

SMART AIRPORT SYSTEM USING BEACON TECHNOLOGY

Viraj Pai¹, Kirsten Castelino², Avinash Castelino³, Priyanca Gonsalves⁴

¹B.E. student, Information Technology, St. Francis Institute of Technology, Mumbai, India

²B.E. student, Information Technology, St. Francis Institute of Technology, Mumbai, India

³B.E. student, Information Technology, St. Francis Institute of Technology, Mumbai, India

⁴Assistant Professor, Information Technology, St. Francis Institute of Technology, Mumbai, India

Abstract - Over the last decade, internet technologies have moved out of the home and into our pockets, purses, hands and onto our bedsides. Mobile devices are a constant companion to consumers and they are playing an increasingly intimate role in a consumer's everyday life. The widespread adoption and use of mobile devices presents marketers with new opportunities to reach and serve consumers. An attempt is made to ease the airport travel experience using the internet technology with this paper. A Smart Airport system based on Beacon technology is developed. This Wi-Fi Beacon based system consists of three key components (i) Android Application (Front end) (ii) Database (backend) and (iii) Beacon (Wi-Fi). The smart phone application is used by the passengers travelling through the airport which will connect to the server once it's inside the airport using the beacon technology. The passenger once entering the airport will connect to the Wi-Fi beacon through the smart phones in order to get the flight information such as flight details, gate number, push notifications to the user in the airport and various offers to be displayed [1]. The application also contains a map which provides direction.

Key words: Beacon, Bluetooth low Energy, Android Application, Advertisements, Database.

1. INTRODUCTION

Over the past years due to increase of air traffic changes in the flight timings has become more and more mundane routine for the travelers[3]. Due to this erratic changes in flight timing as well as changes in gate number, travelling through an airport has become more of a exhausting job. To overcome this problem we propose a solution through amalgamating beacon technology inside an airport system. In recent years, innovation in communication technology and the popularity of smart phones make the work easier than ever. Main purpose of innovation in technology has been in simplifying life on earth or making every day's work easier and faster. One regular activity that human beings spend significant amount of time in is shopping. According to a survey carried out by US Bureau of Labour [1], customers spend 1.4 hours every day on shopping. Moreover, according to a study conducted by CISCO Internet Business Solution Group [2], the top four reasons for customers to use new technology are to (i) Find best price (63%), (ii) Save time (47%), (iii) Find best assortment (26%) and (iv) best quality

(25%). As shopping also happens regularly inside airport too, we have included location based advertisement in our proposed system. The application will get the notification dynamically when the user will pass through the adjoining store about the related offer inside the store. The application will use beacon technology for the dynamic change in the data inside application. According to a survey carried out by SWIRL [2], Beacon marketing campaigns are influencing shopper behavior: 73% of shoppers surveyed said that beacon- triggered content and offers increased their likelihood to purchase during their store visit, 61% said they would do more holiday shopping at stores that delivered mobile content and offers while they shop, 61% said they would visit a store with beacon marketing campaigns more often, and 60 % said they would buy more as a result of receiving beacon- triggered marketing messages. The Beacon technology has made the process of collecting data on customers easier and faster in order to reduce costs and to improve services and precisely personalized offers based on the customer's preferences. In this paper, we describe the other technologies in related works in section II The rest of this paper is outlined as follows: Section III gives the methodology, Section IV talks about proposed solution, and Section V shows implementation. Section VI gives expected results and graphical analysis and Section VII conclusion.

2. RELATED WORK

The beacon technology provides various services such as push in notifications, various offers when moving around the airport. The features in this project contain connectivity, offers and ads, flight details, feedback and also overall layout of the airport.

