A Study of Parking Issues on NC State Campus

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ABSTRACT

This project report introduces the problem of parking faced in all colleges and universities throughout the United States and also the world at large. We developed three solutions based primarily on feedback from a focus group comprising of students of North Carolina State University who've helped us in defining the problem. We present the three solutions and analyse all three of them to find the benefits and shortcomings of each of them. We finally draw a conclusion based on the solutions and our own experience working on this project.

1. INTRODUCTION

Reflecting on former President of University of California, Clark Kerr's words- "I have sometimes thought of the modern [U.S.] university as a series of individual faculty entrepreneurs held together by a common grievance over parking.", one can draw the conclusion that his words ring painfully true in today's day and age. Without a doubt parking seems to be the most widespread and frustrating problems affecting Colleges and Universities. Rising enrollment numbers are one of the main reasons that so many institutions are facing parking shortages. Enrollment jumped from 14.5 million to 18.2 million between 1997 and 2007 in the United States, putting a severe strain on a service that's already at the breaking point. One could also point to how today's students are products of a "car culture" that urges them to drive to destinations when walking will often suffice.

To combat this problem, we proposed an automated parking solution for NCSU, which is an Android application which aims to solve a lot of the problems facing all the stakeholders on college campuses. We have offered 3 different solutions to combat the problems of parking, and they are as follows:

1. Standalone NCSU parking application: A user can download the application on their Android phone and it enables them see the percentage of empty space in any of the NCSU parking lots. Using this they have an idea about possible parking spaces or lack-thereof, before they even arrive at the campus.

2. NCSU Parking App with login and authentication: A user can register and sign up on the same application. By signing up on the app a user can also "favorite" a particular parking slot on campus, maybe one where they have to park each day and they can get real time notification on their phone indicating that the parking spot is currently full.

3. Parking Management System: A registered user can also use the same application as a central hub of parking management system. The user can register their car in this system using their car's number plate. This connects to the central transportation centre of NCSU so essentially the user has registered his/her car with the NCSU transport office. If the car happens to be parked illegally on campus and a fine is issued on the car or if the car is being towed the transport office can send a real-time notification to the user about the traffic violation being issued or the fact that the car is being towed. This system can also keep track of the fines collected on a particular car based on their number plate and a user can pay their fines from within the application by collecting to the NCSU Shibboleth server for authentication and payment of the fine.

Thus these 3 solutions aim to provide a holistic approach to solving the parking problem on NCSU campus.

2. RESEARCH

A very important part of this study was to collect the general consensus of public with respect to the issues and data regarding the problems that are faced when handling this subject. We adopted the approach of Personal Interviews and Survey to base our app development on. This was worked out in the month of January with an aim to focus our development on the result and analysis of this research.

2.1 Personal Interviews

The purpose behind taking personal interviews was we wanted to form a feature set to include in our app. We were sure about what we wanted the app to do, but we weren't sure about what features the users wanted and hence taking a brief survey before starting app development was the perfect way to know the demands of the users and to get feedback from them about our own ideas.

2.2 Survey

We created a survey[1] where we had formulated a set of questions and presented it to people to record their responses. This survey was circulated to our colleagues in NCSU via direct e-mails, Facebook, Whatsapp and other social networking sites.

This question was added to the survey after the personal interviews, as we realized that people who were new to the campus and didn't bring car regularly to campus are more inclined towards having a mobile app for NCSU Transport Management. Since they were in the process of getting their cars registered with the university they were more inclined towards the initial setup. Compared to this people who brought their cars regularly to campus were more inclined towards a Car Parking finder App.

Would you like an automatic search and payment option for parking?

- Yes
- No

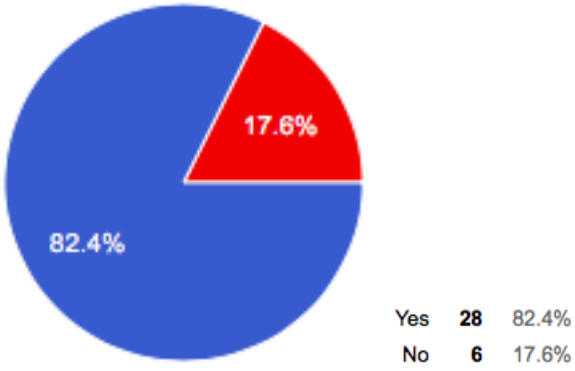

Figure 1: Percentage distribution for question 4

This question was also added after personal interviews were conducted. We felt from the tone of people that this was something that everybody using the parking system needed.

