Contextual Awareness Location Smartphone App

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Abstract

Nowadays, mobile applications play an important role, which helps the retail shops, restaurants, cinema theaters to attract more customers. The aim of this research project is to study, design and develop contextual awareness location mobile application using Beacons. The development of this app is to improve the customer shopping experience. Since this application is not specific to particular sectors, it focuses on retailers in shopping malls due to the time limit of the project. This app allows the shops to notify the customers of real-time discount offers. Shop owners will update the offers in the web application. The users get the discount offer notifications or latest products up in the store, which is pushed to the mobile based on beacons in the shops, whenever they pass through nearby shops.
Acknowledgements

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I would also like to thank the technical team of various technologies discussed in this project.

Special thanks to my wife, my family and my friends for their continuous support during my MSc. Dissertation.
Declaration

I, Renil Rajan Karumathil, confirm that this work submitted for assessment is my own and is expressed in my own words. Any uses made within it of the works of other authors in any form (e.g., ideas, equations, figures, text, tables, programs) are properly acknowledged at any point of their use. A list of the references employed is included.

Signed:
Date: 20/08/2015
## Table of Contents

Abstract ................................................................................................................................. ii
Acknowledgements .............................................................................................................. iii
Declaration .......................................................................................................................... iv
Table of Contents .............................................................................................................. v
List of Figures ..................................................................................................................... vii
List of Tables ....................................................................................................................... x

### CHAPTER 1: Introduction ................................................................................................. 1

1.1 Aim & Objectives ......................................................................................................... 1
1.2 Research Report Outline ............................................................................................. 2

### CHAPTER 2: Literature Review ..................................................................................... 3

2.1 Context Awareness ...................................................................................................... 3
2.2 Why Contextual Awareness App for Retailers ............................................................ 4
2.3 Smart Phones ............................................................................................................... 5
2.4 Trends in Smartphones and Mobile Apps. ................................................................. 5
2.5 Technology Types for context awareness ................................................................. 9
   2.5.1 QR Codes .............................................................................................................. 9
   2.5.2 RFID .................................................................................................................... 10
   2.5.3 NFC ..................................................................................................................... 10
   2.5.4 Beacons ............................................................................................................. 10
2.6 Comparative Analysis of Context Awareness Technology ......................................... 11
2.7 Estimote Beacons ....................................................................................................... 12
2.8 Web Application ......................................................................................................... 13
   2.8.1 Client – Server Architecture .............................................................................. 14
   2.8.2 Cloud Computing Service .............................................................................. 14
2.9 Technologies Used For Development ....................................................................... 16
   2.9.1 XAMPP .............................................................................................................. 16
   2.9.2 MySQL .............................................................................................................. 16
## CHAPTER 10: Conclusion

10.1 Further work ........................................................................................................... 73
10.2 Summary ................................................................................................................. 73

**References:** .............................................................................................................. 74

**Appendices**................................................................................................................ 1

- Appendix A ................................................................................................................. 1
  - A.1 Source Code ........................................................................................................ 1
- Appendix B ................................................................................................................. 1
  - B.1 User Evaluation .................................................................................................. 1

### List of Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Context-Aware Logic Space</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>Analysis of Mobile Phone Users</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>Statistics of Smartphone Users</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>Statistics of Mobile Ownership by Type of Device</td>
<td>7</td>
</tr>
<tr>
<td>5</td>
<td>Statistics of Usage of Mobile Apps vs. Mobile Website</td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td>Statistics of Mobile App Loading Time</td>
<td>8</td>
</tr>
<tr>
<td>7</td>
<td>Sample of QR code</td>
<td>9</td>
</tr>
<tr>
<td>8</td>
<td>Structure of Beacon</td>
<td>11</td>
</tr>
<tr>
<td>9</td>
<td>Beacon Range Detection</td>
<td>13</td>
</tr>
<tr>
<td>10</td>
<td>Client – Server Architecture</td>
<td>14</td>
</tr>
<tr>
<td>11</td>
<td>PHP workflow architecture</td>
<td>17</td>
</tr>
<tr>
<td>12</td>
<td>GCM Architecture</td>
<td>18</td>
</tr>
<tr>
<td>13</td>
<td>Hybrid Waterfall Agile model</td>
<td>26</td>
</tr>
</tbody>
</table>
Figure 37. Device.php........................................................................................................48
Figure 38. Json.php part 1..................................................................................................49
Figure 39. Json.php part 2..................................................................................................49
Figure 40. Menu screen after login..................................................................................50
Figure 41. Offer screen......................................................................................................51
Figure 42. Settings screen..................................................................................................51
Figure 43. Which source of information do you use to check latest shop offers?..............61
Figure 44. How often do you use smartphone apps?.........................................................61
Figure 45. Are you aware of contextual app?....................................................................62
Figure 46. Do you use any shop offer mobile apps?.........................................................63
Figure 47. Since this app uses both Bluetooth and internet connection, how often do you prefer to enable them to receive offers?........................................................................................................63
Figure 48. Did you face any noticeable delay in the loading of the mobile app?...............64
Figure 49. How quick was the notification received?.......................................................65
Figure 50. Did you receive the same notification twice, when you pass by the same area?..65
Figure 51. How do you rate the battery consumption level of smart phone, when using this app?........................................................................................................66
Figure 52. Did you find the offer screen visually appealing?...........................................67
Figure 53. How do you rate usability of the mobile app?..................................................67
Figure 54. How do you rate the design and layout of the app?.........................................68
Figure 55. How do you prefer to get the shop offers on your smart phone?.....................69
Figure 56. Why do you prefer to use this app?.................................................................69
Figure 57. Do you think this app will improve your shopping experience?.......................70
Figure 58. Overall, how effective is this app?.................................................................71
List of Tables

Table 1. Risk Assessment Table........................................................................................................29
Table 2. Test Case ID 1A .........................................................................................................................51
Table 3. Test Case ID 2A .........................................................................................................................52
Table 4. Test Case ID 3A .........................................................................................................................52
Table 5. Test Case ID 4A .........................................................................................................................52
Table 6. Test Case ID 5A .........................................................................................................................53
Table 7. Test Case ID 6A .........................................................................................................................53
Table 8. Test Case ID 7A .........................................................................................................................53
Table 9. Test Case ID 1B .........................................................................................................................54
Table 10. Test Case ID 2B .......................................................................................................................54
Table 11. Test Case ID 3B .......................................................................................................................54
Table 12. Test Case ID 4B .......................................................................................................................55
Table 13. Test Case ID 5B .......................................................................................................................55
Table 14. Test Case ID 6B .......................................................................................................................55
Table 15. Test Case ID 7B .......................................................................................................................56
Table 16. Test Case ID 8B .......................................................................................................................56
Table 17. Test Case ID 9B .......................................................................................................................56
CHAPTER 1: Introduction

1.1 Aim & Objectives

The aim of this research project is to develop a contextual awareness location smartphone application with beacons. It tracks the smartphone user and provides real-time discount offer through push notification service whenever the user passes through an area of retail shops and restaurants. It enhances the user shopping experience in the form of ease of access to others in real time without having to login to the app by just passing by the entrance to a shop. It also improves in maintaining the better relationship between customers and retailers.

The development will be concentrated exclusively on Android platform now due to limitations of the time frame for the project.

The objectives of this research project are:

- To study the various techniques currently available for contextual awareness and choose to implement the effective method.
- To research and integrate beacons to the smartphone app.
- To analyze, design and develop smartphone applications for the end-users to get real-time special offer notification based on their location.
- To develop a web application for the shop/restaurant admin so that he/she can login to the application and add new the offers if any.
- To deploy the web application on the cloud.
- To push notification from the web application server to the mobile of the user when he/she is nearby the area of shops/restaurants.
- User Evaluation of the application.
Following are optional features, which is to be developed at a future stage:

- To allow users to select their favorite categories from the list to avoid unwanted offers.
- To view loyalty points for the customers.

1.2 Research Report Outline

Following are the chapters covered in this research report

- Introduction: This chapter covers the aim and objective of the project.
- Literature Review: This chapter the background study of the technology used in this project.
- Requirement Analysis: This chapter covers the requirement analysis.
- Project Plan: This chapter covers the methodology, project plan and risk assessment of the project
- Professional, Legal, Ethical and Social Issues: This chapter covers professional, legal, ethical and social issues of the project.
- Design: This chapter covers the system design including database design and user interface.
- Implementation: This chapter covers fundamental functionalities of development.
- Testing: This chapter covers the test cases of the prototype application.
- User Evaluation: This chapter covers the user evaluation of the prototype Android application.
- Conclusion: This chapter provides the summary of the report and future works.
CHAPTER 2: Literature Review

The world has changed a lot in the way technology has been used. Before there used to be times when mobile phones were used just for calling purpose but now it has been part of everyday life for the people. Due to advancements in the field of technology, people need everything to be at their fingertips. Use of smartphones and mobile apps in marketing for retailers and loyalty programs is increasing. Shopping experience and relationship with customer and retailers needs to improve by providing notifications to customer smartphones with their current offers. The aim of this research software project in developing contextual awareness location app is to provide a better shopping experience for the users. It will also help in maintaining relationships with customer and retailer. When the customer passes by a particular shop, he/she receives push notification of current offers and top selling items in their smartphone. This chapter covers the theoretical background study of the research and development of this software project.

2.1 Context Awareness

There is a rapid change in the field of technology for mobile and ubiquitous computing. Context-aware applications enhance the experience of the user. It tends to be enhanced mobile applications due to the following:

- Change in user context depends on the mobility behavior of the user.
- High demand for context awareness in mobiles.

