TECHNOLOGY ACCEPTANCE FACTORS AFFECTING INTENTION TO ADOPT GEOGRAPHICAL INFORMATION SYSTEM (GIS) AMONG THE LOCAL GOVERNMENTS IN WEST ACEH, SUMATERA, INDONESIA

JAMAL MIRDA

UNIVERSITI SAINS MALAYSIA
2010

GIS-BASED DISASTER MANAGEMENT SYSTEM IN LOCAL GOVERNMENT OF WEST ACEH, SUMATERA, INDONESIA

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by

JAMAL MIRDA

Dissertation submitted as partial fulfillment of the requirements for the degree of Master of Science (Information Technology Technopreneurship)

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DECLARATION

Name : JAMAL MIRDA

Matric No : PCOM0032/09

School : SCHOOL OF COMPUTER SCIENCE

Thesis title : TECHNOLOGY ACCEPTANCE FACTORS AFFECTING INTENTION TO ADOPT GEOGRAPHICAL INFORMATION SYSTEM (GIS) AMONG THE LOCAL GOVERNMENTS IN WEST ACEH, SUMATERA, INDONESIA.

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FAKTOR-FAKTOR PENERIMAAN TEKNOLOGI YANG MEMPENGARUHI NIAT UNTUK MENGADOPSI SISTEM MAKLUMAT GEOGRAFIS (SIG) DIANTARA ORGANISASI KERAJAAN DI ACEH BARAT, SUMATERA, INDONESIA.

ABSTRAK

Tersedianya data/maklumat yang tepat adalah bahagian yang penting untuk mengatasi persoalan-persoalan saat menangani pelbagai bencana. Memandangkan Aceh ialah daerah yang rawan terhadap bencana alam, maka perlu adanya konsep-konsep yang mendasar untuk mengatasi kekurangan data/maklumat terutama bagi pertubuhan-pertubuhan kerajaan. Sistem informasi geografis (GIS) adalah salah satu teknologi yang ada dan diakui sebagai alat yang ampuh untuk menyelesaikan masalah yang timbul dalam pengurusan kecemasan. Tujuan dari penelitian ini adalah untuk menentukan tahap keinginan pengguna untuk mengadopsi GIS dan untuk menyiasat hubungan antara faktor-faktor penerimaan pengguna dan keinginan pengguna untuk mengadopsi GIS.

Terdapat satu pembolehubah bersandar iaitu perilaku niat untuk mengadopsi teknologi GIS; dua pembolehubah tak bersandar yang dikategorikan kepada dirasakan manfaat dan dirasakan kemudahan penggunaan. Satu set soal selidik telah disediakan dan telah diedarkan secara manual kepada 120 responden yang terdiri daripada tiga hingga empat orang dengan posisi sebagai CEO, MIS Manager dan Juruanalisa Sistem (Sistem Analyst) pada 30 sampel organisasi dari jumlah 100 organisasi kerajaan. Analisis statistik regresi berganda telah dilakukan untuk menentukan faktor-faktor dalam penerimaan teknologi.

Didapati bahawa, kemudahan penggunaan memberi kesan signifikan terhadap niat perilaku untuk mengadopsi GIS. Ini adalah penunjuk bahawa usaha ini sangat cocok dan memiliki potensi pertumbuhan dalam tiga tahun pertama dengan peratusan keuntungan margin bersih meningkat dari 28% hingga 94%.

TECHNOLOGY ACCEPTANCE FACTORS AFFECTING INTENTION TO ADOPT GEOGRAPHICAL INFORMATION SYSTEM (GIS) AMONG THE LOCAL GOVERNMENTS IN WEST ACEH, SUMATERA, INDONESIA.

ABSTRACT

The availability and appropriately collected data/information is a crucial part to overcome and provide better response when handling numerous disasters. Since Aceh is an area prone to natural disasters, there is a need to address the lack of data management especially in the governmental organizations. Geographical Information System (GIS) is one of the many existing technologies that has been recognized as a powerful tool to resolve problems that arise during emergency management. The objective of this research is to determine the levels of user intention to adopt the GIS and to investigate the relationship between user acceptance factors and user intention to adopt the GIS.

The dependent variable is the behavioural intention to adopt the GIS technology; whereas the two independent variables are perceived usefulness and perceived ease of use. A set of questionnaire was constructed and used as an instrument to collect primary data. It was distributed manually to 120 respondents comprising of 3 to 4 individuals in the positions as a CEO, MIS Manager and System Analysts in 30 government organizations. The sample size was from 100 organizations. Statistical analysis using multiple regression was performed to determine the technology acceptance factors.

From the study, user perceived ease of use was found to have a significant effect on behavioural intention to adopt the GIS. This in turn is indicative that this business is suitable and has potential growth in the first three years with the net profit margin increasing from 28% to 94%.

SECTION 1.0
EXECUTIVE SUMMARY

Data and information which are accurate and well managed is one of the factors that determine whether an organization is running well or not in support of their tasks to achieve specific goals. Providing data and information as a service is an underlying concept of this business, which will deliver for those organizations especially in the case of disaster management and respond. Based on the positions, Indonesia is one of the many countries that are prone to all types of natural disasters and more specifically Aceh which is located in one part of Sumatera Island. Since the horrible event of Tsunami and other catastrophes that have struck this area, and which has left numerous impacts that were devastated by this tragedy. Given the background, disaster management encompasses a wide range of Government activities at all levels which has primary responsibility to handle it. Therefore, the roles of many types of geospatial data and information were needed to respond to this disaster. Geographic Information System (GIS) technology plays a crucial part to resolve and support many problems that require geospatial data as the main input data in order to assist the responder and in the distribution of aids in the field as well as to support planners and policy makers in assessing actual conditions.

Since the GIS is related to information system area, research have been done to adopt some constructs of Technology Acceptance Model (TAM) as variables that can be used to determine the behavioural intention of individuals within government organization's as well as toward to implement the GIS technology in order to improve their performance especially as civil servants. The contribution of this research will be useful particularly as a first step to disaster management. Therefore,

a consensus between an organization and researcher was established in which the researcher is a civil servant in the government as well. This background becomes a starting point to develop an idea about GIS-based disaster management.

