International Journal of Recent Engineering Research and Development (IJRERD)
ISSN: 2455-8761
www.ijrerd.com || Volume 02 – Issue 08 || August 2017 || PP. 14-19

Tracking Maker Space Utilization using a Mobile App

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Abstract: We present a novel data collection system incorporating a mobile app and cloud database for tracking and measuring utilization of Maker Spaces. Our system offers the ability to track a visitor's time spent in the Maker Space and provides detailed reports on the activities of the visitor. Our system is customizable and offers flexibility with respect to the types of activities that are logged into the database. For additional detail, we demonstrate a process for cross-referencing student information systems to obtain demographic information of the visitors.
We discuss the student related issues of convenience, access, and informational accuracy. We address concerns related to the Institutional Review Board approval process and provide recommendations for getting accurate data while maintaining compliance with IRB guidelines. Our system provides maker space management with the ability to better understand the needs of visitors and plan for a more efficient allocation of resources.
Keywords: Maker Space, Cloud computing, App development

1. Introduction

The goal of our utilization tracking system is to gather data around hours of maker space usage, determine who is using the space and what they are using it for. And, for as many users as possible, determine the user's demographic information such as; college, major, class level, and what course the activities might be related to. The purpose of gathering this information is to offer a feedback mechanism to administrators and employees of the maker space to better understand and document what is needed by the entrepreneurs and innovators that use the maker space on a regular basis. Further, data will allow initial assessment on possible correlations between students' use of a Maker Space facility and student retention and progression to degree.

A system approach has been adopted to collect the respective data. This approach incorporates an Android mobile device application (AIS App) and remote Cloud resident database for increased adaptability and functionality. The primary source of data input for this system is the AIS App. By using the custom designed mobile App on a tablet, the staff within the Maker Space is able to enter the utilization data of the students into the system with hand held tablets and also record the student's institutional ID. The AIS App version 1.2 has been tested for the previous two semesters and preliminary data has been collected. The AIS App works in conjunction with Cloud to log all entries and allow for reporting of metrics.

The human computer interaction aspect of the utilization tracking system is a separate issue that is less technical, but no less important. The need for a system that is not perceived by the users as intrusive or unnecessary is important to ensure accuracy and a high rate of system utilization and compliance. We discuss the tradeoffs of different approaches to gathering the system data. Privacy concerns are addressed as the system records people's locations. These concerns, as they pertain to the Institutional Review Board (IRB) application, are also reviewed.
The goal of the Maker Space should be a facility "where students, faculty, and staff from diverse fields can come together to create, learn and work" and where "campus community members can freely tinker, design and prototype their ideas" (Meyer, 2015).

2. System overview

To collect and use the data as proposed in our introduction, there is a combination of hardware and software tools that are utilized. These tools are combined into a system where by Maker Space staff input a student identification number for each student visitor into the AIS App. This attendance data is moved from the app into a customized Cloud database. Each student identification number is later cross referenced with institutional data from the registrar to obtain utilization reports that will then contain the addition of the demographic information. Attendance trends and activity reports can be obtained without having the data go through the demographic cross referencing process.

3.1 Hardware considerations

The current hardware used in our Maker Space is the Samsung Galaxy Tab 7.0 S with integrated stylus. The AIS App runs very well on these mobile devices. The Maker Space staff utilizes the tablet and stylus to

input attendance information into the AIS App. The AIS App is not hardware specific to this particular Samsung device, the AIS App is compatible with any 6" to 11" Android tablet with similar pixel resolution. The stylus is also not a requirement of the AIS App; however, many users prefer its use for repetitive information entry because of the accuracy associated with the stylus.

Other types of hardware were also considered to help supplement the AIS App in gathering data for the system. A bar code or QR code could also be added onto the student's existing ID and the Android tablet would be able to easily read the data using either of its two cameras. NFC readers on the tablets can also be incorporated to allow information from NFC tag stickers on the student's identification cards to be transferred into the system. Magnetic card readers can also be obtained to read an existing magnetic strip on the student's existing identification card.

3.2 AIS App

The AIS App is a significant and fully customized component of our maker space utilization tracking system. The primary role of the AIS App is to serve as a convenient data entry point into the Cloud database. It must interface with the Cloud components seamlessly and ensure that all update requests are carried out accurately to the database. The interface of the AIS App needs to be simple and intuitive. It should allow for quick entry of repetitive data information and also allow for customization that captures the essence of the student's project or activity.

For the design of the AIS App the development team used the AppInventor program developed by Google and the Massachusetts Institute of Technology (Watters, 2011). The AppInventor program is an excellent mobile application development platform that offers an intuitive interface and quick steps to complex logical program flows for nonprogrammers. AppInventor offers remote connection capability that interfaces with the Cloud database with only a few parameters required for full functionality. AppInventor also offers a highly visual interface that can be richly documented so that follow-up programmers of the app can readily understand the underlying code and quickly make changes that are required without substantially reducing the performance of the AIS App.

