An Automated System for Disaster Management Based on BRAC Standard Operating Procedures (SOP)

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An Automated System for Disaster Management Based on BRAC Standard Operating Procedures (SOP)

A thesis submitted in partial fulfillment of the requirement for the degree requirement for the degree of Bachelor of Science in Computer Science and Engineering of BRAC University

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DECLARATION

This is to certify that the thesis work entitled ‘‘An Automated System for Disaster Management Based on BRAC Standard Operating Procedures (SOP)’’ is submitted by Rehnuma Shoujanya (10101011), Christy Bernadatte Gonsalves (10101017) and Mashrufa Harun (10101018) to the Department of Computer Science and Engineering partial fulfillment of the requirement for the degree of Bachelor of Science in Computer science and Engineering. The content of this thesis have not been submitted elsewhere for the award of any degree or any other publication.

We hereby declare that this thesis is our original work based on the results we found. The materials of work found by other researchers and the sources are properly acknowledge and mentioned by references. We carried out our work under the supervision of Professor Mohammad Zahidur Rahman.

Dated: December 28, 2014

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FIANL READING APPROVAL

Thesis Title: An Automated System for Disaster Management Based on BRAC Standard Operating Procedures (SOP)

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The final form of the thesis paper is read and approved by Professor Mohammad Zahidur Rahman. Its format, citations and bibliographic style are consistent and acceptable. It's illustrative materials including figures, diagrams and tables are in place. The final manuscript is satisfactory and is ready for submission to the Department of Computer Science and Engineering, School of Engineering and Computer Science, BRAC University.

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Abstract

Disaster is a very common phenomenon to the human society. It has been experienced by them since time immemorial. During and after any extreme event of natural or man-made disasters, getting people out of danger and place them to an area of safety are the primary objectives. Orderly and efficient evacuations, providing support in medical emergency are the key to saving lives. An automated system for disaster management can be extensively used in different tasks of disaster problem solving such as communication among agents, collective decision making, cooperation, collaborative planning in large scale that deals with uncertainty and conflicting information during disaster management. This thesis is aimed at developing an android application to generate an automated mobile-based system which can model and manage emergency situations; run numerous, accurate event-driven emergency scenarios and the movement of first responders and security personnel. The purpose of such development was to assemble an application with a user friendly interface for the responders and implement some effective ways considering minimize the communication gap. In order to develop the application, different algorithms, approaches and languages were examined that can ensure the motives mentioned in case of emergency. Evaluating with the real time information, this thesis can be a very promising application to help the BRAC volunteers or responders with their operating procedure.

Keywords: disaster management system, standard operating procedures, location detection, BRAC, DECC, CPP, Google map.

TABLE OF CONTENTS

1. Introduction:

Bangladesh is a country of six seasons. Here climate changes very rapidly. Sometimes heavy rainfall causes flood, riverbank erosion and landslide. Less rainfall causes drought. Change of wind speed causes tornado, cyclone. Mainly flood and cyclone are the two main natural disasters happen a lot in this country. One of the world's most natural disaster-prone nations, Bangladesh has to live with recurring floods and cyclones which have claimed hundreds of thousands of lives over the past four decades. To handle these damages we propose an automated system for disaster management based on BRAC standard operating procedures (SOP).

Disasters, both natural and man-made, can strike anytime or anywhere. There are two ways to overcome disasters:

- The first is to prevent them from occurring, and
- Second to have an emergency system and plan of operation prior to the occurrence of any crisis.

In either approach, information technology plays an important role in disaster management.

1.1 Objectives:

The objectives of this report are as follow:

- To discuss the natural disasters in Bangladesh.
- To identify current disaster management system in Bangladesh and discuss BRAC standard operating procedures.
- To explore relevant technology which suited for disaster management?
- Finally to propose an automated system for disaster management based on S.O.P. in Bangladesh.

The overall objective is to provide a situational state and command decisions which will escalate responder's efficiency and effectiveness in dealing with complex, evolving disasters using technology.

1.2 Motivation:

This project was motivated by the lack of rational, comprehensive decision support systems for disaster response management. Catastrophic events such as the cyclone of 1970, flood of 1998 and the SIDR (cyclone) of 2007 have reminded us of the difficulties in preparing for and responding to man-made and natural disasters. Because the time, location, and scale of the events are impossible to predict, it is increasing clear that pre-event planning and preparedness are imperative in order to limit the damage to human lives and property and restore the affected communities to a semblance of normal operations [1]. In today's digital age, it is important that the responders get to use the latest technology for efficient management in time of disaster. The use of information access through mobile phones among the general people has increased in recent years, which has made a positive impact on almost everything. However, there is still a lacking of information sharing and responding at the right moment between the volunteers and the incident commander(IC) while it comes on issues like warnings, rescue operations or providing relief, shelters, medical help.

1.3 Methodology:

Smartphones are being used for a wide range of activities including messaging, social networking, calendar and contact management as well as location and context-aware applications. The ubiquity of handheld computing technology has been found to be especially useful in disaster management and relief operations. To work on disaster management, there is a procedure by BRAC which is standard operating procedure (SOP). The mobile application has been developed for Android Phone and the remote server application is developed by CSS, HTML, PHP, JavaScript, JSON, Google map API. As a first step, this system focuses on creating a service for management of situations during disaster using mobile phones. It is possible to make this an autonomous system for situation type identification and providing help based on location detection, rating emergency level, weather forecasting reports but it is essential to govern the data by an expert so that the volunteers get the assistance for their situations as fast as possible regarding disaster management.

1.4 Outlines:

Chapter-2 reviews types of disasters, current disaster management system in Bangladesh, the background study for development of the current system, BRAC standard operating procedures followed by the literature review for related works in this field.

Chapter-3 presents the system design of the developed system. It includes various figures and diagrams that were used for designing and developing the application.

Chapter-4 describes the implementation details of the application, including the analysis & techniques used for detecting the location of volunteer, level of emergency, type of assistance needed.

Chapter-5 reviews the results of the research and provides a discussion on the project findings.

Chapter-6 specifies the limitations of the system and provides the conclusion and future guidelines.

2. Literature Review:

2.1: Disaster:

Digital Information Resources for Disaster Management of Libraries and Information Centers[2] by Bidhan Chandra Biswas and Sabuj Kumar Choudhuri, this paper is based on disaster and its types and seeks to identify parameters to design and develop a successful disaster management plan.

A disaster is the tragedy of a natural or human-made hazard (a hazard is a situation which poses a level of threat to life, health, property, or environment) that negatively affects society or

environment. The Center for Research on the Epidemiology of Disasters (CRED) in Brussels, Belgium, uses the following definition. “A disaster is a situation or event which overwhelms local capacity, necessitating a request to a national or international level for external assistance.” In the Australian Emergency Management Glossary a disaster is defined as: “A serious disruption to community life which threatens or causes death or injury in that community and/or damage to property which is beyond the day-to-day capacity of the prescribed statutory authorities and which requires special mobilization and organization of resources other than those normally available to those authorities”.

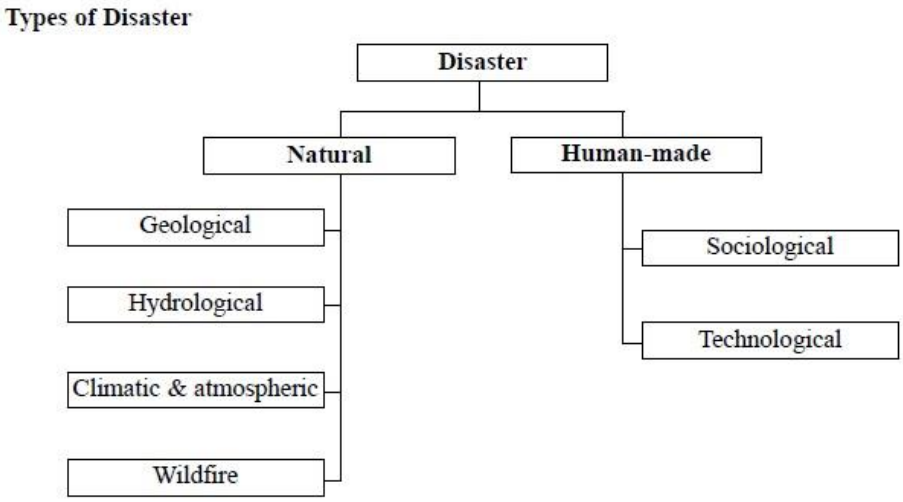


Fig. 2.1.1: Types of disaster

The geographical setting of Bangladesh makes the country vulnerable to natural disasters. The mountains and hills bordering almost three-fourths of the country, along with the funnel shaped Bay of Bengal in the south, have made the country a meeting place of life-giving monsoon rains, but also make it subjected to the catastrophic ravages of natural disasters. Its physiography and river morphology also contribute to recurring disasters. [3]

Table 1: Year wise natural disasters and its deaths in Bangladesh

Year	Disaster	Death
1970	Cyclone	300,000
1988	Flood	2,373
1988	Cyclone	5,704
1989	Drought	800
1991	Cyclone	138,868
1996	Tornado	545
1997	Cyclone	550
1998	Flood	1,050
2004	Flood	747
2007	Flood	1,071
2007	Cyclone(SIDR)	3,406
2009	Cyclone(AILA)	190

Fig.2.1.2: Number of deaths due to natural disasters in Bangladesh

Table 2: Overview of natural disasters from 1980 – 2010 and its impact

No of events:	234
No of people killed:	191,836
Average killed per year:	6,188
No of people affected:	323,480,264
Average affected per year:	10,434,847
Economic Damage (US$ X 1,000):	17,072,500
Economic Damage per year (US$ X 1,000):	550,726

Fig.2.1.3: Overview of Natural disasters from 1980-2010 and its impact

2.2: Disaster Management:

[3] According to ‘‘Disaster Management Through Mobile Technology: A Conceptual Model For Bangladesh’’ by S.M. Yeasir Azad, Khalid Md. Bahauddin, Tariq Muhammad Salahuddin Himel,2013, Bangladesh is among the nation’s most vulnerable to climate change, floods, cyclones and other major natural disasters such as storm surge, flash flood, drought, tornado, riverbank erosion, and landslide. The UN ranked Bangladesh as the 6th most at-risk nation with regard to natural hazards. In recent times, the frequency and severity of the natural calamities increased and inadequate resources and lack of accurate and real-time information for decision making impeded the ability of our central disaster management capacity, which results in long term negative impact on our socio-economic development.

