worsen the problem.

Author also faced difficulties in learning Visual Basic and MySQL programming. It takes a lot of reading and consultation from expert before the author managed to develop the programming himself. The author tries to make the GUI as simple as possible so that the new user can adapt easily with the interface. Is interface is also finalized but the author still can improve it to meet client requirement.

Despite of all difficulties, the system still managed to be completed successfully according to plan. Credit to all people involved for their cooperation, knowledge sharing, endless guidance and continuous support on the work in order to complete the project successfully.

CHAPTER 5
CONCLUSION & RECOMMENDATION

5.1 Conclusion

This "RFID Tagging System for Newborn Babies" is using a special tamper-proof strap attached to ankle of the babies. If the tag is lifted from the baby's skin or if the ankle strap is compromised, the system immediately triggers an alarm, alerting hospital security to the situation. This system will protect babies against mismatching events by affixing matching RFID tags to mother and child. If the mother is given the wrong child, the RFID tag detects the mismatch and activates an audible alarm. The most important things it will also overcome infant abductions problem since there are many abduction cases involving newborn babies nowadays. This system will ensure smooth flow of infant management in maternity ward since this system will prevent from any confusion especially when the nurses want to hand in the babies to their respected parents. A laboratory test was carried out using RFID component available at UTP communication laboratory. The working prototype was tested successfully and the system is still improving to meet the requirement of hospital in Malaysia. The BabyTraxx will be tested in real life environment. The real life prototype testing will be carried out at Hospital Sungai Buloh later.

5.2 Recommendation

There is no restriction in improvement for RTSNB. The recommendation for better advancement and adding new features will benefit the system to realize with real applications in wider fields. Thus, the recommendations are as follows:

i. Implementation of GSM Modem to the system in order updates the status of the babies directly to the parents and the authorized person via SMS.
ii. Implementation of GPS (Global Positioning System) for double security of the system.
iii. To improve the monitoring system by combining current RFID system with CCTV monitoring. Thus the efficiency and reliability of current system can be improved.

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APPENDICES

APPENDIX A

GANTT CHART FOR FYP1

No.	Detail/ Week	1	2	3	4	5	6	7	8	9	10	11	12	12	13	14
1	Selection of Project Topic	■	■									Mid-semester break				
2	Preliminary Research Work		■	■	■											
3	Submission of Preliminary Report				●											
4	Project Work					■	■	■	■							
	- Hospital Visits								●							
	- Survey Questionnaire									●						
5	Submission of Progress Report									●						
6	Seminar (compulsory)										●					
7	Project work continues									■	■		■	■	■	■
8	Submission of Interim Report Final Draft														●	
9	Oral Presentation															●

● Suggested milestone

■ Process

GANTT CHART FOR FYP2

No.	Detail/ Week	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1	Design and Development of Database	■	■	■	■	■	■	■	■	■	■	Mid-semester break				
2	Submission of Progress Report 1				●											
3	Submission of Progress Report 2								●							
4	Integration Database with Hardware												■	■		
5	Seminar (compulsory)												●			
6	Prototyping														■	■
7	Submission of Final Dissertation Report														●	
8	Submission of Technical Report														●	
9	Oral Presentation															●

● Suggested milestone

■ Process

APPENDIX B

SURVEY QUESTIONNAIRE

RFID Tagging System for Newborn Babies.

Two infants are bathed and each accidentally returned to the incorrect bassinet. A mother picks up her child according to the bassinet label, unaware that a swap has taken place. This problem will eventually happen if there is no proper method to identify the baby. Maternity wards are handling more and more births daily. Keeping track of the growing number of babies has become a challenge for even the most modern hospitals.

The main objective of this project is to develop a RFID Infant Protection System prototype to prevent infant abductions and inadvertent child mismatching. A special tamper-proof strap will be attached to ankle of the babies. If the tag is lifted from the baby's skin or if the ankle strap is compromised, the system immediately triggers an alarm, alerting hospital security to the situation. The system should be able to protect against mismatching events by affixing matching RFID tags to mother and child. If the mother is given the wrong child, the RFID tag detects the mismatch and activates an audible alarm. Therefore this research is made to find the feasibility of this project.

