**CHAPTER 2**

**REVIEW OF RELATED LITERATURE**

This chapter provides related topics and studies about the concept of interactive mapping. Also, this chapter covers past researches in the context of interactive mapping in the scope of universities, MSU-IIT in particular. Technologies and principles used will be tackled in the succeeding part of this chapter.

## **Interactive Map**

Interactive maps can be a great way of displaying useful information in an engaging and attractive way by inviting the user to take action. This technology has given a lot of websites an ability to embed the map on their web pages and use it according to their purpose. It is an additional tool or feature in providing information especially on different academic institutions and businesses (Eder, Nocete, Rances, Tarrosa, Yanson, 2015). These help in keeping visitors engaged and can demonstrate information relevant to the institution in several ways. Interactive maps are also always up to date (Three Scale, 2014).

### **Studies on Using Interactive Maps in Universities**

Roth et al. (2009) presented two web-based interactive maps of the University of Wisconsin-Madison campus: The University of Wisconsin-Madison Interactive Campus Map and the Lakeshore Nature Preserve Interactive Map. Although the two projects represent the same university campus, the former follows a wayfinding-based model of campus mapping while the latter follows an atlas-based model of campus mapping. The purpose of the University of Wisconsin-Madison Interactive Campus Map is to search for, navigate to, and retrieve information about specific features on campus. The purpose of the Lakeshore Nature Preserve Campus Map is to present the rich history and unique geography of the University’s Lakeshore Nature Preserve. The interactive, online development of these maps follows the broader university transition to digital media for retrieving information and organizing student activities. Although both maps represent the same campus, the two interactive, online maps take two distinct approaches to campus mapping. We describe these two different approaches as a wayfinding-based model and an atlas-based model of campus mapping. As demonstrated through the two examples, both approaches can produce a useful and engaging tool.

Also, Roth (2013) provided a review of the current state of science regarding cartographic interaction, a complement to the traditional focus within cartography on cartographic representation. Cartographic interaction is defined as the dialog between a human and map, mediated through a computing device, and is essential to the research into interactive cartography, geovisualization, and geovisual analytics (Roth, 2013). The review is structured around six fundamental questions facing a science of cartographic interaction: (1) what is cartographic, (2) why provide cartographic interaction, (3) when should cartographic interaction be provided, (4) who should be provided with cartographic interaction, (5) where should cartographic interaction be provided and (6) how should cartographic interaction be provided. The review showed how traditional and interactive maps differ so much from each other. It is really suggested to create an interactive map based on the science of cartographic interaction.

Similarly, Eder et al. (2015) developed a web-based interactive campus map using the Google Maps API. Availability of the overlay function has been taken advantage to create custom map functionalities. Collection of building points were gathered for routing, and to create polygons which serves as a representation of each building. Storing data about the building, room, and staff information, and university events and campus guide are among the primary features that their study has to offer. The campus map is open to constant updates, user-friendly for both trained and untrained users, and capable of responding to all needs of users and carrying out analyses. Based on the data gathered through questionnaires, researchers analyzed the results of the test survey and proved that the system is user friendly, deliver information to users, and the important features that the students expect.

Moreover, Nikoohemat (2013) implemented comprehensive indoor navigation systems that not only needs technology platform but also cartographic and well-designed maps especially for mobile devices. A set of thirty (30) respondents composed of students and staff were asked to answer an exploratory survey. The focus group of the survey are campus map users, staff and students. Some of these students were familiar with the campus and some are not. The survey was also answered by students from other universities who were just enrolled in the campus for one semester and experienced being in different campuses. The survey questionnaire consisted of 20 questions and were distributed in printed form among focus group.

The study concluded several points from its survey. One of which was that finding lecture rooms is the most important functionality in the application followed by routing, finding points-of-interests and staff’s offices in undetermined order. Another point was students preferred 2D maps than 3D maps, preferably without captions. Additionally, using background maps and images has less significance to students to which they prefer better functionality than design for the application. Lastly, reliability and fast loading were the key factors for the importance of the smart campus map.

## **Local Existing Virtual Maps**

Through an extensive collection of related studies, the project developers obtained the following studies that were developed in the local setting. On this part, the developers will comprehensively tackle the methodology introduced by each existing system with a short evaluative summary at the end of this chapter.

### **Lakbay IIT: 3D Virtual Tour of MSU-IIT Campus**

A 3D environment is one that exists in three dimensions and is capable of being moved around in and explored. Campus virtual tours are becoming popular in the websites of many colleges, universities and organizations. It has become a favored medium of communicating to prospective students since it will provide useful information about the campus to the prospective students, parents and any interested party.

