SILLIMAN3D: A 3D AUGMENTED REALITY MOBILE APPLICATION OF

SILLIMAN UNIVERSITY MAIN CAMPUS

A Capstone Project

presented to

the College of Computer Studies

Silliman University

In Partial Fulfilment of

the Requirements for the Degree of

Bachelor of Science in Information Technology

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ABSTRACT

Augmented Reality (AR) is one of the biggest technology breakouts in the 21st century. The impact that it has on the citizens of today is limitless. One such effect is for people to be informed. Silliman3D, as an application, envisions to perform this, through the use of AR Technology, for all users that demonstrate an interest in Silliman University and its facilities.

The application informs, entertains, and interacts with the users through their devices. It utilizes features such as Target Image—where the user will be able to project the campus on their screens and, at the same time, freely view the campus. To interact with the buildings, users can scan for them around the campus, and their respective details will show after performing specific actions. A Navigation feature is also present, where users can select two separate buildings and discover the closest path between them, which will then serve as their guide in going around the school.

This capstone project aims for the interested users to have more in-depth knowledge about Silliman University, especially the information regarding its buildings and its geography, in general.

COLLEGE OF COMPUTER STUDIES
SILLIMAN UNIVERSITY
Building Competence, Character & Faith

APPROVAL SHEET

This Capstone Project entitled "SILLIMAN3D: A 3D Augmented Reality Mobile
Application of Silliman University Main Campus"

is presented by

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CHAPTER 1: Introduction and Background of the Study

1.1 Introduction

Silliman University, located in Dumaguete City, is a 62-hectare campus. It is filled with a great number of buildings that are old enough to be called as heritage, such as the Silliman Hall, Hibbard Hall, and Silliman University Church. Not merely that, along with its long lanes, gates that have meanings, and of course, the acacia trees that are situated around the place --- certainly this is a huge campus. With all these facts, touring around the campus would take someone quite some time, especially when someone is explaining around every bit of history that Silliman University has. However, for those who are situated far away from where the campus is, that kind of privilege and access cannot be easily attained.

In 2019, Silliman University had approximately 12,500 students enrolled in the first semester [1]. Those enrollees are also composed of international students, students that are representing 56 countries all around the world [1]. This makes Silliman University a campus that has an international reach. With these facts, Silliman University has a suitable number of interested parents and students that would want to study inside the school, and most of those are far from Dumaguete City. This is proven to be true because of the number of student organizations in Silliman University that are for non-locals of Dumaguete City [2]. Since Silliman University is a 62-hectare campus, a single poster that speaks about what is inside the school would not satisfy the eagerness of these interested applicants and parents to know more about the school [3].

Navigating and familiarizing is important when someone plans to adapt to a new place, especially to a new school where almost everyone spends their post-adolescent life [4]. Therefore, there are certain applications created for tourists (who could potentially be future citizens) in navigating and familiarizing the place [5]. The same goes for Silliman University, as this place is also considered as a tourist spot in Dumaguete City because of its rich history [6].

Knowing the technology in this current generation, it is possible to create ways for those who are unable to physically come to Silliman University. Technologies such as "Augmented Reality" and "Virtual Reality" have the potential to transform how information is delivered and how every living person views the world. By making use of such technologies, the team will be able to effectively share what Silliman University is all around the world.

These are the goals of "Silliman3D": for people all around the world to recognize and experience Silliman University, wherever he or she may be; become a platform where people could understand the history beneath every building the University has; for them to know all the ways around the corners point-to-point; for each to see if the school fits right on his or her checklist, so he or she could inquire to the school. And all of these functions are accessible right on the screen of a mobile phone. It is believed that this application will not only improve Silliman University as a school, but also as a landmark, a spot, and a heritage all around the world.

1.2 Objectives of the Study

This project's main objective is to provide an Android mobile application that will be an avenue where people will be able to see what is inside Silliman University. To project a complete 3D model and finish the project, the team will be using the AR technology and create three different modules. First, a module that will create a path depending on the user's starting point and destination point to navigate through the campus. Second, a module that will provide information to the users. Such information includes the history, details, and even the available programs in certain buildings that offer college programs. Finally, a module that will permit the users to view a sorted list of buildings on the campus. Furthermore, the project aims to provide quality and legitimate information that come directly from the school's bulletin boards of information, therefore ensuring information veracity.

1.3 Scope and Limitations

Scope

This application allows a user:

- see Silliman University in a bird's eye view by focusing around the printed marker;
- zoom in and out of their view of the school;
- tap a building to know its information; and
- generate a path that will give directions to the users in going around the campus.

Limitations

- This application is available for Android OS only.

- The application will not display anything found inside a building.

- The application will not display structures found inside the campus that have lengths and widths less than or equal to 1 meter.

- Humans and animals will not be included in the 3D simulation.

- The application is strictly for viewing only. No services such as enrolment, reservation, and payments will be done through the application.

- A mobile phone camera is required to project the Augmented Reality 3D campus.

- The mobile application will not be able to display the Augmented Reality 3D model of Silliman University if the printed marker is not clearly printed, for the mobile phone camera will not be able to detect it.

- The mobile application cannot print a printable marker. Instead, it can only export a file that is to be printed in a printer.

- The mobile application will only display a semi-detailed model of the buildings and campus.

1.4 Significance

This project can help people who are interested in enrolling at Silliman University. With this, users of the application will be able to have a grasp and understanding of what Silliman University is. Through this, users can finally decide if choosing Silliman University is the right decision. Not merely that, but this can also be used by current students of Silliman University if they do not know the way going around the campus. They can freely use this mobile application to guide them.

This project can also be a way for Sillimanians who want to market Silliman University to their families and peers. However, it is not solely limited to Sillimanians, but for tourists of Dumaguete City and potential tourists of Dumaguete City. Furthermore, this mobile application can then be labeled as a gateway where people can explore Silliman University in a unique 3D experience, packed with its interesting history and its 62-hectare majesty.

1.5 Definition of Terms

- 3D Campus   – A projected 3D campus of the Silliman University.
- Augmented Reality   – A technology that superimposes computer-generated image on a user's view of the real world, thus providing a composite view.
- Marker   – A unique image that needs to be detected by the application to display the 3D campus.
- Path   – A guide that will serve as a pathway from one point to another.
- Printed Marker   – A printed version of the marker.
- Virtual Reality   – It is the use of computer technology to create a simulated environment.

CHAPTER 2: Review of Related Literature and Systems

2.1 Review of Related Literature

As one of the hottest technologies of today, Augmented Reality sure has created its name in the world of technology [7]. This is an experience of seeing an object as a whole, anywhere a person may be in this world. One of the most famous applications that use Augmented Reality is Pokémon GO [8], an application that will allow players to go around the place and catch Pokémon via the Augmented Reality technology. However, Silliman3D is not the same as that, because it uses a marker-based technology in Augmented Reality [9]. Using this, the users will be able to see Silliman University as a whole only by scanning the printed file provided by the mobile application. Thus, this project will also be utilizing image processing technology.

Aside from merely simply entertaining the users, Augmented Reality can do more than that. Its potential for marketing a product, in this case, Silliman University, is huge [10]. People do not have to check matters physically because the users will have everything in one touch. This also is a huge challenge for the product marketers, as they should be able to put up high-quality and great details of the product that they wish to advertise. This is where interaction between the marketer and the customers is very important, which is why Augmented Reality is such a powerful tool to use.

According to Greatschools.org, one of the points that a parent should prioritize during his or her child's studying season is to check the school that the child is about to study in [11]. This is because parents need to know more about the events the children are

attending. If the parent wishes to, they could ask other parents, check out some articles about the school and ask the school itself. This makes parents feel secure in the place where their child would spend a great deal of time, whatever level of education the children may be in. In some cases, parents send off their child to go study somewhere far, for the parents believe that the children would benefit much from it. This makes students have to go through a transition, realizing that they are now in a new suitable environment, ready to take on new challenges in life [12]. Because of distance, most probably, the families do not have the opportunity to witness Silliman University as it is. With the fear of sending their children into a school that they might not know, seeing it by any means possible would be a superior idea. In this case, that idea is seeing Silliman University in the full 3D model using Augmented Reality technology.

To clarify subjects, Augmented Reality is not the same as Virtual Reality. In Virtual Reality, a user will be experiencing a simulated environment using a device, whereas in

Augmented Reality, a user will be experiencing an enhanced version of reality [13]. In the year 2017, a capstone project by Aricheta, Dadea Jr., and Marinay entitled "SU[VR]", a point-by-point, interactive virtual reality campus tour, which allows interaction and navigation by hovering or voice recognition using a head-mounted display, was implemented [14]. However, that capstone project is different from this project. One of the biggest reasons why Augmented Reality is the most effective way to allow people to experience Silliman University is because it is one of the biggest technologies of today. Many companies have been adapting and using this technology to showcase, market, and interact with their products to the customers. IKEA is one of the giant furniture companies

around the world, which also uses Augmented Reality via an application, to showcase their furniture to their customers [15]. However, it is not only limited to non-perishable objects. In the words of ARCritic, a portal where users could read news and articles all about Augmented Reality, it was said: "Augmented Reality Food is going to be a big hit" [16]. This shows how significant the market and reach of this technology is in this current generation and for the generations to come.

2.2 Review of Related Applications

One of the related applications regarding Augmented Reality is the **YouVisit Campus**. This application will help people to have a full 360° experience of places, depending on where the client wishes. YouVisit is a technology company that is powered by Aria, the leading enterprise platform that enables brands and organizations to market their products well by interacting with their potential customers. There is a "Showcase" version available on the Android Play Store so that interested customers would have a grasp on how Aria does affairs in terms of a full Augmented Reality experience.

Another mobile application focusing on Augmented Reality is **Microsoft Reveille.** It is an Augmented Reality mobile application that will allow users to experience a mobile tour around the East Campus of Microsoft that is located in Redmond. It is also a marker-based Augmented Reality application. Users only have to point it towards the marker and then it will instantly display their campus. Not only that, but users can even see their campus in a panoramic view, depending on their choice.

CampusReality by BundlAR is also a platform that will allow schools to create an Augmented Reality experience inside their mobile application or develop their own

branded mobile application. There are custom solutions built inside it that users can choose from depending on the preference and request. With this mobile application, users will be able to allow campus visitors to feel an enhanced experience and also gather the information that would help them in their recruiting, fundraising, and community engagement.   Speaking of campuses, an Augmented Reality application for Silliman University, called **SAM,** was also developed. It was an Android mobile application that served as the personal information guide for users around Silliman University. If there are times that the school's campus ambassadors are not around, SAM is an effective alternative. This application was developed by Diaz, Elmaga, and Martinez.

Also, there is a Virtual Reality application created for Silliman University. The application's main purpose is for touring around the campus, it is the **SU[VR]**. This is when a certain individual will not be able to physically go to Silliman University. Instead of walking around the campus, plugging a phone to a VR headgear becomes a wise alternative. This application was developed by Aricheta, Dadea Jr., and Marinay. **Google Maps** also has its Augmented Reality features. Google Maps do not execute the same process as this project. The difference between the two is that this project is marker-based, while Google Maps is projection-based. It will display users' directions and guides on how to go to a place right in front of the user using the smartphone camera.

Touring as a whole, there is also an application for that: the **3DVista**. It is a VR software that will give the user a professional virtual tour around places. There are even sounds interconnected to the video displayed by the software to cause users to appreciate the tour.