‘‘A Web-based Disaster Management-Mitigation Framework Using Information and Communication Technologies and Open Source Software’’ by Muhammad Asif, Tripathi Nitin, Kifayat Ullah and M.S. Sarfraz states, The term disaster management can be defined as "The

range of activities to maintain control over disaster and emergency and provide a framework to help those at risk, to avoid or recover from the impact of the disaster [4]. In case of a disaster, it is very important to get comprehensive information about the location, places and people i.e. what kind of destruction is there due to disaster, when hundreds of people are on the line waiting for a quick response [3]. Despite the deficiency of several resources even in developing countries, the past decade have seen an exponential growth in cellular telephony. Constantly decreasing price of cellular phones and wide network coverage of the cellular technology has enabled the mobile phones to penetrate even in the remote areas of a particular country [4].

2.3: Disaster Management Plan for Libraries or Information Centre:

2.3.1: Identifying Risks

A prudent first step is to list geographic and climatic hazards and other risks that could jeopardize the building and collections. These might include the institution's susceptibility to natural as well as human made disaster.

2.3.2: Decreasing Risks

The disaster planner should devise a program with concrete goals, identifiable resources, and a schedule of activities for eliminating as many risks as possible.

2.3.3: A Cooperative Plan

Disaster planning should not take place in a vacuum. To work effectively, it must be integrated into the routine operating procedures of the institution.

2.3.4: Identifying Resources

Identify sources of assistance in a disaster. Determine the supplies you will need for disaster response and salvage efforts for your specific collections.

2.3.5: Setting Priorities

The first priority in any disaster is human safety. Saving collections is never worth endangering the lives of staff or patrons.

2.4: Bangladesh's ICT Policy, 2009 And Government Vision Regarding To Disaster Management:

In strategic theme it stated that protect citizens from natural disasters through ICT based disaster warning & management technologies.

• Utilize remote sensing technologies for disaster management and mitigation

• Promote SMS based disaster warning systems targeted to the population likely to be affected

• Utilize GIS based systems to monitor flood & cyclone shelters (including equitable distribution in vulnerable areas)

• Utilize GIS based systems to ensure equitable distribution of relief goods with special focus on the hard to reach areas

2.5: Vision of Government of Bangladesh:

The Disaster Management vision of the GOB is to reduce the risk of people, especially the poor and the disadvantaged, from the effects of natural, environmental and human induced hazards, to a manageable and acceptable humanitarian level, and to have in place an efficient emergency response system capable of handling large scale disasters.

2.6: Current Disaster Information Management System in Bangladesh:

The responsibility for managing disasters in Bangladesh is entrusted with the Disaster Management Bureau (DMB), a government agency, under the ministry of Disaster Management and Relief.

The functions of disaster management bureau are as follows (DMB, 2002):

• To coordinate disaster management activities;

• To organize training and public awareness activities;

• To collect, preserve and analyses data on various disasters;

• To operate an Emergency Operation Center (EOC);

• To promote prevention and preparedness at all levels on various disasters;

• To help line ministries, departments and agencies to develop contingency disaster management plan and arrange effective dissemination of disaster warning and

• To organize logistics arrangement in connection with disaster management.

2.6.1 Current information flow system:

Local disaster shelters play a central role during disaster. The local centers are basically two storied buildings located in the disaster-prone areas. The number of cyclone centers that provide shelter during cyclone in Bangladesh as of 1999 is 1841 and this number for flood shelters that provide shelter during flood in Bangladesh as of 1998 is 2000 (DMB, 2002)

• Use of radio is only effective medium to communicate directly with disaster prone area and this device has got widest reach even to the people living below poverty line.

• Uses of television for disaster information are increasing but yet get effective as the number of television is not significant due to un-affordability and lack of electricity in rural areas.

• Use of flag in cyclone centers and local focus points is another old medium for communication of disaster information. Information flow through human chain, that is word of mouth, is still the only duplex medium of communication.

• Private wireless communication is in use in some district level areas.

So from this situation of information flow system, it can easily say that here mobile technology can play a vital role for its rapid information flow and mobile phone users are robust in number in everywhere in Bangladesh which can be together with for implementation of an effective disaster management in Bangladesh.

2.7: Disaster, Environment and Climate change (DECC) program of BRAC:

The main target of DECC is to reduce the risk of disaster. BRAC has taken different initiative against climate change and disaster problems. The main target of this program is to increase BRAC's institutional capability, decrease disaster risks and increase adaption during disaster, forecast disaster information and instruct about environment change and natural disasters.

During natural disaster for quick response BRAC has launched Standard Operating Procedures (SOP). BRAC's staffs and community members work flow during natural disaster and what will be their responsibility all these are mentioned in this policy. [5]

DECC program has already started to instruct people how to response before and after disaster.

2.7.1 Standard Operating Procedure:

S.O.P. gives volunteers an overall instruction about disaster management.

SOP followed the disaster management policy of Bangladesh, Standing Orders on Disaster (SOD) and different policy using in different national and regional areas. In SOP there are clear instructions about what to do before disaster, during disaster and after disaster. There are given periodic instructions for first 24 to 72 hours of during disaster. According to ICS commands SOP conducts its programs.

2.7.2 Incident Command System (ICS):

Incident Command System (ICS) is a standard autonomous management system which can work during the disaster according to situation demand.

In any kind of disaster ICS follow five rules and they are as follow as:

- Command/instruction-find the purpose of incident.
- Operation- takes necessary steps to prevent or handle the outcome of the incident.
- Administrative works-search all types administrative and account related works.
- Schema-prepare demand draft, information and strategic efficiency.
- Logistics- all types of necessary things and steps to help responders.

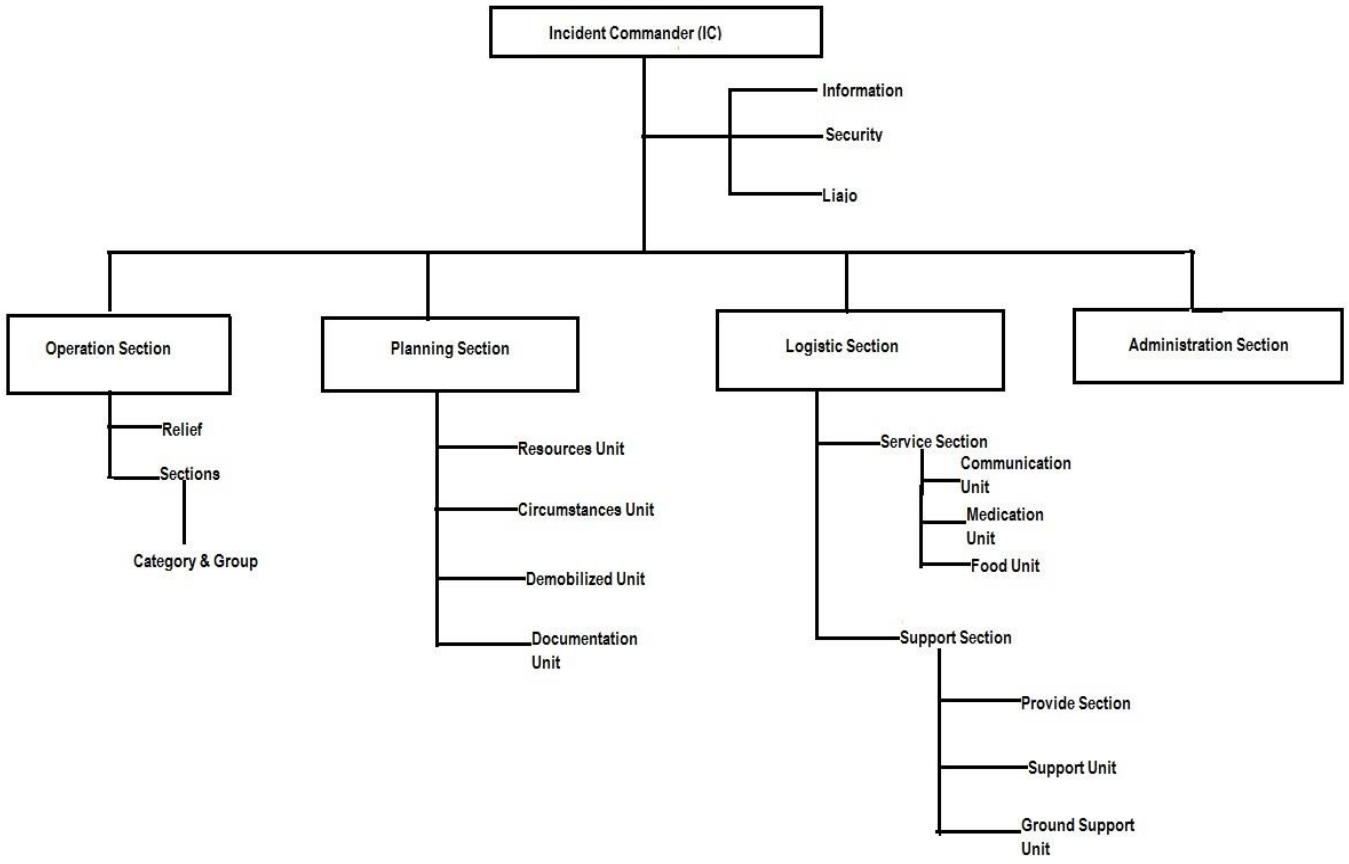


Fig 2.7.2: Workflow of Incident Command System (ICS)

