Dynamic Geofencing In Supervision Of Seller Performance

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Abstract

Geofencing is a virtual perimeter in a geographical area that uses location-based services as a boundary for an area. Salespeople are often seen as one of the most important parts of sales management in supporting the success of the company and also in bridging the relationship between the company and consumers. This research applies Dynamic Geofencing technology in monitoring salesperson performance where in some cases many workers enter the area of other workers. By utilizing GPS technology the signals of employees' cellular devices can be tracked or monitored, if one day employees cross the geofencing area, the supervisor will receive a notification from the system. Dynamic Geofencing is expected to provide information to supervisors regarding the whereabouts of workers while in the field. Based on the testing that has been done, the overall function of this surveillance system can run well following the needs that have been made, based on 3 criteria made for testing point A gets a value of 93.75%, testing point B gets a value of 93.75%, and the last test gets a value 87.5%.

Keywords:
dynamic geofencing, salespeople, supervision, area boundaries

1.   Introduction

Technology helps a lot in all matters of human work, one of these technologies is Geofencing. Geofencing is a virtual perimeter in a geographical area that uses location-based services as a boundary for an area (Rumbewas 2019), utilizing geographic coordinates in the real world by determining boundaries or parameters virtually so that Geofencing is called an innovative technology(Priono and Setiawan 2017). Many studies discuss how the technology is applied in various activities or services such as child surveillance services (Segara and Subari 2017), making dynamic maps for automatic steering of a car(Maiouak and Taleb 2019), tracking patient Alzheimer(Yüce, Gülkesen, and Barcin 2012). In general, the shape of the boundary fence virtual area in the form of polygons that are formed from the points of a coordinate that follows an area of a boundary of an area or region on the map. Some of the techniques of geofencing are Geofence Area, Proximity with Point of Interest, Route adherence, and Route and schedule adherence (Hidayatullah 2011). According to Rodrigo R. Oliveira, monitoring must provide location information in real-time and know the pinpoint load within a certain time (Oliveira et al. 2015). In practice, there are several main technologies used, namely GPS (Global Positioning System) and FCM (Firebase Cloud Messaging).

Salespeople are often seen as one of the most important parts of sales management in supporting the company's success and also in bridging the relationship between the company and consumers (Kasus et al. 2006). Salespeople are the spearhead of a company because they have to sell and offer products following the targets given by the company (Kurniawan n.d.). Salespeople can be concluded to have superior performance if the target set by the company is reached, for example, the number of products sold has increased (Diponegoro and Bajari 2006). When salespeople carry out routine in selling goods and services, they will be divided into several regions or their respective working areas. Humans as individual creatures sometimes want to be free so that he will do a variety of ways to be free from all the bonds and regulations that limit their activities (Tri Handoko n.d.). The company always gives their respective areas to workers, but there are still many related workers who always enter the area of other workers so that there is a struggle over the area. So the company wants to have a system that can track the whereabouts of employees in real-time and find out whether the employee is in a predetermined area or not. This research applies Dynamic Geofencing technology in monitoring salesperson performance where in some cases many workers enter the area of other workers.

The main contribution of this scientific work is the supervision of work activities in real-time from employees who have been given their respective working areas by using Geofencing technology assisted by GPS so that employees can be monitored, when employees come out of the specified area boundaries a notification will appear to employees. Furthermore, this solution can also provide direct supervision and minimizing employee fraud. The need for this research is because there are still many employees who cannot be supervised directly by the company so that many employees enter the area of other employees.

Although there have been many studies that discuss Geofencing (Ilmiah et al. n.d.)(Tengah et al. 2011)(Falkowski et al. 2018), no one has done intense salesforce supervision. We consider this oversight to be carried out because there have been many frauds committed by other employees. We combine several services into a unified system that can carry out surveillance activities. This research was conducted in the village area of Cikadut, Bandung Regency, West Java, Indonesia.