CHAPTER 3: Methodology

3.1 Conceptual Framework
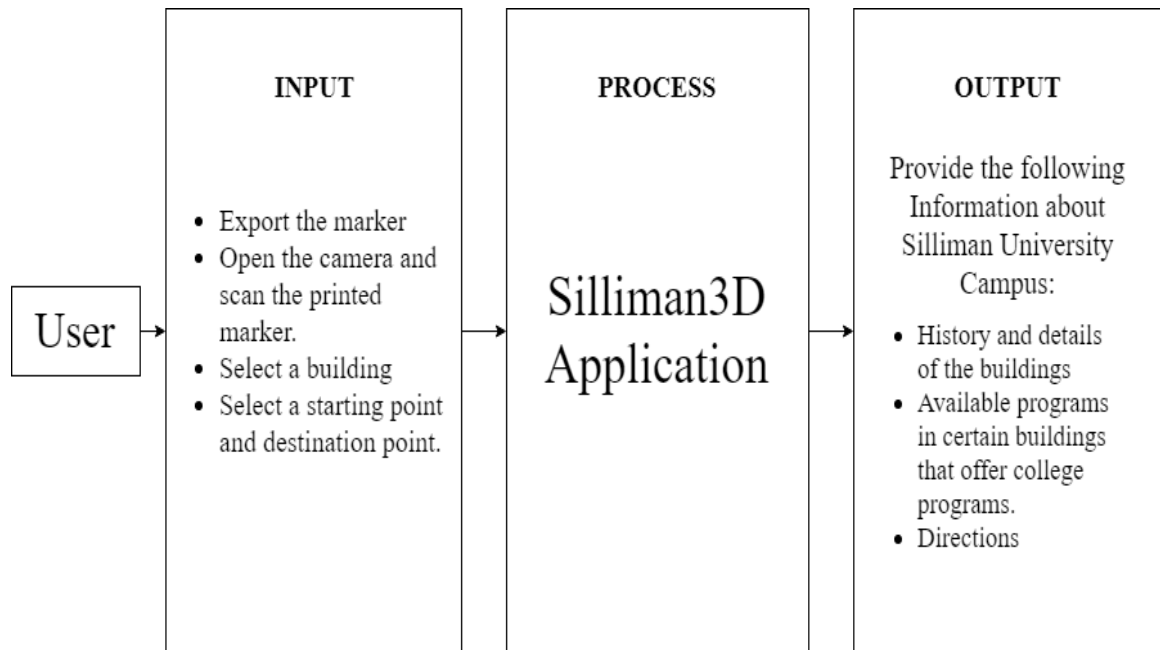
Figure 1: *Conceptual Framework*

3.2 List and Descriptions of the Stakeholders of the System

Tourists – These are the main users of the application. They will be the ones who will contribute ideas to the team, namely the user interface, additional features, and user experience. These will all be used so that the team will know what matters to improve during development are.

Students – Some of the information that will be gathered from the school are not given by the school directly, they will be

through the students. As these students will serve as the representative of some of the respective departments of the school.

Silliman University   – The structure of the school will be used as the application's main feature. Every landmark and building around the school will be studied and remodelled in the application. Also, the information that is coming from the offices of the school and the school itself will be used in the application.

Developers   – The application developers who will design the interfaces, create the 3D models and write the computer programs to meet the specific requirements.

Adviser   – The person who will serve as the coach of the team of developers. He or she will guide the team by checking up on them if they are doing the right procedures and tasks in developing the application.

3.3 Software Development Model being used
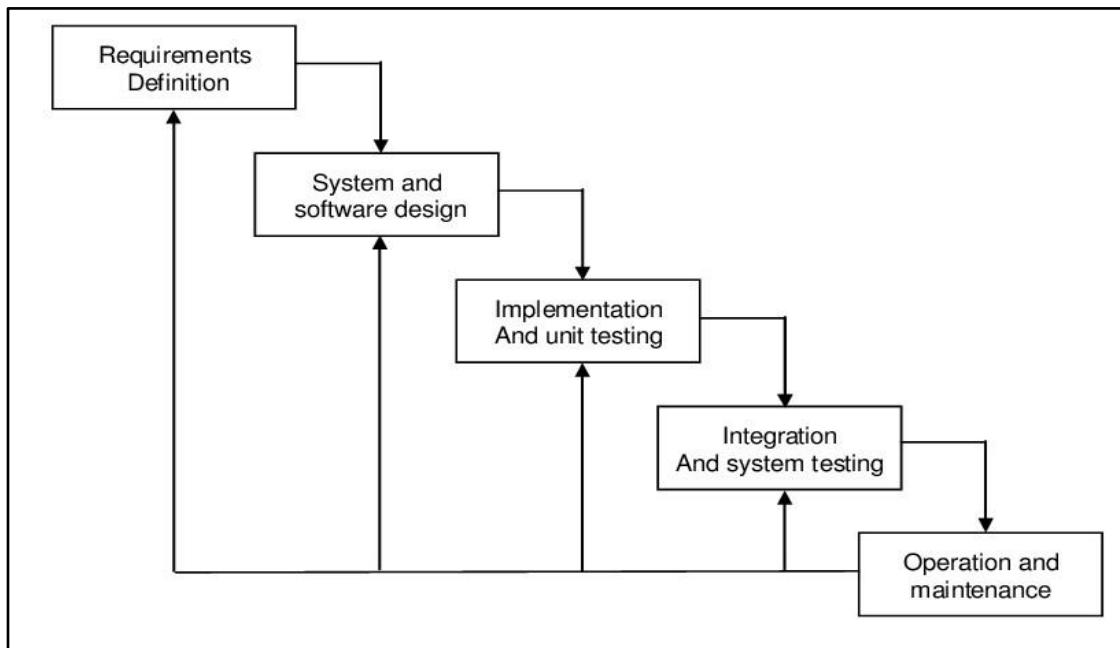
Figure 2: *Waterfall Model (Sommerville, 2011)*

A waterfall model has different phases and each phase should be carefully executed before moving on to the next one. The team decided that it is best to use the waterfall model because it is highly applicable to this project. As such if one phase is not done correctly, it might compromise the quality of the succeeding phases. There will be 5 different phases, which are Requirements Definition, System and Software Design, Implementation and Unit Testing, Integration and System Testing, Operation and Maintenance. The principal stages of the Waterfall Model directly reflect the fundamental development activities.

The activities in every phase are as follows:

Phase 1: The system's offered services, limitations, constraints, and goals were established. These goals were defined in detail and then served as a system specification. Afterward, the team conducted proper research about the related applications of this project. To improve their research, the team also took a good look at the establishments that were created in Silliman University. Together with the adviser of the team, the team discussed the possible services and constraints that are found from the related applications.

All of the discussed details were documented under the Functional and Non-functional Requirements of this document.

Phase 2: The system and software design will take place after analyzing all of the requirements specifications individually. In this stage, the State Diagram and Screen Layouts will be put together so that there will be a concrete idea of what the application that is to be developed will look like.

Phase 3: The implementation and unit testing will take place after the project's architecture will be put up. Implementation processes will be involving conversion of the designs into codes, these processes will be done by every module or unit. The Unit Testing process will be involving the testing of the developed modules individually so that it will be ensured that it will be able to meet the requirements that are specified in the (to be specified) Functional and Non-functional requirements of this document.

Phase 4: After all of the modules will be done, the integration and testing of the whole application will take place. The individual modules will be integrated and tested well as one whole complete system. This is to ensure that the whole software requirements

will be met. If the integration and testing phase will turn into a success, the software system should be ready for installation.

Phase 5: The system will be installed into practical use for all interested users. When there will be bugs around the software system, maintenance will be conducted. This will involve correcting the errors that were not discovered during the initial stages of the life cycle. This will then improve the implementation of the system units and enhance its system services.

Truthfully, the phases mentioned should not be initiated not until the previous phase has been completed. During practice, these stages will overlap and feed information onto the other. This means that during the designing phase, there could be potential problems that could be discovered which will lessen the complication in the succeeding phases, and all that comes after that.

3.4 Minimum Hardware and Software Requirements

Table 1: *Minimum Requirements for Development*

Hardware	
Processor	Core i3 or AMD Phenom II X4
GPU	Graphics card with DX10 capabilities
RAM	4GB
Software	
Operating System	Windows 10 (64 bit only) or MAC OS

Integrated Development Environment	Unity and Visual Studio Code
Development Tools	Ionic Framework TypeScript Android SDK GitHub Java Development Kit Android NDK Unity Vuforia Plugin

Table 2: *Minimum Requirements for Implementation*

Hardware	
Android Device	128MB RAM 256MB Flash External QVGA TFT LCD or larger, 16-bit color 5-way navigation phone Standard mini-B USB interface ARM-based Gyroscope Sensor 8MP rear camera
Software	
Android	Android 7.0 or higher

3.5 Project Timeframe/Timeline/Schedule

Table 3: *Time Management*

Activities	Prerequisites	Duration
Requirements Definition		
A. Requirements Analysis and Specification	None	2 Weeks
System and Software Design		
B. Design and Specification	A	2 Weeks
Implementation		
C. Coding and Modeling	A, B	13 Weeks
D. Debugging and Optimization	C	2 Weeks
Integration and System Testing		
E. Integration and System Testing	D	2 Weeks
Operation and Maintenance		
F. Delivery and Implementation	E	2 Weeks

Table 4: *Project Timeframe*

Activities	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
A. Requirements Definition			■	■																						
B. System and Software Design						■	■																			
C. Implementations									■	■	■	■	■	■	■	■	■	■	■	■	■	■				
D. Integration and System Testing																							■	■		
E. Operation and Maintenance																									■	■
Weeks	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Months	May				Jun				July				Aug				Sept				Oct				Nov	

Legend:

Expected
Actual
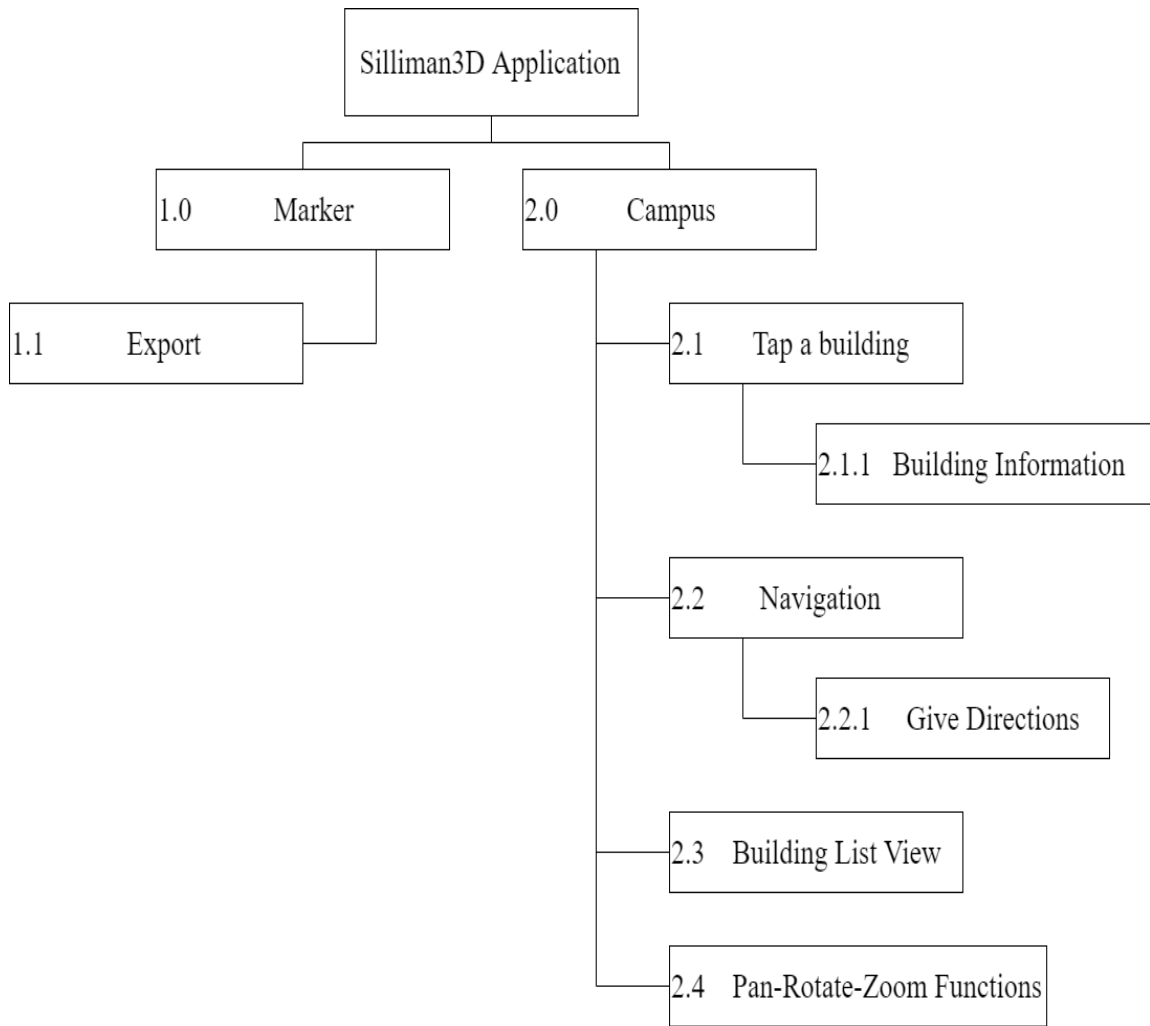
4.1 Analysis

Figure 3: *Work Breakdown Structure*

4.1.2 Functional and Non-functional Requirements Analysis and Specification

Functional Requirements

UR1: The user shall be able to exp   ort a printable marker in a PDF file format to be

printed in a printer.

