REAL TIME INTEGRATED DISASTER MANAGEMENT SYSTEM (RIDMAS)

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ABSTRACT

During the past few years natural disasters have victimized the Pakistan. Due to unavailability of reliable and precise information system, decision makers are unable to pace with the objectives of good governance. In this scenario, Real-time Integrated Disaster Management System (RIDMAS) is a combination of Geographic Information System (GIS) along with Information and Communication Technology (ICT) to meet the needs of precise disaster management in a participatory manner. It facilitates the users to share the information in a real-time manner during and after the disaster with its spatial contexts so that administrative authorities may be enabled to take important decisions in an efficient and transparent way regarding rescue, rehabilitation, response and recovery. The users can collaborate with the system via internet, SMS and android geo-tagging for input and output of information.

Keywords: Real-Time, GIS, ICT, Geo-Tagging, Participatory GIS , Android, SMS

1. INTRODUCTION

Disasters are the part of our environment. Different experts have defined hazards according to their nature. Gipson (2002) has defined the following different types of disasters/hazards:

"Technological hazards are those accidental failures of design or management affecting large-scale structures and transport systems, or industrial activities that present life threatening risks to the local community.

Natural hazards result from those elements of the physical environment harmful to Man and caused by forces extraneous to him.

Human-induced natural hazards are those that are caused by the human modification of the environment".

It was 8th October, 2005 when Pakistan was struck by a devastating earth quake of 7.6 magnitudes exposing the country's vulnerability to natural disasters. According to NDMA (2007), it caused over 73,000 deaths over an area of 30,000 Sq Km, largely in Azad Kashmir and the North-West Frontier Province. This incident stimulated the creation of disaster management authorities both at federal and provincial levels in Pakistan. Later on Monsoon 2010 brought with it abnormal rainfall resulting a massive flood affecting 78 district out of total 141 districts of the country. The Punjab Province faced flooding in 11 districts out of its total 36 districts. The magnitude of destruction was twice the Pakistan Earth Quake 2005,cyclone Katrina 2005,Indian Ocean Tsunami 2004,cyclone Nargis 2008 and Haiti Earth Quake 2010 as shown in Table 1, NDMA (2010).

Table 2 shows that according to United Nation's Office for Disaster Risk Reduction, Pakistan is included in different disaster prone areas in year 2012. The UNISDR report shows the most vulnerability to disaster is in case of floods where it is ranked 21st out of 162 flood affected countries.

The use of modern technologies beside innovative ideas is very much required to meet the rehabilitation and relief during a disaster. In this concern, GIS and ICT in a combination can play an important role in this concern. Many of the developed countries are using ICT based solutions to manage the hazardous situations as mentioned in next section. The current scenario and past history of poor Disaster Management in the country highlighted need to develop a state-of-the-art geospatial design which should be quick and accurate to properly manage the disaster.

RIDMAS is a complete example of Participatory GIS (PGIS) storing, analyzing, reporting and processing the input information through modern communication channels e.g. internet and mobile, etc. against the four key components of disaster management. Moreover, it enables different categories of people to collaborate with the system either as users, data sharers, rescue teams or decision makers.

2. LITERATURE REVIEW

As the mobile technology is being increasing day by day resulting the launch of various smart phone applications and operating systems. Hence, ICT solutions are being adopted by the management and decision makers throughout the world. Moreover, being an economical real-time data sharing source, the use of mobile technology for disaster management is also getting popularity in many countries although the technical approaches changes with respect to economic and technological development of countries.

2.1 SMS Based Disaster Management in Bangladesh

The united Nation's Report on Disaster Prone countries, 2011 has ranked the Bangladesh as sixth most vulnerable country to natural disaster. On the other hand, Bangladesh was described as a mobile phone market with high growth rates in a recent study by Business Monitor International. It also said that 75% of population in country is rural and settled in disaster-prone areas which are potential places for mobile phone users and sellers to mitigate disasters.

In this concern, Bangladesh Disaster Management Bureau has started working to develop a mobile based integrated system in early 2012. It is basically a warning system which will work for coastal districts in the country. The system will work with the help of SMS spread and integration into government's disaster management committees spread across the country in different districts, sub-districts and union level.

Under this alert system alarming in case of cyclones or flooding will be sent to user's handset screen. The user will not require any kind of message retrieval. In this concern, the involved mobile partners are Grameen Phone and Teletalk (State-Run).

A voice based warning system is also in development phase in collaboration with the Airtel (mobile Operator), the Campaign for Sustainable Rural Livelihoods (CSRL), the Center for Global Change (CGC) and international NGOs Oxfam and CARE (Ushahidi, 2011).

2.2 Mobile Location Based Services for Disaster Management

Another method of real time disaster management system which is getting popular now-a-days is Location based mobile services. Location based services are basically a general class of computer programme-level services. It is used to control spatial location and time data in computer programmes. As LBS is a source of information and has many uses in social networking as an entertainment services. It makes itself accessible through mobile devices through the mobile network and which uses information on the geographical position of mobile devices (Wikipedia, 2012).

Similarly, it can play a significant role in case of disaster management. Ragia et al, 2009 has developed a Mobile Location Based disaster management services. This prototype system has a central database which constitutes both traffic data and additional information for incoming disaster phenomenon. The geometrical attributes are based on the standard maintained by Geospatial consortium. It facilitates its user in terms of spatial queries such as requests regarding

the contents, location, street address and time of occurrence of disastrous event. One can find the disastrous effect in context of spatial buffers such as user can process the query as "All the fires in a distance of 50km with respect to the coordinates (X,Y)".

The system is meant to enable the user to provide data using virtual tagging a location. The spatial messages can be sent to different users. In case when Bluetooth GPS is connected to the mobile phone, it gives the current position of the user. In this way GPRS protocol is used by the user in case of any emergency.

The system facilitates the users with spatial queries. It helps in selecting, storing and detecting user with respect to its location.

2.3 Android-Based Disaster Management System

The Philippine also stands amongst the most disaster prone countries which are lacking an efficient disaster management system which may be able to help at the time of need for quick rescue and rehabilitation. It is 20 among 200 countries which are most at risk from earthquakes, floods, tropical cyclones, and landslides countries. The existing free and open source web based disaster management system known as SAHANA FOSS has been deployed in many areas of the country but there was no any kind of system to help during the disaster to rescue the system.

By looking into the fact that the use of mobile phones in the Philippines is widespread, the disaster management system was implemented as a mobile application and the application environment used was Google's Android. In this regard, Therese et al,2009 has developed a disaster management system Android application known as My DisasterDroid. It determines the optimum route along different geographical locations that the volunteers and rescuers need to take in order to serve the most number of people and provide maximum coverage of the area in the shortest possible time. Geographic locations can be entered either through the My DisasterDroid application or via SMS and to determine the most optimum route, genetic algorithm was applied.

