International Journal of Multidisciplinary Approach and Studies
ISSN NO:: 2348 – 537X

Post-Disaster Needs Analysis Using Predictive Analytics

Ebajo, Cheryl A.* **& Kummer, Marifel Grace, DIT****

**School of Information Technology and Engineering, Doctor in Information Technology, St. Paul's University Philippines*

***Dean, School of Information Technology and Engineering, Doctor in Information Technology, St. Paul's University Philippines*

ABSTRACT

Post-disaster recovery methods are empirical steps undertaken by both government and disaster-stricken groups. The identification of post-disaster needs is one of the heaviest challenges in post-disaster recovery and is crucial in ascertaining that post-disaster responses including funds are properly implemented and managed. Currently, the local DRRMs in Biliran utilizes manual operation which is prone to duplication of post-disaster strategies and mismanagement of emergency funds. This study aimed to develop a model for evaluating post-disaster needs analysis using predictive analytics. It was carried out to provide data on post-disaster needs and delivery methods through the use of gauges such as geographic, physical, economic and social and other predictors of vulnerability and to determine the vulnerability index of disaster-prone areas in the province of Biliran. The developed system will aid DRRM directors and other officials in implementing operational and well-organized steps or processes in procuring, handling and delivering relief goods and materials to a specific person or area. Participants of the study comprised of municipal disaster risk reduction officer, barangay captains and designated officials per municipality, provincial disaster risk reduction management officer, selected households in the province and IT experts, with a total of 459. Data were gathered through survey questionnaire, document scanning, and focused group discussion. Results showed that household structure, household location and vulnerable groups are correlates of vulnerability and that the CART algorithm was the most appropriate for the study. Results likewise showed that the system is compliant with ISO/IEC 25010 Software Quality Standards to a very great extent.

KEYWORDS: *disaster vulnerability, disaster recovery, post-disaster needs, predictive analytic*

INTRODUCTION

The Philippines is the third most vulnerable country in the world to natural catastrophes (National Economic and Development Authority [NEDA], 2017). Typhoons, earthquakes, floods, volcanic eruptions, landslides, and fires are all natural calamities that afflict the nation. More than 160 million people were affected and $10.5 billion in damage was caused by 531 disasters that struck the country between 1900 and 2012. (Center for Excellence in Disaster Management and Humanitarian Assistance, 2018).

With the enactment of the Climate Change Act of 2009 (RA 9729) and the Disaster Risk Reduction and Management Act of 2010, disaster risk reduction, climate change adaptation, and mitigation (DRRCCAM) has been included into development plans at all levels and across industries.

The country's DRRM efforts can be strengthened by using communication as a tool. Because almost 80% of the country's households have mobile phones (IRIN, 2012) and 32% have smart phones (Statista, 2017), texting early warning notifications is a potential solution.

Because of its location and geography, Biliran is not one of the most regularly hit by natural disasters in the region. As a result, this research gathered information on the types of disasters that have hit the province of Biliran, as well as how the vulnerability index of families was used to manage community needs during disasters.

Unlike earlier hazard mapping studies that use a geographic information system (GIS) to generate data, this one relied on data from DRR coordinators in the province of Biliran as well as community people. In addition, rather of using data mining, statistical modeling was used to provide predictive analytics.

