# *Designing of a Mobile Application for the Pre-Admission Process of a Vocational School*

*Julio Amaro Massó*
*Master of Engineering in Computer Engineering*
*Advisor: Nelliud Torres, DBA*
*Electrical and Computer Engineering & Computer Science Department*
*Polytechnic University of Puerto Rico*

***Abstract*** *— The Department of Education of Puerto Rico (**DE**), has begun to implement and improve its administrative processes using web technology. Platforms such as SIE (**Student Information System**), a system that collects, manages and stores all data related to students and the academic offer in schools, allows the teacher to perform tasks in a more efficient and cost-effective manner. Although the DE has made an effort to implement web technology, the PR school's still does the pre-admission, admission and enrollment processes in the traditional way of collecting information using the paper. Process that in the case of the Vocational School Miguel Such is extremely tedious and archaic, where much of the data collected is redundant and poorly processed due to lack of standardization and protocols in the processes. This often resulted in duplication of work and the incurrence of incorrect information causing the pre-admission process to be affected. The implementation of mobile technology through the development of an app, could speed up the pre-admission process by guaranteeing the collection of data in an orderly manner without redundancy and duplication of work.*

***Key Terms*** *— Cocoapods, DE, Firebase, iOS, Pre-Admission, Vocational Miguel Such, Xcode.*

## INTRODUCTION

As mobile devices such as smartphones, PDAs and tablet PCs are becoming increasingly popular, mobile applications exert a great influence on the way people communicate and access information [1]. The Metropolitan Vocational High School Miguel Such is a complex school located in San Juan, large in space and enrollment, which makes it difficult to administer effectively. The school relies unnecessarily on paper, documents, informal personal contacts, over-monitoring and supervision of simple tasks that would be solved with an adequate use of modern Information Systems. In addition, the advancement of new technologies in communications (smartphones, tablets and laptops) has made the way in which students, parents and teachers communicate more accessible and faster. Even so, there are schools that are still communicating in the traditional way, depending on the use of paper, printers and ink, making the communication process inefficient between both parties. People nowadays use Facebook, Instagram, Twitter and other social networking platforms to communicate, making the information faster [2]. It is for this reason that the schools have to acquire and implement new technologies for the use of the students, parents, teachers and administration, in order to provide a better and efficient experience.

This proposal does not intend to solve all the problems exposed. However, if we initiate the steps for the digitalization of the information collected in the registration, together with a standardized process establishment we could take the initial steps form the Vocational Miguel Such more agile and organized.

## MOTIVATION

For years our school has lacked a standardized and organized process to enroll students. The pre-registration process - where parents fill out admission papers - is a tedious, slow and repetitive process, you find yourself filling out forms asking for the same information over and over again. This process creates problems when processing documents because many of them are lost, have incomplete information and sometimes written information is not understandable. Besides, the Vocational School Miguel Such since the

implementation of Law 7, does not have corresponding staff (Register) to address this issue that is so important to the school. Due to this problem, the enrollment process is not finished, and they end up in other schools, affecting the workshops and the teachers that, for lack of students, are removed. Additionally, an official list of students who have applied for is not generated in time, nor is an official list of students enrolled for courses generated. This meant that in 2017, neither the teachers nor the students had an official program of classes.

The root of these problems is the way in which the data is collected manually in the registration. If that initial step was carried out digitally many processes in the future would be facilitated and it would not depend on multiple points of data collection of students. In addition, it could reduce the time it takes a parent or guardian to complete the entire process.

## SITUATIONS

The problems that a pre-admission digital system could solve are identified

a) The enrollment process is disorganized, slow and repetitive before those in charge.
b) This process is not organized in order for the information collected to be useful to the school.
c) The information that is collected is not validated or its uniformity is guaranteed.
d) We depend on the manual organization of documents to be able to make multiple reports.
e) There are multiple data collection points after enrollment.
f) The information collected is not accessible to the staff that needs it in the correct format.
g) There are multiple manual tasks that occupy time and human resources that could be replaced by computers to increase the time dedicated to direct service to students, teachers and managers.
h) The absence of student lists, student programs and teacher programs cause school time to be lost as the whole school is organized.
i) The lack of information delays and hinders the preparation of the school organization, the M1, the administrative reports, etc.