In addition, this survey will be useful for market expansion effort that includes all institutions within the local authority of governments. Subsequently, the application of GIS technology will be expanded again to deal with problems, especially in making regional development planning policies. The results of the survey based on the questionnaires have been analyzed using descriptive statistics in the SPSS program, which consist of parameters such as reliability, correlation, and regression. These parameters measured all of the determinant variables, perceived usefulness, perceived ease of use, behavioural intention and adoption of GIS as well as demographics information. Overall the yielded results are in line with the expectation of the research, which is to adopt the GIS. In conclusion, this business is suitable and has shown potentially significant growth in the first three years as already described in the financial projection section.

SECTION 2.0
INTRODUCTION TO THE COMPANY

2.1 Company Background

In principle, this idea comes from accumulated facts and direct experiences as a Local Government Official in West Aceh. The researcher is currently undergoing a research study in an effort to obtain a MSc degree. Therefore, this research is expected to contribute and bring about benefits to the Local Government in doing their daily task, which is to provide better service to the society. Currently, agencies, institutions and services in the Local Authority still lack the database on management and maintenance. As we know the effectiveness and efficiency of an organization is dependent on data resources that are well managed and properly filed. More importantly in specific cases like data/information pertaining to geospatial such as map, visualization, attributes, etc.

Starting from this fact, a concept has emerged to implement the information system technology particularly in geographic and spatial, or intimately known as Geographic Information System (GIS), and the name of the company that will establish this, is the Aceh Barat Data Center's (ABDC's). The problem statement and user needs, to be discussed in the next section, will focus on the case of disaster management. Consequently, this business in terms of GIS-based disaster management system will be targeted and implemented in a special institution within Local Authority particularly for the Disaster Management Implementing Agency.

As mentioned earlier, this research aims to support the performance of Disaster Management Implementing Agency. Officially these researches have constructed consensus from this agency for future utilization of GIS-based technology. The

consensus concept approach was established in order to gain better understanding between this enterprise and organization. Furthermore the disaster management agency already recognizes the researcher as a public servant of local government, which in turn establishes emotional responsibility and reciprocally between researcher and organization.

Therefore, this enterprise is setup in the model of governance to governance (G2G) and also governance to business (G2B). Next the enterprise aims to perform with the main aim which is to enhance the capability in the Local Authority for emergency management orientation. It is also an effective tool that can help in any business purpose, specifically with information management, processing, dissemination and communication as well as focusing on further discussions. The vision of this enterprise is to drive better performance of Local Government with the motto: “empower GIS toward the better quality services of West Aceh Government".

2.2 Business Intent

In general, geologically and geographically Indonesia is an archipelago located in the path of four plates of the earth and sits on the path of volcanic arc. This condition becomes a potential and very vulnerable area to natural catastrophes such as earthquakes, floods, fires, volcanoes, hurricanes, as well as Tsunamis. Shortly, the enormity of natural catastrophe that has devastated Aceh a few years ago has left a deep trauma, especially for the injured people either directly or indirectly.

At that time, the world witnessed one of the most horrible tragedies in the history of man-kind. Up to 30 meters high tsunami waves wiped out the coastlines of Aceh and northern part of Sumatra, Indonesia and several other countries in South East Asia. The catastrophe had become worst since nobody was aware of what was

happening. See Figure 2.1 for the affected areas by Tsunami. According to Hakim (2005), this catastrophe had cost 229,000 lives, including more than tens of thousands of them who are still missing. Over 21,000 houses were destroyed and approximately 800,000 Acehnese were displaced. The estimation of total impact of the catastrophe was IDR 41.2 trillion, including the IDR 27.2 trillion of damaged assets and IDR 14.2 trillion of losses in the future flow of economy. See Table 2.1 for details.