In a study conducted by Campil et al. (2010), the problem they faced were (1) exploration of the campus was limited because the campus was presented in 2D graphics, (2) prospective students are not given the opportunity to explore the campus in detail before actually going there, (3) guides around the campus are not enough to help the students with directions from a location to another and (4) students seldom experience several inconveniences during times of enrolment. Preliminary interviews claimed that although there were guides (e.g. maps, signage, posts) found around the campus, those will not still be enough because people, in general, do not give much attention to those kinds of guides. Most of them were not familiar with the buildings and others don't have the resources to visit before busy days (e.g. enrollment, clearance signing).

To address this problem, the researchers developed a desktop application that shows a 3D virtual map of MSU-IIT. This map will enable students to visit different 3D rendered buildings around the campus. However, their application required standard computer unit or device capable for 3D visualization. 3D visualization requires heavy computer specifications. particularly processor speed, graphics processing speed and memory capacity. A prototype was developed but was limited to desktop use only. The prototype only included individual buildings (e.g. Main Library, College of Business Administration and Accountancy, College of Engineering, College of Education, College of Science and Mathematics. School of Computer Studies and the MSU-IIT Gymnasium).

A set of thirty (30) respondents were asked to evaluate the system. These are students of the campus. These users are limited to navigating the map, generating reports and viewing information. The researchers conducted a usability test during and the development phase of the system. Three sets of questionnaires were given to the respondents. These are the pre-test, post-task and post-test questionnaires. The pre-test questionnaire was used during the session introduction to verify the qualifications of the participants and gather additional background information to interpret test data.  The post-task questionnaire was used to capture the participants’ perception of the task’s difficulty and to gather relevant comments where applicable.  The posttest questionnaire should capture the participant’s overall perception of the system’s usability and specific perception.  User sentiment was also considered during the system test.

The researchers also conducted a usability test after the development phase of the system. The observations gathered during the first system test were recognized and changes were made in the system. The users’ sentiments during the first system test were also addressed causing significant changes to the system’s usability.

After the tests were conducted, the researchers were able to find out the participants’ overall and specific perception of the system’s usability.

In conclusion, recommendations were formulated by the researchers, to wit: (1) Additional collision detection on walls, gates, and other objects, (2) Enhancement of the texture of models, (3) Inclusion of minute details like room numbers, bulletin boards, cars, computer, etc., (4) Additional exploration modes like guided tour mode and walk mode, (5) Additional human model for a 3rd person point of view, (6) Additional clickable mini map feature, (7) Optimization of the system for better performance, (8) Additional full screen feature, (9) Improvement on sky limitation, (10) Additional mouse hover labels of rooms and buildings, (11) Inclusion of shortest path feature, (12) Additional pop-up bubble of building or college information and (12) Additional current location indication.

### **Suroy Iligan: A Web-based Virtual Tour of Iligan City**

Many locals and tourists want to discover and explore Iligan City but lack the information of famous places to visit. If they do, it seems to be some common tourist spot. There are tourists who want to check the place first by looking at multimedia elements, such as photographs and videos before visiting the place. They want to have familiarity with what experience these tourist spots can give them. These tourists depend mainly on what the Internet can provide.

Bala et al. (2012) stated that the problem is that the Iligan City tourism website does not have these elements that would give the tourist information about tourist spots and encourage them to visit.

To address this problem, the researchers focused on creating a web-based tour where one can explore the place and give users a first-hand preview on their possible experience if they visit the place. The functionality of the project includes Google Maps integration where locations and information of the places where provided, such as the entrance fees and business hours. The system also aimed to develop a virtual tour of the top inns, restaurants and attractions of Iligan City as recommended by the city tourism office. The system gathered data that are provided by brochures, tourist guides and web pages. The system is easy to use and will aid tourists in finding exact locations of some tourist spots in the city. Every spot has its own location, description, pictures and animations. Panoramic views of suggested places are shown to help tourists have an idea about the spot. The system gives an overview of different destinations that tourists wanted to know about. The aim of the system is to supplement the existing tourism website of the city. The system is an interactive environment where users can explore a panoramic representation of different spots in the city.