Apoorv Raghav et.al.[1] in this paper aims at implementing a Bluetooth low energy-based attendance management system. The question the authors are trying to solve is "How to make the attendance system in colleges easier?". It is a very important question as it helps to make the system easier and better. The solution presented in the paper is a smart and fast attendance monitoring system through Bluetooth low energy sensors. These sensors can be attached to each identity card. They contain a unique string which can be associated with the id card they are attached to. This is coupled with an android application on the teachers mobile phone

which is used to collect the data. When the students enter the class, the teacher switches on the Bluetooth on the phone and opens the application. The application senses any beacon stickers that are around 200m of the Bluetooth sensor of the phone and thus it inputs the data of the students into the app. In this way, the attendance of the students is taken instantaneously. The authors claim that the entire process saves a lot of time, precious resources like paper and saves the teacher's headache of maintaining all the records and submitting them to the concerned authorities. The scope of the project is limited within a certain distance.

In a research paper titled "Analytical Comparison of Bluetooth Low energy Beacons" [2] comparison is done between various Low Energy Beacons and their pros and cons are stated. The authors are trying to solve the question "Which Low Energy Beacon is the best?". This question determines which beacon is going to be used in a future project which the author intends to develop. The comparison is done in terms of battery used, coverage, expected life in years, average energy consumption and SoCs. The authors claim that comparison of beacons is a tricky operation because not all beacons have same battery or transmission power when the expected life in years is calculated. For instance, beacon with twice higher power consumption than other may run more time with more than twice higher capacity battery. Hence the expected life in years will be higher but energy consumption will also be higher. It is not clear how energy consumption changes with increasing the transmission power or advertising interval. This should be investigated in future.

The voltage of the battery may affect the current consumption. In a research paper on Beacon [3], authors have aimed to develop a system that can be used in shopping center to make shopping more enjoyable and efficient for the customer and the monitoring real-time easier for the stores management. The authors are trying to answer the question how can shopping be made more enjoyable and efficient for the customer and the monitoring real-time easier for the store management? This question is more important to the store than the customer as it determines the number of sales of the store. In this paper, a highly scalable marketing system using Beacon and the smart phone application was built to send push notifications to users based on the current location of customer inside the mall. The authors claim that this geo-marketing solution which makes the shopping experience more pleasurable and efficient for the shoppers and helps marketing decision-makers to strengthen the relation with them

through personalized service and promotion plans will augment the satisfaction and loyalty of customers. In the future, if all studies are favorable, there will be advancement with the implementation of a prototype for proposed architecture for testing in a real hypermarket scenario and will try to find similar customers by using social vectors with the purpose of providing product recommendations, and send customized marketing messages such as mobile advertisements or e-coupons to customers' smart phones as soon as they enter a shop or are close to the shop.

Saraswat Gaurav et.al. [4] in their paper aim to provide a real-time surveillance of an institution which will automate the administrative operations with establishing working discipline and it can also send Web page links and notifications in order to communicate with students. The author tries to solve the question How to make surveillance in a campus better without causing the campus officials too many problems?. To implement the system, one beacon has been placed on the geometrical center pointer of the class which will broadcast the packets. To show the complete system working, android apps for student got installed inside student devices and the second app will be used by the teacher to find the attendance records and status from the server. The authors claim to have described a Campus Surveillance System which utilizes the relative locations of different students. A key area of future work is to use distance and proximity from the beacon, to build applications that automatically infer of the social context of such interactions. The application could monitor and analyze the interactions and provide a strategy to improve the effectiveness of studies. It would enable the faculty to know the attendance of each student, provide automated assignments, analyze the attendance history, and lots more.