2.4 Web-based Disaster Management System

2.4.1 Geospatial Assessment Tool for Operations and Response (GATOR)

GATOR is a web based geospatial application for operations and response during disaster. It is developed to present common operation picture/Situational awareness to the Florida Division of Emergency Management (FDEM) and the State Emergency Response Team (SERT). FDEM plans for and responds to both man-made and natural disasters. The range of its working spans from floods and hurricanes to incidents caused by technology or nuclear power, FDEM (2010). The interactive web mapping interface of GATOR displays the geographic information to support emergency preparedness, operations and Response. It facilitates the visualization of Real-time data like weather radar, weather watches and warnings, and tropical storm tracks along with the basic geospatial layers such as roads, facilities and aerial photographs.

2.4.2 Global Risk Data Platform (GRDP)

This application is the advance generation of REVIEW initiated in 1999 by UNEP/GRID-Geneva. At present the GDRP is providing all standards for spatial data infrastructure (SDI) and ensuring all the web services in compliance with the OGC.

The data being presented through the GRDP is sourced from new developments made for the Global Assessment Reports on Disaster Risk Reduction Version 2009 and updated for the 2011 and 2013 versions.

The outcomes in this application were developed by a large group of interdisplinary researchers from around the globe. As a result a global application of disaster risk is made visible which is a key step towards mobilizing the political and economic commitments to reduce it.

A team of 24 independent members selected by World Meterological Organisation (WMO) and the United Nations Education and Scientific Cultural Organization (UNESCO) reviewed the methodologies for hazard modeling.

The GDRP allows the user to visualize the data regarding natural hazards, its exposure on both human and economics beside the possible risk. A toolbar is also provided to perform zoom/pan to a particular area. Moreover, different spatial layers of general data including cities, national parks, etc. can be uploaded. It also facilitates to highlight different components reflecting vulnerability such as population, GDP Per capita, land cover, elevation, etc. The yearly average of disasters such as tropical cyclones, droughts, earthquakes, biomass,fires and floods can also be visualized. The users can visualize, download or use the data live in a GIS software.

The comparative Summary of all the above mentioned disaster management system (Web base & Mobile Based) is given in table 3.

3. RESEARCH STATEMENT

To develop a GIS based Real-time synchronous collaborative disaster management system so that the information regarding assets, health facilities, food storages, affected people etc may be circulated among decision makers in a precise manner.

4. MATERIALS AND METHODS

4.1 Disaster Indicator Management Analysis (DIMA)

The process of disaster management involves four phases: mitigation, preparedness, response, and recovery. The mitigation phase is the attempt to reduce disaster risks by focusing on long-term measures of eliminating disasters. The preparedness phase is the development of an action plan for an upcoming disaster. The response phase is the mobilization of services and relief when disaster strikes and the recovery phase is the restoration of the affected area to its previous state (Therese et al, 2009).

Before the interface design of RIDMAS, a complete analysis was performed in collaboration with the government officials, stakeholders (NGOs, Disaster Management Authority, Tehsil Municipal Authorities (TMAs) to develop an indicator design which need to be kept n view while designing a disaster management system, meant for making important decisions (Table 4).

4.2 Technical Approaches to RIDMAS

As RIDMAS is designed to quickly response in case of any disaster. So, a reliable, efficient and cost affective mode of information sharing was required. By keeping it in view, this is designed using ICT channels and geospatial approaches. But, it was very necessary to look into the characteristics of underlying technology, available internet exposures, mobile devices, resources requirements, number of users, possible information sharing types and devices to deliver information by means of ICT; and its contribution for a system as RIDMAS.

A data collection regarding present users of internet and mobile technology in Pakistan was carried out to assess the success in achieving a reliable and efficient channel of communication.

4.2.1 Internet Users

According to CIA World Fact book, there were 20.431 million internet users in Pakistan upto January 2012. Obviously, the present numbers will be higher than this. Please, refer to Figure 1 and Table 3 to look into the increase in internet users for the interval from year 2000 to year 2009.

Pakistan is ranked 21 in the world among the top 50 countries with most internet users. The comparison of internet users in Pakistan is given in Figure 1 and Table 5.

So, a web based application can be accessible through a large number of users. But, internet can be used only by literate persons who are experienced in web surfing. Especially, in rural areas where the awareness about technology and literacy rates are comparatively low with respect to urbanized areas, internet is not a good choice to receive and response to the issues. This communication channel can be useful for decision makers who are to analyze the situation in their workplaces or at locations where mostly internet is accessible.

4.2.2 Mobile Users

The mobile technology in Pakistan has attained a breakthrough over the past decade. According to United Nation's statistics of year 2010, there are 59 cellular subscribers per 100 persons in Pakistan.

1. Similarly, according to Pakistan Telecommunication Authority (PTA) there are millions of people in Pakistan using mobile technology enjoying different services significantly since year 2003, as shown in Figure 2 (a, b, c& d).Mobile technologies can be divided into the following categories with respect to type of mobile device, manufacturers, Operating Systems. In literature there are three basic types of mobile devices:

- Type 1: Mobile Phones with no internet access but with capability of sending/receive text message.

- Type 2: Mobile phones with internet access and also can send/receive text messages.
- Type 3: Smart phones which can run specially designed software (Schweiger, 2011).

  A wide variety of mobile devices is available in market. Please, refer to Annexure A to know about the available mobile types, technologies, operating systems and manufacturers in market.

2. In third step, a random questionnaire survey was carried out to assess the percentage of usage against different types of mobile devices (Annexure B). It depends on following key factors:

- Education
- Knowledge about Technology
- Economic condition of user
- Tendency to learn new techniques and methods

  The survey brought the results as shown in figure 3 (a & b).

5. RIDMAS ARCHITECTURE AND DESIGN

The three basic adoptive approaches of RIDMAS architectural design are as follows:

- The only GIS based virtual platform to be used by all of stake holders for input and output of information during emergency days.
- Each user/client/decision maker can use collaborative involvement with the system using communication channels such as web, Mobile SMS, Geo-tagging etc.
- The information is only disseminated through the central data warehouse which is holding precise, consolidated and integrated information.

RIDMAS has following key components.

5.1 Central Data Storage (CDS)

CDS is working as the main spatial and attributive data repository. Its function is to collect, store and process the desired query for the data retrieval. It has the capacity to hold geospatial data sets incoming real-time data sharing from different input channels.

5.2 Real Time Integration Server (RIS)

The RIS is working as the main distributor of the both spatial and attributive information. It is a complete server based system which is meant to receive the input from user, store it in local databases and disseminate back to the user and beneficiaries. It is integrated through G2G, G2B and G2P linkages.

The basic concept of RIS, as a component of RIDMAS is given in figure 4.