## LITERATURE REVIEW

Exploring how we can solve the problem of data collection, we understand that it is necessary to apply technology based on the web. The Education Department through federal laws such as the "No Child Left Behind" and the new law "Every Student Succeeds Act, ESSA" has sought to improve the implementation of technology to improve service at the administrative level as in teaching. The Curriculum Renewal Project of the Department of Education (2003) pointed out the urgency for students and teachers to appropriate technology; that is, that they are able to work autonomously, in collaboration and determining what technology is required to carry out a task and when it is convenient to integrate it [3]. The DE has created several portals on the web to facilitate certain administrative processes such as:

**SIE (Student Information System)** – is the system that collects, manages and stores all data related to students and the academic offer in schools. The application manages a universal database that stores among others; student demographic information, academic information, school organization, school information, discipline incidents, enrollment, attendance, and student grades [4].

**MiPE (Mi Portal Especial)** – is an electronic PEI (Special Education Procedures), establishes the educational services that the student will receive according to their particular needs.

The system electronically stores the PEI information and communicates electronically with the Student Information System (SIE). This allows the information to appear pre-populated in the corresponding fields and streamlines data entry. In addition, it has the ability to store all student data

and generate a variety of reports including statistics [5].

**Sistema Tal** – electronic portal where the teachers and non-teaching employee verifies, claims and adjusts their time and their licenses.

These platforms that have emerged in mid-2006 onwards have facilitated the process of collecting and managing information in an organized way, eliminating much of the time of doing them if they are done in the traditional way of paper deliveries [6].

Even so, we still have a long way to go, given that a large part of the admission and enrollment process of public schools in Puerto Rico do not have a digitized system to deal with this issue. Even though the SIE exists, many of the public schools in Puerto Rico fall back into the process of paperwork to enroll, it is necessary for each school to integrate its students in the SIE system. Process that in the case of the Voc. School. Miguel Such takes weeks and up to a month to complete. Creating in itself disorganization in the list of students with their pre-admissions process and their respective classes. The DE has implemented a new platform for students to register online. This states that "This new process will save many parents, mothers or caregivers having to go personally to the school to perform such management by hand, as was done" [7], but the reality is that this process is external and part of the internal process that leads the specialized schools as it is in the case of the Voc. Miguel Such where it is required other documents and other information, such as certifications, transcripts and interview process for which the student aspires. All this information consists of at least 9 documents for the pre-admission process and at least 18 documents for the enrollment process. That is why, in this research, a prototype that manages this process of collecting information in a simple and orderly manner will be discussed.

The Voc. Miguel Such School (VMS) is a specialized school in the occupational area. Technical courses are offered, such as general mechanics, diesel mechanics, carpentry, nursing, commerce, among others. At some point in 2002, there were about 28 workshops, where one of them was an aviation mechanic. So far (2018), the school has 23 workshops. The reasons why it has closed workshops are diverse, but one of the aspects that have been evident by the recruiters is the lack of effective promotion in social networks. The school does not have any official website where its workshops are announced and promoted. It was not until 2014 that VMS was inserted into social networks such as Facebook. Certainly, social networks are one of the most used communication methods of today's world. Their use in different fields has been examined in several research studies [2].

The VMS has lost a lot of enrollment from around 1,400 students (2002) to one of only 900 students (2018). So far there is no website to guide potential students about the courses offered at the institution. And much less, there is no website to request admission and / or enroll. In comparison with universities, they have adopted technology to temper the times of a new generation (Millennials) that represents a collection of “smart, practical and techno-savvy” people who are characterized by shared common life experiences that will ultimately influence how they impact the world for many years to come [8]. A survey conducted by Noel-Levitz (2009) found that 88 percent of college-bound prospective students would be disappointed or possibly eliminate a school from consideration if the institution’s Web site did not meet their expectations. This overwhelming majority emphasizes the impact technology can have on student recruitment [9]. Over the years, generalized best practices for how colleges and universities should advertise themselves and engage with today’s prospective students have created an emphasis on the following: use of multimedia (whether it is face-to-face or online), simpler Web sites, personalized messages (both in print and electronic) and keeping individualized contact as relevant and practical as possible [10]. Millennial students often do not express interest in information that is not directly related to what matters to them, nor are they willing to give a second chance at a

first impression [11]. As a result, the balance between making a student feel welcomed by an institution and providing them with the information necessary to make an informed decision is a very delicate balance.

