Development of Evacuation Plan by Utilizing Transportation Modeling in the City of Borongan, Eastern Samar

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Abstract: This research aimed to generate and develop an evacuation plan by means of transportation modeling. This study created a transportation model which could be used during the evacuation process. It included the determination of the most efficient and safest routing strategy. Moreover, the capacity of existing evacuation center was analyzed. In generating the evacuation plan, the study area was divided into geographic zones and the formulation of trip generation, trip distribution, modal split and route selection will be made. Based on result of the study, the City of Borongan does not have a sufficient number of evacuation center and their existing evacuation center did not pass the DSWD standards for evacuation centers. The city does not have enough paved roads, which makes it harder for the people to evacuate in times of calamities.

Keywords: Transportation Modeling, Evacuation Plan, Route Selection

1. INTRODUCTION

1. 1. Background of Study

According to the Weather Philippines Foundation, 100 cyclones form in the world every twelve months, where two-thirds become typhoons and hurricanes. Western North Pacific Ocean which includes the Philippine Sea has the highest typhoon formation of 30%, then the East Pacific Ocean by 15%, the East Pacific Ocean by 15%, Western Atlantic Ocean-South and North Indian Oceans-South Pacific Ocean by 12%, and lastly Northern and Western Australia by 7%. By observing the location of the Philippines, we can say that the occurrences of Typhoons are very usual. Moreover, the rate of global warming-induced climate change has increased which led to significant increase in number and strength of the storms striking our country. Also, Time magazine stated that since our country is a located in the western circumference of the Pacific Ocean, thus, making the Philippines as the most exposed to the typhoons. With 7,107 islands, the shores are susceptible to storm waves. The Northern Luzon and Eastern Visayas are the country's area that is most visited by typhoons. Thus, we can say that the Philippines posts great danger in the presence of typhoon. In fact on the year 2009, Philippines was struck by typhoon Ondoy, on 2010 typhoon Juan, on 2011 typhoon Sendong, on 2012 typhoon Pablo and last year, super typhoon Yolanda which is by far the most powerful tropical cyclone ever recorded in history. Typhoons that happen to landfall greatly damage our country by destroying infrastructures, agriculture, etc. Taking Typhoon Yolanda into consideration, the accumulated cost of damages equivalent to 79.64 billion for both infrastructure and agriculture. Typhoon Yolanda also brought 6,500 casualties, 28,689 injuries and 1,061 missing.

One of the main priorities of a Civil Engineer is to ensure the safety of civilians. Thus, in order for engineers to save people effectively during calamities, evacuation planning is very essential. A successful evacuation is characterized by its speed and the effectiveness. The speed of evacuation is generally the time needed to evacuate all of the people before the storm reach them. Effectiveness of evacuation is about evacuating the people completely in a certain area.

Evacuation planning has been implemented in various countries yet in the Philippines, there are few evacuation plans and some are even outdated. Previous experiences during typhoons have thought us that the main cause of deaths is the failure to evacuate safely. From this, the researchers were inspired to create an evacuation plan that will answer the needs of the people during calamities. The researchers choose Borongan City, Eastern Samar (one of the areas that was affected by Typhoon Yolanda) as the area under study and the beneficiary of the generated evacuation plan.

1.2. Statement of the Problem

Every year, typhoons not only cause deaths but also hinder the growth of economy. Our government has been very active in implementing policies and even formed the NDRRMC to address the problem that occurs during typhoon.

Several typhoon prone areas in the Philippines has either an obsolete evacuation plan or does not have any evacuation plan at all, which imposes great danger to the citizens living on those areas. The researchers found out that Borongan City doesn't have an existing evacuation plan. The lack of an evacuation plan increases danger to the lives of people and lessens the chance of survival. Moreover, evacuation plans are very critical during disaster. It is very necessary in promoting safety and in lessening the rate of fatalities acquired during a disastrous typhoon.

1.3. Goals and Objectives

The core goal of this study is to create a sufficient and effective evacuation plan in the City of Borongan, Eastern Samar that can be used during typhoon evacuation.
The other goals and objectives that the researchers would like to achieve are the following:

- To design and to determine the most efficient and safest routing strategy
- To determine the capacity of existing evacuation center and to determine whether the evacuation centers are enough or not

1.4. Significance of the Study

This study targets to generate a new evacuation plan for the City of Borongan which would help in assisting the people to safety during disaster. This would be possible by utilizing transportation system planning by means of transportation modeling.

This study would be of great help to the local government unit (LGU) of Borongan City and to the citizens of the said area. In addition, it would guide the evacuees during evacuation on which path they should take and the safest place they could go to. Plus, it would increase the chance of survival and promote safety during disaster. This thesis will be very beneficial to the country since it would be able to reduce the death toll caused by typhoons. Moreover, this study could serve as a basis in generating evacuation plan to other areas prone to typhoon.