5.3 Real-time Reporting Mechanism (RRM)

This is the most important component of RIDMAS. The actual spirit of a Disaster management system is to report and response in quick intervals of time to carry out the decisions regarding

relief and rehabilitation. RRM is responsible to generate and disseminate the reports on quick intervals of time. It is acting in two ways:

- **Real-time Reports** which are updated synchronously at every instant as the data and field reporting is updated. One can view these reports by entering to the web interface.
- **Consolidated Reports** which are sent to the decision makers, Rescue teams and users via email and SMS on daily bases. Moreover, weekly and monthly reports are also maintained to facilitate the relief and rehabilitation plans and programmes during and after a disaster.

The complete architecture of RIDMAS is shown in figure 5.

6. KEY FEATURES OF RIDMAS

RIDMAS is designed to complement the requirements evolved in the indicator design of Disaster management.

Here are following key features of the system.

6.1 Spatial Data Layers

It is providing a large amount of Geospatial vector data layers against the required indicators for the geographical analysis of pre and post disaster situations. The decision makers can easily visualize the spatial context of the area in terms of existing land use, property ownership, road network and scattered facilities throughout the areas for health, shelter and food, etc. within the administrative boundaries. Figure 6 (a & b) are showing a snapshot of web interface to understand the web-based geospatial data accessibilities.

6.2 High Resolution Satellite Imagery

RIDMAS is provided with the high resolution Google Imagery. The imagery is updated with the passage of time. Moreover, past imagery is also available fom Google Earth. For example, in case of flooding, one can easily query to compare the pre and post flood situation to analyze the area under water and dealing with the property claims with respect to its nature and area (Figure 7).

6.3 Real-Time Data Sharing

RIDMAS is providing a downloadable and easy to install android based application known as "Disaster Tag"which allows smart phone users to geo-tag the location and event in disaster affected area. But as the survey showed that 85% users in Punjab province are having conventional phones and 35% of them are having type-1 phone which do not have internet access. As a result RIDMAS is flexible enough to facilitate the public for SMS based data inputs in a real-time manner. The users are required to send the data in the form of a prescribed SMS format which duly becomes the part of web interface with in 2 seconds of sending SMS. For example, a person who is in water locked area will send SMS in the following format, i.e*Ijaz Ahmad* MZG*WL*0.*

In above example WL stands for water locked area. Similarly, in case of fire the user will send FIR to the RIDMAS server. If the situation is in control then user will type "0" otherwise if everything is getting back to control then report will come as "1".

6.4 Route Optimization

Both the web and android component of RIDMAS (Disaster Tag) facilitates the user to calculate the shortest route as well as optimum route. This component is specially designed for the rescue teams who have to visit the disaster locked areas and facilitate the relief camps during emergency days. Initially, the shortest distance between two points is calculated through the simple Euclidean Distance between the two points calculated by the formula implemented on two location (x1,y1) and (x2,y2),i.e,

$$d = \sqrt{|x1 - y1|^2 + |x2 - y2|^2}$$

But as during the disaster condition optimum route evaluation is most important beside the shortest displacement for the rescue teams. Later on all the possible calculated shortest distances are passed from a optimization filter which calculates and highlights the most optimum route by incorporating the important landmarks and disaster situations obtained from the user feedback.

The snapshot from the "Disaster Tag" are given in figure 8 (a & b) to understand its functionality with respect to the section 6.3 & 6.4 of the document.

6.5 Live chats and Comment Box

Live chats and meeting is the most important feature of RIDMAS in terms of participatory GIS. Decision makers can login the system in groups. At a time every member of group can benefits from the tools provided in its interface. The live screen sharing enables them to view the same area at the same time. For example, if one zooms to the vector layer or satellite imagery of model Town Lahore, every one included in discussion group will be able to watch the zoomed area at his screen. As a result simultaneous discussion will be redirected to the concerned area. Moreover, tool box facilitates the user to put some spatial annotation in form of point, line and polygon to highlight the concerned areas to update the land use and important location. For example, a director from National Disaster Management Authority can collaborate with the chairman of Planning and Development Department to analyze the situation of a particular area so that a necessary collaborative action can be taken. Please, refer to figure 9.

6.6 User Specific System Interactions

Another important feature of RIDMAS is that its users can interact with it differently in accordance with their roles in governance using its multi- channels for data input and output. For example, general public can visualize information through web-based interface. In other ways, rescue teams and departmental personals in field can benefit from its smart phone component for optimum route finding to approach the nearest relief camp. The field teams can also contact to

the CDS to update the current condition of any area. Later on, this ongoing information flow can be retrieved by the decision makers through internet and they can view the current reports and join the virtual chats and discussions for further measurements. Please, refer to figure 10 to understand the RIDMAS user interactions.

7. CONCLUSIONS

- It is found that RIDMAS is a useful system for disaster management. It is a state-of-the-art system which facilities the decision makers to respond the emergency issues in a quick way.
- The rescue teams are fully facilitated to be provided a guide map component so that they may visit the affected areas and relief camps in an efficient way.
- General Public is enabled to participate with the system regarding data sharing using farm to table approach.

8. FUTURE RECOMMENDATIONS

- RIDMAS is required to be enhanced in future with more possible features as the trends and technologies are always changing. The geospatial data will be updated on regular intervals to manage the disaster.
- Moreover, a complete support and interdepartmental connectivity should be maintained to achieve its real objectives i.e Public participation and sound Decision making.

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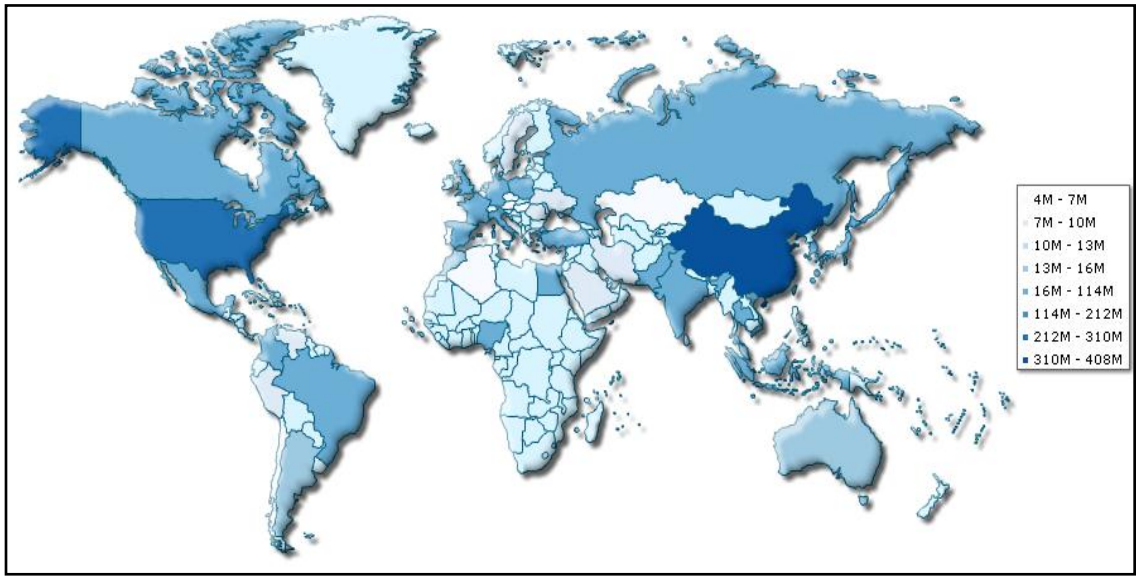