Conceptual Paradigm of the Study

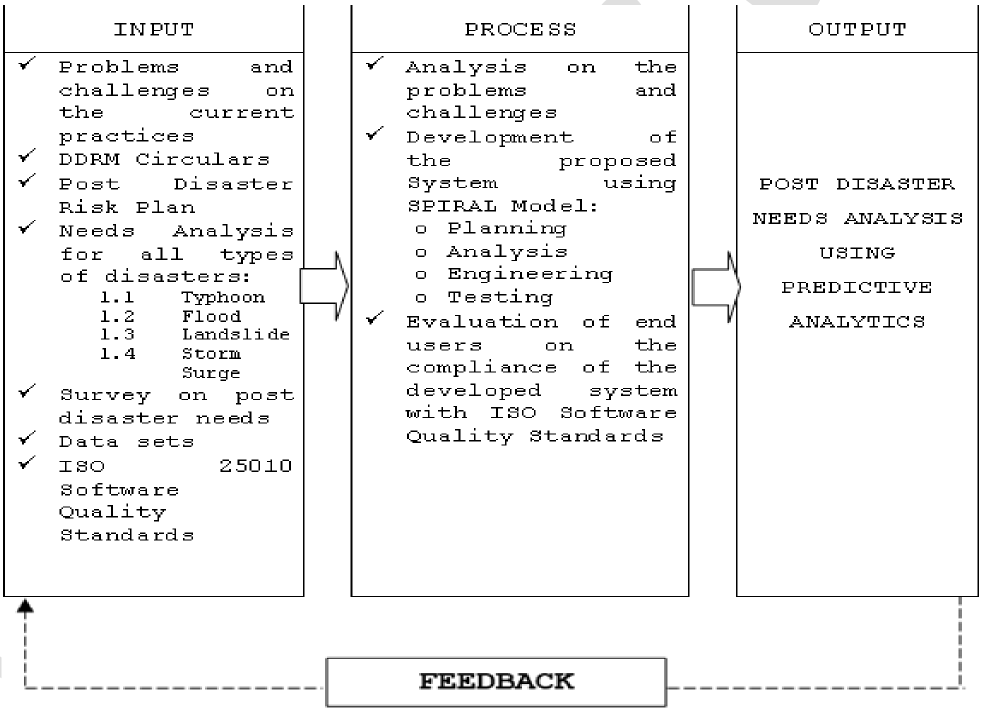


Figure 1. Conceptual Paradigm of the Study

The conceptual paradigm of the study is depicted in Figure 1, it shows the input-process-output (IPO) framework in order to help in evaluating the effectiveness of the application, it shows how the specific activities undertaken in this study. The IPO framework is based on classic systems theory, which states that the general structure of a system is as important in determining how effectively it will function as its individual components (Iresearchnet, 2019). Similarly, the IPO model has a causal structure, in that outputs are a function of various group processes, which are in turn influenced by numerous input variables.

Statement of the Problem

This study seeks to develop a model for evaluating Post-Disaster Needs Analysis Using Predictive Analytics.

Specifically, it sought to answer to the following:

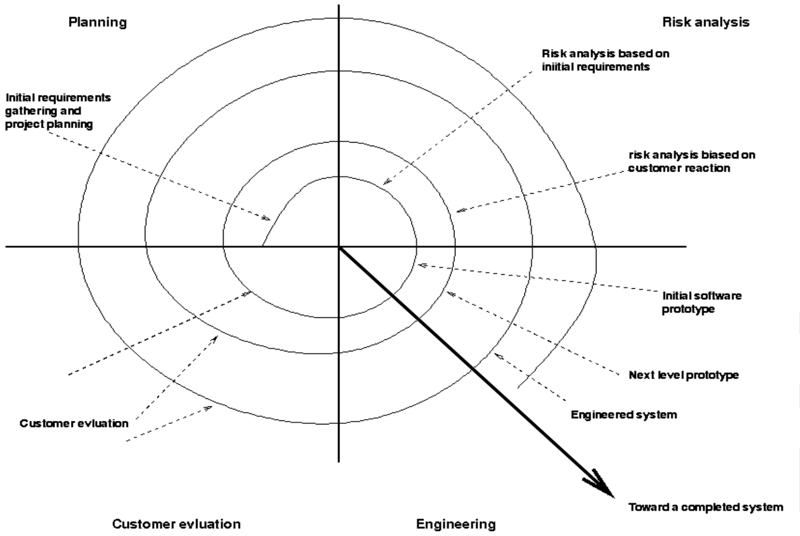
1. What are the current practices employed by the PDRRMC after the disaster?
2. What are the significant correlates of vulnerability?
3. What are the predictors of vulnerability?
4. What classification algorithm is most appropriate to build predictive models for vulnerability?
5. What model can be developed to manage the vulnerability?
6. What system can be developed to manage the vulnerability basing on the index?
7. What is the extent of compliance and usability acceptance level of the developed application with ISO 25010 Software Quality Standards as assessed by the IT Expert and Users in terms of: Functional Suitability, Performance Efficiency, Compatibility, Usability, Reliability, Security, Maintainability, Portability;
8. What enhancement can be done to improve the developed system?