The context-aware system, as per the figure 1, depicts in three-dimensional space with context modeling, pervasiveness and system behavior. Some smartphones use the sensor for context awareness to retrieve contextual information, which is termed as proximity. It works based on user location context where the context is

- A nearby place where the user is located.
- Computing Object
A reasoning process in which new context is derived from an existing or consistent one is known as pervasiveness. Context modeling is a methodology based on structured logic of abstract or definite environment entities describing physical or conceptual object. System behavior is an adaption of the system with the reaction of change of context dynamically. [1]

![Context-Aware Logic Space](image)

**Figure 1. Context-Aware Logic Space [1]**

### 2.2 Why Contextual Awareness App for Retailers

Context is defined as “Any information that can be used to characterize the situation of entities (i.e. whether a person, place or object) that are considered relevant to the interaction between a user and an application, including the user and the application themselves. Context is typically the location identity and state of people, groups and computational and physical objects” [2]. In context awareness, it is either the user detects the location of object or object detects the user, creating a ubiquitous environment. Demand for contextual awareness will change the technology lifestyle of the smartphone in the future. Retailers used to consider many marketing strategies to attract customers to their shops. The possibility of reaching out to the potential
customers were less. The customers need to read newspapers or magazines to see any discount offers or promotions of a specific retailer.

2.3 Smart Phones

Smartphones are mobile telephones with the functions of computers for email, web browser and multimedia along with Wi-Fi and Bluetooth. It runs on the Operating System (OS) developed for smartphone processor, which focuses on battery consumption and performance due to its portability. IBM developed the first smartphone, and it was expensive at that time of its launch in 1993 [3]. Apple, Google and Samsung started to introduce smartphones later. Nowadays, smartphones are advancing in the technology of innovation compared to their older versions. Screen sizes increased along with higher display resolution due to demand in usage of smartphone replacing the laptop or personal computer (PC). Currently, two operating systems are in high demand in the smartphone market – iOS from Apple and Android from Google. Most of the smartphone manufacturers like Samsung, HTC, and Sony use Android whereas iOS is exclusive only to Apple products like iPhone and iPad. Microsoft also entered the mobile market by introducing Windows Phone OS with flat user interface design. The Mobile App is an application, which runs on smartphones developed for mobile phone OS. Demand in mobile apps is one of the main factors of sales of smartphones. These apps are downloaded from the online app store where users can choose based on the categories available.

2.4 Trends in Smartphones and Mobile Apps.

Usage of smartphones, replacing the laptops is trending around the world. As we say that without mobile apps, there is no purpose of owning a smartphone. The Mobile apps trend for downloads is mainly focused on user-friendliness, user interface, user experience, functions, features and the security. This section focuses on statistics for demand in smartphones and mobile apps in the future.
Based on eMarketer research data, mobile phone usage is going to increase by 4.77 billion people around the world. Regions such as the Middle East and Africa will see a rise in users of mobile phones and demand for smartphones will increase by a quarter. Switch from mobile phone to smartphones are growing at a rapid pace with the deployment of 3G and 4G cellular networks [4]. This deployment also reflects the use of mobile apps for social networking, video call and location map-based apps. Based on Nielsen survey data, the smartphone demand in developing countries is still emerging. As per the figure, China ranks 1st with 66% of smartphone users [5].

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**Figure 2. Analysis of Mobile Phone users [4]**
The number of users who prefer apps over the mobile website is increasing. Almost more than 80% use mobile apps. This increase is due to factors of user experience, faster app performance and more convenient to use [6].
The users also reported slowness in loading the app. As a normal process, any user will try to open the app again if the app crashes during the first loading screen. When a further app crash is expected, then this effect the rating of an app in the store that effects download ratio compared to other apps [6].

When considering shopping retailers, restaurants and movie theaters, smartphone apps are mostly used to look into product review and to compare with other products. Apps like Zomato helps the user to find the ratings of the best restaurant in town. Similarly, IMDB app gives a review of the movies rated by critics and users.
2.5 Technology Types for context awareness

There are different technologies, which can be used to integrate with contextual awareness app. Some of them are QR codes, RFID, NFC and Beacons.

2.5.1 QR Codes

Quick Response (QR) code is barcode in the form of a two-dimensional matrix. It can support large data and its compatibility to integrate with any smartphone makes it more popular nowadays [7]. The process is similar to a barcode, which are used to scan in supermarkets. Once scanned, it retrieves item price [8]. The smartphone camera using QR code scanner app scans the QR code. There are different types of scanning apps for QR available in the app market. Based on an algorithm in the app, the code is analyzed and decoded to an output in the form of URL link or description. Retail shops use QR code to promote their official websites or social networking sites. One of the disadvantages of QR code is that the user needs to scan code manually by going to QR code app. This strategy affects promotional and marketing campaign of the company. The security issue is another drawback. It is less secure due to malware and virus content that can be part of the website at the URL of QR code. Users also need to be aware of safe and trustworthy links before accessing the webpage [8]. Since the latest innovations for contactless technologies like NFC, RFID and beacons were introduced, the QR codes are getting outdated [9].

Figure 7. Sample of QR code.
2.5.2 RFID

Radio Frequency Identification (RFID) is contactless technology, which identifies tags through radio waves [10]. It can detect RFID tags from scanning a large area. It can also update the data in real time from scanning. RFID is mostly used in event marketing where the number of visitors inside or outside the building in real time can be tracked. There are other sectors also which use RFID like it can track vehicle entry to a particular area. [9]

2.5.3 NFC

Near Field Communication (NFC), is a part of RFID that uses a short-range contactless technology where the distance for connection needs to be less than 4cm [10]. Most of the current smartphones come with an inbuilt NFC feature. They are used for credit and debit card payments, which are deployed in major retail stores. The smartphone or contactless card needs to be shown at NFC reader first. Then the payment process starts. The major security issue is eavesdropping and it can be easily hacked. The companies providing NFC technology need to be aware of strong encryption by adding a Personal Identification Number (PIN) to prevent access from hackers. [8] This security is similar to the use of PIN in debit cards.

2.5.4 Beacons

Beacons are small transmitters, which uses Bluetooth Low Energy (BLE) technology. It is cheap and low in energy consumption. Since it uses new Bluetooth technology, it needs Smartphones with Bluetooth 4.0 for connections. Most of the new smartphone comes with Bluetooth 4.0 [11]. The purpose of a beacon is to calculate the proximity of another device with the broadcaster. Based on signals transmitted, the smartphone device gets to know how far the range for connection is. [12]
Some companies are also conducting research on beacon technology for indoor navigation. iBeacon is Apple’s technology for location services to work with iOS devices. It uses Bluetooth technology, which uses low energy instead of tracking with coordinates of latitude and longitude for user positioning [13]. Estimote, Bluecats, Bluesense and Gelo are some of the companies who manufacture their beacons, which support both iOS and Android devices [14]. Many sectors like airports and retailers are implementing beacons for customer experience either in the navigation or the context-aware notification. “Some of these companies and organizations are:

- Virgin Atlantic using iBeacons pilot run for premium customers in London Heathrow Airport.
- Starwood Hotel room keys replaced by Beacons, which is also under a pilot run.
- Walmart trial runs using beacon equipped GE light bulbs in stores.” [14]

2.6 Comparative Analysis of Context Awareness Technology

This section provides a summary and comparative analysis of technology types for context awareness, based on study in the previous section. All these technologies are useful but have their limitations. QR codes need more attention due to its security flaws of malware and virus links. It also requires the user to take the mobile app and scan the code. Due to this, many users do not try to scan the code. QR code also takes time in scanning depending on camera quality. NFC needs very close distance to communicate and transfer data. It also controls the user to
use the NFC reader. NFC security is also a major concern. RFID are expensive since the transmitter end needs RFID tag to communicate with each other. Another limitation of RFID is it cannot pass through iron or thick walls. Considering these technologies, Beacons are used in this project due to the following:

- Uses latest Bluetooth Smart Technology.
- Low power consumption with the battery life starting from 6 months to almost four years.
- Range to detect goes up to 70 meters depending upon the Beacon power
- No need for the customer to go and check the offer or scan the QR code.
- One beacon can respond to many user devices.
- Beacons broadcast only signals to the smartphones, which implies no security risk. [15]

There are many beacons from different manufacturers available in the market. Out of these, Estimote beacons are chosen for this project due to its high reviews and ratings compared to other beacons. Battery life of the Estimote beacon is also better compared to other manufacturers.

### 2.7 Estimote Beacons

Estimote is one of the leading beacon manufacturers in the world founded in 2012. Their primary objective was to enhance the user experience with beacons using the technology of Wi-Fi and Bluetooth [16]. “It has a powerful 32-bit ARM® Cortex M0 CPU with 256kB flash memory, accelerometer, temperature sensor and 2.4 GHz Bluetooth 4.0 Smart bi-directional radio.”[17] Estimote Beacon is being used as communication transmitter for this project to transmit signal for context-aware notifications. The lifetime of Estimote beacon battery is around three years but also depends on the usage as per configuration settings. [16]
Beacons broadcast signals with unique id in the form of set of values:

- proximity UUID which is 16 bytes
- major number which is 2 bytes
- minor number which is 2 bytes

This gives a unique id of 20 bytes. The approximate range of the Estimote beacon is up to 70m radius. [18]

![Beacon Range Detection](image)

**Figure 9. Beacon Range Detection [18]**

### 2.8 Web Application

The project requires web application console, which is a context management system to manage the context description and beacon id. Context managed web application will be developed using MySQL, PHP, HTML, JavaScript, CSS and Apache. The web application uses client – server architecture along with cloud computing service.
2.8.1 Client – Server Architecture

The client-server architecture is a network architecture where client workstations send the request and receive data from a centralized server. This type is being used for web applications where the client uses web browsers to access the application and server provide the data. One client workstation can request data from the server whereas another client workstation can request for a different function like inserting or updating the database, both happening at the same time. [19]

![Client – Server Architecture](image)

Figure 10. Client – Server Architecture [20]

2.8.2 Cloud Computing Service

Cloud computing is the current trend in IT technology where on-demand computer resources are accessed from the centralized server stored in different location over the web. By this technology, the user can access from web browser online instead of installing the software and database on the own server on the same intranet. Many IT companies like Amazon, Google, and Microsoft provide cloud-computing services.