1.5. Scope and Limitations

This study intends to promote risk reduction during calamities. It is mainly concerned in creating a transportation model which would help in generating the evacuation plan. This study would involve the determination of the safest and the most effective routing strategy that could be used to reach a safe destination. This thesis would also involve the identification of the safest areas within the city in an event of natural calamity by classifying the areas with high and low elevation. It would also cover the time it would take evacuees to reach their destination and the mode of transportation preferred by the evacuees.

However, the generated evacuation plan will be limited to the City of Borongan, Eastern Samar. Even if the researchers are concerned in the capacity of the evacuation center, this study is not concerned with the design or creation of evacuation centers.

2. REVIEW OF RELATED LITERATURE

Evidences of the World's Climate Change

The Climate change is evident all over the world. According to the Intergovernmental Panel on Climate Change (IPCC), which is an organization of 1,300 scientists from the different parts of the world, predicted a temperature increase of 2 to 4.5 degrees Celsius in the coming years. IPCC also states that: "the range of published evidence indicates that the net damage costs of climate change are likely to be significant and to increase over time". The panel forecasts that the freshwater availability estimated to reduce in Asia in the coming years. The seaside areas in the Asia will be at danger due to excessive flooding. The death rate from flood and drought related diseases are anticipated to increase in other places of Asia

Republic Act 10121

In the Philippines, the government has passed an act as a response to the occurrence of natural calamities in the country. According to the DILG, "The Republic Act 10121 otherwise known as the Philippine Disaster Risk Reduction and Management Act of 2010. The National DRRM Plan serves as the national guide on how sustainable development can be achieved through inclusive growth while building the adaptive capacities of communities; increasing the resilience of vulnerable sectors; and optimizing disaster mitigation opportunities with the end in view of promoting people's welfare and security towards gender-responsive and rights-based sustainable development. This act has laid the basis for a paradigm shift from just disaster preparedness and response to disaster risk reduction and management (DRRM)." The section 3 of the RA 10121, Disaster preparedness is classified as ability of the administration, certified response and recovery associations, community and the people to efficiently foresee, react and recover from the impending hazardous situation. Disaster Prevention is the complete prevention of the impacts of the impending hazardous situation. It also involves the complete avoidance to difficult impact through taking measures in advance. Disaster Mitigation is the reduction of the impacts of the impending hazardous situation. Mitigation includes engineering practice and construction of disaster resilient structures as well as enhanced environmental policies and civil responsiveness. Prevention and Mitigation presents the strategic measures that provide significance to plans in danger assessment and alleviation, susceptibility study, and classification of hazardous areas.

A model for evacuation risk assessment with consideration of pre- and post-disaster factors

Along with funding programs that would save the earth from global warming and climate change, we should also do something to prevent risks and possible deaths because of this matter.

In the study by Chen, X., Kwan, Li and Chen, J. (2010) where they have discussed the pre- and post-disaster factors of risk assessment, they also identified seven phases of evacuation. An evacuation plan is a necessity in places that are prone to typhoons, floods and other natural calamities, especially now that there is an expected increase in floods in coastal areas. Evacuation is a necessity to mitigation from disasters. It is also described as transferring hazardous places to safe places. Evacuation can be compulsory or optional but should be performed in accordance to an evacuation plan. Evacuation is a difficult procedure of seven stages. The first phase is when a hazardous event has been distinguished, while in the second phase, the evacuation order is being issued. The time span from the end of phase I to the end of phase II is identified at the decision time. In the third phase, the order should be delivered to the public through the use of transmitters. The end of phase II to the entire duration of phase III is considered as the notification time. The fourth phase is the phase where the community decides and prepares to evacuate, this is known as the evacuation time, while the fifth phase is when the people moves through the transportation network to the evacuation areas or the safe areas. The sixth phase is the arrival of the evacuees to the evacuation site, while in the last phase the number of evacuees should be verified to check if they made it to the designated safe area. Phases V to VII is identified as the response time or the clearing time (Stepanov & Smith, 2007). Evacuation is a synchronized response to catastrophes. As a vital part of disaster response, evacuation is made to lessen loss of life and property by transferring people from hazardous places to safer places. (Perry & Lindell, 2003). Evacuation can also be made even before a catastrophe started. Due to catastrophes being unanticipated, Successful evacuation is a precautionary action to deal with unanticipation. (Cutter, 2003).

Evacuation Transportation Modeling: An overview of research, Development, and Practice

In the study by Tuite and Wolshon (2012), they were able to discuss the steps and methods used in evacuation transportation modeling. Transportation modeling is important in this study since it is the method that will be used in making the evacuation plan. The study enumerated the steps that should be made in transportation modeling. For this study, the researchers just choose the steps that are significant. The methods used are: zoning, demand modeling, traffic assignment and route selection, and evacuation strategies.