METHODOLOGY

Because the study was descriptive-correlational in nature, the descriptive-correlational research design was used. In descriptive investigations, researchers observe, count, outline, clarify, and classify events (Polit & Beck, 2010). Data from the study was used to determine the types of disasters that occur and where they occur. To identify data on the community's prospective needs in the case of a catastrophe, descriptive labels were employed. The intensity of a relationship between two numeric features in a data collection utilizing descriptive data and Weka® is described as correlation.

The descriptive-correlational research design was adopted in the study. Researchers conduct descriptive studies to characterize a certain event by observing, counting, delineating, elucidating, and classifying it (Polit & Beck, 2010). The survey data was utilized to define the different sorts of catastrophes that occur and where they occur. Data on potential community needs during catastrophes were labeled descriptively. Correlation is extracted from descriptive data using Weka®, which specifies the strength of association between two numerical features in a data collection.

Architectural Design



The Software Development Model is depicted in Figure 2. The spiral model of software development was used to create the system. The evolutionary process starts in the centre and goes clockwise. Prototyping is used as a risk reduction strategy and allows for the construction of prototypes at any point of the evolutionary development.

The municipal disaster risk reduction officer, barangay captains and designated officials for each municipality, the provincial disaster risk reduction management officer, selected households in the province, and IT experts evaluated the system for compliance with ISO standards for software quality in terms of functional sustainability, usability, reliability, efficiency, maintainability, and portability. Table 1 lists the study's participants.

Table 1. Number and Percentage Distribution of Participants of the Study

Participants	Number	Percentage
municipal disaster risk reduction officer	8	1.743
barangay captains per municipality	40	8.72
provincial disaster risk reduction management officer	1	2.20
Households	400	87.20
IT Experts	10	2.18
Total	459	100.00

The data for this study were acquired using an accepted survey questionnaire from the International Federation of Red Cross and Red Crescent Societies' nine (9) modules (2000). Purposive data sampling was used in this study, which included real polled participants from households as well as data acquired from other LGUs' records, barangay, municipal, and provincial disaster risk officers, and IT experts. Other information was gathered through Focused Group Discussion and a face-to-face interview. Data triangulation was also performed to ensure the study's credibility. The spiral model of software development was used to create the program. The program was evaluated by the end users.

The information gathered was tabulated, examined, interpreted, and summarized using descriptive and inferential statistics. The statistical techniques listed below were used: 1) to characterize the data, descriptive statistics such as frequency counts, percentage, mean, and standard deviation were employed.

Table 2: ISO 25010 Software Quality Characteristics

Rating Scale	Range	Qualitative Descriptive
5	4.20-5.00	Very High Extent
4	3.40-4.19	High Extent
3	2.60-3.39	Moderate Extent
2	1.80-2.59	Low Extent
1	1.00-1.79	Very Low Extent

2)Correlation was utilized to create a model to determine the susceptibility level of a certain home. Text, tables, and graphs were used to convey the data. SPSS was used to analyze the collected data. Similarly, Weka was used to determine the correlations of vulnerability and the predictors of vulnerability.

Table 3: Qualitative Interpretation of Household Structure, Household Location and Vulnerable Groups

Rating Scale	Range	Classification
5	4.20-5.00	Very High
4	3.40-4.19	High
3	2.60-3.39	Moderate
2	1.80-2.59	Low
1	1.00-1.79	Very Low

