2017

Wireless baby tracking system to curb child kidnapping

Caroline Muthoni Mwangi
Faculty of Information Technology (FIT)
Strathmore University

WIRELESS BABY TRACKING SYSTEM TO CURB CHILD KIDNAPPING

Mwangi Caroline Muthoni

057069

Submitted in partial fulfilment of the requirement for the Degree of Masters of Science in Information Technology

Faculty of Information Technology

Strathmore University

Nairobi, Kenya

June, 2017

Declaration

I declare that this research is my original work and has not been presented for the award of a degree by this or any other university. To the best of my knowledge and belief, the research contains no material previously published or written by another person except where due reference is made in the research itself.

Mwangi Caroline Muthoni

06/06/2017

Approval

The thesis of Mwangi Caroline Muthoni was reviewed and approved by the following:

Dr. Humphrey Njogu,
Senior Lecturer, Faculty of Information Technology,
Strathmore University

Dr. Joseph Orero,
Dean, Faculty of Information Technology,
Strathmore University

Professor Ruth Kiraka,
Dean, School of Graduate Studies,
Strathmore University

Abstract

Child kidnapping is common case, not only in Kenya but also all over the world. Infants are more vulnerable due to the fact that they are helpless and can easily be carried away without anyone noticing that something is amiss. Over time, different approaches have been developed to track children especially in public places. Many of these solutions involve GPS tracking but not many organizations and events involving gatherings of many children have been in a position to adopt such solutions. This is because they are expensive and do not integrate easily with other systems.

The study seeks to come up with a solution to track babies within the workplace. It puts into consideration the "babies at work" policy, which has been adopted many companies including some in Kenya. The solution is based on RFID and basically combines active RFID tags with the existing wireless LAN. RFID has been greatly improved and the use of active RFID tags, which broadcast a signal to the access point, enables companies with an existing Internet connectivity to make use of their bandwidth without having to purchase RFID readers. The work is meant to provide a cheap and scalable solution that can traverse different scenarios, such as, public baby day-care centres, Churches and other social events.

The proposed solution will be based on prototyping from the analysis phase to the implementation phase. The solution will then be tested to check on its reliability, performance and accuracy. The language to be used in development of the solution is PHP, Python, HTML, CSS, Javascript and MySQL database.

Keywords

Day-care, Radio Frequency Identification, "babies at work" policy, wireless LAN

Abbreviations

- AP – Access point
- DFD – Dataflow Diagram
- ERD – Entity Relationship Diagram
- RFID – Radio Frequency Identification
- WEP – Wired Equivalent Privacy
- WLAN – Wireless Local Area Network

Definition of Terms

- Baby at work policy - A policy that allows mothers to carry their babies to work and look after them as they go about the duties in the workplace. It enables mothers to breastfeed optimally: allows for the creation of designated places for mothers to be able to express and store their milk. This enhances their productivity and reduces work-related stress (Wainaina, 2015).
- Radio Frequency Identification (RFID) – this is a type of automatic identification technology that enables the user to "tag" objects with a tiny device that can later be detected by automatic means. That detection can range from simply noting the presence of the device, to obtaining a fixed identification number for the device, to initiating a two-way communication with the device. When the tag is in the presence of an appropriate radio frequency (RF) signal originated by a reader, it responds by sending back a reflected RF signal with information in response. At the higher-end RF technology, the contactless RFID tags have been enhanced with the full capacity of smart card chips containing general-purpose computer processors and larger non-volatile memory spaces (The use of RFID for Human Identity Verification, 2006).
- Tracking - recording the progress or development of something over a period (Cambridge Dictionary, 2017)
- Wireless Local Area Network - Wireless LAN (WLAN) allows nodes to communicate with each other wirelessly. The architecture of this type of network is the same as Local Area Network (LAN)'s except that the transmission happens via radio frequency (RF) or Infrared (IR) and not through physical wires/cables, and at the MAC sub-layer, as uses different standard protocol. This technology provides people with a ubiquitous communication in various places such as, offices, hospitals and campuses (Kazemitabar, Ahmed, Said, & Hasbullah, 2010).

Table of Contents

Table of Figures

List of Tables

List of Equations

Chapter 1: Introduction

1.1 Background

Kenya's new Constitution, passed in 2010, provides a powerful framework for addressing gender equality. It outlines the rights of women and the untapped potential of women and girls is gaining greater attention in Kenya (Gender Equality and Women's Empowerment in Kenya, 2016). According to one of the longest running surveys measuring public opinion in the U.S., three-fourths of Americans (75%) believe the U.S. has come a long way toward reaching gender equality, but issues clearly persist (The Harris Poll, 2016). To encourage ladies to go into motherhood and still have job security has therefore led to the option of young mothers bringing their children to the workplace. Some 200 companies and organizations in the U.S. now have a "babies at work" policy, according to the Parenting in the Workplace Institute (Pawlowski , 2015).

Ensuring security of the babies brought to work is crucial in order to reduce cases of child kidnapping. Any missing child is exposed to risks that range from drugs, poor health, murder, rape or infection with killer diseases (Shalev, 2010). Efforts have been made globally to ensure that infants are protected, especially in public areas, for instance in shows and child fun zones. Wearables with GPS tracking which can pinpoint the exact position of the person you are looking for using a map on a smartphone or a tablet and are a part of the solutions offered for child tracking (Lamkin, 2016). Another example is Huawei's Disney Kids Smartwatch, which is based around GPS tracking for parents and activity tracking for the little ones. The watch has a day and a half of battery life from the 300mAh pack with a full charge taking two hours (Paul, 2016).

Despite these efforts, there are still challenges in terms of the number of organizations that have adopted child-tracking solutions, especially in the developing countries. This is due to the fact that a lot of these solutions are quite expensive, both the software and the hardware. Also, integration of child tracking solutions is not easy, as most of them are built as stand-alone solutions. The work therefore focuses on developing a baby-tracking solution that lowers the cost of the infrastructure by making use of existing wireless LAN.

1.2 Problem Statement

Baby trafficking is a lucrative business in Kenya (Onyulo, 2015) and hence ensuring that security is high within the workplace to prevent stealing of babies from the baby care centre is crucial. It is estimated that more than 20,000 children are trafficked annually in Kenya (Odhiambo, Kassilly, Maito, Onkware, & Obaka, n.d.). In 2014, some 658 child trafficking victims were reportedly identified in 18 out of the 47 counties in Kenya (Ongiri, 2015).

When a child gets lost, every minute counts (Singer, 2016). Some baby tracking solutions have been developed, such as the Victoria tracking solution which is a GPS tracking solution which records the position of a child every time they move 20 feet, or every 10 seconds if they are inside a vehicle that is moving over 10 miles per hour (Tracking System Direct, 2009). However, GPS is not always 100 percent accurate as a result of various factors such as blocking of the line of sight between the GPS device and the GPS satellites or poor mobile network coverage (Potential Problems with GPS Tracking, n.d).

The research seeks to develop a wireless baby tracking system that monitors babies in baby care centres in corporates, which have formal programs in which guardians can bring their babies to work. The RFID solution combines active RFID tags with the wireless LAN to track the current location of the baby. The work is meant to enable each parent to track their baby from their smartphone or tablet. The solution is cheap to deploy as it takes advantage of the existing wireless LAN.

1.3 Research Objectives

This research is based on the following research objectives:

1. To investigate the data required for tracking babies at workplaces.
2. To review the shortcomings of the existing baby-tracking systems.
3. To develop a wireless RFID-based baby tracking system.
4. To test the effectiveness of the developed system.

1.4 Research Questions

This study is based on the following research questions:

1. What is the data required to track babies at workplaces?
2. What are the shortcomings of the existing baby tracking systems?
3. How can the wireless RFID-based baby tracking system be developed?
4. How can the developed system's effectiveness be tested?

1.5 Justification

Child tracking in public places has been implemented in various areas such as Disney and has led to fewer cases of parents spending endless hours looking for their children (Paul, 2016). Companies that have adopted the policy that allows mothers to bring babies to work also need to ensure that security of these children is catered for within their premises. With the wireless baby tracking system, mothers and guardians can be in a position to receive alerts on their phones in case their children are taken out of the baby care without their knowledge.

1.6 Scope and Limitations

The research covers monitoring of babies to prevent child theft in offices that encourage mothers to bring their babies to work. It does not cover security of the babies outside the corporate premises. The system, however, can be applied at baby day-care centres, which are common in estates and can also extend to places such as Churches and child fun zones.

The cost of infrastructure is a huge limitation as it may call for a wireless infrastructure upgrade using Cisco access points that support active RFID. There may also be need to increase the bandwidth as a result of increased network traffic due to the additional devices (RFID) on the network.

Chapter 2: Literature Review

2.1 Introduction

This chapter includes a critical analysis of the relationship among different works with my research. The work done by various authors is vital in creating a foundation for the research and provides information on what has been done by other people to solve the issue of child kidnapping in public places. Various solutions using different technologies such as GPS and also RFID have been used to facilitate in curbing child theft.

2.2 "Babies at Work" Policy

There is a need for work place support to enable mothers' breastfeed optimally: a need for designated places to be put in place for mothers to be able to express and store their milk while at work. This enhances their productivity and reduces work-related (Wainaina, 2015). The changing employment trends have also driven Kenyan parents to work longer hours. Entrepreneurs and companies are investing more in day care centres to meet demand for specialised child-care services (Wafula, 2010).

In most parts of the world, the main focus of diversity efforts is on hiring and promoting women. The major reason for this is that women, who make up 50% of the population, represent a large, untapped (or under-tapped) resource, which companies will need in the future as Baby Boomers begin to retire (Global Diversity and Inclusion: Perceptions, Practices and Attitudes, n.d.). As a result, some companies have embraced the "Babies at Work" policy to encourage ladies to go into motherhood and still have job security.

Businesses have also been born out of this initiative, such as Babies in Business Solutions (BIBS), which provides assistance to organizations with the implementation of formal programs in which parents can bring their babies to work with them every day and care for them while doing their jobs, generally until the babies are six to eight months of age or crawling (Babies in Business Solutions, 2016).

Inevitably there are fears that bringing a baby into the office will be disruptive to the parent's work and also to colleagues. However, a solution could be setting aside baby care zones and designating co-workers who are happy to help with childcare to ensure the needs of the baby are

constantly met. Parents should also formally agree not to let their childcare responsibilities interfere with their ability to do the job (Jenkin, 2016). More than 2,100 babies in 200 organizations have been successfully brought to work and baby programs have been successful in office-based, cubicle-based, open-plan and retail environments (Parenting in the Workplace Institute, n.d.).

2.3 Baby Day-care Centres

Baby day-care centres have been in existence for a while, especially with first-time parents both having a full-time job. This has been facilitated by need to increase households' income as the cost of living skyrockets. (Orengo & Obegi, 2014) These centres are especially common in estates. Driving the shift is the emergence of new labour laws on the hiring of house helps. Analysts say more domestic workers are savvy about employment laws such as minimum wage, health care cover, and other allowances — leading to higher costs of maintaining them.

Day care centres are also capitalising on parents cautious of rising insecurity in light of a surge in kidnappings and child theft (Wafula, 2010). The contemporary society is the largest contributor to the day-cares in Kenya since it harbours single or married parents who are the busiest working class. The parents enjoy the flexibility and this has enabled them to engage these centres on-a-need basis, such as day care for children with special needs, sick day- care and 24-hour day-care. The ease of accessibility to these day-cares also gives parents an easy time when deciding on the most suitable programme for their babies (Daycare, 2014).

As highlighted earlier, high maintenance costs of house helps and a rise in kidnapping cases have led to a rise in day-care centres in estates. It becomes hard for many mothers in Kenya to do their jobs and at the same time take care of their toddlers during daytime. The other option, apart from having a fulltime nanny, is therefore to take a child to a day care during daytime, which allows you plenty of time to do our job without having to worry about the safety of your toddler (Kenya Business Ideas, 2015). Some day-care centres have the correct licensing to engage in the business. Reason being, sometimes, accidents happen and with children around the percentage is a little higher. Talking with the officials at the Municipal offices to assist in running a check to verify if your premises is ideal for this business is therefore key (Stephanie, 2015).

As mentioned above, only some of the day-care centres have the proper licensing to conduct their business as some of the owners use their homes as the business premises. This implies that some could actually be operating in premises that are not ideal for the babies. Keeping classrooms clean and tidy and ensuring toileting and diapering facilities are clean and that the centre/facility has adequate space for storage, outdoor play and meal/snack preparation in key. (Glass, 2016) Unlicensed day-care centres usually do not put all these into consideration and hence the children may often fall ill due to the questionable environment. A long-term study conducted by researchers at the University of Montreal from 1998 to 2006 found that toddlers in group child care get sick more often than toddlers who stay at home (Anderson, 2016).

With the overwhelming demand, it is inevitable for some the day-cares to host more children than they can handle. The rising number of single parents in the contemporary society has also served to significantly spur demand for day care centres. (Wafula, 2010) As a result of the high incidences of poverty and illness, childcare centres in Kenya can host 50 to 300 children at any one time and there is always high demand for volunteer assistance (Volunteer in childcare in Kenya, n.d.). The rising need for childcare within the estates has also led to higher chances of child theft and lack of sufficient attention to every child's need.

Parents who leave their children at day-cares have to pay a costly fee for late pickups, scramble for backup care when the center is closed on holidays, and stay at home when your child is sick. Children are also less likely to get the one-on-one care that is taken for granted with a stay-at-home mother or nanny. Babies, in particular, need a lot of love and attention to thrive and do well (babycenter, 2016).

2.4 Benefits of Managing Baby Day-care Centres using Technology

Technology has greatly improved over the years and different solutions have been built around tracking of people. There are various benefits brought about by the use of technology to track children. The child GPS tracking industry has advanced greatly in the last few years and is a fairly new use of GPS technology. Some of these GPS tracking systems can provide you with your child's heart rate, blood pressure and body temperature. This information can help you know if your child feels comfortable or if they have a sense of fear and discomfort indicating they may be in trouble (Destiche, 2010). New technology, in the form of voice watches and

miniature sensing devices, is aimed at thwarting such distress by keeping track of children who are too young to carry a smartphone. The new devices use GPS, Wi-Fi and other location-tracking technology and can be linked to apps on a parent's phone (Eisenberg, 2013). With technology, child tracking can be made much easier and hence ease the burden of parents and guardians having to worry about their little ones.

With an improved electronic tracking system, BioEnable Technologies, a company in the field of advanced electronic automation aims at reducing the incidents of newborn child swapping and child thefts. The have introduced a system can also be used in tracking the parents of lost child, making it easier to reach the child to its original parents in case of theft or swapping. The Child ID solution was launched with a broader perspective: a social responsible to reduce the number of female infanticide in hospitals and nursing homes (YS, 2012).