2.   Related Work

Tri Handoko made a study of monitoring sales performance using geofencing monitoring and mobile-based cloud messaging technology(Tri Handoko n.d.). This model uses services such as Android, Cloud Messaging, and GPS that are interconnected with Geofencing so supervisors will more easily obtain information about the whereabouts of employees. Information about the whereabouts of employees is sent to the supervisor via GPS contained in the android application. With the website and mobile application to run the Transaction Monitoring System can help companies to review or monitor the activities of their employees in this case sales when in the field during working hours. And with this system, the company can find out the violations committed by sales to make decisions to provide sanctions accompanied by evidence of each violation. The system proposed by (Oliveira et al. 2015) presents an intelligent model of automatically managing freight forwarding without user interaction. The main strength of this research is the time optimization solution and minimizing human error, and also control in cargo can identify some errors in logistics delivery, for example, shipping and pickup that is felt wrong and also the potential for cargo theft. In the proposed model the authors developed several components such as SafeDuino, these components are mounted on the back door of the truck with an RFID shield. The main technologies used for logistics tracking are barcode, RFID (Radio-Frequency) Identification), GPS (Global Positioning System), and GSM (Global System for Cellular Communication).

Afrizal alfath et al created a marketing application for an Android-based café. This application was created to help maintain a small business to continue to retain customers, add new customers, and increase the intensity of product purchases by consumers(Rahman, Kharisma, and Dewi 2018). The marketing technique used is to utilize LBS or Geofences services, the use of GPS found on consumer smartphones, mobile push notifications, and Firebase. In the research conducted, the trigger Geofences used are transitions when entering the Geofence area that has been created. The results of the Geofences trigger send information about the café to the android user. The marketing café application is then tested by User Experience. User experience testing is carried out in this study using a questionnaire technique with User Experience Questionnaire (UEQ) using 20 respondents. Based on the test results using the User Experience Questionnaire (UEQ) obtained value of user experience based on 6 scales with an Attractiveness value of 1.45, Perspicuity of 1,725, Efficiency of 1.4, Dependability of 1,275, Stimulation of 1.4375, and Novelty of 1.0125. Based on the results of benchmarking tests with 246 other products, the results of comparison of 6 scales with Attractiveness results are above average, Perspicuity is good, Efficiency is above average, Dependability is above average, Stimulation is good and Novelty is above average.

Ahmad Rifai created an information system to monitor the position of Unsri official car vehicles using GPS technology. The number of official cars that are used improperly makes the writer make this information system. The application is stored on a web server that functions as a GPS Tracking Server(Rifai 2013). The monitoring computer will connect to the web server's address to be able to monitor the position of its movable objects. The application is built using a digital map display taken from a Google Map. The Google Map is programmed through the API (Application Programming Interface) available to display objects that represent the position of a moving object / 4GPS Tracking Device. The object's position information is taken from the MySQL database where the data is always updated by the GPS Tracking Device periodically. As a result, the author will get the effect of moving every time we refresh the data and display it on a Google Map map. An official vehicle is deemed deviant if:

1.   Official vehicles leave the designated work area.
2.   Official vehicle speed exceeds the maximum speed limit set by the agency/company concerned.
3.   Official vehicles are used outside company/agency working hours.

Apriansyah Putra represents a study for the use of Geofencing technology in traffic jam information. In this study, geofencing techniques were used to determine areas where congestion might occur according to community

reports(Putra and Bardadi 2017). People who are at the jam location will press a button in the application which then sends the position of the jam area. Other communities that are outside the geofencing area radius will receive information on the location of the congestion, so that vehicle congestion can be avoided. The method used in this research is the crowdsourcing method. The crowdsourcing method refers to empowering people to achieve a certain goal. In this research, the crowdsourcing method is used as the backbone of the system to get information about traffic jams on the road. The level of traffic violations in Indonesia is increasing. This is proven by the increasing number of accidents in the city of Surabaya. To reduce the reduction in traffic violations the authors developed the E-ticket traffic light application using the Android-based Google Geofencing API technology (Palupi, Akbar, and Brata 2018). The mechanism of the workings of CCTV e-ticketing is first, the violator's data will be recorded on CCTV, the data contains the violator's policy number, type of violation, and the date of the violator's event. Then, the data that has been recorded by CCTV will be sent to the police for further action. The types of violations that are usually recorded by CCTV are, violating red lights, violating road markings, going against directions, and exceeding the line limit when red lights. The purpose of CCTV e-ticketing is to educate the public so that the traffic is orderly to reduce the number of accidents.