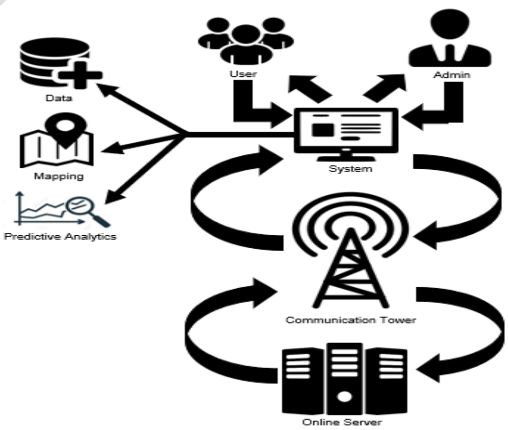


Figure 3. System Architecture

The system architecture is depicted in Figure 3, which depicts the flow of the two-user interface, the user interface, and the administrator interface. The user interface has restricted access in which the system can be accessed using the user's account and password, maps can be seen and loaded, and data in the disaster risk reduction management office can be utilized by the user to engage with its system. As shown in the diagram, after login into the system, the user will pass the communication tower, which is the gateway to the server, which contains all of the data obtained by the researcher.

RESULTS AND DISCUSSIONS

The Provincial Disaster Risk and Reduction Office (PDRRMO) has also encountered notable problems and challenges, such as insufficient Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA) databases and tools/systems for database establishment Risk assessments were based on Hazard Maps generated by Mines and Geosciences Bureau due to a lack of data and information the need for well-trained technical personnel to handle the tools and systems for establishment, insufficient/lack of database management system for climate change adaptation/disaster risk reduction, absence of functioning database and website for climate change adaptation/disaster risk reduction Human and Financial Resource Management, and insufficient physical, financial, and human resources Furthermore, additional help should be offered to stakeholders who are currently creating and managing disaster risk reduction measures in order to lessen food sovereignty challenges in areas of the nation when natural catastrophes occur.

The housing construction, location, and susceptible groups were identified as the significant vulnerabilities for this purpose.

Table 4. Significant Correlation of Vulnerability

	Attributes	Pearson r	Sig.(2-tailed)	Description
1	House Structure	.505**	.000	significance
2	Location	.435**	.000	significance
3	Vulnerable Groups	.525**	.000	significance

**. Correlation is significant at the 0.01 level (2-tailed).

As seen in Table 4, the vulnerability predictors had an r-value less than 0.01** level of significance. As a result, it may be drawn or interpreted that such characteristics are directly associated or have influenced the level of susceptibility, which is noteworthy.

Table 5. Predictors of Vulnerability

	Attribute Name	Description
1	House Structure	Shanty Light Materials Semi-Concrete Concrete Concrete Two-Storey Up

2	Location	Landslide Prone Flood Prone Storm Surge Prone
3	Vulnerable Groups	Pregnant Person with Disability (PWD) Children (ages 1-12) Senior (ages 60 above)

Table 5 on the preceding page displays the household data that will be used to determine the predictors of vulnerability. These include vulnerable populations such as pregnant women, people with disabilities, children, and the elderly. Household types are also classified as shanty, light materials, semi-concrete, concrete, and concrete in two or more stories, and the site of the home is described as landslide, flood, and storm surge prone. These data provided as a source of data information in discovering its flaws.

Table 6. Comparison Accuracy and Performance of the Algorithms

Algorithm	Time taken to build model	Correctly Classified Instances	Incorrectly Classified Instances	Kappa Statistic	TP Rate
CART	0.03	386 - 96.5%	14 - 3.5%	0.9318	0.965
J48	0.04	376 - 94%	24 - 6%	0.8855	0.940
SPAARC Decision Tree	0.01	383 – 95.75%	17 - 4.25%	0.9175	0.958

The findings are examined and displayed using the table obtained, which is the Comparison Accuracy and Performance of the three Algorithms. It was discovered that the CART Decision Tree algorithm performs better for the study and is the most appropriate predictive model to be integrated in managing and determining post-disaster resilience in terms of the level of vulnerability of the household and forecasting the post-disaster community needs when contrasted to the SPAARC Decision Tree and J48 Pruned Tree algorithms for the model's creation.