2.5 Existing Frameworks

Different frameworks have been used to enhance child protection. One such example is Australia's child welfare service systems, which more closely resembles an hourglass than a pyramid. As demands on child protection services have grown, child protection services have grown to meet that demand. Child protection services cannot provide a response to all vulnerable children and their families (Australia, 2009). A public health model offers a different approach with a greater emphasis on assisting families early enough to prevent abuse and neglect occurring. It seeks to involve other professionals, families and the wider community – enhancing the variety of systems that can be used to protect children and recognizing that protecting children is everyone's responsibility (Higgins & Katz 2008). The Australian Child Protection Framework is illustrated in figure 2.1 below:

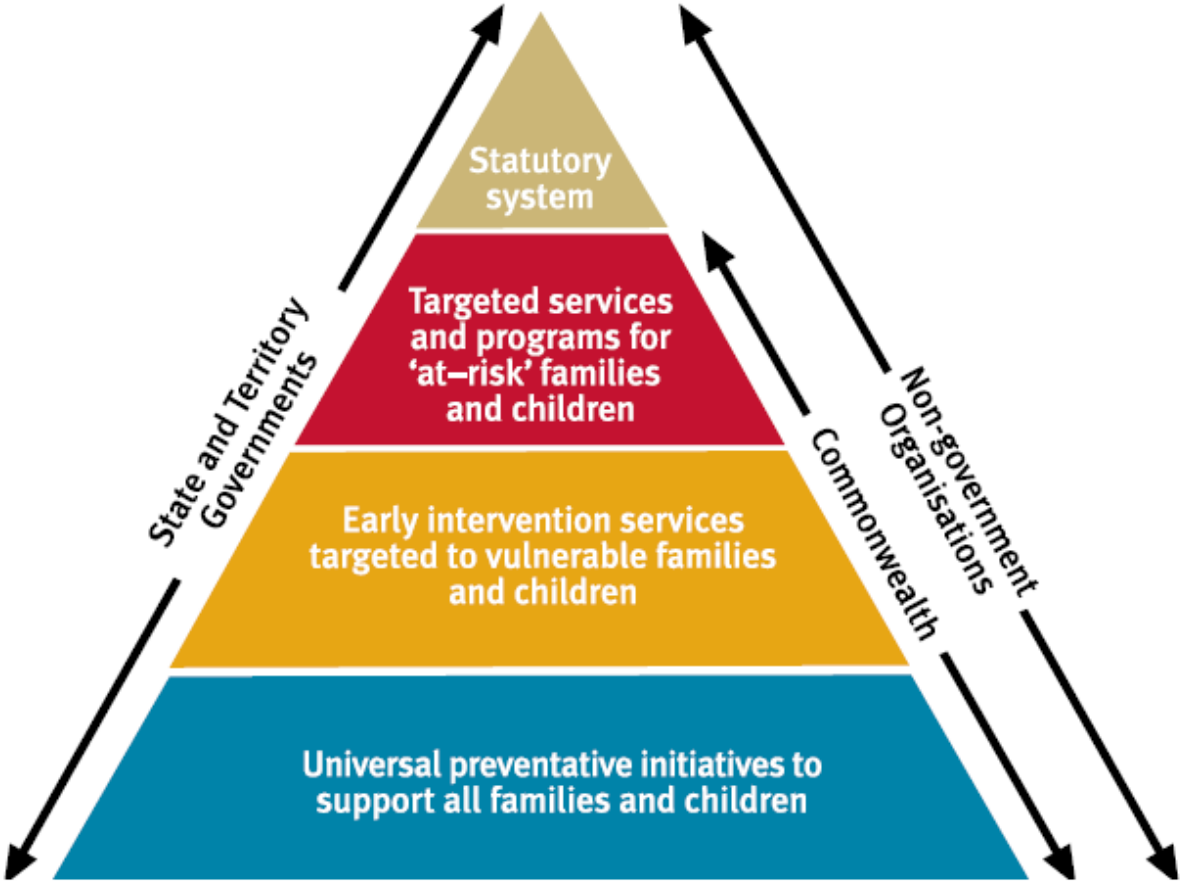


Figure 1.1 Australian Child Protection Framework

The statutory system is struggling as it is more aligned to having the Government do everything in accordance to the law to protect children. However, the various levels below it seek to give a helping hand by proposing policies and implementing them to assist in child protection. Outposted child protection officers, located in the two Child and Family Centres, work collaboratively with the government and non-government sector to provide early intervention services (National framework for protecting Australia's children 2009–2020, 2009).

UNHCR also has a framework for the protection of children, which marks an evolution in UNHCR's policy and practice, recognizing both the centrality of children's protection to UNHCR's work and the growing body of practice and expertise in the child protection sector globally (A framework for the protection of children, n.d.). The Framework articulates six goals that encapsulate UNHCR's commitment to protect and realize the rights of children of concern to the Office, and offers practical guidance on how to achieve them.

The six goals are:

i. Girls and boys are safe where they live, learn and play
ii. Children's participation and capacity are integral to their protection
iii. Girls and boys have access to child-friendly procedures
iv. Girls and boys obtain legal documentation
v. Girls and boys with specific needs receive targeted support
vi. Girls and boys achieve durable solutions in their best interests

(A framework for the protection of children, n.d.)

2.6 Existing Solutions

Different wearables with GPS tracking such as smartwatches which can pinpoint the exact position of the person you are looking for using a map on a smartphone or a tablet (Lamkin, 2016) are a part of the solutions offered for child tracking. Huawei's Disney Kids Smartwatch which is based around GPS tracking for parents and activity tracking for the little ones. The watch has a day and a half of battery life from the 300mAh pack with a full charge taking two hours (Paul, 2016). However, there are some drawbacks to this solution as the watch is expensive (costs about $100) and is customized for Disney by Huawei. This watch has 1.5 days of battery life and full charge takes 2 hours (Lamkin, 2016).

Mi Bunny kids' GPS smartwatch launched by Xiaomi meant for child tracking, supports both GPS and GLONASS, with both Wi-Fi and Bluetooth connectivity. It also has an SOS button (including position and seven seconds of audio) and sends alerts when the child moves outside a custom security zone. This watch also has a silicon strap (Charara, 2016). This watch is highly suitable for the outdoors, rather than indoor places.

Usually, some institutions, for example Lenox Hill Hospital, in New York, have a newborn security system (Department of Obstetrics at Lenox Hill Hospital, 2016). The degree of theft of babies in not only in public areas but also in secluded areas just shows how vital it is to have baby monitoring systems to keep track of every baby. This solution is predominantly meant for a hospital setting and hence may not integrate easily in other environments.

2.7 Conceptual Framework

The solution is based on the following conceptual framework:

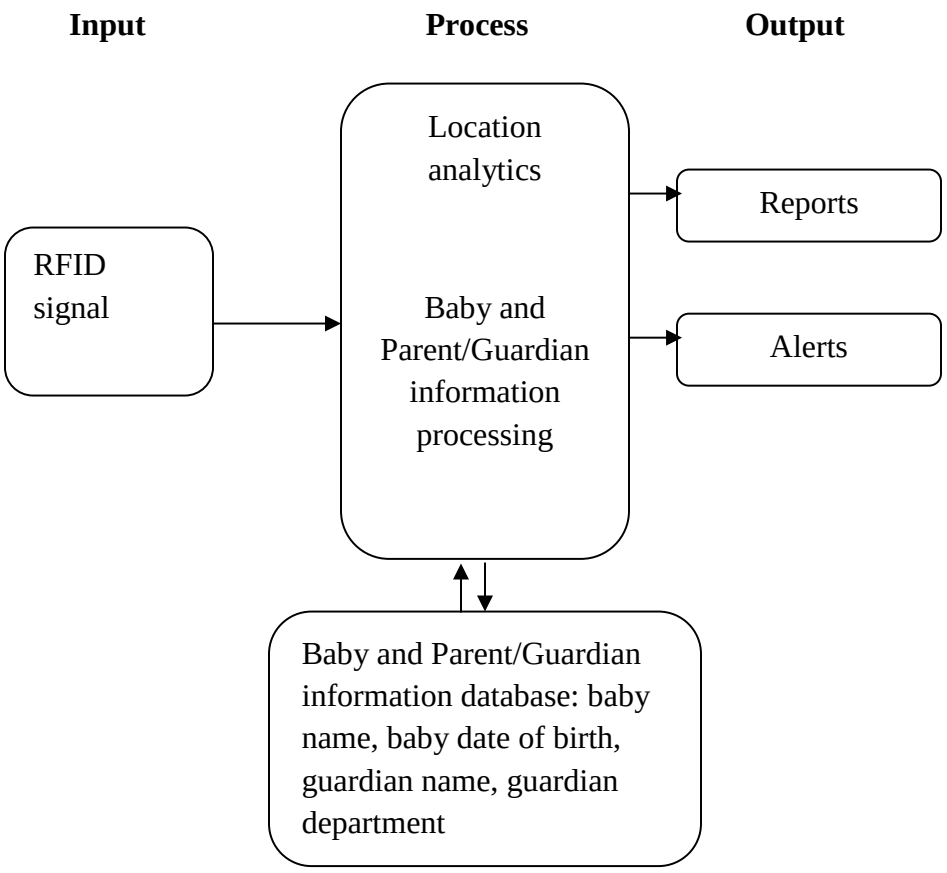


Figure 2.2: Conceptual Framework

Some of the information that will be used as the input is the GPS location, baby's name, parent or guardian's name and the baby's date of birth. The information will be processed to provide reports and the location of the baby, which basically involves continuous monitoring, and provision of real-time baby location.

2.8 Ethical Issues Related to RFID

RFID tags are used may increase human safety but may also raise ethical issues. This may include compromise of child privacy. However, ethical guidelines to be considered in this study

will include an informed-consent process where users (parents, guardians and management) will be privy to possible uncertainties associated with RFID (Bacheldor, 2007).

2.9 Conclusion

The “babies at work” policy has been helpful to working mothers as they can take care of their babies as they work. There are benefits and challenges in day-care centres and technology has been one of the ways used to curb the different challenges, such as, child kidnapping. Different frameworks have been applied to help in protecting children in the event of a kidnap or before it happens. There are also existing solutions that have been developed to assist in child tracking, predominantly in the Americas and Asia. However, such solutions are either too expensive or do not integrate easily and hence the slow adoption in Kenya.

Chapter 3: Research Methodology

3.1 Introduction

This chapter showed the systematic steps adopted by the researcher to solve the research problem. Research methodology is essentially meant to ensure that prior to development, the researcher does enough background research in order to come up with the necessary supportive data and user requirements for the work. It helps to determine the research strategy, tools and techniques to apply as the researcher seeks to come up with the proposed solution. The research mainly applied action research (practical and continuous development).

3.2 Description of the Study

The research was conducted in Nairobi County, Kenya. Copy Cat Group is located in Nairobi County, Westlands, Kenya. It has a total number of about 290 employees. The headquarters are in Nairobi and there are 4 regional offices: Rwanda, Tanzania, Uganda and Ethiopia. The Nairobi headquarters was used as the data collection area, with a sample being taken from the population. The Company has a combination of different age groups with the average age being about 31 years.

3.3 Research Design

3.3.1 Case Study Research

The research applied a case study design. A case study is the investigation of particular settings to obtain deep understandings of related entities in a particular process or context (Woodside, 2010). This type of research can investigate one case or multiple ones and may be applicable in many study environments. It can also produce better understandings in ambiguous situations (Yin, 2009).

3.3.2 Applied Research

The research also employed applied research and used quantitative research methods in order to examine the relationship between variables. Its purpose was to provide information relayed to end-users in order to ensure that the security of their children was intact.

3.4 Population and Sampling

3.4.1 Sample Size

The sample constituted 20 employees of Copy Cat Group. This included men and women. Whose children are below 5 years. This excluded salespeople as they work remotely. It was an appropriate sample size, as it constituted guardians who were in the parenting age group and hence would directly benefit from the solution if adopted.

The researcher applied random sampling technique in order to obtain the desired sample size. Random sampling allows for every element in the population to stand a chance of being chosen to be part of the sample; which therefore eliminates any bias. To obtain the required sample size, equation 3.1 was used:

$$n=N/ (1+N (e)^2) \text{ (Yamane, 1967)}$$

Eq. 1: Sample Size Calculation

Where:

n = Sample size (20)

N = Total population (290)

e = Margin of error (10%)

3.5 Data Collection and Requirements Gathering

During this research, the researcher will aim at collecting both primary and secondary data. This involves:

- Structured online questionnaires: these are data collection tools in which written questions are presented that are to be answered by the respondents in written form (Chaleunvong, 2009). The researcher used a free online survey and questionnaire tool called Cognitoforms (Cognitoforms, 2016).

  The questionnaires were easy to distribute as they were sent as a link via email to the different respondents.

- Observation: this enabled the researcher to identify the various ways in which new mothers within the office would constantly check on their babies while at work and just having brief one-on-one conversations with them.

3.6 Data Analysis

This involved associating data collected and breaking it further in order to get a better understanding. The data was analysed using Microsoft Excel. Excel is easy to use; Excel tables hold the data that needs to be analysed. It is easy to do quick and easy analysis, using simple Excel statistics such as sorting and filtering. Excel also has tools for cleaning and organizing the raw data that needs to be analysed (Nelson & Nelson, 2014).

Data analysis results will be presented using the following tools:

i. Tables – to summarize the significant variables
ii. Pie charts – to provide a visual representation of the quantitative data and to facilitate comparison and correlations within the data.

User requirements will be analysed and system design models generated. These will include dataflow diagrams (DFDs). Use case models, sequence diagrams, entity relationship diagrams (ERDs) and class diagrams.

3.7 Software Development Methodology

Software development is a series of resource-limited, goal-directed cooperative games of invention and communication (Alok, 2011). Agile software development method allows for iterative incremental processes and more frequent release with subsequent user feedback. The iterations are aimed at delivering working software build at each phase/iteration (Highsmith, 2011). Figure 3.1 that seeks to explain agile methodology phases:

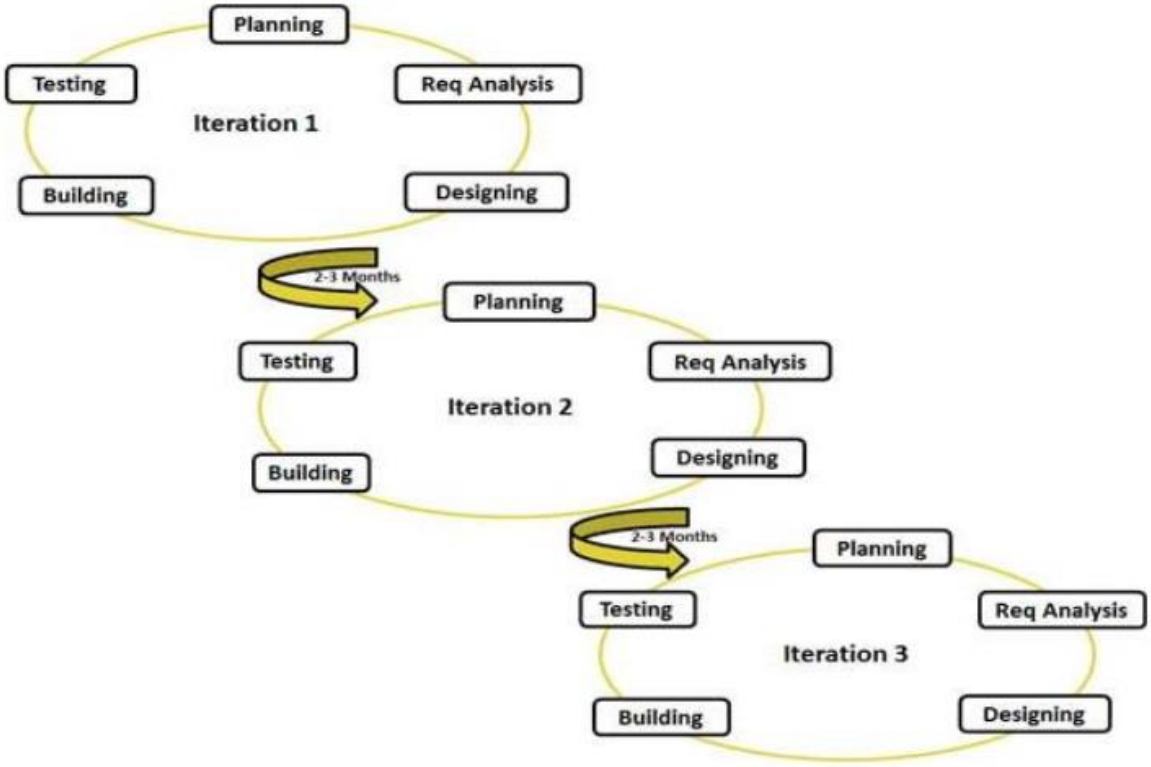


Figure 3.1: Agile Methodology

3.7.1 Planning Phase

This was the initial phase of agile methodology. It aimed at facilitating laying down the plans of how the entire process will be undertaken (Highsmith, 2011). This phase also assisted in identifying the resources needed to develop the system. As part of the planning phase, the researcher was able to do initial preparations to carry out the research by identifying the target group for the solution. The researcher was also able to find out about the "babies-at-work" policy and also hold discussions with part of the target group, in trying to determine the need for the solution. The researcher was able to identify some gaps in terms of the need for a local solution for child tracking that would scale in different environments.