The questionnaire below is divided into 3 sections which are A, B and C. Please answer the questions by referring to every section's instructions. To simplify and save time, point forms are encouraged.

Section A: General / Background Information

Please fill in the blanks and tick in [ ] provided.

I. Respondent Information:

1. Are you married?
[ ] Yes [ ] No

2. How many children do you have? :
[ ] None [ ] 1-2 [ ] 3-4 [ ] > 5

II. Hospital Information:

1. How many hospitals have you been to deliver babies?
   [ ] 1-2 [ ] 3-4 [ ] 5-6 [ ] > 7

2. How many times have you been to Maternity Ward?
   [ ] 1-2 [ ] 3-4 [ ] 5-6 [ ] > 7

3. Do you know how situation of the Maternity Ward is?
   [ ] Yes [ ] No

Section B: Perception of Maternity Ward

Please fill in the blanks and tick in [ ] provided.

1. Do you know any current method for tagging babies?
   [ ] Yes [ ] No [ ] Not Sure

2. Do you feel that current baby tagging method can ensure that your babies won't mix-up with others?
   [ ] Yes [ ] No [ ] Not Sure

   If you answer **No**, please state the reason(s) why.

   _____

   _____

   —

3. Do you think your can trust nurses handling your babies?
   [ ] Yes [ ] No [ ] Not Sure

4. Do you think that your baby is safe from abduction in maternity ward?
   [ ] Yes [ ] No [ ] Not Sure

Section C: Feasibility Study

Please fill in the blanks and tick in [ ] provided.

1. Will you pay more for the safety of your child?
   [ ] Yes [ ] No [ ] Not Sure

2. Will you go to hospitals that offer RFID Tagging System for Newborn Babies?
   [ ] Yes [ ] No [ ] Not Sure

Section D: Feedback

1. Do you prefer to know result of this research?
   [ ] Yes [ ] No

2. Would you willing to be contacted to provide additional information to support this research?
   [ ] Yes, my contact telephone number is _____ ext : _____
   [ ] No.

Thank you for your time and cooperation in completing the questionnaire. Your response will be used for research purpose only. I would be appreciated if you could return this questionnaire as soon as possible, latest by 17th October 2008.

APPENDIX C

RESULT OF SURVEY QUESTIONNAIRE

The results of the survey for every question are shown below:

Section A: General / Background Information

I. Respondent Information:

1. Are you married?
   [ ] Yes [ ] No

Result:

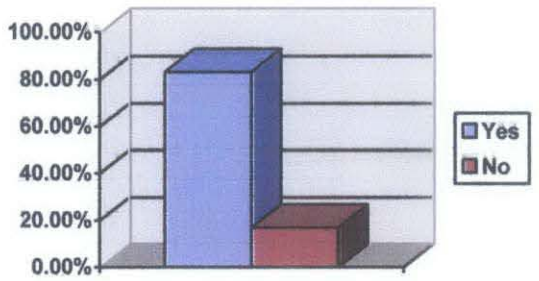

Figure 20 Bar Chart for Question 1

About 80 % respondent answer "Yes" and 20% answer "No". It shows that most of the respondent is married.

2. How many children do you have? :
   [ ] None [ ] 1-2 [ ] 3-4 [ ] > 5

Result:

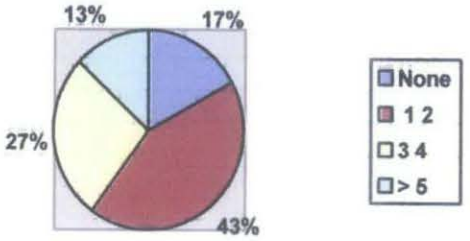

Figure 21 Pie Chart for Question 2

It shows that most of the respondents have 1-2 children.