Would you like to include options for parking rule violations reporting?

- Yes
- No

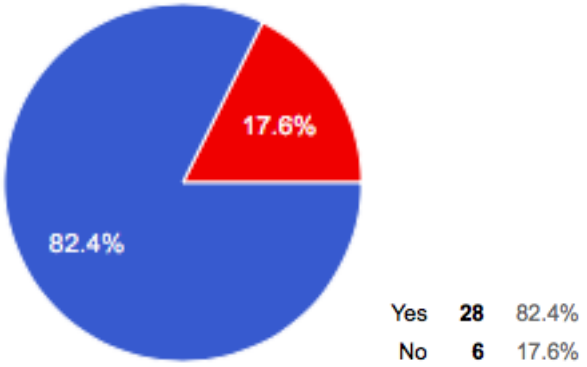

Figure 2: Percentage distribution for question 5

The following questions were subjective questions which were included to understand any other kind of issue which we would have missed in the personal interviews or the survey.

- Can you share some horror story you or someone you know faced while bringing a car to campus?
  - Getting a ticket on parking in a wrong lot.
  - Getting towed for running in to turn in a paper.
  - It was too expensive to park on campus so a friend of mine has to park off campus and take a bus despite owning a car.
  - I know a friend of mine who did not have a pass, ended up paying so much for few hours and bought a parking permit the same day.
- Would you like to share your overall experience with bringing a car to campus?
  - Takes a lot of time and effort from my day to get to class on time due to lack of AFFORDABLE parking.
  - It is annoying to park not only because of the limited parking available (especially overnight) but also the high prices that come with it.
  - The main thing I am frustrated with is trying to get a parking permit for Dan Allen. Even though I have enough credit hours now, it still won't let me even get on the wait list until next school year.
  - It has been mostly fine so far, really the only annoying thing is not knowing all of the rules regarding parking.
  - HORRIBLE. There are so few places to park anywhere temporarily
  - The parking fee is expensive and the parking lot is hard to find. That is why I only take school bus to school.

– It is normally ok if you come early in the morning, but it is a hassle at other times of the day to try to find a spot that is not on the roof of the deck and the traffic in the deck is awful too

– Good and expensive. I always find a spot very fast.

These responses helped us understand that a more streamlined application is required which can help people identify correct parking spots, handle towing issues, and realizing parking costs accurately.

3. PROPOSED SOLUTIONS

Now that the problem has been extensively examined and there is little doubt of the scope of the problem, an all-in-one solution is needed to address all the problems which have been identified. Mobile phones have become ubiquitous and their computation power as well as usability have reached the point that a lot of users rely solely on their mobile devices for most of their daily task. Hence for maximum reachability and ease of use from a user's point of view, building an Android application was determined to be the best solution. During the course of the project development phase, a simple Android application was developed which aims to automate the parking system on NCSU campus. It can act as a standalone app for any user to check the percentage of free parking space in any of the NCSU parking decks and can also act as parking management system for tracking and payment of fines and traffic violations.

3.1 Standalone Parking Application

The standalone parking application feature is the most basic of all the features implemented in our parking app. However it is in the simplicity where this solution is highly desirable. No irritating logins, no forgetting and recovery of passwords, you just open the app and find out the status of the free parking space in any of the NCSU parking lots. We have used Google Maps APIs for this particular application and have added all the NCSU parking lots by tying in the geo-locations from the NCSU transport office. We've also enabled a feature of the app to track your location in real time with respect to the parking lot you've chosen. With this feature implemented and tying the navigation API of Google Maps we can navigate to the parking lot closest to your current location. With this implementation of the app, any user can download this application, open it and find a free parking space on NCSU campus and navigate to it, all without any signups or logins.

3.2 Authorization Feature

This solution is aimed towards users who plan on using this app more frequently, for eg. students who park their car in the same parking lot each time they come to campus or faculty and support staff who come to campus each day and have difficulty in finding parking closer to their workplace. For such a user base this app has a sign up and login feature. By signing up on this app, a user enjoys all the benefits of the standalone feature app and also has the option to "favorite" their most frequently used parking spot. This feature aims to automatically open the favorite parking spot for the user every time they open the app so that the user doesn't have to deal with the hassle of first locating and then finding the correct parking lot which he/she uses each day and then finding out how much parking space is available.