As part of the planning phase, the researcher was also able to identify the tools that she would use to gather data from the target group. This phase also laid a foundation for the researcher to identify the development tools and environment that she would use to develop the solution, as well as other possible alternatives in terms of the development language. The researcher was also able to establish the possible challenges that she would encounter when approaching the target

group and thus planned for alternatives for the same.

3.7.2 Requirements Analysis Phase

This was the second phase; it basically involved analysing the requirements of the system. It will assist the researcher in finding out the environment needed to develop and test the application. It was also help to determine the user requirements in order to satisfy this need. As mentioned earlier, questionnaires were used to collect the system requirements. During this phase, the researcher was able to collect some requirements for the solution from the target group or respondents. The requirements helped the researcher to put more considerations into the initially proposed solution, thus enabling her to build a solution that would suit the target group. The data was collected using online questionnaire. Upon collection, the researcher was able to analyse the data and put the present the information in pie charts and tables.

The requirements analysis phase also created an avenue for the researcher to engage the target group further and get a better understanding of their pain points. This formed a foundation for the next phase, which is the design phase.

3.7.3 Design Phase

This phase started after the requirements have been analysed. Designs are vital as they guide the next phase, which is actual development. Unified modelling language (UML) diagrams will be used in design. As highlighted earlier include, use case diagrams will be used to illustrate the actors: users of the system. Entity relationship diagrams to guide database creation; this will show the various entities, their attributes and the related associations, with their cardinalities. This phase enabled the researcher to have a visual presentation of how the system would work in the back-end and how it would operate. The researcher was able to design diagrams of the layout of the database, the different interactions between the solution and its users and also the expected outputs of the solution.

The design phase enabled the researcher to have a schematic view of the solution thus enabling her to prepare for the implementation phase of the solution.

3.7.4 Building Phase

This was the actual development or implementation phase of the designs done above. Prototype development is key and the aforementioned phases are a preparation to development of the system. The building phase was basically the stage that involved implementation of the system. The user was able to put into perspective the phases done prior in order to develop as viable solution for the target group. This phase involved using different development tools and languages to build the solution. This also involved constantly looking into the requirements to see to it that they were considered during the building phase and that none of the functionalities was left out.

This phase enabled the researcher to put together a working prototype that would be tested in the next phase, to see to it that the solution met the proposed standards and would serve the purpose for which it was intended.

3.7.5 Prototype Evaluation and Testing

The prototype was then be subjected to various types of tests, which include: usability testing, integration testing, functional testing and validation (by the users to confirm whether the system addressed the raised issues). This phase enabled users to test the solution in terms of functionality, usability, solution components and also to confirm that all necessary validations had been taken into consideration. The key test done was user acceptance testing and quality testing.

3.8 Ethics in Research

The research maintained strict ethical standards, ensuring that the data collected from the respondents was only used for the intended research and by keeping the questionnaires confidential. This was also communicated in writing on the questionnaire presented to the respondents. Respondents also had the option of not including their names in the questionnaire for anonymity.

3.9 Reliability and Validation

The research questions included in the questionnaire were brief and non-intrusive, thus prompting the respondent to answer in a more confident way. Prior to sharing the questionnaire, it was also reviewed by an external party, in order to ensure that the questions encompassed the

relevant areas of the research and were logically arranged. The observation done by the researcher also provided an alternative way of affirming reliability of the research. The validity of the research was confirmed by the fact that the feedback collected from the questionnaires was instrumental as it enabled the researcher to identify key design requirements of the solution. Observation was also a good way of getting first-hand unbiased information on the behaviour of the target group, in their natural state, that is, the constant care and concern of guardians about their children when they are at work.

3.10 Conclusion

The chapter looks into tools and techniques used in conducting research work prior to development of the solution. It is key that enough data is provided to ensure that the study fulfils its goal and is suitable for satisfying the need which it is meant for.

The chapter also looks into the methodology suitable for the researcher and most importantly for the study. It facilitates the researcher in getting a clear understanding of user requirements and allowing room for change, where the researcher feels there is need to re-define the requirements.

Chapter 4: Data Analysis, Presentation and Interpretation

4.1 Data Analysis and Findings and Response Rate

To gather user requirements, online questionnaires were distributed to Copy Cat staff. The results were analysed and diagrammatically presented using pie charts.

The questionnaires were issued to 20 people and all respondents were able to give back their feedback. The response rate was 100%. The good response to the questionnaire was highly contributed by the easy way in which the questions were laid out using a simple online tool: Cognitoforms (Cognitoforms, 2016). The respondents were guardians who take care of children under the age of 5 years.

4.2 Age Bracket

The age bracket for the respondents was also put into consideration. As illustrated in Figure 4.1, none of the respondents were under the age of 21 years. 5% of the respondents were above 40 years. 35 per cent were between ages 21 and 30 while the majority, which comprised 60%, fell between 31 and 40 years. The larger population therefore comprised of parents between 21 and 40 years, which basically made up 95% of the respondents. According to research done on world fertility patterns in 2015, Africa remains the region with the highest fertility at 4.7 children per woman (United Nations, 2015). This would therefore be a good age-group to further engage in not only during development of the solution but also in using the solution for at least more than one of their children.

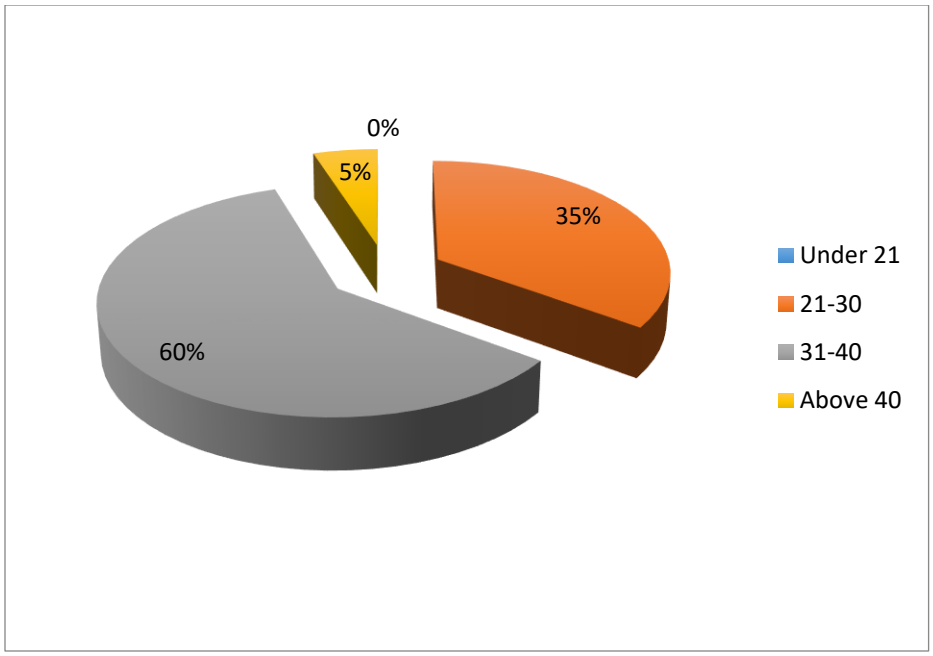


Figure 4.1: Age Bracket of Respondents

4.3 Persons with Phones

Being a solution that entails constantly using a phone to check on alerts, access to a mobile phone was compulsory, thus the need to ask the respondents if they had a mobile phone. All 20 of the respondents had access to a mobile phone and hence making up the 100%.

4.4 Adopting a Remote Monitoring System

There being no existing remote monitoring system used within the Company, the respondents were asked if they would consider adopting a remote monitoring system that would alerts them if their children were outside a predefined area. As illustrated in Figure 4.2, 90% of the respondents said that they would consider using adopting such a solution while 10% said they would consider adopting it. 18 of the respondents out of the 20 therefore felt that the proposed solution would be a viable solution to child tracking while 2 of them were not convinced.

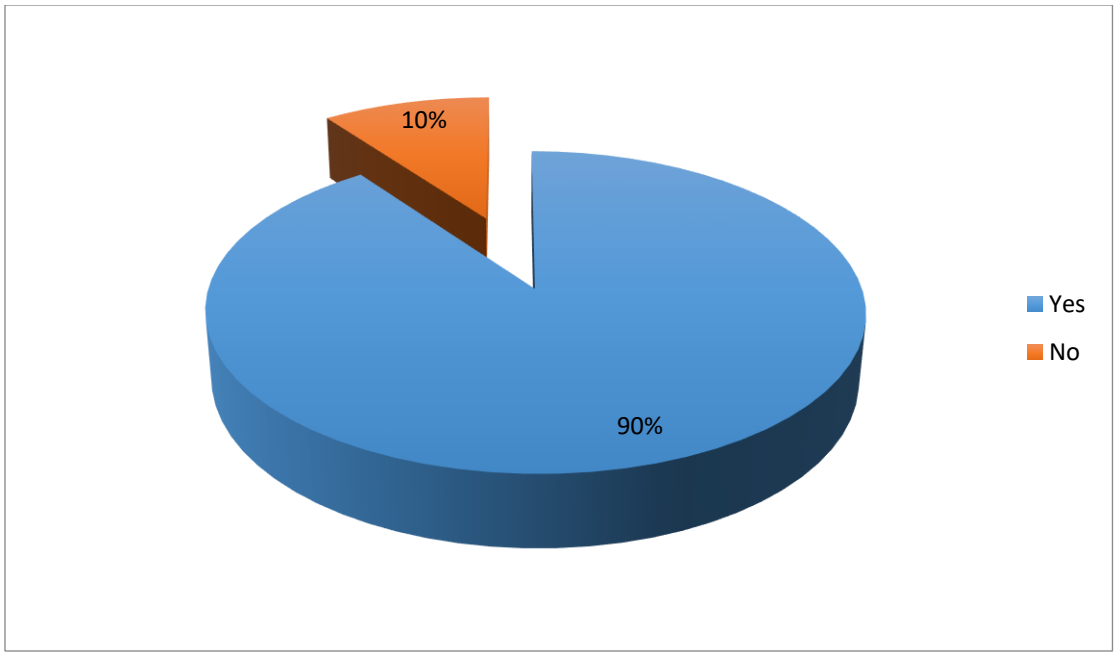


Figure 4.4: Likelihood of Adopting a Remote Monitoring System

4.5 Features

The respondents were then asked to rate the solution in terms of some of the features that they would consider to be most important to them, on a scale of 1 to 5, with 5 being the strongest.

This brought the number of respondents down to 18, seeing that 2 respondents would not consider adopting the solution as earlier mentioned.

4.5.1 Security

As illustrated in Figure 4.3, 66% of the respondents felt that security of the solution was very important to them, hence gave it a scale of 5. 22% felt that it would be important thus gave it a scale of 4, while 6% gave it medium priority hence a scale of 3 and 6% felt it would not really matter, thus giving it a scale 1. None of the respondents gave security a scale of 2, hence the 0%.

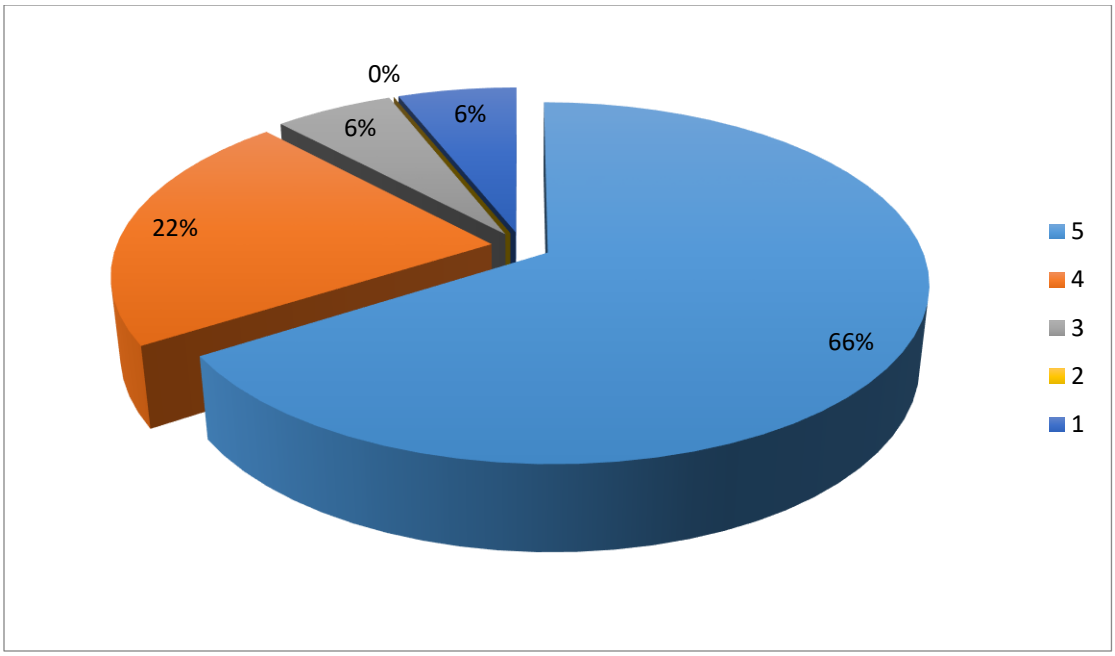


Figure 4.5: Security Feature

4.5.2 Reliability

As illustrated in Figure 4.4, half (50%) of the respondents felt that security of the solution was very important to them, hence gave it a scale of 5. 38% felt that it would be important thus gave it a scale of 4, while 6% gave it medium priority hence a scale of 3. Another 6% gave it a scale of 2, while none of the respondents gave it a scale of 1. This implies that reliability of the solution is quite important to a greater percentage of the respondents.

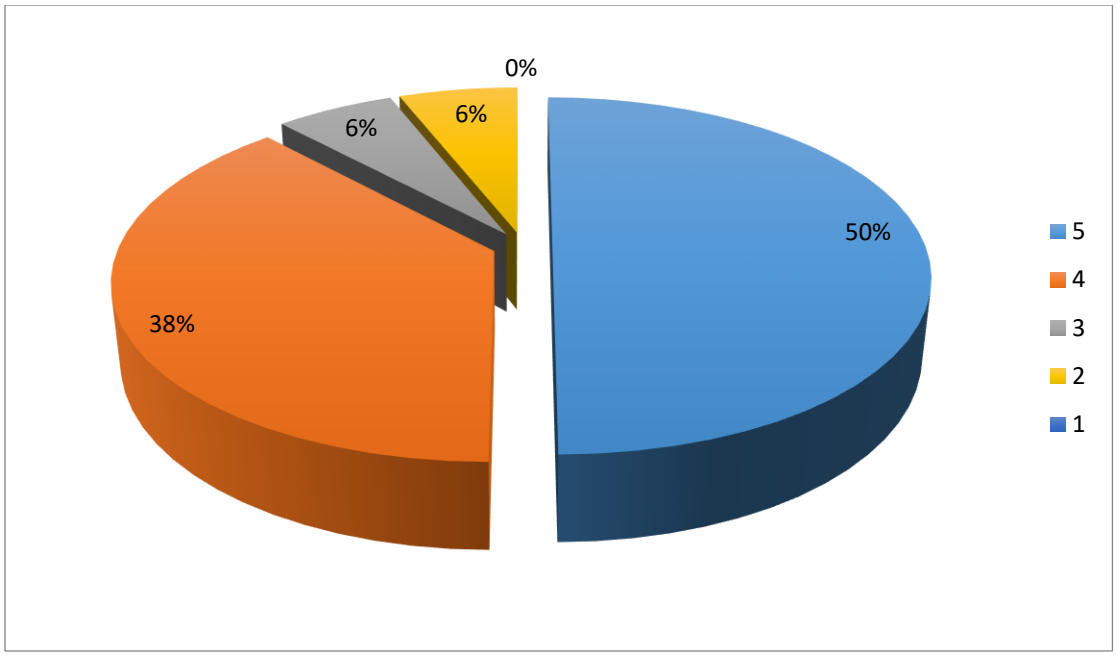


Figure 6.4: Reliability Feature

4.5.3 Usability

As illustrated in Figure 4.5, 33% of the respondents felt that reliability of the solution was very important to them, hence gave it a scale of 5. 45% felt that it would be important thus gave it a scale of 4, while 11% gave it medium priority hence a scale of 3. Another 11% of gave it a scale of 2, while none of the respondents gave it a scale of 1. This implies that usability of the solution is quite important to a greater percentage of the respondents in order for operational efficiency of the solution to be experienced.