Azmi et.al. [5] in their paper aims to propose the implementation of UniSas to be used for student attendance taking process in University Tenaga Nasional Putrajaya campus (UNITEN), Malaysia. Further, the performance of the paper-based attendance, RFID attendance system and UniSas are compared. The authors ask the question Which of these three technologies are better?. The answer to this question is important as it is important to use an efficient technology. The implementation of UniSas is divided into two parts. The first part is a web-based management system, which is used by lecturers to monitor attendance data. The second part is the mobile application. The mobile application needs to be downloaded and installed by students and is used for recording attendance. The authors claim that it shows that UniSas yields the best overall results in term of accuracy, time and energy consumption. Okamoto et.al. [6] in their paper proposes a new

targeted advertising method experimentally accommodated to digital signage systems by using Bluetooth Low Energy (BLE) beacons. This paper proposes a new targeted advertising method accommodated to digital signage systems by using BLE beacons. Results of the experiments say that the proposed system succeeded in achieving 1) Greater number of attributes that are capable of acquiring, 2) Better data accuracy in every attribution compared to the existing method, and 3) Lower psychological resistance by using the new method. The experiments were done to compare and contrast between the existing method (i.e., targeted advertising method using cameras) and the proposed method from the following points of view: 1. Number of attributes capable of attaining 2. Accuracy of the data attained 3. Psychological resistances when using each method. Also, the previous methods using camera had been able to see how well the 4 advertisements resulted by tracking the eye movement of the users. Conversely, it is difficult to know how well the advertisement attracted the user with the method stated in this paper, compared to the prior method.

In a research paper titled "Study of Indoor exhibitions using BEACON Mobile Navigation"[7] aim is using Beacon devices and supporting applications to transmit the messages he exhibitor wants to present to the visitor mobile device so as to interact with the visitors and enable visitors to understand the exhibition site service provided. The author asks the question How to understand how BLE Beacon indoor positioning technology can provide visitors with quick and effective access to information?. The author claims that due to accuracy issues, indoor positioning is not as widely used in daily applications as the outdoor positioning system, and as a result, the types of services it provides are also fewer. However, if the accuracy of indoor positioning can be improved, then the service model of the outdoor positioning system can be extended to indoor use. Currently there are still many issues to overcome for wider application of this technology, such as optimization of the positioning, real-time message communication, battery life of the system, privacy protection for the users and protocol standardization. Thangadorai, Kavin Kumar.et.al [8] in this paper aims at implementing Wi-Fi Mesh network is made up of Mesh Access Points (MAPs). MAPs perform two roles: Mesh Station (STA) to communicate with other MAPs, and Basic Service Set (BSS) AP to interact with Wi-Fi client devices. Hence, MAPs typically broadcast two kinds of independent beacons periodically, which will be received by other MAPs and Wi-Fi client devices. The proposed Unified Signaling Beacon Framework (USBF) operates between BSS AP and Mesh STA in MAPs. USBF does two main functionalities, (i)

unifying two independent beacons of BSS AP and Mesh STA in MAPs using Unified Signaling Beacon Discovery Function (USBDF), and (ii) beacon synchronization of the unified beacons among MAPs using Unified Beacon Collision Avoidance (UBCA) mechanism. In USBDF, unified beacons are formulated which contains standard 802.11 beacon frame encapsulated with Mesh Information Element (IE). Mesh IE further includes Mesh ID Element, Mesh Configuration Element as per 802.11s.

In a research paper titled of Beacon Interval on the performance of Wi-Fi-based passive radar against human targets [9] investigates the impact of the Beacon Interval (BI) on the passive radar performance. Limit values are suggested for practical applications. In a research paper on Beacon [10], authors have aimed to develop a system that can be used in position awareness in unknown and large indoor spaces represents a great advantage for people, everyday pedestrians have to search for specific places and product.

Hence, we were able to study different related works from the above stated researches which helped us to find a solution to the gaps in the system. Due to which we were able to amalgamate the technologies and develop this smart airport system.

3. METHODOLOGY

What is beacon?

A beacon is a transmitter. These small hardware devices incessantly transmit signals. The smart phones are capable of scanning and displaying these signals.[12]

How does a beacon work?

To understand how beacons work let's take an example of a shopping mall with beacon deployment.