A set of thirty-five (35) respondents were asked to evaluate the system. The researchers considered the effectiveness of the system to the intended users (locals and tourists). The researchers first showed a prototype to the client and proceeded to Alpha testing. They did some tests and checked all the features of the system and defined those that did not function properly. Beta testing followed in which the researchers let the respondents use and explore the system. The respondents then were given questionnaires to answer. The questionnaires include evaluation on how reliable the system is in providing information about the city. It then served as a guide for the researchers to determine the needed improvements based on the locals’ and tourists’ feedback and attitude towards the system. The questionnaire was composed of different categories: (1) Ease of Use, (2) Content, (3) Technical Aspect and (4) Usability.

In conclusion, recommendations were formulated by the researchers such as: (1) Make the system kiosk-ready, (2) Make it dynamic by adding backend functionalities, (3) Include places that are not commonly visited, (4) Make panoramic views in hotels, (5) Include big hotels in the city, (6) Additional mouse hover labels, (7) Shortest path feature, (8) Optimization of the system for better performance, (9) Include menus of featured restaurants, (10) Add current location feature, (11) Convert to 360 view panoramic tour and higher quality of panoramas.

### **MSU-IIT Geolocator Information System: An Isometric Virtual Tour of the MSU-IIT Campus**

Ferrater et al. (2013) stated that some graduates and undergraduates stated that they are not familiar with the structure of the campus due to lack of reliable and updated campus map. This gave rise to problems, (1) locating particular areas of the campus was difficult due to lack of information provided and (2) new students and visitors will not have dependable information regarding locations.

They focused on developing a Flash-based system that displays a virtual tour of the MSU-IIT campus using isometric projection. Isometric projection is a method for visually representing three-dimensional objects in two dimensions in technical and engineering drawings. The system guides users in searching for specific locations in the said campus by providing visual and text direction of the most direct route to any college building in the campus. In this study, a kiosk machine was strategically placed in the entrance of the campus, providing initial information about MSU-IIT and short path navigation from the kiosk to any building. Also, the system was limited to one kiosk, disabling the users to freely roam while using the system.

A set of one hundred (100) respondents were asked to evaluate the system. These are students or visitors of the campus. Five instructional statements serve as tools for evaluating and determining the overall value of the system design. These statements are (1) The overall Geolocator is attractive, (2) The Geolocator’s graphics are of good quality, (3) The Geolocator has a good balance of graphics versus text, (4) The colors used throughout the Geolocator are attractive and (5) The typography (lettering, heading, and titles) is attractive.

With the implementation of the system, an alternative approach of organizing, integrating, and presenting information about buildings was developed. The system offers a way users search for buildings, colleges, offices, and significant people.

**Table 2.1** Problem and Recommendations of Lakbay IIT

|  |  |  |
| --- | --- | --- |
| **System** | **Problem** | **Recommendations** |
| **Lakbay IIT** | Respondents experience inconveniences during times of enrolment. | 1. Collision detection;  2.Texture enhancement;  3. Minor details;  4. Walk mode;  5. Human model;  6. Clickable map;  7. System optimization;  8. Full screen feature;  9. Sky limitation;  10. Mouse hover on buildings;  11. Shortest path;  12. Info window on buildings;  13. Additional current location indication. |
| **Geolocator** | 1. Locating particular areas of the campus;  2. New students and visitors will not have dependable information regarding locations. | 1.Expansion of geographic scope;  2. Guest book;  3. Search for people;  4. GUI enhancement;  5. Search for courses;  6. Button to show all searchable keywords;  7. First person view;  8. System optimization. |
| **Suroy Iligan** | Iligan City tourism website lacks necessary information on tourist spots and services to encourage prospective tourist to visit. | 1. Kiosk application;  2. Backend functionalities;  3. Include new/rare places;  4. Panoramic view for hotels;  5. Include big hotels;  6. Introduce hover labels;  7. Shortest path feature;  8. Optimization for better performance.  9. Include menus of featured restaurants;  10. Add current location feature;  11. 360 view panoramic tour and higher quality of panoramas. |

In conclusion, the following recommendations were stated by the researchers: (1) Expand the geographic scope of the application, (2) Additional guest book that would monitor the number of users of the application, (3) Extend the search for people, i.e., allow the user to see other faculty and staff of the campus, (4) Enhancement for the graphical components of the system, (5) Extend the search for courses, i.e., allow the user to see graduate programs and the location of each program, (6) Additional button to view all the searchable keywords, (7) Additional walking human model for guiding for the shortest path and (8) Optimization of the system for better performance.

Table 2.1 presents the problems and recommendations of existing systems. These were used as guides for the developers in the implementation of the system that suits the needs of the current audiences.