Public Behavior Response Analysis in Disaster Events Utilizing Visual Analytics of Microblog Data

In the work by Chae, Thomb, Jang. Kim. Ertl and Ebert, they have presented a visual analytics system for public behavior analysis and response planning in disaster events using social media data. They also proposed multiple visualizations of spatiotemporal analysis for disaster management and evacuation planning. For the spatial decision support, they demonstrated an analytical scheme by combining multiple spatial data sources. The temporal analysis enables analysts to verify and examine abnormal situations. Moreover, they demonstrated an integrated visualization that allows spatial and temporal aspects within a single view. They still have some limitations with these techniques including the potential occlusion issues in the spatiotemporal

visualization. For future work, they will investigate the flow of public movement before and after disasters and the analysis for recovering from disasters and crises. They also plan to design the glyphs with varied sizes adapting to the zoom level in the spatiotemporal visualization. In addition, they will conduct a user evaluation for the usability and effectiveness of the geospatial visual support, and the impact of interactive spatiotemporal visual analytics using social media data on disaster management.

3. METHODOLOGY

The study used 4-Step Model of Transportation Modeling to analyze the gathered data. The 4-Step Model is composed of Trip Generation, Trip Distribution, Mode Assignment, and lastly Route Assignment.

In Trip Generation, it determined the number of trips that are needed to evacuate the entire population. To know the number of trips, the researchers identified the number of population at risk in Borongan City. After identifying the different population at risk, the researchers divided the population into different zones. The entire city was then divided into different zones. These five clusters are the Poblacion cluster, Maypangdan cluster, Benowangan cluster, Lalawigan cluster and lastly, the San Jose- Calingatngan cluster.

For the next step, Trip Distribution, the researchers identified the number of trips needed for a certain destination. In this study, the researchers identified a number of pick- up points per barangay and proposed area for a suitable evacuation site.

In Modal Choice, the researchers decided what kind of transportation can be implemented. However in this study, it is assumed that the evacuation process takes place hours before the typhoon and that all the vehicles that will be used are trucks and other government vehicles.

Lastly for route assignment, the researchers recommended route which is the safest and shortest way that can be used to evacuate the people in the safest and fastest way possible.

4. RESULTS AND DISCUSSION

The group's major goal is to create a sufficient and effective evacuation plan for the city of Borongan, Eastern Samar. Since the main goal is to create an evacuation plan, the necessary data were obtained which includes several maps. The following are the maps that were obtained:

1. City Map
2. Flood Hazard Map
3. Storm Surge Hazard Map
4. Rain-induced Landslide Hazard Map

The maps came from the City Disaster Risk Reduction Management Council (CDRRMC) and are enough to find the safe place for both the earthquake and typhoon disasters. But since the concern is only with typhoon disaster, the first four maps on the list were only used. Those are the city map which includes possible roads, flood hazard map, storm surge hazard map and lastly, the rain-induced landslide hazard map. Figure 4-1 shows the city map.

The city map is one of the most important maps that were obtained in order to plan an evacuation since it showcase the different barangays, the roads that connect each of the barangay and the city boundaries. The city map is also important since it can be used to measure the distance between two places. By looking on the city map, the barangay that will be in danger

if ever a typhoon came will be identified. Those barangays are the coastal barangays near the Philippine Sea and in the Pacific Ocean since generally typhoons originate in the ocean. But to be sure, the hazard maps were used.

This Map of the City of Borongan shows which areas are susceptible to flooding. The blue shaded part of the map indicates the areas that are low to moderate susceptibility to flood. Moreover, the red shaded parts of the map indicate the areas that are highly susceptible to flood. Another feature of this map is that it shows the bodies of water that will be a flash flood exit point. As shown in Figure 4-2, the areas near the bodies of water such as rivers and lakes are also the areas that are shaded. Coastal areas in maps are also shaded which clarifies the recent conclusion that areas near the coast are hazardous to live in. Another map that must be considered is the storm surge map.

The storm surge map of the City of Borongan, Eastern Samar shows the susceptibility of Borongan City to storm surges. A storm surge can be defined as a tsunami-like phenomenon. It comprises of abrupt increase in water level normally related with typhoons. Storm surges are generally Tsunami-like waves made from the storm's wind pattern. In the map shown above, different shaded parts are divided into red, violet, yellow and white. White shaded parts are areas that are not susceptible to storm surges. Yellow shaded parts are areas that are susceptible to inundations of 1 meter surges. Violet shaded parts are areas that are susceptible to inundations of greater than 1 meter to 4 meters of storm surges. Red shaded parts are areas of the map that are susceptible to inundations that are greater than 4 to 12 meters of storm surges. Determining the areas that are susceptible to storm surges isvital to evacuation planning becausethe areas whichthe inhabitants will be at risk will be able to be determined. Another map that was obtained is the rain-induced landslide map.