2.7.3: Disaster Warnings, Forecasting & Preventions

An Analysis of the Causes of Non-Responses to Cyclone Warnings and the Use of Indigenous Knowledge for Cyclone Forecasting in Bangladesh by Shitangsu Kumar Paul and Jayant K. Routray shows the cyclone signal system for maritime and river ports in Bangladesh and various primary sources used during SIDR(2007). [6]

Table 2.2 Cyclone signal system for maritime and river ports in Bangladesh

No.	Maritime signals		Riverine signals	
	Warning signal	Wind speed (kph)	Warnings signal	Wind speed (kph)
1	Distant cautionarys signal No. I	51–61	Not applicable	–
2	Distant warnings signal No. II	62–88	Not applicable	–
3	Local cautionary signal No. III	40–50	Local cautionary signal No. III	40–50
4	Warning signal No. IV	51–61	Warning signal No. IV	51–61
5	Dangers signal No. VI	62–88	Dangers signal No. VI	62–88
6	Great dangers signal No. VIII	89–117	Great danger signal No. VIII	89–117
7	Great dangers signal No. IX	118–170	Great danger signal No. IX	118–170
8	Great dangers signal No. X	>170	Great danger signal No. X	>170

Source Adopted from BMD (2009)

Fig.2.7.3_1: Cyclone signal system in Bangladesh

Table 2.3 Primary sources of early warning for Cyclone Sidr, 2007 (multiple responses)

Sources of early warning	Study villages							
	Inland (N = 189)		Shoreline (N = 81)		Island (N = 6)		All (N = 276)	
	N	% of cases	N	% of cases	N	% of cases	N	% of cases
Radio	83	43.9	66	81.5	3	50	152	55.1
Television	5	2.6	2	2.5	0	0.0	7	2.5
Newspaper	4	2.1	0	0.0	0	0.0	4	1.4
Bangladesh red crescent society volunteers	139	73.5	71	87.6	1	16.7	211	76.4
Local government, NGOs	44	23.3	3	3.7	0	0.0	47	17.1
Word-of-mouth (peers, relatives, neighbours)	135	71.4	57	70.4	6	100	198	71.7

Source Household Survey, 2009

Fig.2.7.3_2: Primary sources of early warnings during SIDR

Managing Natural Disasters In Bangladesh by Dr. A. M. Choudhury states how flood forecasting and warning works in Bangladesh, Govt. has taken up both the structural and non-structural measures of flood mitigation. For flood forecasting a network of hydrological stations connected with telemetering gauges or by telecommunication or teleprinter links with the forecasting center has been established by the Water Development Board. Available hydrological data consist of discharge, water level and rainfall records. Historical records of data have been analyzed to prepare forecasting procedure. For major rivers, correlations of water levels or discharges between upstream and downstream stations are utilized in preparing forecasting procedure. For rivers with smaller catchments rainfall-runoff relation, flood routing, co-axial graphical correlation methods are used. Extensive modeling of flood in our river system is necessary for effective forecasting. The Flood Forecasting Cell of Bangladesh Water Development Board has considerably improved its facility for the issuance of flood forecasting. It uses the remote sensing data along with ground data. The methods need further automation. Remote Sensing data have been used to delineate the flood affected areas. [7]

BRAC's Experience on Flood Disaster Management by Nasima Akter describes BRAC's 2004 Flood Relief Programme Strategy during flood, As soon as the flood reached disastrous proportion, BRAC came to the aid of the affected people with the full might of the organization in both rural and urban areas. It began a massive relief operation for the marooned people to help them avoid starvation. Makeshift kitchens were opened at BRAC field offices to prepare hand-made wheat-flour *ruti* and it was distributed with molasses and safe drinking water. Relief materials during and after flood ruti, beaten rice, molasses, pap rice, rice, pulses, biscuits, milk for children, bleaching powder, alum, included water purifying tablets, ORS packets, assistance for tube well washing, repairing, cleaning, and latrine and medical checkup and treatment. [8]

2.8: Mobile Technology for Disaster Management

2.8.1: Basis of Using Mobile Technology for Disaster Management In Bangladesh

To disseminate pre-disaster warnings

Mobile phones may be used to disseminate information about impending disasters. Since only 30 Percent of the population of Bangladesh has access to electricity, they do not always have access to other media such as TV or radio, and if they have, they may not have it turned on during emergency. But mobile phones are widely prevalent and are 'always on'.

To disseminate post-disaster announcements

The government and NGOs can send relevant announcements such as transferring to specific shelters or information about relief distribution after a disaster. Immediately after a disaster, it is found that many are left homeless and always on the move. During these situations, sending out announcements through mobile phones can be an effective means to keep people organized and run post-disaster operations smoothly.

To receive information about relief needs

The mobile phone can also be an effective means for the affected people to send out information about relief needs, and notify relevant bodies about unequal or undesired relief distribution strategies. This can empower the affected people and enable them to find a voice during a helpless time.

To exchange information about health hazard

The mobile technologies can also be used to send emergency information about health hazards, both from the side of the government and also from the side of the disaster-affected people. The government can send warnings about possible hazards and preventive measures, and likewise the affected people can send information about the situation on the ground and notify relevant bodies about medication needs.

2.8.2:BRAC & RIMES for weather forecasting report:

The international community has been helping the country improve disaster preparedness with bilateral agencies and non-governmental organizations (NGOs) like BRAC contributing to strengthening end-to-end early warning systems in Bangladesh. These include the Regional Integrated Early Warning System for Africa and Asia (RIMES) with the collaboration of the Asia Disaster Preparedness Centre. [21] RIMES has supported Bangladesh in developing long-lead flood forecasting and in concurrent monitoring of depressions and cyclone formation in the Bay of Bengal. It has developed and transferred technology to the Bangladesh Meteorological Department and Flood Forecasting and Warning Center. User agencies such as the Disaster Management Bureau, the Department of Agricultural Extension have been working with RIMES in the interpretation of new forecast products and translation into impact outlooks and response

options for resource and disaster risk management. RIMES reports daily provision of weather simulation outputs for BMD weather forecasting.

2.9: Related works:

According to **Multi-Agent Based Disaster Management System: A Review** by Swati Basak, Neelam Modanwal , Bireshwar Dass Mazumdar, Disaster Management System can be viewed as four interrelated sub-phases. The first is damage assessment, in which loses and their magnitudes are identified. The second is needs assessment, in which initially required response is identified. The third is prioritization of response measures, in which required response matches with available resources. If response demand is greater than the current available resources, decision makers must establish priorities or act for external resources. The fourth is actual response, in which crisis resources are deployed, and decisions are disseminated to responders and the population at large. During the four sub-phases, crisis response activities face challenge of reducing the influence of crises cause to society, the economy, and the lives of individuals and communities and they continuously adapt their behavior and make quick decisions to tackle unpredicted events [9].Multi-agent disaster system has been extensively used in the different tasks of decentralized disaster problem solving such as communication among agents, collective decision making, cooperation, collaborative planning in large scale that deals with uncertainty and conflicting information during disaster management. In detail, this type of disaster systems can be viewed on information and knowledge fusion and take the feedback from the existing agents for sensing, coordinating, decision making and acting. It must be able to achieve these objectives in environments in which: control is distributed; uncertainty, ambiguity, imprecision; multiple agents with different aims and objectives are present; and resources are limited and vary during the system's operation.

According to **Digital Information Resources for Disaster Management of Libraries and Information Centres** by Bidhan Chandra Biswas and Sabuj Kumar Choudhuri, Sahana is an integrated set of web-based disaster management applications that provide solutions to large-scale humanitarian problems in the aftermath of a disaster. The main applications built into Sahana and problems they address so far are missing person registry, organization registry,

request management system, camp registry, volunteer management, inventory management, situation awareness. [1]

3. System Model:

3.1 System Overview

The system consists of a mobile application, which will enable the BRAC volunteers to select pre disaster, during disaster or post disaster terms, select the type of aid needed, rate the emergency level, take photo if needed using their mobile phones and send it to a central server where the central system in the server will get the location of occurrence based on global positioning system (GPS), Google map view, using weight management in order to measure the level of emergency. Each BRAC volunteer will be assigned with a unique ID which will be registered & stored in the database in order to avoid confusion or conflicts. An expert incident management team will be available to check the status of the situation, analysis data and provide assistance based on the report and their resources, which will be sent to the location along with a notification to the volunteer.