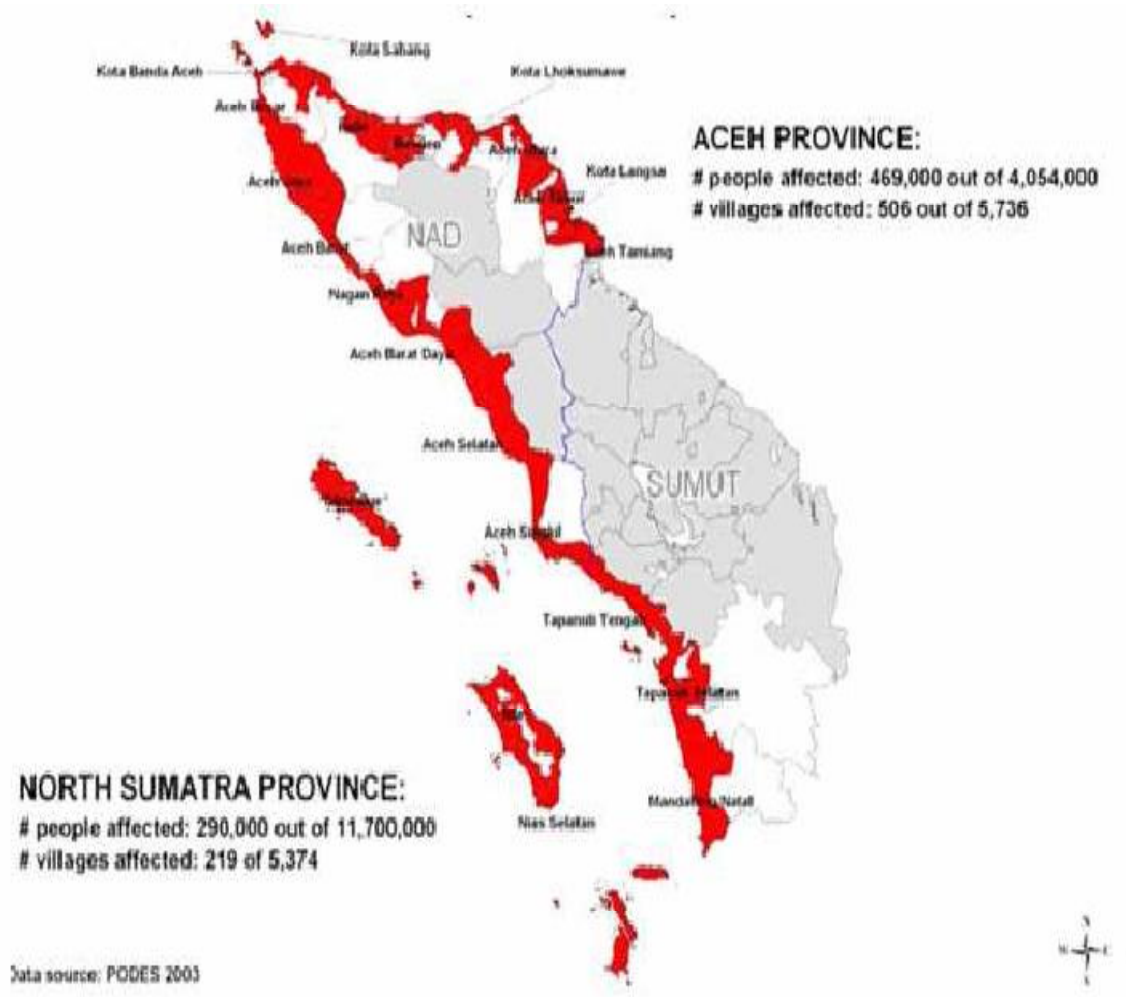

Figure 2.1: Affected Areas (shown in red) in Aceh and northern Sumatra, Indonesia (Hakim, 2005)

Table 2.1: Summary of estimation of impact catastrophe (BAPPENAS, 2005; Hakim, 2005)

	Total Impact (in IDR Billion)		
	Damage	**Losses**	**Total**
Social Sector	15577	612	16189
Infrastructure	5915	2239	8154
Production Sector	3273	7721	10994
Cross Sectoral	2346	3718	6064
	27161	**14240**	**41401**

Basically, these natural disasters are inevitable, but efforts to reduce its impact can be made to minimize casualties both life and property. In comparison lets us look at a similar condition which happened in Japan in the year 1985 in which human deaths was approximately 5488. According to the data provided 81% was died at first seven hours in the morning after the earthquake (Nagami, 2005). See the following Table 2.2 and Figure 2.2 for the further information.

Table 2.2: Cause of the Death on Earthquake Disaster in Japan Year 1995 (Nagami, 2005)

Cause of the Death	**Number**
Suffocation or crushing	4224
Burn	504
Cranial or cervical injury	282
Major organ injury	98
Traumatic shock	68
Traumatism	45
Crush syndrome	15
Others	128
Not classifiable	1245
Total	**6609**

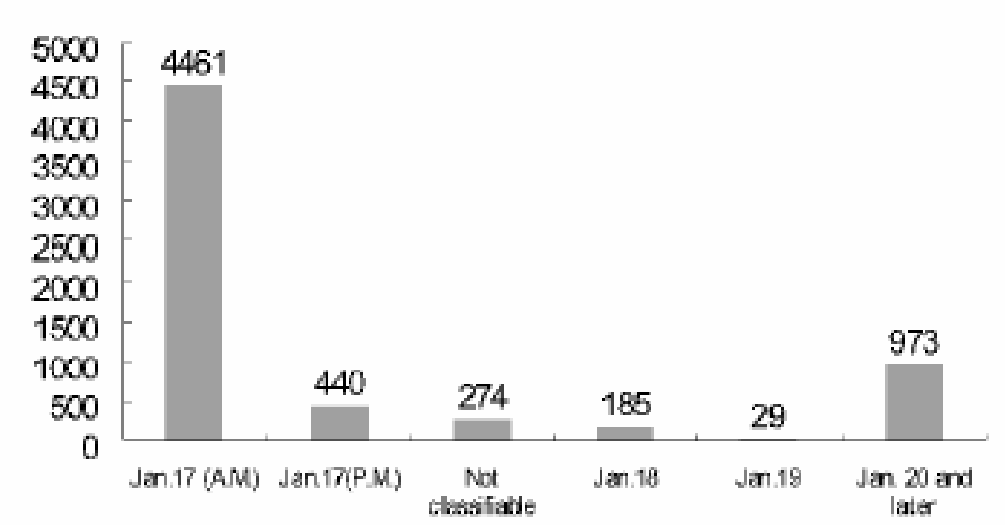

Figure 2.2: The Chronological Number of Death during Earthquake in Japan 1995 (Nagami, 2005).

Lessons can be learnt from the catastrophic phenomenon above and descriptions in both cases as comparison between natural catastrophes which has been occurring in Aceh and Japan. In order to anticipate any possibility that would impact a broader area and bigger lost of life and property, the information and communication technology and useful in planning and managing is vital. Apart from that providing immediate responses to the stakeholders in making decisions, particularly within government agencies should be more responsive in disaster management process and must be done quickly and precisely. But the reality is contradictory. This is based on the experience of researcher who works in West Aceh Government. At that time Local Government could not provide data or information which was required by various parties, such as non-governmental organizations both national and international, and even among institutions themselves.

Therefore the researcher's business intent was focused on:

a) Research and development of GIS technology in case as stated above

b) Offering to adopt GIS for Local Government to be more useful

c) Improve the quality of service in the Local Government through enhancement with the intention of including overall agencies in the Local Authority to adopt GIS.

Even the target scope of this business intent is only with the West Aceh Local authority; hopefully it yields best performance especially for the government and further implementation will cover a broader area. The utilization of the GIS enables the geographic and geo-historical dimensions which are useful for various business lines, such as natural resources, utilities, logistics, telecommunication, environment, education, defence, marketing planning, and so forth.

