Decision Support Infographics System for Disaster Risk Reduction and Management

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Abstract- Using the descriptive and developmental design, the study developed a decision support infographics system for DRRM in Biliran province. It answer significant issues as to challenges encountered by the participants regarding the DRRM, application that can be developed to address the identified disaster risk and reduction management, extent of compliance of the developed application to ISO Standard. The participants of the study include two groups of individuals. Participants in the focus group discussion were the ten DRRM officer from the different municipality of the Province of Biliran. The second group were the ten (10) ICT experts who participated in the technical evaluation of the developed system. The study adopted two types of research instruments, which includes proving questions for the FGD, and the evaluation tool based on the ISO 25010. Interestingly, result implies that the area which needs appropriate action based on the FGD conducted was the absence of computerized system for DRRM. There is really a need to come up with a system that is capable of addressing issues on DRRM and is anchored on the agenda of the PDRRMO. Moreover, areas evaluated based on ISO standard were met by the developed application and can be used as a tool for disaster planning and mitigation measures.

Keywords: Disaster risk, Mitigation, Disaster risk reduction management, Decision support system, infographics.

I. INTRODUCTION

The Philippines is considered one of the most exposed country in the world when it comes to natural disasters. According to the 2017 world Risk Report, the Philippines ranks third on the index, which indicates the risk of disaster in consequence of extreme natural events. The Philippines as revealed in the World Risk Index (WRI) has a 52.46% greatest exposure to natural disaster (UNUIEHS, 2017).

The Philippines is highly susceptible to typhoons, earthquakes, floods, landslides, tsunamis, and volcanic eruption due to its geographical location. This explains the existence of more or less 300 volcanoes of which 22 are classified is active, and the several occurrence of earthquakes and tsunamis all year round (Doroteo, 2015)

Since 1990, (Reyes, 2017) the Philippines has been affected by 565 natural disaster events that have claimed the lives of nearly 70,000 Filipinos and caused an estimated $23 billion in damages. At least 60 percent of the country's total land area is exposed to multiple hazards, and 74 percent of the population is vulnerable to their impact.(Dela Cruz, 2014)

Every year in the Philippines an average of 20 typhoons make landfall, and over the last decade typhoons have become stronger and more devastating. In 2013, Super Typhoon Haiyan (Yolanda), has taken lives among people,caused extreme damage including the agricultural lands and structures.

The province of Biliran is vulnerable to these types of catastrophes namely, landslides, floods, storm surge and

earthquakes, because it lies along the typhoon and earthquake belt. Biliran volcano is one of the many active volcanoes in the Philippines and the only active volcano in Eastern Visayas. Its last recorded eruption was in 1939; however, there was no available information as to damages in terms of lost lives and properties caused by the eruption. Being in the typhoon built, PAGASA reported that 19 percent of the tropical cyclones that enter the Philippine's Area of Responsibility affects the province. Heavy downpours usually cause watershed to overflow resulting to flooding in low-lying areas. Landslide is also a threat to some areas of the province not only in steep land but also in high slope areas. Land erosion is triggered by heavy and prolonged rainfall due to the passage of a tropical cyclone, and too much water in the soil may destabilize the steep land, causing a land erosion or mudflows.

The province is generally prone to Hydro-meteorological and Geologic Hazards. Eighty-one barangays are prone to flood, while 95 are high risk to Rain-induced land erosion. The overflowing of watershed due to heavy and prolonged rainfall during tropical typhoons usually causes flooding in the province. Eight major rivers are found in the five largest settlements of the province, the biggest of which the Caraycaray River, located in one of the barangays of Naval. Recent surveys conducted by the Mines and Geosciences Bureau reveal that these rivers are already heavily silted, including their tributaries; thus, reducing their carrying capacity and posing flood threats to constituents (PDPFP 2011-2016.)

In 2017 Typhoon Urduja hits Eastern Visayas region and the most affected area was the Province of Biliran. According to the Biliran PDRRMC (2017) there were 42 deaths, 105 injured, 14 still missing up to this present. Bridges, infrastructures and agricultural crops were devastatingly damaged during the said incident.

