ParkPal: A Park Sharing and Crowdsource Park Monitoring Mobile Application

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ABSTRACT
Whenever a car owner drives to a destination, the first thing to consider is parking. Due to the lack of parking facilities, car owners are forced to park along the secondary or sometimes main roads to go about their business. With smart phones increasingly being integrated into our lives, it is not a new idea to utilize phones as a tool to help in solving societal problems such as the lack of available parking space in the metro. The project aims to solve this problem by developing a mobile application to create collaborative online community marketplace with sharing economy concept by bringing together two crowds: people who are looking for parking slots and business-minded persons who wants to make profit out of his/her unutilized parking lot/space. Alongside, *ParkPal* also offers the ability to monitor the density of public commercial spaces through the implicit collection of data contributed by *ParkPal* users generated from Activity Recognition API and Geofencing API.

CCS Concepts
• **Information systems**→ **World Wide Web** • **Web Applications** → **Crowdsourcing**

Keywords
Sharing Economy; Crowdsource; Mobile Application; Geofencing; Activity Recognition; Park Monitoring; Park Finder.

1. INTRODUCTION

The Crowdsourcing concept has been gaining a lot of attention over these recent years. With a lot of studies being made on where one can implement this method for solving a problem. This is due to the fact that almost everyone owns a smartphone, this availability coupled with the method of crowdsourcing; this combination caused a paradigm shift on how to collect data or work organization. Examples of crowdsourcing mobile application such as Grab [1] and Quora [2]. Waze is a community based GPS Navigation App that utilizes crowdsourcing by letting their real-time data on traffic situation and incidents [3]. These applications requires the manual input of its users in order to get the data but this could be quite heavy of a task for a user. The proponents have developed a mechanism that would allow its users to have a choice of forwarding their parking data (implicitly and explicitly).

Another aspect of the paper includes the application of the Sharing economy. Applications that applies this model such as GetAround [4] and Spinlister [5] allows its users access to service or products without even having to own them. Airbnb is an application that offers accommodation in a house, apartment, boat, room or something less conventional like a tree house or even an igloo [6]. The proponents saw the opportunity of this concept in handling personal parking. Users would be allowed to find slots that are accepted by the system.

The mobile application developed is named "*ParkPal*". It came from two words: Park and Pal. The title conveys that you can have a friend to help you park your car. Similarly, its purpose is to bring together two crowds: people who are looking for parking slots and business-minded persons who wants to make profit out of his unused parking lot/space. With *ParkPal*, users can choose from a variety of parking slots based on affordability, rating and reviews, and nearest location. As with the appeal improvement existing parking complex, we also propose to include them in the system.

The remainder of this paper is organized as follows. In Section II, the scope of the study are discussed per module. This includes the park sharing module and crowdsource parking module. Section III presents the studies that are related to our paper. The technologies that are used in the development of the application will be discussed in Sections IV. Finally, conclusions are drawn in Section V.

1.1. Objective of the Study

The goal of the project is to provide a way for property owners looking to make income by utilizing his/her space as an alternative parking and matching them to vehicle owners looking for a temporary and/or long term lease parking space by providing a collaborative online community marketplace with sharing economy concept. The project would also provide a crowdsource information regarding the circling time on a particular commercial parking space in Makati.

2. LITERATURE REVIEW

Over the last few years, a multitude of Internet services have emerged based on the principle of shared economy or collaborative consumption or peer-to-peer (P2P) marketplaces, which are engaged in renting and sharing accommodation and various facilities and activities. An excellent example of such a service is Airbnb.com. Airbnb is a community-based online platform for listing and renting local homes. It connects hosts and travelers and facilitates the process of renting without owning any rooms itself. Moreover, it cultivates a sharing-economy by allowing property owners to rent out private flats [6].

The concept of shared economy became the main element of the system and this will be implemented in the process of posting and acquiring a desired parking based on the qualification of the customer. The location will also be considered in a way that if a customer is in a place the nearby available posted parking will be suggested.