2.3 Target Markets

As mentioned earlier, the company's background and research relevance on special case in disaster management, the start up business will prioritize one organization that has the duty and responsibility to organize, manage and response for any disaster in the Local Authority of West Aceh. The organization mentioned is Disaster Management Implementing Agency.

Expectations in the future which is based on the business intention that emphasizes data or information service providers to the stakeholders who really need to improve their organizations. Therefore the potential target markets are government in West Aceh which consists of several internal departments or agencies, as well as institutions within their local authority. A rough estimate of the target market is represented in Table 2.3 and overall the names of these institutions are representative the actuality that exist in the Government of West Aceh.

Table 2.3: Departments, Agencies and Institution within West Aceh Government

1	Dinas Kesehatan
2	Dinas Perhubungan, dan Telekomunikasi
3	Dinas Cipta Karya dan Sumber Daya Air
4	Badan Pengendali Dampak Lingkungan
5	Kantor Pemadam Kebakaran dan Alat Berat
6	Dinas Pertanian dan Peternakan
7	Dinas Kehutanan dan Perkebunan
8	Dinas Perindustrian, Perdagangan dan Koperasi
9	Dinas Prasarana Wilayah
10	Dinas Pendidikan
11	Badan Pengelola Rumah Sakit Umum Cut Nyak Dhien
12	Dinas Pertambangan dan Energi
13	Dinas Kependudukan dan Pencatatan Sipil
14	Dinas Sosial
15	Badan Perencanaan Pembangunan Daerah
16	Sekretariat Dewan Perwakilan Rakyat Kabupaten
17	Sekretariat Daerah Kabupaten Aceh Barat
18	Dinas Kelautan dan Perikanan

The implementation of the GIS technology in the future will focus more on developing planning and other relevant fields of this technology, so that the researcher can also target for market expansion purposes which involves the stakeholders like institutions in the Local Authority of West Aceh whereby they will directly face/focus on the particular areas within the relevant local authorities, as depicted in Table 2.4. Even though, there are still have another organizations existing in West Aceh, but in this case researcher particularly has determine only these organization with the argument they are potential to implement the technology mentioned.

Table 2.4: Local Authority Organizations in West Aceh Government

No	Organization Names	Number of Subsidiaries'
1	Johan Pahlawan	28
2	Samatiga	42
3	Bubon	24
4	Arongan Lambalek	35
5	Woyla	49
6	Woyla Barat	36
7	Woyla Timur	33
8	Kaway XVI	58
9	Meureubo	39
10	Pante Ceureumen	34
11	Sungai Mas	22
12	Panton Reu	25

2.4 Revenue Model

The researcher has decided to improve the quality for overall government sectors in those local authorities. Hence the implementation of the GIS technology which will be offered and provided based on this research-which is emergency management. The further purpose of this service will be more holistic as well, since the GIS technology enable to maintain and manage the integrated database that obviously the government will need this service to organize and improve the ability to develop the region in the local authority.

In order to generate revenue from this business, below are the models which have the potential to earn money.

a) Sales of product (data).

The product output which was yielded by GIS, specifically for comprehensive data/information including its attributes, whereby purchasing through web-based access and the output will provide in the form of map. It means the map consists of general information and relevant to the particular case, in example about types of maps such are: *planimetric* (a map designed to portray the horizontal positions of features, e.g. municipal base map); *topographic* (a map designed to portray features on the surface of the earth, including relief/elevation, hydrography, and cultural features; *image* (a map representative a remotely sensed picture or reflection of all or part of the earth's; *thematic* that used to visualize relationships and patterns among information pertaining to some theme or concept; and the last type is *cadastral* (a map representing boundaries of land parcels, ownership, land use, valuation, and other related information;

b) Sales on the conventional ways.

The point is product output by the GIS will deliver to the organizations in the direct ways, it means this business will be delivering directly to organizations, since they are located far away from the capital district and commonly does not have accessibility to the internet.

c) Interactive service and data management.

Due to the GIS support the management, analysis and visualization of spatial data. Hence, this business will be delivering GIS systems to meet targeted organization needs, specifically solutions that enable organizations to quickly view and analyze integrated data.

2.5 Operational Setup

In order to run this business, the researchers will set up an office or other alternative options in lieu of the fact that the researcher is a government officer and therefore, if allowed, the researchers will establish an institute in the field of data management with GIS-based technologies. The researcher perceives with the opportunities that exist currently, GIS operations and all requirements can be setup in the researcher's offices.

As a sustainable effort, the researcher will perform continuous research and development on the implementation GIS for wide area and will attract more intention to adopt it to the broadest local authority.

2.6 Market & Competitors Information

According to business intent that has already been mentioned above, the researcher has noticed that the GIS field has still not been explored by anyone, which means that the local authority service still lacks data management, particularly in cases like disaster management. Nonetheless, businesses based on data/information especially in geospatial through global web already exist such as Google Earth. But this information is too general and the content does not associate with the particular issues in West Aceh Authority.

2.7 Strengths & Weaknesses

All initial business and even experienced will have its strengths and weaknesses and thus, the following were yielded from the SWOT analysis on the enterprise of GIS in West Aceh. However, the important thing is that there is an opportunity and that will ensure the business will be able to sustain.

a) Strengths

Experience has predicted that this enterprise will be low on start up and equipment establishment, and is due to be installed within the researcher's office. While for the system will be embedded in the GIS application, it will be low in terms of software procurement, because the software used is from open source and no need to spend money to obtain it.