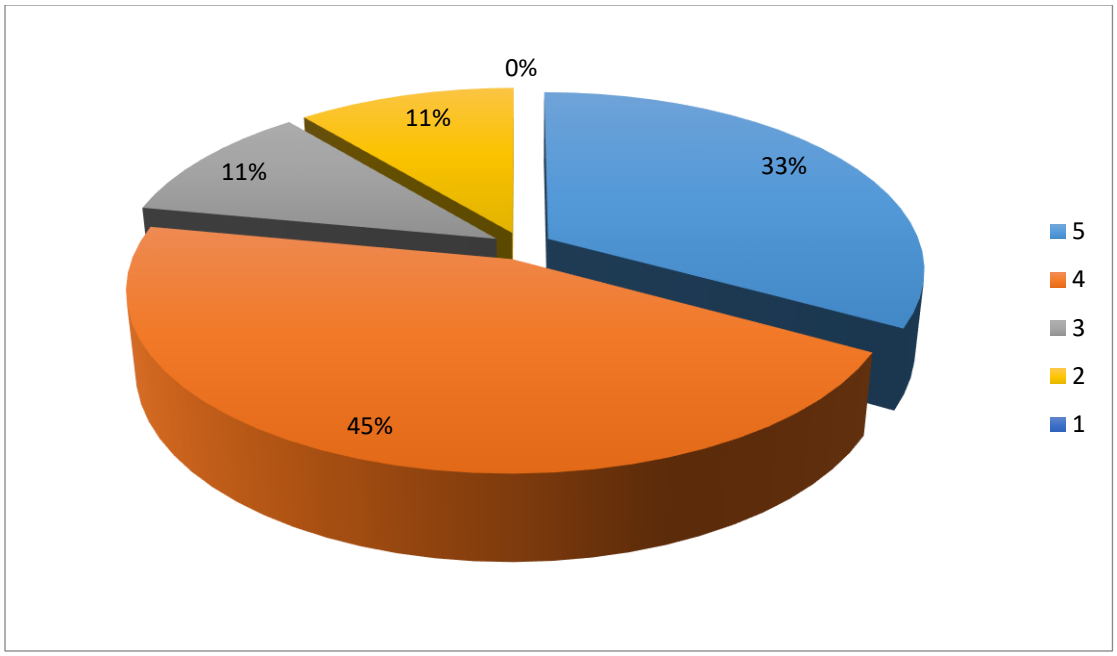


Figure 4.7 Usability Feature

4.5.4 Control

As illustrated in Figure 4.6, 44% of the respondents felt that having control of the solution in terms of dictating what to see and having super user privileges was very important to them, hence gave it a scale of 5. 28% felt that it would be important thus gave it a scale of 4, while 17% gave it medium priority hence a scale of 3. 11% of the respondents gave it a scale of 2, while none of the respondents gave it a scale of 1. This implies that control of the solution is quite important to a greater percentage of the respondents in order for them to feel that they can fully utilize the solution.

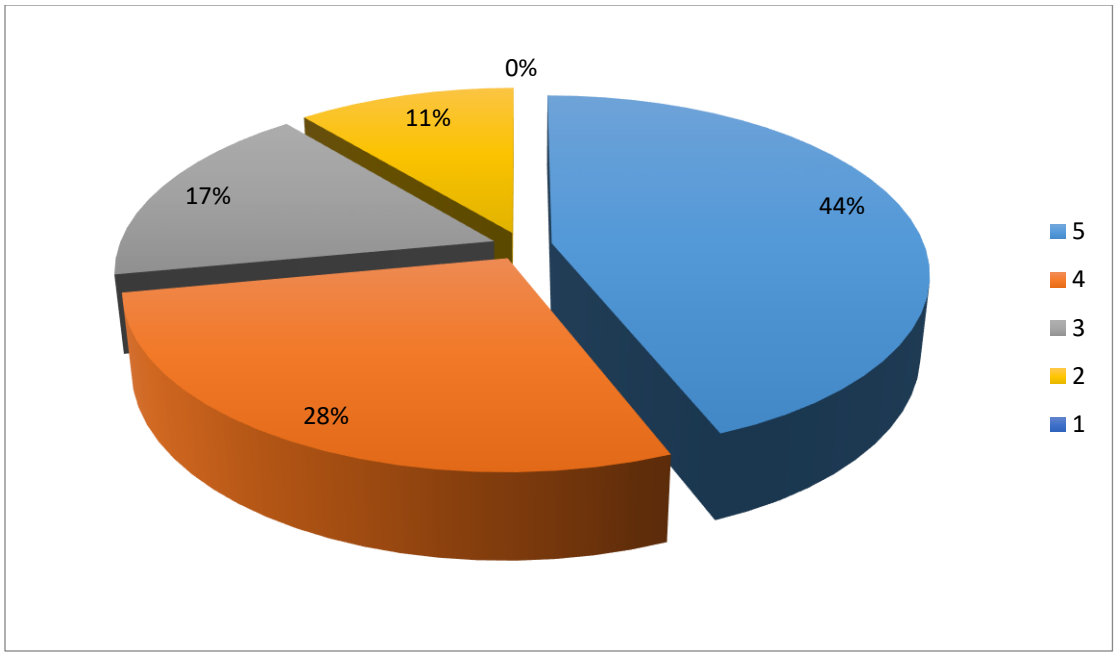


Figure 4.8: Control Feature

Chapter 5: System Design and Architecture

5.1 Overview

System design is the process of defining the top-down description the system's architecture, modules, interfaces and components with the aim of satisfying the specified user requirements (Faisandier , 2012)

This chapter looks into the design of the solution from the overall architecture to the finer details of how the system interacts with different actors in the use case diagram and how it is represented using objects in the class diagram. The chapter analyses the design and application

5.2 Requirement Analysis

Through the questionnaire administered and from observation of the guardians, the research found that the users needed:

a) A system that would be reliable and have minimal downtime and few false alerts
b) A system would only send alerts to those guardians who were legitimately assigned a baby.
c) A system that would be easy to use as it would be in high usage for most of their office time.
d) The system should be secure.
e) The system should accommodate children beyond 5 years.

The user requirements were then categorized into functional and non-functional requirements. Functional requirements capture the intended functioning of a system while the non-functional requirements form constraints of the functional requirements (Zhou, 2004)

5.2.1 Functional Requirements

i. The system users (managers, human resource and guardians) will all be registered by the system administrator.
ii. The guardians shall use their credentials to log in before using the system.
iii. Each baby is assigned a unique RFID tag.
iv. The developed system should allow the guardians to be associated with a certain baby.
v. The system should also allow a baby to be assigned to more than one guardian.

vi. The system should allow the system administrator to add or delete a system user, for instance when a guardian leaves a company. The tag can be re-used by another baby and assigned to their respective guardian.

vii. The system should send a notification to the guardians assigned the respective baby.

viii. The system should validate the trigger sent from a tag prior to sending an alert, such that only those tags that only a tag that matches an entry in the database is are allowed to proceed and send an alert.

5.2.2 Non-functional Requirements

i. The system should be reliable.

ii. The system should be secure.

iii. The system should be easy to use.

iv. The system should not flexible.

v. The system should scale to other environments, besides the work place.

vi. The system should only be accessible to authorized parties.

vii. The system should be timely in generating reports.

5.2.3 System Requirements

The system should have the following system requirements:

a) Relational Database Management System

This is to ensure easy organization and capturing of data for the system administrator.

b) Security

This is to ensure that information regarding all users is safe and above all, that the system is not hacked thus compromising the security of the babies.

5.3 System Architecture

Figure 5.1 shows the top-level view of the system architecture. A baby if assigned an RFID tag that is unique for their identification in the system. The bay also has other details taken, such as their name, date of birth and gender. The tag broadcasts packets regarding its location frequently and this information is stored in the database. Whenever a baby goes out of the predefined location a trigger is sent. However, validation of the tag ID is done through the location register

which first confirms that the RFID tag is among the list of tags input in the database. An incident is generated and from there an alert is sent to the respective guardian.

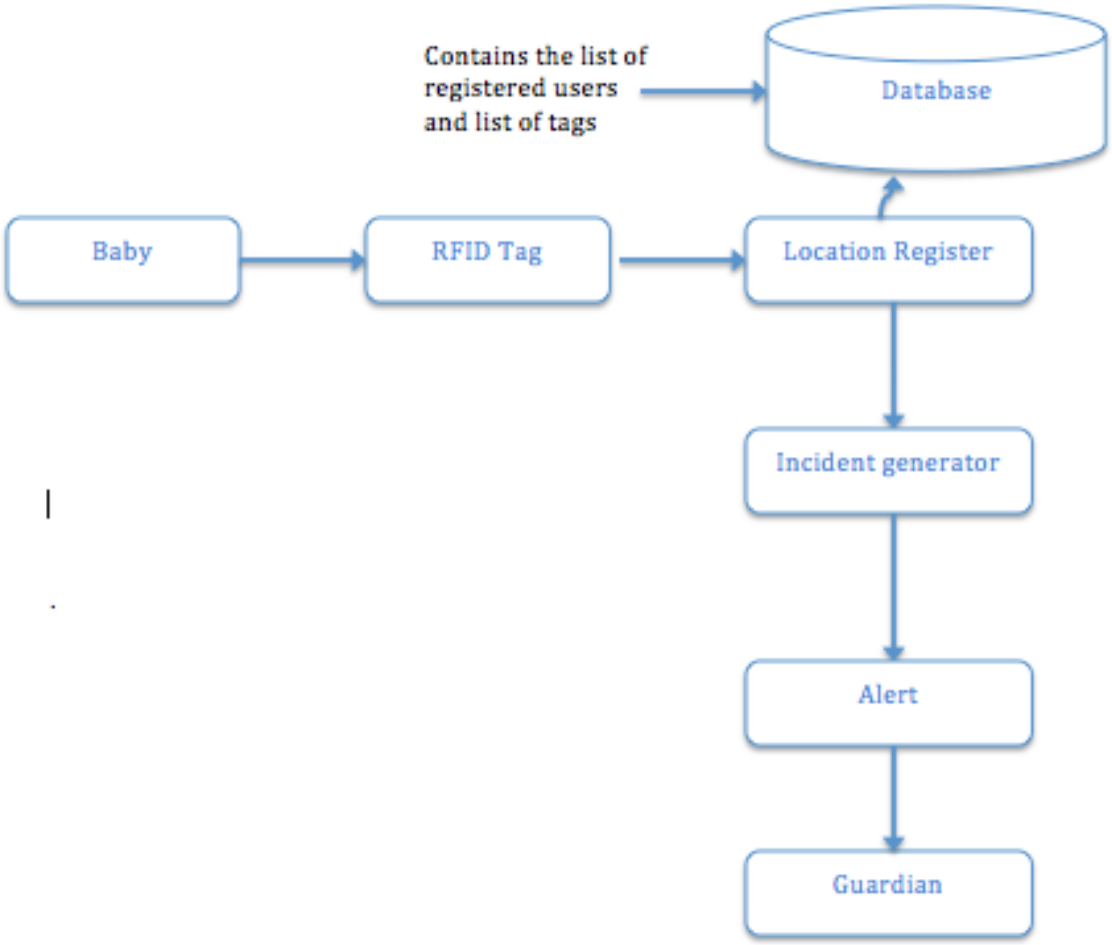


Figure 5.1: System Architecture

5.3.1 Input

The main input is the RFID signal as the baby details (name, date of birth, gender and the tag ID and associated guardian) are recorded initially and put in the database. The RFID tag has different attributes, such as the manufacturing date, the tag number and the version number. This information is communicated in the register as the tag broadcast its coordinates, which are passed to the location register.

5.3.2 Process

Information of the baby assigned the respective tag is processed. A user is also registered into the system. The location register also processes the coordinates transmitted by through the RFID broadcasts. Upon validation of the details, that is, to ensure that the RFID tag broadcasting the packets is part of the list of tags in the database, the trigger by the tag is allowed to proceed.

5.3.3 Output

As part of the output, the incident generated produces an incident. The incident then sends an alert to the guardian associated with the baby. From this, reports can be generated and viewed by the authorized parties.

5.4 Database Design

5.4.1 Class Diagram

The design of the database was illustrated by two key diagrams: the class diagram and the entity relationship diagram. The class diagram as illustrated in Figure 5.2 constituted 6 classes, namely: the baby, the tag, the system administrator, the location, the incident, the system, the guardian and the alert.

Each baby had a unique tag associated with them. The tag had a unique number with it and all these details were recorded in the database. The tag broadcasts signals frequently of the current location thus if a baby got out of the predefined area, the signal was recorded as an incident, and this was sent as an alert to the guardian. From the incidents, reports could be generated and the system administrator would be in a position to view them. Besides viewing reports, the system administrator was also able to register new guardians into the system. The guardians would then use their credentials (email and password) to log into the system from where they could get an account on the incidents reported about the status of their babies.

All the attributes of the classes were private (as show by the hyphen “-” before every attribute), which implied that they could only be accessible by the class methods only. The methods, on the other hand, were all public (as show by the plus sign “+” before every method), which implied that they were accessible to all classes.