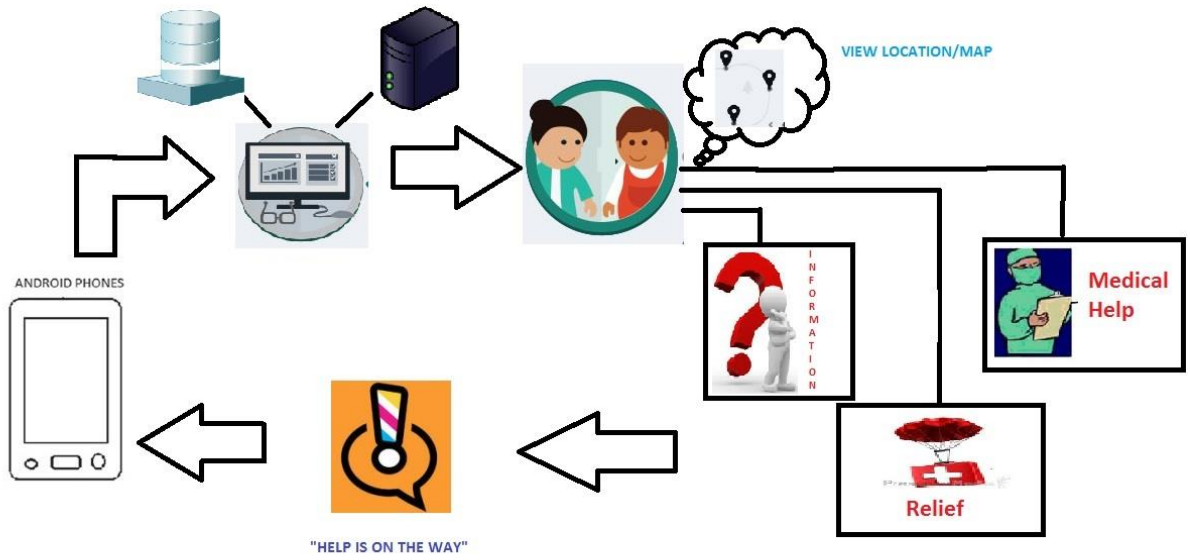


Fig. 3.1: General system architecture

3.2 Activity Diagram

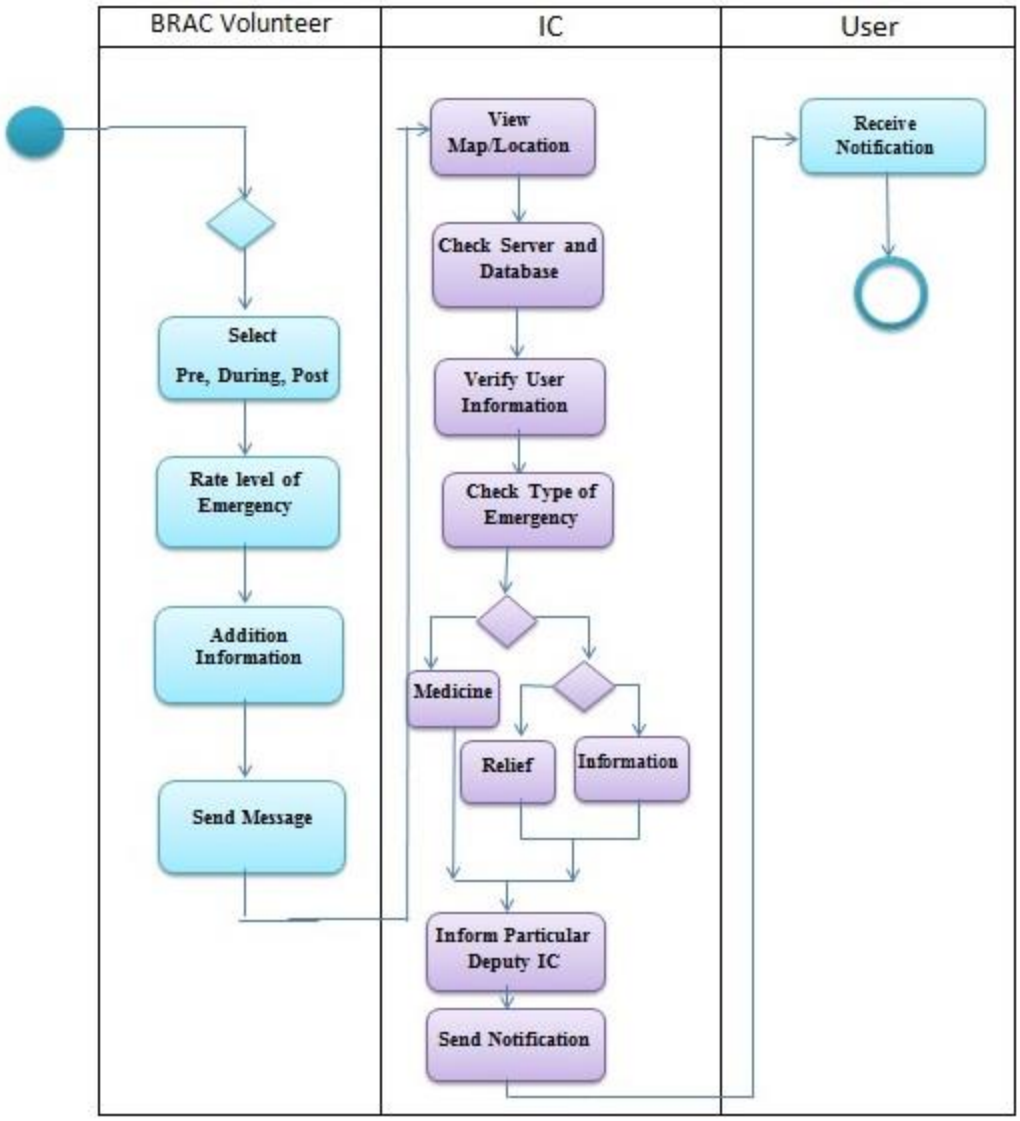


Fig. 3.2 BRAC volunteer and Incident commander activity diagram

3.3 Use Case Diagram

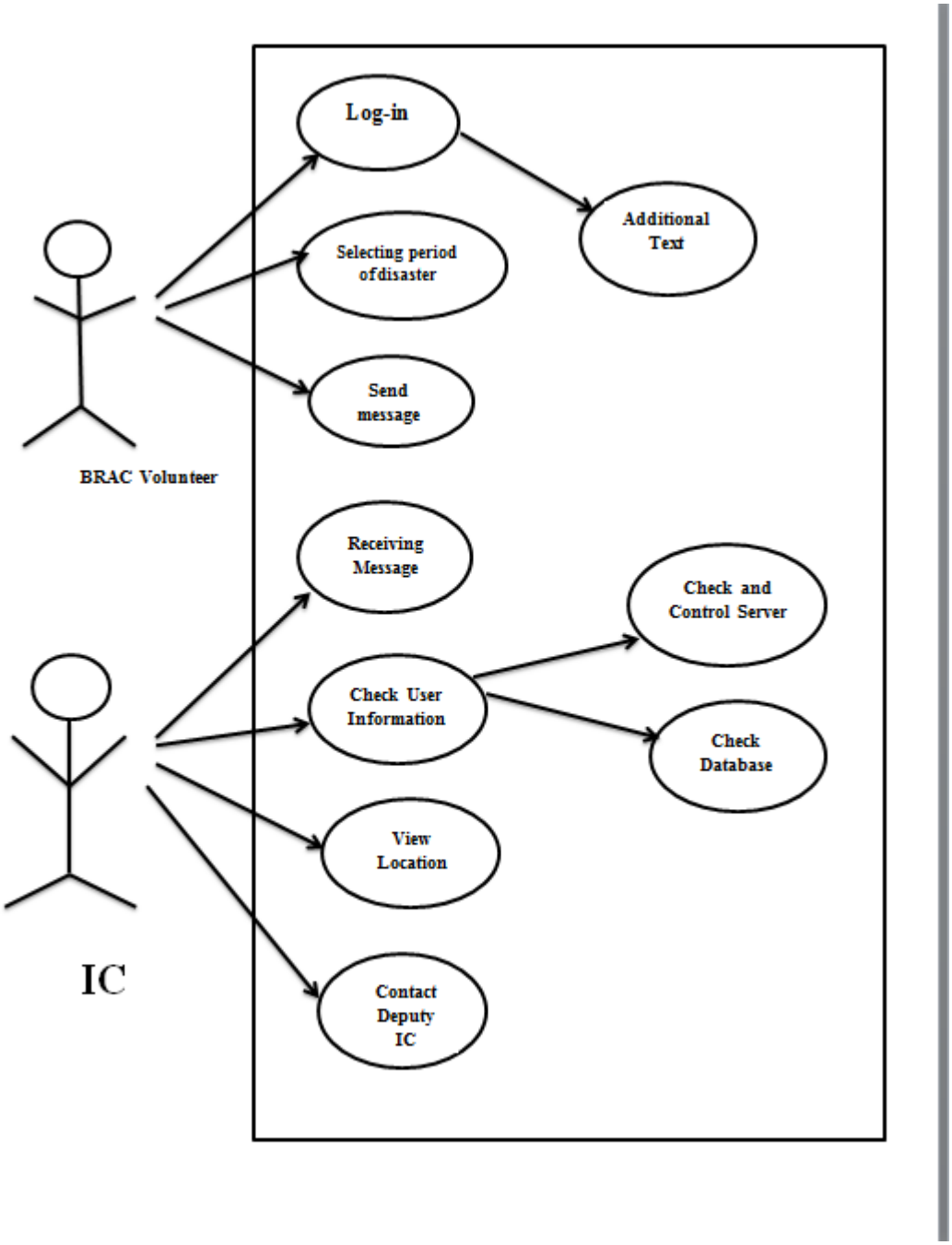


Figure 3.3_1 Use Case Diagram for BRAC volunteer and IC

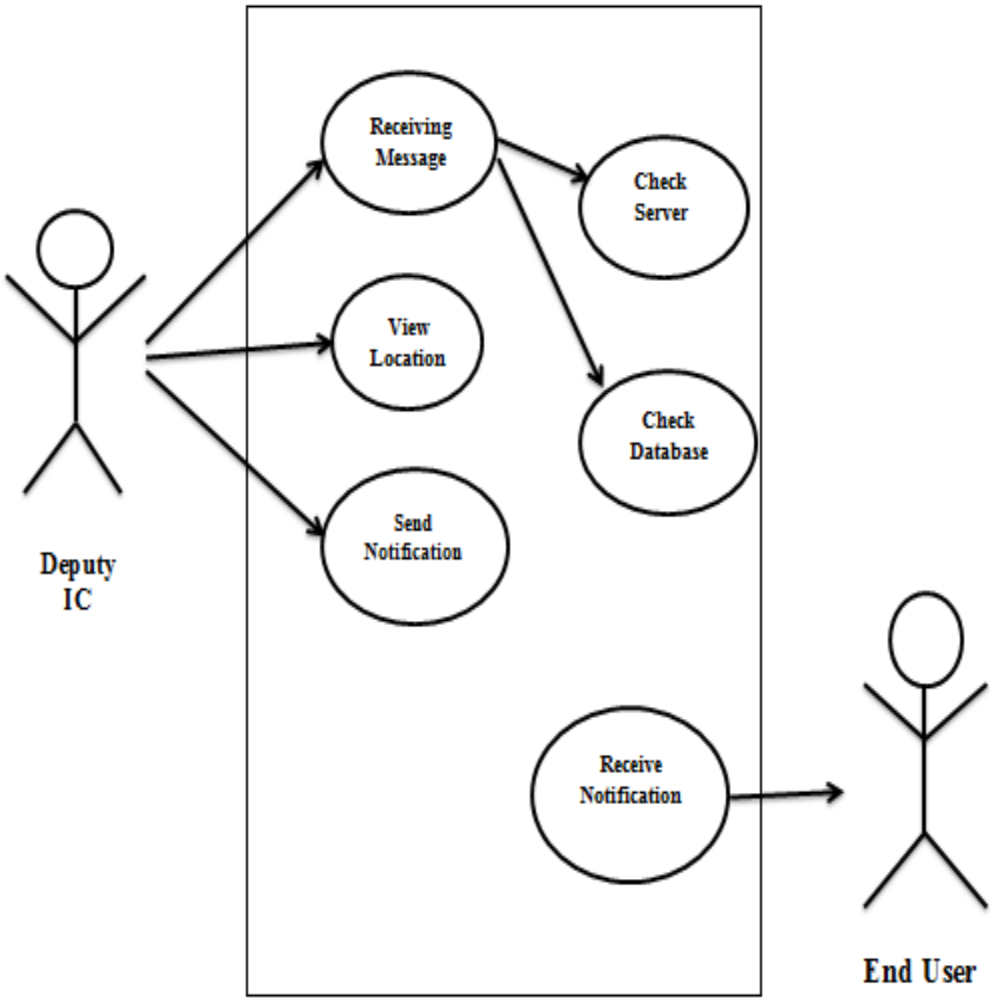


Figure 3.4_2 Use Case Diagram for deputy IC

4. System Implementation:

The automated system for Disaster Management based on BRAC Standard Operating Procedure is targeted to be used by the BRAC employees and volunteers. There are a number of mobile development environments. One of is Android which is an open and comprehensive platform for mobile devices. It is designed to be more open than other mobile operating systems so that developers, wireless operators, and handset manufacturers will be able to make new products faster and at a much lower cost. The end result will be a more personal and more flexible mobile experience to the user [17]. For this reason, this mobile development environment was used in the implementation of the disaster management system. This mobile application has been developed for android user using Java as programing language. Android SDK was used for implementation of the basic functionalities with the application.

4.1 Basic functionalities:

The mobile application consists of 5 basic functionalities. They are:

1) Registration of BRAC volunteer
2) Pre-disaster help
3) During-disaster help
4) Post-disaster help
5) Rate the emergency level

4.1.1: Registration of BRAC volunteer:

At the very first page of the application, the application bar asks the user for Volunteer ID and password to log in.

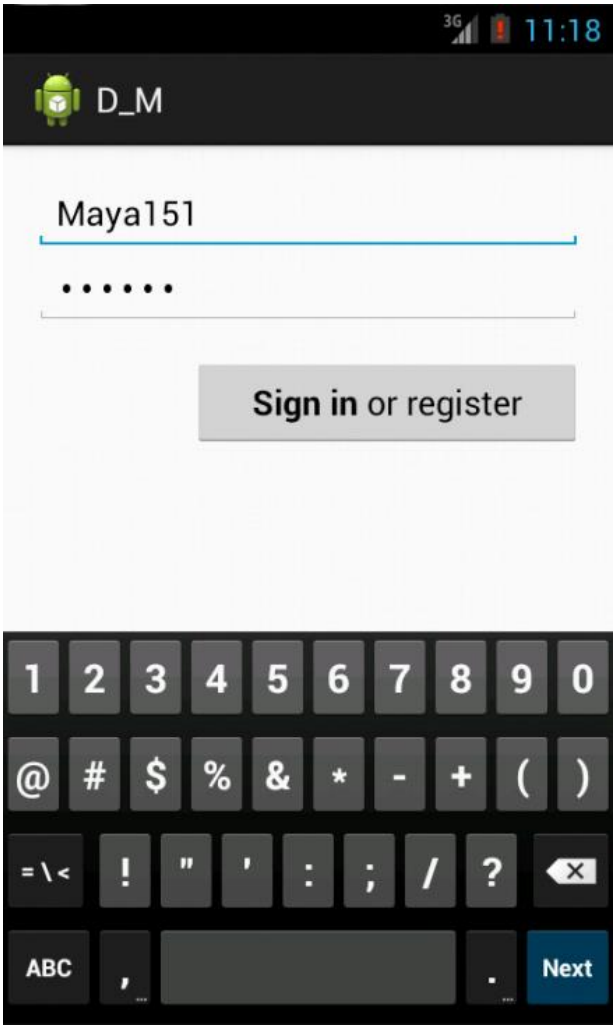


Figure 4.1.1 Registration panel

At the very first part of this application BRAC volunteer have to register him so that Incident Commander (IC) can recognize his location and can send help as soon as possible. Database will be updated every time a new volunteer registers.

4.1.2 Pre-Disaster:

Figure 4.1.2 Pre-disaster help

The term 'Pre- Disaster' indicates the prevention period of a disaster moment. People get time to save themselves, livelihood, move to cyclone centers or nearby shelters in this period depending on the level of emergency. Under Pre Disaster, there are three types as follows:

1) Disaster safety or recovery tips, here volunteers can view the tips for safety and recovery while needed.

2) Warning signals and to-dos, here the can know the meaning of various warning signals for flood or cyclone and actions based on these signals.

Warning signals for cyclone:

(a) Pre-Disaster Stage (Off-cyclone season)

(b) Alert Stage (Signal No. I, II and III)

(c) Warning Stage (Signal No. IV)

(d) Disaster Stage (Signal No. V, VI, VII and VIII, IX, X)

(e) Post-Disaster stage (Immediately after the cyclone till normalcy is attained)

Warning signals for flood:

(a) **Red warning**: Serious flooding expected in low lying areas. (Response: evacuation)

(b) **Green warning**: flooding is threatening. (Response: alert for possible evacuation)

(c)**Yellow warning**: flooding is possible. (Response: monitor the weather condition)

4.1.3 During-Disaster:

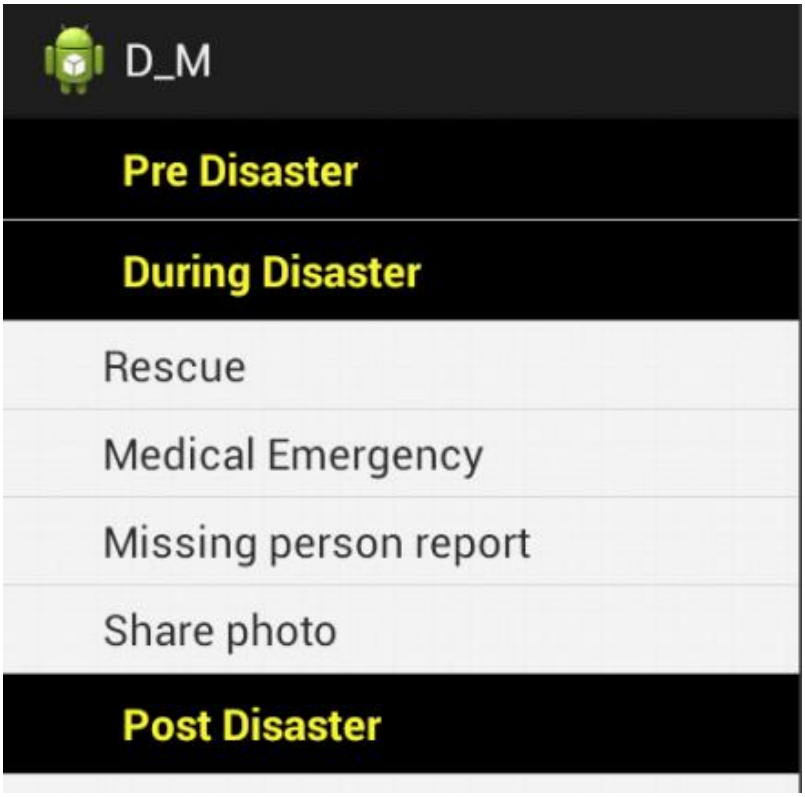


Figure 4.1.3 During-disaster help

During the disaster the assistance needs as quick as possible. The term ‘During Disaster’ indicates the first 24 to 48 hours of a disaster period. Here, it has four sections as follows,

1) Rescue, in case of conducting emergency rescue operation to save lives. At that crucial moment volunteers ask for help as recue. A rescue team will be sent immediately for assistance for this type of situation.
2) Medical emergency, emergency medical assistance when necessary during a disaster. A medical team will be sent immediately for aid.
3) Missing person reports, here a volunteer can report if anyone is missing in his assigned area and related information.
4) Share photo, this is an optional section which suggests to take a photo and send it to the server when it is hard to explain the actual condition if necessary.