Moreover, they have a dedicated and passionate team and these persons are expert working with the GIS, since they used to work in this field and naturally have the experience and skills from their previous workplaces as well as they have been involved for numerous of GIS workshop and training. An additional support will come from the Head of the Local Government in West Aceh. Hence, it will be a power to implement the GIS system to overall organization within local authority of West Aceh government, and obviously will have impact for the market strategy because those organizations will have strong intention to adopt GIS.

b) Weaknesses

Due to assessment and GIS database inventory, there was a need for extra effort in terms of employing numerous staff from within involved in collecting, surveying, and reporting as well as time consumables in order to generate data or information which are needed by the GIS. Therefore, some alternatives in order to overcome these issues are increasing the sell price of the product then, also develop relationship with another satellite service provider (such as Quickbird and Ikonos satellite images, Spot5, Landsat imagery, National Coordinating Agency for Survey and Mapping or calls as Bakosurtanal aerial image, etc) in order to gain better and sustainable collaboration in the future.

c) Opportunity

Due to the common goal among agencies in the local authority, to provide better service to society, GIS enterprise will deliver particular data or information to those who require them.

Furthermore, since the researcher is an officer within the Governance, can affect to access easily as well as connection with other parties in the Local Authority. Consequently, it will open a chance's to provide this service and will have impact for the business intent to generate intention all organizations in order to adopt GIS system.

d) Threat

In order for the business to be focused on the Government sector, several possibilities of threat will surface, due to bureaucracy, procedure and political issues that, it is will give an impact on the progress of the business in the future. Hence, one possibility that can perform to overcome this problem is to deeply recognize and learn more about the regulations and requirements for a business can be implemented within government organizations. An example is to put in extra efforts by socializing to generate interest and convenience in the affairs of the future application of this business.

SECTION 3.0
EMPLOYMENT OF KNOWLEDGE WORKERS

3.1 Management Team

The management board consists of five key positions as it is a new business and they are strongly motivated and perform a general role in formulating technical decisions concerning the long-term and daily operation of the GIS.

a) Advisor

Dr. Ahmad Suhaimi Baharudin. He is currently a lecturer in University Sains Malaysia in Penang. He has specialization in the area of Information Systems, and has research interest on current issues in management information system, issues relating to people (users, management, contractors/vendor and stakeholders) and so forth.

Mr. Fuadri who is currently the Vice Leader/Head (called as "WAKIL BUPATI") of West Aceh Governance, has the authority and power within the Local Government policies and other related issues especially in organizing and improving human resources toward to the better quality.

b) Chief Executive Officer

Jamal Mirda, the initiator and Chief Executive Officer of ABDC's, holds a Bachelors Degree from the Faculty of Mathematical and Natural Sciences, Syiah Kuala University, Banda Aceh, Indonesia. He has job experiences specifically in the Information Technology and Communication area. He has been a manager at the Information Technology Department with an International Organization and used to work or participate in reconstruction and rehabilitation programs after the Tsunami

and Earthquakes' impacts. He has experience in supporting, maintaining, and improving services to end-users. Besides that he is an officer with the Indonesia government in data management and development planning agency that is required by private sectors, citizens, and inter-agency.

c) GIS Technician

Dinar Dwiriansyah, has job experience as GIS Expert and has worked in this field for five years with an International Organization. He is currently pursuing his Masters in Regional Planning in University of Gadjah Mada Indonesia. He has overall responsibility to the Department GIS architecture and development framework and also responsibility for the technical implementation, deployment and support of spatial applications to end-users.

d) Chief Marketing Officer

Dara Mustika is a person who is currently working with the Indonesian Government and has a daily task in organization and financial management. She also has working experience with International Organization in the position of Human Resource Business Process. He graduated from Syiah Kuala University Indonesia majoring in Business Management.

3.2 Organizational Chart

All of the management team members as introduced above will be shown in the organizational chart in Figure 3.1. The organization chart will be lead by one CEO which is the position will be held by the researcher itself. The CEO will be in-charge of day-to-day operations and also plan the strategies to move the business. The CEO will be responsible to monitor everything that is happening and must know the future undertakings of the business. In order to get better performance of the business, it will be engages two advisors which are an information system expert and governance advisory. However, the important roles of personnel that will assist and support the enterprise GIS, they are GIS technician and GIS marketing officer as well as in the field of R&D development.

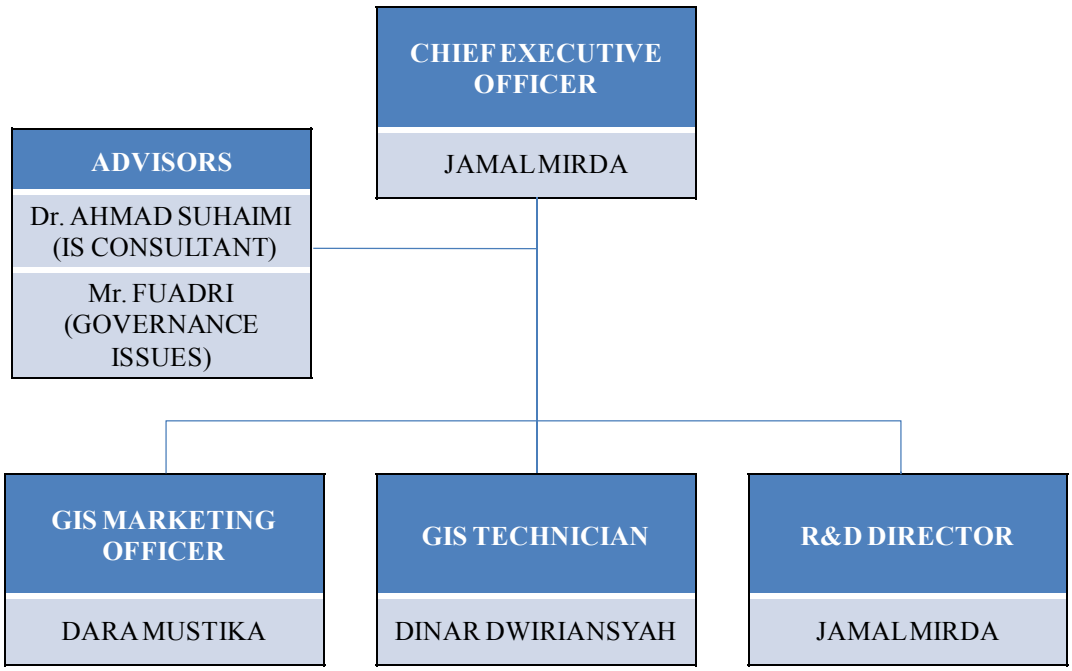

Figure 3.1: Organizational Chart of ABDC's

3.3 Human Resource Plan

Being a start up enterprise, the management team will employ some personnel particularly in the first year. By the second and the third year, would be able to add a few more personnel to the team as the business is already launched and would be picking up speed. ABDC's will employ the personnel especially for the GIS technician, marketing as well as for R&D in order to improve the capability and existence of the business in future. The GIS's human resource detailed plan for the first three year is shown as per Table 3.1.

