

MapServer in GIS application

By

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Dissertation submitted in partial fulfillment of
the requirement for the
Bachelor of Technology (Hons)
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CERTIFICATION OF APPROVAL

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Approved by,



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1) Geographic Information Systems
2) IT/IS - Thesis

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work of my own except as specified in the references and acknowledgements, and that the original contained here in have not been undertaken or done by unspecified sources of persons.



MOHD BADRULHISHAM MOHD YUSOFF

ABSTRACT

Geographical Information Systems (GIS) represent one of the fastest growing segments of the nowadays technology. The system was initially employed to help travelers in new place to find way to go to another, to ease them in making decision in selecting location and to disseminate information regarding exact location selected. This project aims to generate an online map for Klang Valley area by using MapServer which can represent information from in that area. The development begins with investigation, then problem identifying, follow with the cycle of design, prototyping and implementation because of methodology practice in rapid application development. The proposed system captures the Klang Valley area, making it available for new comers to the city in getting information in Klang Valley. Furthermore, Klang Valley online map has been considered as the open source technology in GIS application by using MapServer. Experiments were conducted in ensuring the accessibility and capability of the application in responding query from user.

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ABBREVIATIONS AND NOMENCLATURES

- UTP – Universiti Teknologi PETRONAS
- WWW – World Wide Web
- GIS – Geographical Information System
- ESRI – a company's where focus remains on producing excellent software and delivering exceptional service to users in GIS application.
- HTML – Hypertext Markup Language
- PHP – PHP Hypertext Preprocessor
- API – Application Programming Interface
- PDA – Personal Digital Assistant
- SQL – Structured Query Language
- DGPS – Differential Global Positioning System
- MySQL – a open source software multithreaded, multi-user, SQL (Structured Query Language) Database Management System (DBMS) with an estimated six million installations.
- Mapserver – an OpenSource development environment for constructing spatially enabled Internet-web applications.
- CGI – Common Gateway Interface (CGI) is an important WWW technology that enables a client web browser to request data from a program executed on the Web server.
- FreeType – a software font engine that is designed to be small, efficient, highly customizable and portable while capable of producing high-quality output (glyph images).
- Open source software — software whose source code is published and made available to the public, enabling anyone to copy, modify and redistribute the source code without paying royalties or fees. Open source code evolves through community cooperation.
- GDAL – a translator library for raster geospatial data formats that is released under an X/MIT style Open Source license.

CHAPTER 1

INTRODUCTION

1.1 Background of Study

The growing reputation of the Internet in the early 1990s has made most people nowadays turn to utilize it for their daily operation such as on-line transaction, getting information, e-mailing friends, interactive chatting and many more. The increase of their popularity has made the internet a vital part of our society. The access to the internet and interactive content of the World Wide Web (WWW) have made them great means for people to access, exchange, and process information. The Internet is a modern information relay system that connects hundreds of thousands of telecommunication networks and creates an “internetworking” framework. [1] These applications create numerous of field area to be studied and therefore, it makes Internet become more well-liked year by year.

One of various field evolutions in Internet was Internet Geographical Information System (GIS) application. GIS is a part of today’s current technologies, plays an important role in variety application that help to govern geographical information. Internet GIS is a research and application area that utilizes the Internet and other internetworking systems (including wireless communication and intranets) to facilitate the access, the processing, and dissemination of geographic information and spatial analysis knowledge. [1] With the interactive of WWW, GIS applications now revolve from a stand alone side to web base application which can be accessed and used by all people around the world. Internet is affecting GIS in three major areas: GIS data access, spatial information dissemination, and GIS modeling / processing.

People today can now straightly access spatial information from their web browsers at home or public services or offices without purchasing any expensive GIS software. GIS apart from contributing for data integration from different data sources, enables data visualization using maps, which enhance the system usability. [2] Therefore, by using spatial information dimension, user can discover new information through spatial joins and other operation. In particular, GIS can combine multidimensional databases, resulting in very powerful decision support system. [3]

So far at present, GIS have commenced new potential decision support tools effectively in organizations whose demands for spatially oriented databases. [4] These systems will have a substantive impact in selected industries, government units, and business by integrating maps spatially oriented database information and enabling decision makers to access forms of information not previously available. [5] For example, Industries that rely on the use of natural resources keep maps on the availability and quality of such resources as timber, vegetation, soils and ores. While, utility companies maintain maps of power and waterlines. At the same time, local government track land use. Police and fire department analyze the locations of crimes and fires to quick distribute their personnel and equipment. The corporate sector's, use of GIS for such functions as marketing analysis, circulation evaluation, site selection, vehicle routing and dispatching, map management, logistic studies, and real estate management is also growing. For all those example mentioned above, many business and government agencies realize that the most importance of spatial references data is into their work.

One of the first fields to benefit from the development of Internet GIS was transportation field. These days via Internet, transportation has become popularized by on-line trip-planning program. The emerging of the Internet and WWW has transformed the process of information dissemination, communications through the important makeover to the traditional functions of transportation services. There are many on-line transportation information systems such a simple, static schedule displays to more sophisticated real-time system that show traffic conditions.

1.2 Problem Statement

1.2.1 Problem Identification

In general, searching location for travelers always become an issues. The objective of transportation system is improving individual accessibility. The purpose of transportation information on the web is to announce and display, such services changes, schedules and routing. Geographical Information System comes into play when those travelers need to search the exact location they intend to go. It becomes more issues when there is no such system in Malaysia that can provide the direction information via Internet. This research and project aims to generate an online map for Klang Valley area by using MapServer which can represent information from in that area.

Various scenarios call for a more efficient and effective in searching location for travelers. The routing of vehicles in a company that services a fairly large geographical area can easily become quite a very complex task. The task can be simplified by applying GIS, which automatically reduce the complexity by bringing out relationships that can form the basis of good decisions. Moreover, traveler who is unfamiliar with new places, always confuse with places that they want to go. They need to come out of what public transport to use, time-consuming, cost-effective and route optimizing to solve their puzzle in new places. In addition, the public services department, such as police, fire and hospital department always use it when comes to emergency to distribute their equipment.

In the Malaysia context, the Internet GIS based application only limited to map displaying and information dissemination of area selected. Furthermore, those applications mainly focus by static web mapping, although there is some web browsers provide interactive web mapping application to the users. The emerging of transportation system in web application has demanded for beneficial of all usage.

Segregated below are the main problems associated with transportation system which can be solved with the implementation of GIS application.

Scenario 1

The corporate sector's, use of GIS for such functions as marketing analysis, circulation evaluation, site selection, vehicle routing and dispatching, map management, logistic studies, and real estate management. The routing of vehicles in a company that services a quite large geographical area faces efficient way in making decision. These logistic vehicles need to have a routing and scheduling to minimize all kinds of costs including mileage, overtime and also considering beneficial customer satisfaction and the planning to schedules. Vehicle tracking need to able involves keeping track of the location and having the latest information on its position and operating status. Oil tankers for example, distribute oil from refinery to petrol station to carry out the needs of petrol in certain area. While the couriers, pick up things or customer order via direct delivery systems which needs of rapid efficient delivery process

Scenario 2

Travelers routing in a new places face problem when want to travel from one place to another place. Travelers especially visitor or unfamiliar places for salesperson or even domestic tourist always get confused when come to a decision to make tracks to other place. The need of reflect on timing-consuming and cost-effective made them in dilemma to rather than stay on or move away to place they decide to go.

Scenario 3

The public services such as police and fire department analyze the locations of crimes and fires to quick distribute their personnel and equipment. Ambulance for example, always move on and out to fetch patient by traveling road on the specified area. The traffic condition constantly set difficulty to attendance drivers to drive safely and quickly to the hospitals.

1.2.2 Significance of the Transportation System in GIS application

The emerging of the GIS application make Internet becomes more widely used in these days. One of the applications that currently in use was the Intelligent Transportation System (ITS). ITS program is an initiative of the United States Department of Transportation to add information technology to transport infrastructure and vehicles. It aims to manage vehicles, loads, and routes to improve safety and reduce vehicle wear, transportation times and fuel costs. [18] The promising of these technologies comes to improve transportation safety and mobility and enhances productivity through the use of advanced communications technologies. [17]

ITS include a broad range of wireless and wire line communications-based information and electronics technologies. When integrated into the transportation system's infrastructure, and in vehicles themselves, these technologies relieve congestion, improve safety and enhance American productivity. [17] Currently, there is a few application relates to ITS application area. Most of them provides an overview of the technologies addressed by the Federal Intelligent Transportation Systems (ITS) program and contains links to various information resources that will be useful in the planning and deployment of ITS. [19]

While there certainly have been continuous challenges in developing such systems, several researchers have actually proven their reliability and accuracy. Such GIS application will have significant impact on the delivery of transportation services.