Some of the advantages are:

- Client users do not need to invest money in purchasing the hardware and software license.
- The user or developer does not need to look into the maintenance of the server.
Clouding computing services are of three types:

2.8.2.1 SaaS
Software as a service (SaaS) provides cloud-based applications. The cloud providers deploy their apps like Gmail where the user just need to access the system online. [21] The system can be accessed from anywhere in the world. One of the major advantages is that all resources and updates of the hardware and software will be taken care by the cloud provider. The user also needs to pay for the service depending on the usage as per cloud provider.

2.8.2.2 PaaS
Platform as a service (PaaS) provides cloud service for web-based applications normally. Developer deploys the web application on the cloud where the cloud providers host the hardware and software. [22] Any updates in deployed application needs to be taken care by a developer who leased or rented the PaaS service. Cloud providers support the rest of the hardware and software resources. [23]

2.8.2.3 IaaS
Infrastructure as a service (IaaS) provides virtualized infrastructure like networking, data center storage spaces on a cloud. The advantage of IaaS is no need to run backups for the server. If any failure occurs, cloud provider holds the responsibility to fix it [24]. The investment cost is lesser when compared to setting up the same hardware infrastructure.

In this project, PaaS cloud computing service will be used for deploying the web application on the cloud.
2.9 Technologies Used For Development

This section covers the technologies used for the development of this project.

2.9.1 XAMPP
XAMPP is an open source PHP development environment to create a web application using MySQL, Apache and PHP. It provides easy installation of Apache web server, PHP and MySQL. XAMPP is available for Linux, OS X and Windows, which makes it, cross-platform web application solution. [25]

2.9.2 MySQL
MySQL is an open source database where many top companies like Facebook and Google rely on [26]. MySQL is used as a database for web application in this project. It is being considered as the most powerful database engine for the transaction. Some of the features, why MySQL is used mostly for web applications, are:

- Highly scalable and flexible with high performances.
- Easy to manage and strong security for data protection [27]

2.9.3 PHP
Hypertext Preprocessor (PHP) is an open source scripting language used in web application solutions, which can run on any OS. It contains text, HTML, CSS, JavaScript, PHP code and supports most of the database types. Similar to other programming language, PHP can generate dynamic pages, collect data from forms, cookies can be send and received, update the data in database, data encryption and restriction can be applied to certain users to access website pages. [28]

Being a server-side language, the code of PHP normally remains on a web server. When the client workstation user requests data from PHP server, data is retrieved from the database using PHP engine. Once retrieved, the PHP server sends output in the form of HTML or XML. [29]
2.9.4 HTML
HyperText Markup Language (HTML) is a markup language used for web development. It uses tags to describe documents. HTML code defines the structure of web page along with the design. [30]

2.9.5 JavaScript
JavaScript is a programming language used for web design and development along with HTML. It dynamically changes the HTML attributes and contents. [31]

2.9.6 Android
Android is the most popular mobile OS developed by Google for smartphones and tablets with the powerful development framework. It offers an open marketplace for apps distribution making it easy for hardware partner companies to improve the sales in Android powered devices [32]. Since the mobile app for this project is for Android-powered devices, Android studio is used for development. The latest version of OS is Android 5.0 also known as Android Lollipop uses flat material design [33]. The flat design is the current trend in user experience where most of OS are opting to change. “Google officially introduced Integrated Development Environment (IDE) for Android using IntelliJ IDEA technology. It comes with built-in features of Google Cloud Platform which makes it easier for Google Cloud Messaging (GCM) integration and App Engine.”[34]
2.9.7 Google App Engine

Google App Engine is a cloud computing service provided by Google for PaaS. It is easy to develop and deploy a web application on the Google infrastructure. It supports languages like Python, Java, PHP and Go along with MySQL database [35]. “It includes the following features:

- Persistent storage with queries, sorting, and transactions.
- Automatic scaling and load balancing.
- Asynchronous task queues for performing work outside the scope of a request.
- Scheduled tasks for triggering events at specified times or regular intervals.
- Integration with other Google cloud services and APIs.” [36]

2.9.8 Google Cloud Messaging

Google Cloud Messaging (GCM) is a free service for Android for pushing notification messages or data to Android devices from the server. It can also send back data from Android devices to the server. For this service to function, it requires a mobile device, which is GCM enabled and third party server [37]. GCM also handles message queueing where it stores the messages. Whenever Android device is offline, messages are added to the queue. Once the device is online, it sends a message in the form of notification. The figure shows an architectural diagram of how the GCM works.

![GCM Architecture](image)

Figure 12. GCM Architecture [38]
Here client app is GCM enabled Android device and third party server app is an implementation server, which stores database and other functions [38]. “The basic life cycle flow of GCM is –

- Register to enable GCM
- Send and receive downstream messages
- Send and receive upstream messages.” [38]

2.9.9 Summary

XAMPP will be using during the design and development phase of a web application with PHP, MySQL, Apache and JavaScript. Once developed, the web application will be deployed on Google App Engine. Google Cloud Messaging service will be integrated with Google App Engine and Android Application to synchronize the data contents of MySQL database.

2.10 Evaluation

Evaluation is one of the major criteria for software development process. It is to test the usability and functions as per the objective. Without proper evaluation, the application cannot be released to the public. Usually, the application undergoes a testing during the development process of coding. However, this does not evaluate the application from the end users point of view. The evaluation is being done in two sections:

Formative Evaluation: This evaluation is checked during the development stage of the application. It verifies all the requirement analysis considered.

Summative Evaluation: This is checked after the development of the application is completed. It mainly focuses on testing from end users point of view.
Following three applications are to be used for the evaluation process, which is being categorized as summative evaluation.

- Contextual awareness location app with beacons
- Existing QR code promotion app that is available in the market.
- Web application for context management for beacons.

The evaluation is carried out separately for one stakeholder of this project that are the customers.

Web Application Evaluation: The web application will be tested on the validation of basic requirements for functionality testing.

Customer Evaluation: The contextual awareness beacon app is evaluated by comparing with QR code reader app available in the market, which is used for retail promotions. The final contextual awareness beacon app after development will be provided to the group of users to test its features and functionality. Also, QR code integrated application, which is available in the market with features of offers, will also be provided to the same group of users.

The contextual awareness beacon app is compared with QR code app as per the user evaluation and the study of QR code mentioned in Literature Review. This is then used to evaluate the benefits of beacons over QR and why it will trend in the market for the coming years.

2.10.1 Evaluation Criteria

The following are considered for evaluation criteria of the functionality of application based on the project objective:

- The user friendliness of the smartphone app and web application.
- Does it help the retailers in managing customer relationship?
- Does it ease the retailers in marketing strategy?
- Is the web application compatible with Internet Explorer (IE), Firefox, Chrome and smartphone browsers?

- Does the user receive a notification based on the distance to the beacon?

- Does app notify when the smartphone is unlocked?

- Is the app preferred over QR code app?

- How quick are the new offers sent to the smartphone once updated in the web application?
CHAPTER 3: Professional, Legal, Ethical and Social Issues

Professional code of conduct and standards will be followed in this project. The following laws are acknowledged:

- The Intellectual Property Law
- The Data Protection Law
- The Computer Misuse

During the evaluation process, user data with names will be kept anonymous until the completion of the project. As per Data Protection Law 1998, the data will be deleted after the required data is gathered for evaluation task. The survey data will be treated as confidential and will not be disclosed to an external person. The user login password for application is encrypted in the database.
CHAPTER 4: Requirement Analysis

This chapter covers the requirement analysis for MSc. project. The objective is to provide an enhanced user experience in shopping and other retail sectors in the form of contextual awareness. The aim of this project is to develop contextual awareness location app for smartphones running Android OS with the use of beacons.

The first step is requirement analysis, which is critical in software engineering process. The analyst drafts the basic requirements considering the functionality of the software at a high level. The additional requirements are collected from the stakeholders. These data needs analyzing to develop a better software product. Requirements are of two types, functional requirements and non-functional requirements. Stakeholders in this project are customers and retailers.

4.1 Functional Requirements

Customer:

- Customer needs to download the mobile app.

- Customer needs to register on the mobile app with username and password.

- Customer smartphone must be connected to the Internet through Wi-Fi or cellular data plan.

- Customer smartphone must have Bluetooth enabled.

- The customer receives a notification on a smartphone.

- The customer can view notification context message.

- The customer can favorite the context message to view later.
Retailer:

- The retailer needs to register on the web application with username and password.
- The retailer can view previous and current offer status.
- The retailer can add notification offers.
- The retailer can link the beacon id for the created notification.
- The retailer can log out.

4.2 Non - Functional Requirements

UX / UI Design

The user experience and user interface design is one of the major factors in developing a mobile app. It also needs consideration for web application development. Proper analysis needs to be done for the following:

- Color combinations and alignment of text box fields need to be considered during UI design.
- Ease of access to menus and navigation to view contents.
- Better font selection for contents.

Performance

The performance of app needs to be considered. The notification delay needs to be minimized for the fast response. The server performance needs to be better for the web application.

Security

Securing passwords of login credential by encrypting in the database.
4.3 Optional Requirements

The Optional requirements for this project are:

- To run the mobile app on cross platforms.
- To check compatibility with all web browsers.
- Resolving the bugs and providing app updates.