The proposed system of the journal A Mobile Application Leveraging QR-Codes to Support Efficient Urban Parking is a viable study that we considered in the implementation of the parking process in personal parking spaces. This study uses QR codes per parking slot to determine the present status of that spot. In that way, the user is able to know if how many spots are already taken. The present status of the car park is marked by 4 colors. The usage of QR Codes will be adopted by our system in the process of when a user is already designated to a parking space, a user has to scan the code of that parking place. It will then be sent to the system so that it will start the parking duration. After the user has already used the parking place, an explicit action needs to be done to stop the parking process. This action will calculate the charge fee. *ParkPal* will adopt the process of tagging a parking spot through the use of QR Codes to know the start and end time of the parking service[7].

The journal Mobile Crowdsourcing Platform for Intelligent Car Park Systems is a system in which the main attention is the circling time of a driver in a car park. This article guided the proponents to where the crowdsourcing aspect of the system is going to go and what it will do. The authors applied 2 APIs that can accurately identify the entrance of a driver in the parking complex and interpret the present action of the driver. The data that will be collected will then be used to get the average circling time to assist drivers on which parking complex is already congested or underutilized. *ParkPal* will implement this system through the adoption of its circling time metric to be the implicit value to know the present situation of a car park and the usage of the 2 APIs to generate this value[8].

Collaborative Mobile Application and Advanced Services for Smart Parking aims to solve the problem of wasted resources and time in finding parking space by means of Smart Parking in finding and occupying available parking spaces. The system comprises of web and mobile application wherein parking owners and vehicle owners collaborate. The researchers propose a crowdsourcing solution to address the problem in parking area occupancy. End users can publish to the system their own view of the parking occupancy: empty, or 25% - 50% - 75% - 100% occupied. In this way, the system produces useful information by collecting and mediating feedbacks about the state of the lot, where in general there could be end users that have parked their vehicle and paid using traditional means (i.e., coins), or unauthorized end users. *ParkPal* will make use of this explicit crowdsourcing to address the occupancy of a parking area [9].

The journal An Introduction to QR Code Technology gives us a general view of how QR Codes is used. *ParkPal* plans to implement this technology in the process of starting and ending a parking service. The use of QR codes has been phenomenal through the years with application being used in Manufacturing, Retail, and Transportation. There is no denying to the fact this technology has been widely used and this made the proponents to consider this to be implemented in the system [10].

The use of QR Code Technology in Urban Parking has been proposed because of its cheap implementation compared to sensors. The study a Mobile Application Leveraging QR-Codes to Support Efficient Urban Parking introduces an application that supports wide area parking service, from search to occupancy up to start/end including reservation. The identification of a slot will rely on the QR Code assigned to it. The code has the data needed for the transaction to start.[10] The authors of the study adopted the use of QR Code in the personal parking aspect of the system. This would allow the users of *ParkPal* to start/end their parking service.

3. SCOPE OF THE STUDY

The project aims to maximize and utilized the available spaces in the metro and use it as an alternative parking space. This would help property owners gain an additional income by utilizing their available space. Alternately, the proponents want to minimize the time spent by vehicle owners in finding a suitable parking space by providing a medium through which they can find and rent a space in advance. The proponents will use crowdsourcing and economy sharing concept as the ground for building this project.

The crowdsourcing will be two-way, explicit and implicit.

The implicit crowdsource uses a user GPS data that is transmitted in real-time and analyze by the app on the cloud. With the used of another Google API, Geo-fencing, the proponents would create a

polygon on the perimeter of a commercial parking spaces in Makati. Once the geo-fencing senses that the users entered the perimeter it will trigger the start of the circling time. Another Google API, activity recognition would sense if the driver has stopped driving and is either walking or running. This would trigger the end of the circling time. The total circling would then be analyzed and displayed on the display screen. Table 1 shows the threshold used for parking status indicators.