The AIS app starts with a login authentication to register the staff member responsible for entering the visitor data. Next the AIS App provides a menu that provides the staff member with the choice of individual visitor entries by student ID number, or for group visits. Before submitting the attendance data, the maker spacer staff member also selects from a menu of options describing the purpose for the student or group visit to the maker space. There is also a customizable purpose for visit option so that details can be added about the visit.

The group visit option is very important since many groups of people tour, visit and utilize the maker space as groups that are not just currently enrolled students. This allows for capturing workshop attendance, tour group information etc. The group visit option does not require any particular student ID number and therefore has limited individual demographic information but does capture critical utilization information that can be summarized and reported. An option is also under development that will track attendance on individual projects so as to report individual project effort data.

Figure 1. Screenshot of the AIS App.

Each entry submitted from the AIS App is timestamped and encoded into the Cloud database. The AIS App verifies its connection to the Cloud upon startup. Each change is logged and buffered into the Android

device's local memory before it is transferred up to the Cloud. Should there not be any Wi-Fi connection for the Android device, it will continue to buffer the data until a connection is made. At this point all of the previously buffered data is sent to the Cloud.

3.3 Cloud Computing

The AIS App incorporates commands from the Cloud Application Programmer's Interface (API) to perform critical operations running in the background of the app. By incorporating predefined functions from the API the AIS App is able to perform all of its permanent data storage needs exploiting the virtual storage offered by the Cloud.

Employing the Cloud for data collection and storage offers many inherent benefits (Viswanathan, 2015). The Cloud seamlessly handles synchronization of data that can be entered from multiple sources with different latencies and that may be received at different times. Accurately synchronizing of the database is taken care of behind the scenes by the Cloud and the database is always current and accessible. Small and large changes to the database can be handled behind the scenes within the Cloud management structure and do not necessarily affect the design of the AIS App. This offers a more universal technical solution that can be readily adapted and adopted. The data can be downloaded into spreadsheet form so that any type of analysis can be performed with the information obtained. Custom reports can also be created directly on the cloud and made sharable for near real time utilization data. The data can also be further worked to match it up with a student's individual demographics.

Figure 2. Sample entries in Cloud database.

3.4 Demographic data cross reference

The purpose of this portion of the maker space utilization tracking system is to convert the student identification numbers into a more usable form of data. This step is critical for obtaining the most important demographic information from the AIS App that collects visit data by student identification number only. This step does not occur on the fly or in real time. It occurs through a data processing method that first will take the Cloud database and convert the ID data to a list of unique student identification numbers. This list is provided to the registrar to fill out the corresponding student demographic data of the students. The information required to cross reference the student identification numbers is provided back from the registrar's office with the corresponding student demographics. At no time are names collected or included with the returned demographic information. With the included demographic information, we can determine which colleges and programs are utilizing the maker space most often. We can determine the participation of women and minorities within the maker space to ensure that we are being inclusive of all stakeholders.

3.5 Initial staff feedback

The staff's initial feedback has been very positive. They tested the AIS App on a semi-regular basis for two semesters and have provided feedback for upgrades that will be implemented in AIS App 2.0, which is currently under development. The staff acknowledged that it does take some discipline to use the system properly. Consistency is something that should also be stressed so that the maker space staff is entering activities in the same manner with some consistency. It has been emphasized that the collection of data should be as accurate as possible but should at no time take precedence over their other duties especially service to the client.

The suggested changes also include adding a way to see how many visitors are currently in attendance. The staff would like to see 'at a glance' how many students are shown in the space and have an ability to select a particular participant. The staff reports that it is hard to recognize a student by their identification number when they leave. They have suggested a nick name field in the AIS App may be needed to more effectively

manage the students present. This possible solution would implement a nick name field in the AIS App that would allow an identification number to have a comment field for a nickname or initials. For privacy purposes this field would not be retained by the AIS App beyond its immediate usage. This field would not be stored or retained in any way.

This solution would also assist with another staff request. The maker space staff has requested an easy method to check out someone who leaves the maker space without notice. The members of the maker space staff don't want to require everyone to formally check out when they leave. To keep the natural flow of students in and out of the space, the staff would like to be able to 'check out' students as they leave without any interruption. With this particular update the AIS App will allow a selection from a live list of nick names that the maker space staff member can use to check out the appropriate student.

3.6 Additional data collection techniques

There is no reason that demographic information couldn't be self-reported at the time of initial sign up for participation and consent to providing data for the tracking system. It would not be difficult to add a signup screen for initial data entry of the student's information. This data could be submitted into the Cloud database at the time of sign up and provide the Cloud database with the complete demographic profile of the maker space users and visitors. This would alleviate the process of requesting demographic information from the university registrar.