4.4 Assessment Criteria

The assessment criteria is to assess the requirements mentioned above. Functional requirements are to undergo testing during the development phase of the software. Non-functional requirements will be tested based on user evaluation of the software on the following:

- UI / UX
- Performance
- Maintenance
- Security
CHAPTER 5: Project Plan

5.1 Methodology

The methodology is development lifecycle of software. The waterfall model is one of methodology but it alone cannot be used since the project development requires testing and coding approach. For traditional waterfall model, the process goes systematically. Once the coding phase is complete, it cannot go back to coding process when bugs occur during testing. Also, agile model alone has its limitations. The methodology to be used in this project will be hybrid of waterfall approach, which is linear and traditional along with agile approach. The following figure shows hybrid waterfall agile model.

Figure 13. Hybrid Waterfall Agile model [39]
5.2 Project Task List

The project plan is used to manage time and resources to complete a project within given time. The task-lists and Gantt chart are created using Project Libre, an open source application for project management.

<table>
<thead>
<tr>
<th></th>
<th>Name</th>
<th>Duration</th>
<th>Start</th>
<th>Finish</th>
<th>Predecessors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MSc. Project</td>
<td>118 days</td>
<td>5/2/15 8:00 AM</td>
<td>8/27/15 5:00 PM</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Design</td>
<td>14 days</td>
<td>5/2/15 8:00 AM</td>
<td>5/15/15 5:00 PM</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>UML</td>
<td>6 days</td>
<td>5/2/15 8:00 AM</td>
<td>5/7/15 5:00 PM</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Database</td>
<td>3 days</td>
<td>5/8/15 8:00 AM</td>
<td>5/10/15 5:00 PM</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>User Interface</td>
<td>5 days</td>
<td>5/11/15 8:00 AM</td>
<td>5/15/15 5:00 PM</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>Implementation</td>
<td>62 days</td>
<td>5/16/15 8:00 AM</td>
<td>7/16/15 5:00 PM</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Coding</td>
<td>50 days</td>
<td>5/16/15 8:00 AM</td>
<td>7/4/15 5:00 PM</td>
<td>5</td>
</tr>
<tr>
<td>8</td>
<td>Testing</td>
<td>12 days</td>
<td>7/5/15 8:00 AM</td>
<td>7/16/15 5:00 PM</td>
<td>7</td>
</tr>
<tr>
<td>9</td>
<td>User Evaluation</td>
<td>10 days</td>
<td>7/17/15 8:00 AM</td>
<td>7/25/15 5:00 PM</td>
<td>8</td>
</tr>
<tr>
<td>10</td>
<td>Report Writing</td>
<td>24 days</td>
<td>7/27/15 8:00 AM</td>
<td>8/19/15 5:00 PM</td>
<td>9</td>
</tr>
<tr>
<td>11</td>
<td>Dissertation Submission</td>
<td>1 day</td>
<td>8/20/15 8:00 AM</td>
<td>8/22/15 5:00 PM</td>
<td>10</td>
</tr>
<tr>
<td>12</td>
<td>Poster Session</td>
<td>1 day</td>
<td>8/27/15 8:00 AM</td>
<td>8/27/15 5:00 PM</td>
<td>11</td>
</tr>
</tbody>
</table>

**Figure 14. Project Plan**

Project plan is divided into following task lists:

- Design: It consists of UML design, Database design and User Interface design that is planned for 14 days.
- Implementation: It consists of coding of a web application, Android app and testing that is planned for 62 days.
- User Evaluation: It is planned for ten days.
- Report Writing: Report drafting and final reviewing is planned for 24 days.
- Dissertation Submission: Dissertation submission is scheduled on August 20th, 2015.
- Poster Session: Poster session is scheduled on August 27th, 2015.
5.3 Evaluation Plan

Once the software coding and testing stage is completed, groups of users are asked to fill in the online survey questionnaire, which is based on the usability and functionality of the application. The evaluation will be conducted in a group of 10 - 15 users. The questionnaire is an online survey form created using survey monkey. Due to the limitation in the free version of Survey Monkey for the number of questions, Google forms survey is used.

Customer Evaluation: The minimum requirement for the users to take part in survey questionnaire is to have knowledge of smartphone usage and the internet. A group of random users are selected by around 10 -15 users. The contextual awareness beacon application and QR code app will be given to Group. Then these users are requested to use these apps and provide feedback on the survey questionnaire.
5.4 Risk Assessment

The Risk assessment identifies the possible risks to occur along with the action plan. The risks, which occur during the project, needs to be identified to overcome the consequences.

<table>
<thead>
<tr>
<th>Risk</th>
<th>Likelihood</th>
<th>Action Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delay in shipping delivery of required hardware and availability of software.</td>
<td>Likely</td>
<td>To make sure all required hardware and software are in hand before the project start.</td>
</tr>
<tr>
<td>Learning curve time for beacon technology</td>
<td>Likely</td>
<td>To make sure sufficient time assigned for learning curve before the project start.</td>
</tr>
<tr>
<td>Unexpected delay in time frame</td>
<td>Likely</td>
<td>To make sure the time frame is checked on a daily basis.</td>
</tr>
<tr>
<td>Coding error</td>
<td>Likely</td>
<td>To make sure testing is done properly to avoid bugs.</td>
</tr>
<tr>
<td>Lack of user cooperation for evaluation</td>
<td>Unlikely</td>
<td>The App is using new technology, which users are ready to try.</td>
</tr>
</tbody>
</table>

Table 1. Risk Assessment Table
CHAPTER 6: Design

6.1 Database Design:
Database design is one of the main foundation of the application design. In this project, two databases were created. One in server side and the other on the client side.

Server side database: MySQL is used for server side database, which is hosted on a cloud server. The following tables were created for offer management web application.

Shops: This table stores the shop information along with the login credentials. Shop_id is the primary key, which is also a foreign key in the device table. Name is the shop name, username is the login username and password is the login password, which is md5, encrypted. Email, logo_url, about, phone and website are general shop information details. Category is the type of shops.

Offers: This table stores the new offers created which needs to be pushed to the Android application. Offer_id is the primary key. Following are pushed to the Android application that then be displayed in the notification as well as an Android application.

- Title is the name of the offer, which shows as a title in the notification as well as the Android application.
- From_date and to_date are dates when the offers start and end.
- Description is the detail of the offers, which will be displayed in the Android application.
- Img_url is the image of the offer which will be shown in the Android application.
- Location is the description of the location.
- Device_id to set which beacon UUID will get this offer.
- Shop_inner_id uses the same data of shop_id that is used to push the company details.

Device: This table includes all information of beacon device. Device_id is the primary key, which is also a foreign key in offers table. Device_name is the description of the device and UUID is the universally unique identifier of the beacon, which is provided by beacon manufacturer.
Client-side database for Android application:

For Android application, three tables are created along with shared preferences.

**Offers:** This table fetches the data from the Offers table from the server side

**Shop:** This table fetches the data from the Shop table from the server side.

**History:** This table keeps the offer data in history in the mobile app. There is also an option to mark the offer as Favorite.
6.2 Class Diagram Android Application

Figure 17. Database in Android application

Figure 18. Class Diagram Android Application
Login activity:

Login activity is the first activity in the application. It contains following two API’s for login buttons to retrieve the user data:

- Facebook login button to login into the app using Facebook Graph API
- Google account login button to login into the app using Google Account API.

Base activity:

Base activity contains the shared functions used in the subclasses. Each activity, which use these functions, must extend to base activity.

- onBackPressed to close left menu
- MaterialSearchSetup to configure search bar in the application.
- CreateDrawer to create the left menu

Main Activity:

This is the main activity, which is displayed after the login activity and contains navigation drawer. Main activity contains a list of available offers near the device. It displays the offers as a list. After which the user can click on any item to view its details.

Details Activity:

Details activity displays more detailed information about the selected offer. When the user clicks on any offer, the data of selected offer id is retrieved from the database and populated on the views of this activity.

Favorites Activity:

This activity displays the offers, which were marked as favorites. The user can mark an offer from Details activity by clicking on a favorite button.
6.3 User Interface

The user interface of the application is one of the major design parts in the system design. It effects the user experience. The name of the android application is set as “Ubicuo”. This word is derived from the term ubiquitous. Logo of the Android application was designed in Adobe Illustrator CC. Some aspects were considered in its design to make the logo more appealing to the user. The login screen design of the Android application was also created using Adobe Photoshop CC.

![Figure 19. Logo and Icon of the Android application](image-url)
Figure 20. Login screen of the Android application

Web application management:

The layout of the interface was designed in Adobe Dreamweaver CC using HTML. The theme of the website was taken from previous assignment work of MSc Course. Since the application is a prototype, more focus were given on the Android application and its functionality. Due to which the user experience on the web application were given less importance. Fig. 21 shows the screenshot of the login page of the web application management.
The home page was designed considering easiness in retrieving the information. It shows the list of created offers, a list of the device created and the company information. As per Fig.22, the layout of the homepage was considered due to its flat design structure.
Figure 22. Home page of the web application
CHAPTER 7: Implementation

This chapter discusses the implementation process of the application. As discussed in literature review chapter, this application is a client – server architecture. PHP, MySQL and Apache with XAMPP is used in the development of the web application, which is hosted on the web server. HTML is used for layout of the web page, and Android Studio is used in the development process of the application. The web application is used to enter offer details. The initial plan was to use Google Cloud Messaging to push notifications to an Android smartphone. Later during the analysis phase, it was finalized to go with the following approach since it is easier to implement.

- The Android application will request the URL link and parse the JSON data.

7.1 Android Application

The functionality of the Android application is as follows:

- Beacon device will send device ID to the Android application installed on a smartphone when the user enters the coverage area.

- Android application then sends HTTP request with this device ID to the PHP server, which is hosted on the cloud server.