Table 1. Parking Status

Status	Description
Red (Congested/Full)	Above 15 minutes circling time
Orange (Moderate)	Above 10 minutes less than or equal to 15 minutes circling time
Green (Free)	10 minutes and below

At the same time, it would also prompt the user to explicitly crowdsourced their assessment on the availability of the parking spaces. They can rate them based on their perception of the availability of the parking space: Full, Moderately Full, Open/Free spaces.

3. 1. Platform

The application which is called *ParkPal* would be available through mobile platform via the Google Play Store. Access to the device would require users to have a mobile device with the application installed and a network connection.

3.2. Location and User

Clients are grouped into two, those who are looking for parking space options (Vehicle Owners or Parking seekers), and individuals who are looking to make profit of their unutilized parking space (Property Owners or Parking Host). The application would be based on Makati. It would also include the commercial parking spaces in Makati.

3.3. Account Management Module

Process 1(Account Management Module) – Users are capable of modifying their profile and subdivided in the following subprocess: Registration, Profile Settings, Messages, List My Space, Notifications, History, Help, Reports & Feedbacks. Figure 1 shows the application navigation drawer of the developed system.

3.3.1. Registration

Registration would prompt the users to type details and basic information that would be tied to his/her account. These includes:

Name and Mobile Number.

3.3.2. Profile Settings

Profile Settings of vehicle owners registered at *ParkPal* would contain the basic information provided by the user during registration. User can edit all this information and log in or out of the app. Upon new log in the user would be prompted to enter his mobile number. And modification of registered mobile number would also mean a new verification would be sent and tied to the account.

3.3.3 Messages

The app would also include a messaging similar to that of Uber and Grab that would only be access once a reservation and/or transaction is made. Here vehicle owners and property host can communicate and make arrangements if certain conditions on the business rules would not be met. *ParkPal* would also include templated messages for the user's convenience.

3.3.4 List My Space

My spaces would be the properties that a property owner has put up for rent. The owner would need to provide details about the space for rent. Rate, exact location, type of parking and availability are sample details to be provided. Figure 2 shows the screenshot of Add Parking Module.

A space would first need to be assessed and approved before being posted in the app. This evaluation would be done by the administrator of the applications. The evaluation parameters to be check would be the: Accuracy of the location and Condition of the parking space. Upon Approval the space is then posted and available for renting. A management screen would allow the property owner to view the current status of his spaces as well as incoming booking and/or pending transactions.
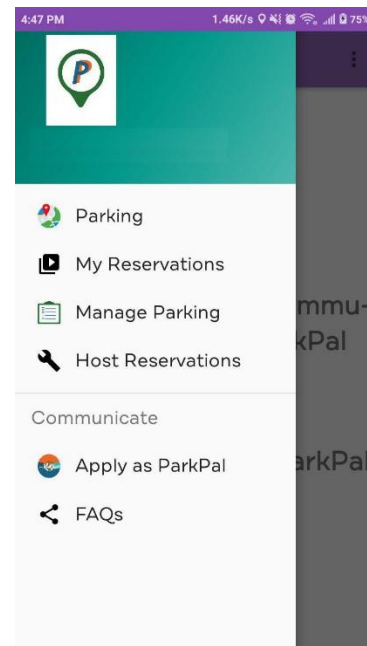

Figure 1. Application Navigation Drawer

Figure 2. Add Parking Module.

3.3.5. Notifications

ParkPal would also include notification that will show the latest updates and promos.

3.3.6. History

This would show the transaction history of the user. These would include the details of every transaction made by the user.

3.3.7. Help

Help tab would be subdivided into the following categories: Guide – guide on the overall use of the App.

Rules and Regulation – Rules and regulation that *ParkPal* implements.

3.4. Park Finder Module

Process 2 (Parking Finder Module) – To initiate a new procedure, the User provide the module a point-of-interest with

the address specifically located in Makati, then select a tolerance radius. The application would then fetch the data and present them in the display. Parking would be divided into commercial and residential, as shown in Table 2. It would be distinguished by icons.