3.   RESEARCH METHOD

The problem-solving method that will be used in this research is to build two web-based platforms as data center information and smartphone-based for client data, by reading GPS coordinates from mobile devices that will be analyzed on the server-side for processing objects with the Geofencing method.

3.1   Geofencing Area

Geofencing is a digital-based map barrier that can be applied to monitor the movement of objects in certain areas. Geofencing requires GPS assistance to detect objects on a map, this technique provides push-based and active control in location-based services for mobile devices(Nakagawa et al. 2016). In the system we made, we drew geofencing into a polygon shape, making polygons requires coordinate points on the map so that these points merge into one form, as depicted in Figure 1.
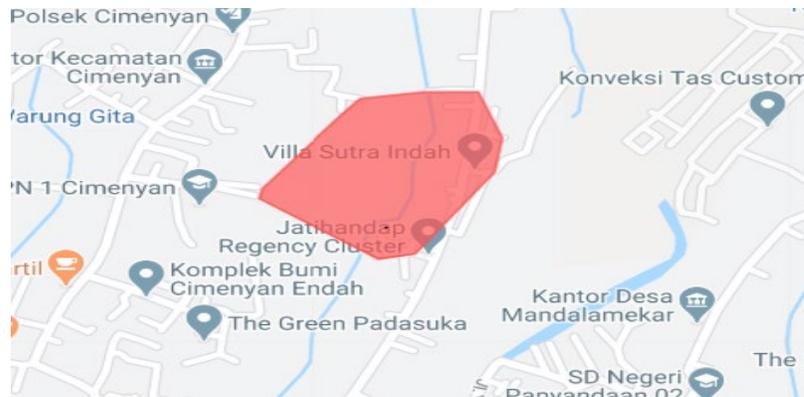

Figure 1. Geofencing Area

The geofencing depiction in the map is made into a polygon form, the depiction is made by determining the point of each map coordinate to form a polygon. the data needed is latitude and longitude. This study took place in the district of Bandung precisely the Cimenyan district. Supervisors can also change the geofencing area according to the work area of each employee.

3.2   Tracking System

Tracking using GPS requires an active signal sent from the GPS receiver to the database through the employee's smartphone (see Figure 2). To be able to track a moving location, the person who wants to do the tracking must have access to the part of the application that will be specifically designed to track.
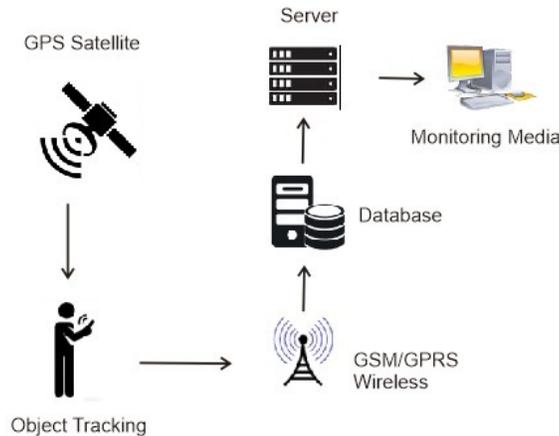
Figure 2. The main component of the tracking system using GPS

The receiver used must be equipped with a cellular modem that is used to transmit the location data of the object to be tracked. The smartphone used must be the latest so that tracking using GPS can be done easily. The location is sent directly to the supervisor through the cell phone network service. Monitoring can be done using a computer or smartphone application that is equipped with maps that are connected directly to the internet. Firebase is a platform that supports the development of mobile and web-based applications or also known as Backend as a Service (BaaS) (Somya and Aprillia 2019).