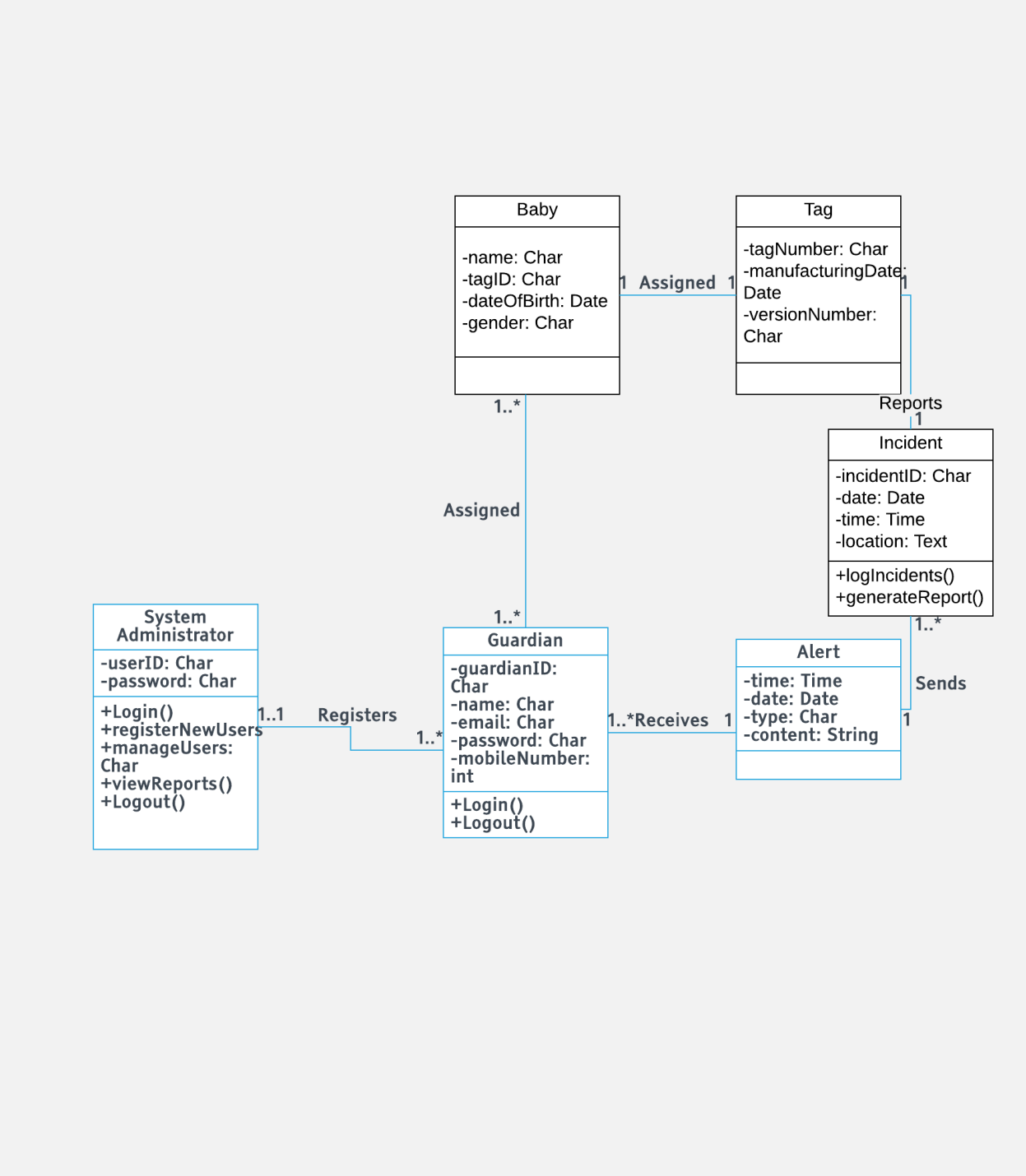


Figure 5.2: Class Diagram

5.4.2 Entity Relationship Diagram

Using the ERD, the different entities and their relationships were as illustrated in Figure 5.3. The entities were similar to the classes in the class diagram: baby, tag, incident, alert, guardian and the system administrator. Some of the business rules that apply to the ERD included:

1. A guardian can be a parent; many guardians can monitor many babies as it is possible for both parents to be workmates. A parent can also propose another friend or workmate to oversee the baby.
2. An administrator can either be a HR, System Admin or a Manager as the system is majorly to assist guardians and not management.
3. Various reports can be viewed by the different parties: administrator and guardian.
4. A baby is directly linked to their guardian hence there is no direct relationship between the administrator and the baby.
5. A baby does not interact directly with the system.
6. An alert can be sent to at least one guardian

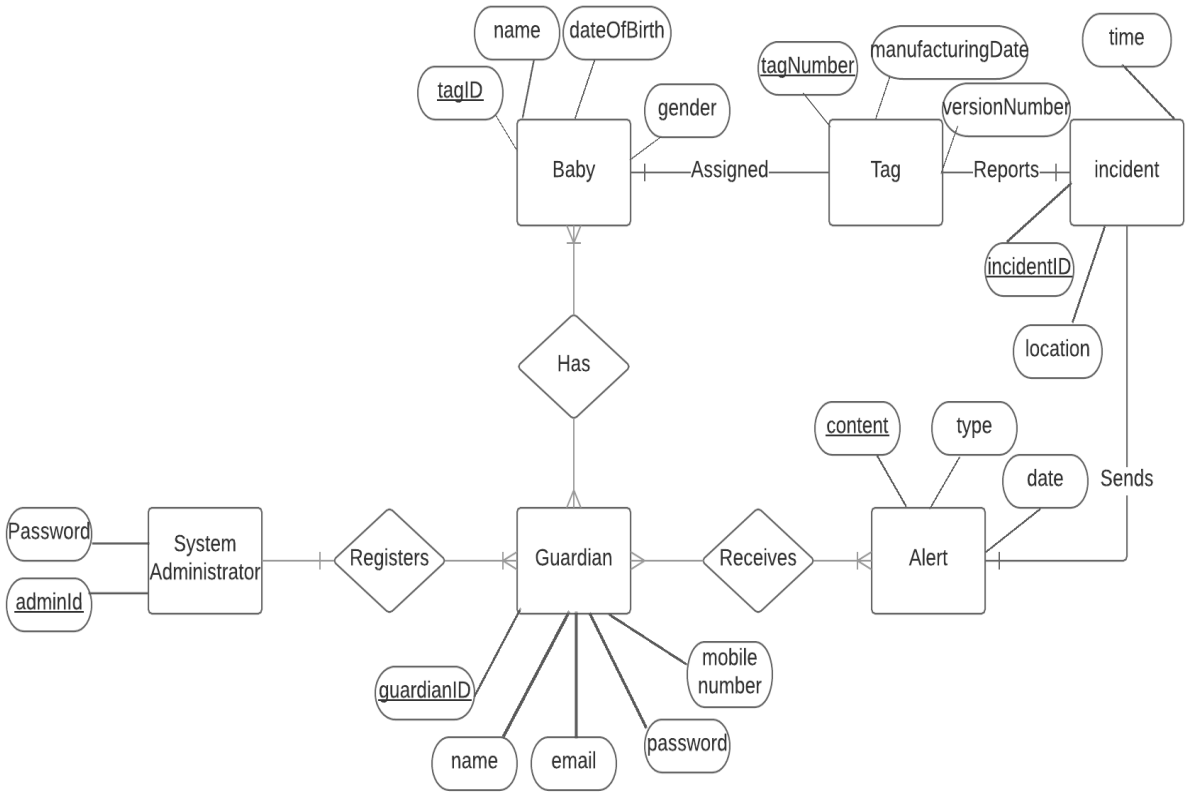


Figure 5. 3: Entity Relationship Diagram

5.5 Other Designs

5.5.1 Dataflow Diagram

i. Context Level Diagram

The context level diagram, also known as level 0 dataflow diagram (DFD) shows a high-level overview of the system thus only has one main process. This process is has four main external entities: baby, guardian, system administrator and management. The main process is to track a baby. The system administrator registers new users into the system. However, the dominant users are the guardians as they are the direct recipients of the system. They are able to get status on their children and are also able to access reports to do with any incidents that nay have occurred during a certain period of time. The management, on the other hand, are only able to get access to the tracking reports. This is illustrated in the context level diagram in Figure 5.4

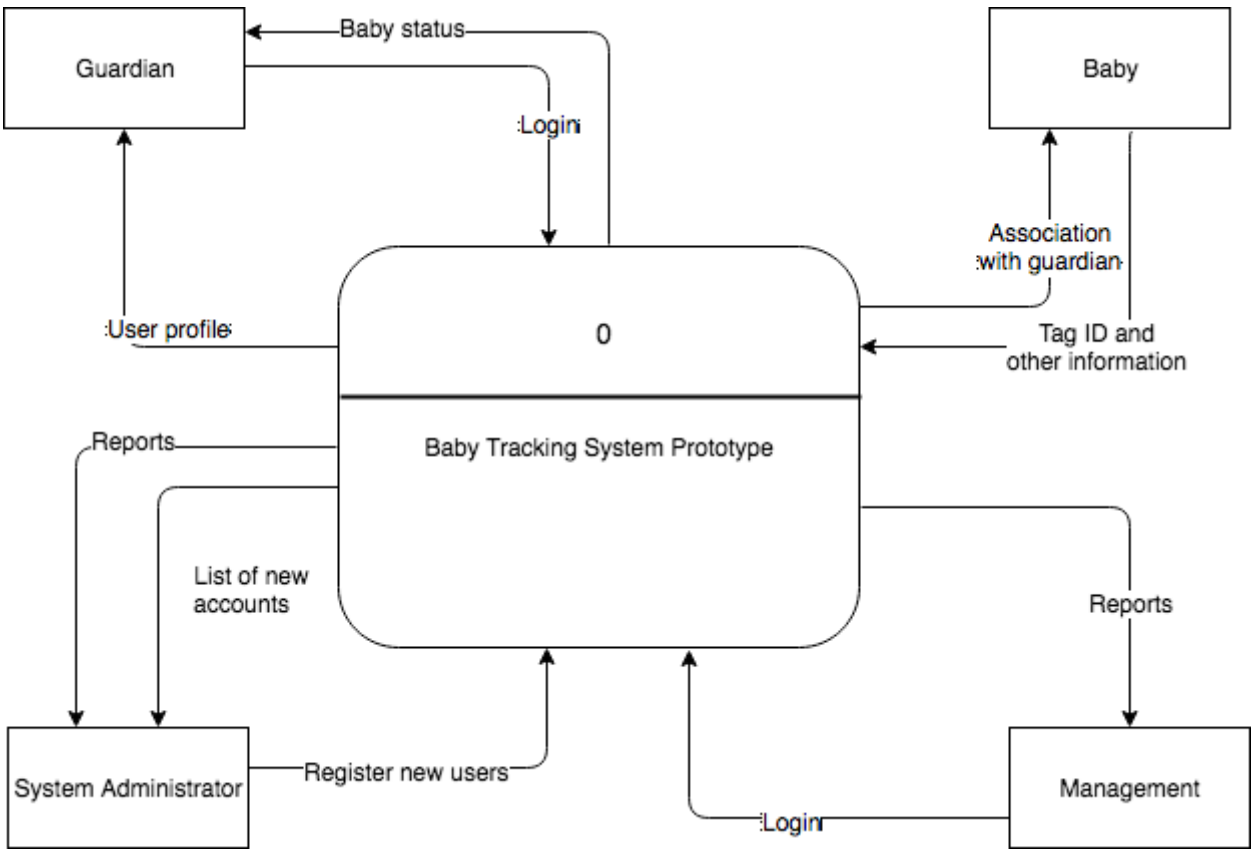


Figure 5.4: Context Level Diagram

ii. Level 1

The level 1 DFD is a decomposition of level 0 DFD. It is illustrated in Figure 5.5

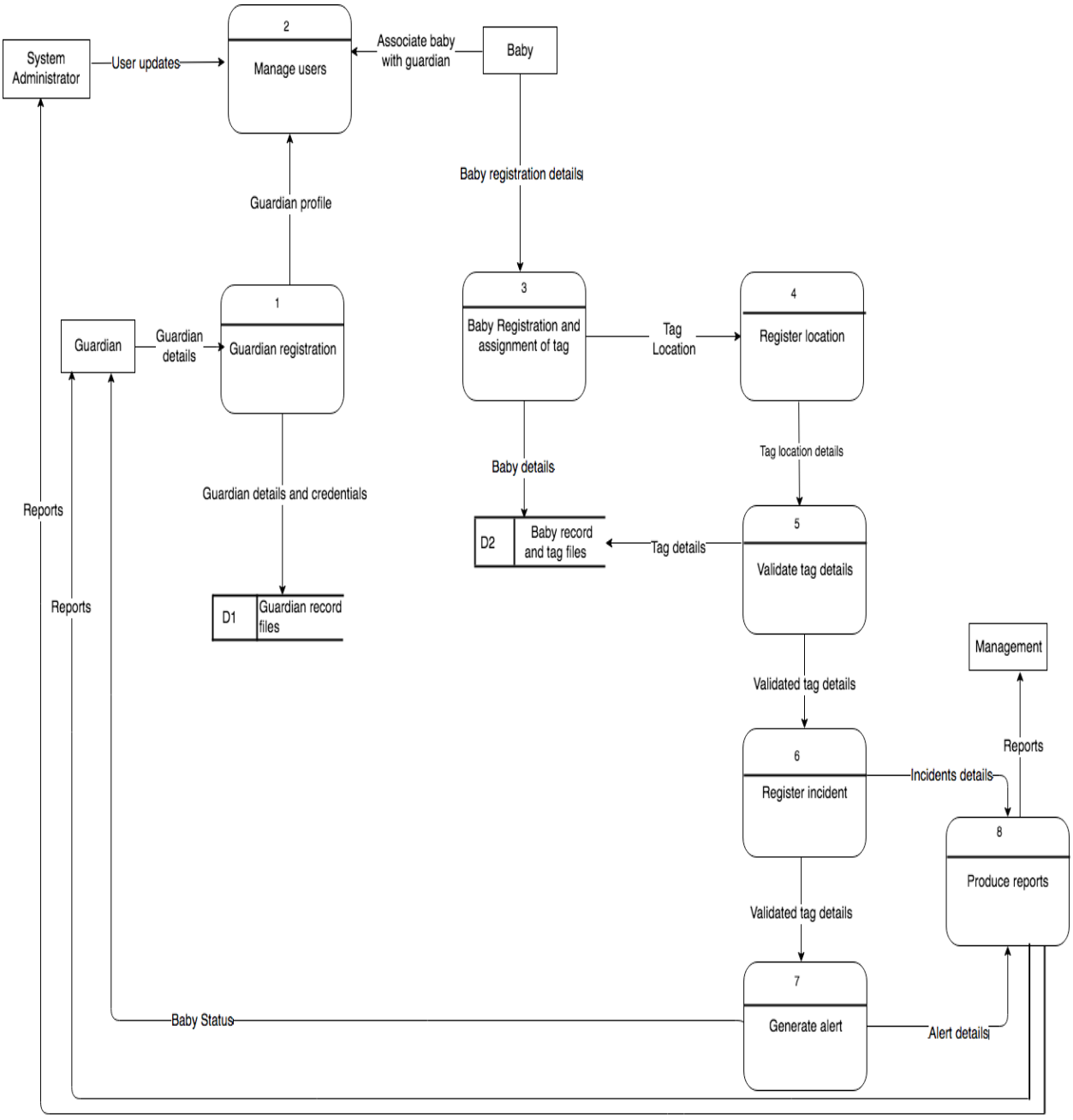


Figure 5.5: Level 1 Dataflow Diagram

5.5.2 Sequence Diagram

The sequence diagram outlined the various interactions between the system administrator and the system. The key input of the administrator was to register new guardians into the system. Each baby was assigned a unique tag. The tag broadcasted packets sending its location and if the baby was out of the predefined area, a trigger was sent. However, to validate that the tag was actually in the tags assigned to the different babies and not any other in order to avoid sending false alerts, the tag id was confirmed against those in the database (listoftags object). This is illustrated in Figure 5.6.