Let's assume, beacons are deployed at the entrance of a shopping mall

- 1) These beacons transmit signals in its range. The range of beacons varies from 30m to 300m.
- 2) Smartphone in the range will be easily caught in its range
- 3) The Smartphone then sends a unique number attached to the signal to the cloud server
- 4) The server responds with the action linked to the beacon ID. It could be a notification introducing a new appetizer in shopping mall for offers and discounts and feedback
- 5) These notifications will then be attached to a web page which the customer will be directed.[12]

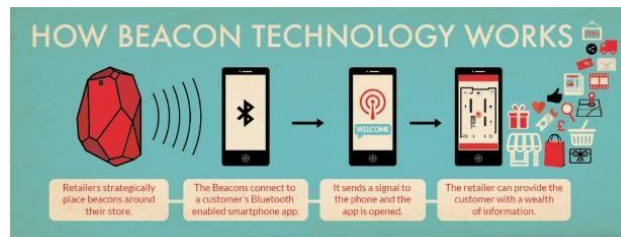


Figure 1. Working of beacon technology [11]

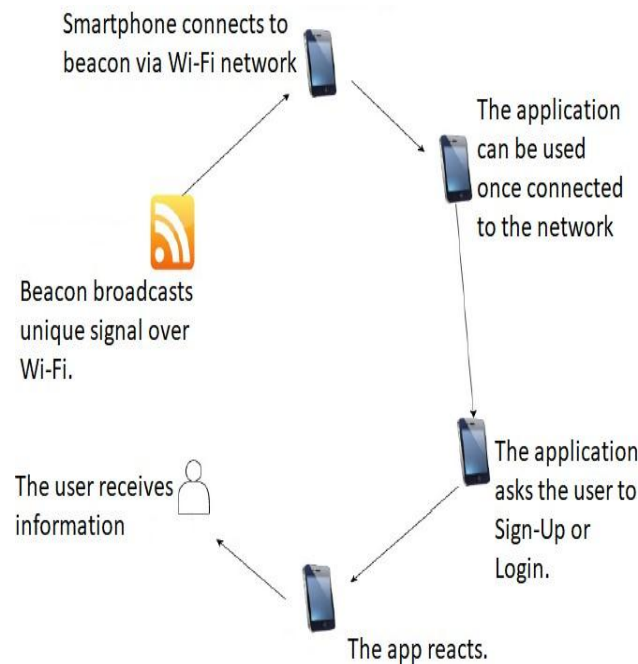


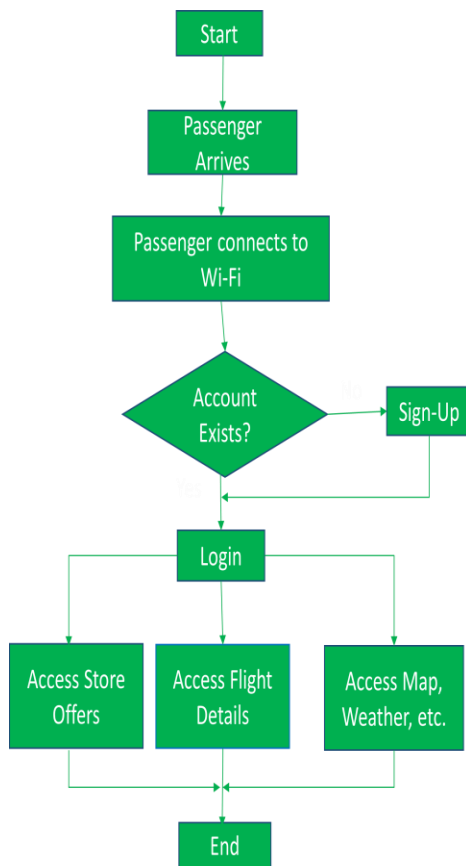
Figure 2. Flow of beacon technology

Beacon broadcast a unique signal around certain proximity according to the type of beacon used once the user logs in to the application the beacon will automatically be connected to the network. Smartphone gets connected to the beacon within the proximity. The user will then be able to send and receive the data automatically. The dynamic changes will be updated to the user. The user will stop receiving the information once he is out of the proximity.