Supervision that is done requires the location of employees, to get the location in real-time the author makes an android-based application that functions to retrieve location data and the location will be sent to the web-based surveillance system. The workings of a mobile application are similar to absences, so each employee presses the absent button then the mobile application will take coordinate data from the employee's location and store it in a database and send it to the web system.

3.3 Firebase Messaging Cloud (FCM)

FCM is a service provided by Firebase to get push notifications on Android and iOS devices. Why push notification? If a device pulls off every few seconds to check notifications, the application will be wasteful of power, the server serving will be down if done by many devices at the same time, and there will be a delay to get notifications so that it is not realtime. Firebase Cloud Messaging is very useful for an application that requires a push notification.

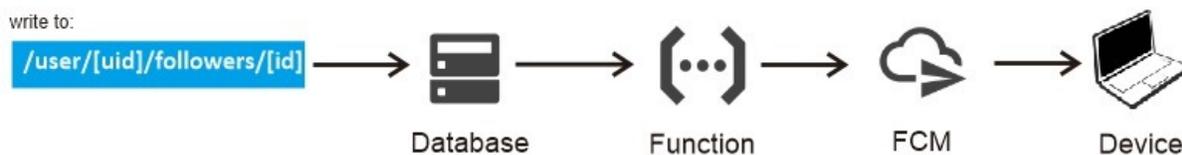Broadly speaking, the workings of the FCM can be seen as shown in figure 3.

Figure 3. How Firebase Cloud Messaging Works

The device must register first with Firebase to get the token because To be able to send messages from Firebase Cloud Messaging, an application instance must have a token so that the backend can send messages to the appropriate device. To receive tokens generated by Firebase Cloud Messaging. an application instance must have a service that extends FirebaseMessagingServices.

Firebase Cloud Messaging (FCM) will provide a notification to the supervisor when the employee being supervised out of the geofencing area boundary, the message received in the form of information that the employee has exited the geofencing along with the employee's location. To get push notifications you must have installed the FCM SDK then the writer makes a message that will be sent to the supervisor later and then saves the message on the FCM server.

4.   RESULT AND DISCUSSION

Making a web application for salesperson supervision using the CodeIgniter framework, the reason for using the framework is because it supports the concept of MVC (Model, View, and Controller) in website development so that it is easy to manage code files. This monitoring website will later be used by supervisors to supervise salesperson employees. In this study, I developed a prototype based on the proposed model and used the web as communication between GPS data and the surveillance system. To display the map on the system the author takes data on the map using the Mapbox.

4.1   Implementation Result

The picture shows the POI (Point of Interest) or the coordinate point of the location of a particular point that shows the object at that point. This Point of Interest is a form of the database regarding information in an area or arguably the main focus point in a map, as seen in Figure 5.
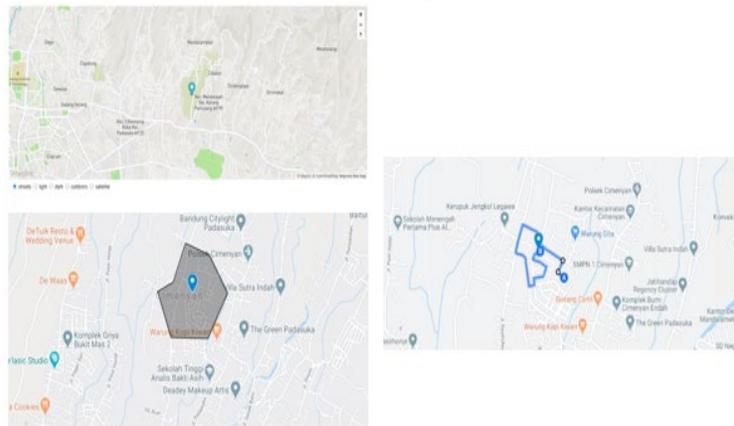

Figure 4. Implementation Results

The shape of the surveillance area is a polygon. For the determination of each boundary area of the employee is determined by the supervisor through the web monitoring system taken from the coordinate points taken from the Mapbox map, for the supervised area is specific to the Bandung Regency, especially the Cimenyan area. Through this page, the supervisor can also add and change the Geofencing that has been made. A trigger is created so that when a supervised employee exits the Geofencing area issues a warning, the system will send a warning message to the employee that the employee has left the Geofence area. The position of each employee will be tracked in real-time and can be seen by supervisors.