The rain- induced landslide map of Borongan City, Eastern Samar shows the vulnerability of the city of Borongan to rain-induced landslide. Rain-induced landslide occurs when the rain make the soil easily collapsible. The map is divided into different shaded parts such as white, yellow, violet and red. White shaded parts are areas that are not susceptible to rain-induced landslide. Yellow shaded parts are areas that are low susceptible to rain-induced landslide. The violet shaded parts are areas that are moderately susceptible to rain-induced landslide. The red shaded parts are areas that are highly susceptible to rain-induced landslide. Another feature of the map is that it shows possible areas that are prone to landslide accumulation. Now that the different hazard maps are known, identifying the number of population that lives on those hazardous areas was next. The CDRRMC of the city of Borongan was able to identify the population at risk due to typhoons. Appendix C shows that population at risk with respect to the different barangays. After identifying the different population at risk, the population was divided into different zones. The city was divided into different zones with respect to its land use. It was divided it into 5 clusters, namely, the Poblacion cluster, Maypangdan cluster, Benowangan cluster, Lalawigan cluster and lastly, the San Jose-Calingatngan cluster. The Figure 4-5 shows the boundaries and divisions of each zone.

4.1 Problacion Cluster

4.1.a Trip Generation

The Poblacion cluster is the main cluster of the city of Borongan. This cluster is where the city capital as well as the province capital is located. The Poblacion cluster is composed of barangays: Balud, Songco, Campesao, Sabang South, Alang-Alang, Taboc, Bato,Brgy. A, Brgy. B, Brgy. C, Brgy. D1, Brgy. D2, Brgy. E, Bgry. F, Brgy. G, and Brgy. H. The accumulated population at risk is 3266 people for Poblacion cluster.The number of

population at risk is given by the Disaster Risk Reduction Management of the City of Borongan.

4.1.b Trip Distribution

The tables below shows the population at risk, number of trip, distance from the pick- up points to the safe place, average vehicle speed, approximate time of travel per trip, the total time of the evacuation process and the proposed route. The data are separated per barangay where the pick-up points are positioned.

Table 4.1.b-1 Data and Proposed Route for Bry. Balud

Barangay Balud	
Population at Risk	599
Number of Trips	8
Distance to the safe place, Km	1.8
Average Vehicle speed, Kph	30
Approximate time of travel per trip, minutes	4
Total time, minutes	48
Proposed Route: Balud 2 rd. Circumferential Road	

Table 4.1.b-2 Data and Proposed Route for Bry. Campesao

Barangay Campesao	
Population at Risk	29
Number of Trips	1
Distance to the safe place, Km	2.5
Average Vehicle speed, Kph	30
Approximate time of travel per trip, minutes	5
Total time, minutes	10
Proposed Route: Campesao rd. Circumferential Road	

Table 4.1.b-3 Data and Proposed Route for Bry. Sabang South

Barangay Sabang South	
Population at Risk	584
Number of Trips	8
Distance to the safe place, Km	1.9
Average Vehicle speed, Kph	30
Approximate time of travel per trip, minutes	4
Total time, minutes	64
Proposed Route: Real st. Circumferential Road	

Table 4.1.b-4 Data and Proposed Route for Bry. Songco

Barangay Songco	
Population at Risk	500
Number of Trips	7
Distance to the safe place, Km	1.2
Average Vehicle speed, Kph	30
Approximate time of travel per trip, minutes	3
Total time, minutes	42
Proposed Route: Real St. Circumferential Rd	

Table 4.1.b-5 Data and Proposed Route for Bry. A

Barangay A	
Population at Risk	63
Number of Trips	1
Distance to the safe place, Km	2.2
Average Vehicle speed, Kph	30
Approximate time of travel per trip, minutes	5
Total time, minutes	10
Proposed Route: Cinco St. Real St. New Taboc Road	

Table 4.1.b-6 Data and Proposed Route for Bry. B

Barangay B	
Population at Risk	98
Number of Trips	2
Distance to the safe place, Km	1.5
Average Vehicle speed, Kph	30
Approximate time of travel per trip, minutes	4
Total time, minutes	16
Proposed Route: Abenis St. Real St. Circumferential Rd.	

Table 4.1.b-7 Data and Proposed Route for Bry. C

Barangay C	
Population at Risk	123
Number of Trips	2
Distance to the safe place, Km	1.6
Average Vehicle speed, Kph	30
Approximate time of travel per trip, minutes	4
Total time, minutes	16
Proposed Route: Libanan Rd. Real St. New Taboc Rd.	