- PHP script collects the data from MySQL database.

- The collected data is encoded in JSON format, which is sent to the android application.

- Android application parse the encoded data and display in human readable form on the smartphone.

Estimote Beacon SDK’s were used for integration of beacon with the Android application. Stack Overflow, Estimote support, and W3schools were used for the study and clarification of the design and coding phase.
Some of the major sections in the main functionality of Android application are discussed below.

EstimoteManager.Java as shown in the figure 24, 25, and 26 is the beacon API, which configure a beacon device and initialize its methods.
```java
public class EstimoteManager {
    private static final int NOTIFICATION_ID = 123;
    private static BeaconManager beaconManager;
    private static NotificationManager notificationManager;
    public static final String EXTRA_Beacon = "extraBeacon";
    private static final String ESTIMOTE_PROXIMITY_UUID = "BD007F3C-F9F8-466E-AFF9-28868B5F8D9D";
    private static final Region ALL_ESTIMOTE_BEACONS = new Region("regionId", null, null, null);

    public static void Create(NotificationManager notificationMngr, Context context, final Intent i) {
        Toast.makeText(context, "Created.", Toast.LENGTH_LONG).show();

        notificationManager = notificationMngr;

        // Create a beacon manager
        beaconManager = new BeaconManager(context);

        // Beacons heartbeat to be set at one second.
        beaconManager.setBeaconPeriod(TimeUnit.SECONDS.toMillis(1), 0);
    }

    // Method called when a beacon gets...
    final Context finalContext = context;
    beaconManager.setMonitoringListener(new BeaconManager.MonitoringListener() {
        @Override
        public void onEnteredRegion(Region region, List<Beacon> beacons) {
            String minor = "";
            String UUID = "";
            if (beacons.size() > 0) {
                minor = beacons.get(0).getMinor();
                UUID = beacons.get(0).getProximityUUID();
                AppLog.i(" UUID === " + UUID);
                AppLog.i(" minor === " + minor);
                AppLog.i(" DataLoading.getNewOffer === ");
                DataLoading.getNewOffer(UUID, finalContext, new IDataLoadingCollectionListener<Offer>() {
                    @Override
                    public void onSuccess(boolean isChanged) {
                        AppLog.i(" isChanged " + isChanged);
                    }
                });
                @Override
                public void onExitedRegion(Region region) {
                    sendNotification(finalContext, "Estimote testing",
                                     "I have lost my estimote!!!");
                }
            }
        }
    });
}
```

**Figure 24. EstimoteManager.Java – part 1**

```java
// Method called when a beacon gets...
final Context finalContext = context;
beaconManager.setMonitoringListener(new BeaconManager.MonitoringListener() {
    @Override
    public void onEnteredRegion(Region region, List<Beacon> beacons) {
        String minor = "";
        String UUID = "";
        if (beacons.size() > 0) {
            minor = beacons.get(0).getMinor();
            UUID = beacons.get(0).getProximityUUID();
            AppLog.i(" UUID === " + UUID);
            AppLog.i(" minor === " + minor);
            AppLog.i(" DataLoading.getNewOffer === ");
            DataLoading.getNewOffer(UUID, finalContext, new IDataLoadingCollectionListener<Offer>() {
                @Override
                public void onSuccess(boolean isChanged) {
                    AppLog.i(" isChanged " + isChanged);
                }
            });
            @Override
            public void onExitedRegion(Region region) {
                sendNotification(finalContext, "Estimote testing",
                                 "I have lost my estimote!!!");
            }
        }
    }
});
```

**Figure 25. EstimoteManager.Java – part 2**
EstimoteManager.Java is a service, which will run in the background to make the previous operations when the receiver catches a beacon.

EstimoteService.Java

```java
import android.app.NotificationManager;
import android.app.Service;
import android.content.Context;
import android.content.Intent;
import android.os.IBinder;
import android.app.android.RateApp;
import android.app.android.RateEstimoteManager;

public class EstimoteService extends Service {

    @Override
    public IBinder onBind(Intent intent) {
        return null;
    }

    @Override
    public int onStartCommand(Intent intent, int flags, int startId) {
        try {
            Log.i("EstimoteService onStartCommand ");
            NotificationManager notificationManager = this.getSystemService(Context.NOTIFICATION_SERVICE);
        } catch (Exception e) {
            
            return START_STICKY;
        }
    }
}
```

Figure 26. EstimoteManager.Java – part 3

Figure 27. EstimoteService.Java
EstimoteReceiver.Java is a broadcast receiver that listens to the Bluetooth if it is turned on or off. The onReceive method detects if the Bluetooth is on or off.

```java
import android.bluetooth.BluetoothAdapter;
import android.content.BroadcastReceiver;
import android.content.Context;
import android.content.Intent;

import se.shopoffers.android.Service.EstimoteService;

public class EstimoteReceiver extends BroadcastReceiver {
    private Intent estimoteServiceIntent;

    // Method called when bluetooth is turned on or off.
    @Override
    public void onReceive(Context context, Intent intent) {
        final String action = intent.getAction();
        if (action.equals(BluetoothAdapter.ACTION_STATE_CHANGED)) {
            final int state = intent.getIntExtra(BluetoothAdapter.EXTRA_STATE, BluetoothAdapter.ERROR);
            switch (state) {
                case BluetoothAdapter.STATE_TURNING_OFF:
                    // When bluetooth is turning off, let's stop estimotes ranging
                    if (estimoteServiceIntent != null) {
                        context.stopService(estimoteServiceIntent);
                        estimoteServiceIntent = null;
                    }
                    break;
                case BluetoothAdapter.STATE_ON:
                    // When bluetooth is turned on, let's start estimotes monitoring
                    if (estimoteServiceIntent == null) {
                        estimoteServiceIntent = new Intent(context, EstimoteService.class);
                        context.startService(estimoteServiceIntent);
                    }
                    break;
            }
        }
    }
}
```

Figure 28. EstimoteReceiver.Java
DataLoading.Java in the Android contains the main part of fetching JSON data from the server. This file does the following:

- PostData to Get data from the server.

```java
private static void PostData(String dev_id, Context c, IDataLoadingListener event) {
    AppLog.i("PostData ----");
    StrictMode.ThreadPolicy policy = new StrictMode.ThreadPolicy.Builder().permitAll().build();
    StrictMode.setThreadPolicy(policy);

    final OkHttpClient client = new OkHttpClient();
    FormEncodingBuilder formFarms = new FormEncodingBuilder();

    formFarms.add("user", "add");
    RequestBody formBody = formFarms.build();
    String url=AppConstant.ServerUrlNewFace+dev_id;
    AppLog.i("AppConstant.ServerUrlNewFace " + url);
    try {
        Response response = client.newCall(request).execute();

        if (response.isSuccessful()) {
            String html = response.body().string();
            event.onSuccess(html);

            System.out.println(html);
            AppLog.i("App ==> " + html);
        }
    } catch (IOException ex) {
        ex.printStackTrace();
        event.onFail(ex.getMessage());
    } catch (Exception ex) {
        ex.printStackTrace();
        event.onFail(ex.getMessage());
    }
}
```

Figure 29. DataLoading.Java – PostData
- pushOffers to parse the JSON data and store in the database

```java
public static void pushOffers(Context c, String jsonText) {
    try {
        ShopDao shopDao = new ShopDao();
        OfferDao offerDao = new OfferDao();
        HistoryDao historyDao = new HistoryDao();

        JSONArray array = new JSONArray(jsonText);
        JSONObject obj = null;
        long server_id_off, server_id_shop;
        int categoryId;
        String name, logoURL, about, phone, website, categoryName;
        String title, fromDate, toDate, description, imgUrl, locations;

        AppLog.i("array.length() \(=\) "+array.length());

        for (int i = 0; i < array.length(); i++) {
            obj = (JSONObject) array.get(i);
            name = obj.getString("name");
            logoURL = obj.getString("logoURL");
            about = obj.getString("about");
            phone = obj.getString("phone");
            website = obj.getString("website");
            categoryName = obj.getString("categoryName");
            server_id_shop = obj.getLong("server_id_shop");
            long server_id = shopDao.addShop(server_id_shop, name, logoURL, about, phone, website,
                                                categoryName, 1);
            Shop shop = Shop.load(Shop.class, server_id);

            JSONArray offers = obj.getJSONArray("offers");
            JSONObject obj_in;

            AppLog.i("offers.length() \(=\) "+offers.length());

            for (int j = 0; j < offers.length(); j++) {
                obj_in = offers.getJSONObject(j);
                server_id_off = obj_in.getLong("server_id_off");
                title = obj_in.getString("title");
                fromDate = obj_in.getString("from_date");
                toDate = obj_in.getString("to_date");
                description = obj_in.getString("description");
                imgUrl = obj_in.getString("img_url");
                locations = obj_in.getString("locations");

                try {
                    offer = offerDao.addOffer(server_id_off, title, AppConstants.DateConversion.getDateFromString(fromDate)
                                                                                   , AppConstants.DateConversion.getDateFromString(toDate), description, imgUrl, locations, shop);
                    hist = historyDao.addHistory(-1, 1, offer, false, false);
                    History h = History.load(History.class, hist);
                    AppSettingDao ss = new AppSettingDao();
                    if (ss.isNotificationEnabled()) { sendNotification(c, h, offer, title, description); }
                } catch (Exception e) {
                    e.printStackTrace();
                }
            }
        }
    }
}
```