Fig 1. Comparison of Pakistan with top 50 countries for Internet Usage

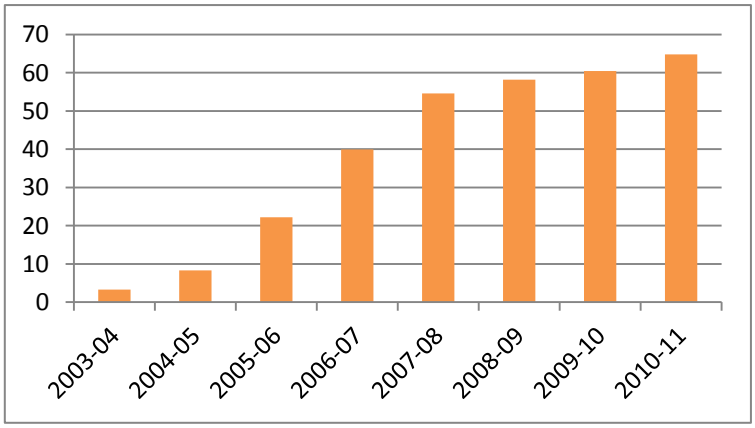

Fig 2 a. Cellular density (%) in Pakistan (2003-2011)

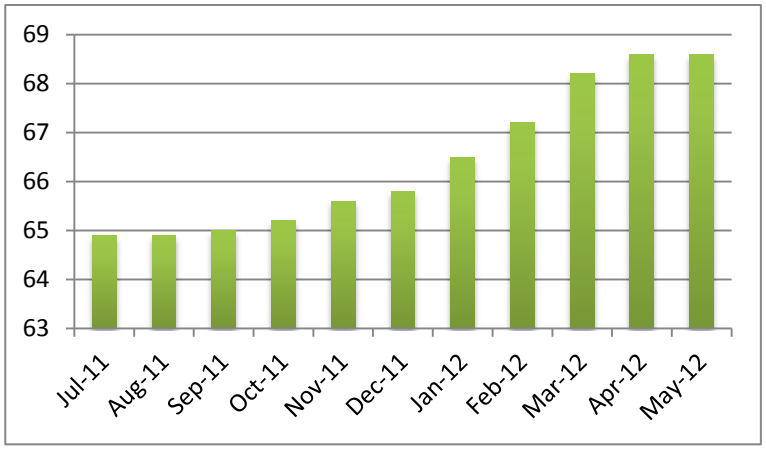

Fig 2 b. Cellular density (%) in Pakistan (Jul 2011-May 2012)

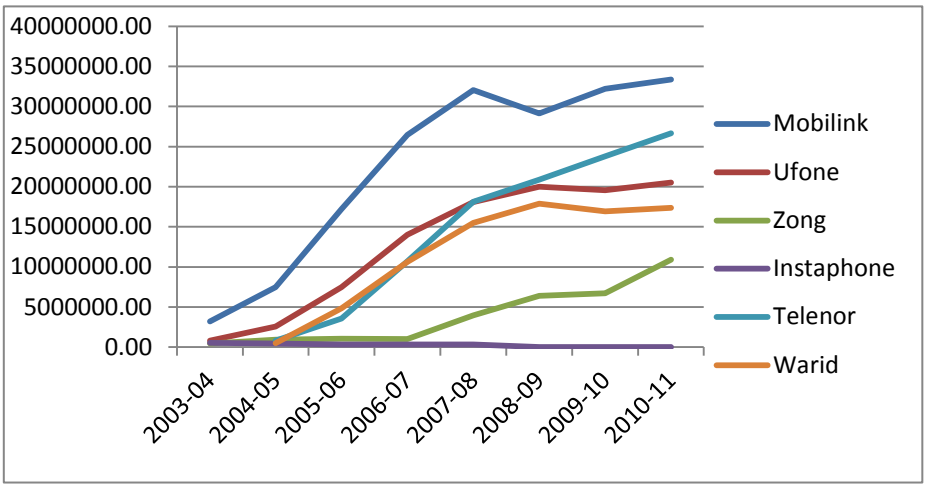

Fig 2 c. Number of different connection holders (2003- 2011)

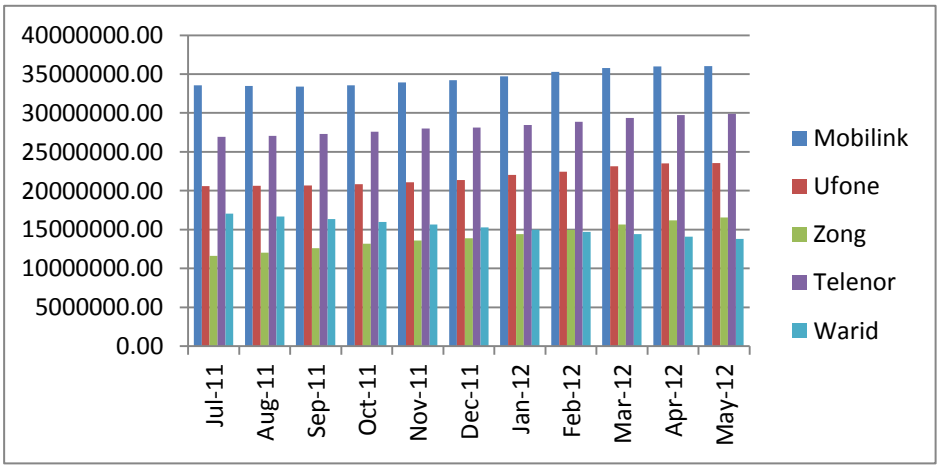

Fig 2 d. Number of different connection holders (Jul2011-May 2012)