The PDRRM Act of 2010 have sought to take into account all the comprehensiveness and sensitiveness, complexities and perplexities, improvements as well as impediments which are all involved in the preparation of a community to all kinds of disaster also the enforcement of the Local DRRM Office.

One of the mandates of the PDRRM Act of 2010 is pre disaster preparedness programs, which includes disaster planning and mitigation. The province DRRM particularly

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in Biliran province find it difficult to consolidate data from barangay level, municipal level as mentioned by the provincial DRRM officer. The planning and decision making is a tough job because of inadequacy of data.

Presently, there has been no systematic approach being done in a form of automation as a tool for disaster planning and mitigation in the province. Anchored on the preceding information, the researcher would like to generate a decision support infographics system for disaster risk and reduction management in biliran province, design to aid the policy makers or authorities in their planning and preventive efforts, and the possibility to prevent or reduce the casualties and damage to property and infrastructure.

Conceptual framework

The conceptual framework of this study will be anchored to the diffusion of innovation and influence. The diffusion of information and innovations is now part of the interactional and network tradition. Interaction in networks plays an important role in relationships, groups, organizations, and in mass communication as well. The diffusion of an innovation occurs when the adoption of an idea, practice, or object spreads by communication through a social system (Littlejohn and Foss, 2015).

The diffusion of innovation and influence is also known as the two-step flow concept. It posits that the effect of media is influence by interpersonal communication. It argues that information flows from the mass media to certain opinion leaders in the community, who pass information on by talking to peers. Every group has opinion leaders but these individuals are difficult to distinguish for the others group members because opinion leadership is not a trait but a role taken by some individuals in certain circumstances (Littlejohn and Foss, 2015).

Recent research on two-step flow has shown that dissemination of ideas is not a simple two-step process. A multiple step model is now more generally accepted as more accurate in terms of the actual process. Research has shown that the ultimate number of relays between the media and final receivers is variable. In the adoption of an innovation, certain individuals will access it directly from media sources, whereas others will be many steps removed (Littlejohn and Foss, 2015).

Based on the assumption that the opportunities for contact provided by communication networks serve as a mechanism that exposes people, groups, and organizations to information, attitudinal messages, and the behavior of others (Burt, 2010, 2013; Contractor & Eisenberg, 2010 as cited in Monge & Contractor, 2013). This exposure increases the likelihood that network members will develop belief, assumptions, and attitudes that are similar to those of others in their network (Carley, 2005; Carley & Kaufer, 2007 as cited in Monge & Contractor, 2013). The contagion approach seeks to explain organizational members' knowledge, attitudes, and behavior on the basis of information, attitudes, and behavior of others in the networks to whom they are linked. (Rogers and Kincaid, 2011, as cited in Monge & Contractor, 2013) refer to this as the convergence model of communication.

The concept of the diffusion of innovation and influence also informs the present study since it deals with the community affected area, disaster risk reduction group, policy making body to use the infographics as a tools in mitigation of the disaster preparedness and preempted evacuation of the possible disaster risk in the communities and mitigating measures planning. The study will use infographics as a tool for mitigation how they perceive the innovation's relative advantage and its compatibility with existing values and experiences, and how they adopt or refuse to adopt the innovations.

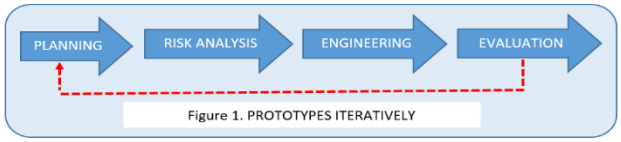


Figure 1. PROTOTYPES ITERATIVELY

The diffusion of innovation and influence inspire the researcher and the use of spiral model for this study provides an opportunity to build various prototypes to understand the problem better and slowly arrive at a solution using the Figure 1 which shows four types of prototype iteratively where it starts in planning, risk analysis, engineering and finally evaluation. For software development the conceptual paradigm was develop in the study to come up with the desired application tool.