### **Summary of Local Existing Systems**

It was first addressed through Campil et. al (2010) the need for a virtual campus map since they have learned that prospective students and visitors experienced several inconveniences on navigating the campus site. Collectively, Bala et. al (2012) addressed the lack of information regarding on potential travel spots on the local (Iligan) city's tourist website. Ferrater et. al (2013) highlighted the former that the lack of reliable and updated content still produced problems to visitors. Even with different methodologies exercised by these studies, potential problems would always spring up in them that in the long run these systems would become obsolete.

Campil et, al (2010) produced a 3D virtual map built as a desktop application which requires high end hardware capabilities to render 3D building models. Constructing 3D models alone require excessive time to which the problem was not properly addressed. Furthermore, their system was constructed as a static application and thus data would eventually become obsolete. This problem can also be found on Suroy Iligan not because it was a web application but the contents in general do not promote interactivity since these data are statically integrated. Additionally, it was also addressed in their recommendation to add backend functionalities to make the system dynamic thus the problem (Bala et. al 2012).

**Table 2.2** Feature Comparison of Systems

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Features** | **Lakbay IIT** | **Suroy Iligan** | **Geolocator System** | **Newly Developed System** |
| 3D Graphics | ✔ |  |  | ✔ |
| First person POV | ✔ | ✔ |  | ✔ |
| Interactive |  | ✔ | ✔ | ✔ |
| Informative |  | ✔ | ✔ | ✔ |
| Map |  | ✔ | ✔ | ✔ |
| Desktop-ready | ✔ | ✔ | ✔ | ✔ |
| Mobile-ready/web-based |  | ✔ |  | ✔ |
| Search function |  |  | ✔ | ✔ |
| Event Management |  |  |  | ✔ |
| Updatable Content |  |  |  | ✔ |

Although with good remarks on visual representation of MSU-IIT campus data, the problem was also recurrent in the system of Ferrater et. al (2013) since it was built on a kiosk machine with little to no instructions on how to update relevant data. They had the same problem with Suroy Iligan whereas the data presented was also statically integrated. Additionally, mobility of kiosk machine can be costly on the end of users since they need to find these machines placed on multiple areas around the campus.

Even with these problems present, visualization of different data from the stated systems were potentially viable that their strong suits can still be integrated into one long-term dynamic application.

## **Usability**

Usability is a quality attributethat assesses how easy user interfaces are to use. The word "usability" also refers to methods for improving ease-of-use during the design process. Usability is defined by 5 quality components: *Learnability, Efficiency, Memorability, Errors* and *Satisfaction*. There are different methods in usability testing (Nielsen, 2012). One of which is the System Usability Scale.

The study provided valuable data concerning the usability of each individual tool; the researchers also derived some conclusions relevant to geovisualization techniques in general. They found that users were, in principle, able to understand and adopt the new ideas of map interactivity and manipulability. However, these ideas needed to be appropriately introduced; people could hardly grasp them just from the appearance of the maps and controls.

### **System Usability Scale**

SUS or System Usability Scale is a Likert Scale and a psychometric tool for measuring psychological quality of a product or a system. It provides measurement of people's subjective perceptions of usability in short time available mostly during evaluation. SUS has become an industry standard, referencing to over 1300 articles and publication (Brooke, 2013).

SUS has proved to be a valuable evaluation tool, being robust and reliable. It correlates well with other subjective measures of usability. SUS has been made freely available for use in usability assessment, and has been used for a variety of research projects and industrial evaluations. The SU scale is generally used after the respondent has had an opportunity to use the system being evaluated, but before any debriefing or discussion takes place. Respondents should be asked to record their immediate response to each item, rather than thinking about items for a long time. All items should be checked. If a respondent feel that s/he cannot respond to a particular item, they should mark the center point of the scale.

### **Likert Scale**

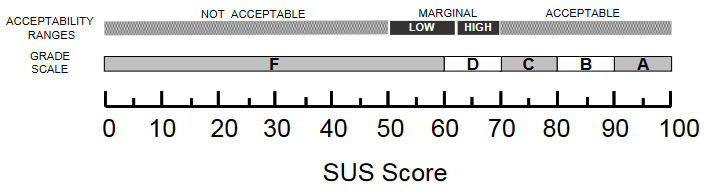
A Likert scale is a common rating format for surveys. Respondents rank quality from high to low or best to worst using five or seven levels. Likert scales were developed in 1932 as the familiar five-point bipolar response that most people are familiar with today. These scales range from a group of categories—least to most—asking people to indicate how much they agree or disagree, approve or disapprove, or believe to be true or false.

