Post Disaster Assessment with Decision Support System

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Abstract *–The study aimed to develop an online system that would expedite the response of agencies after disaster strikes; generate a list of the kinds and volume of relief aids needed per family affected for a fair, precise and timely distribution; implement community-based ICT by remotely gathering all the necessary data needed for disaster assessment; and adhere to ISO 9126 standards. The system was designed to calculate the effects of disaster in human lives and economy. Integrated into the system were Goggle Maps, Mines and GeoSciences Bureau Hazard Maps, SMS sending features, best passable routes calculations, and decision support on the needs that has to be addressed. The system was made live at pdrrmcguimaras.herokuapp.com to allow remote data entry.*

The functionality and usability of the system were evaluated by 19 potential users by computing for the arithmetic Mean and Standard Deviation of the survey. The result showed that most of them strongly agreed that the system is acceptable based on these criteria. A group of IT experts also evaluated the system's conformance to ISO 9126 standards using the same method. The result showed that majority of them strongly agreed that the system conforms to this international standard.

The system is seen as a valuable tool for the Provincial Disaster Risk Reduction Management Council (PDRRMC) and the National Disaster Risk Reduction Management Council (NDRRMC) for it could help expedite the assessment of the effects of disasters and the formulation of response plans and strategies.

Keywords *–Assessment, Decision Support System, Disaster Assessment, Disaster Support*

INTRODUCTION

The Philippines ranked 3rd out of 173 countries that are prone to natural calamitieswhich kill at least 31, 835 Filipinos and affect the lives of 94,369,462 people for the past 20 years. To mitigate the effects of disasters in the country, the government has formed the National Disaster Risk Reduction Management Council (NDRRMC), an agency that would be responsible to provide the "legal basis for policies, plans and programs to deal with disasters". The NDRRMC works together with the Local Government Unit (LGU) and the Provincial Disaster Risk Reduction Management Council (PDRRMC) [1].

The government may have implemented organized strategies to help its people cope with the effects of disasters; however, experiences from the past revealed some challenges that needed to be addressed, and these were the following:

Firstly, the statistical computations and disaster impact assessments were manually done, thus slowing down response time. Manual computations of data gathered also gives inaccurate results.

During the time the Visayas Region was hit by super typhoon Haiyan (Yolanda), the national government seemed unreachable and that victims of the massive disaster became hopeless [2]. The national government defended their actions by explaining that the assessment of the impact of the typhoon took long than expected since they only responded according to the available data and resources on hand and that was right after the assessment was done [3].

Secondly, the kind and volume of relief aids needed by each affected area were hard to determine, and thus allocation and distribution were not accurately and fairly done.

The improper relief aids allocation and distribution has been a problem and it has added to the misery of the victims to affected people's lives. During the massive earthquake that devastated Haiti in

the year 2010, "Haiti aid agencies warned about chaotic and confusing relief effort which is costing lives" [4].

Thirdly, members of the communities were less involved in collaborating with government authorities during disasters, and thus it resulted to slow and inaccurate data gathering.

To address the above mentioned challenges on the part of the PDRRMC, the study entitled Post Disaster Assessment and Decision Support System was conducted pursuant to RA 10121, an act strengthening the disaster reduction and management system.

The study deployed an online software developed using the Ruby on Rails programming language that was capable of gathering pertinent input data from remote locations to empower barangays to actively collaborate with PDRRMC. Essential processes were integrated into the system. These processes involved user validation to ensure that only authorized users gain access to the system; calculate disaster impact based on human lives and economy affected; generate reports needed for statistical analysis; generate substantial charts for data analysis; analyze immediate needs and determine its priority level; list down possible response and agency to be contacted; send alert messages to agencies needed in the area of disaster; and determining the best route for the delivery of relief aids to victims.

The system contributes significantly in the information dissemination by generating real-time reports that could be sent online whichcould beutilizedby NDRRMC, PDRRMC, and agenciesas bases for (1) a well-established disaster response operations; (2) adequate and prompt assessment of needs and damages at all levels (3) and integrated and coordinated search, rescue and retrieval capacity – which are actually the NDRRMC's goal on Thematic Area 3: Disaster Response for the year 2028: [5].

RELATED STUDIES

Several studies were conducted over time to help mitigate the effects of disasters. One of them is the Rapid Earthquake Damage Assessment System (REDAS)developed by DOST and Philippine Institute of Volcanology and Seismology. REDAS is a system that is used to assess the damage of an earthquake disaster which generates hazards and risk maps after a strong earthquake has hit [6].