## MOBILE APP APPROACH

Regarding the new emerging technology, the use of smartphones has been increasing. We understand that the best approach to implement our interactive platform is through a mobile application. Based on a recent study by Pew Research Center on Smartphone [12], nearly two-thirds of Americans are now smartphone owners. Among the smartphone owners, Millennials (ages 18-34) are by far the most technologically advanced user group, with a 95% cell phone ownership. The majority of the cell phones today are smartphones. Smartphones are widely used for navigating numerous important life activities ranging from searching for health information, using educational re- sources, finding jobs, reading news, sharing contents with others, following the driving direction, performing tasks, to staying connected to the world, and many other usages [13]. For many users, these de-vices are a key entry point to the online world [12]. One of the main driving forces that make people more and more "smartphone-dependent" is the rich resources available from the web."

## FUNCTIONALITY SUMMARY

The main function of the first phase of the mobile application called MiguelSuch app that will be to collect and provide information related to the pre-registration process and in addition, provide updated school notifications, and many other functionalities to keep up to date with the school.

### Project Goals

The application will focus on improving user communication within the school, parents and students. The following table 1 shows some of the goals of the application.

**Table 1**
**Project Goal**

| Project Goal | Comment/Description/Reference |
|---|---|
| **Functional Goals:** | |
| Pre-registration process | Parents will be able to register the student using the app. |
| School Notification | Automatic notification of important student or teacher tasks. |
| School Calendar | Show a calendar specific and tailored to each student/teacher. |
| **Business Goals:** | |
| Time to Market | Be able to deliver a high-quality product in a short time |
| efficiency, cost, quality | Best in Class school communication application |
| **Constraints:** | |
| Development time | Time to complete development and debugging is limited |

### Deliverables

This project will be delivered in phases. Phase I will be part of this course and will include the following tasks:

### Pre-Registration Process

Part of the tasks includes the registration of the user where it will be indicated if he is a student or parent/guardian. Then, the options are presented for requesting, either ninth grade, tenth grade or a transfer (which may occur from another vocational school at any time during the academic year). After determining the grade interested, the system will collect detailed information of the student such as: number of SIE ("Sistema de Informacion Estudiantil"), name and surname, type of student (regular, special education or 504), postal and residential address, country of origin and if the requested grade have been repeated. Also, family information will be requested to identify the socio-economic profile such as: name of parents or guardians, occupation, place of work, highest academic degree, beneficiary of federal and/or state aid and annual income. At the end of this process a section will be presented that will allow attaching documents. It is suggested that parents or guardians can use the camera of the mobile device as a scanner making the process even more convenient.

### School Notification

This functionality will show important notifications about school, courses, teacher, or student related task. Application will interact with the iPhone Notification Center to automatically popup school notifications to the end user.

## METHODOLOGY

The methodology is based on the Rapid Development process. **Rapid Application Development (RAD)** – is a development technique which aims to produce a working piece of software between 60 and 90 days. RAD is a concept that products can be developed faster through the gathering of requirements using workshops or focus groups, prototyping and early, reiterative user testing of designs, the re-use of software components, a rigidly paced schedule that defers design improvements to the next product version and a less formality in reviews and other team communication [14].

The structure of the RAD lifecycle is thus designed to ensure that developers build the systems that the users really need. This lifecycle, through the following four stages, includes all of the activities and tasks required to scope and define business requirements and design, develop, and implement the application system that supports those requirements [15].

**Requirements Planning -** Also known as the Concept Definition Stage, this stage defines the business functions and data subject areas that the system will support and determines the system's scope.

**User Design -** Also known as the Functional Design Stage, this stage uses workshops to model the system's data and processes and to build a working prototype of critical system components.

**Construction -** Also known as the Development Stage, this stage completes the construction of the physical application system, builds the conversion system, and develops user aids and implementation work plans.

**Implementation -** Also known as the Deployment Stage, this stage includes final user testing and training, data conversion, and the implementation of the application system.

## PROTOTYPE

For the prototype of the platform, it will be a native application using the iOS operating system. For this it is necessary to do it from an Apple computer. Apple has its own integrated development environment (IDE) called Xcode. Xcode supports several languages like Objective - C, C ++, Swift among others. But since the 6.x version of Xcode series, Swift became the predominant language for developing mobile applications [16] The current version for our prototype is Xcode 9.3.1. It is also important to implement a database, our approach to this is to use Firebase. Firebase is a cloud service provider as well as a backend business that allows you to obtain organized data for mobile apps [17]. It is google provided API to create a database and fetch from it in real time with only a few lines of code. Data is stored as JSON and is accessible from all the platforms. Firebase is a paid service and you get 200 MB of storage space for free, that will do enough for the prototype. [18]

Some of the firebase features that we can implement are:

**Authentication:** Feature in firebase that permits only authorized users to access your application. Firebase provides login through Gmail, Github, twitter Facebook and also let the developer create custom authentication, but for our prototype we are only going to use email and password authentication.