Table 3.1: Human Resource Plan

Position/Role	**Y1**	**Y2**	**Y3**
CEO	1	1	1
Advisor	2	2	2
GIS Technician	1	2	3
GIS Marketing Officer	1	2	3
R&D Director	1	2	3
Total No. of Workers	6	9	12
Total Knowledge Workers	6	9	12
% of Knowledge workers	100	100	100

SECTION 4.0
PRODUCT OR SERVICE DEVELOPMENT

4.1 Product and Technology Overview

As mentioned earlier the business intent for this study was designed primarily for the end user. This is due to the fact that the GIS enterprise will also provide services as a web based approach besides the business on a conventional basis. The following are the basic concepts that will be employed:

Figure 4.1: The Front Layout of the GIS web-based design.

The content of the above layout is based on the scope of GIS enterprise with the expectation of easy to use and providing detailed information in particular fields. The breakdown on each item is as described below:

a) **Homepage:** includes a paragraph about Enterprise GIS in West Aceh, and also allows for users to login in order to have more authority in the website as well as to enable to trace and record the user upon login.

b) **Order:** provides the link to the user in order to request any particular data or information especially in West Aceh and it is based on the user's or organization's need and they will be charged for each request.

c) **West-Aceh info:** provides a general description about the West Aceh in geographic, demographic, potential resources and other related information that may be useful to other users, organizations or stakeholders beyond the West Aceh Local Authority to extend the business or vestment idea.

d) **Usage help:** provides the step by step assistance or guidance for the user or organization in order to make an order as well as to request GIS products for their needs.

e) **Contact us:** provides the information about the administrator which includes, the webmaster's e-mail, phone and fax numbers and also the postal address.

The unique content inside this layout is the order page, which also allows the individual or organization to obtain the relevant data or information based on the organization's business purpose. When the user goes to the order page, it will direct the form to prompt to the user to fill certain information according to the basic user information and what they need or why they are requesting for it.

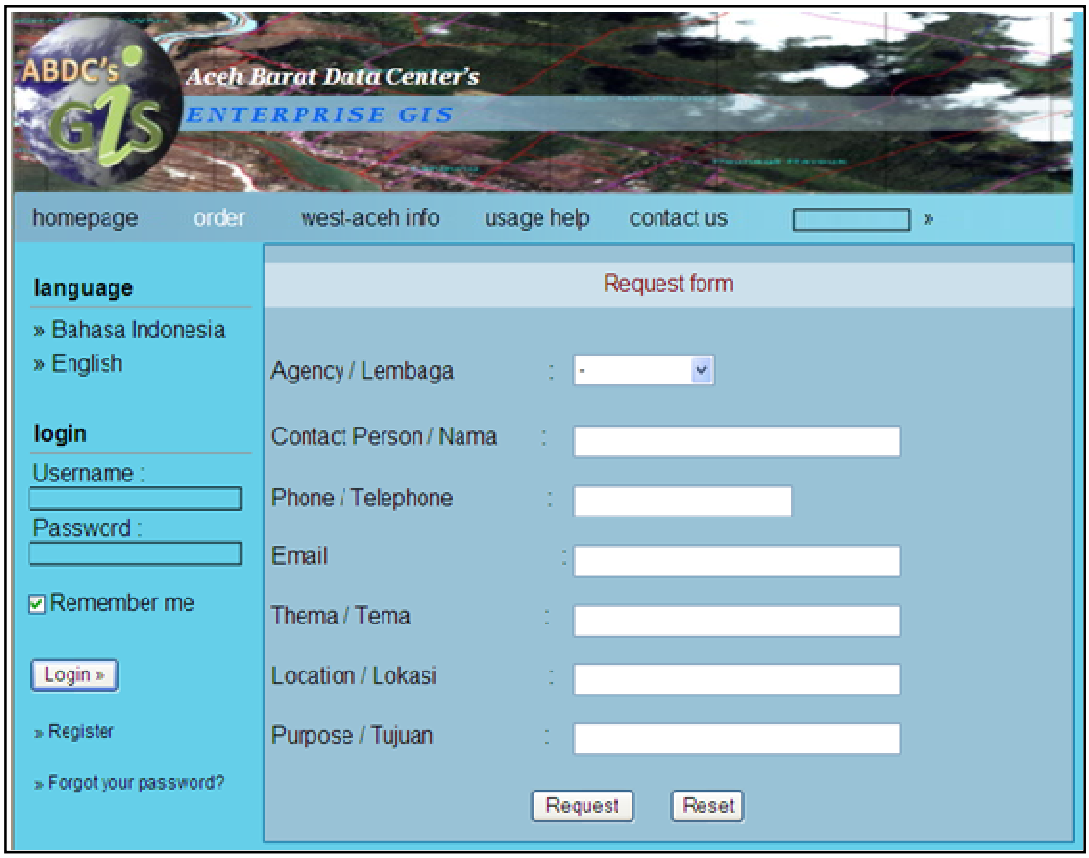

Figure 4.2: The Request Form Layout.

Figure 4.2 meets the official requirements to avoid possible illegal applications by any organizations. Moreover, this data was issued by governmental agency so that for any inquiry as well as legality will be directly associated to those government agencies and also can prevent multiform of data sources such as boundaries, administration, territory, unit area, symbolic, etc.