Another system that makes use of database to organize its data about disasters is the EM-DAT (The International Disaster Database) developed and managed by the Center for Research on Epidemiology of Disasters (CRED) since 1988.EM-DAT contains essential core data on the occurrence and effects of over 18,000 mass disasters in the world from 1900 to present. The database is compiled from various sources, including UN agencies, non-governmental organizations, insurance companies, research institutes and press agencies [7]".

The EM-DAT is similar to the system developed in terms of its remote data gathering, online applications, decision making support, calculations of human lives lost, and method of assessment. However, the Post Disaster Assessment with Decision Support Systemwas designed to be used by PDRRMCs in the Philippines, LGUs and barangays. Only users who were already predefined in the system's database are authorized to add, edit, view, and search for data. The SMS feature to send alert messages is activated in the system. The decision support has been integrated in the analysis of needs, and relief aids distributions and allocations. There were trained route update senders to report route status after a disaster has struck.

OBJECTIVES OF THE STUDY

Generally, the study aimed to develop a Post Disaster Assessment with Decision Support System. Specifically, the study aimed to develop a system with the features that: (1) Expedite the response of responsible agencies after disaster strikes by (a.) automatically assessing the impact of a disaster to provide fast analysis of needs of the affected populations; (b) sending alert messages through SMS to responsible agencies for fast notification; and (c) providing suggestions on the best possible route from the source area to the destination area for fast delivery of needed services; (2) Generate a list of the kinds and volume of relief aids needed per family affected for a fair, precise and timely allocation and distribution; (3) Implement community-based ICT by remotely gathering from each barangay the validated data for pre-storing, the type of hazard or calamity that has hit, the list of affected populations, and road status; and (4) Evaluate based on ISO 9126 standards: functionality, usability, reliability, portability, efficiency, and maintainability.

MATERIALS AND METHODS

The system entitled Post Disaster Assessment with Decision Support System is a natural disaster and

needs assessment computer software integrated with automated computations of disaster impact on human lives and economic loss, volume and kinds of relief aids to be delivered, determining status of road networks, determining road network shortest paths, generations of statistical charts, Mines and GeoSciences Bureau Geological Database Information System, Google map, SMS alert notification, and email processing.

This system covers the top five disasters that are known to most likely hit Guimaras which are flood, typhoon, landslide, storm-surge, and tsunami. It stores pertinent data in preparation for disasters. These data includes people/residents data, zones data, barangay data, municipality data, list of agencies to be contacted, and hazards data. After a disaster hits, the system is capable of gathering pertinent information such as the type of disaster(what), the date and time of occurrence (when), the list of affected zones, barangays, and municipalities (where), the population affected (who), the number of dead, missing, injured, displaced and relocated persons, and the road status (passable / not passable).

The system automatically computes the impact of disasters and generates decision support by automatically providing the list of needs to be catered, the agencies to be contacted, and the kinds and volume of relief aids to be distributed.

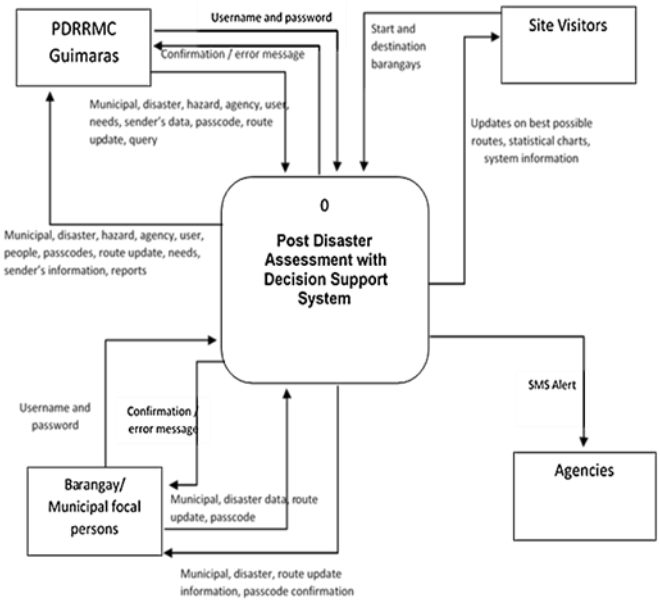

Figure 1. Context Diagram of the System

Figure 1 shows the Context Diagram of the System. The set of entities that connects with the system are the office of PDRRMC Guimaras, barangay/municipal focal persons, agencies, and site visitors.