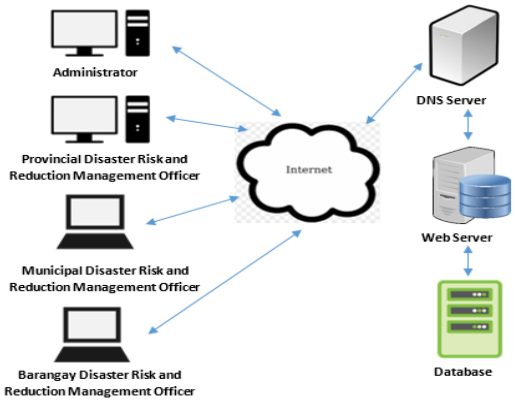


Figure 2. System Architecture

Architectural specification was understood and designed in this phase. Data transfer and communication is well understood and clearly seen in this stage through producing adequate information thus proper integration will be done accordingly. The behavior of the system is clearly systematic as shown in figure 2 wherein an administrator will take hold of the three management officer and through collaboration of all informations, a decision support is being made.

Statement of the problem

The main goal of this study is to develop a Decision Support Infographics System for Disaster Risk Reduction Management in Biliran Province.

Specifically, this study sought to answer the following:

1. What are the challenges encountered by the participants as regard the DRRM?

2. What proposed application can be developed to address the identified DRRM?
3. What is the extent of compliance of the developed application to ISO 25010 Software Quality Assurance Standards in terms of:
   a. Functional Sustainability
   b. Performance efficiency
   c. Compatibility
   d. Usability
   e. Reliability
   f. Security
   g. Maintainability
   h. Portability
4. What are the strengths and limitations of the developed systems?

II. METHODOLOGY

Research design

The study involves qualitative, developmental and quantitative in design. The qualitative aspects involved a Focus Group discussion aiming to describe the challenges encountered by the participants as regard to the DRRM (Disaster Risk Reduction Management). The Developmental part focuses on the development of the Decision Support Infographic system while the quantitative portion contains the evaluation of the system using the instrument based on the ISO 25010 software quality standard.

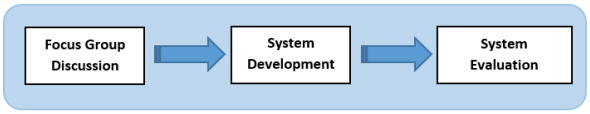


Figure 4. Flow of the Study

1. Focus Group Discussion

The participants are the following (Provincial DRRM, Municipal DRRM, Barangay DRRM, Local Government Unit, and Heads of Sections) needed to conduct brainstorming for a consensus view, articulated their insight and feedback. Expressed their experiences in their field of expertise and events. The researcher of this study served as the facilitator of the Focus Group Discussion. The number of participants (n=10) during the focus group session was within the range recommended by Maughan (2003) and Lewis (1999) which is six to twelve key informants. The feedback, recommendations, and insights gathered from the participants became an information and data given was used in the development of the decision support infographics system for DRRM. Below is the process of the Focus Group Discussion:

1. Selecting Participants. The participants are selected on the basis of information they can contribute.
2. Designing the Focus Group Discussion Session. The Focus Group Discussion sessions were done in the Province of Biliran.
3. Preparing for the Focus Group Discussion Session. It is important that the participants understand what is expected of them. The ultimate goal of the Focus Group Discussion session is to develop an understanding of the current system then the participants have to bring data's or documents needed in the design phase of the system and system flow.
4. Conducting the Focus Group Discussion Session. All the participants of the Focus Group Discussion sessions had followed a formal agenda with formal ground rules that define appropriate behavior and observe time schedule and accepting opinions, disagreement.

2. System Development

The researcher used a spiral model for software development to improve the software process in the development, spiral model is adopted to software designing a primary document driven or code driven process in a risk driven approached does resolves and incorporates strengths and many of its difficulties.