Figure 30. DataLoading.Java – pushOffers - part 1

```java
for (int j = 0; j < offers.length(); j++) {
    obj_in = offers.getJSONObject(j);
    server_id_off = obj_in.getLong("server_id_off");
    title = obj_in.getString("title");
    fromDate = obj_in.getString("from_date");
    toDate = obj_in.getString("to_date");
    description = obj_in.getString("description");
    imgUrl = obj_in.getString("img_url");
    locations = obj_in.getString("locations");

    try {
        offer = offerDao.addOffer(server_id_off, title, AppConstants.DateConversion.getDateFromString(fromDate)
                                                                                   , AppConstants.DateConversion.getDateFromString(toDate), description, imgUrl, locations, shop);
        hist = historyDao.addHistory(-1, 1, offer, false, false);
        History h = History.load(History.class, hist);
        AppSettingDao ss = new AppSettingDao();
        if (ss.isNotificationEnabled()) { sendNotification(c, h, offer, title, description); }
    } catch (Exception e) {
        e.printStackTrace();
    }
}
```

Figure 31. DataLoading.Java – pushOffers - part 2
- sendNotification to push the offer notification

```java
public static void sendNotification(Context context, History h, long off, String title, String msg) {
    AppLog.i("sendNotification done");
    android.support.v7.app.NotificationCompat.Builder mBuilder =
        new android.support.v7.app.NotificationCompat.Builder(context);
    mBuilder.setSmallIcon(R.mipmap.ic_launcher);
    mBuilder.setContentTitle(title);
    mBuilder.setContentText(msg);
    // Creates an explicit intent for an Activity in your App
    Intent resultIntent = new Intent(context, DetailsActivity.class);
    resultIntent.putExtra(AppAction.WXTSA EXTRA, off);
    mBuilder.setContentIntent(PendingIntent.getActivity(context, 0, resultIntent, PendingIntent.FLAG_UPDATE_CURRENT));
    mBuilder.setAutoCancel(true);
    NotificationManager mNotificationManager =
        (NotificationManager) context.getSystemService(Context.NOTIFICATION_SERVICE);
    // mL allows you to update the notification later on.
    mNotificationManager.notify((int) off, mBuilder.build());
    h.save = true;
    h.save();
}
```

**Figure 32. DataLoading.Java – SendNotification**

```java
public static void getNewOffer(String DeviceId, final Context c, final IDataLoadingCollectionListener event) {
    AppLog.i("getNewOffer ===");
    PostData(DeviceId, c, new IDataLoadingListener() {
        @Override
        public void onSuccess(String html) {
            int newOffers = 0;
            pushOffers(c, html);
            boolean isHaveNewData = false;
            if (newOffers > 0)
                isHaveNewData = true;
            event.onSuccess(isHaveNewData);
        }
        @Override
        public void onFail(String error) {
            event.onFail(error);
        }
    });
}
```

**Figure 33. DataLoading.Java – getNewOffer**
7.2 Web Application

The web application consists of PHP, HTML, and MySQL. For the Android application to receive offers, the web application needs to be hosted on the server. The web application is hosted on http://www.ubicuomanagement.com/ums/main.php. The following are the web page and PHP files:

- Main.php: This is login screen of the web application shown in Fig. The screen has an option to register if the user does not have an account for the web application.

- Login.php: This consists of login scripts for validation.

```html
<html>
</html>

```
- **Home.php**: This is the home screen of the web application as shown in Figure.22 with HTML and PHP scripting.
- **Sqlcon.php**: This file contains scripts for database connectivity.
- **Register.php**: This file contains HTML script for registering a new user.

![Ubicuo Management System](image)

**Figure 35. Register.php**

- **Submit-form.php**: This file contains PHP MySQL scripts to insert the new registered users into the database. Members of stack overflow website assisted in developing a script for file upload with validation and uploading in the images folder.
- **Add_device.php**: This file contains PHP MySQL scripts to insert new beacon details.
- **Add_offers.php**: This file contains PHP MySQL scripts to insert new offers that need to be pushed to the Android application.
- **Offers1.php**: This file contains HTML scripts for adding offers.

![Offers1.php](image)

**Figure 36. Offers1.php**

- **Device.php**: This file contains HTML script for creating beacon details. Beacon UUID is used to detect the beacon.

![Device.php](image)

**Figure 37. Device.php**
- Json.php: This file contains JSON script. JSON was tested after publishing the website on the server.

```php
<?php

// connect to the server
$server_name = "phuongnamuong@gmail.com";
$username = "mysql";
$password = "php";
$database = "mydb";

// Create connection
$conn = mysqli_connect($server_name, $username, $password, $database);
// Check connection
if (!$conn) {
    die("Connection failed: ": mysqli_connect_error());
}

mysqli_select_db($conn, $database);
$dev_id = $_GET['dev_id'];

$sql = "SELECT shops.shop_id, shops.name, shops.logo_url, shops.about, shops.phone, shops.website, shops.category FROM device, shops WHERE device.shop_id = shops.shop_id AND UUID="."$dev_id."";

$result = $conn->query($sql); // return shop data
if ($result->num_rows > 0) {
    // output data of each row
    while ($row = $result->fetch_assoc()) {
        $temp = json_encode($row, ":

        while ($row = $result_offers->fetch_assoc()) {
            $str = json_encode($row, ":

        $outer_array[] = array('Server_id' => $row['shop_id'],
            'Name' => $row['name'],
            'LogoURL' => $row['logo_url'],
            'About' => $row['about'],
            'Phone' => $row['phone'],
            'Website' => $row['website'],
            'CategoryName' => $row['category'],
            'Offers' => $row['offers']
        );
    } else {
        //echo "[]";
    }
    mysqli_close($conn);
    echo json_encode($outer_array);
}
```

Figure 38. Json.php part 1

Figure 39. Json.php part 2
CHAPTER 8: Testing

Both Android and web application were tested after development. The Beacon UUID was added in the web application along with shop id and shop offer. The following main functionality were tested with minimum requirement of Bluetooth and Internet connectivity:

- Login using Facebook or Google account.

![Menu screen after login](image)

Figure 40. Menu screen after login

- Receive notification on Android smartphones when the user is in inside range of beacon
- View the offer.
- Add offer as favorites
- Disable the offer.
- Logout.

Test Case ID: 1A

<table>
<thead>
<tr>
<th>Test Case</th>
<th>Login to the Ubicuo App using Facebook or Google account</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Steps</td>
<td>- Click Login button for Facebook or Google account</td>
</tr>
<tr>
<td>Expected Results</td>
<td>Valid</td>
</tr>
<tr>
<td>Actual Results</td>
<td>Accepted</td>
</tr>
<tr>
<td>Status</td>
<td>Passed</td>
</tr>
</tbody>
</table>

Table 2. Test Case ID 1A
### Test Case ID: 2A

<table>
<thead>
<tr>
<th>Test Case</th>
<th>Log out from the Ubicuo App</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Steps</td>
<td>- Click Logout button in settings screen.</td>
</tr>
<tr>
<td>Expected Results</td>
<td>Valid</td>
</tr>
<tr>
<td>Actual Results</td>
<td>Accepted</td>
</tr>
<tr>
<td>Status</td>
<td>Passed</td>
</tr>
</tbody>
</table>

Table 3. Test Case ID 2A

### Test Case ID: 3A

<table>
<thead>
<tr>
<th>Test Case</th>
<th>Receive notification when entering the range of nearby Beacon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Steps</td>
<td>- Walk towards an area where the beacon is placed.</td>
</tr>
<tr>
<td>Expected Results</td>
<td>Valid</td>
</tr>
<tr>
<td>Actual Results</td>
<td>Accepted</td>
</tr>
<tr>
<td>Status</td>
<td>Passed</td>
</tr>
</tbody>
</table>

Table 4. Test Case ID 3A

### Test Case ID: 4A

<table>
<thead>
<tr>
<th>Test Case</th>
<th>View notification offer in detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Steps</td>
<td>- Click on the notification to view in full screen in Ubicuo App.</td>
</tr>
<tr>
<td>Expected Results</td>
<td>Valid</td>
</tr>
<tr>
<td>Actual Results</td>
<td>Accepted</td>
</tr>
<tr>
<td>Status</td>
<td>Passed</td>
</tr>
</tbody>
</table>

Table 5. Test Case ID 4A
### Test Case ID: 5A

**Test Case**
Add to favorites to view selected offers for later viewing.

**Test Steps**
- Click on the favorite icon on the offer screen.
- Go to the menu of the app.
- Click on favorites.
- Selected offers that were added to favorites are seen.

**Expected Results**
Valid

**Actual Results**
Accepted

**Status**
Passed

*Table 6. Test Case ID 5A*

### Test Case ID: 6A

**Test Case**
Switch on Bluetooth and internet connection after reaching near the beacon

**Test Steps**
- Enable Bluetooth

**Expected Results**
Valid. The new offer notification needs to be received by the user.

**Actual Results**
Accepted. The new offer is received when the user enables Bluetooth after reaching near the beacon.

**Status**
Passed

*Table 7. Test Case ID 6A*

### Test Case ID: 7A

**Test Case**
Pass by the same beacon twice.

**Test Steps**
- First, pass by Beacon A.
- Then return to pass by Beacon A again.

**Expected Results**
Valid. The user will not receive the same offer notification, which was previously received in the first passing.