4. PROPOSED SOLUTION

1. Wi-Fi beacons use to create a network to transmit a identifier picked up by a compatible app or operating system. The identifier and several bytes sent with it can be used to determine the device's physical location, track customers, or trigger a location-based action on the device such as a push notification.
2. When a passenger enters the airport a the security enters the passengers name using the beacon into a database which maintains the details of the passenger until he/she catches their flight.
3. The beacons also trigger a push notification onto the passengers Smartphone which gives them details about the prices and various discounts at the different stores in the airport.
4. This project also aims to provide the passenger with a solution navigate inside the airport.

Flow of the smart airport system



The user of the application will connect to the network once he/she enters the airport area. Passenger will enter his details and register to the application. Once the sign up is done the user will login to the application. The authenticated user will then be able to use the features of the application. The user has to enter his PNR number to check his flight details. The PNR number will be matched to the backend system and the system will be able to show the data of the respective flight details. The changes of the flight and gate number will be notified to the user. The user will be given different on the application of the stores around him as he passes by it and similarly he will be able to use different other features of the application.

5. IMPLEMENTATION

We have successfully implemented the front end (application) as well as the admin side pages of the system. The system works in a n orderly manner and the passenger could use it in the following ways:

LOGIN AND REGISTRATION

1. The application will give an option of login and registration to the passengers when he downloads the application at the airport