UR2:   The user shall be able to scan the printed marker to display the 3D campus.

UR3:   The user shall be able to zoom, pan, and rotate around the 3D campus.

UR4:   The user shall be able to tap a specific building on the campus.

UR5:   The user shall be able to read the history of the tapped building.

UR6:   The user shall be able to read the details of the tapped building.

UR7:   The user shall be able to see the programs offered if the tapped building is a
       college building.

UR8:   The user shall be able to navigate around the 3D campus.

UR9:   The user shall be able to generate a path from a point to a point inside the 3D
       campus.

UR10: The user shall be able to open the Silliman University website through a
       redirected link in the application.

UR11: The user shall be able to view the sorted list of buildings by department, college,
       and program in the List of Buildings module.

Non-functional Requirements

URN1: The user shall be able to access the application with an Android OS mobile
       device.

URN2: The user shall need a camera in order to scan the printed marker.

URN3: The user shall be able to access the application at any time.

System Requirements

Functional Requirements

SR1:   The system shall allow the user to export a printable marker in PDF format.

SR2:   The system shall allow the user to see the Silliman University Campus in a 3D model.

SR3:   The system shall allow the user to navigate around the 3D campus.

SR4:   The system shall be able to show the name of a building when it is tapped by a user.

SR5:   The system shall be able to display the history of the tapped building.

SR6:   The system shall be able to display the details of the tapped building.

SR7:   The system shall be able to display the offered programs of a college if the tapped building is a college building.

SR8:   The system shall be able to generate a path to guide the user from a point to a point inside the campus.

SR9:   The system shall redirect the user to a link to a website when the user has tapped a link inside the application.

SR10: The system shall be able to sort the list of buildings by department, college and program in the List of Buildings module depending on the user's preference.

Non-functional Requirements:

SRN1: The system shall run the application on an Android OS mobile device.

SRN2: The system shall be accessible to the user at any time.

4.2 Design

4.2.1 State Diagram
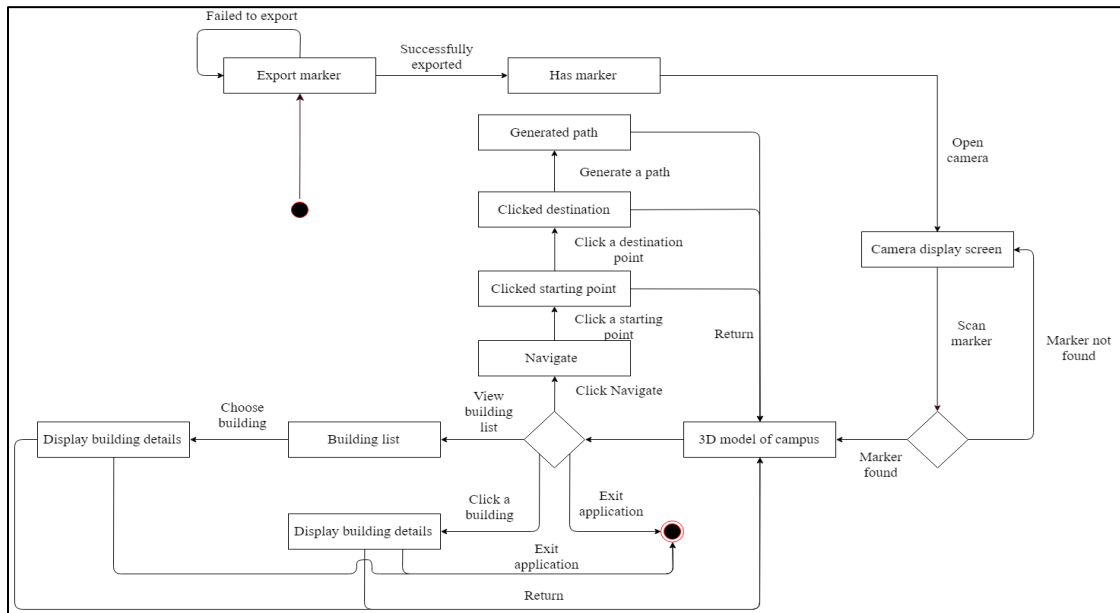
Figure 4: *State Diagram*

4.2.2 Screen Layouts

Figure 5: *Welcome screen of Silliman3D*

This is the first layout that will appear. The elements in this screen, except for the background, will fade in and slide up to add effects. Tapping the button will move the screen to the next slide. The background of this screen is the Silliman University Hall.

Figure 6: *Marker screen of Silliman3D*

In this screen, the user will have the option to export the marker for the augmented reality campus. Upon tapping, the app will allow the user to choose if he or she wants to export a PDF file. Upon tapping the "NEXT" button, it will move to the next screen. The background of this screen is Hibbard Hall.

Figure 7: *Reminder screen of Silliman3D*

This will be the last screen that the users will see before they will proceed to the actual camera. There is a warning sign in the middle of the screen. On the lower part, there is a button and underneath it is the slide number indicator. Upon tapping the button, the application will redirect to the camera screen. The background of the photo is the East Quadrangle of Silliman University.

Figure 8: *Camera Screen and 3D Model of Silliman3D*

This will be the page where the actual projection of the 3D models will be displayed. The screen turns black when the camera is not yet detected or if the camera is facing a very dark target. The upper left button is the Home Button, which will reposition the perspective of the 3D campus. The upper right button is the Navigation Button, which will enable the users to generate a path from a point to another inside the 3D campus. The left button is the building list button, which will enable the user to view specific buildings by sorting. The buttons on the button right corner are the side view button and top view button, which will enable the users to change the view of the 3D campus. The orientation of this screen is in landscape mode, different from the rest of the screens which is in portrait mode.

Figure 9: *Navigation Screen of Silliman3D*

This page is where a path will be generated based on the user's selected starting point and destination point. The button on the top left corner of the screen is the again button; it will enable the users to remove a path and create a new one. The button on the top right corner of the screen is the close button; it will enable the users to close the navigation mode. The orientation of this screen is in landscape mode.
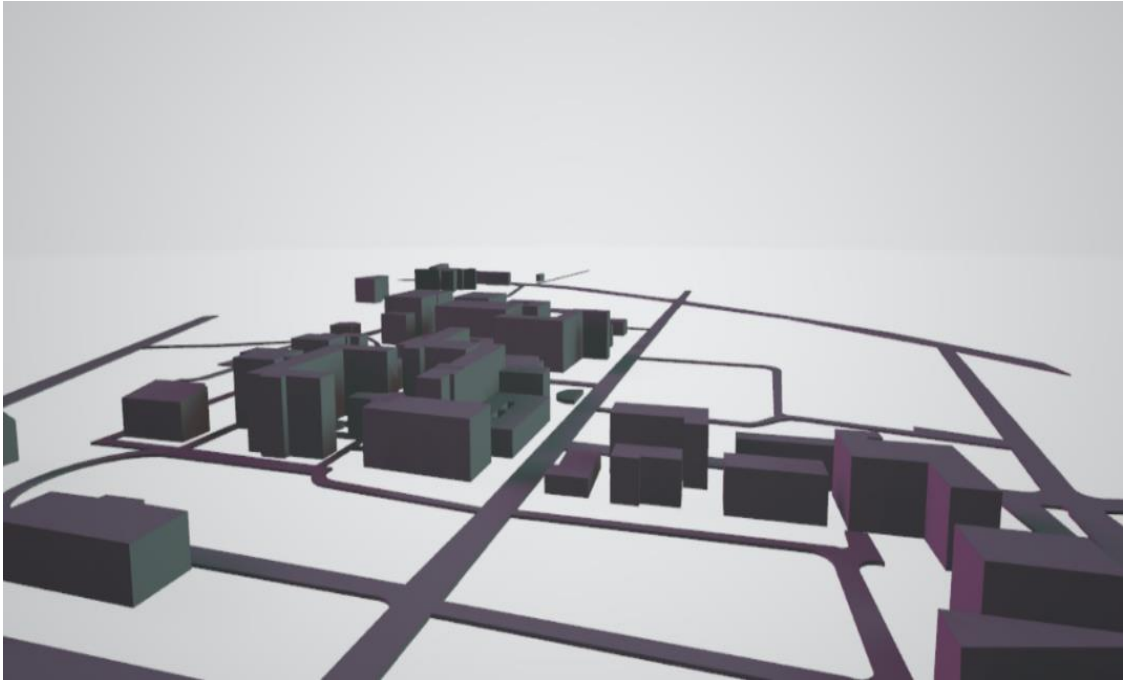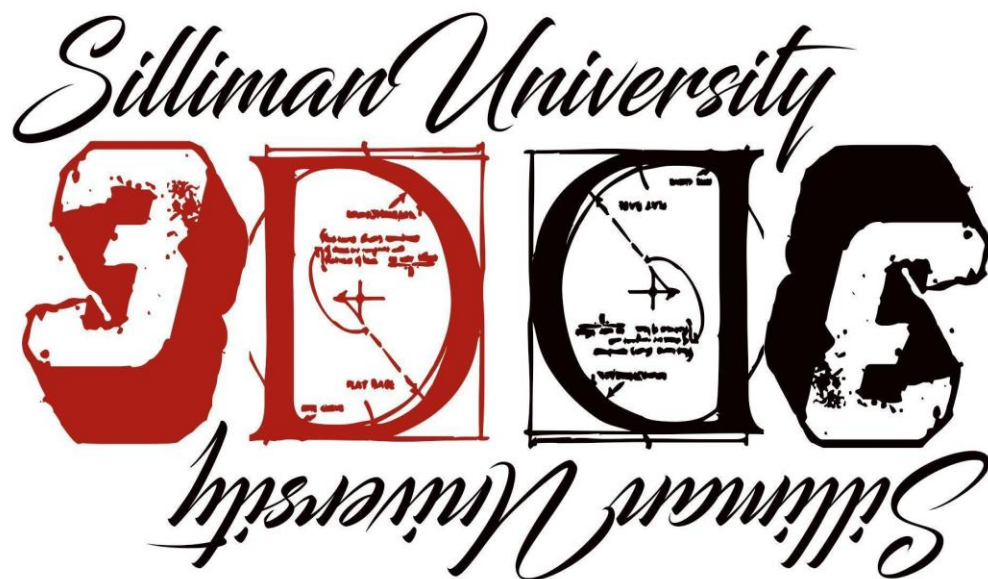
Figure 10: *3D Model of Silliman Main Campus*
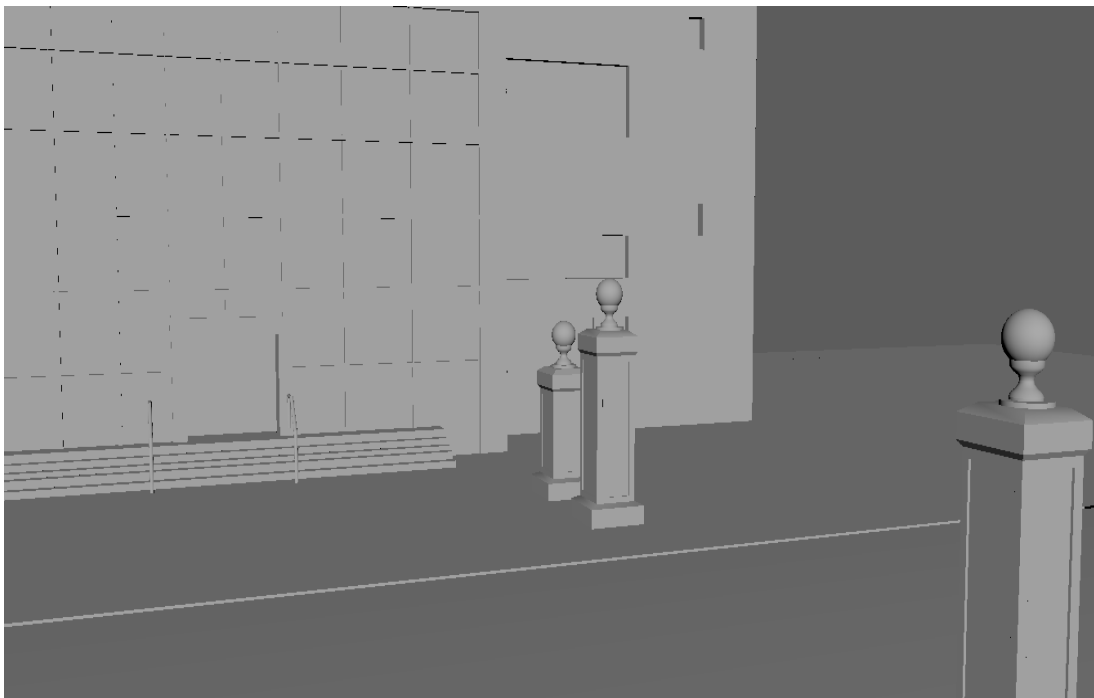
Figure 11: *3D Model of Portal West*