The radial dimension in Figure 8. The angular dimension signifies its stages of workload to be completed in its cycle the researcher addresses portion of its level of elaboration from the concepts of operation, document and coding of each program.

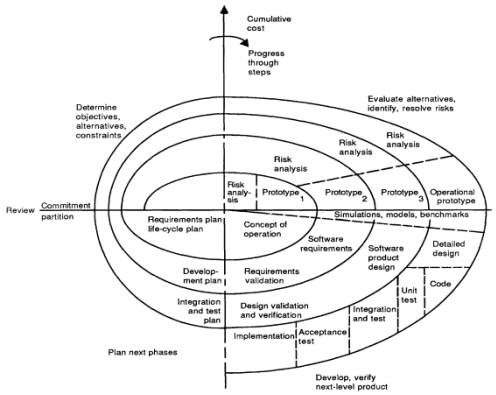


Figure 8. The Spiral Model for software development

Identification of spiral cycle:

(a) the objectives of the system as to its performance, functionality and ability to adopt change;
(b) the implementation of the system as to its design A, design B, reuse and test and
(c) the constraints of the system as to its cost, schedule and interface.

3. System Evaluation

The system was evaluated to determine its extent of compliance using the ISO 25010 Software Quality Assurance Standards tool in terms of: Functional Sustainability, Reliability, and Performance efficiency, Security, Compatibility, Maintainability, Usability and Portability.

Participants of the study

The participants of the study include two groups of individuals. The first group were the participants in the focus group discussion while the other group were involved in the evaluation of the newly developed system. The participants in the focus group discussion were the ten (10) disaster risk reduction management officer from the different municipality of the Province of Biliran. The participants were gathered together to discuss about a predetermined topic (i.e. Design, functionality, Flow, Data needed and challenges as to DRRM) This method

encourages the participants to express their feelings, to articulate their insights and feedback, to clear their doubts and conflicts, and to raise their needs in a small discussion and brainstorming group.

The second group were the ten (10) ICT experts who participated in the technical evaluation of the developed system. They were composed of one (1) System Administrator, One (1) Web Administrator, Two (2) Computer-based Information Manager, One (1) System Programmer, One (Senior Programmer) and Four (4) ICT Instructors.

The participants in this study were chosen using a purposive sampling. Purposive sampling is deemed appropriate in this situations because it requires to capture the knowledge of the participants pertaining to DRRM and the acceptability feature of the developed system.

Instrumentation

The study adopted two types of research instruments, which includes Proving Questions for the Focus group discussion to come up with a Thematic Clustering and to find out what are the Challenges encountered of the Disaster Risk, Reduction and Management, after consolidating all the Significant Statements of the participants and also gathered data as to the needs of the locale to be as inputs and the needed test data in infographics and the evaluation tool based on the ISO 25010. The evaluation tool included items to describe the system in terms of functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability. The feedbacks from the participants were used to further enhance the developed system.

Data gathering procedure

The following activities were conducted upon approval of the research topic:

*Preliminary Preparation***.** A letter of intent from the Saint Paul's University Philippines was prepared with the approval of the Dean of the Graduate School and was forwarded by the researcher to the office of the Provincial DRRM in the Province of Biliran. The purpose of the letter intends the researcher to conduct a Focus group discussion with the target participants of the study. A letter of consent was made for the participants for their voluntary participation in the focus group discussion.

The Focus group discussion was done in the Province of Biliran at the Provincial Environmental Protection and Disaster Management Office the Focus Group Discussion lasted one (1) day with the participation of the target participants and supporting secondary data were given. These were done in order to ensure that the decision support infographics system covered information regarding the needs of the locale. Furthermore, the participants transcripts of interview were analyzed as to the Significant statement were consolidated in order to come up with the Thematic clustering of the Challenges encountered by the DRRM of the locale, thereby categorizing as to frequency and ranking of the challenges.