Table 4.1.b-8 Data and Proposed Route for Bry. D1

Barangay D1		
Population at Risk	16	
Number of Trips	1	
Distance to the safe place, Km	1.3	
Average Vehicle speed, Kph	30	
Approximate time of travel per trip, minutes	3	
Total time, minutes	6	
Proposed Route: Abadago / Abenis St.	Real St.	New Taboc Road

Table 4.1.b-9 Data and Proposed Route for Bry. D2

Barangay D2		
Population at Risk	290	
Number of Trips	4	
Distance to the safe place, Km	2.0	
Average Vehicle speed, Kph	30	
Approximate time of travel per trip, minutes	4	
Total time, minutes	32	
Proposed Route: Abadago / Abenis St.	Real St.	New Taboc Road

Table 4.1.b-10 Data and Proposed Route for Bry. E

Barangay E		
Population at Risk	28	
Number of Trips	1	
Distance to the safe place, Km	2.3	
Average Vehicle speed, Kph	30	
Approximate time of travel per trip, minutes	5	
Total time, minutes	10	
Proposed Route: Cinco St.	Real St.	New Taboc Road

Table 4.1.b-11 Data and Proposed Route for Bry. F

Barangay F	
Population at Risk	18
Number of Trips	1
Distance to the safe place, Km	1.2
Average Vehicle speed, Kph	30
Approximate time of travel per trip, minutes	3
Total time, minutes	6
Proposed Route: Real St.	New Taboc Rd.

Table 4.1.b-12 Data and Proposed Route for Bry. G

Barangay G	
Population at Risk	82
Number of Trips	2
Distance to the safe place, Km	2.5
Average Vehicle speed, Kph	30
Approximate time of travel per trip, minutes	5
Total time, minutes	20
Proposed Route: Cinco St. → Real St. → New Taboc Road	

Table 4.1.b-13 Data and Proposed Route for Bry. H

Barangay H		
Population at Risk	363	
Number of Trips	5	
Distance to the safe place, Km	2.0	
Average Vehicle speed, Kph	30	
Approximate time of travel per trip, minutes	4	
Total time, minutes	40	
Proposed Route: Campesao Rd.	Real St.	New Taboc Road

Table 4.1.b-14 Data and Proposed Route for Bry. Alang-Alang

Barangay Alang-Alang		
Population at Risk	299	
Number of Trips	3	
Distance to the safe place, Km	3	
Average Vehicle speed, Kph	30	
Approximate time of travel per trip, minutes	4	
Total time, minutes	24	
Proposed Route: Rawis Rd.	Real St.	New Taboc Rd.

Table 4.1.b-15 Data and Proposed Route for Bry. Bato

Barangay Bato		
Population at Risk	681	
Number of Trips	5	
Distance to the safe place, Km	2.2	
Average Vehicle speed, Kph	30	
Approximate time of travel per trip, minutes	5	
Total time, minutes	50	
Proposed Route: Provincial Jail Rd.	Real St.	New Taboc Rd.

Table 4-3.16 Data and Proposed Route for Bry. Taboc

Barangay Taboc	
Population at Risk	91
Number of Trips	1
Distance to the safe place, Km	0.75
Average Vehicle speed, Kph	30
Approximate time of travel per trip, minutes	2
Total time, minutes	4
Proposed Route: Libertad St.	New Taboc Rd.

4.1.c Modal Choice

In this study, it is assumed that the evacuation process takes place hours before the typhoon and that all the vehicles that will be used are trucks and other government vehicles which have an average capacity of 50 persons.

4.1.d Route Assignment

Figure 4.1.d-1 Two Proposed evacuation center in Poblacion Cluster and the proposed routes from each barangays

The figure above shows the proposed location of the evacuation centers. Evacuation Center 1 will be located at Brgy. Songco and Evacuation Center 2 will be located at Brgy. Taboc.The residents of Brgy.Balud, Songco, Campesao, and Sabang South will be accommodated at Evacuation Center 1. While the remaining brangays, Brgy. Alang-Alang, Taboc, Bato, Brgy.A, Brgy. B, Brgy. C, Brgy. D1, Brgy. D2, Brgy. E, Bgry. F, Brgy. G, and

Brgy. H will be accommodated at Evacuation Center 2. Figure 4.1.d-1 also shows the proposed safe route that the residents can use in case of calamities these shown in green arrows. The red lines shows that dangerous roads that should be avoided during typhoons.

4.2 Lalawigan Cluster

4.2.a Trip Generation

The Lalawigan Cluster is located in the southern coastal area of Borongan City. It has member of 9 barangays. The Lalawigan cluster is composed of: Lalawigan, Cabong, Can- Abong, Camada, Locson and Suribao. The accumulated population at risk is 3346 people for Lalawigan cluster. The number of population at risk is given by the Disaster Risk Reduction Management of the City of Borongan.