The project is significant in terms of providing travelers in decision making through online web application. The research involves area of the effectiveness and efficiency of new comers in tracking and searching way to certain area via accessing web browser. With development process using the open source application, it comes to prove that open source software also suitable for development of Internet GIS application for decision making system.

1.3 Objective, Scope of Study and Feasibility of the Project

The objective of this project is to research on methodologies that have been used by other researches in developing solution for transportation system in GIS application. Besides, it aims to simplify and assist travelers make decision by developing a web based application on transportation system in selected area in shortest time.

1.3.1 Objective

The objectives of this project are:

- To identify user location by providing map at current location.
- To disseminate information regarding exact location selected.
- To aim in simplifying and assist travelers by developing a web based application

1.3.2 Scope of Study

This project focuses on the services and features available in the GIS application.

The main features of this project would be:

- Focusing on simulation transportation system in GIS application in Klang Valley area

1.3.2 Feasibility of the Project within Timeline and Scope

This project can be considered as technically feasible as the scope of the project is limited to transportation system solution. There is no relative cost related to the project as the GIS application can be developed using open sources application resources that is already available in the Internet. There are also adequate resources available to support the project such as Internet developers' forums, open sources, books, online resources as well as expertise from GIS field itself.

The time given to complete the project is also sufficient. The project timeline indicates the time allocated for each tasks and it serves as guidance for project execution.

CHAPTER 2

LITERATURE REVIEW / THEORY

2.1 Introduction

Internet GIS is a research and application area that utilizes the Internet and other internetworking systems (including wireless communication and intranets) to facilitate the access, the processing, and dissemination of geographic information and spatial analysis knowledge. [1] With the interactive of World Wide Web (WWW), GIS applications now revolve from a stand alone side to web base application which can be access and make use by all people around the world.

In each case, geography is the key to cutting costs. Geography determines which truck will go to or be able to service how many address. Geography determines the time taken by the distributor to get new stocks to the retail outlet. Geography determines how much stock can be transported to the truck in one trip from the warehouse to the truck. [6]

2.2 GIS in Logistic and Vehicle Routing Application

Shubhabrata's [6] states that the routing of vehicles and the management of logistics operations that services a large geographical area can easily become a very complex task; this problem can be reduced by applying Geographic Information Systems, which automatically reduce the complexity of geographic patterns and facilitate to make good and quick decision. Some systems like ArcLogistics Route already solve certain problem by introducing some applications like Vehicle Tracking and Dispatch, Route Analysis, Warehouse Operations, Facilities and Depot Management, Routing and Scheduling developed by ESRI. [6] On the journal, it is more focusing in recent GIS application which can help update logistics related to business processes like inventory management, fleet/truck management and warehousing applications.

ESRI, an organization focusing on producing excellent software and delivering exceptional service to users in GIS application has always had strong networking and analysis tools with products like ArcNetwork and/INFO.ESRI has expanded this feature-loaded toolkit with other focussed products like ArcLogistics Route, RouteXpert and NetEngine for networking and logistics operations.

The model company which use ESRI technology, Sears Roebuck and Co., one of the largest retail chains in the United States recently put to use ESRI GIS software to take care of in-warehouse routing and direct delivery systems. The system not only functioned well but also received recognition for its efficiency and success at its work.

In each case, geography is the key to cutting costs. Geography determines which truck will go to or be able to service how many address. Geography determines the time taken by the distributor to get new stocks to the retail outlet. Geography determines how much stock can be transported to the truck in one trip from the warehouse to the truck. [6]

Shubhabrata has broken the complex process down into five smaller areas:

- 1 Vehicle Tracking and Dispatch involves being able to keep track of the location and the inventory on every vehicle in the field and having the latest information on its position and operating status.
- 2 Route Analysis is the operation which aims at minimizing the cost of travel involved in transporting goods from one location to another whether in terms of trips required or time or distance or a combination of these.
- 3 Warehouse Operations become significant in cost reduction when the operation grows big and each warehouse becomes a very large operation in itself.
- 4 Facilities and Depot Management involves minimizing waste by considering the location aspects, the available capacity, the inventory in question and the range or effective covered area of each facility.
- 5 Routing and Scheduling aims at minimizing all kinds of costs including mileage, overtime and maximizing all attendant benefits including customer satisfaction, adherence to schedules etc.

From the journal overview, the entire logistics operation in a company can be handled with great efficiency by implementing GIS based logistic system like ArcLogistics Route and Arc/Info Network.

2.3 ArcLogistic Route [7]

ArcLogistics Route is a complete out-of-the-box solution for complex routing and scheduling problems. [8] By using ArcLogistic Route on desktop for routing and scheduling solution, it can determine which vehicle should serve each customer location and the best stop sequence to accommodate customers' time windows while minimizing travel time. ArcLogistics Route offers intelligent routing by taking into account actual network drive times, vehicle characteristics, renewal points for loading, vehicle capacity, and more. [8] After completing solving routing problems, ArcLogistics Route will export routes and schedules back to database or print routes with driving directions.

Usually, there are a few services which use ArcLogistics Route. Those couriers and messengers, speed of services is counts. In the food and beverage industry, freshness is paramount. In the furniture and retail business, timely delivery is vital. While in local government, the service is a key.

In all these delivery settings, efficiency—in time, money, and resources—is the bottom line. [8] Whether it's strict business rules or matched pairs, scheduling routes or modeling bids, ArcLogistics Route gives the power and flexibility needed to plan and staff routes from desktop.

2.4 World Wide Web Mapping Review [13]

Selecting Web-based mapping software is difficult. User who is looking to choose the right package for developing web based applications, need to examine certain criteria for selecting a Web-based mapping product as well as assessing on how software been measured up. Basically, developers need to realize, web-based mapping is not the same as GIS or desktop mapping. Developers must notice that web mapping solutions are directed at a different audience than GIS or desktop mapping packages. The level of expertise required, training to be expected and intensity of involvement are much different. This is a key distinction, and Web mapping developers need to keep the user base's characteristics in mind if a site is to meet its goals. [13]

One of the more confusing aspects to selecting the best web mapping product is that everything is link each other. For example, the speed of the Internet connection affects the amount of data transferred; the type of data also affects transfer volumes, which, in turn, also influence the speed as an example.

The capabilities of many Web mapping products in late 90's are different from those available recently. In further details, it is necessary to decide a site's purpose and audience in the first point. Developing Web mapping application is been looked at the various parts separately as well as the side affect to each other.

Some condition need to be identified are whether want user to simply display a static map and let them pan and zoom, or want them to define an area on a map to generate complex reports, retrieving spatial data and new maps. Some of points that should be taken of are whether all of users linked through a high-speed intranet, or plan to serve maps to the world. All these options are possible. Moreover, not all of users afford to have all possible software available.

In other discussion is about the speed and interactivity. User interactivity is an important factor that needs to be given considerable thought. It gives user bad impact when requires images but failed to generate it. Thus, the first image sent to a user will be showing good status towards the mapping browsers. User expects greater user interactivity means more functionality they will browse through. Therefore, user interactivity is an important factor that needs to be given considerable thought.

For data distribution, many of MapServers that download data to the client also allow the data to be captured locally. In this situation, users can browse data interactively and then saved it locally. This may not be pleasing in some settings. For example, data may be proprietary. In such situations, many servers permit the data to be viewed but not saved locally. Some servers even encrypt the data so that they can not be captured even with reverse engineering.

In addition response by geotechnology industry's web mapping software developers, there is certain characteristics need to be taken into. The group has summarized in three tables; system characteristics, data formats and function. All the tables can be a valuable asset to help determine the products that best fit a user's particular needs.

On system characteristics summary, covers each package cost, basic operating system and configuration factors. For a standard web browser, no cost required. Some cases, some vendors provide free plug-in, and some of them must be purchased. When there is client cost, it varies with different numbers of clients. Others consideration include server base cost, client operating system cost as well as plug-in requirement.

Spatial data format indicates the types of data that can be used directly by the software, with no conversion, to create web products. Some solutions can use various data, but must firstly be processed to appropriate forms before server can use them. Furthermore, the client side ability to “write” data mean the product allows users to directly save spatial data on client machine.