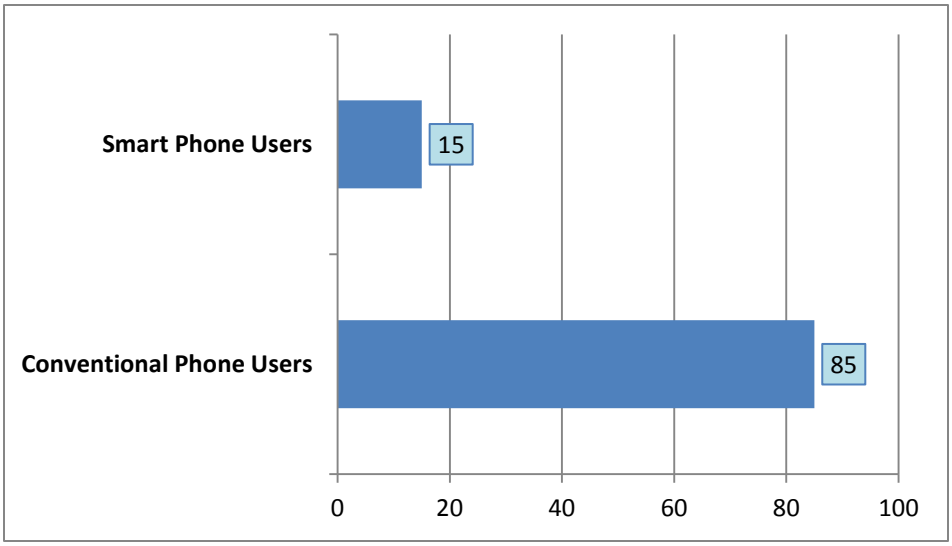

Fig 3 a. The percentage ratio of smart phone users and conventional phone users

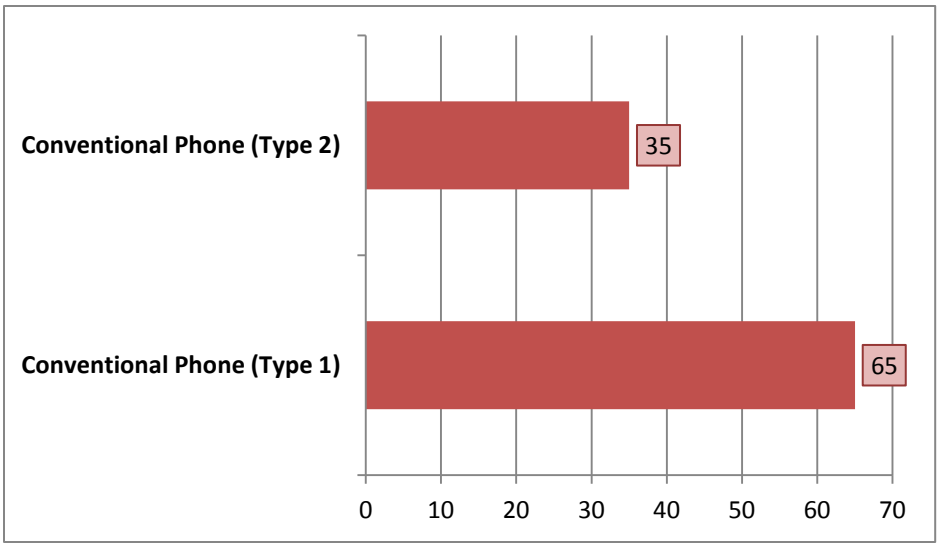

Fig 3 b. The percentage distribution of conventional phone users with respect to Type 1 & Type 2