All this information goes to server and checks from database to verify user information and viewed by ICS experts.

4.1.4 Post-disaster:

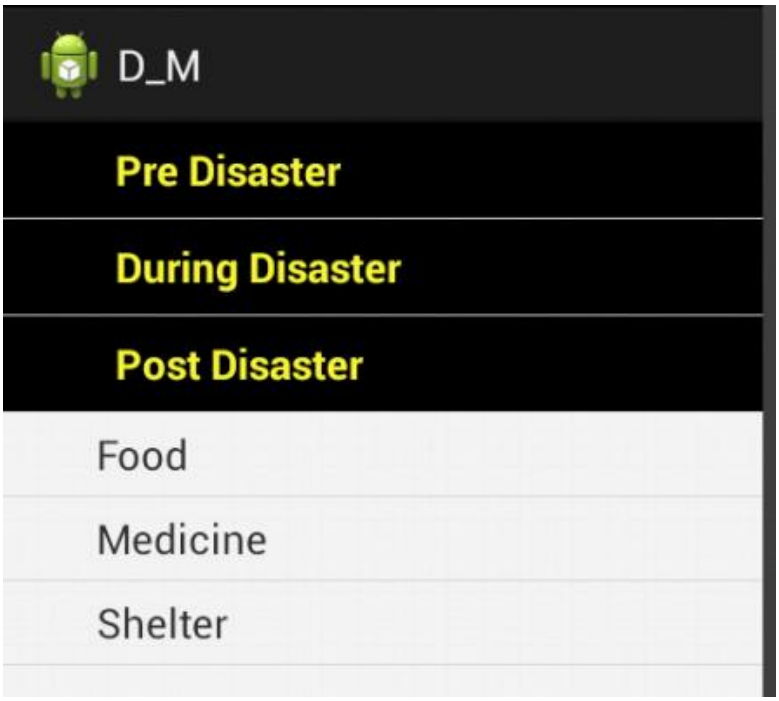


Figure 4.1.4 Post- disaster help

The term 'Post-Disaster' refers to the time-period right after a disaster occurs. Here, it is divided to main three sections which goes under the relief part as follows, 1)Food, 2)Medicine, 3) Shelter. The information goes to the server. From database it verifies user information and then checks the help type and send it to Relief manager and thus the help will reach to the victims. A volunteer can add the amount and type of first aid needed or number of people who needs shelter or food.

4.1.5 Rating the emergency level:

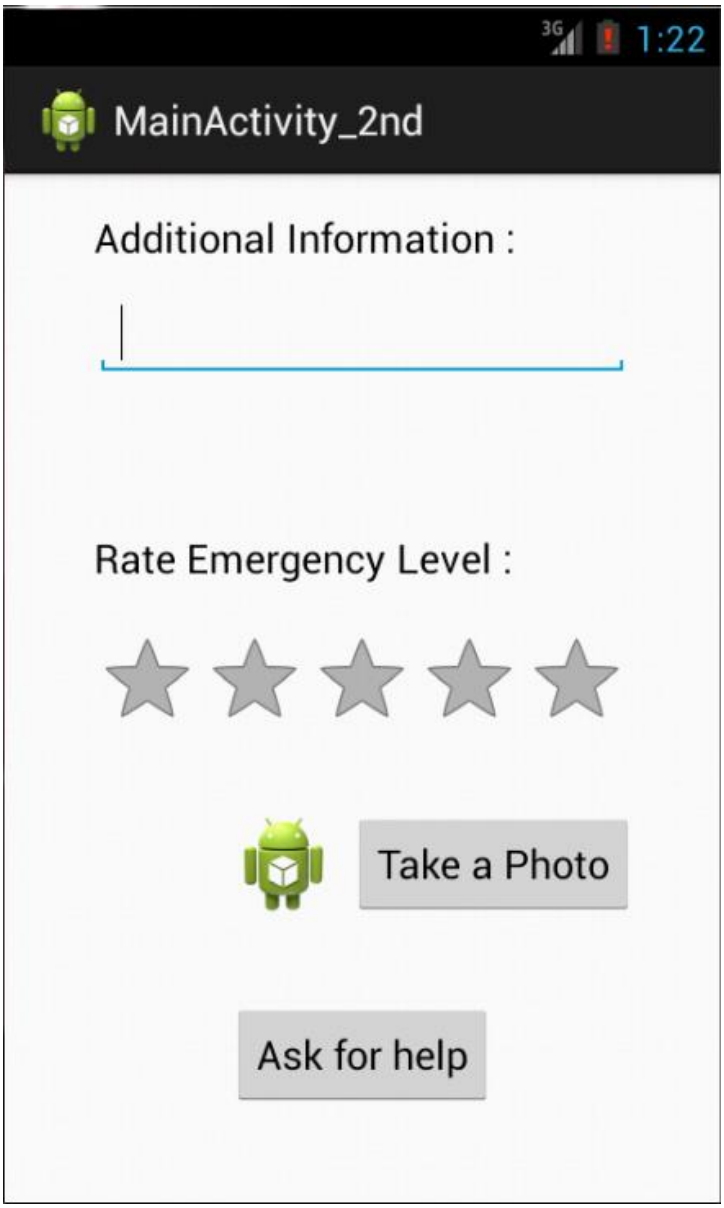


Figure 4.1.5 UI of rate the emergency level

User can rate the emergency level. How rapidly he needs help he can rate by the stars. He can also take photo and ask for help. Here by selecting the 'Ask for Help' button a massage goes with all the information selected and given by the volunteer with his current location to the server.

4.2 Remote Server Script for Storing Data

The image and the data uploaded from Android Phone application is received in the remote server using a PHP script. The information is stored within the assigned directory and the device URL is mapped in the database against every help request in the database.

4.3. Local Server Application Development

The local server application is dedicated for the use of the Incident Command System (ICS) of BRAC. The server application is an application developed by CSS, HTML, PHP, JavaScript & Google map API. The purpose of this application is to provide three functionalities to the expert, 1) Incident Commander (IC) view, 2) Deputy IC view, 3) Upazilla Manager (UM) view for alert/search/rescue & medical emergency, 4) Branch Manager (BM) view for relief distribution.

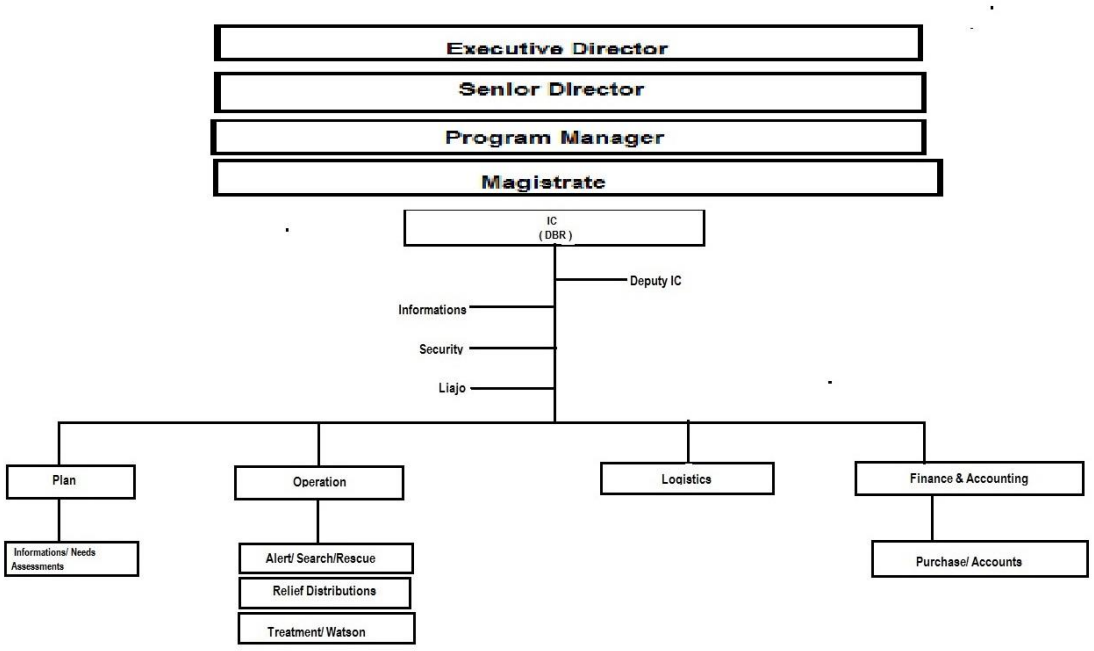


Fig: 4.3 workflow of executive director to volunteer

4.4: Application implementation:

A web based application capable of storing the information on a centralized location which can be further analyzed and visualized by the decision makers on the web. Google API's are very important part of this component to view the exact location of the people to rescue and the damaged infrastructure by displaying it on the Google map. It will have capability to synchronize the data with the local application on the Smartphone.[4] The capability of fetching and displaying the data from the web server to the phone will help decision makers and volunteers to visualize the data on server and local phone to get better idea of other parts of the disaster zone.The whole scenario of pre disaster, during disaster, post disaster sent by BRAC volunteers, map view of the current location of the volunteers & weather forecasting report by RIMES is observed by the IC, the during disaster part which includes medical emergency, rescue, search is observed by the UM in a different interface, the post disaster part which includes food, shelter, medicine is assisted by the BM in another interface. For the volunteers, Android operating system along with basic phone functionalities, Global Positioning System (GPS) enabled and is capable of taking the location of a particular incidence.[4] It is natural that after occurring a disaster in a particular area all the infrastructure usually damage. So in that case it is very important for central authorities to get information on the damaged places and the people who need rescue operation for decision making purposes. The most important and the key component of framework is the application on the mobile phone with capability of gathering the information related to different factors of disaster. This application will be helpful to capture the data about factors like people location, information about damaged infrastructure including pictures of the damaged area, with the help of built in camera in smart phone.