The functionality lists the various display and analysis capacities to users, whereby means that operations are performed solely by client. For spatial operations, two operations were selected to serve as indicators of each capabilities; the buffering and point-in-polygon operation. The operations are most desirable analytical processes and required complex interactions between client and server.

As the world web-based making quantum leaps, web mapping constantly is also changing. From browse through a map turn into interactions on database plus analyzing in spatial data as well as data delivery, it is already describe the today’s web mapping market continually revolutionize. The solution to have web mapping requirement is based on definition and comparison on requirements with what outside and make own solution on top of continuously waiting for best solution.

2.5 MalaysiaGIS.com – USJmap.com - <http://www.usj.com.my/>

One the best example of Malaysians GIS web base application is from *USJmap.com* which developed by residents and ratepayers in the Subang Jaya city, Selangor Darul Ehsan. This committee volunteers their time to promote a knowledge-based community that control on the huge potentials of Internet and as well as communications technologies.

Basically, *USJmap.com* committees focus on the discussing on recent news within their area. With growing of technologies arena, the committee members has develop a web application which enable Internet user to browse to Subang Jaya map as well as Expressways serving Subang Jaya, USJ and Bandar Sunway rather than as a tools to connecting them in sharing information. New comers who wondering where USJ 4/1C is now can identify which area they currently in. Normally, this comprehensive site provides maps and information about UEP Subang Jaya. It lets user zooming from a map of USJ sections to a map of USJ Street. This project is collaborations between *MalaysiaGIS.com* and *USJ.com.my* to provide dynamic maps for the area of UEP-Subang Jaya. This pioneering service is a new web-based service to enable anyone with a USJ address to easily find the location. This is by far the most detailed mapping on the Internet for any township in Malaysia. [11]

There are plenty of services offers in *USJmap.com* such as ease to use application, up-to-date features as well as a good functionality. Applications appear in familiar browser interface and free from any plug-in requirements make it ease to use to user. In addition, it is ease of use results in high uptake by users, increasing the effectiveness of the operation. Online, secure access to live; up-to-date spatial information make it sense in term of up-to-date features. Besides, it is enable user to find nearest bank, school, police station or other places.

From the functionality point of view, each map is rendered on-the-fly to generate a GIF image from highly accurate vector datasets. For user navigation views, they can enjoy functions such as zooming, panning and feature selection and querying for the map. There is also additional feature information, about an object selected on a map or from a query result in HTML/PHP or locate any street intersection, postal code or business directory. With associated documents features, user can view documents such as photos associated with map objects or specific locations on a map. [11] Maps output will let user to print high-quality custom maps with scale bar, north arrow and legend right from user browser. The most important functionality which is preferred by the user is real-time weather information. In all over the world airports make a so-called METAR-report once an hour. A METAR report is an aviation weather report to be used primarily by airplanes. The report contains data about temperature, humidity, wind speed and direction and much more. [11] Using PHP Weather, it converts this format, caches the data in MySQL database for easy retrieval using Sultan Abdul Aziz airport in Subang as reference.

The architecture of the system runs entirely on open source software which consists of Apache, Javascript, Red Hat Linux, MySQL and PHP. The map database consists of roads, buildings, land use, natural features and places of interest around USJ. Other layers being considered for future implementation will depend on the feedback received. Future developments will be porting the dynamic maps to the PDA platform.

Developing the geodatabase was a major undertaking in its own right. Map data was mostly collected using DGPS positioning and plain old paper and pen. Photographs were also taken for major landmarks as well as public amenities. [11] Data were then entered into a SQL database (for textual data) and spatial data went through data cleaning and polygon generation process. [11] At this stage, a decision was made to deliver the maps in the vector form as the mapped area is quite dense.

The web applications are delivered with Apache web server. When a page in a PHP application is requested by a browser, PHP interacts with backend systems and database like MySQL, and dynamically generates a Web page that is returned to the browser. Figure 2.1 below shows how the entire application works. [11]

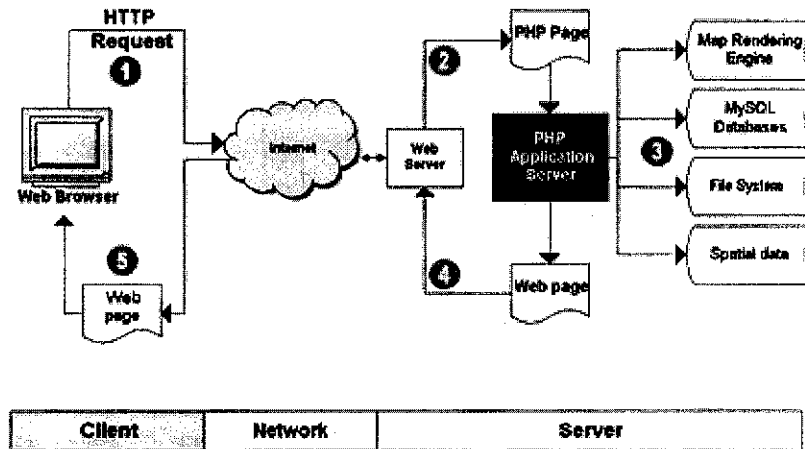


Figure 2.1: System Architecture of web based GIS [11]

1. Users type in the location they're looking for. When a user clicks a "Submit" button on a form or a hypertext link on a page, the user's Web browser sends a HTTP request to the Web server via the Internet.
2. The Web server passes the data submitted by the client and the appropriate page to PHP engine through a server API.
3. PHP reads the data from the client and processes the tags in the page. Based on the PHP, the server interacts with MySQL database servers, the file system and potentially the map rendering engine. If a map is to be returned to the client, a request to the GIS application server which generates a map graphic.
4. PHP dynamically generates an HTML Web page that wraps around the map graphic and is returned to the Web server.
5. The Web server returns the HTML page to the user's browser.

On hardware specification point of view, with a high-speed MapServers feature with high-availability and redundancy features are setup on Intel-based servers. This application is hosted from a secured Internet facility featuring 24X7 monitoring, backup power systems, and access to multiple Tier-1 Internet providers. [11] It is hoped that the mapping application will bring another added component in the success of the e-community.

2.5 Conclusion

As a conclusion in Malaysia, GIS technology is potentially to be embarked in several years ahead. Currently, even there are some sites in Malaysia which used the GIS technology, most of them still using normal standard pictures formats such as in GIF, JPEG, TIFF or others picture format which only allowed users to view using standard pictures view. Furthermore, it is limited to map displaying, static mapping, and information dissemination of area selected. Thus, simulations tools of GIS application via web based are needed to aid the raise of the Internet technology in develop country such as Malaysia itself. The emerging of transportation system in web application has demanded for beneficial of all usage.

CHAPTER 3

METHODOLOGY / PROJECT WORK

3.1 SOFTWARE PROCESS MODEL

In response to faster pace of the project, rapid application development has become a popular route for accelerating systems development. Therefore, for this project, the development methodology used is the rapid application development (RAD) where is created to decrease time needed to design and implement Information Systems radically that incorporates prototyping during system development. The development life cycle begins with preliminary investigation whereby consists of project scope and plan. The next phase was the problem identification which consolidates of problem, requirement, and decision analysis phases like the basic life cycle methodology. The design may use model. The final design will evolves from subsequent working prototypes. The project continues with the prototype development phase, where the project is constructed here. Greater time need to be spent in constructing the working prototypes. Analysis is based on user feedback to the prototype. This analysis tends to focus on revising requirements and identifying user concerns with the design. Therefore, analysis cycles back to iterative design and the prototyping loop repeats itself. The prototype itself is considered valuable for implementation phase. The next version of the system may continue through the design-by-prototyping loop. The figure on the next page will depicted clearly about the whole system development cycle by using RAD methodology.