Administration of the Questionnaires. After the system has been developed, the researcher disseminated the survey questionnaires for evaluation of the system that has been developed. A short orientation about the study was conducted to inform the participants about its purpose. The evaluation aims to determine the extent of compliance in terms of Functional Sustainability, Reliability, Performance efficiency, Security, Compatibility, Maintainability, Usability and Portability.

Retrieval of the Questionnaires. The survey questionnaires will be collected right after the participants had finished answering. The questionnaires will be arranged, tallied, computed and tabulated to come up with a significant data.

Data analysis

The qualitative and quantitative data were processed using descriptive statistics. Content analysis was used to treat the qualitative data in order to categorized verbal purposes of classification, summarization and tabulation of the data. The Weighted Mean was used to determine the extent of compliance of the developed application to ISO 25010 Software Quality Assurance Standard. This was utilized to analyze responses from the data gathered as regard to the extent of compliance of the developed system.

The Likert Scale is often used 5-point format with extreme ends. It requests participants to specify their level of agreement to each of a list of statements. The result is obtained by calculating the average (i.e. mean) of all the results added together. The Likert scales are often used in questionnaires.

III. RESULTS AND DISCUSSION

I. Challenges and Problem Encountered in the implementation of Disaster Risk Reduction and Management

Table 2. Challenges Encountered

Challenges Encountered	Freq.	Rank
Absence of a computerized system for DRRM	18	1.0
Lack of capable human resource	4	2.0
Management problem	2	3.0
Lack of DRRM facilities	1	4.5
Dwelling of participants	1	4.5

As reflected in Table 2, it can be seen that most of the responses of the participants during the Focus Group Discussion (FGD) in terms of the challenges encountered is the absence of computerized system for DRRM which had a frequency of 18 and rank as 1. Lack of capable human resource obtained a frequency of which fell under rank 2. Rank 3 was the management problem with a count of 2. And finally, lack of DRRM facilities and dwelling of participants share the same rank of 4.5 with a frequency of only one count.

This implies that the area which needs appropriate action based on the FGD conducted was the absence of computerized system for DRRM. This implies further that there is really a dire need to come up with a system that is capable of addressing issues on DRRM and is anchored on the agenda of the PDRRMO.

II. Decision Support Infographics System for Disaster Risk and Reduction Management

The developed decision support infographics system. The developed application was based on the result of the study. Illustrations were presented as to: Administrator Dashboard, Add Municipality Dashboard, Diffirent Menus, Forms, Infographics and Hazard prone Maps.

Figure 1. Administrator Dashboard

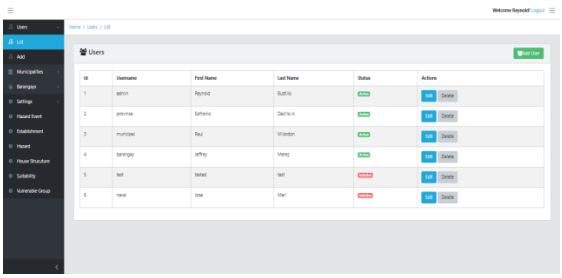


Figure 2. Add Municipality Dashboard

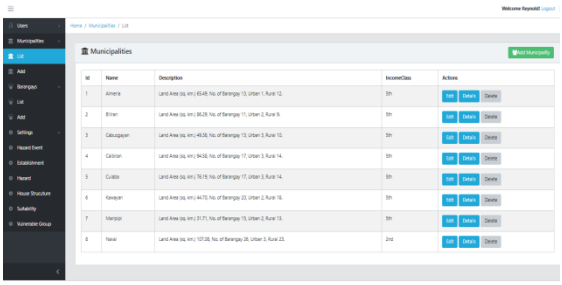


Figure 3. Consolidated Infographics per Municipality (Top)