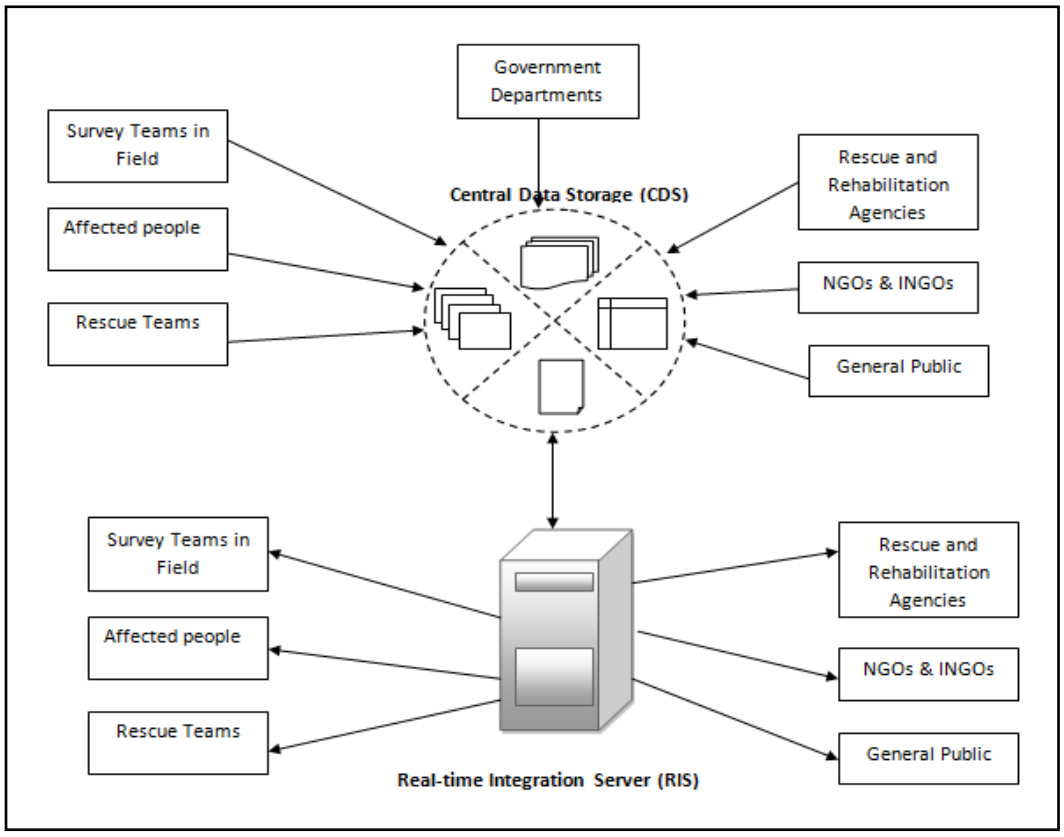

Fig 4. Concept behind Central Data Storage and Real-time Integration Server

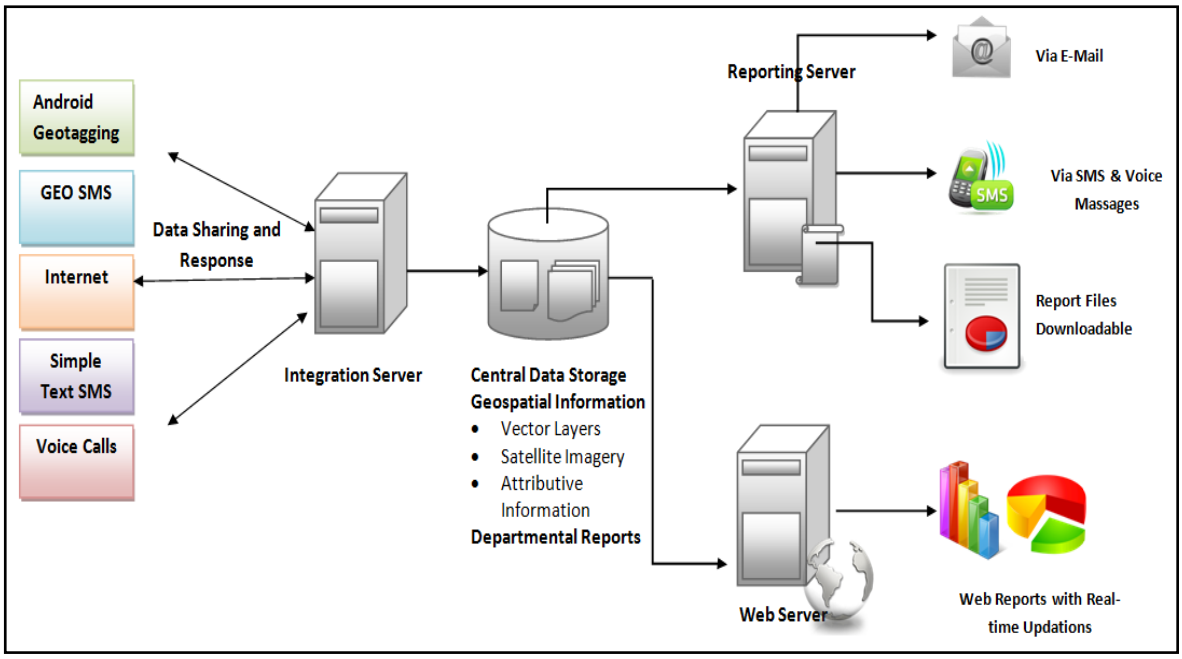

Fig 5. RIDMAS Architecture

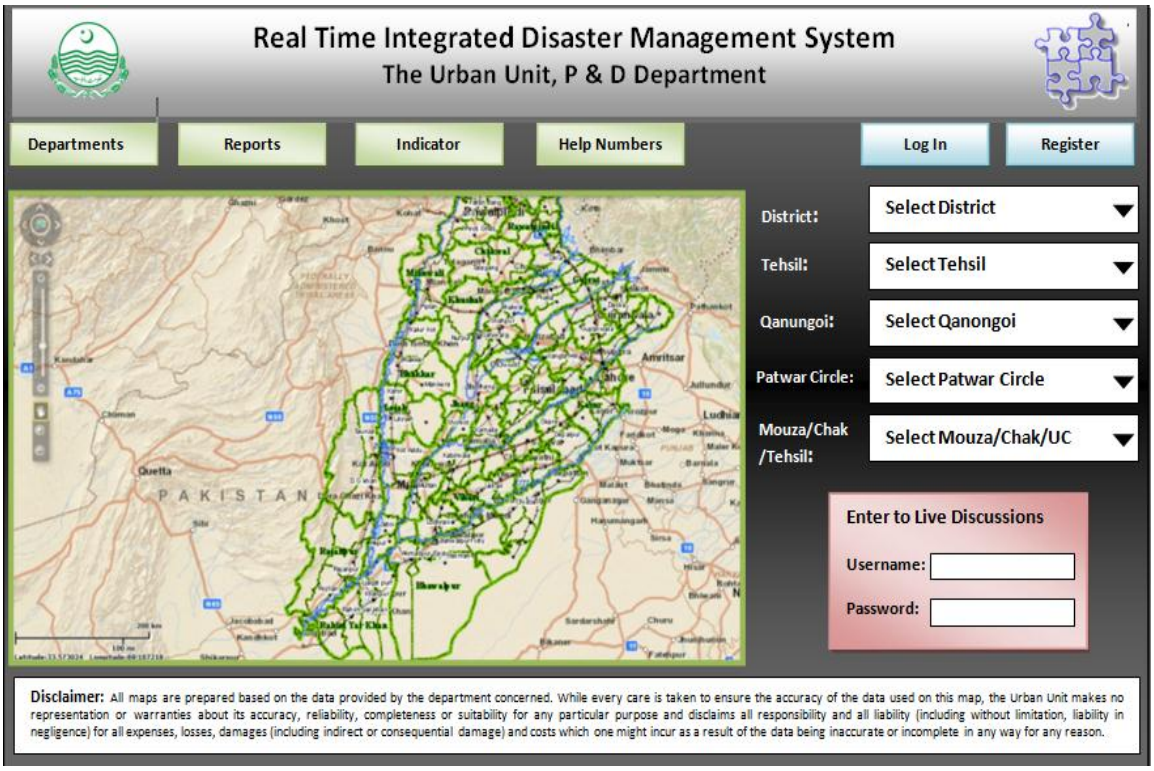

Fig 6 a. The designed web interface for RIDMAS

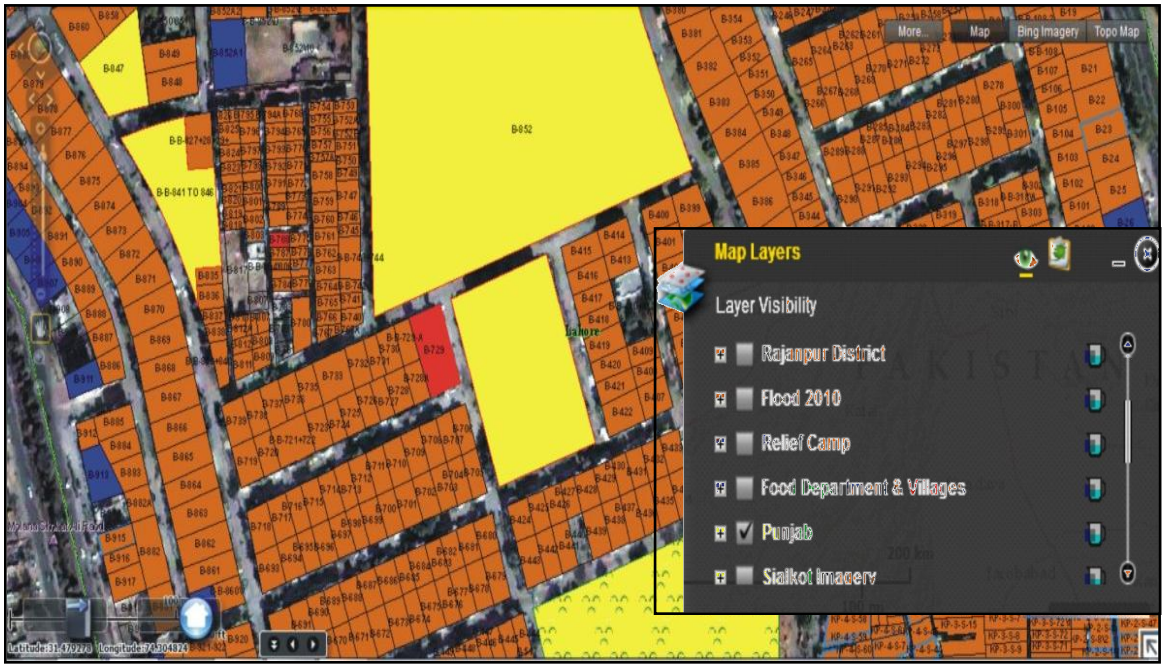

Fig 6 b. Developed land use layer of a particular area for RIDMAS

Fig 7. RIDMAS helping to understand the ownership status of property

Fig 8 a. The designed interface of Android application of Disaster Tag

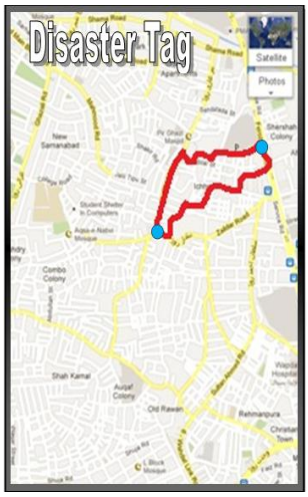

Fig 8 b. Optimum Route Finding using Disaster Tag- RIDMAS

Fig 9 a. Real-Time user's input for landuse on RIDMAS interface

Fig 9 b. Real-Time user's input for location marking on RIDMAS interface

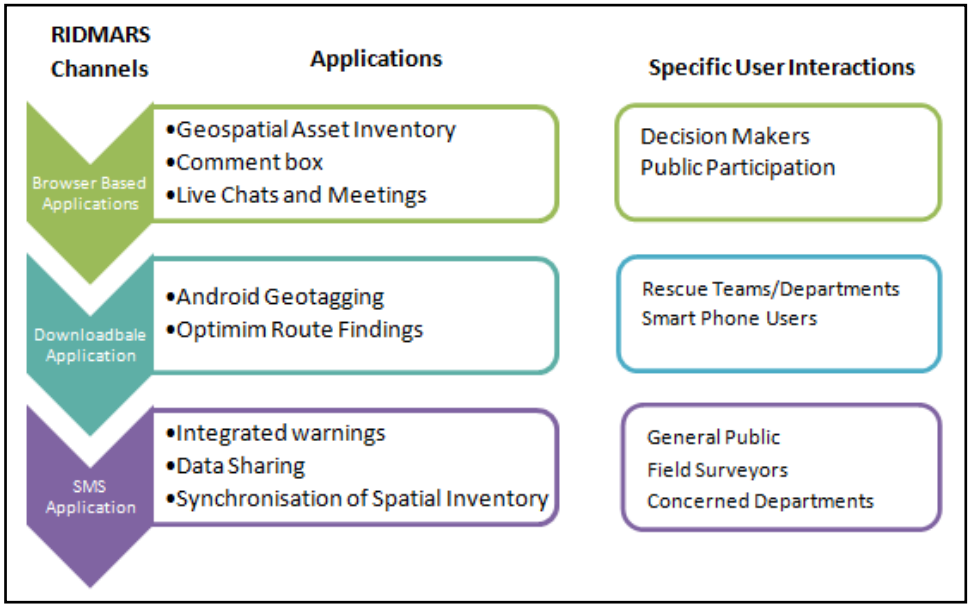

Fig 10. RIDMAS User Interactions

Table 1. Comparison of Flood 2010 with other major Disasters in the World[1]

	Pakistan Floods 2010	Pakistan Earth Quake 2005	Katrina Cyclone USA 2005	Nargis Cyclone Myanmar 2008	Indian Ocean Tsunami 2004	Haiti Earthquake 2010
Population Affected (No)	20,251,550	3,500,000	500,000	2,420,000	2,273,273	3,200,000
Area affected (sq Km)	132,000	30,000	N.A	23,500	N.A	13,226
Deaths (No)	1,985	73,338	1,836	84,537	238,000	230,000
Injured (No)	2,946	128,309	N.A	19,359	125,000	300,000
Household Damaged (No)	1,894,530	600,152	200,000	450,000	N.A	250,000

[1] **Source: Internal Study by DRR Wing, NDMA**

Table 2. Pakistan Risk Profile according to UNISDR, 2012

Hazard	% Pop. Exposed	Ranking	% GDP Exposed	Ranking
Drought	7.24%	53rd out of 184	-	-
Earthquake	1.76%	55th out of 153	1.39%	65th out of 153
Flood	0.35%	26th out of 162	0.62%	21st out of 162
Cyclone	0.21%	66th out of 89	0.31%	66th out of 89
Tsunami	0.07%	55th out of 76	0.18%	44th out of 76
Landslide	0.01%	83rd out of 162	0.06%	79th out of 162

Table 3. Comparison of RIDMAS with other existing systems

Application	Extent	Area of Disaster Management	Technology Input/Output method	Merits	Users
Disaster Management In Bangladesh	Coastal districts in the country	Emergency Warning	SMS	Quick and Cost efficient method to aware the fisher men	Fishermen
Android-Based Disaster Management System	Philippine	Response	SMS & Android Operating System	• Real-time System • Facilitate its users to find optimum route during disaster by entering spatial location either by SMS or Android application.	Rescue teams Affected People