II. Hospital Information:

4. How many hospitals have you been to deliver babies?
   [ ] 1-2 [ ] 3-4 [ ] 5-6 [ ] > 7

Result:

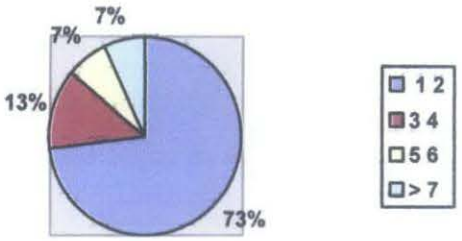

Figure 22 Pie Chart for Question 1

About 73 % respondents answer "1-2". It shows that most of the respondent went to 1 to 2 hospitals only to deliver babies.

Section B: Perception of Maternity Ward

5. Do you know any current method for tagging babies?
   [ ] Yes [ ] No [ ] Not Sure

   Result:

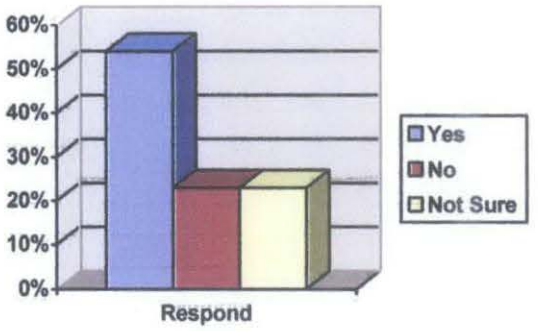

Figure 25 Bar Chart for Question 1

About 50 % answer "Yes". It shows that they're aware of the current method for tagging the babies.

6. Do you feel that current baby tagging method can ensure that your babies won't mix-up with others?
   [ ] Yes [ ] No [ ] Not Sure

   If you answer **No**, please state the reason(s) why.

Result:

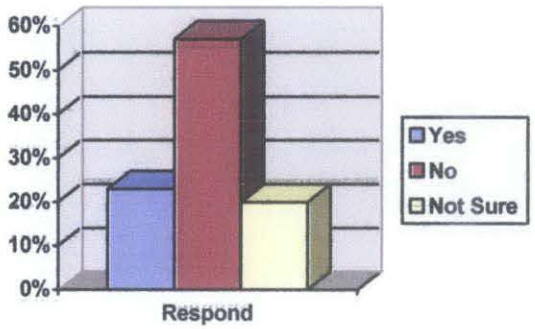

Figure 26 Bar Chart for Question 2

About 60 % answer "No". It shows that they're not confident in the current baby tagging method. Most of the respondent that answer "No" stated that the current method is not reliable because the conventional paper strap can be compromised easily.

7. Do you think your can trust nurses handling your babies?
   [ ] Yes [ ] No [ ] Not Sure

Result:

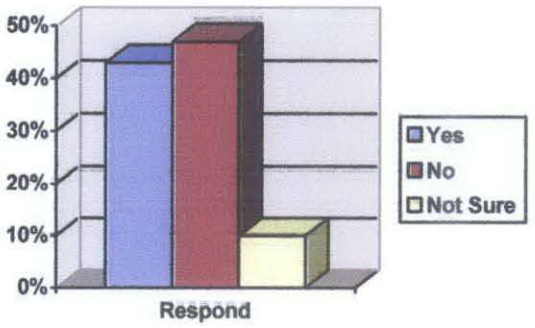

Figure 27 Bar Chart for Question 3

About 43 % answer "Yes" and 47% answer "No". It shows that most of the respondents have doubt for the nurses handling their babies.

8. Do you think that your baby is safe from abduction in maternity ward?
   [ ] Yes [ ] No [ ] Not Sure

   Result:

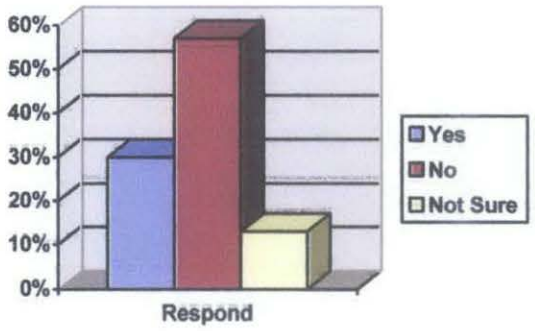

Figure 28 Bar Chart for Question 4

About 30 % answer "Yes" and 57% answer "No". It shows that most of the respondents feel that their babies are not safe from abduction in maternity ward.