3.3 Parking Management System

This feature integrates with the Authorization feature of the app and hence is available only to those users who have logged into the app. With this solution, a user has a complete parking management system all in a single app on his/her mobile device. The user can register his/her car inside of this system and with the integration of the app to the NCSU transport office, this will automatically register the car with with transport office. Now the office can flag the car for any misdemeanors, hand out fines and traffic violations to the user if the car is parked illegally or in the wrong lot and also indicate if the car is being towed away, all by sending a notification to the user from inside this app. In this way the user can easily view the status of fines (paid or unpaid), rush to the car if it's being towed away and pay for the traffic violations, all from right within this app. Hence this solution aims to bring a comprehensive Parking Management System for the user.

4. OBSERVATIONS AND TELEMETRY

To collect application data and user feedback we approached observations and telemetry from 2 ways- to get user feedback from surveys indicating which solution the users liked and why, and to use Google Analytics to get results like how many users have logged into the program, which devices have been used to login to the app, how many screens have been viewed etc. We look at the figures from various graphs and draw our conclusions from these results.

4.1 User Survey

We presented a total of 16 NC State students with this application and asked them to use it. We explained to them what each of our solutions were and how they were different from one another. We then asked them to give a short survey to provide us their feedback of what they thought about the app. Here is the result of the survey:

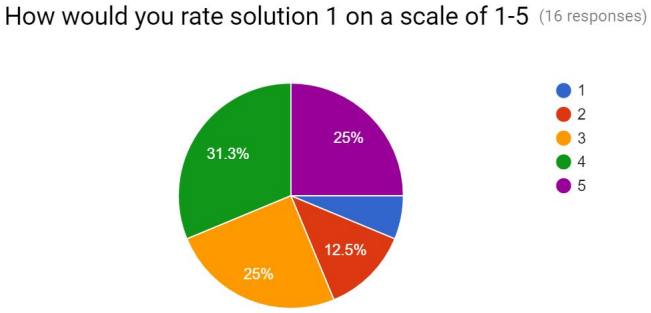

Figure 3: Ratings of Solution 1

Looking at Fig. 3, 4 and 5, we can see from the feedback of the students that they prefer solution 3 with 62.5% of the students giving it a 5 rating followed by solution 1 with 25% 5 ratings and finally solution 2 with 18.8% 5 ratings.

From Fig. 6, we observe that 81.3% of the students gave the app a favorable rating with 56.3% of the students giving