Figure 12: *3D Model of Silliman Church*

Figure 13: *Silliman3D Marker*

CHAPTER 5: Testing and Discussion

5.1 Description of Respondents

The survey was conducted for one week to a total of 30 respondents. Twenty (20) of them were conducted in Dumaguete City, three (4) in Sibulan, four (4) in Hinobaan, and two (2) in Cebu City. All of the respondents are not students or alumni of Silliman University. The questionnaire has two parts; identification and questions about the mobile application. In identification, respondents are asked to identify the buildings by name and location. In the questions about the application, respondents are asked to answer some questions related to the application's functionality and design. The respondents have tested the application using the developer's android device after answering the first part of the questionnaire.

5.2 Testing Administration

The survey that was conducted in Cebu City was made possible when one of the team members went to Talisay City, Cebu. The team member asked a few of his previous high school classmates to answer the survey and test the application.

Another team member went to Hinobaan, Negros Occidental. The team member asked a few of his relatives to answer the survey and test the application.

The rest of the survey was conducted in Negros Oriental. The team members contacted people they know that are non-Sillimanians and asked them if they could survey with them. Upon agreeing, immediately they set a time and place to conduct the survey.

Some of the respondents were faculty and students of Negros Oriental State University, Foundation University, and St. Paul University Dumaguete.

All of the surveys were conducted in each of the respondent's preferred venue.

5.3 Results

Figure 14 to Figure 16 are the results of the identification part of the survey questionnaire. These questions were answered before using the mobile application.
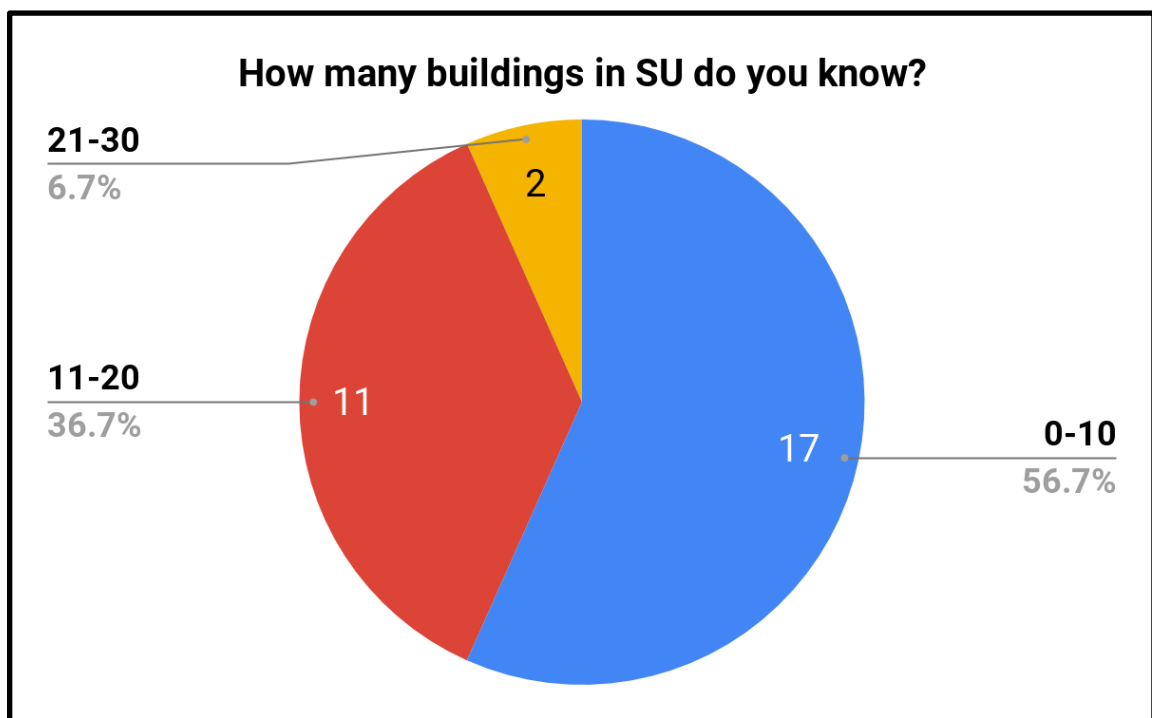
Figure 14: *The number of buildings that respondents know inside Silliman University.*

The figure above shows that the majority of the respondents know little to no buildings in Silliman University, based on the number of buildings that they marked in the

first part of the questionnaire (Figure 14). Seventeen (17) respondents (56.7%), which is more than half of the respondents answered that they only know zero (0) to ten (10) buildings inside Silliman University. Eleven (11) respondents (36.7%) answered that they only know eleven (11) to twenty (20) buildings in Silliman University. Two (2) respondents (6.7%) answered that they only know twenty-one (21) to thirty (30) buildings in Silliman University. There were no respondents that answered that they know more than thirty (30) buildings at Silliman University.
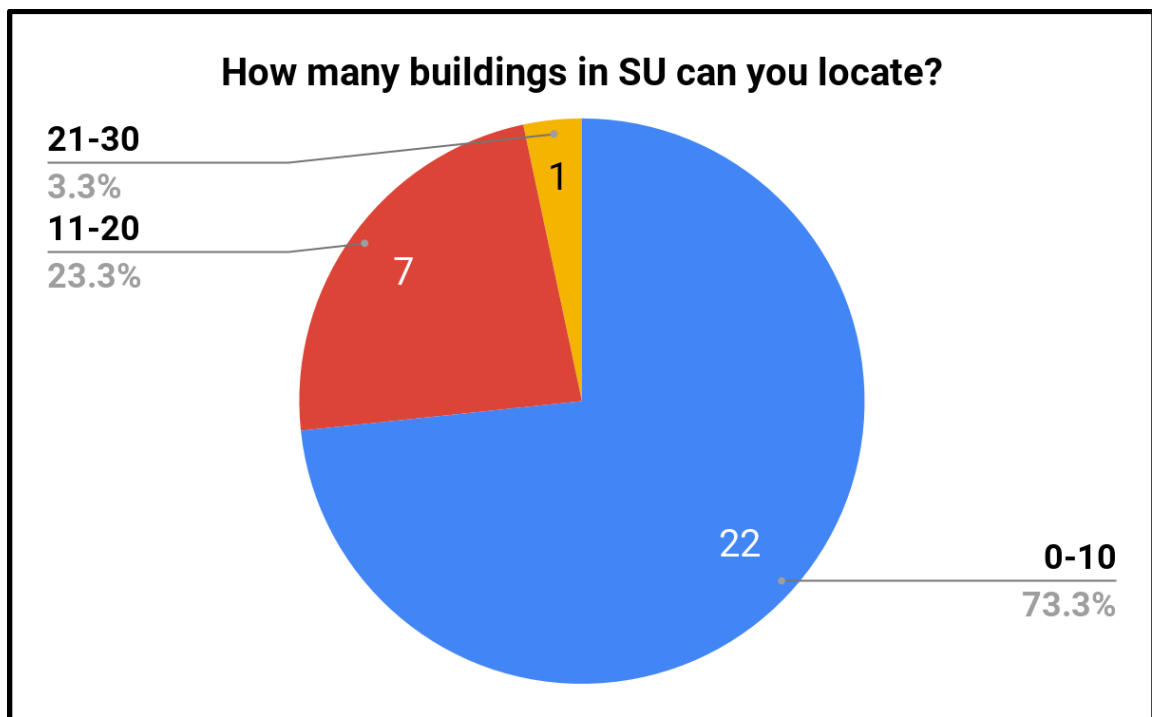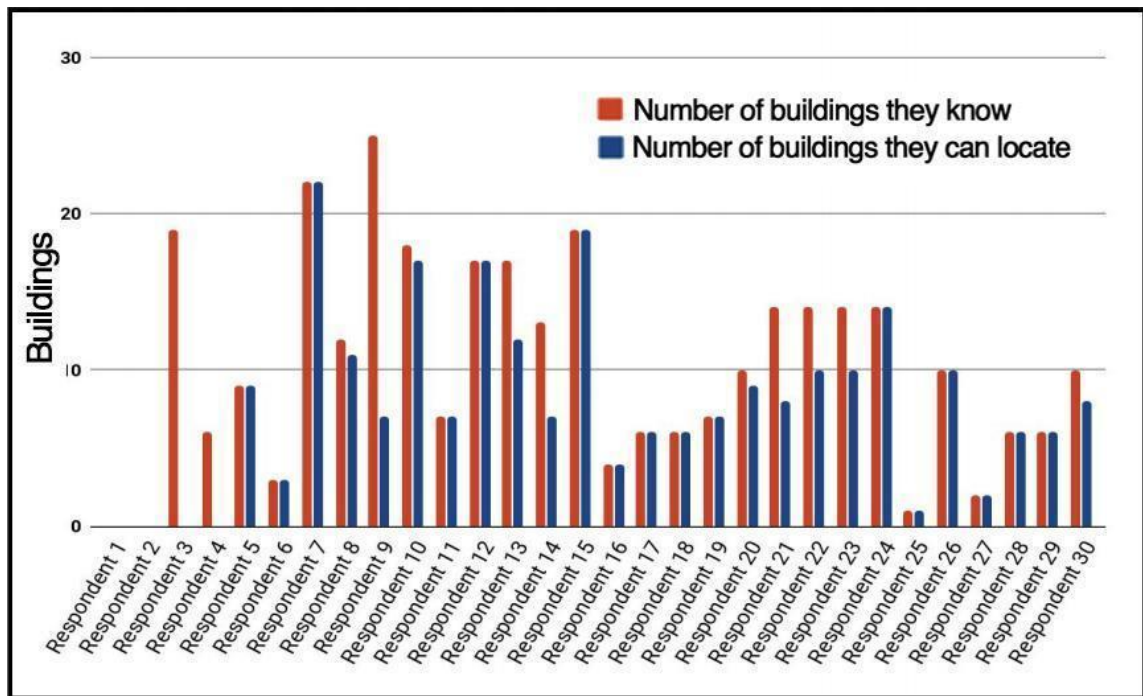

Figure 15: *The number of buildings that respondents are able to locate inside Silliman University.*

This figure (Figure 15) shows that the majority of the respondents can locate little to no buildings at Silliman University. Twenty-two (22) respondents (73.3%), which is more than half of the respondents answered that they can locate zero (0) to ten (10)

buildings inside Silliman University. Seven (7) respondents (23.3%) answered that they can locate eleven (11) to twenty (20) buildings at Silliman University. One (1) respondent (3.3%) answered that they can locate twenty-one (21) to thirty (30) buildings in Silliman University. There were no respondents who were able to locate thirty-one (31) or more buildings at Silliman University.