**Actual Results**
Accepted.

**Status**
Passed

*Table 8. Test Case ID 7A*
### Test Case ID: 1B

<table>
<thead>
<tr>
<th>Test Case</th>
<th>Login with registered username and password</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Test Steps</strong></td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>Enter correct username and password</td>
</tr>
<tr>
<td>-</td>
<td>Click Login</td>
</tr>
<tr>
<td><strong>Expected Results</strong></td>
<td>Valid</td>
</tr>
<tr>
<td><strong>Actual Results</strong></td>
<td>Accepted</td>
</tr>
<tr>
<td><strong>Status</strong></td>
<td>Passed</td>
</tr>
</tbody>
</table>

**Table 9. Test Case ID 1B**

### Test Case ID: 2B

<table>
<thead>
<tr>
<th>Test Case</th>
<th>Login with blank username and password</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Test Steps</strong></td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>Click Login by keeping username and password blank</td>
</tr>
<tr>
<td><strong>Expected Results</strong></td>
<td>Invalid. The application does not allow login with blank username and password.</td>
</tr>
<tr>
<td><strong>Actual Results</strong></td>
<td>Rejected. Validation message is shown on the screen.</td>
</tr>
<tr>
<td><strong>Status</strong></td>
<td>Passed</td>
</tr>
</tbody>
</table>

**Table 10. Test Case ID 2B**

### Test Case ID: 3B

<table>
<thead>
<tr>
<th>Test Case</th>
<th>Login with correct username and blank password</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Test Steps</strong></td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>Enter correct username and keep password blank</td>
</tr>
<tr>
<td>-</td>
<td>Click Login</td>
</tr>
<tr>
<td><strong>Expected Results</strong></td>
<td>Invalid. The application does not allow login.</td>
</tr>
<tr>
<td><strong>Actual Results</strong></td>
<td>Rejected. Validation message is shown on the screen.</td>
</tr>
<tr>
<td><strong>Status</strong></td>
<td>Passed</td>
</tr>
</tbody>
</table>

**Table 11. Test Case ID 3B**
<table>
<thead>
<tr>
<th>Test Case ID: 4B</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Test Case</strong></td>
<td>Login with incorrect username and password</td>
</tr>
</tbody>
</table>
| **Test Steps** | - Enter incorrect username and password  
- Click Login |
| **Expected Results** | Invalid. The application does not allow login. |
| **Actual Results** | Rejected. Validation message is shown on the screen. |
| **Status**      | Passed |

Table 12. Test Case ID 4B

<table>
<thead>
<tr>
<th>Test Case ID: 5B</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Test Case</strong></td>
<td>Login with incorrect username and correct password</td>
</tr>
</tbody>
</table>
| **Test Steps** | - Enter incorrect username and correct password  
- Click Login |
| **Expected Results** | Invalid. The application does not allow login. |
| **Actual Results** | Rejected. Validation message is shown on the screen. |
| **Status**      | Passed |

Table 13. Test Case ID 5B

<table>
<thead>
<tr>
<th>Test Case ID: 6B</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Test Case</strong></td>
<td>Login with correct username and incorrect password</td>
</tr>
</tbody>
</table>
| **Test Steps** | - Enter correct username and incorrect password  
- Click Login |
| **Expected Results** | Invalid. The application does not allow login. |
| **Actual Results** | Rejected. Validation message is shown on the screen. |
| **Status**      | Passed |

Table 14. Test Case ID 6B
### Test Case ID: 7B

<table>
<thead>
<tr>
<th>Test Case</th>
<th>Login with blank username and correct password</th>
</tr>
</thead>
</table>
| Test Steps| - Enter blank username and correct password  
- Click Login |
| Expected Results | Invalid. The application does not allow login. |
| Actual Results | Rejected. Validation message is shown on the screen. |
| Status | Passed |

Table 15. Test Case ID 7B

### Test Case ID: 8B

<table>
<thead>
<tr>
<th>Test Case</th>
<th>Register company details with all correct fields</th>
</tr>
</thead>
</table>
| Test Steps| - Fill in all details for company user registration  
- Click the register button. |
| Expected Results | Valid. |
| Actual Results | Accepted. |
| Status | Passed |

Table 16. Test Case ID 8B

### Test Case ID: 9B

<table>
<thead>
<tr>
<th>Test Case</th>
<th>Register company details with one or more fields blank</th>
</tr>
</thead>
</table>
| Test Steps| - Fill in all details for company user registration  
- Click the register button. |
| Expected Results | Invalid. The application does not allow to register without filling all fields. |
| Actual Results | Rejected. Validation message is shown on the screen. |
| Status | Passed |

Table 17. Test Case ID 9B
### Test Case ID: 10B

**Test Case:** View the existing offers and existing devices created from home screen

**Test Steps:**
- Login with correct username and correct password
- Click Login

**Expected Results:** Valid.

**Actual Results:** Accepted.

**Status:** Passed

### Table 18. Test Case ID 10B

### Test Case ID: 11B

**Test Case:** Create new offers by filling all correct fields.

**Test Steps:**
- Login with correct username and the correct password.
- Click Login.
- Click Add Offers.
- Fill in all the fields.
- Click Add.

**Expected Results:** Valid.

**Actual Results:** Accepted.

**Status:** Passed

### Table 19. Test Case ID 11B

### Test Case ID: 12B

**Test Case:** Create new offers by keeping one or more fields blank

**Test Steps:**
- Login with correct username and the correct password.
- Click Login.
- Click Add Offers.
- Fill in by leaving one or more fields blank.
- Click Add.

**Expected Results:** Invalid. The application does not allow creating new offer without filling all details.

**Actual Results:** Rejected. Validation message is shown on the screen.

**Status:** Passed

### Table 20. Test Case ID 12B
### Test Case ID: 13B

<table>
<thead>
<tr>
<th>Test Case</th>
<th>Create a new device by not filling one or more missing fields.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Test Steps</strong></td>
<td>- Login with correct username and the correct password.</td>
</tr>
<tr>
<td></td>
<td>- Click Login.</td>
</tr>
<tr>
<td></td>
<td>- Click Add Devices.</td>
</tr>
<tr>
<td></td>
<td>- Fill in by leaving one or more fields blank.</td>
</tr>
<tr>
<td></td>
<td>- Click Add.</td>
</tr>
<tr>
<td><strong>Expected Results</strong></td>
<td>Invalid. The application does not allow creating new device without filling all details.</td>
</tr>
<tr>
<td><strong>Actual Results</strong></td>
<td>Rejected. Validation message is shown on the screen.</td>
</tr>
<tr>
<td><strong>Status</strong></td>
<td>Passed</td>
</tr>
</tbody>
</table>

### Table 21. Test Case ID 13B

### Test Case ID: 14B

<table>
<thead>
<tr>
<th>Test Case</th>
<th>Create a new device by filling all the fields.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Test Steps</strong></td>
<td>- Login with correct username and the correct password.</td>
</tr>
<tr>
<td></td>
<td>- Click Login.</td>
</tr>
<tr>
<td></td>
<td>- Click Add Devices.</td>
</tr>
<tr>
<td></td>
<td>- Fill in by leaving one or more fields blank.</td>
</tr>
<tr>
<td></td>
<td>- Click Add.</td>
</tr>
<tr>
<td><strong>Expected Results</strong></td>
<td>Valid.</td>
</tr>
<tr>
<td><strong>Actual Results</strong></td>
<td>Accepted.</td>
</tr>
<tr>
<td><strong>Status</strong></td>
<td>Passed</td>
</tr>
</tbody>
</table>

### Table 22. Test Case ID 14B

### Test Case ID: 15B

<table>
<thead>
<tr>
<th>Test Case</th>
<th>Only offers created by the user can be seen once user log in.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Test Steps</strong></td>
<td>- Login with correct username and the correct password.</td>
</tr>
<tr>
<td></td>
<td>- Click Login.</td>
</tr>
<tr>
<td><strong>Expected Results</strong></td>
<td>Valid.</td>
</tr>
<tr>
<td><strong>Actual Results</strong></td>
<td>Accepted.</td>
</tr>
<tr>
<td><strong>Status</strong></td>
<td>Passed</td>
</tr>
</tbody>
</table>

### Table 23. Test Case ID 15B
Test Case ID: 16B

<table>
<thead>
<tr>
<th>Test Case</th>
<th>User logout the session</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Steps</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Login with correct username and the correct password.</td>
</tr>
<tr>
<td></td>
<td>- Click Login.</td>
</tr>
<tr>
<td></td>
<td>- Click Logout.</td>
</tr>
<tr>
<td>Expected Results</td>
<td>Valid.</td>
</tr>
<tr>
<td>Actual Results</td>
<td>Accepted.</td>
</tr>
<tr>
<td>Status</td>
<td>Passed</td>
</tr>
</tbody>
</table>

Table 24. Test Case ID 16B

Summarizing the above test cases of the main functionality for the Android application and web application, all tests requirements as mentioned in functional requirements are passed. This proves that the application is working as per the aim and objective of the research report.
CHAPTER 9: User Evaluation

As discussed in the project plan chapter, the evaluation was to get feedback from the users after using the Android mobile application on the experience, functionality, and usability. The evaluation was conducted in an open area in a shopping mall with a group of 15 users. All users who participated were in the age group 21 – 35. The shopping mall was selected so that users get the real-time experience of the Android application. Two beacons were placed in two different locations. One of the main requirement was to have an Android smartphone since the prototype application was developed only for the Android platform. Those users who did not have Android smartphone was provided with one. After the users test the Android application, the online survey questionnaire created from Google forms was forwarded to the users by email and social messaging apps. The use of the application was briefed to all the users before using the application. A third party QR code reader, which was available in Android store was downloaded. It was given to the users after they tested Ubicuo app. The sample QR code was generated from QR code generator website. The printed copy was then given to the user to experience the difference of using an Ubicuo beacon technology app and QR code reader app.

Following are the results based on the questionnaire:

**Question-1:** Which source of information do you use to check the latest shop offers?

**Rationale:** This question is to find out if the users check shop offers from any other source of information in their everyday life. It helps to know if they will use this shopping app.

**Responses:** As per Figure.43, the majority of the respondents check for shop offers through social media, newspapers, and websites. 10 of them agreed they look at social media, 4 agreed on newspapers and magazines and 1 agreed on websites. This shows that the main reason for shopping has best offers.
Question-2: How often do you use smartphone apps?