Section C: Feasibility Study

3. Will you pay more for the safety of your child?
   [ ] Yes [ ] No [ ] Not Sure

   Result:

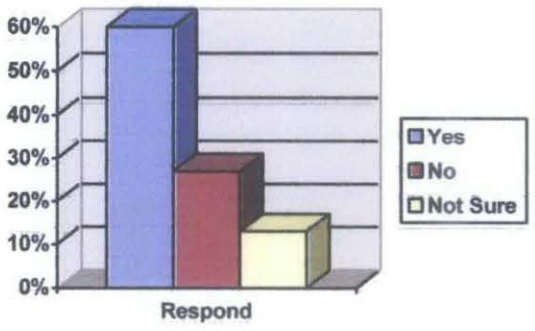

Figure 29 Bar Chart for Question 1

About 60 % answer "Yes" and 27% answer "No". It shows that most of the respondents concern about the safety of their babies and willing to pay more.

4. Will you go to hospitals that offer RFID Tagging System for Newborn Babies?
   [ ] Yes [ ] No [ ] Not Sure

   Result:

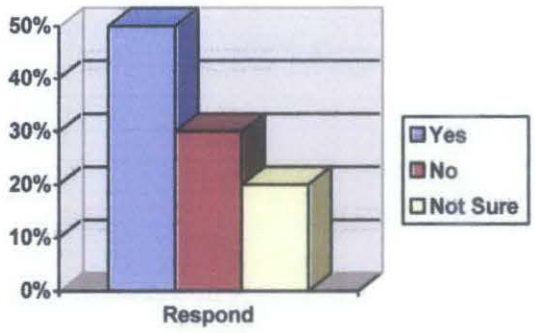

Figure 30 Bar Chart for Question 2

About 50 % answer "Yes" and 30% answer "No". It shows that most of the respondents choose to go to hospitals that offer this baby tagging system over the hospitals that still use the conventional baby tagging system.

Section D: Feedback

3. Do you prefer to know result of this research?
   [ ] Yes [ ] No

   Result:

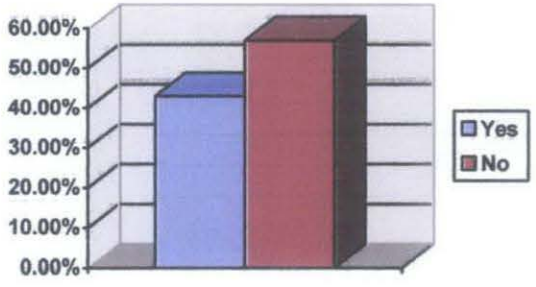

Figure 31 Bar Chart for Question 1

About 43 % answer "Yes" and 57% answer "No".

4. Would you willing to be contacted to provide additional information to support this research?

   [ ] Yes, my contact telephone number is _____ ext : _____

   [ ] No.

   Result:

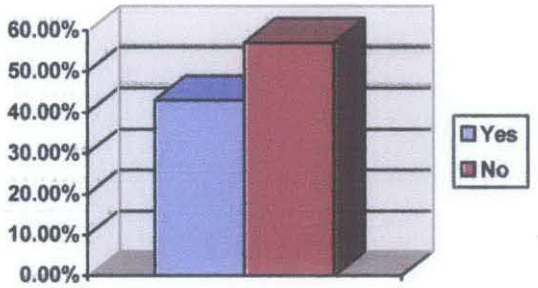

Figure 32 Bar Chart for Question 2

About 43 % answer "Yes" and 57% answer "No".