Figure 16: *The illustration that shows the number of buildings that the respondents know and the number of buildings that they are able to locate.*

In Figure 16, the difference between the number of buildings that all of the respondents know and the number of buildings that they can locate is shown. The value in the red bar is higher compared to the blue bar because most of the respondents only know the buildings by name and image. They were asked why that is so, and they replied that they are not familiar with the road inside the school and they might get lost going to the building that they only know by name. As shown in the illustration (Figure 15), it can be

concluded that most of the respondents only know the building by name or image but are not able to locate them.

Figure 17 to Figure 31 show results from the answers in the "About the Application" part of the survey questionnaire, these questions were answered after using the mobile application.

The next survey question was: *Do you think that using Silliman3D is an effective way of informing the users about the buildings of Silliman University Main Campus?*

Thirty (30) out of thirty (30) respondents answered yes to this question. Since all of the respondents are non-Sillimanians and most of them have no idea about the buildings of Silliman University, they have concluded after using that the application can help and guide users about the buildings of Silliman University, both in the buildings' structure and information.

After that, the next survey question was: *Do you think that Silliman3D gives the correct path in going around Silliman University Main Campus?*

Thirty (30) out of thirty (30) respondents answered yes to this question. All of them have tried the navigation feature of the application. They have carefully tested the feature and looked at the path generated by the application and see where it will go. After testing the feature, they concluded that the navigation feature is effective. They have also based their answers by comparing the map using the 3D Campus Display and Navigation feature. Non-Sillimanians from Dumaguete City added that the feature is helpful when touring around Silliman University.
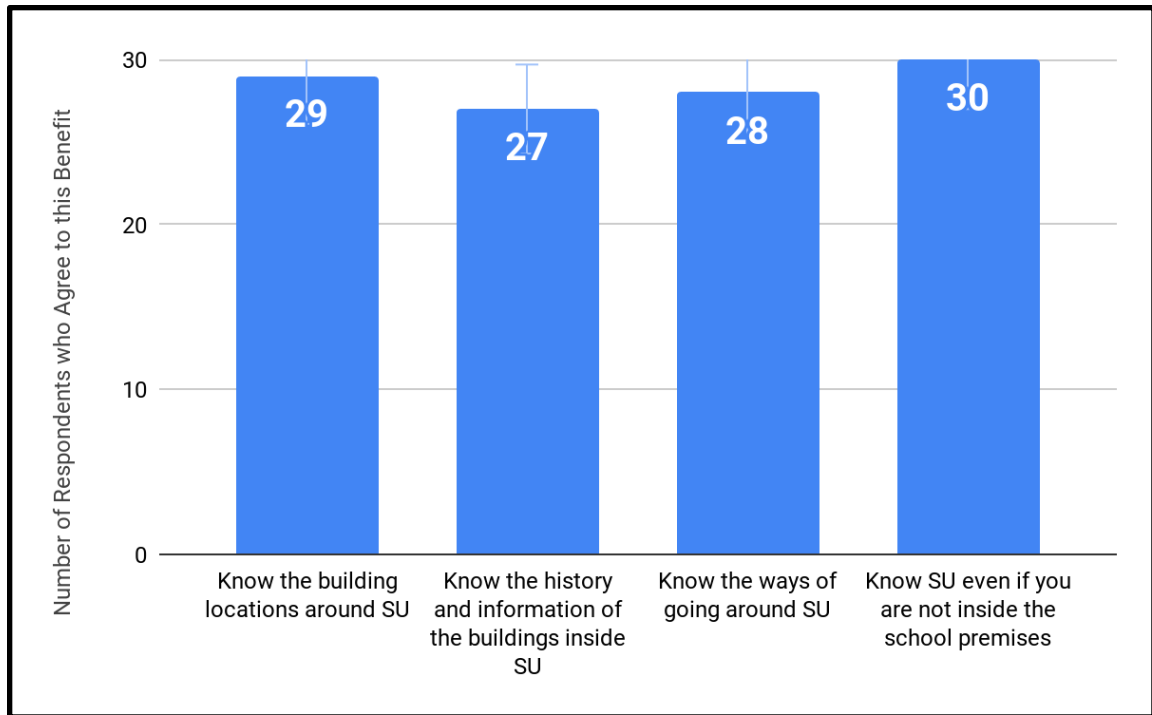
Figure 17: *The different benefits of using Silliman3D, according to the respondents.*

This figure (Figure 17) shows the different benefits of using Silliman3D. Respondents were asked to check one or more of the choices given. Based on the graph, most of the respondents agree that using Silliman3D is beneficial in such a way that one will know the building locations around SU, know the history and information of the buildings inside SU, know the ways of going around SU, and know SU even if one is not inside the school premises. This shows that most of the respondents agree that there are benefits when using Silliman3D.

After that, the next survey question was: *Do you think that new students of Silliman University will find Silliman3D helpful in their first days of class?*

Thirty (30) out of thirty (30) respondents agreed to this question. Most of them gave positive remarks, one of the respondents said, "*Gamit kaayo ni kung bag-o paka na*

studyante, especially before *ug* after *ka ma* enrolled" (This is very useful if you are a new student, especially before and after you get enrolled).

The last question of the survey was: *Do you think that non-Sillimanians will learn more about Silliman University when using Silliman3D?*

Thirty (30) out of thirty (30) respondents agreed to this question. Since they are all non-Sillimanians, they have indicated that after using the application, it gave them additional useful knowledge about the school even if they are not a Sillimanian or have never been to Silliman University.

After asking all questions related to each module of the application, the team then asked questions related to how respondents would rate the application based on its functionality and design.

Functionality

For this part of the survey, ten (10) statements that describe the functionality of the application were provided. The respondents were asked to rate each statement based on how much they agree or disagree with the said statement. Five (5) means that the respondents *strongly agree* with the sentence, four (4) means that the respondents *agree* with the sentence, three (3) means that the respondents feel *neutral* about the sentence, two (2) means that the respondents *disagree* with the sentence, and one (1) means that the respondents *strongly disagree* with the statement.
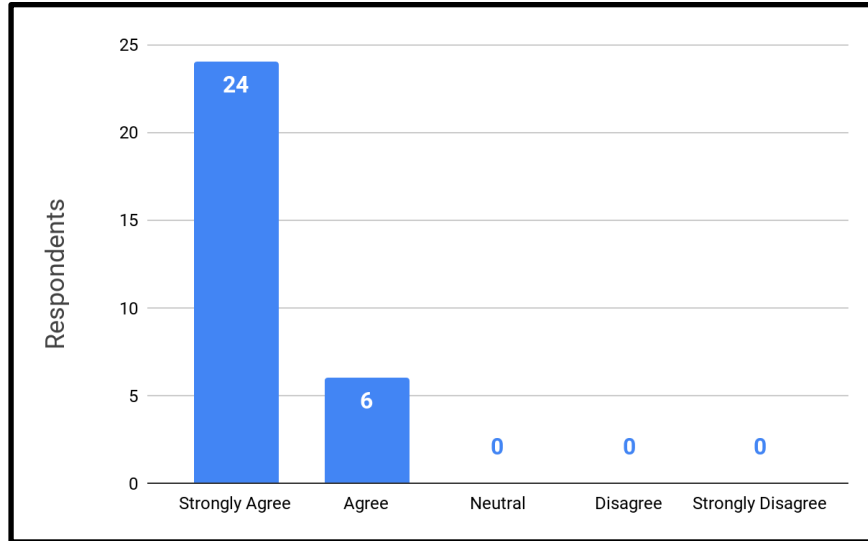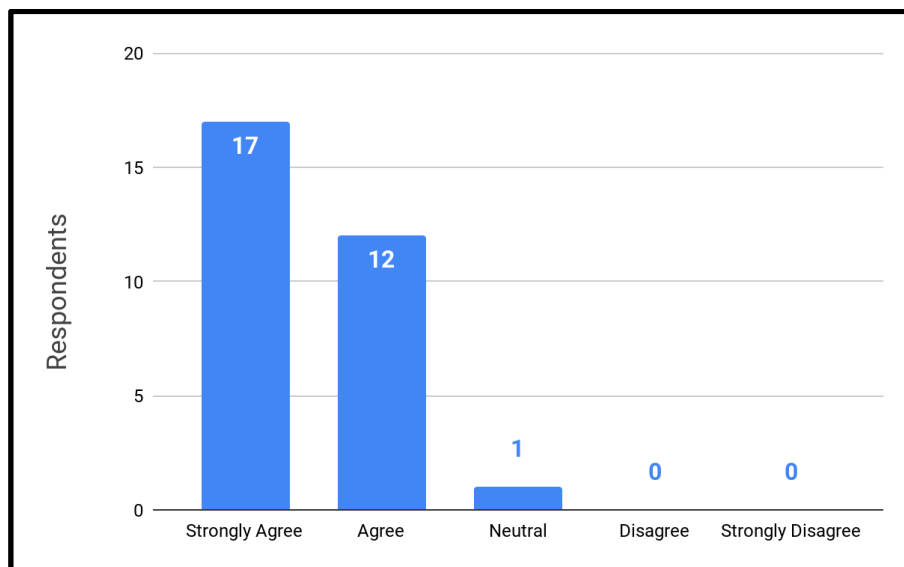
Figure 18: *Respondents who agreed and disagreed whether Silliman3D can be a medium for people to know more about Silliman University.*

All of the respondents agree that Silliman3D can be a medium for people to know more about Silliman University. Twenty-four (24) users answered *Strongly Agree,* while six (6) users answered *Agree* (Figure 18). This question serves as a guide for the team to know if reaching out non-Sillimanians to make them know more about Silliman University, using this mobile application is effective.
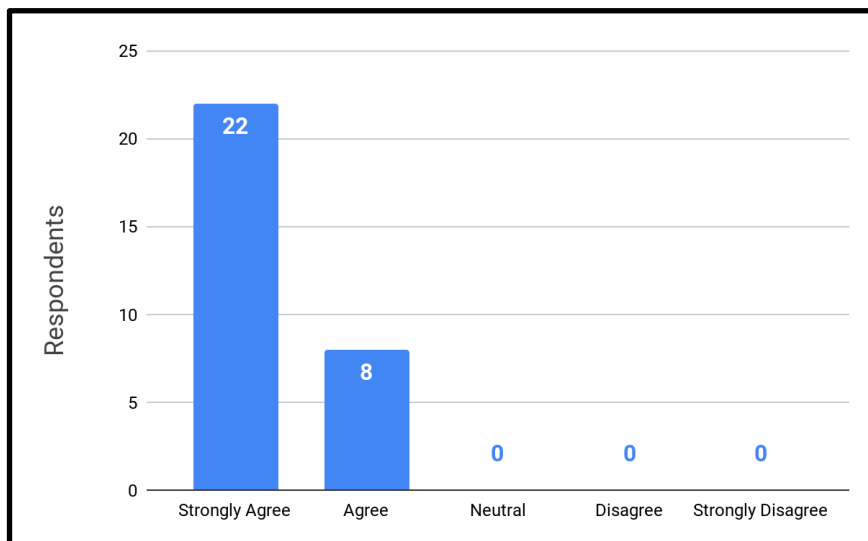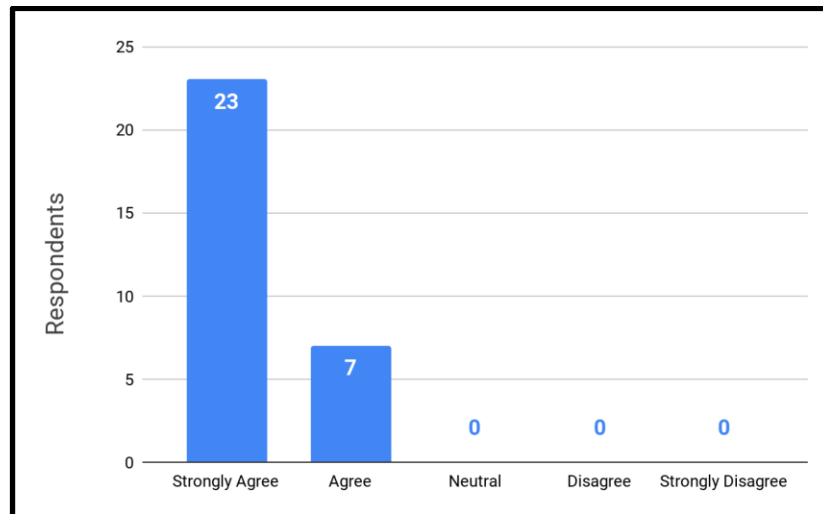
All of the respondents agree that Silliman3D can help those that are not physically present inside Silliman University to be familiar with the school. Twenty-two (22) users answered *Strongly Agree,* while eight (8) users answered *Agree* (Figure 19). By using the mobile application, respondents, whether they've been to Silliman University or not, agree that the mobile application will help them be familiar with the school.