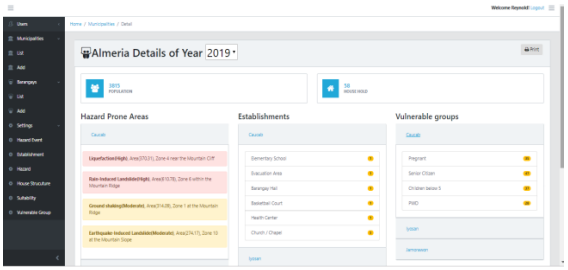


Figure 3. Consolidated Infographics per Municipality (Down)

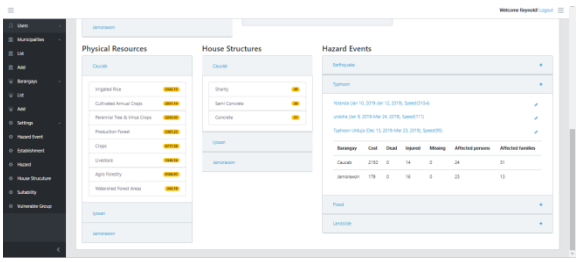


Figure 4. Add Barangay Dashboard

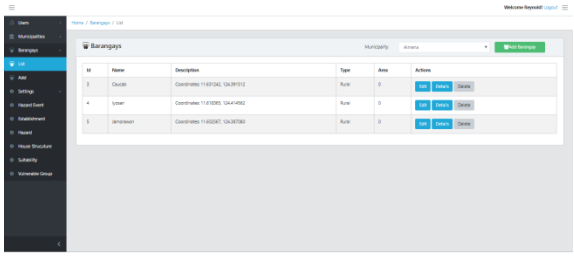


Figure 5. Infographics per Barangay (Top)

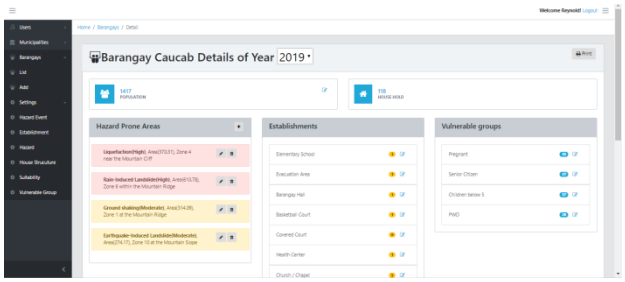


Figure 5. Infographics per Barangay (Down)

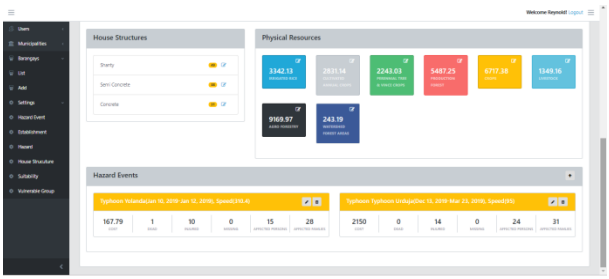
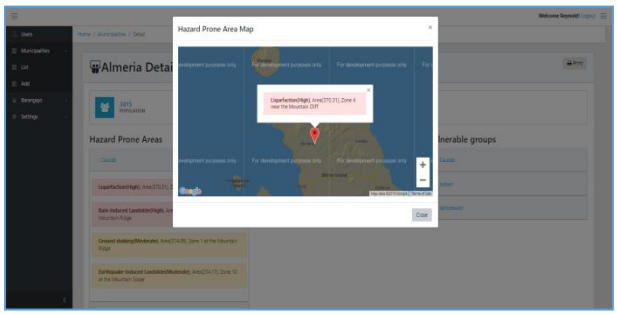


Figure 6. Hazard Prone Area Map



III. System Evaluation of the Decision support infographics system for Disaster Risk Reduction and Management.

Table 11. Summary Evaluation of the Application

Area of Evaluation	Mean	Description
1.)Functional Sustainability	4.23	Very High Extent
2.)Performance Efficiency	3.83	High Extent
3.)Compatibility	3.70	High Extent
4.)Usability	4.30	Very High Extent
5.)Reliability	3.90	High Extent
6.)Security	4.20	Very High Extent
7.)Maintainability	3.80	High Extent
8.)Portability	4.00	High Extent
Overall Mean	**3.99**	**High Extent**

As revealed in Table 11, it can be noted that functional sustainability, usability and security of the application had a category mean of 4.20-4.30 interpreted as “very high extent”. Meanwhile, performance efficiency, compatibility, reliability, maintainability, and portability obtained category mean ranging from 3.70 to 3.90 signified as high extent.