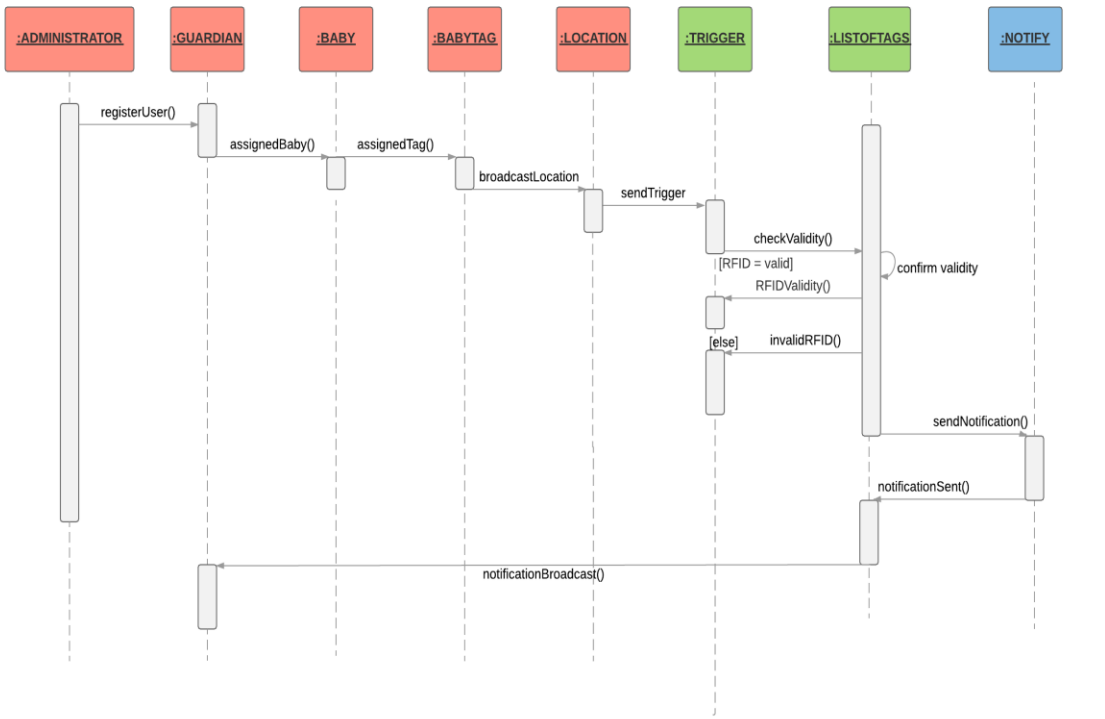


Figure 5. 6: Sequence Diagram

5.5.3 Use Case Diagram

The use case diagram illustrates the various systems and actors interacting with the baby tracking system, as illustrated in Figure 5.7

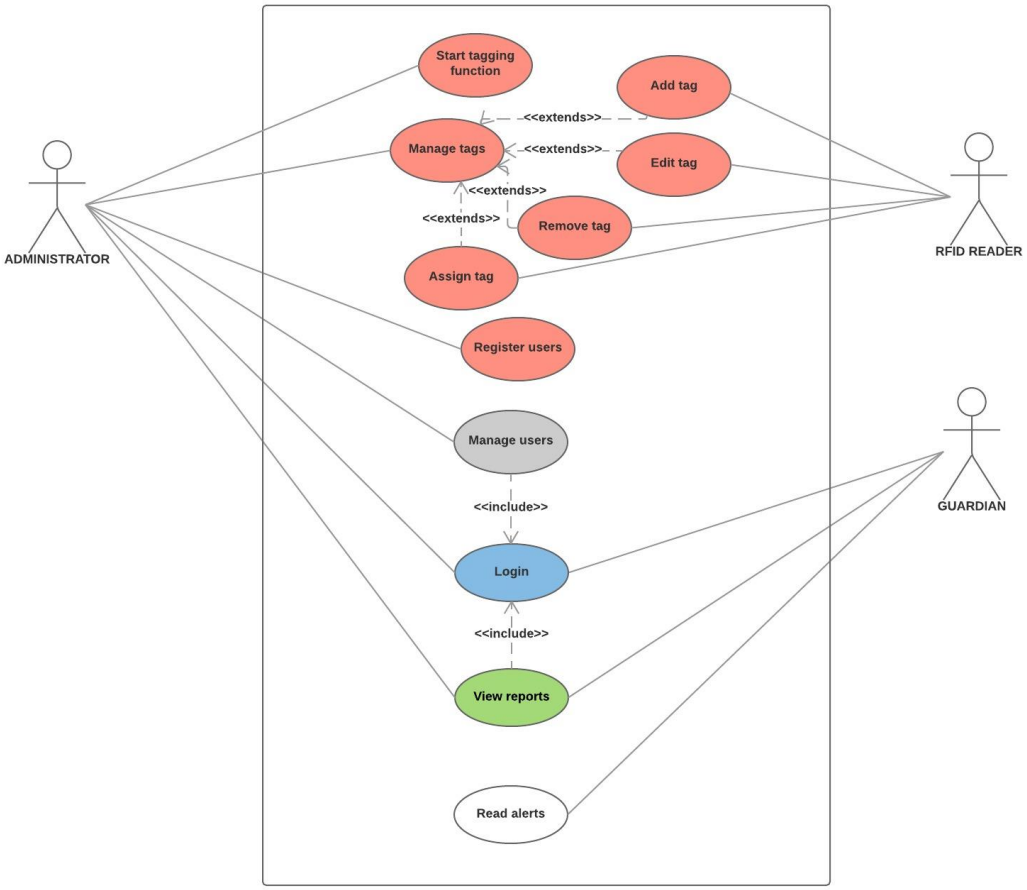


Figure 5.7: Use Case Diagram

This use case can be summarized in tabular format. Table 4.1 shows the main use cases and the actors in the system.

Table 5.1 The Main Use Cases

Actor	Use Case
System Administrator	Register users Manage users View reports
Guardian	Login View reports Read alerts
Management	View reports

The first use case relates to user management, which includes registering new users. The users are mostly guardians who have to have an account in order to follow up on the status of their babies and view reports on the same. In order to register new users, the system administrator has to login first. This is therefore a precondition. The details input regarding the guardian include the name, email address, phone number and they are also assigned a unique ID (guardianID).

Under manage users, the system administrator is allowed to update user accounts. Updating refers to reviewing information of the user by putting in the latest information as provided by the user. The system administrator is also able to delete users from the system. Deleting a user may be necessary for instance, where a guardian leaves the company thus no longer needs access to the system. A user may also decide that their baby is not old enough to be left at home, and also as per proposed age by the company. The tag associated with the baby also gets reset and can therefore be reused by another baby.

The management can only view reports from the system.

5.6 Network Design

The network design of the solution was as illustrated in Figure 5.8. The design constituted various network components, including end devices and intermediary devices. The end devices included an access point and a wireless LAN controller. The access point was used to broadcast a WiFi signal while the wireless LAN controller was meant to manage the access point. The intermediary devices, on the other hand, included the switch and the router. The switch connected directly to the end devices to create a LAN while the router provided an Internet connection.

Each baby had an RFID tag. The tags emitted broadcast packets frequently. Assuming the daycare has only one exit, an RFID reader will be mounted at this exit. The reader will be strategically mounted such that, when a baby is about to exit from the room, as opposed to sounding an alarm, the trigger will be sent over Wireless LAN upon which validation will be done and an alert sent to the respective guardian.

The solution utilized the Wireless LAN within the office and alerts will be sent out either through email or through text message. Owing to the fact that that more than one guardian could be assigned to a baby, there was elimination of a single point of failure, in case one guardian missed the text alert or email.

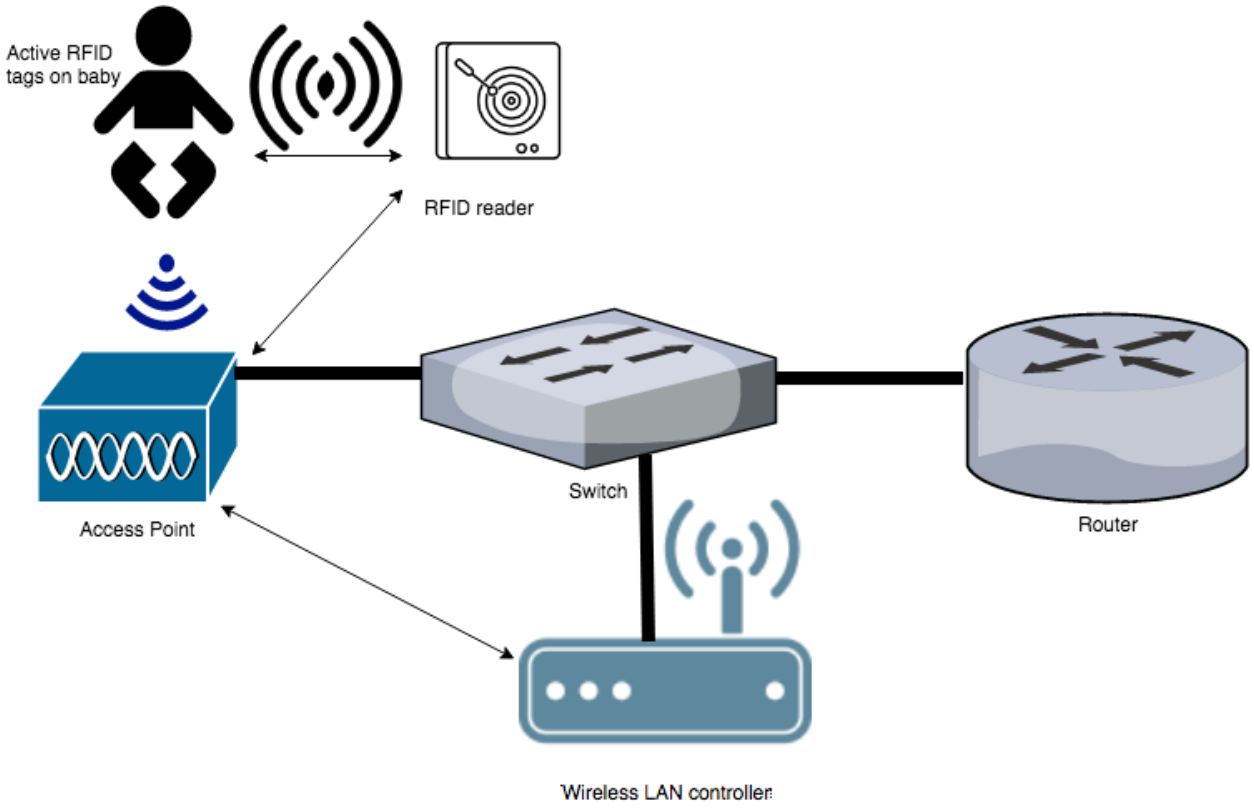


Figure 5.8: Network Design

5.7 Security Design

Data security was crucial in this project. Information on the baby was stored in a secure central database and Web application. Constant checking of the RFID tags by the reader and communicating the information over the wireless network also reduces chances of an intrusion. The centralization also helps to provide workflows to help in security regulatory compliance. The valid tag configuration was also done as getting location data included assigning an IP address to the tags, whereby Wired Equivalent Privacy (WEP) for security was enforced. The wireless LAN controller also provided security policies and intrusion prevention. For network security, the switch and the router came in handy. The router and the switch had embedded firewall capabilities and thus could act as firewalls.

The user accounts were password protected thus users were also prompted to enter their credentials in order to access their accounts. The system administrator also had to login in order to access the back-end to manage users or to view reports. This meant that only authorized

parties could view the reports and that guardians were only privy to their respective baby's information. Users were also educated on how to use the system and the importance of keeping their credentials to themselves. Figure 5.9 shows how the solution was secured.

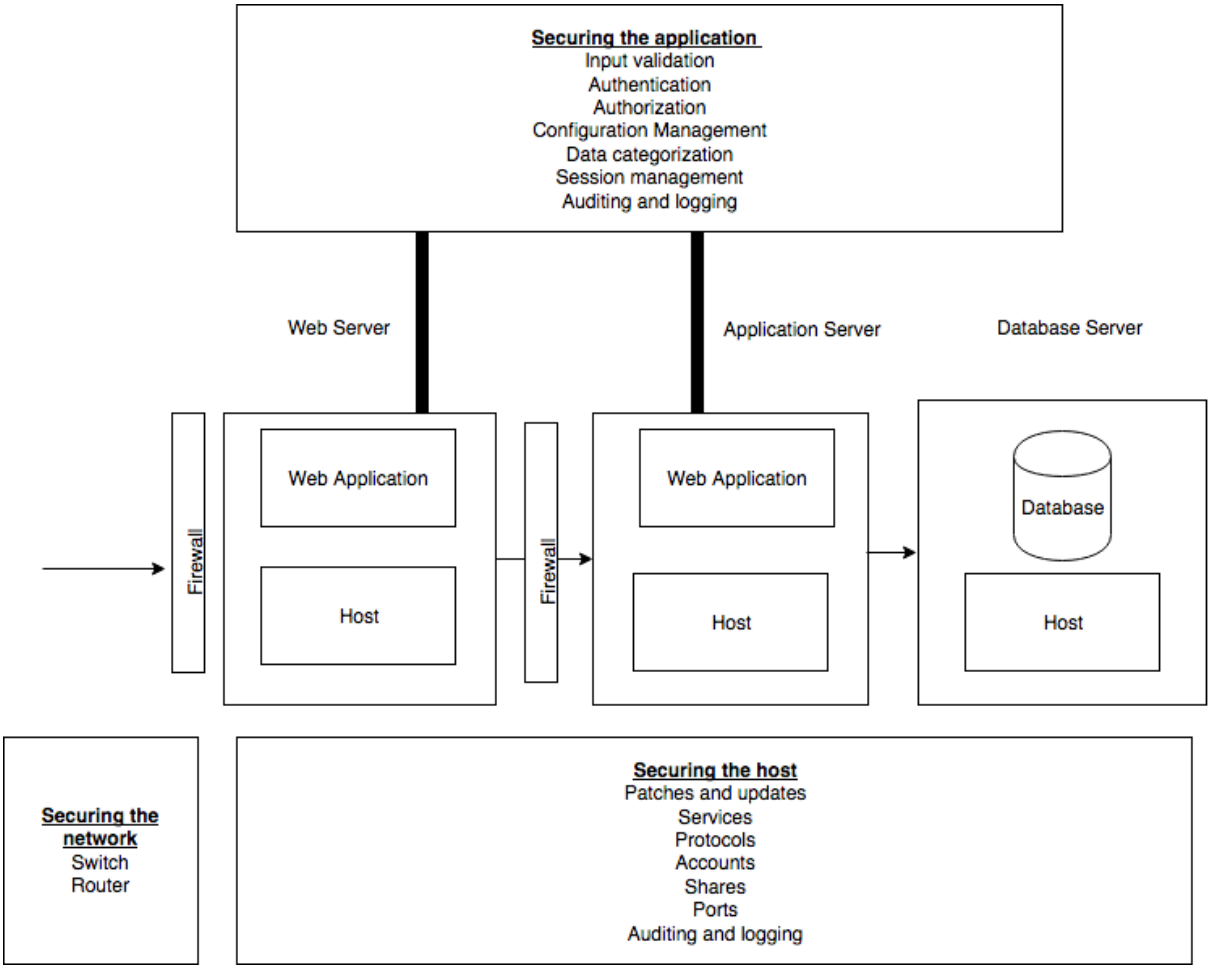


Figure 5.9: Security Design

5.8 Wireframe

The wireframe of the solution was as illustrated in Figure 5.10 The user started by logging in their credentials: username and password. The user, usually the guardian then got access to their profile and also their baby's profile. However, only the administrator was able to update this information in order to avoid any misuse of alteration of details that may cause disrupting of the reliability of the solution.

The user then got access to the dashboard where they could view reports associated with any recorded incidents. Before an incident is recorded, a signal from an RFID tag broadcasting its location basically gets to be validated. This involved checking whether the tag was part of the list of tags recorded in the database. If legitimate, the location of the tag was recorded in the location register. This information was then used to log an incident, which was essentially generated by the incident register. The incident then triggered an alert that was sent to the user/guardian associated with the baby assigned to the tag. The different logs can be viewed on from the dashboard.