APPENDIX D

VISUAL BASIC CODING

Login.vb

```
Public Class Login

    Private Sub OK_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles OK.Click
        If UsernameTextBox.Text = "Syazwan" And PasswordTextBox.Text
= "1234" Then
            MainMenu.Tag = UsernameTextBox.Text
            MainMenu.Show()
            Me.Close()
        Else
            MsgBox("Wrong Username or Password")

        End If
    End Sub

    Private Sub Cancel_Click(ByVal sender As System.Object, ByVal e
As System.EventArgs) Handles Cancel.Click
        Me.Close()

    End Sub

    Private Sub UsernameTextBox_TextChanged(ByVal sender As
System.Object, ByVal e As System.EventArgs) Handles
UsernameTextBox.TextChanged

    End Sub

    Private Sub Login_Load(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles MyBase.Load

    End Sub
End Class
```

MainMenu.vb

```
Public Class MainMenu

    Private Sub Form1_Load(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles MyBase.Load
        Label3.Text = Me.Tag
    End Sub

    Private Sub AddBaby_Click(ByVal sender As Object, ByVal e As
System.EventArgs) Handles cmdAddBaby.Click
        frmAddBaby.Show()
        Me.Hide()

    End Sub

    Private Sub cmdStatus_Click(ByVal sender As System.Object, ByVal
e As System.EventArgs) Handles cmdStatus.Click
        Form3.Show()
        Me.Hide()

    End Sub

    Private Sub Button1_Click(ByVal sender As System.Object, ByVal e
As System.EventArgs) Handles Button1.Click
        Dialog1.Show()

    End Sub

    Private Sub TextBox1_TextChanged(ByVal sender As System.Object,
ByVal e As System.EventArgs)

    End Sub

    Private Sub Button4_Click(ByVal sender As System.Object, ByVal e
As System.EventArgs) Handles Button4.Click
        MsgBox("Please make sure mother and baby are in zone.")
    End Sub

    Private Sub Label1_Click(ByVal sender As System.Object, ByVal e
As System.EventArgs) Handles Label1.Click

    End Sub

    Private Sub Label3_Click(ByVal sender As System.Object, ByVal e
As System.EventArgs) Handles Label3.Click

    End Sub

    Private Sub Button5_Click(ByVal sender As System.Object, ByVal e
As System.EventArgs) Handles Button5.Click
        MsgBox("Under Construction")
    End Sub

    Private Sub Button2_Click(ByVal sender As System.Object, ByVal e
As System.EventArgs) Handles Button2.Click

    End Sub
End Class
```

AddBaby.vb

```
Public Class frmAddBaby
    Dim ID As String

    Private Sub Exit2_Click(ByVal sender As System.Object, ByVal e
As System.EventArgs) Handles Exit2.Click
        Dialog2.Show()
    End Sub

    Private Sub Button3_Click(ByVal sender As System.Object, ByVal e
As System.EventArgs) Handles Button3.Click
        MainMenu.Show()
        Me.Close()
    End Sub

    Private Sub frmAddBaby_Load(ByVal sender As System.Object, ByVal
e As System.EventArgs) Handles MyBase.Load
        'TODO: This line of code loads data into the
'HospitalDataSet.motherdetails' table. You can move, or remove it,
as needed.

Me.MotherdetailsTableAdapter.Fill(Me.HospitalDataSet.motherdetails)


        If ID = "" Then
            Me.Text = "Create New Record"
            MotherdetailsBindingSource.AddNew()
            'btnApprove.Visible = False
            'txtApprove.Visible = False
        Else
            Me.Text = "Edit Existing Records"
            MotherdetailsBindingSource.Position =
Me.MotherdetailsBindingSource.Find("ID", ID)

        End If
    End Sub

    Private Sub Button1_Click(ByVal sender As System.Object, ByVal e
As System.EventArgs) Handles Button1.Click
        Me.Validate()
        Me.MotherdetailsBindingSource.EndEdit()

Me.MotherdetailsTableAdapter.Update(Me.HospitalDataSet.motherdetails
)
        Me.HospitalDataSet.motherdetails.AcceptChanges()
        MessageBox.Show("Baby details being saved successfully.",
"Add Baby", MessageBoxButtons.OK, MessageBoxIcon.Information)
        Me.Close()
        MainMenu.Show()

    End Sub
End Class
```