Incident Commander View:

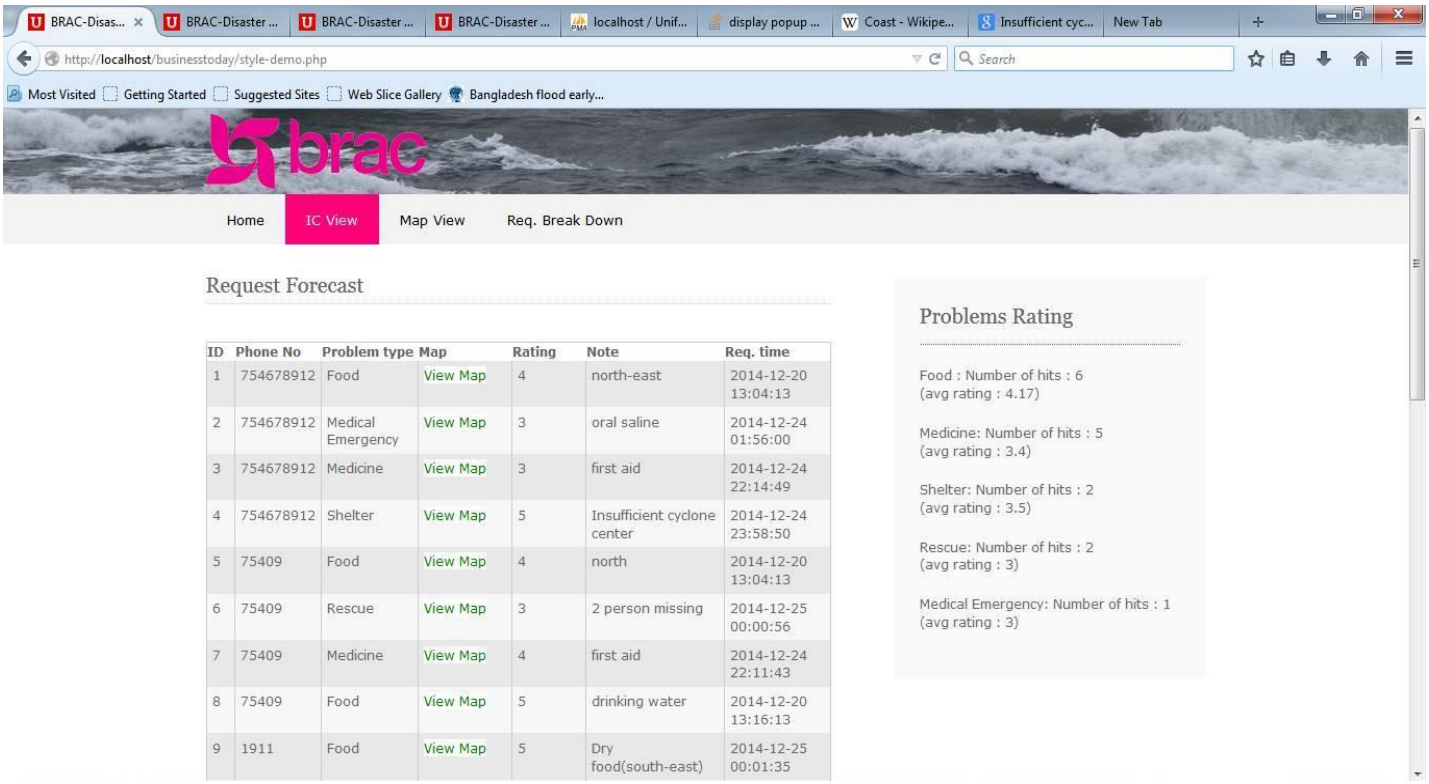


Fig 4.4 Incident Commander View from database

Incident commander is the head of ICS. He can observe the total view of the current situation of relief, shelter, medical emergency, rescue along with location in Google map & time of request.

Map Location View:

User can see the location of volunteer who needs assistance in Google map along with the daily weather forecast provided by RIMES.

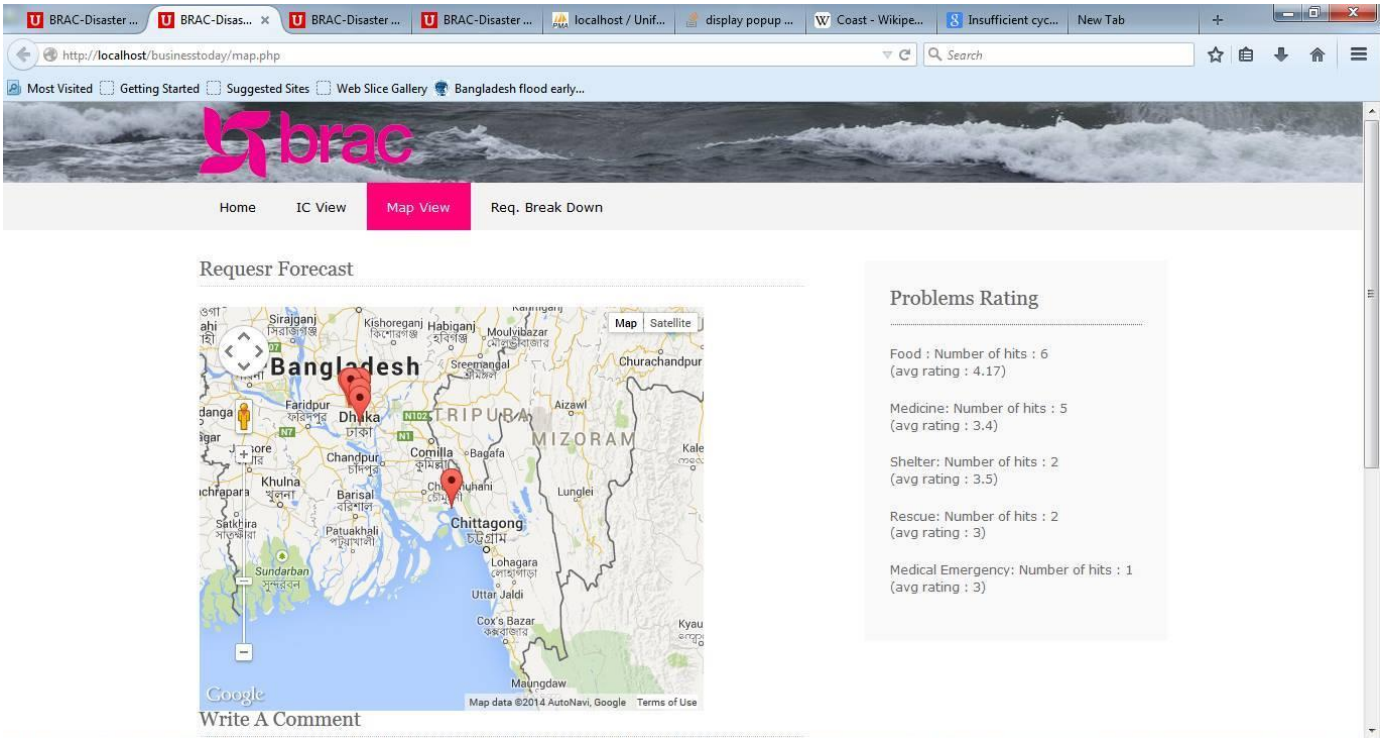


Fig: 4.4 Map View

Branch Manager(BM) View:

According to SOP the BM manages the relief sector of ICS. He can see only the relief section which provides the food, shelter, medicine information sent by volunteers & take necessary steps.