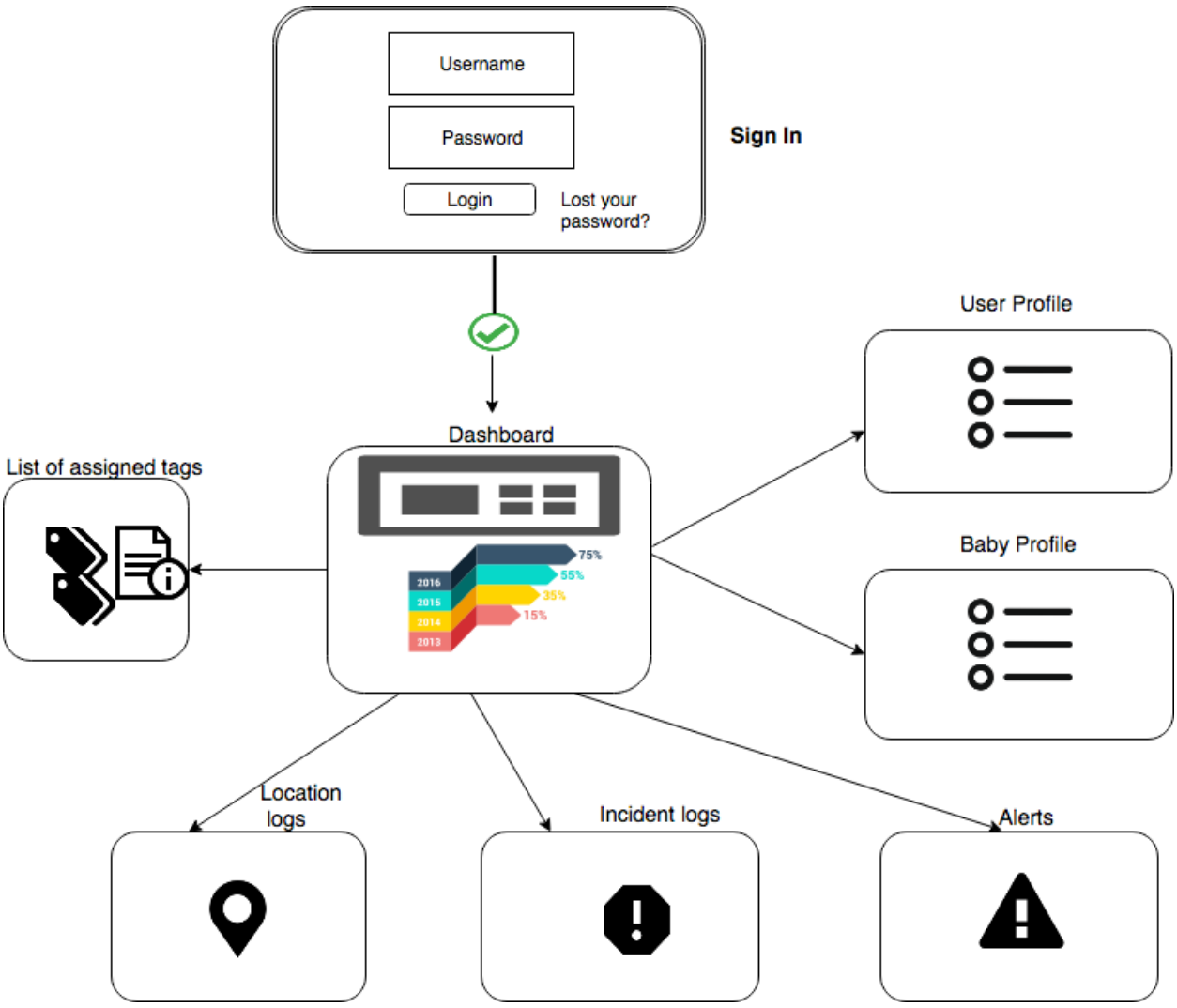


Figure 5.10: Wireframe

5.9 Conclusion

This chapter highlighted the different design diagrams used to help the researcher to come up with a visual presentation of the solution to be implemented in the next chapter. It gave the researcher much ease during implementation as different designs, including that of the database, showing the different relationships between the entities was put into consideration. The network architecture also helped the researcher to visualize how the solution would fit into the network and the different devices involved.

The security design enabled the researcher to think of how the different aspects of security, from application security, security of the host and the database, data security and server security would

be effected in order to ensure that the solution was secure. The visual presentation of the graphical user interface through the wireframe also enabled the user to have a better understanding of usability and also the look-and-feel of the solution. This enabled the researcher to develop the solution much more effectively, while constantly referring to the schematics and including the various features to ensure user satisfaction.

Chapter 6: System Implementation and Testing

6.1 Introduction

The design in Chapter 5 was used to implement the prototype and to also test it. The prototype was developed using advanced PHP, Python, HTML, CSS, Javascript and MySQL database. In this case, PHP and Python were to execute the logic. HTML and CSS, on the other hand were used to implement the look-and-feel of the prototype. Javascript was used for validation. MySQL database was used to store data.

6.2 Program Flow

The administrator is able to give users accounts and after a successful login, the authorized party is associated with their baby's details and thus gets access to these details, which come embedded on the tag. The details include the name, date of birth, gender and RFID tag. The prototype is able to detect signals sent from the active RFID tags and is then able to convey this information and pass on the required trigger. Whenever a child gets out of the geofence, an alert is sent to the guardian associated with them.

6.3 Server Requirements

6.3.1 Hardware Requirements

Table 6.1: Hardware Requirements

Hardware	**Minimum Requirements**
Processor	Intel Core
Cycle speed	200MHz
Hard Disk Space	15GB

6.3.2 Server Software Requirements

Table 6.2 Software Requirements

Software	**Minimum Requirements**
Server Operating System	Any Linux flavor, Windows 2008/2010 Server
Client Operating System	Any Linux flavour, Windows 7/8/10
Web Server	Apache 2.0+
Web Browser	Mozilla Firefox, Internet Explorer, Chrome, Opera, Safari
Database Management System	MySQL 5.0+

6.4 User, Roles and Access

The system was designed to have role-based access. It was meant to help the guardians to monitor their children remotely and thus had two key users: the system administrator and the guardian.

6.4.1 Guardian

This was the main recipient of the system and thus will be in a position to be registered into the system and get an account where he or she can get to see the details of the baby, including the RFID tag number of their baby. This user will also be able to receive alerts from the system in case their baby goes out of the geofence. The user will also be in a position to view reports generated from the system. The user is meant to receive alerts through email notifications.

6.4.2 System Administrator

This user registered new guardians into the system and is therefore able to see all their details, including the baby associated with them, through the RFID. Different users hold the administrator role, however, each has different privileges. The system administrator is the superuser while the management get viewing rights but cannot register new users of the system.

The system administrator therefore had access to all roles associated with the other administrators and thus could also add other administrators and assign privileges.

6.5 Sample Forms Used

Appended in Figure 6.1 is the login screen, which basically allowed guardians and management to enrol into the system with the help of the system administrator. It was a simple page that enabled the users to have access to their profile. For the guardians, upon association of their accounts with their respective babies, they would be in a position to also view the profiles of their babies, with information such as, the name, data of birth, gender and RFID tag identified with them.

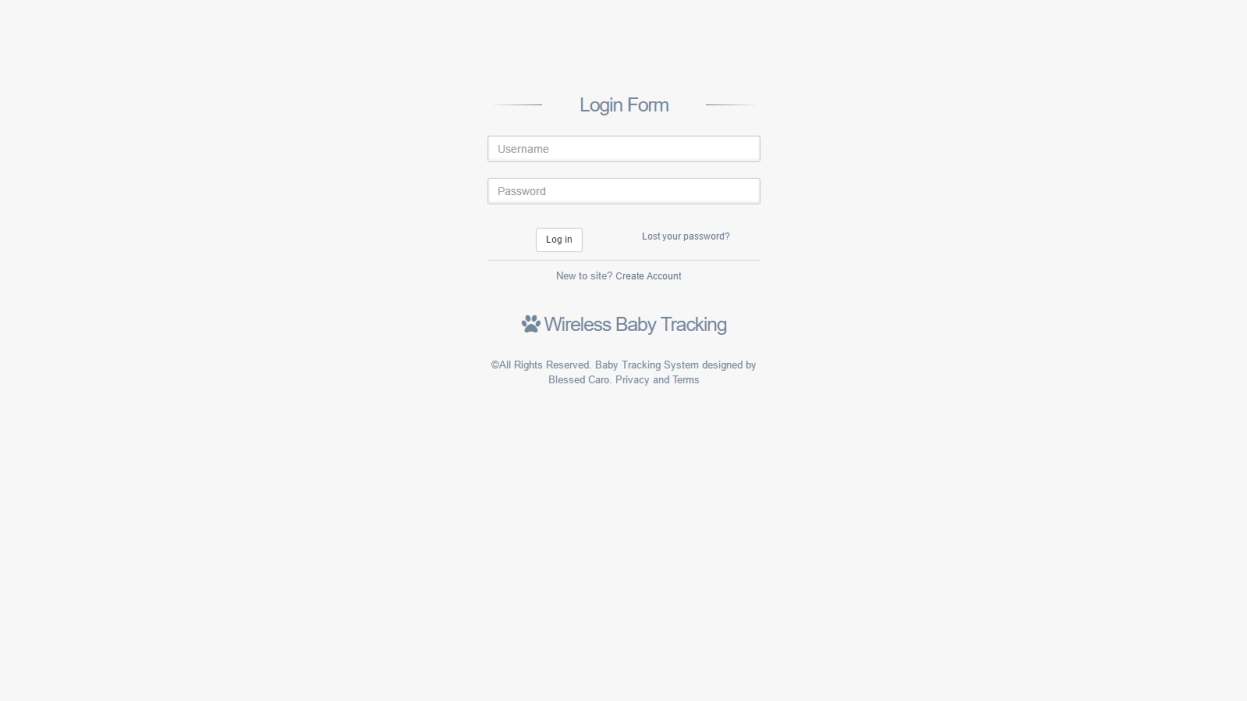


Figure 6.1: Login Screen

This was the system administrator's dashboard, which allowed him or her to view the user profiles and real-time sign-ups by users. It also showed the alerts sent and a graphical representation of the same.

Figure 6.2: System Administrator View

6.7 Testing

The solution was tested through user acceptance tests, whereby users were asked to give feedback on the different aspects of the performance especially on the key features as highlighted during data collection. The feedback was positive and different people have already approached the researcher will various ideas of scaling the solution.

Chapter 7: Conclusions and Recommendations

7.1 Project Summary

The main focus of this project was to develop a wireless baby tracking system designed for the workplace. This was to enable guardians to receive alerts in case their baby went out of a predefined area, which is within the babycare centre. Analysis of the requirements resulted in the design and development of a Web application that is responsive to all phones works.

The functionality of the solution was taken into consideration in this project. For instance, triggers to sending the alerts were validated in order to ensure that the users were not sent false alerts. The various broadcasts sent by the RFID tags were only reported as incidents where necessary. Security of the solution was also considered in order to ensure that the security of the babies was not compromised.

7.2 Conclusions

While ensuring child safety is still a challenge to most families in Kenya, the study offered a suitable baby tracking solution to assist in tracking babies in the workplace, especially for companies that have adopted the "babies-at-work" policy, or those who are looking to adopt it. The study showed how remote monitoring using RFID tags can be achieved in child tracking. Through the alerts sent to the relevant parties (child's guardian), it was evident that adoption of the solution could lead to less worry in the workplace and more productivity, where parents took their babies to work.

The value of the solution, though seen as initially high and the technology a bit complex, would result in long-term benefits and better services for guardians who are allowed to take their babies to work. The solution though custom-built for the workplace triggered a lot of interest for the guardians who would be willing to be adopt it even beyond this particular environment and also for children much older than the targeted age group of 5 years and below.

7.3 Recommendations

The field of child safety is yet to be fully explored and though there are existing solutions, not all are easy to integrate or fairly priced to be adopted by different users, despite the high need for such solutions.

Despite of the aforementioned issues, the study recommends:

1. With the advent of multiple daycare centres in Kenya as well as social events and functions that call for gathering of children, there is dire need to have solutions such as the baby tracking system within the local market.
2. The solution can also take different forms, including a mobile phone application, whereby parents can have a visual way of tracking their children, hence become more proactive – can foresee a being in the wrong area.
3. Considerations will also be made to enable an alert to prompt a phone to ring. This is per a recommendation made by Dr. Ozianyi, a lecturer within the University, upon presentation of the concept at the IEEE Pan African Conference on Science, Computing and Telecommunications (PACT) 2017.

7.4 Future Development

Besides RFID technology, are also alternative types of technology in the market such as Bluetooth low energy and NFC. This variety largely creates an opportunity to explore different solutions for the local market that, involve low power consumption, easy programmability and maintenance as well as high reliability. This would help make more affordable solutions for the local market.

Improvements on the solution could also include making the tag wearable, such that parents with children in lower primary school and also those children with special needs, could also benefit from tracking their children, for instance to ensure that they got home from school. This therefore means that the solution would be developed further to enable parents to track children outside a certain room or an institution. It would therefore mean incorporating GPS as this technology is better used outdoors. This would avoid limiting the solution to just tracking a baby inside a certain premises, as is the case. Further development of an application, with interactive features such as a chatbot, would be included to enable a guardian to find out where their child is. This would come in handy especially where a child has been kidnapped.

The solution was designed in such a way that an RFID reader would be placed at the exit point in order to sense tags of babies that may leave the room. However, it would be advisable to have a

reader as each entry/exit point, even beyond the daycare in order to offer more security of the children. It would also be an important consideration to not just prevent children from leaving the daycare center (mostly harm by humans), but also from entering some prohibited rooms (harm by various things, such as fire and water). The solution could therefore further be developed to extend certain areas and thus would include putting extra RFID readers in entry/exit points of areas such as kitchens and washrooms and other areas that may be dangerous for children.

References

A framework for the protection of children. (n.d.). From http://www.unhcr.org/50f6cf0b9.pdf

Alok, M. (2011, December). Complex software project development: Agile methods adoption. *Journal of Software Maintenance and Evolution Research and Practice* .

Ambler, S. W., & Holitza, M. (2012). *Agile for Dummies.* Hoboken, NJ: John Wiley & Sons, Inc.

Anderson, K. (2016, September 16th). *Daycare germs: What you need to know*. From Today's Parent: http://www.todaysparent.com/toddler/daycare-germs-what-you-need-to-know/

Australia, C. o. (2009). *Protecting children is everyone's business.* From http://nceta.flinders.edu.au/files/9313/0941/0668/Protecting%20Children%20is%20Everyones%20Business.pdf

Australian Government (2016). From https://www.wgea.gov.au/learn/about-workplace-gender-equality

Babies in Business Solutions. (2016). From http://babiesinbusiness.com/

Bacheldor, B. (2007). AMA Issues Ethics Code for RFID Chip Implants. *RFID Journal* .

Bannister, F., & Remenyi, D. (2000). Acts of faith: instinct, value and IT investments. *Journal of Information Technology , 15* (3), 231-241.

Beckley, T. E. (2009, April 3rd). *Governments Put Traditional Barcode Technology to Innovative Use.* From StateTech: http://www.statetechmagazine.com/article/2009/04/scanning-ahead

Best Practices Guide: RFID Implementation, Testing and Deployment. (n.d.). From Omni-ID: https://www.omni-id.com/pdfs/RFID_Tag_Implementation_Testing_Deployment_Guide.pdf

Cambridge English Dictionary (n.d). From https://www.cognitoforms.com/ Retrieved June 06, 2017, from http://dictionary.cambridge.org/dictionary/english/track

Chaleunvong, K. (2009, September 25th). *Data collection techniques.* Retrieved November 6th, 2016 from http://www.gfmer.ch/Activites_internationales_Fr/Laos/PDF/Data_collection_tecniques_Chaleunvong_Laos_2009.pdf

Charara, S. (2016, April 29th). *Xiaomi Mi Bunny is a GPS watch for kids.* From Wareable: http://www.wareable.com/xiaomi/xiaomi-mi-bunny-kids-watch-price-specs-release-date

Chimwendo, M. (n.d.). *Implementation of Projects.* Retrieved November 26, 2014 from UNECA: http://www.uneca.org/sites/default/files/uploads/module4.pdf

Cognitoforms. (2016). From https://www.cognitoforms.com/

Cooper, H. (1994). *The Handbook of Research Synthesis New York: Russell Sage Foundation.*

Cresswell, J. W. (2014). *Research Design Qualitative, Quantitative and Mized Method Approaches.* Thousand Oaks, CA: SAGE.

Daley, S., & Kulish, N. (2013, August 13th). *Germany Fights Population Drop*. From The New York Times: http://www.nytimes.com/2013/08/14/world/europe/germany-fights-population-drop.html?_r=0

Dawson, C. (2015, January 22nd). *The pros and cons of utilizing an agile methodology.* Retrieved November 1st, 2016 from Neashore Americas: http://www.nearshoreamericas.com/agile-methodology-advantages-disadvantages/

Daycare centers: advantages and disadvantages. (2016, October). From babycenter: http://www.babycenter.com/0_daycare-centers-advantages-and-disadvantages_6050.bc

Daycare, F. A. (2014, April 25th). *What you need to know about daycares in Kenya*. From Childcare Kenya: http://www.estatedaycare.co.ke/daycares-in-kenya/

Denzin, N. K., & Lincoln , Y. S. (2011). *The SAGE handbook of qualitative research.* Thousand Oaks, CA: Sage.