Geospatial Assessment Tool for Operations and Response (GATOR)	Florida	Preparedness and Response	Web Based	Display roads/route unaffected in flood hit areas. Hospitals / Fire brigade / police stations	Florida Division of Emergency Management (FDEM) State Emergency Response Team (SERT)
Global Risk Data Platform	Global	Mitigation (Disaster Risk Reduction)	Web Based	Display hazards history and its locations with affected population along with socioeconomic layers	UNISDR, WMO, UNESCO
Real-time Integrated Disaster Management	Pakistan	Disaster Management (Preparedness, Response	SMS, Android, Web Based	• Real-Time and synchronized system. • Asset Inventory • Spatial Layers of	General Public, Affected people,

System (RIDMAS)		and Recovery)		existing infrastructure; administrative boundaries etc (Refer to table 4 for further details. • Everyone can benefit as per its role there are multiple communication channels for collaboration.	Decision Makers and Concerned Departments

Table 4: Disaster Indicator Management Analysis for RIDMAS

Disaster Management Phases	Indicator	RIDMAS Requirements	
		Spatial	Attributive & Numerical
Mitigation	Practically not possible in case of natural disaster.		
Preparedness	Madical Facilities	Hospitals, Dispensaries, BHU, RHC etc	Number of Beds, Doctors & Paramedical Staff, Equipment etc
	Infrastructure	Road Network, Tracks etc	Name, Length, connectivity, Major intersections etc
	Rescue	Rescue Agency such as 1122, Edhietc	Available Equipment, Ambulances, Capacity and Emergency Handlings
	Law enforcement	Police Stations, Military Post etc	Available Staff in general, Equipment, Vehicles etc
	Community	Community Based Organizations, NGOs etc	Available funds ,Rescue equipment and capacity
	Possible Temporary Relief Availabilities	Schools, Parks, Vacant Lands, High-rise buildings etc	Capacity in terms rooms, space and elevation.
	Food	Godowns, Marts etc	Capacity and Availability.
	Economy	Banks	Available money, possible money transactions and rotations
Response	Quick Mobilization of Services and Decision Support System	Optimum Route findings, Real-time information sharing with respect to above mentioned spatial context etc	ICT based geospatial models and techniques, Channel of communications (Mobile, Internet, Telephone, Fax etc)
Recovery	Rehabilitation Plans	Pre & Post disaster Comparison, Landuse	Property size and ownerships to deal with claims and provision of rehabilitation facilities