**Messaging:** firebase cloud messaging lets you to deliver messages.

**Real-time Database:** Database in firebase is a cloud-based database and does not need SQL-based queries to store and fetch data. Database is highly reliable and superfast which means that data is updated and synchronized in no time and data is maintained even user lose internet connection.

**Storage:** Firebase also provides storage facility. It can store and retrieve content like images, videos and audio directly from client SDK. Uploading and downloading is done in the background. Data stores are safe, and the only authorized user can access it [16].

Finally, the way that firebase can communicate with our application for iOS is through special libraries that are provided by the firebase platform.

For this, CocoaPods was installed. CocoaPods is a dependency manager for Swift and Objective-C projects. It has thousands of libraries and can help you scale your projects elegantly. Ultimately, its goal is to improve discoverability of, and engagement in, third party open-source libraries, by creating a more centralized ecosystem [cocoapods.org]. Dependencies for projects are specified in a single text file called a Podfile with which CocoaPods resolve dependencies between libraries, fetch the resulting source code, and then link it together in an Xcode workspace to build your project [19].

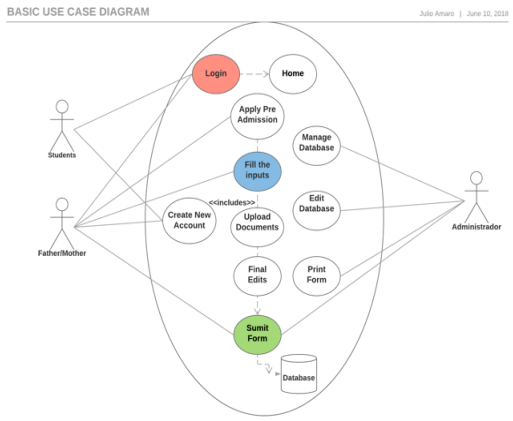


**Diagram A**
**Basic Use Case Illustrating the Pre-Admission Process and its Users**

## PRE-ADMISSION SCENARIO

The prototype so far consists of three users; the student, parent and the administrator. In this first phase, where the pre-admission process is done, the father / mother plays an important role. The parent will need to create an account to begin the pre-admission process, where the parent will be asked to fill out a form with the corresponding information. Also, the parent will have to upload certain documents as part of the pre-admission requirements. When the father has filled out the entire form he will have to submit the form to the cloud. A notification will appear declaring that the process was successfully uploaded to the cloud or not. The administrator will manage, edit the database, this also includes adding and removing users. The administrator has the option of printing the information in the database for administrative purposes. Although in this first phase we want to facilitate the pre-admission process, we also want to expand that the admitted student has access to the events and calendars found on the Home screen (See diagram A).

## APPLICATION COMPONENTS

The application consists of a graphical user interface (GUI) using the Human Interface Guidelines from Apple. In Figure 2, we can look at the design of the Interface for the prototype, Main screen will consist of three buttons to either: enter your username and password, create a user, or move directly to the pre-registration form.


**Figure 2**
**Main Screen – It Provides Three Options for the User**

If the user pushes the "Request of pre-admission" button this will take him to the screen privacy & Policy statement, (see Figure 3), there will be a contract of the app and contract of providing reliable information when filling out the forms. When the user pushes the continue button, the user accepts the conditions of use and can proceed to create his account. Additionally, it is necessary that the user already have at least one email in advance.

To create a new user, see Figure 4, it is needed to specify what type of user you are, including

students, parents and teachers. So far, there will be no functionality for the user / teacher as it seeks to involve in this first phase the student and the parent. To be able to access the pre-admission page, it is important that the user is the parent.


**Figure 3**
**Privacy & Policy Statement – Rules, and Other Consideration for Using the App**


**Figure 4**
**Create New Account**

To create a new user, you need to specify what type of user you are; it included students, parents and teachers. So far, there will be no functionality for the user/teacher as it seeks to involve in this first phase the student and the parent only. To be able to access the pre-admission page, it is important that the user is of the parent-mother type. By pressing continue, they will go to the pre - admission pages. The first section is for the student information; a second section is for the parent information and at the end the user selects the courses that are interested in taking. See Figure 6.