Department of Obstetrics at Lenox Hill Hospital. (2016). From Northwell Health: https://www.northwell.edu/find-care/locations/department-obstetrics-lenox-hill-hospital

Destiche, A. (2010, October 6th). *Child GPS tracking systems give parents peace of mind*. From FieldLogix: http://www.fieldtechnologies.com/news/child-gps-tracking-systems-give-parents-peace-of-mind/

Eisenberg, A. (2013, November 2nd). From The New York Times: http://www.nytimes.com/2013/11/03/technology/if-a-young-child-wanders-technology-can-follow.html?_r=0

Faisandier , A. (2012). *System Architecture and Design* (Vol. 3). Belberaud, France: Sinergy'Com Publishers.

Gender Equality and Women's Empowerment in Kenya. (2016, July 13th). From USAID: https://www.usaid.gov/kenya/gender-equality-and-womens-empowerment-kenya

Georgandis, N. (2016, January 14th). From The San Fransisco Globe: http://sfglobe.com/2016/01/12/newborn-was-stolen-from-hospital-but-astranger-spots-a-key-clue/

Gichoya, D. (2005). *Factors Affecting the Successful Implementation of ICT Projects in Government.* Loughborough University, UK, Research School of Informatics,.

Glass, M. (2016). *Child day dare business risk & challenges*. From Small Business: http://smallbusiness.chron.com/child-day-care-business-risk-challenges-39955.html

Global Diversity and Inclusion: Perceptions, Practices and Attitudes. (n.d.). Alexandria, USA. From http://graphics.eiu.com/upload/eb/DiversityandInclusion.pdf

Harindranath, G. (1993). Information Technology Policies and Applications in the Commonwealth Developing Countries: An introduction. In: G. Harindrabath and J. Liebenau, eds,. *Information technology policies and applications in the commonwealth developing countries* , pp. 1-5.

Heeks, R. (2002). *Information Systems and Developing countries: Failure, success, and local improvisations.* . Retrieved November 23rd, 2014 from http://www.fes.uwaterloo.ca/crs/plan674d/isysanddcountries.pdf

Highsmith, J. (2011). *Agile software development: the business of innovation.*

Independent and dependent variable examples. (n.d.). From Your Dictionary: http://examples.yourdictionary.com/independent-and-dependent-variable-examples.html

Jenkin, M. (2016, January 13th). From theguardian: https://www.theguardian.com/sustainable-business/2016/jan/13/babies-at-work-onsite-childcare-office-goldman-sachs-addison-lee

Kazemitabar, H., Ahmed, S., Said, A. B., & Hasbullah, H. B. (2010, September). A comprehensive review on VoIP over Wireless LAN networks. Perak, Malaysia.

Kenyabusinessideas (2015, January 6th). From Kenya Business Ideas: http://kenyabusinessideas.com/2015/01/06/start-a-baby-day-care-business/

Khaled, M. (2003). *Information technology in government: an action plan for Bangladesh.* Retrieved November 27th, 2014 from http://www.sictgov.org/IT%20Action%20Plan%20for%20BG.doc

Khalifa, G., Irani, Z., Baldwin, L., & Jones, S. (2004). *Evaluating Information Technology With You In Mind.* . Retrieved November 9th, 2014 from http://www.ejise.com/volume-4/volume4-issue1/issue1-art5.htm#_ftn1

Khan, M. A., Parveen, A., & Sadiq, M. (2014).

Khan, P. M., & Beg, M. M. (2013).

Knott, R., & Dawson, R. (1999). *Software project management.* Loughborough: Group D Publications.

Kothari, C. R. (2004). *Research Methodology.* New Delhi: New Age International (P) Limited.

Kothari, C. R. (2004). *Research Methodology* (4th ed.). Nairobi, Kenya: New Age Internal Publishers.

Lamkin. (2016, August 10th). *The best kids trackers: Using wearables for child safety*. From Wareable: http://www.wareable.com/internet-of-things/the-best-kids-trackers

Lamkin, P. (2016, August 9th). *Huawei Disney Kids Smartwatch goes live*. From Wareable: http://www.wareable.com/news/huawei-disney-kids-smartwatch-goes-live-in-china-3061

Lamkin, P. (2016, August 10th). *The best kids trackers: Using wearables for child safety*. From Wareable: http://www.wareable.com/internet-of-things/the-best-kids-trackers

Laurel, B. (2003). *Design research: Methods and perspectives.* London, Cambridge, England: MIT Press.

Lohr, S. L. (2010). *Sampling: Design and Analysis.* Boston, Massachusetts, USA: Brooks/Cole.

Matilda, A., & Ivanova, L. *Critical Succcess Factors of Project Management: Empirical Evidence from Projects Supported by EU Programmes.* University of National and World Economy, Sofia, Bulgaria.

Mugonyi, D. (2003). *US queries new computer deal* . Retrieved November 27th, 2014 from Nation Media Group: http://www.nationaudio.com/News/News81.html

National framework for protecting Australia's children 2009–2020. (2009, June). From Australian Government Department of Social Services: https://www.dss.gov.au/our-responsibilities/families-and-children/publications-articles/protecting-children-is-everyones-business?HTML

Nelson, S. L., & Nelson, E. C. (2014). *Excel Data Analysis for Dummies.* Hoboken, New Jersey: John Wiley & Sons, Inc.

Ochilo, O. (1999). *The Growing Gap Between Training And Employment In Communications In Anglophone Africa: Diagnostic And Strategies For Intervention In Tanzania, Kenya And Uganda.* Retrieved November 25th, 2014 from http://www.orbicom.uqam.ca/in_focus/publications/archives/orbi99a.html.

Odhiambo, E., Kassilly, J., Maito, L. T., Onkware, K., & Obaka, W. A. (n.d.). *Kenya's Constitution and Child Traficking as a Security Threat*. From

http://journal.dresmara.ro/issues/volume3_issue2/06_odhiambo_kassilly_maito_onkware_oboka.pdf

Ongiri, I. (2015, September 28th). *Kenya lands on US human trafficking list*. From Daily Nation: http://www.nation.co.ke/news/Kenya-lands-on-US-human-trafficking-list/1056-2888148-vx2t8b/index.html

Onyulo, T. (2015, February 28th). *Baby trafficking is a lucrative business in Kenya.* From USA Today: http://www.usatoday.com/story/news/world/2015/02/28/kenya-stolen-baby-trafficking/23927517/

Orengo , P., & Obegi, B. (2014, February 11th). *Day care centers breeding little monsters*. From Standard Digital: http://www.standardmedia.co.ke/article/2000104424/day-care-centres-breeding-little-monsters

Parenting in the Workplace Institute. (n.d.). From http://www.babiesatwork.org/Babies%20at%20Work%20Fact%20Sheet.pdf

Paul, L. (2016, August 9th). *Huawei Disney Kids Smartwatch goes live*. From Wareable: http://www.wareable.com/news/huawei-disney-kids-smartwatch-goes-live-in-china-3061

Pawlowski , A. (2015, August 11th). *'Baby at work' policies gain momentum with new parents, employers*. From Today Parents: http://www.today.com/parents/baby-work-policies-gain-momentum-parents-employers-t37481

Potential Problems with GPS Tracking. (n.d.). From AutoAlert: http://www.autoalert.me.uk/problems-with-gps-tracking/

Potential Problems with GPS Tracking. (n.d). From AutoAlert: http://www.autoalert.me.uk/problems-with-gps-tracking/

Project Management Institute (2014, August). Retrieved November 25th, 2014 from Project Management Institute: http://www.pmi.org/~/media/PDF/Knowledge%20Center/PMI-Pulse-Requirements-Management-In-Depth-Report.ashx

Research at RIT. (2012, March 15th). Retrieved November 2014, 2014 from Rochester Institute of Technology: http://www.rit.edu/research/srs/compliance/roc/oversight_policy_procedures.htm

Selecting a development approach. (2005, February 17th). Retrieved November 1st, 2016 from https://www.cms.gov/research-statistics-data-and-systems/cms-information-technology/xlc/downloads/selectingdevelopmentapproach.pdf

Shalev, K. (2010). Children Who Go Missing Periodically and Their Involvement in Crime. *International Journal of Police Science & Management , 13* (1), 29-31.

Sieff, K. (2015). *The Washington Post*. Retrieved June 15th, 2016 from https://www.washingtonpost.com/world/africa/kenya-is-threatening-to-close-the-worlds-largest-refugee-camp/2015/04/27/ab296316-e9cd-11e4-8581-633c536add4b_story.html

Singer, B. (2016). From Parents: http://www.parents.com/parenting/technology/best-apps-for-paranoid-parents/

Smiley, S. (2016, March 4th). *Active RFID vs. Passive RFID: What's the Difference?* From RFIDinsider: http://blog.atlasrfidstore.com/active-rfid-vs-passive-rfid

Stephanie. (2015, January 4th). From Gertie's World : http://www.kenyareview.net/wp/2015/01/04/child-day-care-tips-for-running-a-successful-day-care-in-kenya-2015/

SurveyMonkey. (2016). From https://www.surveymonkey.com/

The Harris Poll (2016, March 3rd). From http://www.theharrispoll.com/business/Workforce-Gender-Equality.html

The use of RFID for Human Identity Verification. (2006, December 6th). From https://www.dhs.gov/xlibrary/assets/privacy/privacy_advcom_12-2006_rpt_RFID.pdf

Tracking Systems (2009). From Tracking System Direct: https://www.tracking-system.com/for-consumers/gps-tracking-children.html

United Nations, D. o. (2015). United Nations.

Volunteer in childcare in Kenya. (n.d.). From GoAbroad: http://www.goabroad.com/providers/international-volunteer-hq/programs/volunteer-in-childcare-in-kenya-112113

Wafula, P. (2010, July 13th). *Caring for children becomes money maker too*. From Business Daily: http://www.businessdailyafrica.com/Caring-for-children-becomes-money-maker-too/-/539444/956514/-/6yn0m4z/-/index.html

Wainaina, C. W. (2015, March 27th). *Workplace support for breastfeeding mothers*. From African Population and Health Research Center: http://aphrc.org/workplace-support-for-breastfeeding-mothers/

Woodside, A. G. (2010). *Case Study Research: theory methos practice.* United Kingdom: Emerald Group Publishing Limited.

Yamane, T. (1967). *Statistics: An introductory analysis* (2nd ed.). New York, USA: Harper and Row.

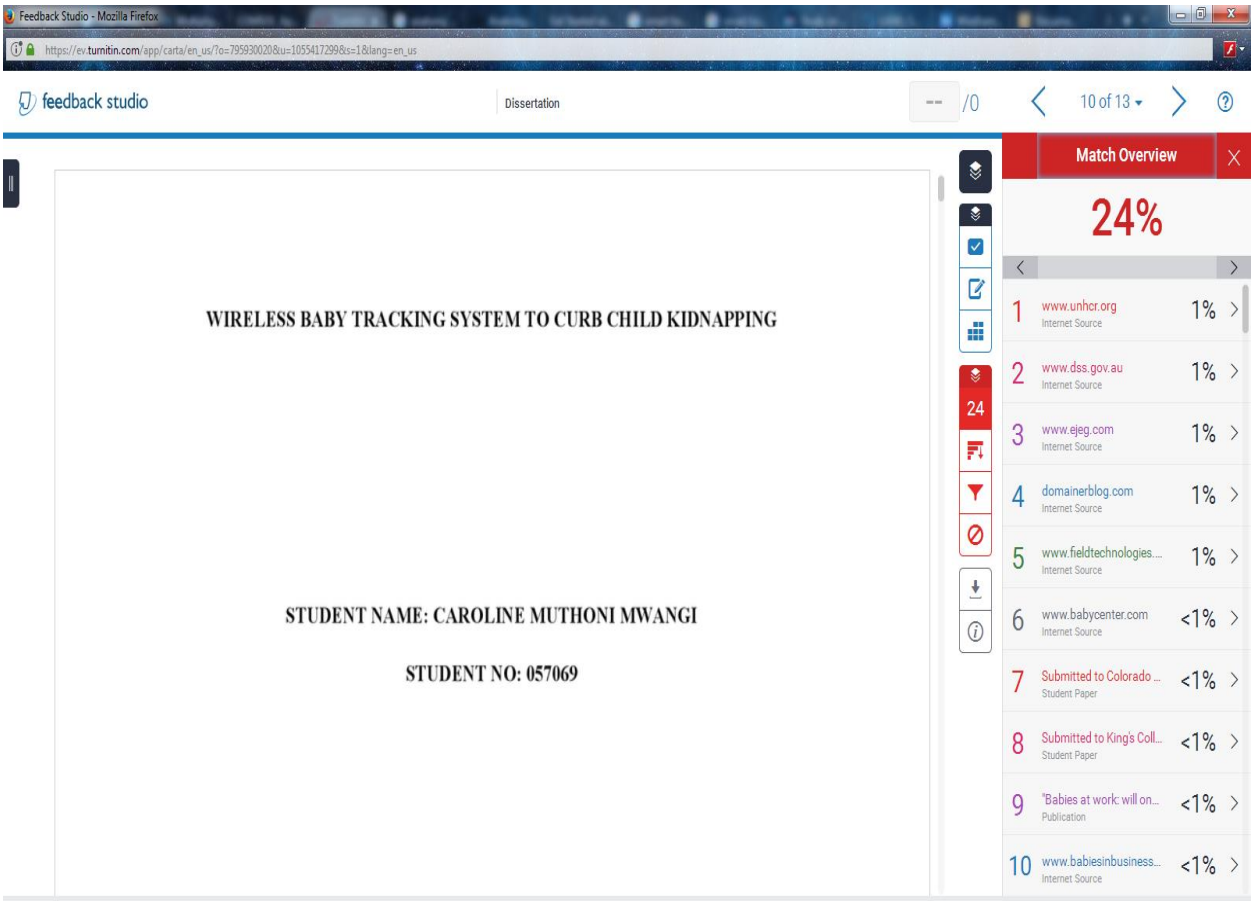
Yin, R. K. (2009). *Case Study Research: design methods* (4th ed.). Sage Publications.

YS, T. (2012, August 19th). *Biometric Technologies launches child-ID to reduce newborn child swapping*. From Yourstory: https://yourstory.com/2012/08/biometric-child-id-to-reduce-newborn-child-swapping-girl-child-killing-and-child-thefts/

Zhou, J. Y. (2004). *Functional and Non-Functional Requirements: A survey.* Quebec: Concordia University.

Appendices

Appendix A: Turnitin Originality Report



Appendix B: User Requirements Questionnaire

Researcher: Caroline Muthoni Mwangi

Master of Science in Information Technology, Strathmore University

This questionnaire will be used to collect information from staff members who would like to bring their babies-to-work. Please complete it by ticking where appropriate considering each question thoughtfully and honestly. Your responses will be highly appreciated and will be treated as private and confidential. All information will be used only for the purpose of this study.

1. Name (optional) ……
2. Age bracket:

   Under 21 years [ ]

   21-30 years [ ]

   31-40 years [ ]

   Above 40 years [ ]
3. Do you have a phone?

   Yes [ ]

   No [ ]
4. Would you adopt a remote monitoring system which notifies you if your child moves out of a predefined area?
5. On a scale of 1-5, kindly rate the monitoring system according to your level of importance:

Features	Scale (tick in the circle) 1 2 3 4 5
SECURITY	◯ ◯ ◯ ◯ ◯

RELIABILITY	◯ ◯ ◯ ◯ ◯
USABILITY	◯ ◯ ◯ ◯ ◯
CONTROL	◯ ◯ ◯ ◯ ◯