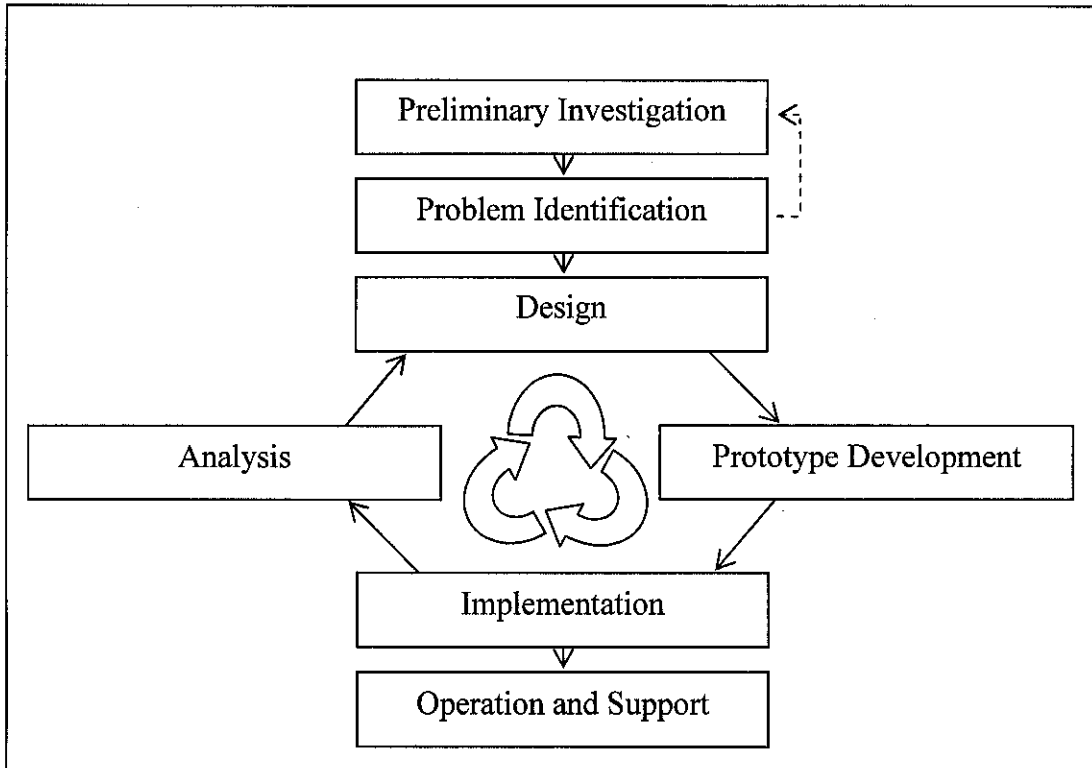


Figure 3.1: Rapid Application Development Route

3.1.1 Requirement Analysis and Definitions

Routing in its most basic form is a question of getting from A to B as fast as possible. Sometimes we want to go from A to B via various ways due to certain constraint such as traffic jam, accident or other reasons. As a result, the features of using open source application can solve the problem in term of having high cost custom-made application.

Identifying which area to be studied and what software to be used were the first problems comes in to mind. The used of Mapserver technology in developing map application for web browser are the thing that should be considered too. The rising technology have moves Mapserver into one step more advance in facilitate the novice user in developing application.

3.1.1.1 Mapserver

The Minnesota MapServer was originally developed as free MapServer software containing various freeware systems such as Shapelib, FreeType, Proj.4, libTIFF and etc. It runs under Windows and UNIX operating systems and supports various formats both raster and vector datasets. In general, it relies on the CGI mode program, Map file and Template file. Parts of the following text are based on available online resources. The purpose of using Mapserver package is to allow MapServer to be installed quickly in a MapServer development environment on their Windows systems. The reasons for needing to use this application are diverse but, in general, this package can support to those developers who want to get to a stable state quickly, trainers who need an easily-installed configuration identical across multiple installs, and novices who need help just getting all the needed bits and pieces together. The purpose of use this application, mainly because of shorter development time period in developing this project.

Furthermore, mapserver package is designed to perform a full installation of Apache, PHP, MapServer (cgi), PHP/MapScript, and to provide the capability to install additional applications easily and quickly where as the reason is the simplest way to do on Windows is to provide a predetermined directory structure and force everything into that mold.

The directory structure, while fixed within itself, is designed to be somewhat portable. While it needs to be installed at the root of a hard drive, it doesn't have to be the C: drive. The design also accommodates simple upgrades to the core package and to applications, without affecting the local configuration or the configuration of other installed applications.

3.1.1.2 Sources for maps

Before deciding on using any datasets, things should be consider is the availability and the capability in getting source of the map or datasets. All maps or datasets used in developing this project are from the Jabatan Ukur & Pemetaan Malaysia, credits to Dr A Nasir, Civil Engineering Lecturer and other attribute data comes from Mr Justin D. Devaraj, Geographical Information System lecturer.

All maps from Jabatan Ukur & Pemetaan Malaysia need to be converted into shape file format. Due to lack of knowledge and supporting tools that required for converting into shape file format, the data from Klang Valley district area had been selected due to problem encounter in converting the real maps.

Tools such as *Cad2Shape 2.0* and *AutoCAD 2005* have been tried out for converting tools. As a result, the datasets are still not detailed enough for project purposes. Commercial software such as *AutoCAD MAP 2000i*, *ArcGIS* and *ArcToolBox* are required for completed and detailed datasets development.

3.1.2 System and Software Design

For this project, the web applications are modeled in accordance with same modeling of the system architecture of Web-based GIS application Design. Below were descriptions of types to model web-based GIS components:-

- Client Web-browser

On here, we can identified it as client web browser, or in simplest way,the user. The user's Web browser will sends a HTTP request to the Web server via the Internet. At the end, the Web server returns the request HTML page to the user's browser.

- Internet

The Internet as the interconnected computer networks that transmit data will be the communication tools to connect it via the network in carrying out data request or perform from the user web-browser or web server and to web server or the client web page.

- Web Server

Computer that is responsible for accepting HTTP requests from clients, which are known as web browsers, and serving them web pages, which are usually HTML documents. The Apache the free software/open source HTTP web server for Unix-like systems, Microsoft Windows, and other platforms as the Web server, will passes the data submitted by the client and the appropriate page to PHP engine through a server API.

- Application Server

A server computer in a computer network dedicated to running certain software applications. It is also refers to the software installed on such a computer to facilitate the serving (running) of other applications. PHP as the application server will reads the data from the client and processes the tags in the page. Based on the PHP, the server interacts with MySQL database servers, the file system and potentially the map rendering engine.

- Storage / File System / Map rendering engine

On the back end side, the database, file system and MapServer will interact with each other in performing the request from the user. If a map is to be returned to the client, a request to the GIS application server which generates a map graphic will returned back the result to the application server. PHP will dynamically generate an HTML Web page that wraps around the map graphic and is returned to the Web server.

Below was the system architecture of the web-based GIS application:-

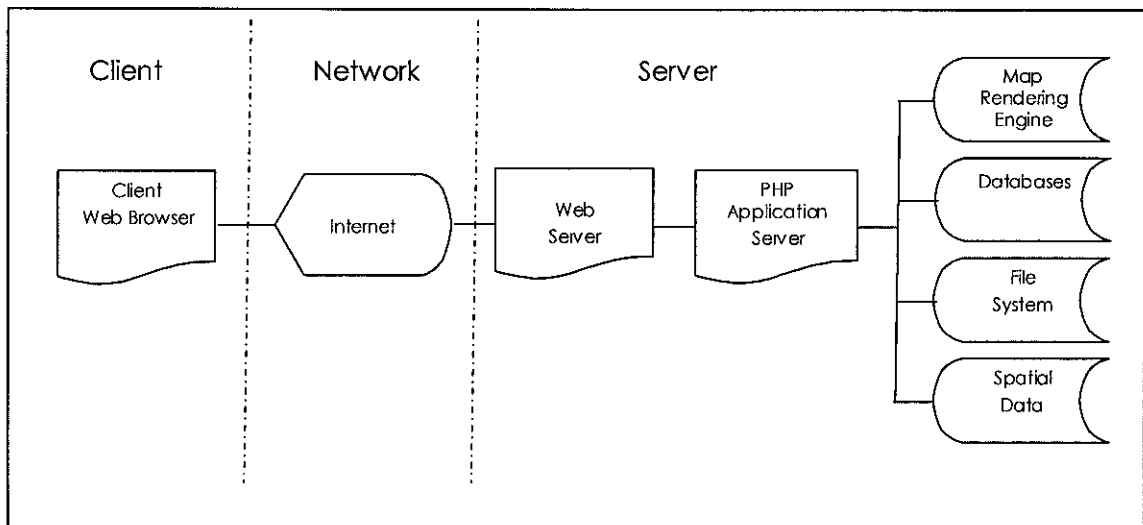


Figure 3.2: The system architecture of the web-based GIS application

Figure 3.2 shows the overview of client-server architecture used in this project. It consists of the client side and server side. In general, the whole architecture is divided into three domains, namely, first tier (client side), second tier (network side) and third tier (server side). The first tier comprises users and the web browsers that are located at the client side.