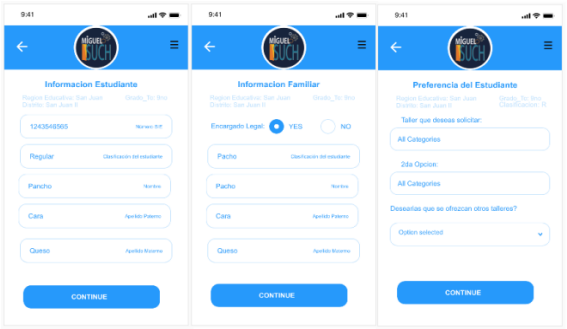


**Figure 6**
**Pre-Registration – Form to Enter the Required Information for Pre-Admission Process**

If the user presses "My account" it will take him to the Log - in screen, (see Figure 7) this screen will allow the user to enter their email and password to access their account and take it to the Home page, see Figure 8. Additionally, on the Log In page there is a link where you will allow the user to recover his password in case he has forgotten it. On the Home screen, events that are relevant to the school community will be presented. Also, at the Home screen, the user can access any of the functions of the application. A toolbar at the top will allow easy access to the calendar, notification and move back to the home page.

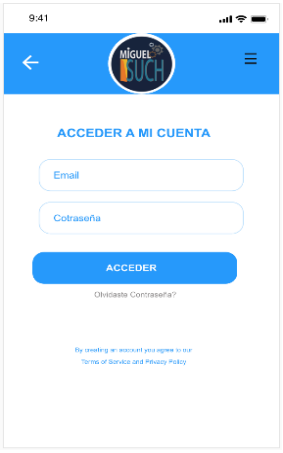


**Figure 7**
**Log – In screen – Introduce Email and Password to Log In (Also There Is a Link In Case the User has Forgotten his Password)**

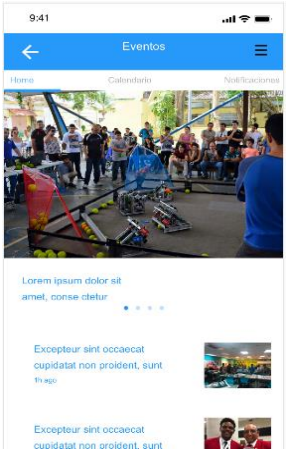


**Figure 8**
**Home Screen**

The calendar screen, will present the semester school calendar or the whole year. It needs to be dynamic and easy to search. The notification screen shows important notifications about school, courses, teacher, or student related task. Application will interact with the iPhone Notification Center to automatically popup school notifications to the end user, see Figure 9. For future work, a menu will be considered, where you will have additional features such as: configuration, admission process, search, my classes, contact us, about us and links to the Facebook, Instagram, and twitter accounts of the school, see figure 10.


**Figure 9**
**Notification Screen**

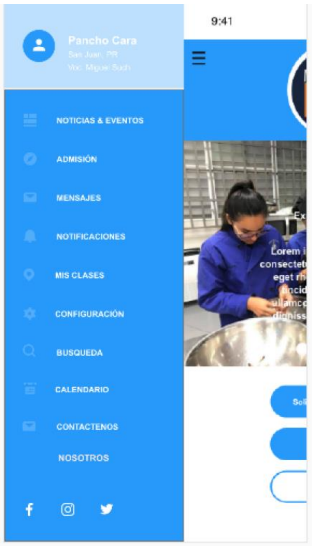


**Figure 10**
**Side Menu with Additional Components**

## COMPETITIVE ANALYSIS

We have identified three applications from different IOS developers that, even though the applications have different functionalities, are available for the same user base; parents, teachers, and students. In the following paragraphs we will go over each of the mobile applications:

"**ClassDojo**" developed by Class Twist Inc., is a free application created with the purpose of enabling a simpler, safer, and faster communication path between teachers, students, and parents. Some of the features includes on this application are: Instant messaging between teachers and parents, parents can see their child's updates at home, photos and videos can be uploaded from the school, and teachers can send encouragement messages to their students. Applications is been made available in more than 5 languages and it is free for grades k-12. Something important to mention is that it has a rating of 5 starts among 435k reviewers.