It obtained an overall mean of 3.99 described as high extent. This implies that all areas evaluated based on ISO standard were met by the developed application. This implies further that the developed system is ready for utilization for the DRRM in the Province of Biliran.

IV. Strengths and Limitations of the Developed Decision Support Infographics System

- A review of this kind, aiming at an evaluation of the said system as a single page application that does not require reloading of the page. Meaning it assumed fast response to transaction.
- On the point of view pertaining to different user access Level and privileges it offers a variety of users security authentication.
- With respect to the DRRM plan of the province as mentioned by the provincial DRRM officer. Included in the core topics are the following; hazard prone area, establishment, physical resources, hazard events, vulnerable groups, house structures (household), and population the developed system manifested to cater major concern needed in creating disaster planning.
- The additional features that the developed system provide, collapsible menu and command button for wider viewer environment and great viewer experience.
- In relation to platform constraints, it support and can run offline and online environment.
- In a dynamic setting of environment the developed system, support a responsive web application that readily deploy to mobile and desktop platform.
- As to dialog and responsive functions in transaction, it has a pop-up messages and dialog in every transaction that required feedback. i.e. Successfully updated, Successfully deleted, etc.
- In addition, the developed system uses a RESTFUL API that is used up by the Angular client application. This decoupled the server from the client application.
- Furthermore, the developed system provides settings section for administrator user functions to make the system more dynamic.
- Yet, while there are some merits of the developed system as mentioned above, in its current form the system is dependent in the end-user input data. That it accept what the end-user input as to the correctness of the data being inputted it must be first validated and refined before inputting to the developed system.
- Another constraint of the developed system it does not have the import and export data capabilities.
- Since the developed system is intended to be a tool in disaster planning the data available and reflected in the system is from the previous or current year.
- Furthermore, the developed system does not have audit trail;
- Another claim that the developed system does not have automatic backup of database capability. It must be manually back-up.
- Even though the developed system is ready to demonstrate function as to mapping of hazard prone area as to its coordinates (latitude and Longitudes) of the specific location. The researcher uses google map in a development API key module that is free and that it has limited functions.

IV. CONCLUSION

This study had showcased two (2) distinct yet complementary areas: IT expert in their fields of expertise and the DRRM officers the experiences, knowledge of the present set-up of the disaster planning of the province.

It showed significant accomplishment in completion, both have great help in the study.

A user-centered approach to development of a decision support infographics system is very helpful to address the actual needs of the end users. To evaluate an information system and adopt the ISO 25010 software standard. Contributory to the completion of the Decision Support Infographics System for Disaster Risk and Reduction Management.

V. RECOMMENDATIONS

Based on the results, findings and conclusions, the researcher hereby recommends the following:

1. The Provincial Disaster Risk and Reduction Management Officer should periodically conduct usability evaluation and yearly updated data of the decision support infographics system for disaster risk and reduction management.
2. The Municipal Disaster Risk and Reduction Management Officer should properly deploy the decision support infographics system for disaster risk and reduction management.
3. The Barangay Disaster Risk and Reduction Management Officer should provide up-to-date data entry to the decision support infographics system for disaster risk and reduction management database.
4. The identified enumerators should conduct quarterly updated data to the decision support infographics system for disaster risk and reduction management.
5. More studies that are related to Disaster Risk and Reduction Management in particular to ICT fields should be explored and discovered for the betterment of the community for a disaster ready and safe community.

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