The second tier is related to the Internet, whereby Internet will be the communication network in interconnected computer networks that transmit data from client web browser to web server and from web server to client web browser.

Finally, the third tier is web processing which contains the web server, user interface, file system and apparently, the MapServer is located in the third tier also. In addition, in the third tier has located the database tier containing spatial and attributes data.

In order to access to the online map, users need web browser like Internet Explore, Netscape Communicator, Mozilla or Opera. With the correct Universal Resources Locator (URL), users can access to the web site of the project online map. Indeed, the web server will search the related web site according to the URL. However, before displaying the interface, the MapServer will retrieve the spatial data from the database. A complete interface of the route map application includes spatial data will display.

3.1.3 Prototype Development

Prototyping in system development involves creating a part of system so that the travelers can get an idea of what the system will offer and provide in the future. The development of prototype will helps to verify the system's integrity and reliability. The system flow from the user's perspective is as shown below;

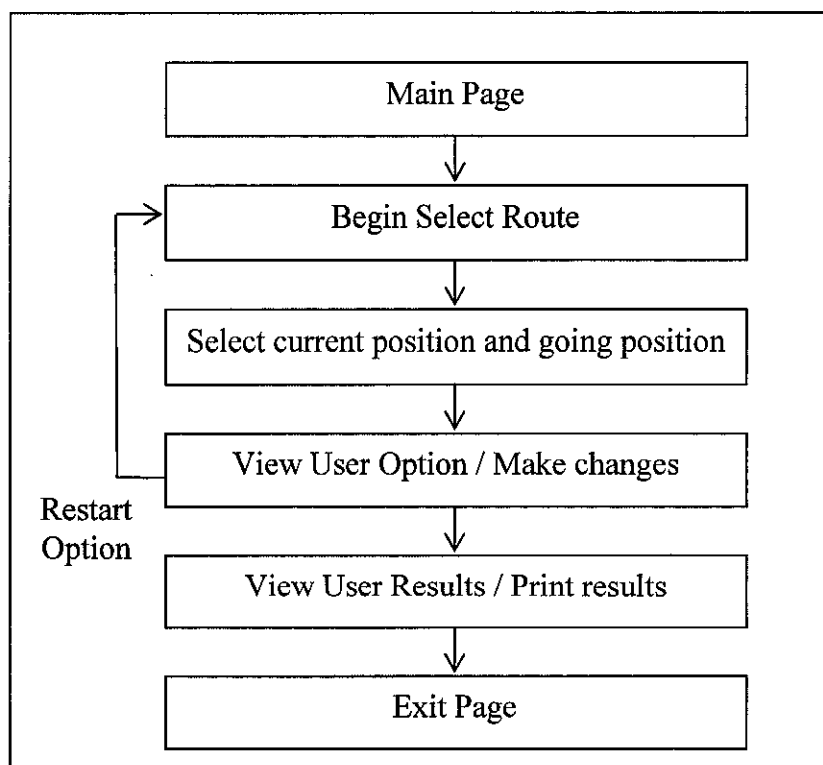


Figure 3.3: System Flow from User's Perspective

Web browser will present every question in a new page. User need to respond to the question or request area by selecting which points to go from a few options given. When there is no selected option, the system will notified user to select any option provided and the system will remain at the same page without proceeding, until further action taken by the user. The option pages are designed to be simple, providing clarity to the users. Map area with area labeled also embedded which aid user to select in which area they are currently in and which area are they going for to provide an illustration of particular area they intend to go.

When the final option is accomplished, the result page will displays the order route in the map area which is in the red color. If no result shows in the final page of the browser or option page is not completed, the user is informed by a message stating that no result can be reached or insufficient information to fulfill the order.

The main page of this project is a web interface that enables access to the online map. It is a typical HTML page that contains the link to project application on the MapServer. It has been developed by using the Microsoft FrontPage 2002 and Macromedia Dreamweaver MX.

3.1.3.1 Application Layout

Before creating a MapServer application, the first think about how and where to place the MapServer files and GIS data. It need to break down the files into three general categories:

1. MapServer-specific files: these would be the map and the HTML template files.
2. HTML graphics/images: files that are not directly used by MapServer but provide aesthetics to the MapServer application
3. GIS data: these are the shapefiles and raster images (more data formats can be used if you are using MapServer compiled with GDAL support).

So, one would typically create a directory for a MapServer application and create a subdirectory for data and graphics/images within that directory, plus with "fonts" subdirectory which consists truetype fonts whereby it going to be used it with MapServer.

In this scenario, it will have a directory structure like this:

```
MapServer_Apps
|
|-----images    <-- images/graphics common to applications
|
|-----data      <-- commonly used datasets
|      |---vector
|      |---raster
|
|-----fonts     <-- truetype fontsets
|-----symbols  <-- symbols files and graphics
|      |---images
|
|-----MapServer_App1    <-- one application
|      |
|      |---images <-- images/graphics used only in app
|      |---data   <-- datasets specific to app
|      |---vector
|      |---raster
|
|-----MapServer_App2    <-- another application
|      |
|      |---images <-- images/graphics used only in app
...    |---data   <-- datasets specific to app
|      |---vector
|      |---raster
```

The purpose of creating more than 1 application on the MapServer is to avoid a lot of redundant data to be kept. Therefore, structuring the directory application will help managing the data store even in another data sore machine.

3.1.3.2 Development of Mapfile

The real point of developing good map for user is by determine the correct layer Map file. In fact, this file defines every object for the map, including data layer, scalebar, map, legend, projection and web object. The objective of object definition is to define how the map will look like and be presented. The definition of each object is different and some examples are illustrated in Figure 3.5. on the next page.

```
MAP
NAME "Kuala Lumpur"
STATUS ON
EXTENT -2200000 -712631 3072800 3840000
SIZE 400 300
SHAPEPATH "./data"
SYMBOLSET "./etc/symbols.sym"
FONTSET "./etc/fonts.txt"
IMAGETYPE PNG
IMAGECOLOR 255 255 255
UNITS METERS
#
# Start of web interface definition
#
WEB
  MINSCALE 2e+06
  MAXSCALE 5e+07
  #
  # On Windows systems, /tmp and /tmp/ms_tmp/ should be created at the root
  # of the drive where the .MAP file resides.
  #
  IMAGEPATH "/ms4w/tmp/ms_tmp/"
  IMAGEURL "/ms_tmp/"
END
#
# Start of reference object (keymap)
#
REFERENCE
  STATUS ON
  IMAGE "images/keymap.png"
  SIZE 100 75
  EXTENT -2.2e+06 -712631 3.0728e+06 3.84e+06
  COLOR -1 -1 -1
  OUTLINECOLOR 255 0 0
  MINBOXSIZE 3
  MAXBOXSIZE 0
  MARKER 0
  MARKERSIZE 0
END

# Layer
LAYER
  NAME "road"
  STATUS OFF
  DATA "road"
  TYPE LINE
  UNITS METERS
  SIZEUNITS PIXELS
  TOLERANCE 0
  TOLERANCEUNITS PIXELS
  METADATA
    "DESCRIPTION" "Roads"
  END
CLASS
  NAME "Roads"
  STYLE
    SYMBOL 0
    COLOR 220 0 0
    SIZE 1
    MINSIZE 1
    MAXSIZE 100
  END
END
```

Figure 3.4: Examples of object definition

Here some cartographic aspects need to be considered by the developer. Building on the correct mapfile on every layer is tedious and need detailed concentration. MapServer draws each layer in a "last in, first out" order (LIFO). For example, if water layer need to be seen on top of background, therefore, it is need to add it as the last layer in the map file.

The defined objects such as map, legend and scale bar are presented on the online map interface. But, the Map file is not used for the designing of the interface, the Template files are used instead. The template files are used for the following tasks, namely, designing the interface, generating mapping tools and conducting query. HTML code is the common stuffs in the Template files (i.e. for designing the interface). Besides HTML code, the MapServer also supports other programming languages such as JavaScript for generating mapping tools.

To conduct query with the Template file, every layer is required to have a particular template file. This template file comprises attribute table and perhaps the query map display. The attribute table contains columns that carry the same as the columns in the DBF file. In addition, the path of the template file is also determined in the Map file. Consequently, the template file can be linked to the DBF file for the attributes data retrieval purposes.

Both Map file and Template file are developed and edited using Notepad. Web browser such as Internet Explorer, Mozilla, Opera or Netscape Communicator could be used to compile the files and view the results.