**"Circle Public School"** developed by Arinum Solutions Pty Ltd. This application has similar features than "ClassDojo" but with additional functionalities that make it more related to the application we are developing. With this application the parents will have the school calendar within finger reach, school will be able to

send instant messages to the parents to assure effective responsive communication, school can share important moments by adding event photos through the application, there is a newsletter section, access social media school pages like Facebook directly from the application and many more features. For teachers, the application has an Administrator console to control all the home page information and links. The application is free for trial and the price starts at $149/yearly for a school with 50 students or less. Something worth to mention is that the developer of this application has more than 150 school apps including the next application we will be reviewing.

**"Herald School"**, developed by Leading Professional Technology, is another mobile application for schools, parents, and students. Herald School is an application for information and resource sharing especially designed for parent and students. With the application the school can share notice, news, file, link resources, share teacher information, and description about the institute through the application. The developer has more than 20 school related applications for different institutions.

**"Tarcutta Public School"** developed by Arinum Solutions Pty Ltd. This application has the following features: academics and activities calendar, Instant push notifications, Photos section, School news. In addition to these features, that were somehow available in the previous reviews, it includes a section for reading documents such as school policies, rules, and other important information directly from your phone. Another section that aligns with our intended application is the Electronic Mobile Form section. On this section the user can instantly fill out most of the school forms (Absent notes, late notes, excursion permissions) and submit them directly from the iPhone. A copy of the submitted form is sent to the email for reference.

After going over various iPhone applications that were developed for school communication purpose the benefits and gaps an application for schools can cover is confirmed. Every application has is particular feature that was created to cover a particular need for the user they intent to impact. The initial focus for the mobile application was only to be used for a student admission data entry form. By adding features found as part of the review the application will be more sellable and useful for the end users. Features like the activity calendar, instant messaging, official documents availability, add additional standard forms, and school news are going to be evaluated for adding them as part of the application.

## EVALUATION METRICS

To be able to evaluate our Phase I application, the following guideline will be used:

- Functionality: It indicates the extent to which the functions specified are made available in the software.
- Reliability: It indicates the reliability of the software.
- Usability: It indicates the usability or the extent to which the users feel the software is easy to use.
- Efficiency: It indicates the efficiency of the software.
- Maintainability: It indicates the extent to which the software can be easily modified and maintained.
- Portability: It indicates the ease of changing the software from one environment to another.

## PROJECT PLAN DETAIL

Considering the limited time, the following Table 2 represents the task and their due date.

**Table 2**
**Project Plan Detail**

| Ident. | Deliverable | Planned Start Date | Planned End Date |
|---|---|---|---|
| T1 | Project proposal & wireframe | 04/30/2018 | 05/07/2018 |
| T2 | Development System Configuration | 05/08/2018 | 05/14/2018 |
| T3 | Application Development | 05/14/2018 | 06/15/2018 |
| T4 | Application Testing & corrections | 06/15/2018 | 06/28/2018 |
| T5 | Production release | 06/28/2018 | 07/05/2018 |

## FUTURE WORK

This prototype is in the 1st phase of development, which consists of being able to do the pre-admission process through a native mobile application in the iOS. For the purposes of this research, it is limited to the functionality of the MiguelSuch app, which is to collect input from the user to save and process the pre-admission. It is contemplated that in the future, this application may also carry out the process of interviewing and re-admitting students. Implement additional libraries that allow you to make other types of validations regarding the information entered by the user. The prototype was written for iOS users, but the application must be expanded to counterpart for android and google devices. The application must be tested with large data and users set to see how efficient it is processing every pre-admissions submission. Authentication support for social media such as Facebook and / or Gmail and implementation of an online payment system that supports online money transfers for the pre-admissions fee and services as an electronic alternative to traditional methods of cash money. Implementing a side menu for additional features such as: configuration, admission process, search, my classes, contact us, about us and links to the Facebook, Instagram, and twitter accounts of the school. Another thing to consider is to know how long it takes a user to complete the pre-admission process using the application vs. the time it takes for traditional means such as filling out paper forms.

## CONCLUSION

The design for this prototype complies with the 1st features of the pre-admission process. It was possible to save the data through the application using external libraries such as in the case of "firebase". The data captured in the system will be used for other purposes, such as data recovery and administration, since the students will feed all the required data. This solves the problems of the avoidable delays involved in the inner-office transfer of data. Additionally, it gives us good beginnings that the pre-admission process can be given on a larger scale including more users. This could reduce the time it takes for a parent to complete the pre-admission process.