The office of PDRRMC Guimaras, which is the system administrator, inputs log in details such as username and password, municipal data, disaster data, hazard data, agency data, user data, needs data, sender's data, passcodes, route update, and queries. As a system administrator, the PDRRMC is authorized to access all features of the system. The PDRRMC can receive information from the system such as municipal information, disaster information, hazard information, agency information, user information, people information, passcodes, route update, needs information, sender's information, and reports. The system also displays a confirmation message if the log in is successful and an error message if not. The barangay/municipal focal persons, who supply pertinent data, have a limited access to the system. After successfully logging in into the system by providing correct username and password, they are only allowed to input passcode, municipal data, disaster data, and route update under their jurisdiction. They are also designed to receive information from the system such as passcode confirmation, municipal information, barangay information, zones information, disaster information, and route update information under their jurisdiction. The system also displays a confirmation message once the log-in is successful and an error message if not.

The Agencies such as the DOH, DSWD, AFP, and the LGU's can only receive alert notifications from the system through SMS if the need arise. The SMS message contains information of the emergency they need to address, the location, and the priority number so they can actaccordingly.

The Site visitors can only view very limited information such as updates on best possible routes, statistical charts and system information after clicking buttons and links associated to information they want to view.

The system was implemented using Ruby programming language on Rails framework. It used the Ruby version 2.1.5, Rails 4.2.1, and Git 1.9.5 for Windows. The source codes were encoded using the Sublime Text 2 editor. The view design was implemented using HTML 5, CSS, and JavaScript. SQLite database was used for the developmental

stage, and PostgreSQL database for production, both modes used the Thin server.

The Spiral Software Development Life Cycle Model was used because the project was seen as risky in terms of its implementation, so, in every step of the way, proper monitoring of the system output and risk analysis of each output were evaluated. Also, the system, after implementation, is still be open to significant changes because additional requirements may still arise.

RESEARCH METHOD USED

The system's acceptability based on its functionality and usability was surveyed from the potential users of the system including fourteen (14) barangay captains/barangay officials from the fourteen (14) barangays of the municipality of Jordan, one (1) Municipal Disaster Risk Reduction Unit staff, one (1) PDRRMC-Guimaras Head, and three (3) PDRRMC staff, for a total of nineteen (19) users. This is the 100% of the user population.

The resulting Mean and Standard Deviation (SD) from the 19 gathered survey materials were computed. The value of the Mean indicates the common perception of the respondents about the system itself. The value of the Standard Deviation (SD) indicates the measure of dispersion of the respondents' perception about the system. A high SD indicates that the respondents' answer on the survey questions were spread out over a wide range, while a low SD indicates that the respondents' answer were so close together, thus data distribution is narrow and concentrated.

Twelve (12) Information Technology (IT) experts who have had experience on software development were surveyed to gather feedback whether the system has complied with the quality standards set by ISO 9126. The determining of the sample size was based on the researcher's judgement sampling. "In judgement sampling researcher relies on his or her own judgement when choosing members of population to participate in the study."[8].

The value of Mean and Standard Deviation (SD) were computed to determine the general perception of IT experts, and to determine the cohesion on their responses, respectively. A high value of SD indicates a wide range of perception, while a low value indicates similarity or commonality on their perception.

VALIDATION OF INSTRUMENT

The user acceptability survey conducted to the potential users of the system used a survey questionnaire duly validated by the coordinator of the Provincial Disaster Risk Reduction and Management Council (PDRRMC) of Guimaras where the study was implemented.

The system adherence to ISO 9126 standards survey conducted to the IT experts used a standardized survey material taken from the study ISO-Based ModelstoMeasure Software Product Quality [9]. The set of questions were edited to suit the need of the study.

DATA COLLECTION PROCEDURE

Qualitative data gathering was used to gather initial data such as system requirements and in depth knowledge of the study. The researcher conducted a face-to-face interview in the office of the Provincial Risk Reduction and Management Council (PDRRMC), headed by Mrs. Teresita Siason, in San Miguel, Jordan, Guimaras. The purpose of the interview was to get initial requirements expected from an online disaster assessment system.

After the system has been done, the researcher conducted quantitative data gathering in the form of a survey using questionnaires. Two sets of survey questionnaires were prepared for two sets of respondents. The first set of survey questionnaires was prepared for IT experts who evaluated the system's quality characteristics namely usability, functionality, maintainability, portability, efficiency, and reliability based on ISO 9126 standards. The second set of survey questionnaires was designed for potential users of the system such as the office of PDRRMC Guimaras, Municipal Risk Reduction staff, and barangay officials.