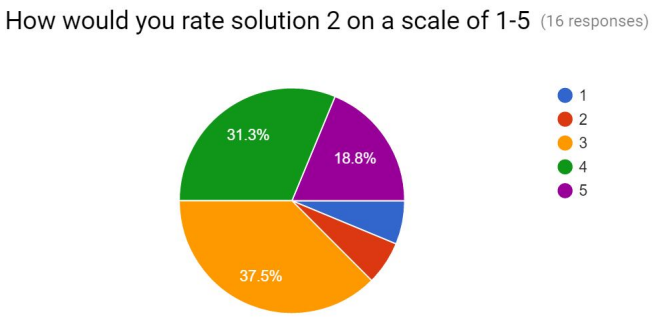

Figure 4: Ratings of Solution 2

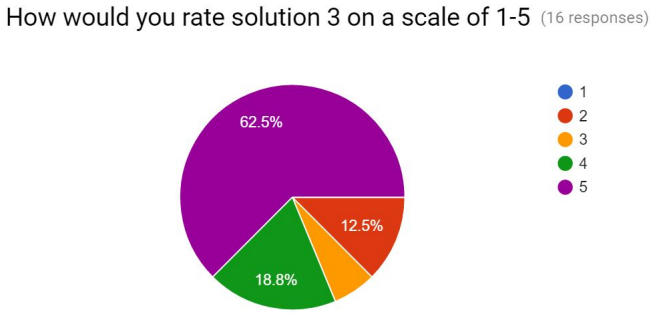

Figure 5: Ratings of Solution 3

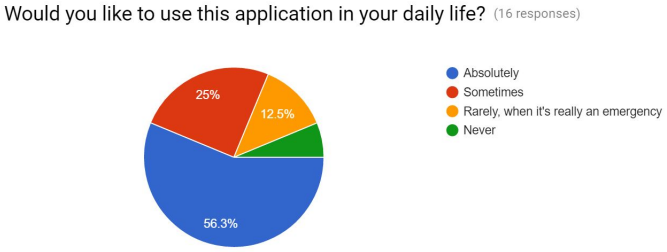

Figure 6: Rating the overall application

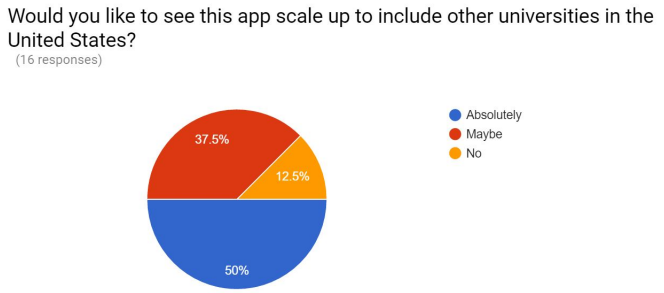

Figure 7: Expansion of app beyond NCSU

us a 5 star rating. Further, by observing Fig. 7, 50% of the students gave us an "absolutely" rating of expanding the scope of the application beyond just NCSU parking lots to other colleges and universities.

4.2 Telemetry

We included Google Analytics inside our application to give us a glimpse of the number of users using app, their usage time and the the number of different screens accessed by the user each time they use the app. These results were extremely helpful in giving us an indication of the solution being used by the user the most.

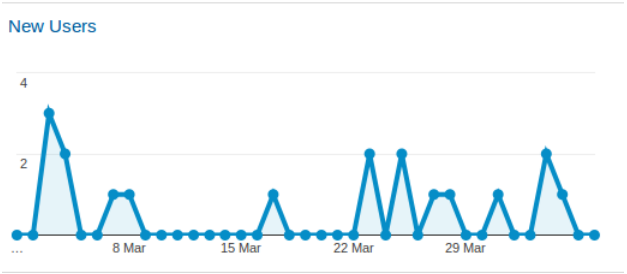

Figure 8: Number of new users

Fig. 8 indicates the number of days new users signed up for the app in the month of March and April.

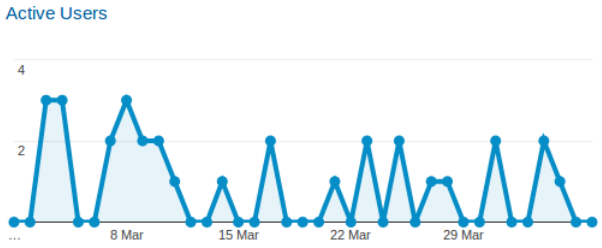

Figure 9: Number of active users

Fig. 9 indicates the number of days active users using the app in the month of March and April.

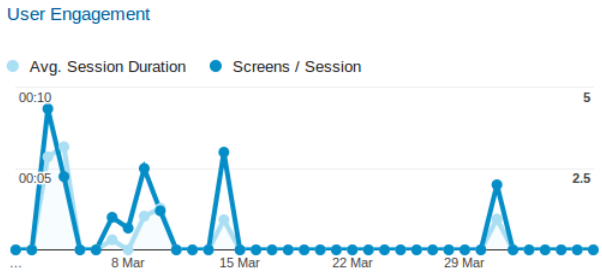

Figure 10: User engagement of the app

Fig. 10 gives us the number of screens being interacted with in each session of app usage. It also tells us the average session duration.

Fig. 11 gives us an overview of the app statistics, like number of screen views, average time spent on each screen, app crashes etc.