Table 7. Summary of System Evaluation in Compliance of the Developed System with ISO/IEC 25010 Criteria

ISO/IEC 25010 Characteristics Criteria	Mean	Interpretation
Functional Suitability	4.58	Very High Extent
Performance efficiency	4.67	Very High Extent
Compatibility	4.59	Very High Extent
Usability	4.68	Very High Extent
Reliability	4.63	Very High Extent
Security	4.66	Very High Extent
Maintainability	4.55	Very High Extent
Portability	4.67	Very High Extent
Overall Mean	4.63	Very High Extent

The table above summarizes the extent to which the created system complies with the ISO 25010 standard. Usability has the greatest weighted mean of 4.68, indicating that it is to a very high level. The participants evaluated the Maintainability as Very High Extent with a weighted mean of 4.55. The evaluation results show that Functional Suitability has a weighted mean of 4.58, Compatibility has a weighted mean of 4.59, Usability has a weighted mean of 4.68, Reliability has a weighted mean of 4.63, and Security has a weighted mean of 4.66, all of which are qualitatively described as very high.

3.1. Screen Designs of the developed system

The succeeding snapshots present the Interface of the developed system, the post-disaster data and information per barangay, where it presents in a statistical graph of data and information determining the exact individual needing post-disaster reliance and determining policies that are needed to supply and support per Barangay.

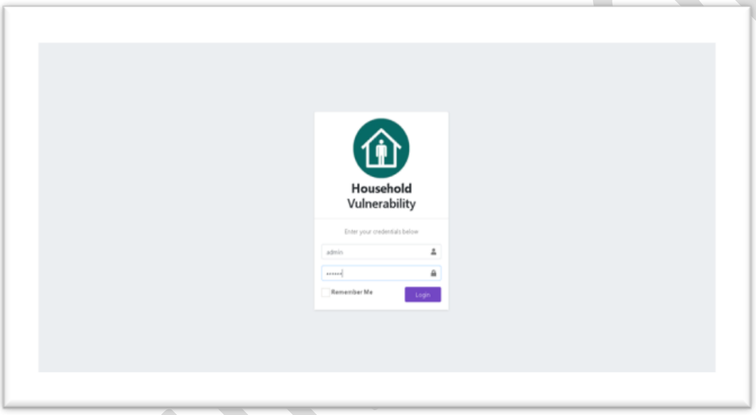


Figure 4. System Login Form

The figure above is the system login form; the main purpose of the login form is to authenticate credentials to access a restricted page of a system or website and that a login form asks username and its password for authentication to access such restricted sites or pages.

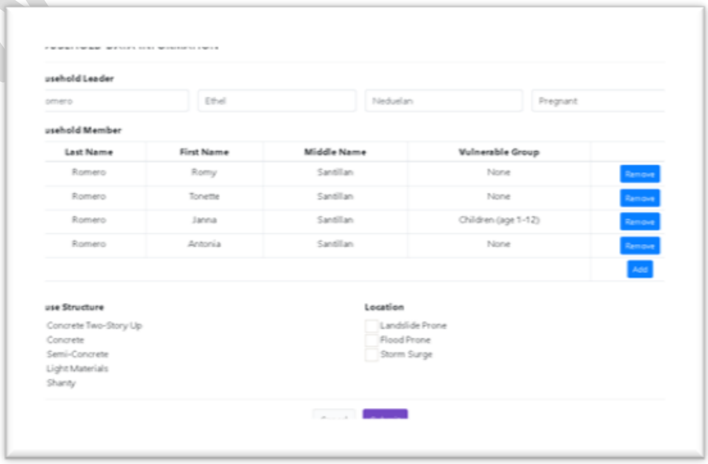


Figure 5. System Login Form

The figure above displays the household form filled-up. It consists of general information of the household where users can update their household information, household member information. The data supplied are the basis in predicting the household vulnerability index.

Figure 6. Household Vulnerability Index Information

Figure 6 shows the vulnerability index result and the color-coded household based on the computed vulnerability index.

HH Leader Data
HH Member Data
HH Vulnerable Data
Reports

Search here..