This approach does have the drawback of having the student provide a lot of information upon their first visit to the maker space. This could easily act as an annoyance that would discourage the visitors. It may be a one-time questionnaire but it shouldn't come to the student at the wrong time. Asking only for their identification number once and then getting the demographic data from an existing database is sure to be less intrusive than an initial questionnaire. The tradeoff is the reliance on the registrar or some other source with providing timely and accurate demographic data for cross referencing with the Cloud database.

Another approach to collect the student's identification number is to have the student proactively provide their data through the use of magnetic swipe cards, bar code labels, and Near Field Communication (NFC) which would allow students to tap a card reader for the identification number entry. Each particular configuration is dependent on the hardware available and the configuration of the student identification cards.

All card reader technologies have their own pros and cons when it comes to user convenience (Sherman, 2014) and the necessary support of the required readers. Using any type of card reader will require the visitor to the maker space to have to retrieve their identification card from their wallet, purse, or backpack and this may not be convenient for the students who are ready to work or whose hands are full with books or laptop computers. If the student has their identification number memorized, then they would not need to retrieve the card and would be able to have their information entered into the AIS App. Also the portability of the tablets with the AIS App provides the capability for the maker space staff to come to the student at a later time in their visit when it may be more convenient for the student to retrieve their identification card or to provide the staff with their identification number.

3.7 IRB considerations

As with all cases concerning using information from human subjects for research, data collection to be used in research should be approved by an institution's IRB. Typical concerns that should be addressed are privacy and security of the information. The student will need to consent to the use of their identification number and their demographic information if research is going to be done with the obtained data. What the collected information is used for is an important consideration for the IRB applicant. It may be possible that a particular configuration or revision of the system may be eligible to receive a waiver since no identifying information is collected in the Cloud database. If the system is only used for internal reporting and the data isn't intended for outside consumption, then the IRB's approval will most likely not be needed. Each institution will have their own specific application process and may view the collection of data as more relevant to the operational metrics required to effectively run a service based organization.

3.8 AIS App version 2.0 and future changes

The next version of the AIS App will incorporate many of the changes suggested by the maker space staff members and student's visitors to the maker space. As mentioned before a screen that provides a live list of the current maker space visitors will allow the Maker Space staff to better ensure the accuracy of the visitor's log. An unsaved field for the student's nicknames or some other identifier will also be added to allow the maker space staff to match a visitor to their ID number. Finally, an easy method for student logout will be provided so that students who leave the maker space without notice are more accurately logged out of the system by the maker space staff.

Other changes to be made will be an automated screen resolution recognition feature that properly sizes the AIS to be more compatible with a wider range of Android screen resolutions. The ability to track time spent on projects was also suggested to help students and faculty better gauge their efforts within the maker space. Another avenue worth exploring is the creation of an AIS App for students that would work in conjunction with the AIS App and the Cloud database to allow students to log their own time in the maker space.

Additional security changes and upgrades will be made to the AIS App's authentication module as well as updates and further security restrictions to the Cloud database. The maker space may also experiment more with using AIS identification stickers placed on the student's identification card. These stickers would carry the student identification number and possibly some demographic information.

Finally, a major upgrade would be to co-develop a version of the AIS Apps that are IOS compatible and able to run on Apple devices. This would make the adoption of the AIS App more widespread by opening it up to an additional 50% of the mobile device market. Technically, there is nothing hardware specific about AIS App that would prevent it from running under different mobile operating systems with different processor chipsets.

3. Conclusions

Tracking the usage of Maker Spaces by students and other visitors provides decision makers with information to better allocate resources based on the current and projected utilization of the maker space. Our AIS App integrates Android tablets into a maker space tracking system that collects useful data about maker space clients and stores this data to a Cloud database. Data is recorded through the use of the AIS App for both individual and group visits. The information is sent and collected into the Cloud database that allows customizable reports to be created based on the AIS App data submissions. Weekly and monthly utilization reports can be created that can be used to help schedule maker space staff members for a more effective use of resources. More detail can be obtained from the visitor data when the recorded identification numbers are electronically cross referenced with demographic data to obtain detailed maker space utilization reports.

To obtain the most reliable data while not detracting from the maker space experience the approach currently used involves the Maker Space staff actively logging the visits of individuals and groups. Suggested changes that will be implemented include visitor nickname, rudimentary project tracking, easy visitor checkout and at a glance list of current maker space visitors. Possible use of identification cards with barcodes or magnetic information may also be looked at for future use by more regular maker space visitors.

Privacy concerns have been addressed through standard encryption techniques and the use of a data does not include any actual names. The demographic information does not retain even the student's assigned nick names. Version 2.0 of the AIS App is currently under development and is expected to roll out during the Spring 2016 semester.

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