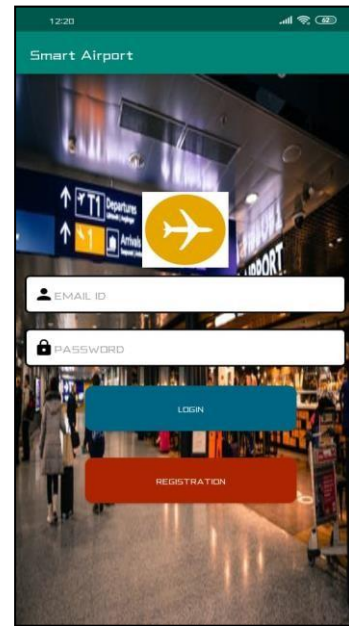


Figure 3 Login page

1. The first time users of the systems has to register using his credentials

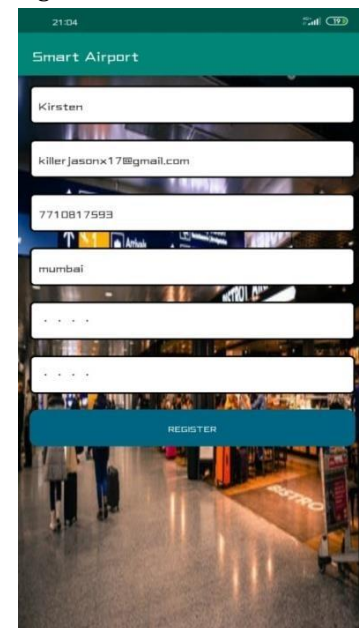


Figure 4 Registration page

2. The user will be able to login using his email id and password to access the system

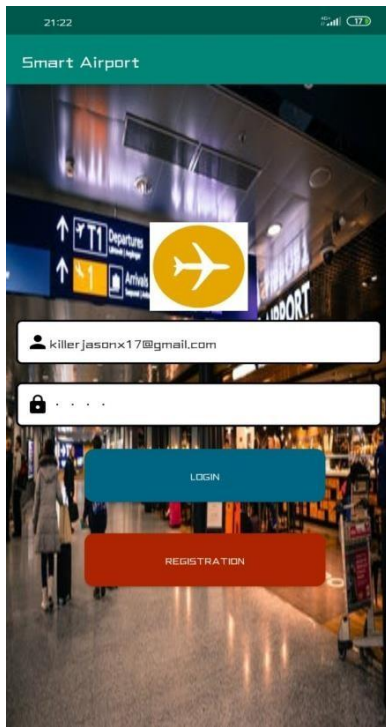


Figure 5 Login

FLIGHT INFORMATION

4. The passenger has to enter his PNR number to access the flight details

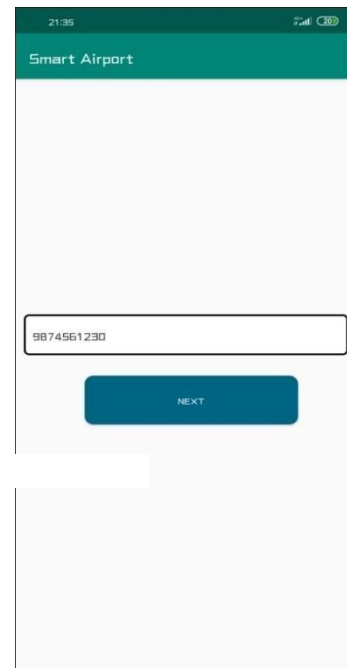


Figure 7 Entering PNR

USER HOMEPAGE

3. The Home page will give the user different choices about the features of the application

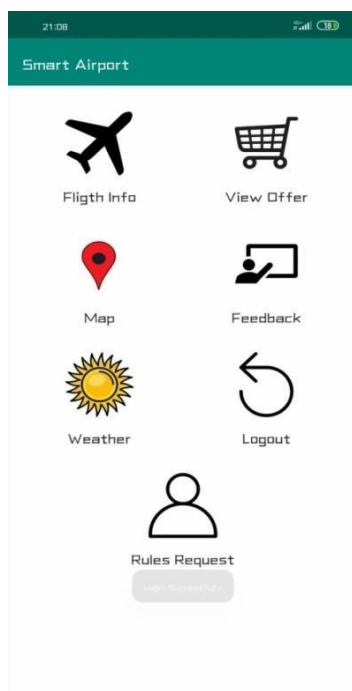


Figure 6 Homepage

5. This is how the user will get his flight details on the application

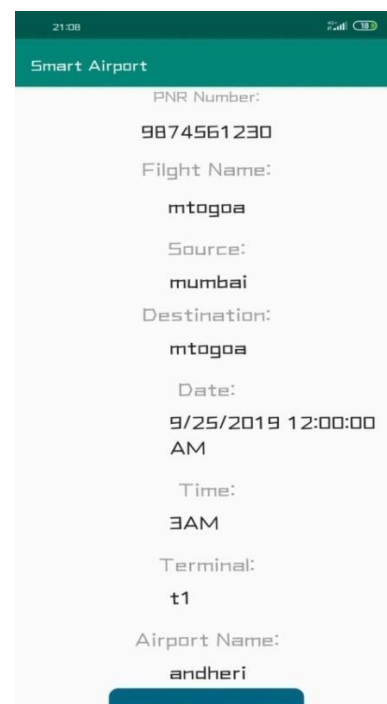


Figure 8 Flight Details

VIEW OFFERS

6. The users will get dynamic offers as it passes from the store

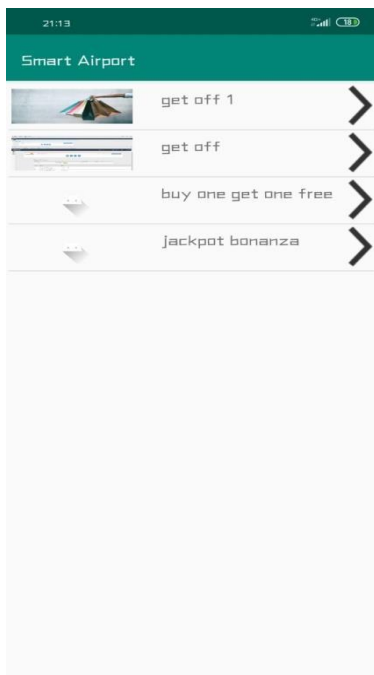


Figure 9 Offers

STATIC MAP

7. The application has a static map attached to it so that the user will be able to locate and relate where they are exactly.