Household Leader	Vulnerability Type	Household Structure	Location
Dela Cruz, Juan Garcia	Senior (age 60 above)	Shanty	Landslide Prone, Flood Prone, Storm Surge
p, u k	None	Shanty	
ETOR, LEONEL TOMOLIN	None	Concrete Two-Story Up	
ETOR, LEONEL TOMOLIN	Person with Disability (PWD)	Light Materials	Storm Surge
ETOR, LEONEL TOMOLIN	Person with Disability (PWD)	Concrete Two-Story Up	Storm Surge
Ebajo, Cheryl Acero	Person with Disability (PWD)	Concrete Two-Story Up	Landslide Prone, Flood Prone, Storm Surge
ETOR, LEONEL TOMOLIN	None	Light Materials	Landslide Prone, Flood Prone, Storm Surge
ETOR, LEONEL TOMOLIN	None	Light Materials	Landslide Prone, Flood Prone, Storm Surge
Ebajo, Cheryl Acero	Senior (age 60 above)	Light Materials	Landslide Prone
ETOR, LEONEL TOMOLIN	None	Light Materials	Landslide Prone, Flood Prone
ETOR, LEONEL TOMOLIN	None	Concrete	Landslide Prone
ETOR, LEONEL TOMOLIN	None	Concrete	Landslide Prone
Romero, Ethel Neduelan	Pregnant	Concrete Two-Story Up	
f, f f	Person with Disability (PWD)	Concrete Two-Story Up	

Figure 7. Household Vulnerability Information

Figure 7 shows a list of household and vulnerability index information in the barangay.

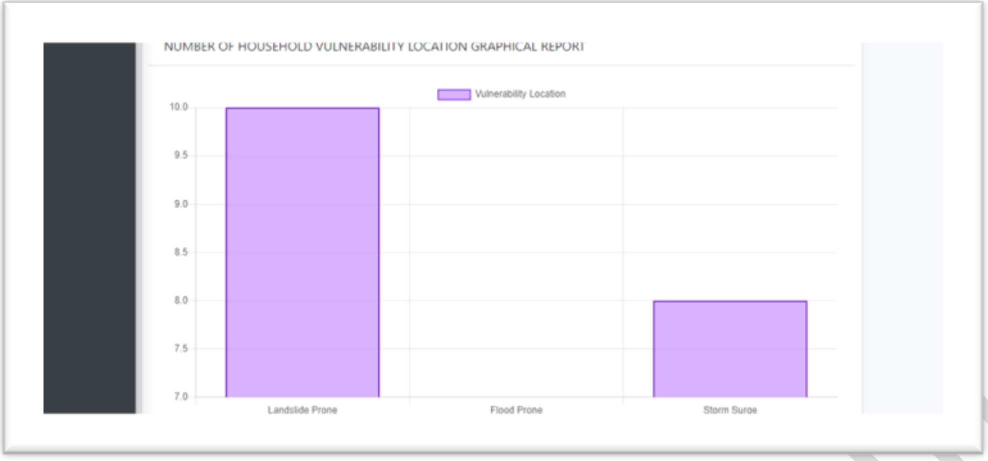


Figure 8. Graphical Reports as to Prone Location

The figure above shows the statistical data and information of the barangay household located in the prone area.

CONCLUSIONS

The developed application of a Post-Disaster Requirements Analysis Using Predictive Analytics is an operational tool for improving the semi-digitalized procedures of recognizing a community's needs following a disaster, particularly in terms of relief operations. Municipal and provincial DRRM directors may use this updated intelligent system to aid them in providing the precise commodities and resources required by a specific location or individual (s). The predictors identified were used as the basis for the computation and identifying the vulnerability level of the household. Such as level will then be the source in giving out the relief assistance as well as prioritization. This technique is also very useful in reducing manual effort in terms of identifying the requirements of a disaster-stricken community and eliminating redundancy in the distribution of relief items, so ensuring an equitable procedure, which is the final problem being addressed.