3.1.4 Integration and system Testing

MapServer reliability is one of the most important issues in developing GIS application for the web browser. Reliability ensures that the application delivers what user want with consistency, accuracy and integrity. Quality representation of user interface requires combination of integration between the web server and application server.

3.1.4.1 Testing

To investigate the accessibility and flexibility of the application, two experiments have been carried out via intranet. Time is recorded for every test. Both experiments are repeated for different numbers of users. In the first experiment, the accessibility of the application is tested that is by the number of users that can access the map concurrently.

In the second experiment where to test the flexibility, users run the map functions provided in the online map. Different users do different functions e.g. queries. The result shows similar trend as the first experiment.

3.1.5 Operation and Maintenance

Once the application is operating, its delivers solutions to the user community. It still require ongoing operational and maintenance as well as support for remainder or update or upgrade purposes. The maintenance purposes will require fixing any errors, omissions, or new requirements that may arise. System support consists of ongoing activities such as assisting users, fixing software defects (bugs), recovering the system and adapting system with new requirements or new technologies.

Here, the maintenance aspect in MapServer application will include the additional datasets to be added as well as the upgrading the web application into more user friendly based system.

3.2 TOOLS REQUIRED

3.2.1 Hardware

- Intel Pentium-4 1.5GHz with 512 MB RAM
- Intra-Network Connection

3.2.2 Software

- Windows XP
- JAVA 2 Standard Development Kit 1.4.2. - j2sdk-1_4_2_08-windows-i586-p
- Mapserver v1.2.2 with PHP/MapScript (Support Client/Server)
 - Apache version 2.0.54
 - PHP version 4.3.11 (running as CGI)
 - MapServer CGI 4.4.2, 4.6.1
 - PHPMapScript 4.4.2, 4.6.1
 - Win32 PostgreSQL version 7.5 / PostGIS.

Browsers supported include:

- Firefox 1.0
- Mozilla 1.4 and higher
- Microsoft IE 6 and higher
- Netscape 6 and higher

Other supporting tools

- ArcView 3.2
- AutoCAD 2005
- Cad2Shape 2.0

CHAPTER 4

RESULT AND DISCUSSION

The GIS application in this project is aimed at representing information from datasets area in Klang Valley and the time taken to access it.

4.1 Result of Testing

Two experiments have been carried out via intranet for testing purposes. Time in accessing the inline map is recorded for every test. Both experiments are repeated for different number of users. Experiment environment consists of user and UTP network itself. User being measured by the ability of the MapServer in processing online map while the UTP network being measured by the capability in responding to user request over different network in UTP consisting village 4 and 5 as well as Lab in building 01. Every process of experiment being evaluated by using stop watch and the loading time inside the application.

In the first experiment, the accessibility of the MapServer is tested that is by the number of users that can access the map concurrently. This experiment is use in calculate average time taken for each user in accessing the GIS application via MapServer. The example of this experiment can be described as web server and map server respond towards the first time user in accessing the online map. According to Table 1, three users visited the online map concurrently within 1 and 2 second. Within 3 seconds, 10 users visited the online map successfully. The MapServer can handle up to 15 users concurrently within 4 seconds.

Table 1.0 Average time taken to access the GIS application

Experiment (first)	Amount of Users (average)						
	1	2	3	4	5	10	15
1 – Lab	00:01.2	00:01.5	00:01.4	00:01.8	00:01.9	00:02.2	00:02.5
2 – village 4	00:01.7	00:02.1	00:02.3	00:02.9	00:03.2	00:03.8	00:04.2
3 – village 5	00:02.2	00:02.4	00:02.9	00:02.7	00:03.1	00:04.1	00:04.1
Average	00:01.7	00:02.0	00:02.5	00:02.5	00:02.7	00:03.4	00:03.6

In the second experiment, it can be describe as users run the map functions provided in the online map. This experiment is to test the flexibility of the online map. Different users do different functions such as zoom in, zoom out and queries information. The result shows below seems like similar trend as the first experiment except the additional time needed in returning the queries by the users. Therefore, more time needed when respond to the user.

Table 2.0 Average time taken to run the functionality of the GIS application

Experiment (Seconds)	Amount of Users (average)						
	1	2	3	4	5	10	15
1 – Lab	00:01.1	00:01.6	00:01.4	00:01.9	00:02.2	00:02.5	00:02.9
2 – village 4	00:01.3	00:01.9	00:02.0	00:02.0	00:02.5	00:03.2	00:03.6
3 – village 5	00:01.2	00:01.7	00:01.8	00:02.2	00:02.3	00:03.1	00:03.5
Average	00:01.2	00:01.7	00:01.7	00:02.0	00:02.4	00:02.9	00:03.3

Table 3.0 Response time when loading the application in every different location in UTP network

Observation	Network Area (UTP)		
	Village 5	Village 4	FYP Lab
Response - 1	0.000128030776978	0.000113964080811	0.000110864639282
Response - 2	0.000111103057861	0.000110864639282	0.000108003616333
Average	0.000119566917495	0.000112414136972	0.00010943412783

4.2 Discussion

According to Table 1 and Table 2, it is worth mentioning that the GIS application running on MapServer is flexible and accessible for multi user requirements concurrently. Therefor its indicated that the MapServer distinguished itself on many fronts, particularly its speed and flexibility. [21] The time of processing depends on the amount of users as shown in Figure 4.1. If more users access the online map concurrently, the MapServer requires longer processing time.

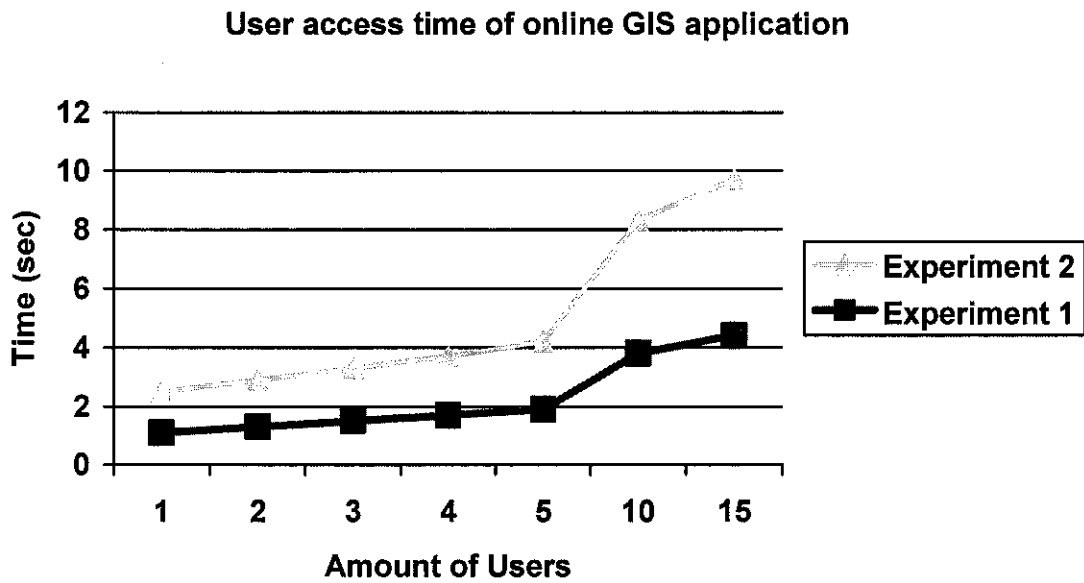


Figure 4.1. The graph shows amount of users versus time.