Figure 10 Static Map

ADMIN SIDE PAGES

1. The system automatically takes the data and stores in the backend of the system which could be only accessed by the admin

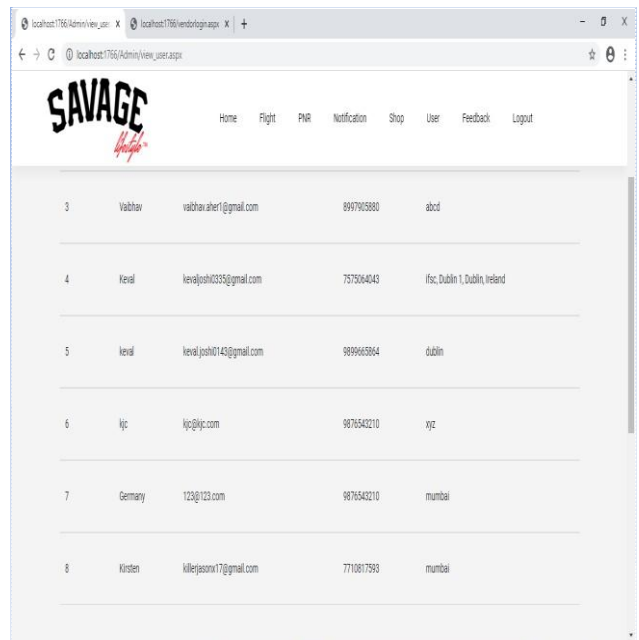


Figure 11 Admin side Database

2. The admin side website has the registered database of the users and could be used to authenticate as well as provide information about respective flights