Table 2. Parking Type

Icon	Description
(P)	Commercial Parking
(red circle)	Residential (Not Available)
(blue circle)	Residential (Available and Bookable)
(yellow circle)	Residential (Booked by another user)
(green circle)	Residential (Available)

Upon selection details of the parking space would be displayed. This includes the following: Property owner details (Name, Rating), Parking Rate, Photos of the parking space.

3.4.1. Booking Module

For spaces that are bookable and available, upon selection a popup would appear that would give users the opportunity to make a reservation. The user need to provide the booking period and the reservation is issued upon the confirmation. Consequently, the user can also modify the reservation through a management screen. The user can either cancel the booking or extend the reservation.

3.4.2. Navigation Module

The navigation will use a third party Navigation API (Google, Waze). This will guide the parking seeker to go into the selected parking location. Figures 3 and 4 displays the sample screenshots of navigation module.

3.4.3. Status Module

Upon arrival and parking of the car at the selected parking spot, the parking seeker can initiate the start of the parking service by scanning location-specific QR code. From there the user can track information about his parking i.e. parking period and amount to be paid, by accessing the management screen. This will also update the status of the parking space in the data repository. An explicit action in form of another scanning of the QR code is required to end the service. This will also trigger the calculation of the fare and charging of the due fare.

3.4.4. Rate and Review

Upon completion of service availed vehicle owners would be given a choice to rate or write a review to the parking host. The property owner would be rated by stars based on the following: 5 – Highest (Excellent), 1 – Lowest (Poor). Based on the following: Service Satisfaction, Security of Parking Space, and Accessibility of the location.
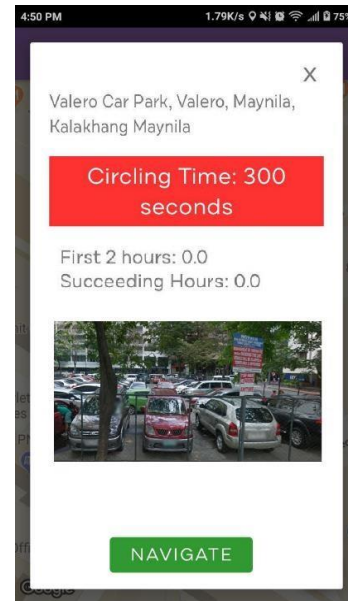

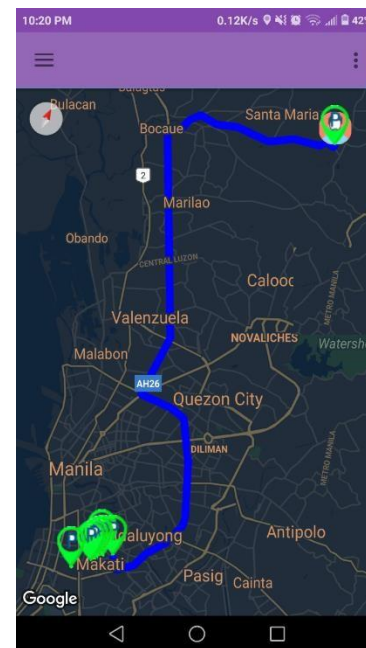**Figure 3. Parking Details Modal**

Figure 4. User Navigation

3.5. Implicit Crowdsource Module

When the application detects that a driving user (Sensed by the Google Activity Recognition API) enters a commercialized parking in Makati through which the perimeter has been marked by the use of Google Geo-fencing API, the circling time is then triggered to start. The timer continued until such tie the activity recognition that the driver is not driving anymore i.e. walking/running. This triggers the circling time to stop and then the data is then analyzed and a feedback is given to the display. The assessment is done by coloring the perimeter of the commercialized parking area. The user is then asked explicitly crowdsourced their assessment on the