Figure 20: *Respondents who agreed and disagreed that Silliman3D is beneficial to non-Sillimanians by making them know the different programs offered at Silliman University.*
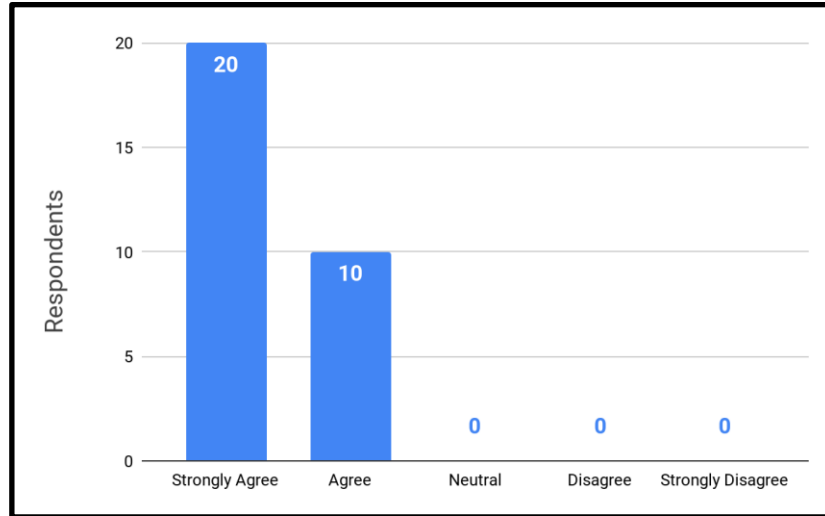
Most of the respondents agree that Silliman3D is beneficial to non-Sillimanians by making them know the different programs offered at Silliman University. Seventeen (17) users answered *Strongly Agree,* twelve (12) users answered *Agree,* while one (1) answered *Neutral* (Figure 20). The figure shows that almost half of those who do not *Strongly Agree*

to the question, which means there are still other more effective ways of informing people about the different programs offered by Silliman University, rather than using Silliman3D.

Figure 21: *Respondents who agreed and disagreed that Silliman3D is beneficial to non-Sillimanians by making them be familiar with the school grounds.*
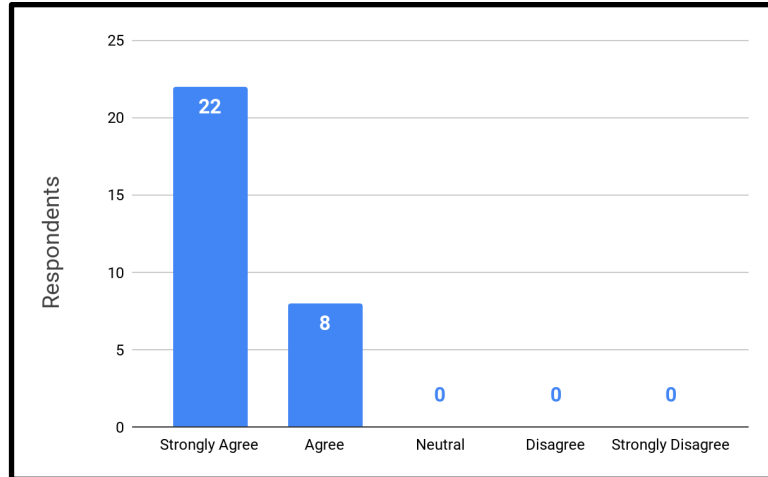
All of the respondents agree that Silliman3D is beneficial to non-Sillimanians by making them familiar with the school grounds. Twenty-three (23) users answered *Strongly Agree,* while seven (7) users answered *Agree* (Figure 21). Similar to Figure 18, the graph shows that Silliman3D can help even the non-Sillimanians to know more about Silliman University and the school grounds.

Figure 22: *Respondents who agreed and disagreed that Silliman3D is beneficial to non-Sillimanians by making them know about the school's history.*

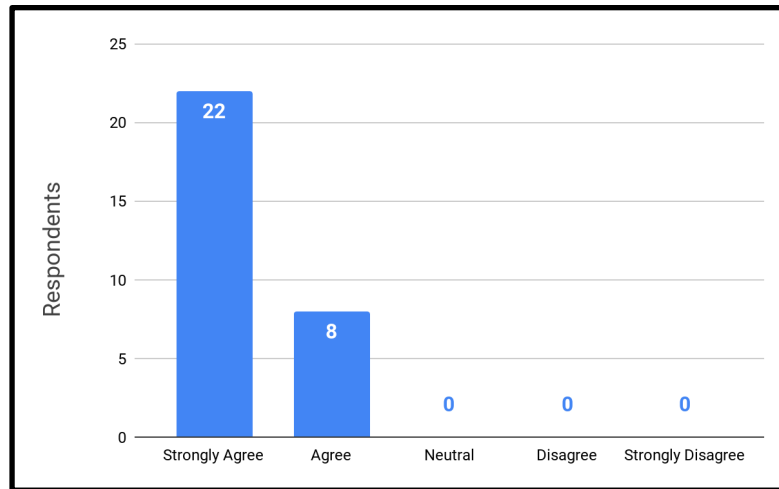All of the respondents agree that Silliman3D is beneficial to non-Sillimanians by making them know about the school's history. Twenty (20) users answered *Strongly Agree,* while ten (10) users answered *Agree* (Figure 22). Since the respondents are non-Sillimanians, some of the data shown to the respondents are proved to be correct by showing them legitimate sources of information. (E.g. Silliman University website)
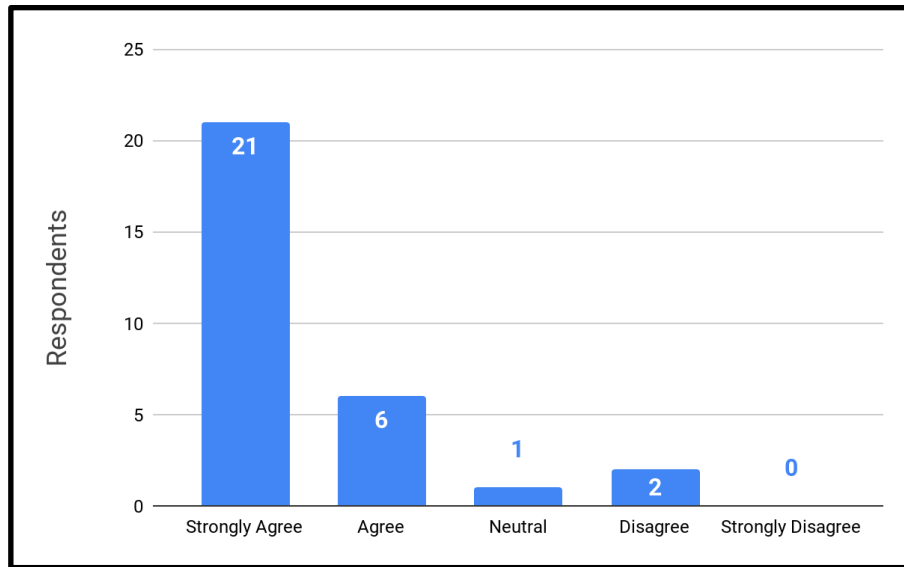
Figure 23: *Respondents who agreed and disagreed that Silliman3D's features can be well-understood.*

All of the respondents agree that Silliman3D's features can be well-understood. Twenty-two (22) users answered *Strongly Agree,* while eight (8) users answered *Agree* (Figure 23). This shows that most of the respondents have understood the features of the application.

Figure 24: *Respondents who agreed and disagreed that Silliman3D runs smoothly by indicating that the application does not freeze.*

All of the respondents agree that Silliman3D runs smoothly by indicating that the application does not freeze. Twenty-two (22) users answered *Strongly Agree,* while eight (8) users answered *Agree* (Figure 24). The application does not freeze, however, there are very few instances that the mobile device used during testing experiences a little mishap which causes an appearance that the application freezes. However, this little mishap is not caused by the application itself, but by the mobile device. (I.e. it could be that someone messaged the phone, a notification popped)
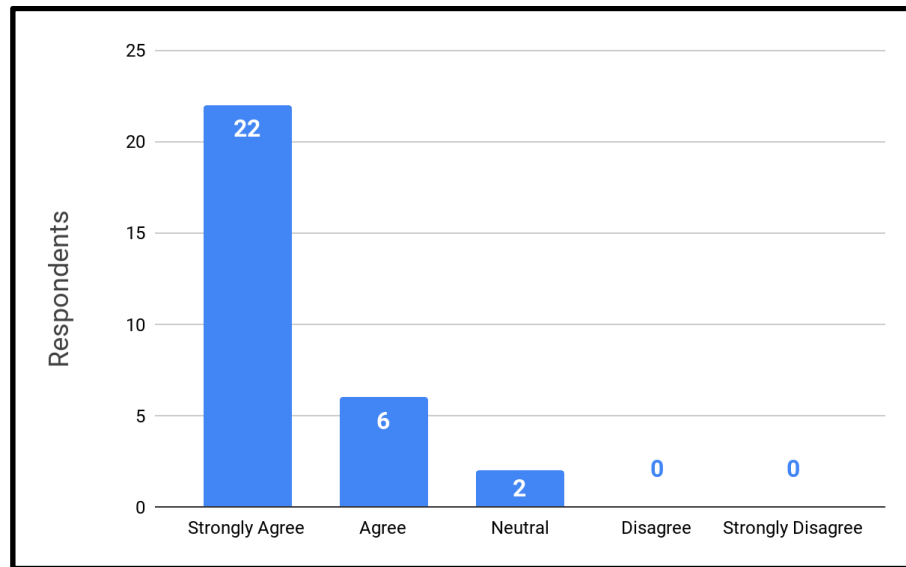
Figure 25: *Respondents who agreed and disagreed that Silliman3D runs smoothly by indicating that the application has no delay when clicking buttons.*

Most of the respondents agree that Silliman3D runs smoothly by indicating that the application has no delay when clicking buttons. Twenty-one (21) users answered *Strongly Agree,* six (6) users answered *Agree,* one (1) user answered *Neutral,* and two (2) users answered *Disagree* (Figure 25). Some buttons are a little bit small and need to be precisely pressed to work. There were some respondents whose fingers were not immediately detected by the phone and mobile application, so there it caused a delay.

Design

For this part of the survey, eight statements that describe the design of the application were provided. The respondents were asked to rate each statement based on how much they agree or disagree with the said statement. Five (5) means that the respondents *strongly agree* with the sentence, four (4) means that the respondents *agree* with the sentence, three (3) means that the respondents feel *neutral* with the sentence, two (2) means that the

respondents disagree with the sentence, one (1) means that the respondents agree with the statement.