Furthermore, a specific data/information produced by GIS relevant to product development according to priority in response to disaster. The initial page of the GIS-Based disaster management, is more likely as an introduction on general information about the enterprise. While other content provides the appropriate information, this will be drawn in the map, where each of those described contain certain information especially to offer the needed information on disaster management and implementation. Therefore, the screen in the following respectively

provides some information about the disaster as well as description about the action that would be taken according to the site, elevation, roads, and other related part.

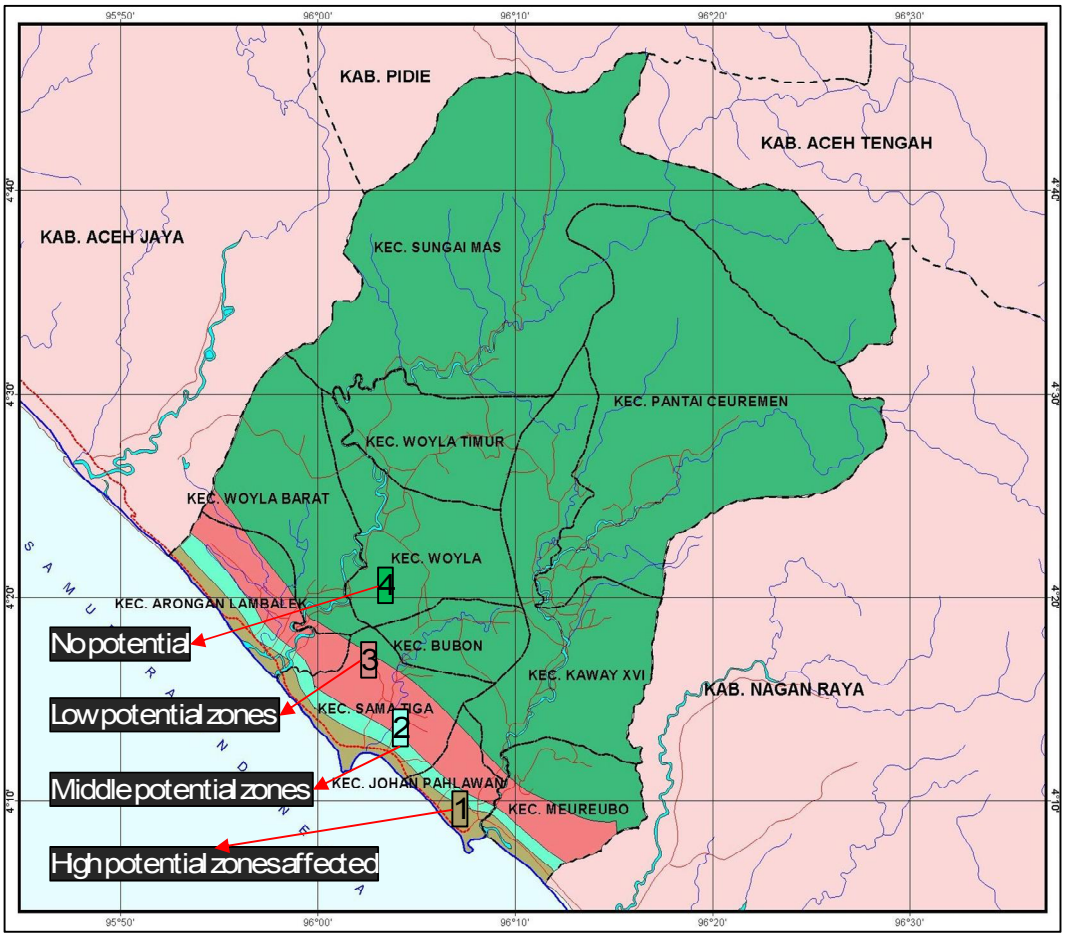

Figure 4.3: Coverage Area of Tsunami

Figure 4.3 shows the variety of West-Aceh zones that were stricken by the Tsunami and each of them declared into number "1" which is the high potential zones affected, "2" is middle potential zones affected, "3" is low potential zones and the last number "4" is no potential which means, not affected by the Tsunami. The uniqueness of the data output of GIS is that it is able to describe clearly in color degradations. Hence, those who interpret the data will find it easy when making decision especially for stakeholders who are in disaster management and organization and separated based on attribute itself.