availability of the parking spaces in the commercial area. They can rate them based on their perception of the availability of the parking space: Full, Moderately Full, Open/Free spaces. Figure 5 shows the screenshot of the Parking Density of the mobile app.
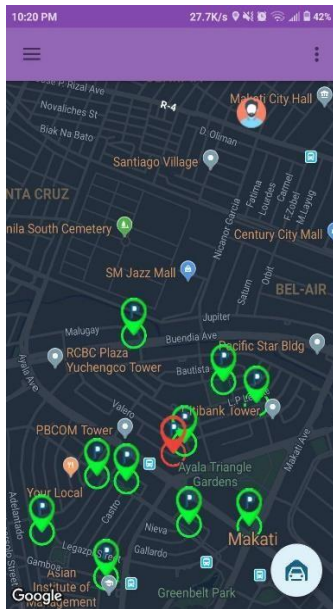

Figure 5. Parking Density

This data is then analyzed and a report in form of a feedback on the app is displayed to give users additional information. The computation of average circling time of a parking is based on the 10 latest averaged individual circling time. Table 3 shows the simulated results of the circling time upon looking for a parking slot.

Table 3. Simulation Table of Circling Time

Users	Individual Circling Time	Average Circling Time
UserID1	20	20
UserID2	18	19
UserID3	15	17.6
UserID4	15	17
UserID5	20	17.6
UserID6	20	18
UserID7	22	18.6
UserID8	24	19.3
UserID9	25	19.8
UserID10	27	20.6
UserID11	10	19.6
UserID12	5	18.3

4. TECHNICAL BACKGROUND

Other than bringing two crowds together, *ParkPal* aims to alleviate the lack of parking slots especially in the metro. Parking lot, or even open lot owners that has unused spaces can reach people who are in need of affordable parking spaces. The user who is looking for parking lot will be able to see nearby parking lot offered by

ParkPal hosts and choose from variation of prices. *ParkPal* features Google Maps API that can get ETA & routing points, access fastest routes towards the parking lot. The implicit crowdsourcing of parking occupancy is made possible through Geofencing technology wherein a virtual perimeter called geofence is set on a certain area. Figure 6 shows the system architecture of the mobile app.

Vehicle owners who are using *ParkPal* will send geofencing data to the cloud. Geofence works with low-ambient Wi-Fi, cell tower data and GPS. Together with geofencing technology, we aim to detect the physical activity (walking, driving, running) of the vehicle owner for the purpose of determining the vehicle owner has already successfully parked their car within the vicinity. This is made possible through Google's Activity Recognition API wherein it utilizes the smartphone's sensor and automatically detects activities by periodically reading short bursts of sensor data. Each parking slot in parking area is provided with individual QR code that contains the unique parking slot ID. The purpose of QR integration is for the system to be able to track the status of occupancy of the parking slots. For an instance, the parking time starts and the parking slot occupancy changes to taken when the vehicle owner scans the QR code.

As the reference for design, *ParkPal*'s design would be similar to popular crowd-sourcing and economy sharing mobile application such as Uber, Airbnb, and Waze. *ParkPal* will be developed in Java programming language using Android Studio. We will be using Google's Firebase Real-time Database. The Firebase Realtime Database is a cloud-hosted database. Data is stored as JSON and synchronized in real-time to every connected client.

Figure 6. System Architecture

5. CONCLUSION

ParkPal can be an alternative to using hardware as a parking monitoring tool. Users can view the density of commercial parking areas in the metro and at the same time contribute to the dataset that is used for monitoring the density. However, the effectiveness of the application dependent on the quantity of users because the data used for computing the circling time is gathered from the application users. Moreover, this application will be very useful as a tool to alleviate the lack of parking slots especially in the metro by providing alternative parking spaces. Parking lot, or even open lot owners that has unused spaces will be able to reach people who are in need of affordable parking spaces. Users will be able to see

nearby parking lot offered by *ParkPal* hosts and choose from variation of prices, location, and personal preference. In upcoming development iteration, the proponents plan to integrate digitalized payment from external digital wallet entities to facilitate the payment between users, and expand the deployment environment to the whole Metro Manila.

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