It is important to adapt to times and new technologies, mostly mobile. There are countless tools to develop mobile applications. Although this prototype was made for the native iOS system, there are other systems that deserve to be considered as Android operating system. Another approach that can be considered would be the development of a hybrid application, which allows you to develop mobile applications for both iOS and Android. There are platforms that perform that task like the ones called Ionic. In short, developing a mobile application for the use of a school can have a significant impact on the school community that we should take advantage of.

## REFERENCES


[1] C. Borcea & A. Iamnitchi, "P2P systems meet mobile computing: a community-oriented software infrastructure for mobile social applications," in *Second IEEE International Conference on Self-Adaptive and Self-Organizing Systems Workshops*, 2008, pp. 242–247.

[2] T. Kaya & H. Bicen, "The effects of social media on students' behaviors; Facebook as a case study Computers," in *Human Behavior*, 59, 2016, pp.374-379.

[3] Departamento de Educación de Puerto Rico. (2016). *Carta Circular núm. 15-2016 – 2017 Directrices y Política Pública sobre el funcionamiento de la Unidad de Tecnología y Currículo, sus áreas y programas* [Online]. Available: http://intraedu.dde.pr/Cartas%20Circulares/15-2016-2017.pdf.

[4] Departamento de Educación de Puerto Rico. (2017). *Sistema de Información Estudiantil* [Online]. Available: http://www.de.gobierno.pr/ofrecimiento-academico/251-tecnologia-educativa/901-sistema-de-informacion-estudiantil-sie.

[5] Departamento de Educación de Puerto Rico, *Manual del Usuario: Mi portal Especial*, 2013.

[6] Departamento de Educación de Puerto Rico. (2016). *Sistema de Tiempo, Asistencia y Licencia* [Online]. Available: http://www.de.gobierno.pr/Sistematal.html.

[7] J. Keleher, "Educación Anuncia Nuevo Sistema De Matrícula Por Internet," in *Filosofía Educativa*, 2018,

Available: www.de.gobierno.pr/edata/51-noticias/2863-secretaria-de-educacion-anuncia-nuevo-sistema-de-matricula-por-internet.

[8] L. Lancaster & D. Stillman, *When Generations Collide: Who they are. Why they Clash. How to solve a Generational Puzzle at Work*, New York: Harper Collins, 2002.

[9] N. Levitz. (2009). "*Scrolling toward Enrollment Web Site Content and the E-Expectations of College-Bound Seniors*," in *E-Expectations* Available: https://eric.ed.gov/?id=ED541572.

[10] Chimes et al., "What Works: A Student and Counselor Explore College Recruitment" in *Journal of College Admission*, no. 199, 2008, pp. 26-30.

[11] W. Strauss & N. Howe, *Millennials Go to College*, Great Falls: Life Course Associates, 2007.

[12] A. Smith, "U.S. smartphone use in 2015," in *PewResearch Center Report on Internet, Science & Tech*, 2015, Available: http://www.pewinternet.org/2015/04/01/us-smartphone-use-in- 2015/.

[13] M. Huynh, P. Ghimire & D. Troung, "Hybrid App Approach: Could it mark the end of native app domination?" in *Issues in Informing Science + Information Technology*, vol. 14, 2017, pp. 49-59.

[14] Automated Architecture. (2005, Oct. 14). What *is Rapid Application Development* [Online]. Available: http://inst.eecs.berkeley.edu/~cs162/sp13/hand-outs/Rapid-Application-Development.pdf.

[15] J. Martin, *What is Rapid Application Development?*, Macmillan Publishing Company, 1991.

[16] C. Bohon, (2014). "Xcode 6, Swift, CloudKit, and More Surprising Developer News from WWDC 2014," in TechRepublic [Online]. Available: www.techrepublic.com/article/xcode-6-swift-cloudkit-and-more-surprising-developer-news-from-wwdc-2014/.

[17] B. Stoneheme, "Google Android Firebase: Learning the Basics," in *Amazon Digital Services*, 2016.

[18] N. Singh, "Study of Google Firebase API for Android," in *International Journal of Innovative Research in Computer and Communication Engineering*, 2016.

[19] Team CocoaPods Dev, (2018, May 10). *CocoaPods Guides* [Online]. Available: guides.cocoapods.org/