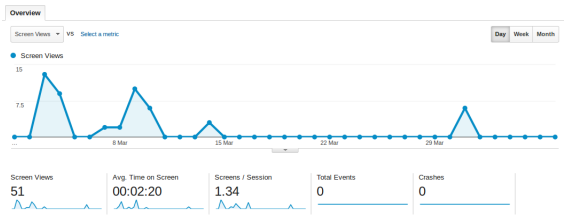

Figure 11: App overview

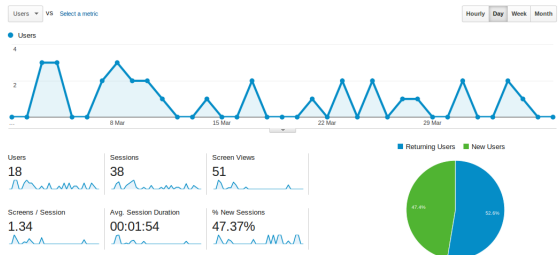

Figure 12: User overview

Fig. 12 gives us an overview of the users using the app. We get information like number of users, number of sessions, % of new sessions and new users. We can collect this statistic in hour's view, day's view, week's view, month's view.

A	B	C	D
id	latitude	longitude	frequency
0	35.7875685	-78.6700427	2
1	35.7707381	-78.6947808	36
2	35.7703173	-78.6938947	102
3	35.7739463	-78.6895529	63
4	35.7782147	-78.6839702	417
5	35.7876163	-78.6695246	25
6	35.7686692	-78.6749212	12
7	35.7664267	-78.6974722	18
8	35.7707191	-78.6944363	7
9	35.7720734	-78.6919917	23
10	35.7714142	-78.6751012	18
11	35.7824156	-78.6682842	11
12	35.788007	-78.6764806	31

Figure 13: Log file from app

Fig. 13 is a log file generated from our application. It logs the latitude and longitude values whenever the user presses the current location button. It logs these values by user ID and also outputs the frequency with which they press the current location button.

5. CONCLUSION

The observations we made and data we collected through Google Analytics and log files educated us in user expectations and reviews as well as bugs and limitations in our application. The results from the user gave solution 3 a comprehensive win with 81.3% of the users finding that the best figure. We were informed that such an app would be immensely helpful to students who are often fined for not paying their fines on time because they lost track of the payments due to the hectic lifestyle they lead. They said having such an app would allow them to check on their dues very easily. The telemetry enables us to see the new users who use the app and how much time they spend per screen. It also indicates how many screens an average user browses.

When we came up with the 3 solutions, we personally thought people would appreciate solution 1 to be the best as it was the most convenient and hassle free. It gave user reasonable functionality without any logins. However from the survey, we can see that the students appreciate solution 3 the most.

During the course of this project we've demonstrated just how frustrating parking troubles are for people arriving on campus. We've taken surveys and read white papers on this subject and have come up with 3 solutions to fix this problem in the form of an Android app. We have developed this app with the feature set derived from the intial survey from users. We tested this app on users and collected logs and telemetry from the usage and drew our conclusions on the best solution based on that. This project can still be expanded by adding new features to the app to make it more useful.

6. LIMITATIONS AND OPPORTUNITIES

Our idea of creating an Automated Parking Solution for the NCSU campus involved a lot of different possibilities in terms of implementation. It also challenged us on what feature set to implement in our application, which user base to target and what the main concerns were regarding parking on campus. This project had a scope much beyond the realms of a graduate class as we didn't have a defined output in terms of what the final result should be. We started with getting feedback from students around campus about what were the problems they faced when it came to car parking and what feature set they wanted to see in the app. From the dozens of responses we decided on the 3 solutions we have implemented to be the final feature set our application should contain before we present it to students for testing and feedback. Another big challenge for us was with regard to app integration with various services as well as the data presented by the app. We have not integrated our app with any NCSU server or user base, we have used our local devices for collection and retrieval of all the data. Where we needed data from external sources like the percentage of parking lot free, we've used mock data to show the results. For our ideas to be realized we'll need proximity sensors installed on NCSU parking lots which can detect and count the number of cars parked and thus calculate the percentage of free space for car parking in the lot.

We don't have the authority to tap into the transportation departments database so we have used the device as a storage space for solution 3 car registration and tracking of fines and traffic violations. If we tried to connect our app to the official transport office it would take a lot of additional coding and connections before our app could fully implement all the features. Hence this is the current limitation of our app. However this can also be thought of as a windows of opportunity for future development to take place on this app to get these various services all connected to this app can talk to these services and get the information needed. This can be thought of as an expansion of our project.

7. REFERENCES

[1] Google form on which observations are based: *http://bit.ly/1Pc3dnl*.
[2] Google form for user surveys: *http://bit.ly/1ShR8O1*.