IT experts from different fields such as the academe, web designing, and programming took part in the completion of the study by participating as respondents. These came from different agencies in Iloilo City such as the Iloilo Science and Technology University, Mavericks Solutions, Iloilo National High School, ABE College, and the DepEd Division Office.

To gather the potential users' feedback about the system, the researcher joined the monthly Ligang Barangay Meeting headed by the Liga President, Brgy. Captain Ofelia Jalandoni, last September 27, 2015 in Jordan Municipal Multi-purpose Hall. During the event, the researcher showed both the online and

local version of the system, discussed the system's functions and lectured them about the importance of the system in Guimaras Island. After the discussion, a short question-and-answer followed. The filling up of survey questionnaires was conducted. Survey questions were afterwards gathered and analyzed. The respondents were adequately informed about the purpose of the study as well as the purpose of the survey conducted.

DATA PROCESSING AND STATISTICAL TREATMENT

To determine the degree of user acceptability and Software quality standard based on ISO 9126, the Mean results of the gathered survey materials from potential users and IT experts were computed and interpreted independently using the following result interpretations:

Scale:	Interpretation
1.0-1.80	- Strongly disagree (SD)
1.81-2.60	- Disagree (D)
2.61-3.10	- Neither Agree or Disagree (NAD)
3.41-4.20	- Agree (A)
4.21-5.0	- Strongly Agree (SA)

RESULTS AND DISCUSSION

Table 1 shows the results of each survey statement. The first part of the survey statement for potential users was concentrated on the system's functionality. The statement were based on each objective of this study.

Table 1. User Acceptability Survey Result

Survey Statements	WM	SD	VI
SYSTEM FUNCTIONALITY			
OBJECTIVE/TASK 1: Expedite the response of responsible agencies after disaster strike			
1. The system was able to accurately perform automatic calculations on the total number of dead, missing, injured, displaced and relocated people and display them for reference after disaster strike.	4.42		SA
2. The system was able to accurately provide a list of agencies' name and contact number to be contacted for specific need right after a hit zone was reported.	4.53		SA
3. The system was able to accurately and directly send alert messages to agencies that need to be contacted right away.	4.37		SA
4. The system was able to accurately provide shortest route from user specified source area to user specified destination area.	4.16		A
RESULT	4.37	0.51619	SA
OBJECTIVE/TASK 2: To be able to generate a list of the kinds and volume of relief aids needed per family affected for a fair, precise and timely allocation and distribution.			
5. The system was able to perform automatic calculations on the number of packs of standard relief aids and the number of packs of baby relief aids and display them for reference after disaster strike.	4.42		SA
6. The system was able to list down all the names of the household that needs relief aids allocation per zone affected.	4.47		SA
RESULT	4.45	0.55012	SA
OBJECTIVE/TASK 3: To be able to implement community-based ICT by remotely gathering from each barangay the validated data for pre-storing, the type of hazard or calamity that has hit, the list of affected populations, and road status.			
7. The system allowed barangay focal persons or municipal focal persons to remotely input necessary data and update on the database.	4.53		SA
8. The system allowed barangay focal persons or municipal focal person to remotely report on disaster, its nature and its affect to people and economy.	4.37		SA
9. The system allowed barangay focal persons or municipal focal person to remotely report on route updates whether it's passable or not passable.	4.21		SA
RESULT	4.37	0.54314	SA
System Functionality Over-All Result	**4.39**	**0.5365**	**SA**
Survey Statement	**Mean**	**SD**	**VI**
System Usability			
1. The user could easily comprehend how to use the system.	4.16		A
2. The user could easily learn to use the system.	4.47		SA
3. The user could use the system without much effort.	4.26		SA
4. The interface looked good	4.26		SA
System Usability Over-All Result	**4.28**	**0.47484**	**SA**
Over-All Result of User Acceptability Survey	**4.37**	**0.5211**	**SA**

The system got an over-all mean of 4.37 and SD of 0.52. The mean value indicates that the acceptability

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of system based on its functionality and usability from the perception of potential users was interpreted as "Strongly Agree". The SD, which has a low value, indicates that the response of potential users to survey questions were not largely dispersed. Thus, this means that the system is very much acceptable to almost all potential users.