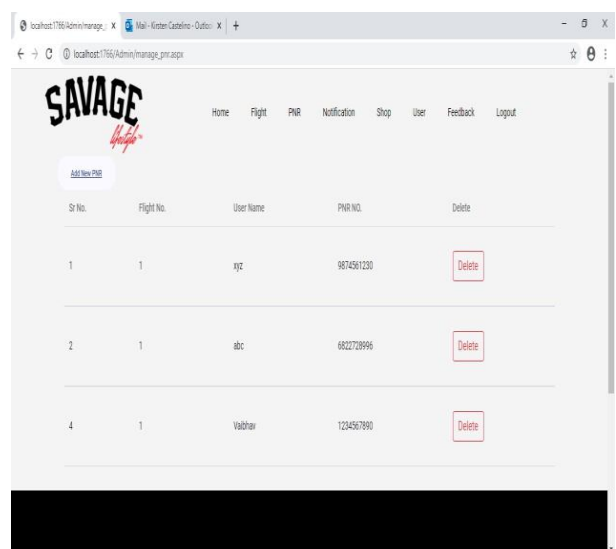


Figure 12 Admin side website

3. The backend of the system will connect it to the entered PNR and flight details will be provided

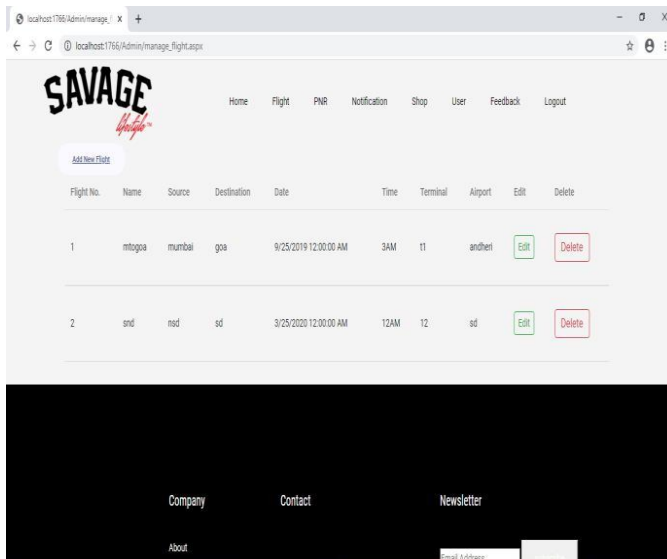


Figure 13 Matching PNR

4. The admin will only have access to the Offers and ads management

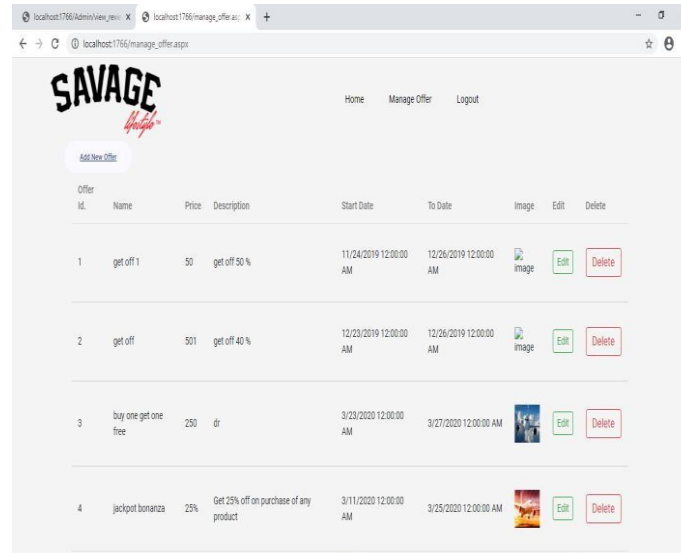


Figure 14 Backend offer section

6. RESULTS AND ANALYSIS

System was rated by 100 users and outcome of the rating is presented graphically below

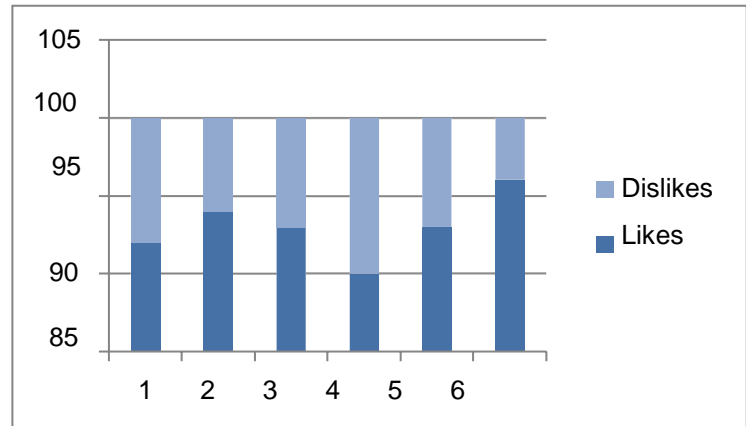


Figure 15 Graph

Graphical analysis of system performance

Parameters:

1. Connectivity -92/100
2. Flight Details-94/100
3. Offers -93/100
4. Map- 90/100
5. Feedback -93/100
6. Overall Layout- 96/100

Efficiency of the system calculated from the above graph is 93%

7. CONCLUSION

The ultimate objective of a passenger on airport is to know the time and gate number. We were able to make an application which is integrated with beacon networks, helps in dynamically provided the information and changes to the passengers. The requirement for early and timely notification of delay and the gate number is notified through this application. In the development of the software we have used Android Studio which will help us to develop the application further. Thus, by implementing all these features together we have created an android application that will make communication and interaction between the passengers and the airport system. Also it will be easier for the management to understanding the needs of the passengers.

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