4.2.b Trip Distribution

The tables below shows the population at risk, number of trip, distance from the pick- up points to the safe place, average vehicle speed, approximate time of travel per trip, the total time of the evacuation process and the proposed route. The data are separated per barangay where the pick-up points are positioned.

Table 4.3.b-1 Data and Proposed Route for Bry. Locso-on

Barangay Locso-on	
Population at Risk	681
Number of Trips	5
Distance to the safe place, Km	8.8
Average Vehicle speed, Kph	60
Approximate time of travel per trip, minutes	9
Total time, minutes	90
Proposed Route: National. Hwy Can-abong Provincial Rd.	

Table 4.3.b-2 Data and Proposed Route for Bry. Cabong

Barangay Cabong	
Population at Risk	72
Number of Trips	1
Distance to the safe place, Km	3.7
Average Vehicle speed, Kph	60
Approximate time of travel per trip, minutes	4
Total time, minutes	8
Proposed Route: National. Hwy Can-abong Provincial Rd.	

Table 4.3.b-3 Data and Proposed Route for Bry. Camada

Barangay Camada	
Population at Risk	369
Number of Trips	3
Distance to the safe place, Km	9.2
Average Vehicle speed, Kph	60
Approximate time of travel per trip, minutes	10
Total time, minutes	60
Proposed Route: Camada Rd. National. Hwy Can-abong Provincial Rd.	

Table 4.3.b-4 Data and Proposed Route for Bry. Can-Abong

Barangay Can-Abong	
Population at Risk	788
Number of Trips	6
Distance to the safe place, Km	2.5
Average Vehicle speed, Kph	60
Approximate time of travel per trip, minutes	3
Total time, minutes	36
Proposed Route: Can-Abong Provincial Rd.	

Table 4.3.b-5 Data and Proposed Route for Bry. Lalawigan

Barangay Lalawigan	
Population at Risk	129
Number of Trips	1
Distance to the safe place, Km	6.5
Average Vehicle speed, Kph	60
Approximate time of travel per trip, minutes	7
Total time, minutes	14
Proposed Route: National. Hwy Can-abong Provincial Rd.	

Table 4.3.b-6 Data and Proposed Route for Bry. Suribao

Barangay Suribao	
Population at Risk	157
Number of Trips	2
Distance to the safe place, Km	7.5
Average Vehicle speed, Kph	60
Approximate time of travel per trip, minutes	8
Total time, minutes	32
Proposed Route: Suribao Rd. National. Hwy Can-abong Provincial Rd.	

4.2.c Modal Choice

In this study, it is assumed that the evacuation process takes place hours before the typhoon and that all the vehicles that will be used are trucks and other government vehicles which has an average capacity of 50 persons.

4.2.d Route Assignment

Two sites for an evacuation center is recommended be the researchers for Lalawigan Cluster. One evacuation center is to be positioned at the hillside of barangay Cabong while another is to positioned at barangay Locso-on. Hazardous routes are the roads near the coast and the pick-up points should be located at the barangay halls.

4.3 San Jose-Calingatngan Cluster

4.3.a Trip Generation

The San Jose- Calingatngan Cluster is located in the mountainous area of Borongan City. It has member of 6 barangays. The San Jose- Calingatngan cluster is composed of:Calingatngan, San Mateo, San Andres, Suroc, San Gabriel, Calicoan, Siha, and Suhotan. The accumulated population at risk is 1200 people for San Jose- Calingatngan cluster.The number of population at risk is given by the Disaster Risk Reduction Management of the City of Borongan.

4.3.b Trip Distribution

The tables below shows the population at risk, number of trip, distance from the pick- up points to the safe place, average vehicle speed, approximate time of travel per trip, the total time of the evacuation process and the proposed route. The data are separated per barangay where the pick-up points are positioned.

Table 4.4.b-1 Data and Proposed Route for Bry. Calico-An

Barangay Calico-An	
Population at Risk	77
Number of Trips	1
Distance to the safe place, Km	4.2
Average Vehicle speed, Kph	60
Approximate time of travel per trip, minutes	5
Total time, minutes	10
Proposed Route: Calico-An Rd. San Gabriel Provincial Rd.	

Table 4.4.b-2 Data and Proposed Route for Bry. Suroc

Barangay Suroc	
Population at Risk	140
Number of Trips	1
Distance to the safe place, Km	6.7
Average Vehicle speed, Kph	60
Approximate time of travel per trip, minutes	7
Total time, minutes	14
Proposed Route: Suroc Rd. Tabunan Nat'l. Hwy Amantacop Rd.	

Table 4.4.b-3 Data and Proposed Route for Bry. San Andres

Barangay San Andres	
Population at Risk	141
Number of Trips	1
Distance to the safe place, Km	6.9
Average Vehicle speed, Kph	60
Approximate time of travel per trip, minutes	7
Total time, minutes	14
Proposed Route: San Andres Rd. Tabunan Nat'l. Hwy Amantacop Rd.	