Table 3. ISO 9126 Survey Result

Survey Statements	Mean	SD	VI
SYSTEM RELIABILITY			
1. (Fault tolerance) The software is capable of handling errors.	4.42		SA
2. (Recoverability) The software can resume working and restore lost data after failure.	4.00		A
Over – all Result of System Reliability	**4.21**	**0.49**	**SA**
SYSTEM EFFICIENCY			
1. (Time Behavior) The system responded quickly.	4.17		A
2. (Resource Utilization) The system utilized resources efficiently.	4.33		SA
Over – all Result of System Efficiency	**4.25**	**0.45**	**SA**
SYSTEM MAINTAINABILITY			
1. (Analyzability) Faults could be easily diagnosed.	4.42		SA
2. (Changeability) The software could be easily modified.	4.33		SA
3. (Stability) The software continued functioning even if changes were made.	4.33		SA
4. (Testability) The software could be tested easily.	4.42		SA
Over – all Result of System Maintainability	**4.38**	**0.55**	**SA**
SYSTEM FUNCTIONALITY			
A. Suitability (Does the system perform the tasks as expected?)			
OBJECTIVE/TASK 1: Expedite the response of responsible agencies after disaster strike.			
1. The system was able to perform automatic calculations on the total number of people dead, missing, injured, displaced and relocated and display them for reference after disaster strike.	4.67		SA
2. The system was able provide a list of agencies name and contact number to be contacted for specific need right after a hit zone was reported.	4.33		SA
3. The system was able to directly send alert messages to agencies that need to be contacted right away.	4.17		A
4. The system was able to provide shortest route from user specified source area to user specified destination area.	4.33		SA
OBJECTIVE/TASK 2: To be able to generate a list of the kinds and volume of relief aids needed per family affected for a fair, precise and timely allocation and distribution.			
5. The system was able to perform automatic calculations on the number of packs of standard relief aids and the number of packs of baby relief aids and display them for reference after disaster strike.	4.33		SA
6. The system was able to list down all the names of the household that needs relief aids allocation per zone affected.	4.42		SA
OBJECTIVE/TASK 3: To be able to implement community-based ICT by remotely gathering from each barangay the validated data for pre-storing, the type of hazard or calamity that has hit, the list of affected populations, and road status.			
7. The system allowed barangay focal persons or municipal focal persons to remotely input necessary data and update on the database.	4.42		SA
8. The system allowed barangay focal persons or municipal focal person to remotely report on disaster, its nature and its affect to people and economy.	4.42		SA
9. The system allowed barangay focal persons or municipal focal person to remotely report on route updates whether it's passable or not passable.	4.50		SA
B. Accurateness (Is the result as expected?)			
1. The system was able to compute the total number of dead, missing, injured, displaced and relocated people accurately.	4.42		SA
2. The system was able to compute the total value of livestock, agriculture, infrastructure and commerce affected.	4.33		SA
3. The system was able to accurately display the specific needs for a given people condition and economic condition.	4.25		SA
4. The system was able to provide the right agency and its contact number for every specific needs that was delivered was by system.	4.42		SA
5. The system was able to send alert message to appropriate agency.	4.33		SA
6. The system was able to provide the shortest route.	4.25		SA
7. The system was able to provide the correct list of people/household who needs relief aids allocation.	4.33		SA
8. The system was able to accurately calculate the total number of standard relief packs and baby relief packs to be distributed.	4.42		SA
9. The system was able to store, retrieve, delete, and update data accurately.	4.75		SA

10. The system was able to generate accurate chart results.	4.50		SA
C. Interoperability (Can the system interact with another system?)			
1. The system could be opened on multiple browsers.	4.67		SA
2. The system could be embedded with different web applications.	4.25		SA
D. Security (Does the software prevent unauthorized access?)			
1. There was a log-in process before accessing the system.	4.92		SA
2. Only the admin could access full system features.	4.92		SA
3. There was a limit set on the access provided to non-admin users	4.83		SA
Over – all Result of System Functionality	**4.54**	**0.39**	**SA**
System Usability			
1. (Understandability) The user could easily comprehend how to use the system.	4.00		A
2. (Learnability) The user could easily learn to use the system.	4.25		SA
3. (Operability) The user could use the system without much effort.	4.00		A
4. (Attractiveness) The interface looked good.	4.00		A
Over – all Result of System Usability	**4.06**	**0.26**	**A**
System Portability			
1. (Adaptability) The software could be moved to other environments.	4.42		SA
2. (Installability) The software could be installed easily.	4.67		SA
3. (Conformance) The software complied with portability standards.	4.08		A
4. (Testability) The software could be tested easily?	4.42		SA
Over – all Result of System Portability	**4.40**	**0.48**	**SA**
OVER-ALL MEAN	**4.31**	**0.36**	**SA**

The over-all mean of the survey on software quality based on ISO 9126 standards conducted to twelve (12) IT experts is 4.31 with an SD value of 0.36. This means that almost all IT experts, who were chosen as respondents, strongly agree that the system complied with the international standards of a software set by ISO.