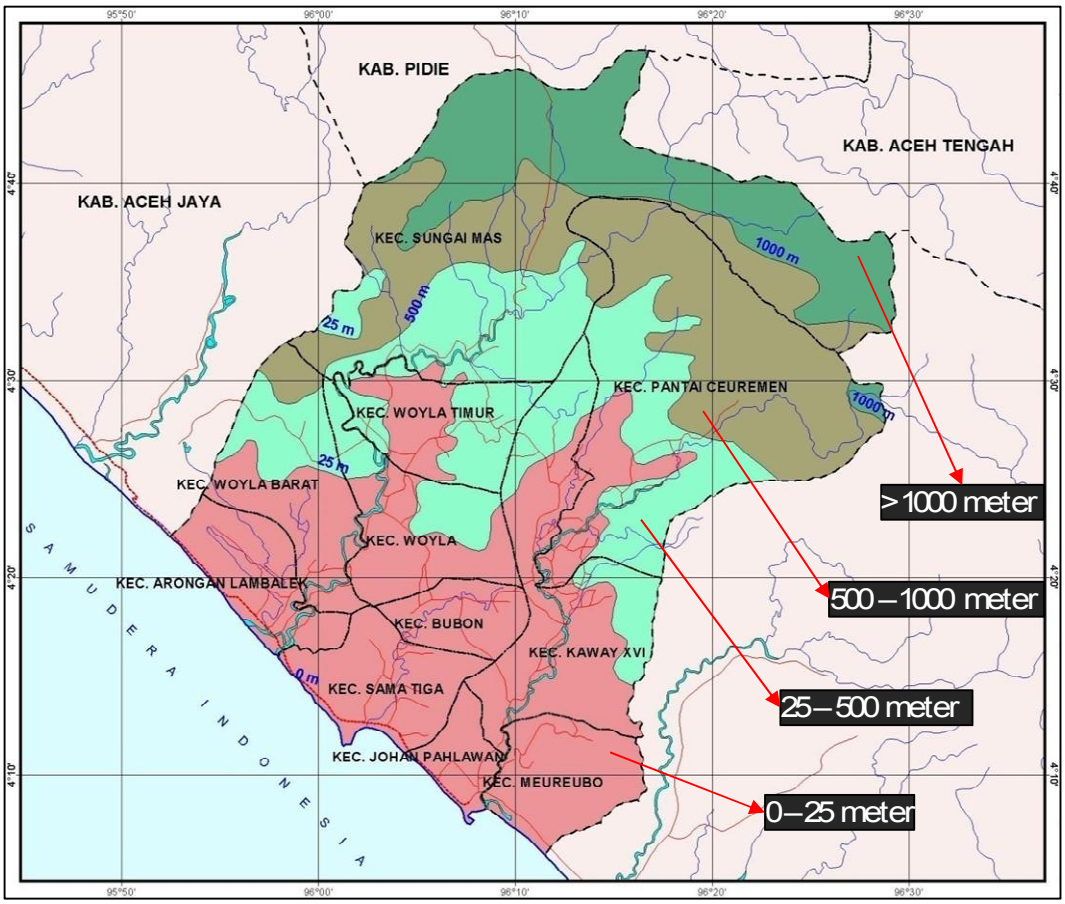

Figure 4.4: The Elevation of Surface

In figure 4.4, the color degradation contains particular descriptions that are depicted in four classifications regarding elevation of the land based from the level of the sea's surface. The area close to the sea or coastal-area is the lowest with an elevation of about zero until 25 meter, and the highest is more than 1000 meter above sea level. This information is useful for decision-makers in planning especially to perform route and direction of escape as well as evacuate the injured people, vulnerable and victims to the higher part of the safe zone.

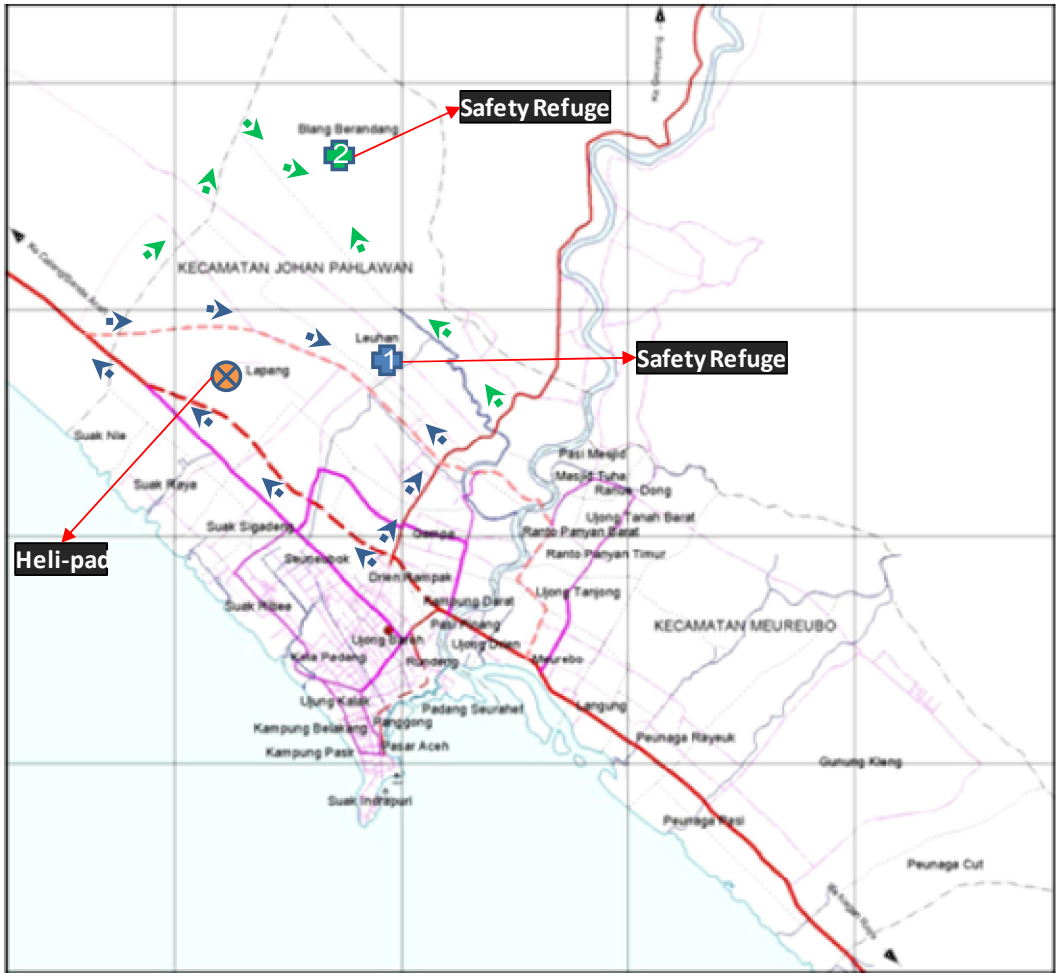

Figure 4.5: Evacuation Routes

According to the Figure 4.5, the routes of evacuation were derived from an extract by zooming of Figure 4.4. This reflects the necessary specific information to conduct several activities in the framework of disaster management, such as finding the pathways or routes to safety places, helicopter landing area determination and shelters availability of victims, refugees and beneficiaries. As set out in the picture, the red lines identified as roads and highlighted by arrow symbols which describe the shortest direction to the destination. The safety zones are located at two parts, with consideration that the first zone is prioritized for medical emergency management center as well as cares about the injured people and vulnerability. The second zone is shelters for refugee and traumatic center. Consequently, the concentration of all the