In addition to supervising employees who are in the Geofencing area, supervisors can also see the tracklog of the employee as shown above. If the employee moves, the representing marker on the map will also move, every time there is a change in the distance of 20 meters the system will send the latest coordinate position to the server. After coordinate tracking, if changes in coordinate data are found within a certain period, the system will display a blue line on the map that is a sign of movement of the employee's track. Tracklog trace data from the system will also be made into a table which will later be made a report by the supervisor.

4.2   Scenario Testing

To find out whether the function that is made to meet the needs has been running well or not, therefore testing is done by trying all the functions by taking as many as 15 objects of supervision. Testing is an important method to guarantee the quality of software and focuses on detecting errors in software products (Gong et al. 2020). There are 3 criteria to be tested so that the system can be declared successful according to needs, the criteria to be tested are as follows.

    a.   When the object exits the geofencing area, the system will continue to send notifications to the supervisor.

b. When the supervisor changes the geofencing area and the object exits the geofencing area, the system will still send notifications to the supervisor. When testing changes in the geofencing area will be carried out continuously to find out the response of the system.

c. The location of the employee in the system is following the original location.

The following results from testing system functions are shown in the table.

Table 1. Test Results

Scenario	Test Results	Testing Values
A	15 people who were monitored; 2 people who came out of the geofencing area did not send a notification to the supervisor	(14 out of 15) 93,75%
B	When there is a change in the geofencing area and the object exits the geofencing area, of the 15 experimental objects there are 2 objects for which the system does not send notifications to the supervisor	(14 out of 15) 93.75%
C	Check the location of monitoring objects on the system whether they are by the original location. Of the 15 experimental objects, there are 2 objects whose locations do not match the original location.	(13 out of 15) 87.5%
	Average Testing	91.67%

Based on the value of each test scenario it can be concluded that the system created has a weighting value of 91.67%. There are some errors when testing so that the value issued is not perfect, as in one of the test scenarios A connection from the smartphone that is used does not turn on so the system cannot detect any objects that come out of the boundary area. Then for the B test scenario, the system cannot withstand the changes in the geofencing area which is done continuously with a fast time. For the C test scenario, there is one location that does not match the original because one of the smartphone configurations used is not correct because each configuration used must use an accurate location type and can also be caused by a slow mobile connection.

5. CONCLUSION

The conclusion that can be drawn is this article presents a model that allows supervisors to directly monitor the whereabouts of employees using the incorporation of Geofencing technology, GPS, and FCM technology (Firebase Cloud Messaging). The main contribution of this scientific work is the supervision of work activities in real-time from employees who have been given their respective working areas by using Geofencing technology assisted by GPS so that employees can be monitored, when employees come out of the specified area boundaries a notification will appear to employees. However, the employee can be monitored if the GPS embedded on the employee's smartphone is connected to the system and the internet connection of the smartphone is on. Apart from all that, supervisors can find out if employees leave geofence and can send notifications to supervisors if certain conditions occur. This system can also store track logs and present them in a route on a system map or in tabular form.

The test is carried out by taking 15 people to be supervised, for scenario testing an of the 15 people tested the system successfully sends a notification to the supervisor when the object exits geofencing and get values testing 93.75%. For scenario testing b testing, when there is a change in geofencing 93.75% of the system still sends notifications to the supervisor. Then for the final test, 87.5% of the total coordinate test data sent was under the actual location. Based on these tests it can be said that the system created is following what is desired by the author and is ready to be used to supervise salesman.

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