Table 5: Comparison of Pakistan with top 50 countries for Internet Usage

Rank	Country Name	Internet Users	Rank	Country Name	Internet Users
1	China	3,890,000,002,009	**26**	Australia	158,100,002,009
2	United States	2,450,000,002,009	**27**	Malaysia	153,550,002,009
3	Japan	991,820,002,009	**28**	Netherlands	148,720,002,009
4	Brazil	759,820,002,009	**29**	Argentina	136,940,002,009
5	Germany	651,250,002,009	**30**	Morocco	132,130,002,009
6	India	613,380,002,009	**31**	Saudi Arabia	97,740,002,009
7	United Kingdom	514,440,002,009	**32**	Peru	91,580,002,009
8	France	446,250,002,009	**33**	Venezuela	89,180,002,009
9	Nigeria	439,890,002,009	**34**	Sweden	83,980,002,009
10	Russia	408,530,002,009	**35**	Philippines	82,780,002,009
11	Russia	408,530,002,009	**36**	Iran	82,140,002,009
12	Korea, South	394,000,002,009	**37**	Belgium	81,130,002,009
13	Mexico	310,200,002,009	**38**	Romania	77,870,002,009
14	Italy	292,350,002,009	**39**	Ukraine	77,700,002,009
15	Spain	281,190,002,009	**40**	Chile	70,090,002,009
16	Turkey	272,330,002,009	**41**	Czech Republic	66,810,002,009
17	Canada	269,600,002,009	**42**	Hungary	61,760,002,009
18	Vietnam	233,820,002,009	**43**	Switzerland	61,520,002,009
19	Colombia	225,380,002,009	**44**	Austria	61,430,002,009
20	Poland	224,520,002,009	**45**	Kazakhstan	52,990,002,009
21	**Pakistan**	**204,310,002,009**	**46**	Portugal	51,680,002,009
22	Egypt	201,360,002,009	**47**	Greece	49,710,002,009
23	Indonesia	200,000,002,009	**48**	Hong Kong	48,730,002,009
24	Thailand	174,830,002,009	**49**	Denmark	47,500,002,009
25	Taiwan	161,470,002,009	**50**	Algeria	47,000,002,009

Annexure A

A 1. Available Mobile Computing Devices

Mobile computing Devices	Characteristics	Examples
Personal Digital Assistant (PDA)	(sometimes called pocket computers) PDAs are handheld devices that combine elements of computing, telephone/fax, Internet and networking in a single device. A typical PDA can function as a cellular phone, fax sender, Web browser and personal organizer. Unlike portable computers, most PDAs began as pen-based, using a stylus rather than a keyboard for input. This means that they also incorporated handwriting recognition features. Some PDAs can also react to voice input by using voice recognition technologies. PDAs of today are available in either a stylus or keyboard version (called a data pad).	Palm Pilot, Revo, Sony Clie, Hewlett-Packard Jornado, Casio Cassiopedia, Compaq iPaq, Toshiba Pocket PC
Smart Phones	Smart phones combine both mobile phone and handheld computers into a single device. Smartphones allow users to store information (e.g., e-mail), install programs, along with using a mobile phone in one device. For example, a Smartphone could be a mobile phone with some PDA functions integrated into the device or vise versa.	Apple I-Phone,Samsung,Sony Ericsson, Palm Treo, Blackberry, Nokia T-Mobile Sidekick, Torq, Motorola Q, E-Ten, HP iPaq, I-mate
Tablet PC	Tablet PCs are a type of notebook computer that has an LCD screen on which you can write using a stylus. The handwriting is digitized and can be converted to standard text through handwriting recognition, or it can remain as handwritten text. The stylus also can be used to type on a pen-based key layout where the lettered keys are arranged differently than a QWERTY keyboard. Tablet PCs also typically have a keyboard and/or a mouse for input.	

A 2. Different Operating Systems In Mobile Computing Devices

Mobile Operating Systems	Characteristics	Specific Devices
Android from Google Inc.	Android was developed by a small startup company that was purchased by Google Inc. in 2005, and Google continues to update the software. Android is a Linux-derived OS backed by Google, along with major hardware and software developers (such as Intel, HTC, ARM, Samsung, Motorola and eBay, to name a few), that form the Open Handset Alliance. Released on November 5th 2007, the OS received praise from a number of developers upon its introduction. On 15 November 2011, Android reached 52.5% of the global smartphone market share	HTC, Samsung, Motorolla, Qmobileetc
Symbian OS	Symbian OS has become a standard operating system for smartphones, and is licensed by more than 85 percent of the world's handset manufacturers.	The Symbian OS is designed for the specific requirements of 2.5G and 3G mobile phones.
Windows Mobile	The Windows Mobile platform is available on a variety of devices from a variety of wireless operators.	Dell, HP, Motorola, Palm and i-mate products. Windows Mobile powered devices are available on GSM or CDMA networks.
Palm OS	Since the introduction of the first Palm Pilot in 1996, the Palm OS platform has provided mobile devices with essential business tools, as well as capability to access the Internet or a central corporate database via a wireless connection.	
Mobile Linux	The first company to launch phones with Linux as its OS was Motorola in 2003.	Linux is seen as a suitable option for higher-end phones with powerful processors and larger amounts of memory.
MXI	MXI is a universal mobile operating system that allows existing full-fledged desktop and mobile applications written for Windows, Linux, Java, Palm be enabled immediately on mobile devices without any redevelopment.	MXI allows for interoperability between various platforms, networks, software and hardware components.

Annexure B

1. **Personal Information**

Name	**Gender**	**Age**	**City**

2. **For how many years you are using a mobile phone?**

3 to 5 years	5 to 10 years	10 years& above	No idea

3. **What kind of mobile are you using?**

conventional mobile without internet connection	conventional mobile with internet connection	Smart phone	Both

4. **What is your education level?**

Below Matric	Matric	Intermediate	Graduate & Above

5. **What is nature of your occupation?**

Self Business	**Corporate**	**IT based**	**Government**

6. **How much is your monthly Income?**

Less than 20,000	20,000 to 40,000	40,000 to 100,000	100,000 and above

7. **What operation you can do easily using mobile phone?**

Dial/receive call	Send/receive text message	Internet browsing	Using mobile applications	All

8. **Are you interested to upgrade your mobile device in future?**

Yes	No	Not Necessary	No idea