Table 4.4.b-4 Data and Proposed Route for Bry. San Mateo

Barangay San Mateo	
Population at Risk	232
Number of Trips	2
Distance to the safe place, Km	6.5
Average Vehicle speed, Kph	60
Approximate time of travel per trip, minutes	7
Total time, minutes	28
Proposed Route: Tabunan Nat'l. Hwy Amantacop Rd.	

Table 4.4.b-5 Data and Proposed Route for Bry. Calingatngan

Barangay Calingatngan	
Population at Risk	174
Number of Trips	3
Distance to the safe place, Km	8.4
Average Vehicle speed, Kph	60
Approximate time of travel per trip, minutes	9
Total time, minutes	54
Proposed Route: Calingatngan Rd. National. Hwy San Gabriel Provincial Rd.	

Table 4.4.b-6 Data and Proposed Route for Bry. San Gabriel

Barangay San Gabriel	
Population at Risk	272
Number of Trips	4
Distance to the safe place, Km	1.3
Average Vehicle speed, Kph	60
Approximate time of travel per trip, minutes	2
Total time, minutes	16
Proposed Route: San Gabriel Provincial Rd.	

Table 4.4.b-7 Data and Proposed Route for Bry. Siha

Barangay Siha	
Population at Risk	550
Number of Trips	7
Distance to the safe place, Km	4.8
Average Vehicle speed, Kph	60
Approximate time of travel per trip, minutes	5
Total time, minutes	70
Proposed Route: Siha Rd. Can-abong Provincial Rd.	

Table 4.4.b-8 Data and Proposed Route for Bry. Suhotan

Barangay Sohutan	
Population at Risk	127
Number of Trips	2
Distance to the safe place, Km	5.6
Average Vehicle speed, Kph	60
Approximate time of travel per trip, minutes	6
Total time, minutes	24
Proposed Route: Sohutan Rd. National. Hwy Can-abong Provincial Rd.	

4.3.c Modal Choice

In this study, it is assumed that the evacuation process takes place hours before the typhoon and that all the vehicles that will be used are trucks and other government vehicles which has an average capacity of 50 persons.

4.3.d Route Assignment

Two site for an evacuation center is recommended be the researchers for San Jose Cluster. One evacuation center is to be positioned at the hillside of barangay San Gabriel while another is to positioned at barangay Siha. Hazardous routes are the roads near the coast and the pick-up points should be located at the barangay halls.

4.5 Benowangan Cluster

4.5.a Trip Generation

The Benowangan Cluster is located in the southern mountainous area of BoronganCiity. The Benowangan Cluster is composed of barangays: Pinanag-An, Benowangan, Hebacong, Canyupay, San Gregorio, Cabalagnan, Banuyo, Baras, And Pinanag-An. The accumulated population at risk is 1486 people for Benowangan cluster. The number of population at risk is given by the Disaster Risk Reduction Management of the City of Borongan.

4.5.b Trip Distribution

The tables below shows the population at risk, number of trip, distance from the pick-up

points to the safe place, average vehicle speed, approximate time of travel per trip, the total time of the evacuation process and the proposed route. The data are separated per barangay where the pick-up points are positioned.

Table 4.5.b-1 Data and Proposed Route for Bry. Benowagan

Barangay Benowangan	
Population at Risk	447
Number of Trips	6
Distance to the safe place, Km	6.7
Average Vehicle speed, Kph	45
Approximate time of travel per trip, minutes	9
Total time, minutes	108
Proposed Route: Camada Nat'l. Hwy Pinanag-an Provincial Rd.	

Table 4.5.b-2 Data and Proposed Route for Bry. Cabalagnan

Barangay Cabalagnan	
Population at Risk	245
Number of Trips	4
Distance to the safe place, Km	9.2
Average Vehicle speed, Kph	45
Approximate time of travel per trip, minutes	13
Total time, minutes	104
Proposed Route: Camada Nat'l. Hwy Pinanag-an Provincial Rd.	

Table 4.5.b-3 Data and Proposed Route for Bry. Canyupay

Barangay Canyupay	
Population at Risk	223
Number of Trips	3
Distance to the safe place, Km	8.5
Average Vehicle speed, Kph	45
Approximate time of travel per trip, minutes	13
Total time, minutes	104
Proposed Route: Canyupay Rd. Camada Nat'l. Hwy Pinanag-an Provincial Rd.	

Table 4.5.b-4 Data and Proposed Route for Bry. Hebacong

Barangay Hebacong	
Population at Risk	270
Number of Trips	4
Distance to the safe place, Km	8.7
Average Vehicle speed, Kph	45
Approximate time of travel per trip, minutes	12
Total time, minutes	96
Proposed Route: Hebacong Rd. Camada Nat'l. Hwy Pinanag-an Provincial Rd.	