Figure 26: *Respondents who agreed and disagreed that Silliman3D is designed in such a way that it is easy to navigate.*

Most of the respondents agree that Silliman3D is designed in such a way that it is easy to navigate. Twenty-two (22) users answered *Strongly Agree,* six (6) users answered *Agree,* while two (2) answered *Neutral* (Figure 26). Navigating around the application is easy because the UI doesn't require a lot of way-finding options.
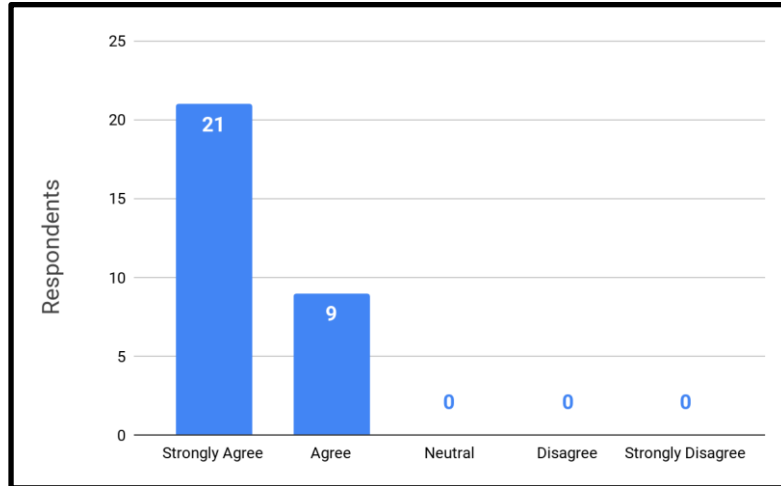
Figure 27: *Respondents who agreed and disagreed that Silliman3D contains clearly-marked way-finding buttons. (E.g. back, exit, etc.)*

All of the respondents agree that Silliman3D contains clearly-marked way-finding buttons. Twenty-one (21) users answered *Strongly Agree,* while nine (9) users answered *Agree* (Figure 27). The way-finding buttons of the mobile application are clearly shown in the interface and it is very easy to locate it. The button icons also have the correct designs and descriptions for easy navigation.
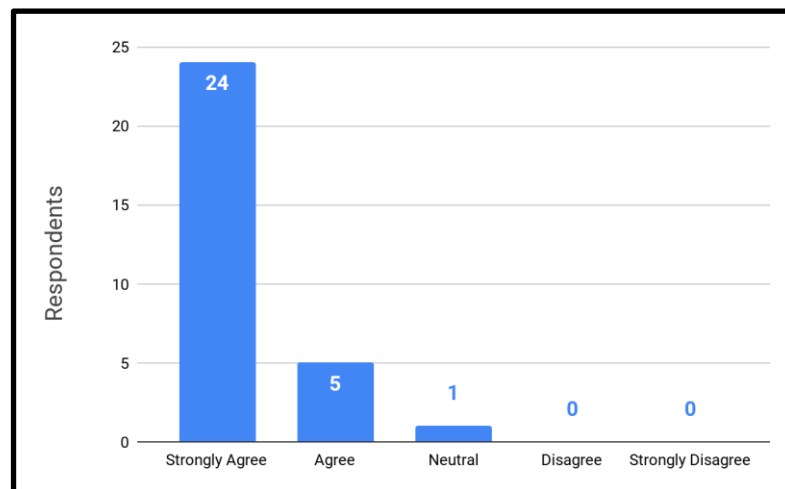
Figure 28: *Respondents who agreed and disagreed that Silliman3D's different features are united in look and feel.*

Most of the respondents agree that Silliman3D's different features are united in look and feel. Twenty-four (24) users answered *Strongly Agree,* five (5) users answered *Agree,* while one (1) user answered *Neutral* (Figure 28). We have matched the elements of the application depending on its placement and purpose, making it have a united look and feel. This reflects the result in the graph that most of the respondents answered *Strongly Agree* and *Agree*, although one (1) answered *Neutral.*
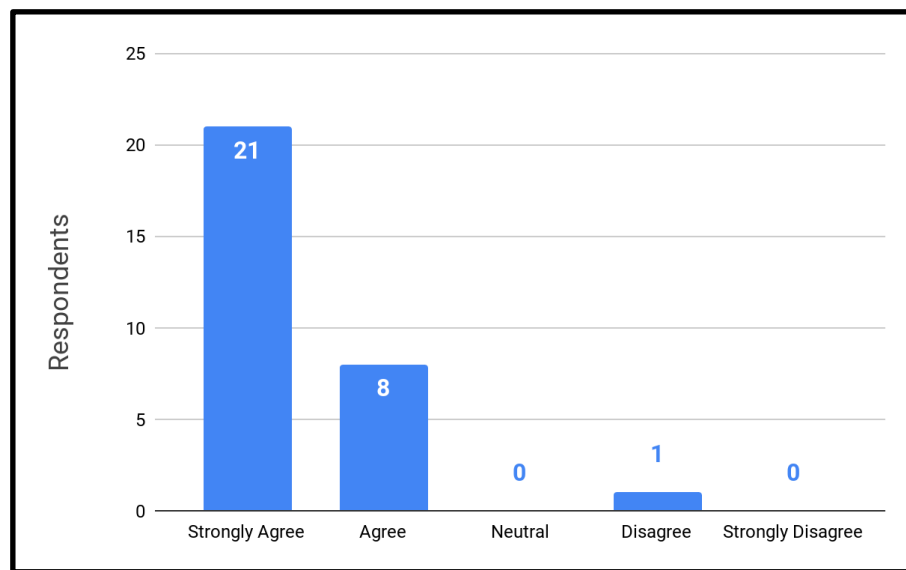
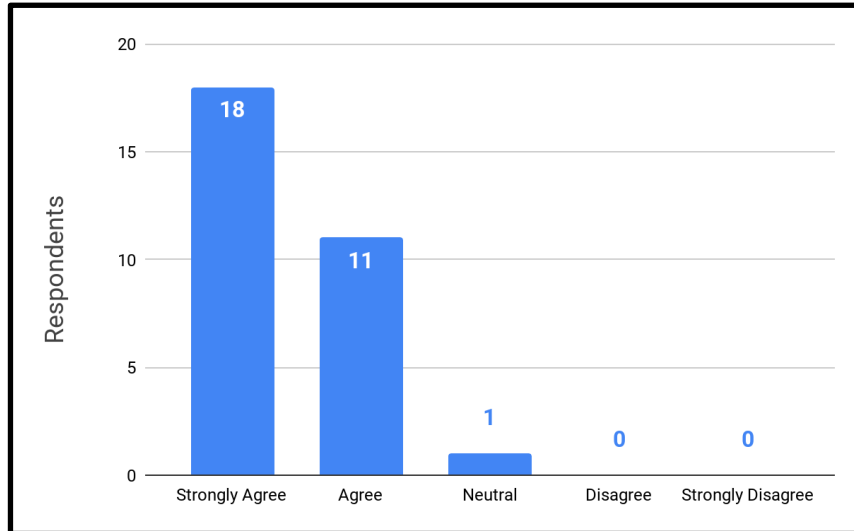

Figure 29: *Respondents who agreed and disagreed that Silliman3D's prompts for input are clear.*

Most of the respondents agree that Silliman3D's prompts for input are clear. Twenty-one (21) users answered *Strongly Agree,* eight (8) users answered *Agree,* while one (1) answered *Neutral* (Figure 29). While testing the application, respondents did not have a hard time going around the prompts for input, because the prompts for input in the mobile application are only a few.

Figure 30: *Respondents who agreed and disagreed that
Silliman3D's texts are readable and understandable.*

Most of the respondents agree that Silliman3D's texts are readable and understandable. Eighteen (18) users answered *Strongly Agree,* eleven (11) users answered *Agree,* while one (1) answered *Neutral* (Figure 30). The text in the application are displayed in bigger fonts and visible color so that users will be able to read it well, and this resulted is reflected in the graph.
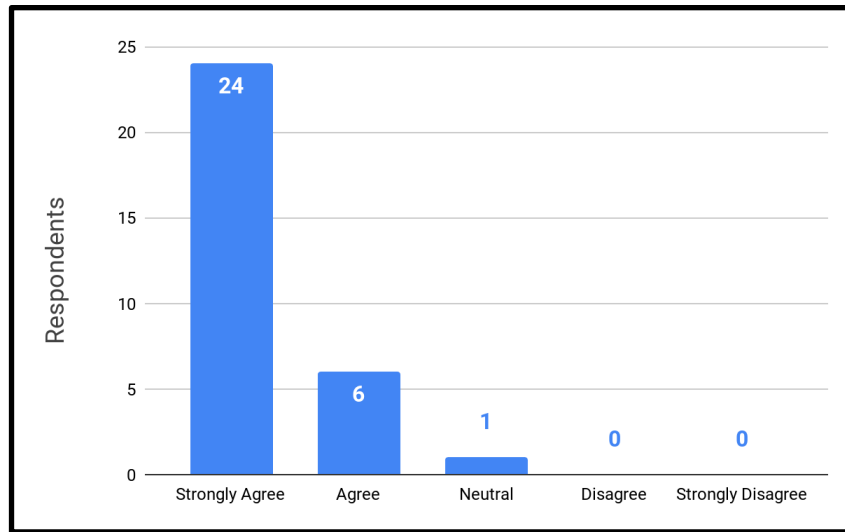
Figure 31: *Respondents who agreed and disagreed that Silliman3D's 3D buildings are clearly displayed.*

All of the respondents agree that Silliman3D's 3D buildings are displayed. Twenty-three (23) users answered *Strongly Agree,* six (6) users answered *Agree,* while one (1) answered *Neutral* (Figure 31). The buildings in the mobile application are modelled well with correct dimensions, they are also placed in a visible ground in the Display Campus feature, and this reflects the result in the graph.

5.4 Discussion

Based on the results of the survey, all modules of the mobile application is functioning as expected. The 3D campus can be clearly seen on the mobile device. Moreover, the user can effortlessly drag the 3D campus and change its camera angle all around it. Some buttons will change the angle of your perspective of the 3D campus to see it clearly. This shows that the Display Campus feature is working.

When clicking the buildings, the correct names of the buildings are displayed. The building information was also accurate as the information of the buildings was up-to-date and legitimate. The history was also accurate as it was gathered from SU Library and from the buildings itself. This shows that the Building Information feature is working.

Finally, the Navigation feature works well too. Everyone who tried the Navigation feature did not encounter a problem using it. They have even left remarks that mean that this feature is very useful when going around Silliman University, especially with the fact that there is no marker needed when using the feature.

CHAPTER 6: Summary, Conclusion, and Recommendation

6.1 Summary

The project Silliman3D is a 3D augmented reality application that is developed for Android users. The project aims to give users an experience of Silliman University by having a 3D model of the school be displayed right in their Android mobile devices; give them history, information and details regarding the different buildings around the school; and generate a path to navigate the way of going around the school from building to building.

The mobile application has six features namely; Display Campus, Building Information, Building List, Pan-Zoom-Rotate, Navigation, and Export Marker. The Display Campus feature allows the users to see the main campus of Silliman University in a 3D model. The users have the option to pan, rotate, and zoom in around the 3D campus. The 3D model can only be displayed if the printed SU3D marker is visible to the camera. The Building Information can be accessed by clicking a building then clicking the Information Button. The Building list can be accessed by clicking the Display Building List button. Panning, zooming, and rotating the 3D campus can be done using different finger gestures. Navigation can be accessed by clicking the navigation button then clicking two different buildings around the campus. Finally, the Export Marker can be done by clicking the Export Button, which immediately exports the Marker File inside your mobile application.

The developers of the application used C# as the programming language. The tools used to develop the application were Unity, Autodesk Maya, Microsoft Visual Studio, and Vuforia.

The survey was done in a week to 30 respondents who are non-Sillimanians. The mobile application was tested by all 30 respondents before answering the survey questions. The survey was conducted in the provinces of Negros Oriental, Negros Occidental, and Cebu.

6.2 Conclusion

Based on the survey results, the development of Silliman3D was successful. The testing of the mobile application and survey proved that the mobile application developed by the team is working and error-free. There were no problems that occurred while conducting the survey.

The objectives that were set before the development of Silliman3D are all met. Thus, the team can conclude that Silliman3D is now ready for implementation.