Rationale: This question is to find out how frequent the users check the apps in their smartphones. This helps to analyze if they will check the shopping app once it is out in the market.

Responses: As per figure.44, the majority uses apps daily, but some use it less often. 13 agreed on daily and 2 agreed to less often. The chances are high that the users will download the app and use it.
**Question-3:** Are you aware of the contextual app?

**Rationale:** This question is to find out how knowledge does the users have for the contextual app.

**Responses:** As per figure.45, a majority of 9 agreed that they are aware of what is contextual app. Remaining 6 didn’t know about the contextual app. Those who agreed with yes can give better feedback.

![Figure 45. Are you aware of the contextual app?](image)

**Question-4:** Do you use any shop offer mobile apps?

**Rationale:** This question is to find out if the users have knowledge on shop offer mobile apps available on the market. If they use, it will be easy for them to give feedback for this prototype app.

**Responses:** As per figure.46, the majority has used shop offer mobile app previously. 9 agreed on using other shop offer mobile apps whereas 6 of them never used.
Figure 46. Do you use any shop offer mobile apps?

**Question-5:** Since this app uses both Bluetooth and internet connection, how often do you prefer to enable them to receive offers?

**Rationale:** This question is to find out if the users prefer to keep Bluetooth and internet connection on. It will give an idea if the users are ok to use Bluetooth.

**Responses:** As per figure.47, responses were good since majority agreed on using the Bluetooth before entering a mall or some prefer to keep Bluetooth and 3G enabled.

Figure 47. Since this app uses both Bluetooth and internet connection, how often do you prefer to enable them to receive offers?
Question-6: Did you face any noticeable delay in the loading of the mobile app?

Rationale: This question is to find out how the performance of the app is in terms of loading.

Responses: As per figure.48, the majority did not face any delay in loading the app. 11 agreed on no and 4 agreed on yes. Since its prototype, chances are there for the delay in loading of the application. This will be added in future releases of the app to make it more stable and fast.

![Figure 48. Did you face any noticeable delay in the loading of the mobile app?](image)

Question-7: How quick was the notification received?

Rationale: This question is to find out how fast is the response of notification pushed to smartphones. It will help in improving the app on performance and functionality.

Responses: As per figure.49, the majority of 10 agreed notification is fast. Remaining 5 noticed a slight lag. This will also be considered for the enhancement of the future release.
Question-8: Did you receive the same notification twice, when you pass by the same area?

Rationale: This question is to find out if there was any duplicate offers send to the same user.

Responses: As per figure 50, the complete respondents agreed on no.
**Question-9:** How do you rate the battery consumption level of a smartphone, when using this app?

**Rationale:** This question is to find out if any enhancement is required on the app to improve the battery life.

**Responses:** As per figure 51, The majority of 8 agreed only < 5% is getting drained from the battery. 6 respondents agreed on 5% - 15%. Enhancement is required to improve the battery life when using this app. There is also a chance where some respondents had many apps running in the background, which shows battery consumption in the range of 5% - 15%.

![Bar chart showing battery consumption levels](image)

**Figure 51.** How do you rate the battery consumption level of a smartphone, when using this app?

**Question-10:** Did you find the offer screen visually appealing?

**Rationale:** This question is to find out if the users liked the offer screen more appealing in the screen layout and graphic design of the app.

**Responses:** All 15 respondents agreed yes.
**Figure 52. Did you find the offer screen visually appealing?**

**Question-11:** How do you rate the usability of the mobile app?

**Rationale:** This question is to find out how the users rate the usability. This rating can be used to enhance the application.

**Responses:** As per figure 53, 8 agreed with excellent, 5 on very good and 2 on good. This shows that the usability of the app is better.

**Figure 53. How do you rate the usability of the mobile app?**
**Question-12:** How do you rate the design and layout of the app?

**Rationale:** This question is to find out how the users rate on the design and layout of the overall app.

**Responses:** As per figure.54, majority 8 agreed on very good and rested 7 agreed on excellent.

![Bar chart showing design and layout ratings](image)

**Figure 54.** How do you rate the design and layout of the app?

**Question-13:** How do you prefer to get the shop offers on your smartphone?

**Rationale:** This question is to find out if beacon technology will be preferred over QR code or any other similar technology.

**Responses:** As per figure.55, complete 15 respondents agreed with notification based on user location. This shows that users do not prefer QR code app, and also they need to scan the code manually.
Figure 55. How do you prefer to get the shop offers on your smartphone?

**Question-14:** Why do you prefer to use this app?

**Rationale:** This question is to find out by what could be the reasons the users prefer to download this app once it is available in the market. It will give an idea on any enhancements, which needs to be added in the future release.

**Responses:** As per figure 56, 7 agreed to use the app if there are exclusive offers that are available only for Ubicuo app users, and other 7 agreed to use this app since they don’t need to unlock the phone to receive the offers. And 1 agreed with other option.

Figure 56. Why do you prefer to use this app?
**Question-15:** Do you think this app will improve your shopping experience?

**Rationale:** This question is to find out if the users will find this app useful when they go out for shopping.

**Responses:** As per figure.57, all 15 respondents agreed that this app will improve their shopping experience.

![Figure 57. Do you think this app will improve your shopping experience?](image)

**Question-16:** Overall, how effective is this app?

**Rationale:** This question is to find out how effectively did the users find the app useful.

**Responses:** Majority agreed that app is very good. Remaining 6 agreed the app is excellent. Only 1 agreed it is good.
Figure 58. Overall, how effective is this app?

**Question-17:** Do you have any comments or suggestions to improve the app?

**Rationale:** This question is to find out if the users have any enhancement suggestions to improve the app.

**Responses:** Since it was prototype and functionality was new to the respondents, only 2 suggested on the app. Following are the suggestion and comments:

- it would be better if the offers are categorized and based on user requirement
- Ubicuo's overall performance is excellent. I am sure that this app will improve my shopping experience through saving time and money.

**Summary**

Throughout the evaluation process, the users were supportive. Based on the questionnaire response, the overall feedback rating for the contextual awareness app was high than expected since it was a prototype. Evaluation response also shows that contextual awareness app was preferred over QR code. The ease of the use of the app without unlocking the smartphone to receive offers is one of the main points in the preference over QR code. The users also found the design of the app, layout and style visually appealing. The usability and user experience feedback rating was high for the contextual awareness app. The users were interested in receiving shop offers by notification even though they had to switch on the Bluetooth and
internet connection. As discussed in Literature Review chapter, QR code has its limitations that make beacon technology take over the contextual awareness.
CHAPTER 10: Conclusion

10.1 Further work
Since this app is a prototype, and the beacon technology is the latest in the market, the scope of further work is open. Some of the features that could be added at a later stage are:

- Categorizing the shops and option for the user to select only particular shops so that he/she do not receive an unwanted notification.
- Integration with shop payment machine, so the user can pay using his smartphone.
- Developing in iOS and Windows Phone OS platforms.
- Enhancement of the web application where the offers are updated. It requires more features since the currently developed web application were mostly focused on functionality to achieve the objective and aim of the MSc. Project.

10.2 Summary
This research report provided the background study, requirement analysis, project plan with the methodology, professional, legal ethics, design, implementation, testing and user evaluation for the development of the contextual awareness app, Ubicuo. The design, implementation and evaluation process was complete on time as per project plan. The objective and aim was achieved. Ubicuo, the Android application, was developed by integrating context awareness in the beacon technology to receive shop offers. Basic and simple web application were also developed to add offers, which was pushed to the Android application based on user location near to the beacon. User evaluation was conducted by providing Ubicuo app to the users. They were then asked to provide feedback through online questionnaire. Also, QR code was given to the users during the evaluation to understand the difference in the experience of the beacon technology and QR code. Based on user evaluation summary and comparative analysis of contextual awareness technology as discussed in the literature review, shows why beacons are the best technology in the market and how it will revolutionize in the future.
References:


APPENDICES

Appendix A

A.1 Source code

Complete Source code is available in the attached CD.

Appendix B

B.1 User Evaluation

Individual response of users is available in the attached CD: ‘Individual response of users - user evaluation.xls’

![Figure 59. Questionnaire – part 1](image-url)
Do you use any shop offer mobile apps? *

- Yes
- No

Since this app uses both Bluetooth and internet connection, how often do you prefer to enable them to receive offers? *

- Once I enter the shopping mall / area
- I keep both Bluetooth and internet connection enabled most of the time
- When I need to check if there is exclusive offers on approaching a particular shop

Did you face any noticeable delay in the loading of the mobile app? *

- Yes
- No

How quick was the notification received? *

- Fast
- Slight Lag
- Slow

Did you receive the same notification twice, when you pass by the same area? *

- Yes
- No

How do you rate the battery consumption level of smart phone, when using this app? *

- < 5%
- 5% - 13%
- 15% - 25%
- > 25%

Figure 60. Questionnaire – part 2
Did you find the offer screen visually appealing? *
- Yes
- No

How do you rate usability of the mobile app? *
- Excellent
- Very Good
- Good
- Average
- Below Average

How do you rate the design and layout of the app? *
- Excellent
- Very Good
- Good
- Average
- Below Average

How do you prefer to get the shop offers on your smartphone? *
- Scanning QR code
- Notification based on user location
- Others

Why do you prefer to use this app? *
- Ubicuo app will notify its users only with exclusive offers.
- No need to keep the phone unlocked to receive offers
- Other: ________________________________

Figure 61. Questionnaire – part 3
Do you think this app will improve your shopping experience? *
- Yes
- No

Overall, how effective is this app? *
- Excellent
- Very Good
- Good
- Average
- Below Average

Do you have any comments or suggestions to improve the app?

Submit

Never submit passwords through Google Forms.

Figure 62. Questionnaire – part 4