The surveys on the user acceptability by the end-users and the system's adherence to ISO 9126 international standards by IT experts showed related results. Both end-users and IT experts "Strongly Agreed" that the system is acceptable based on its functionality and usability. To achieve these system requirements, the focus was on the design of the system because the project was seen as risky in terms of its implementation. Proper monitoring of the system functionsand usability along with other software quality standards such as reliability, maintainability, efficiency and portabilitywere given emphasis during the design stage.

CONCLUSION AND RECOMMENDATION

Based on the results of this study, the following conclusions were drawn: (1) the design of the system is capable of expediting the response of responsible agencies after disaster strike; (2) the system is capable of generating a list of kinds and volume of relief aids needed per family affected for a fair, precise, and timely allocation and distribution; (3) the system is able to implement community-based ICT by remotely gathering from each barangay the data for pre-storing, the type of hazard or calamity that has hit, the list of affected populations, and road status; (4) the system complied with ISO 9126 standards; (5) The system is seen as a valuable tool for the PDRRMC and the NDRRMC for it could help expedite the assessment of the effects of disasters and the formulation of response plans and strategies.

To further enhance the system, the following recommendations are proposed: (1) the system design can be made viewable using tablet or smart phones; (2) a sound alert can be integrated in the system administrator's view whenever a new disaster record has been created by focal persons; (3) the Google's street view can be integrated in the system for finding the best possible route using the Google's map; (4) the Graph of Jordan Road Network can be made dynamic such that only queried routes will be visible to viewers; and (5) other hazards known to men such as drought, health problems and disease outbreaks, and fire can be added into the system.

REFERENCES

[1] Undersecretary Proceso T. Domingo. "EAS-India-Workshop 2012: BuildingRegional Framework for Earthquake Risk Management". URL:http://nidm.gov.in/easindia2012/PDF/Pres/Ses1/Pres2.pdf, Nov. 8, 2012. Date Retrieved: Aug. 20, 2015.

[2] AyeeMacaraig. "World media in PH; Cooper slams slow Haiyan Response". URL: http://www.rappler.com/move-ph/issues/ disasters/ typhoon-yolanda/43544-global-media-coverage-haiyan-philippines, Nov 21, 2013 Date Retrived: January 12, 2014.

[3] Barbara Demick. *"Philippines Government Defends Typhoon Response".*URL: Los Angeles Times http://articles.latimes.com /2013/nov/15/world/la-fg-

wn-philippines- defends-typhoon-response-20131115, November 15, 2013. Date Retrived: January 12, 2014.

[4] Chris McGreal ,EstherAddley. *"Haiti Aid Agencies Warn: Chaotic and Confusing Relief Effort is Costing Lives"*. URL: The Guardians, http://www.theguardian.com/world/2010/jan/18/haiti-aid-distribution-confusion-warning, Jan. 18, 2010. Date Retrieved: January 20, 2014.

[5] Government web site. "National Disaster Risk Reduction and Management Plan (NDRRMP) 2011-2028".page4.Internet: http://www.ndrrmc.gov.ph/attachments/article/41/ NDRRM_Plan_20112028.pdf, [Aug. 20, 2015].

[6] MariaLeonila P. Bautista, et al. "Developing a "Rapid Earthquake DamageAssessment System (REDAS)".Internet: http://phdataprep.pbworks.com/f/REDAS_Writeup.pdf, [Aug. 20, 2015].

[7] CRED. "EM-DAT (The International Disaster Database) The Center forResearch on Epidemiology of Disasters (CRED)". Internet:http://www.emdat.be/, [August 20, 2015].

[8] "Judgement Sampling". URL: http://research-methodology.net/sampling/judgement-sampling/. Date Retrived: March 9, 2016

[9] Alain Abran, Rafa E., Al-Qutaish,Jean-Marc Desharnais, Naji Habra. "ISO Based Model to Measure Software Product Quality". Internet:http://s3.amazonaws.com/publicationslist.org/data/ a.abran/ref-2273/1096.pdf, [Oct. 21, 2015].