6.3 Recommendations

The team recommends the user to have a clear camera, clearly-printed marker, and a bright environment while using the application so that there will be no problem when using the application. Lastly, the team recommends for Silliman3D to be uploaded to the Google Play Store, in that way people will download the application when they need to learn about Silliman University.

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Appendices

Appendix A:
Questionnaire for the Survey

October 30, 2019

Dear Respondent,

We are senior Bachelor of Science in Information Technology students from the College of Computer Studies at Silliman University who are currently in post-implementation stage for our Capstone project entitled, "SILLIMAN3D: A 3D Augmented Reality Mobile Application of Silliman University Main Campus". This is developed for people around the world to know more about the location, history and information of the buildings around Silliman University. We are conducting this survey to get feedback from different users that could be of great help for further improvement of our developed mobile application.

Your participation in this project by way of evaluating the mobile application and answering the questionnaire is very vital. The honest responses we generate will certainly help in the success of this endeavor. Please be assured that your anonymity and the information you give us will be treated with utmost confidentiality and will only be used for this purpose.

Thank you very much for your kind response to this request.

Sincerely,

Agustin Vicente Bas
Researcher

Kent Aldrich Kho
Researcher

Darey Tanoco
Researcher

Noted by:

Asst. Prof. Janice Antoniette V. Förster
Adviser

Approved by:

Asst. Prof. Allan V. Credo
Chairperson, Panel

Asst. Prof. Albert Geroncio Y. Rivera
Member, Panel

Asst. Prof. Jonathan Mark N. Te
Member, Panel

Name (Optional): _____ Age: _____
Date: _____ Survey Test Location: _____
Affiliation: _____

I. PROFILING. This portion should be answered before testing the application. Provide a ✓ on the space provided.

	Do you know this building?	Can you locate this building?
Science Complex	☐	☐
Ethel Chapman Hall	☐	☐
Silliman Library	☐	☐
Luce Auditorium	☐	☐
Silliman Hall	☐	☐
Hibbard Hall	☐	☐
Silliman Church	☐	☐
Alice Fullerton Hall	☐	☐
SU Multimedia Center	☐	☐
CBA Building	☐	☐
Magdamo Hall	☐	☐
Rodriguez Hall	☐	☐
McKinley Hall	☐	☐
Roble Hall	☐	☐
COPVA I	☐	☐
COPVA II	☐	☐

Building		
Ariniego Art Gallery	☐	☐
Angelo King Building	☐	☐
Magbanua Hall	☐	☐
Oriental Hall	☐	☐
Occidental Hall	☐	☐
Olivia Villaflores Yanson Hall	☐	☐
William Barry Thompson Hall	☐	☐
ND Department	☐	☐
Emilio Yap Hall	☐	☐
Uytengsu Computer Studies Hall	☐	☐
Villareal Hall	☐	☐
Ausejo Hall	☐	☐
Udarbe Chapel	☐	☐
Katipunan Hall	☐	☐
SU Computer Center	☐	☐
Mary Marquis Smith Hall	☐	☐
Schiede Chapel	☐	☐
Chapel of the Evangel	☐	☐
Instructional Media and Technology Center	☐	☐
Medical School Building	☐	☐
SUMC Main Building	☐	☐
SUMC Medical Arts Building	☐	☐
Col. Roman T. Yap Hall	☐	☐

Building		
Alumni Hall	☐	☐
Charles Bachelor Building	☐	☐
Cicero D. Calderon Hall	☐	☐
Uytengsu Hall	☐	☐
Leopoldo T. Ruiz Building	☐	☐
Information Booth	☐	
Alumni-Donated Classrooms	☐	☐
Portal East Building	☐	☐
Portal West Building	☐	☐
Mariano and Lina Lao Activity Center	☐	☐
SU Buildings and Grounds Office	☐	☐
High School Two-Storey Building	☐	☐
High School Main Building	☐	☐
New SU Elementary School Building	☐	☐
SU Elementary School North Wing	☐	☐
SU Elementary School West Wing	☐	☐
SU Elementary School East Wing	☐	☐

Out of the buildings that you have provided a ✓, how many of these buildings' history and information are you familiar with?
(History: e.g. date constructed, who donated it. Information: e.g. offices inside, official full names.)
(If you **have not** provided a ✓ to any of the buildings, then select "0-10")

___ 0-10   ___ 10-20   ___ 20-30   ___ 30-40   ___ 40-50   ___ 50-60

II. ABOUT THE APPLICATION. This portion should be answered after testing the application.

A.) Provide a ✓ on the space provided before your answer.

1. Do you think that using Silliman3D is an effective way of informing the users about the buildings of Silliman University Main Campus?
___ Yes   ___ No

2. Do you think that Silliman3D gives the correct path in going around Silliman University Main Campus?
___ Yes   ___ No

3. What are the benefits in using Silliman3D? (You may check more than one)
☐ Know the building locations around SU
☐ Know the history and information of the buildings inside SU
☐ Know the ways of going around SU
☐ Know SU even if you are not inside the school premises
☐ Others, please specify: _____

4. Do you think that new students of Silliman University will find Silliman3D helpful in their first days of class?
___ Yes   ___ No

5. Have you learned something while using Silliman3D?
___ Yes   ___ No

B.) FUNCTIONALITY

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. Silliman3D can be a medium for people to know more about Silliman University.	5	4	3	2	1
2. Silliman3D gives me the correct path in going to my desired location inside the school.	5	4	3	2	1
3. Silliman3D shows the correct information and history about the buildings inside Silliman University.	5	4	3	2	1
4. Silliman3D can help those that are not physically present inside Silliman University to be familiar with the school.	5	4	3	2	1
5.Silliman3D is also beneficial to you because:					
a. You will know the different programs offered by Silliman University.	5	4	3	2	1
b. You can be familiar with the school grounds.	5	4	3	2	1
c. You will know the school's history.	5	4	3	2	1
6. The application's features can be well-understood.	5	4	3	2	1
7. The application runs smoothly:					
a. The application does not freeze.	5	4	3	2	1
b. There is no delay when clicking buttons in the application.	5	4	3	2	1

C.) DESIGN

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. The application is designed in such a way that it is easy to navigate.	5	4	3	2	1
2. The application's buttons, boxes and text are placed well.	5	4	3	2	1
3. The application's design works well together with its features. (e.g. displaying information, navigation, displaying the 3D buildings)	5	4	3	2	1
4. The application contains clearly marked way-finding buttons. (E.g. Back, Exit, etc.)	5	4	3	2	1
5. The different features of the application are united in look and feel.	5	4	3	2	1
6. The prompts for input are clear.	5	4	3	2	1
7. The application's text are readable and understandable.	5	4	3	2	1
8. The 3D buildings are clearly displayed.	5	4	3	2	1

Appendix B:
Ethics Committee Sub-Committee Review

WILL ATTACH ORIGINAL COPY HERE IN PRITNTED VERSION

UNIVERSITY RESEARCH ETHICS COMMITTEE
SILLIMAN UNIVERSITY
6200 Dumaguete City
Philippines

Sub-Committee Review
November 13, 2019

Principal Investigator	Agustin Vicente Bas, Aldrich Kent Kho, Darey Tanoco		
Date Submitted:	October 7, 2019	**Department**	BSIT
Semester:	1st Semester 2019-2020		
Research Title	SILLIMAN3D: A 3D AUGMENTED REALITY MOBILE APPLICATION OF SILLIMAN UNIVERSITY MAIN CAMPUS		
	November 13, 2019	**Venue:** UREC Office	
Sub-Committee Members	Prof. Cyflor Putong Dr. Robert S. Guino-o		

	Full Review Sub-committee	X	Approved		Non-Coverage
X	Expedited Review		Deferred		

SEE ATTACHED

This is to certify that the Ethics Committee has reviewed the proposal.

	Dr. Karl James E. Villarmea	November 13, 2019
	Print Name & Signature	Date

/file

Appendix C:
Informed Consent Form

RESEARCH INFORMED CONSENT FORM

Title

This study is titled Silliman3D: A 3D Augmented Reality Mobile Application of Silliman University Main Campus in partial fulfillment of the requirements for the degree Bachelor of Science in Information Technology.

Researcher

This study is to be conducted by Agustin Vicente Bas, Darey Tanoco, and Kent Aldrich Kho who is pursuing the degree in Bachelor of Science in Information Technology at the College of Computer Studies, Silliman University, with Asst. Prof. Janice Antoniette V. Forster as the adviser. The researcher can be contacted through this mobile number 09260019065 or email address agustingbas@su.edu.ph.

Purposes of the Research

This study aims to find out the following: to provide an Android mobile application that will be an avenue where people will be able to see what is inside Silliman University.

Description of the Research

This study is non-experimental and the data will be gathered through survey questions within 7 months.

Potential Benefits

This study will benefit the users in terms of the following: be familiar with Silliman University's building locations, know the ways navigating around Silliman University, and receive information, history, details and even the available programs of certain buildings around the school.

Confidentiality

In the conduct of the study, full confidentiality will be assured. No information that discloses your identity will be released or published without your specific consent to the disclosure and only imperatively necessary.

Storage and Disposal of Data

The materials that contained the raw information derived from you will be destroyed after data processing within a given period.

Publication

The results of this study may be published in any form for public and scholarly consumption or used in classroom instruction to enrich learning and generate more knowledge for future research.

Participation

Your participation in this study must be voluntary, and you have the right to withdraw if you feel uncomfortable in the process of gathering information from you.

Informed Consent

Given the information above, I confirm that the potential harms, benefits and alternatives have been explained to me. I have read and understood this consent form, and I understand that I am free to withdraw from my involvement in the study any time I deem it to be necessary or to seek clarifications for any unclear steps in the research process. My signature indicates my willingness to participate in the study.

Printed Name and Signature of the Research Participant	Date

Appendix D:
Letters to Offices

Agustin Bas
College of Computer Studies
Silliman University
agustingbas@su.edu.ph

June 20, 2019

Engr. Edgar S. Ygnalaga Jr.
Superintendent, Buildings and Grounds Department
Silliman University
Dumaguete City, Negros Oriental

Dear Mr. Ygnalaga,

We are senior Information Technology students from the College of Computer Studies department of Silliman University. We are currently in the process of developing a mobile application for the school, the application is called Silliman3D: A 3D Augmented Reality Mobile Application of Silliman University Main Campus.

In order to completely develop the application, we are asking permission from your office if we could acquire the exact dimensions of the different buildings located inside the main campus; this includes the College Grounds, East Quadrangle and the High School Grounds. In addition, we will also ask for a blueprint of the school's main campus.

Please let us know if you have inquiries about our application. Your participation in this project is greatly appreciated.

Respectfully yours,

Agustin Bas
Silliman3D

Noted by:

Darey Tanoco   Kent Kho
Silliman3D   Silliman3D

Asst. Prof. Janice Forster
Silliman3D – Content Adviser

Agustin Bas
College of Computer Studies
Silliman University
agustingbas@su.edu.ph

June 20, 2019

Ms. Melita C. Aguilar
Director, Office of Information and Publications
Silliman University
Dumaguete City, Negros Oriental

Dear Ms. Melita,

We are senior Information Technology students from the College of Computer Studies
department of Silliman University. We are currently in the process of developing a mobile
application for the school, the application is called Silliman3D: A 3D Augmented Reality Mobile
Application of Silliman University Main Campus.

In order to completely develop the application, we are asking permission from your office if we
could publish information about Silliman University to our application. We will be publishing
information about; the school in general, the buildings' history, description, details and offered
college programs (if there is any). We will also release a map of the Silliman University main
campus, which includes the College Grounds, East Quadrangle, and the High School Grounds.

Upon submission of this letter, we will be sending our initial project documentation to
oip@su.edu.ph. We will also send our final documentation once the application is fully
developed. Please let us know if you have inquires about our application. Your participation in
this project is greatly appreciated.

Respectfully yours,

Agustin Bas
Silliman3D

Noted by:

Darey Tanoco   Kent Kho
Silliman3D   Silliman3D

Asst. Prof. Janice Forster
Silliman3D – Content Adviser