Table 4.5.b-5 Data and Proposed Route for Bry. Cabalagnan

Barangay Pinanag-an	
Population at Risk	301
Number of Trips	4
Distance to the safe place, Km	2
Average Vehicle speed, Kph	45
Approximate time of travel per trip, minutes	3
Total time, minutes	24
Proposed Route: Pinanag-an Provincial Rd.	

Table 4.5.b-6 Data and Proposed Route for Bry. Baras

Barangay Baras	
Population at Risk	98
Number of Trips	2
Distance to the safe place, Km	3.9
Average Vehicle speed, Kph	45
Approximate time of travel per trip, minutes	12
Total time, minutes	25
Proposed Route: Hebacong Rd. Camada Nat'l. Hwy Pinanag-an Provincial Rd.	

Table 4.5.b-7 Data and Proposed Route for Bry. Banuyo

Barangay Banuyo	
Population at Risk	78
Number of Trips	1
Distance to the safe place, Km	2
Average Vehicle speed, Kph	45
Approximate time of travel per trip, minutes	3
Total time, minutes	10
Proposed Route: Pinanag-an Provincial Rd.	

Table 4.5.b-8 Data and Proposed Route for Bry. San Gregorio

Barangay San Gregorio	
Population at Risk	681
Number of Trips	3
Distance to the safe place, Km	9.6
Average Vehicle speed, Kph	60
Approximate time of travel per trip, minutes	10
Total time, minutes	60
Proposed Route: San Gregorio Rd. National. Hwy Can-abong Provincial Rd.	

4.5.c Modal Choice

In this study, it is assumed that the evacuation process takes place hours before the typhoon and that all the vehicles that will be used are trucks and other government vehicles which have an average capacity of 50 persons.

4.5.d Route Assignment

Two sites for an evacuation center is recommended are the researchers for BenowaganCluster. One evacuation center is to be positioned at the hillside of barangay Pinanag-an while another is to positioned at barangay Banuyo. Unsafe routes are the roads near the coast and the pick-up points should be located at the barangay halls.

5. CONCLUSION AND RECOMMENDATION

Conclusion

One of the effective ways to promote natural disaster risk reduction management is by generating an effective evacuation plan. The researchers were able to come up with an evacuation plan by means of dividing the area into geographic zones, formulating trip generation, assigning trip distribution, incorporating modal split and selecting routes. These steps led to the determination of the shortest and fastest route to the designated as evacuation center. Furthermore, the generated evacuation plan was a pro-active move to ensure the safety of the citizens of Borongan City during disasters.

Other findings include the need to provide several transportation vehicle that could be used by the evacuees. Most of the vehicles in Borongan City are motorcycle driven which could not cater many evacuees.

Based on our analysis, the City of Borongan does not have a sufficient number of evacuation center and their existing evacuation center did not pass the DSWD standards for evacuation centers.The city does not have enough paved roads, which makes it harder for the people to evacuate in times of calamities. Only the poblacion cluster have sufficient roads, while the other areas especially the barrios, does not have paved roads. In order for this study to be fully effective, the Local Government Unit (LGU) should be pro-active in implementing the evacuation plan. The LGU should always coordinate with the agencies involved (e.g. PAGASA, CDRRMC, etc.) and should immediately call for an evacuation before the disaster happens.

Recommendation

Having a concrete evacuation plan is very essential thus it is highly recommended that other areas that are susceptible to typhoons, storm surge, flooding, etc. should have one. Also, further studies on how to improve the evacuation process must be done. Future researches must include how they can prioritize the evacuation of children, senior citizens and persons with disability.

It is suggested that the local government unit of Borongan City should conduct seminars and drills on how they can properly execute the evacuation plan. They should also check the existing evacuation center if it would pass the standards of an evacuation center set by the DSWD. Furthermore, there is a need to construct a permanent evacuation center at Borongan City.

6. REFERENCES

Chae, J., Thomb, D., Jang, Y., Kim, S., Ertl, T., Ebert, D. (2013). Public Behaviour Response Analysis in Disaster Events Utilizing Visual Analytics of Microblog Data DOI: 10.1016/j.cag.2013.10.008

Murray-Tuite, P., Wolshon, P. (2012). Evacuation transportation modeling: An overview of Research, Development, and Practice. DOI: 10.1016/j.trc.2012.11.005

Xiang Chen, Mei-Po Kwan, Qiang Li Jin Chen. (2009). A model for evacuation risk assessment with consideration of pre- and post-disaster Factors. DOI: 10.1016/j.compenvurbsys.2011.11.002

S. Bretschneider, A. Kimms. (2012).Pattern-based evacuation planning for urban area. DOI: 10.1016/j.ejor.2011.07.015