RECOMMENDATIONS

Based on the conclusion reached, the following are recommended by the researcher:

1. The system may be offered to the different PDRRMO and MDRRMO offices in the province for its utilization as it benefits the province of Biliran, especially that of the disaster-prone towns or municipalities. Whereas, with this system of geographical representation of vulnerable areas using maps, area of vulnerabilities will be immediately identified in pre, during, and post disaster response by the concerned LGU and agency of responses to natural disaster.
2. Disaster resilience offices must have close coordination between and among other government agencies and departments that are also engaged in disaster affairs in order to reach the full potential of the system. With this system, a centralized mapping approach of geographic representation of map in vulnerable areas of household will be at utilized.

3. Furthermore, the Provincial Disaster Risk and Reduction Management Office seriously needs to migrate into a digitalized platform especially in terms of post-disaster activities as it would give them data-driven approach in accurately addressing needs of disaster-affected individuals.
4. The researcher may consider adding further category of disasters such as those that are man-made like disease outbreaks, pandemics and armed conflicts.
5. Future researchers may conduct further studies on this topic to improve the developed system and that future researchers may integrate its developed application to the system that will enhance its potential for pre, during, and post disaster resilience.

REFERENCES

i. NEDA. (2017). Eastern Visayas Regional Development Plan. Retrieved from https://www.neda.gov.ph/wp-content/uploads/2018/02/8-Eastern-Visayas-RDP-2017-2022_16Jan2018.pdf

ii. Center for Excellence in Disaster Management and Humanitarian Assistance. (2018). *Philippines Disaster Management Reference Handbook*. https://www.cfe-dmha.org/LinkClick.aspx?fileticket=nZpxHvsFZqA%3d&portalid=0

iii. IRIN. (2012) *Mobile Phone App Could Help Disaster Preparedness*. Retrieved from http://www.irinnews.org/report/96588/philippines-mobile-phone-app-could-helpdisaster-preparedness

iv. Statista. (2017). Number of Smartphone Users in the Philippines from 2015 to 2022 (in millions). Retrieved from https://www.statista.com/statistics/467186/forecast-of-smartphone-users-in-the-philippines/

v. RPat Research. (2018). What is Predictive Analytics? https://www.predictiveanalyticstoday.com/what-is predictive-analytics/

vi. Iresearchnet. (2018). Input-Process-Output Model. Retrieved from https://psychology.iresearchnet.com/industrial-organizational-psychology/group-dynamics/input-process-output-model/

vii. Polit, D. F., & Beck, C. T. (2010). Essentials of Nursing Research: Methods, Appraisal, and Utilization. Philadelphia: Lippincott Williams & Wilkins.

viii. Connelly, L. M. (2020). Inclusion and exclusion criteria. Medsurg Nursing, 29(2), 125-116. International Federation of Red Cross and Red Crescent Societies. (2000). *Disaster Emergency Needs Assessment*. Retrieved from https://reliefweb.int/sites/reliefweb.int/files/resources/68670227B8D36444C1256C36002A192A-ifrc-disaster-jun00.pdf

ix. Cutter, S. L., Ash, K. D., & Emrich, C. T. (2016). Urban–rural differences in disaster resilience. Annals of the American Association of Geographers, 106(6), 1236-1252.

x. Proverbs, D., & Lamond, J. (2017). Flood resilient construction and adaptation of buildings. In Oxford Research Encyclopedia of Natural Hazard Science.

xi. Noda, A., Suzuki, S., Shimada, M., Toda, K., & Miyagi, Y. (2015, July). COSMO-SkyMed and ALOS-1/2 X and L band multi-frequency results in satellite disaster monitoring. In 2015 IEEE International Geoscience and Remote Sensing Symposium (IGARSS) (pp. 211-214). IEEE.

xii. Chang, S.E., Yip, J.Z.K., van Zijll de Jong, S.L. et al. Using vulnerability indicators to develop resilience networks: a similarity approach. Nat Hazards 78, 1827–1841 (2015). https://doi.org/10.1007/s11069-015-1803-x

xiii. Gama, J. & Brazdil, P. (2005). Characterization of Classification Algorithms. Springer, pp. 189-200, https://doi.org/10.1007/3-450-60428-6_16