### **SUS Scoring Methodology**

For the system, SUS scoring is used. To calculate the SUS score, first add all the score contributions from each item. Each item's score contribution will range from 1 to 5. For items 1,3,5,7 and 9 the score contribution is the scale position minus 1. For items 2,4,6,8 and 10, the contribution is 5 minus the scale position. Multiply the sum of the scores by 2.5 to obtain the overall value of SU.

### **Interpreting SUS Scores**

A study by Bangor, Kortum & Miller (2009), through psychometric theory, suggests that multiple questions are generally superior to a single question to which many studies have found that multiple question surveys tend to yield more reliable results than single question surveys. Additionally, multiple interfaces of a product require multiple item questionnaires and single interfaced product requires single item questionnaire. This study constructed a useful analog, from 964 usability studies, to classify ranges of SUS Scores into traditional school grading scale, whereas it has proven useful in declaring strong face validity and the grading scale matches quite well with the acceptability scores, which is another tool constructed by this study of the same reference.



**Figure 2.1** SUS Score Equivalent Scale to Acceptability Range and Grade Scale

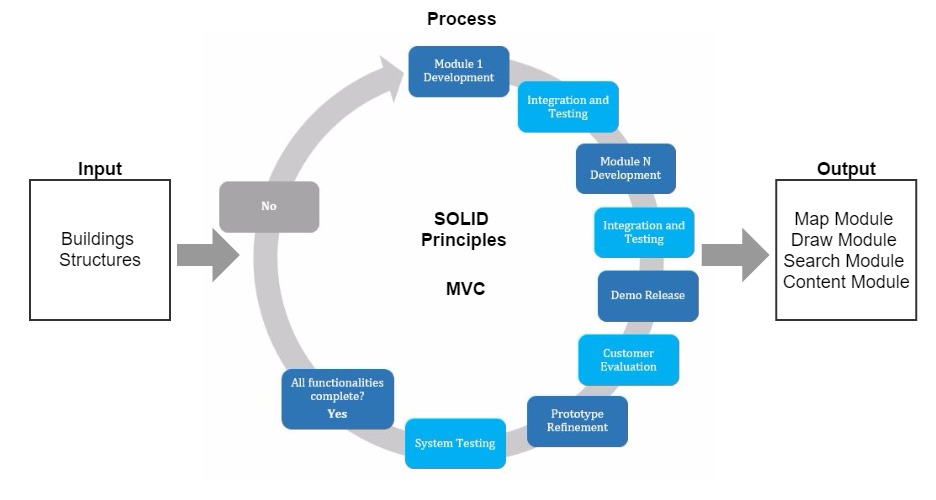
Although this project aimed to present an adjective rating as an additional single questionnaire survey to the collection of SUS scores scale interpretation, it is highly advisable not to include this rating in this research because of incompatibility presented in its discussions, whereas the adjective words used were not specific or were not understood enough for the testers.

### **Analysis of Scaling Methods Used by Existing Systems**

Lakbay IIT used a 5-response Likert scale ranging from one negative response to 4 gradually positive responses (Poor, Good, Average, Satisfactory and Excellent). This makes the product of the study perform with biases in such that the perception to the product itself is always positive. This made the product unreliable enough since it incorrectly conditions the user that the system functionalities are positively usable (Bangor, et. al., 2009).

        MSU-IIT Geolocator Information System used a standard scaling method for their analysis. It also uses 5-response Likert scale but with wordily equal scaling (Strongly Disagree, Disagree, Neutral, Agree and Strongly Agree). However, they presented their question in a positive tone, whereas it could bypass the negative traits of the system that could potentially take the long term usability for the system. With this, the researchers would be able to accurately evaluate the system's usability by using SUS score.

## **Summary and Conceptual Framework of the Study**



**Figure 2.2** Conceptual Framework

The input for this research is the information gathered by the project developers regarding buildings and structures. The developers will use GLMap and Leaflet, both are open source libraries similar to Google Maps. Both libraries use OpenStreetMap (OSM) for the mapping interface because it offers a familiar interface for the users and it allows them to layer custom information on top of the map and provide a platform that will allow them to add new features, like delivering relevant, location-based information. The project developers will also use OSM Buildings so the interactive map will display lightweight 3D-like polygons as buildings.

The development of this system composes of different modules is the terminal outcome of this research. These modules include a map module for displaying the map, a search module so that users can easily search for relevant data, a draw module so designated users can draw buildings in the map themselves and a content module for the database and CRUD functionalities of all events inside the campus. A schematic diagram is presented in Figure 2.1 that shows the relationship between these variables.