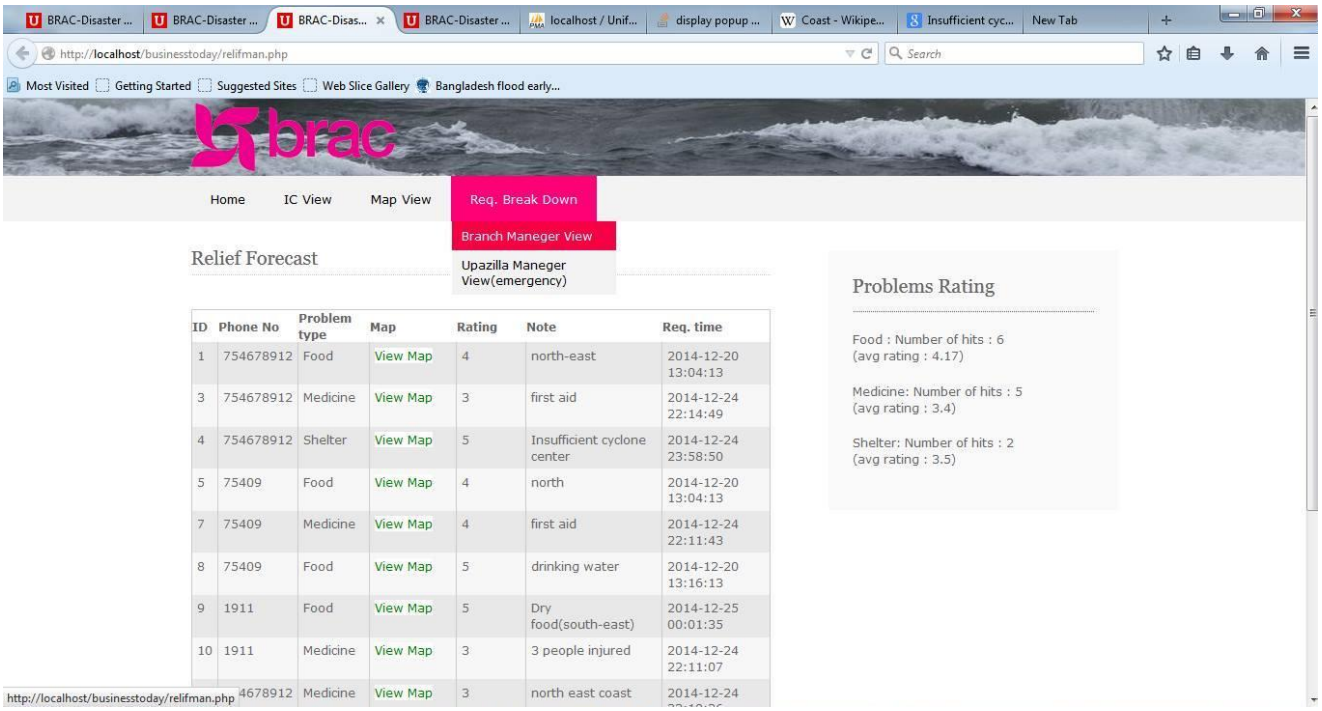
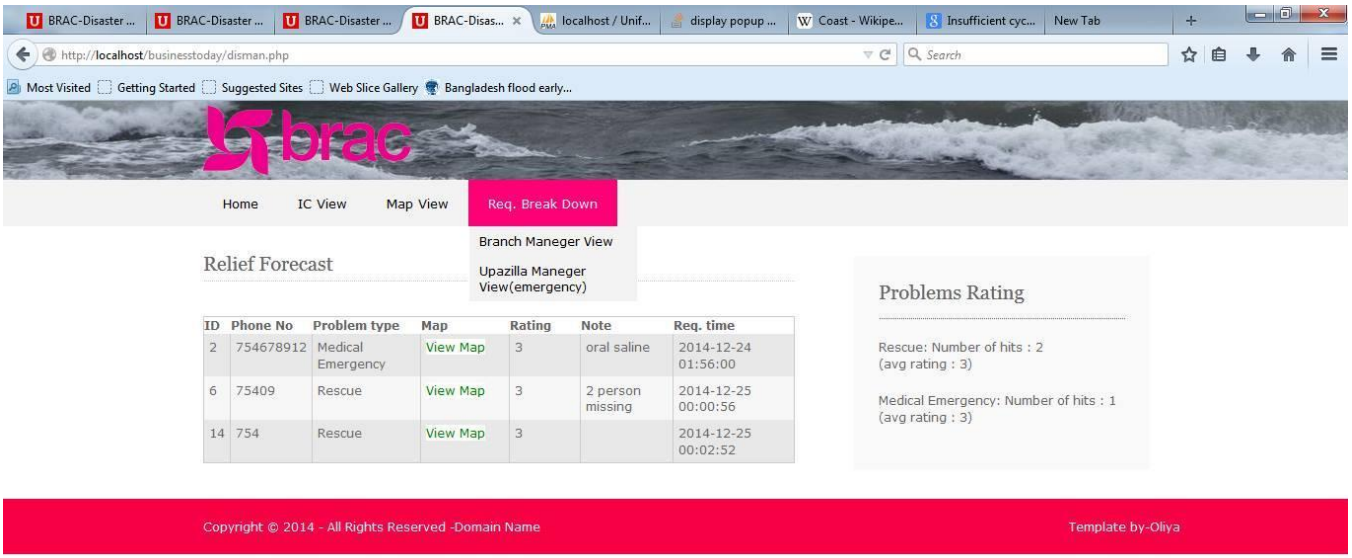


Fig: 4.5 Branch Manager View from database

Upazilla Manager View:

According to SOP the UM manages the warning/search/rescue sector of ICS. He can see only this section which provides the rescue, missing person report & medical emergency information sent by volunteers & take necessary steps.



http://localhost/businesstoday/disman.php#

Needs weight:

- Food : Number of hits:6(avg rating:4.1666666666667)
- Medicine: Number of hits:5(avg rating:3.4)
- Shelter: Number of hits:2(avg rating:3.5)
- Rescue: Number of hits:2(avg rating:3)
- Medical Emergency: Number of hits:1(avg rating:3)

Detecting the level of emergency and which request should be served first, the process goes as follows, for example,

Food weight = (food rating*5) / (no. of food request *5)

Formally, the weighted mean of a non-empty set of data(all Food type rating value)

$$\{x_1, x_2, \ldots, x_n\},$$

With non-negative weights(our rate is 5)

$$\bar{x} = \frac{\sum_{i=1}^{n} w_i x_i}{\sum_{i=1}^{n} w_i},$$

Which means:

$$\bar{x} = \frac{w_1 x_1 + w_2 x_2 + \cdots + w_n x_n}{w_1 + w_2 + \cdots + w_n}.$$

Therefore data elements with a high weight contribute more to the weighted mean than do elements with a low weight. The weights cannot be negative. Some may be zero, but not all of them (since division by zero is not allowed).

5. Experimental Results and Discussion:

The volunteer uses the application according to his needs. He can use it before disaster to know about the recovery tips, warning signs and to-dos and also know about the nearby shelters. He can also ask for help during disaster for rescues, medical emergencies, missing persons report. After disaster he asks for shelters, foods and medicine. He can rate his emergency level and also take a photo at the disaster spot. When he asks for help and sends messages, there automatically goes an alert to the back end in the database which will be seen by the admin. He can see the user's location in the Google map. According to the help he will take necessary steps to serve the aid.

5.1 Environmental setup

1. Android
2. Google Map API
3. JAVA
4. Notepad++
5. WAMP server
6. Windows 7

5.2 Limitations:

We have considered few limitations to the system. One of the drawbacks is prioritizing the emergency level according to situation demand. Rating results regarding this issue might not show accuracy in case of different scenario. We dealt this situation by allowing the user to select the emergency level by rating stars, sometimes it could be little confusing to determine the priority of helps, for example, while shelter is rated 5 stars & rescue is rated 3.5 stars at the same time, which should be served first. In addition, the system is developed in English which might be challenging for the rural volunteers to use. In order to actually spread this system for mass usage, it is essential that mobile application contains the instructions in Bangla.

6.Future Works and Conclusion:

6.1Future works:

We intend to continue updating this system for implementation of the project in real life. The primary focus will be to overcome the limitations of the currently developed system. Applying artificial intelligence based system may be the ultimate solution in order to solve this issue. We have also studied on this and this is massive work which we are planning to prepare at the early future.

6.2 Conclusion:

In this paper we presented an automated system which will help our disaster management to prevent hazards causes by the disasters. An application which is based on android operating system is proposed here which will be able to gather information about the disaster, serve helps during disaster and also after disaster.

Our application is accomplished of data collection from the disaster affected areas even in offline mode. As Bangladesh faces a lot of natural disaster our automated system will be very helpful hazards, so that we can save our beautiful country.

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APPENDIX:

BMD Bangladesh Meteorological Department

BM Branch Manager

CDMP Comprehensive Disaster Management Programme

CPP Cyclone Preparedness Programme

CBDRR Community Based Disaster Risk Reduction

DBR District BRAC Representative

DDMC District Disaster Management Committee

DECC Disaster Environment and Climate Change

DER Disaster and Emergency Response

DL Danger Level

DM District Manager

DDM Department of Disaster Management

DMIC Disaster Management Information Center

DRRO District Relief and Rehabilitation Officer

EOC Emergency Operation Center

EW Early Warning

FFWC Flood Forecasting and Warning Center

ICS Incident Command System

IC Incident Commander

IAP Incident Action Plan

IMD Indian Meteorological Department

IMT Incident Management Team

JSON JavaScript Object Notation

M&E Monitoring and Evaluation

MSL Mean Sea Level

NDMC National Disaster Management Council

NFI Non Food Item

NGO Non-Government Organization

ORS Oral Rehydration Solution

PM Programme Manager

RAT Rapid Assessment Tool

RIMES Regional Integrated Multi Hazard Early Warning System

RIR Rapid Initial Report

SOP Standard Operating Procedure

SOD Standing Orders on Disaster

SWC Storm Warning Center

SDK Software Development Kit

UDMC Union Disaster Management Committee

UDMT Upazilla Disaster Management Team

UM Upazilla Manager

WL Water Level

WMO World Meteorological Organization