Status.vb

```
Imports System.Data.OleDb
Imports VB = Microsoft.VisualBasic
Imports System.Globalization

Public Class Form3
    Dim TagID As String

    Private Sub Form3_Load(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles MyBase.Load
        'TODO: This line of code loads data into the
'HospitalDataSet.motherdetails' table. You can move, or remove it,
as needed.

Me.MotherdetailsTableAdapter.Fill(Me.HospitalDataSet.motherdetails)

        If Me.DataGridView1.Rows.Count < 1 Then
            txtStatus.Text = "No record found."
            MessageBox.Show("No record found.", "No Record found",
MessageBoxButtons.OK, MessageBoxIcon.Information)
        Else
            txtStatus.Text = "Total of " &
Me.DataGridView1.Rows.Count & " record(s) found."
            MessageBox.Show("Total of " &
Me.DataGridView1.Rows.Count & " record(s) found.", "Search Result",
MessageBoxButtons.OK, MessageBoxIcon.Information)
        End If

        Me.MotherdetailsBindingSource.Sort = "[Name] asc"
    End Sub


    Private Sub DataGridView1_CellContentDoubleClick(ByVal sender As
Object, ByVal e As System.Windows.Forms.DataGridViewCellEventArgs)
Handles DataGridView1.CellContentDoubleClick
        If DataGridView1 Is Nothing Then Exit Sub
        If DataGridView1.CurrentRow Is Nothing Then Exit Sub
        Dim frm As New frmAddBaby
        'frm.ID =
DataGridView1.Rows(DataGridView1.CurrentRow.Index).Cells(TagIDDataGr
idViewTextBoxColumn.Index).Value
        frm.Show()
        Me.Cursor = Cursors.Default
        Me.Hide()
    End Sub

    Private Sub Exit2_Click(ByVal sender As System.Object, ByVal e
As System.EventArgs) Handles Exit2.Click
        If MessageBox.Show("Are you sure you want to quit?.",
"Exit", MessageBoxButtons.YesNo, MessageBoxIcon.Question) = vbYes
Then
            Me.Close()

        End If
        MainMenu.Show()

    End Sub

    Private Sub Button3_Click(ByVal sender As System.Object, ByVal e
As System.EventArgs) Handles Button3.Click
```

```
        Me.Close()
        MainMenu.Show()
    End Sub

End Class
```

Exit.vb

```
Imports System.Windows.Forms

Public Class Dialog1

    Private Sub OK_Button_Click(ByVal sender As System.Object, ByVal
e As System.EventArgs) Handles OK_Button.Click
        Me.DialogResult = System.Windows.Forms.DialogResult.OK
        MainMenu.Close()
        Me.Close()
    End Sub

    Private Sub Cancel_Button_Click(ByVal sender As System.Object,
ByVal e As System.EventArgs) Handles Cancel_Button.Click
        Me.DialogResult = System.Windows.Forms.DialogResult.Cancel
        Me.Close()
    End Sub

End Class
```

APPENDIX E

DATABASE TABLE

Alert History

ack	id	Name	alertType	Zone	ProgressTime
ALERT	CI34030	Suhaili	TAMPERED	10	2009-06-03 10:08:12
OK	IS5924	Ibrahim Ali		10	2009-06-03 10:07:55
OK	EE8244	Yon		10	2009-06-03 10:08:14
OK	CHE8691	Siti Nurhaliza		10	2009-06-03 10:08:45
Alert			OUT OF ZONE	10	2009-06-03 10:08:43

Baby Details

id	name	Room	house	bed	tag_id	enroll
CHE8691	Siti Nurhaliza	10	Rusna	211	202	2008-09-03 12:00:00
IS5924	Ibrahim Ali	10	Bedah	218	201	2008-10-02 08:00:00
CI34030	Suhaili	10	Samsiah	213	200	2008-09-11 08:00:00
EE8244	Yon	10	Ahabina	216	203	2008-08-25 07:00:00

Personnel Details

id	name	Password
PE4321	Ismi Ismayatim	4321
PE8723	Zulkarnain Mustapha	8723
KP7777	Mohd Amirul Anwar	7777
KE2834	Al-Ashraf Ibaharin	2834
8797	Djamal	mourir
6825	Mohd Syazwan	6825

Reader

ReaderID	RoomNo
1	10
2	20