Different between 3 network places in accessing GIS application

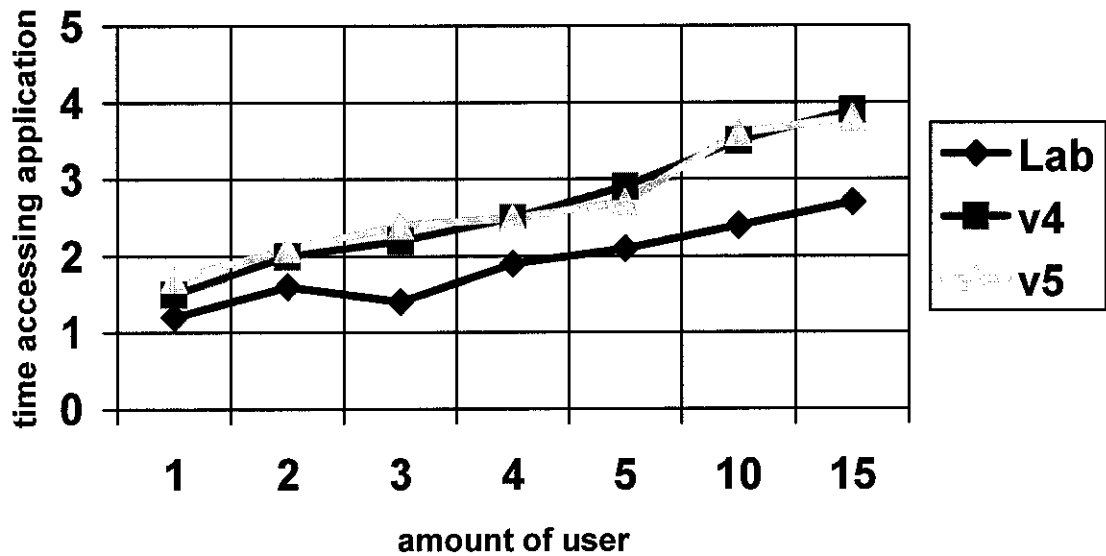


Figure 4.2. The graph shows amount of users versus time via three different places in UTP network

From the observation in the experiments can be identified that, different network area affects the performance of the application:-

- ❖ Village 4
 - The response time to access as well as query is depended on personal computer used.
- ❖ FYP Lab
 - The response time to access as well as query is faster compared to another network area.
- ❖ Village 5
 - The response time to access as well as query is depended on personal computer used.

Furthermore, It has been discovered that the installation of the MapServer software is simple compare the previous planned software to be configured – geoserver. Below where the key features inside the MapServer;

MapServer Key Features

- Server-side, focus on web mapping, not on GIS analysis
- High performance and reliability
- Multiplatform (Windows 95 to XP, Linux, *BSD, Solaris, MacOSX)
- Runs with Apache, Microsoft IIS/PWS, Netscape Enterprise, NCSA Httpd
- Scriptable via MapScript
- OGC WMS Client and Server
- On the fly reprojection (vectors and rasters)
- Direct support for multiple file formats

The emerging technology and the time-in-time development by the commity web server has make the MapServer application helps user easier and simplified in building any application via it. The used of simple CGI – 'mapserv' where as no coding required, but only configuration, as well as predefined functions and controlled via CGI parameters.

It's already solve for previously weakness of MapServer where is it does not have graphic interface module as usually available in the commercial packages. So, the used of the Map file for the interfacing purposes and is not user-friendly no more make it a problem because of new application in MapServer itself serve generating template web application for user-interface purposes.

The weakness of the MapServer is the file placement is crucial issue and need to be done carefully. The files, data and the Mapserv program do not work independently and have to make sure they are connected properly. Typical error caused by incorrect file structure and placement is that the map could not be displayed on the interface.

4.3. Limitation of the Project

In the course of developing this project, a few limitations were encountered. Limitations of the project are as follows;

- 1 Transportation GIS application was built using MapServer and with out integrating with other genetic algorithm implementing on it. Therefore, the result on the user queries will show only possible path not the shortest path or fastest path.
- 2 There are limitations to which the area focusing. The roads show only the main road in the Klang Valley. As user may preferable to use the complex road, because the scope of the project not cover the in detailed road but just the main road connected to each restrict in Klang Valley only. Therefore, a complete set of datasets requires to from proper parties such as Dewan Bandaraya Kuala Lumpur or Department of Town Planning in Kuala Lumpur City to made this project more accurate and efficient.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

Transportation system in GIS application was developed to show possible route in Klang Valley area. The system handles the route in Klang Valley and the process of implementing the Klang Valley online route map using the free MapServer (Minnesota MapServer). The implementation progress is observed and the capability of the MapServer is tested in two experiments. The entire process online map generation involves three basic elements of the MapServer, namely, the Mapserv program, the Map file and the Template file. These elements are inter-dependent. Knowledge of programming as important as the architecture of the web based GIS, therefore is required in order to utilize the MapServer.

Nevertheless, the MapServer offers as an alternative for online mapping and could be used for cheap and rapid dissemination of spatial information. Further and in-depth development and research will help this online map to serve better and more reliable system to user usage.

5.2 Recommendation

Future enhancements of transportation system in GIS application are as follows;

1. Datasets for Klang Valley area need to get from Department of Town Planning in Klang Valley for more accurate data and update attributes as well as getting permission from Dewan Bandaraya Klang Valley (DBKL).
2. The current application only shows route without any fastest route or shortest route. Therefore, in future integration with selected algorithm will enable user to select shortest path for traveling.
3. An extension with Macromedia Flash; this will animate user route where it can make user more interested in using this application.

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APPENDICES

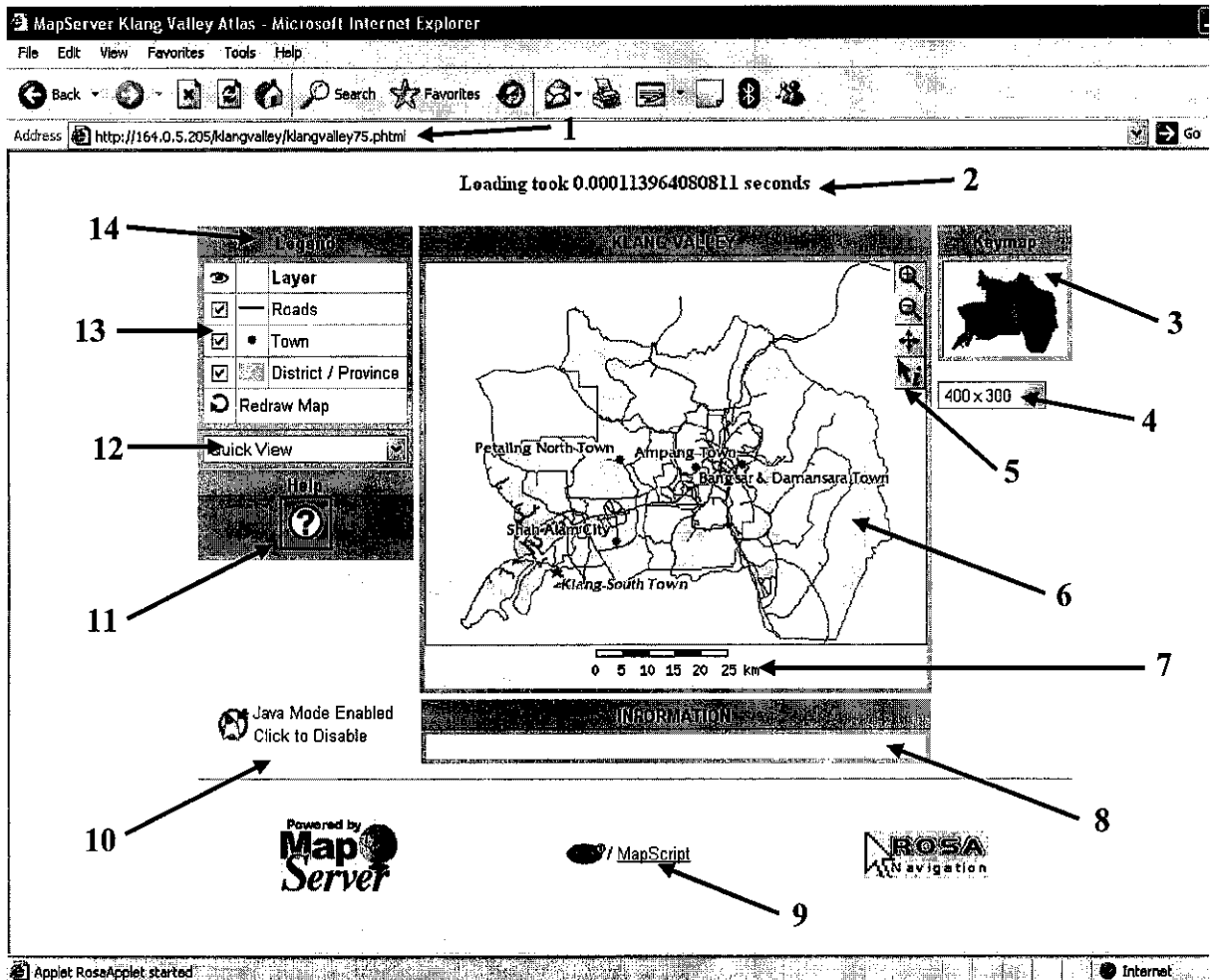


Figure: Graphical User Interface (GUI)

Descriptions:

- | | |
|--|---|
| <ol style="list-style-type: none"> 1. URL 2. Loading Counter 3. Keymap 4. Map Size 5. Functional Tools 6. Map Display Area 7. Scale Bar | <ol style="list-style-type: none"> 8. Information Area 9. Related Links 10. Java Mode 11. Help 12. Quick District Viewer 13. Layer – On / Off 14. Legend |
|--|---|

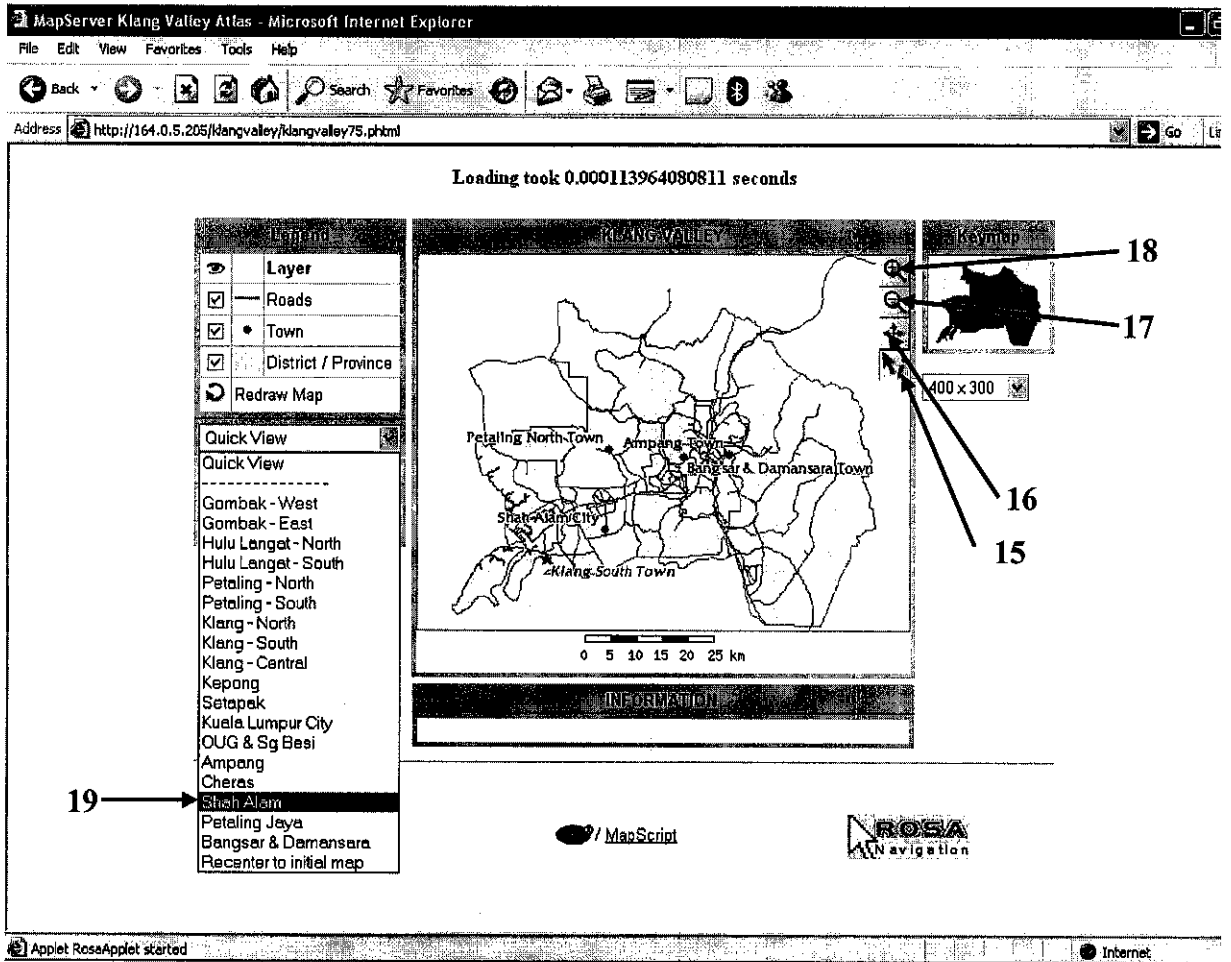


Figure: Screenshot of Functional Tools

Descriptions:

- | | |
|----------------------|---------------------|
| 15. Information Tool | 18. Zoom In Tool |
| 16. Recenter Tool | 19. Select District |
| 17. Zoom Out Tool | |

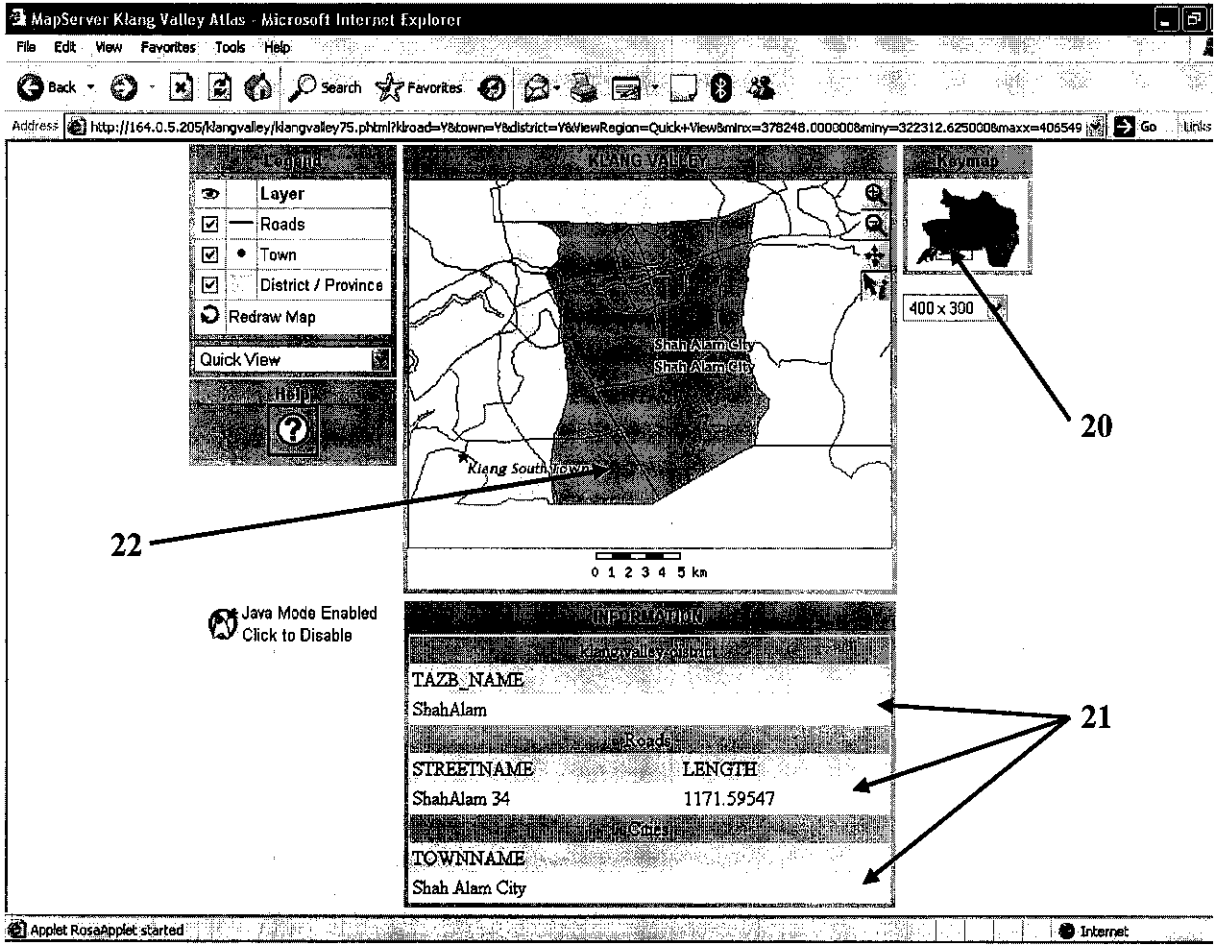


Figure: Screenshot of Querying Information

Descriptions:

20. Current Navigation Area

22. Map Area Selected

21. Information Selected

MapServer Application in GIS

Programme : IS

Village : -

Year : 5

Block : FYP LAB

*Please complete all the survey questions.

* Please circle your answer accordingly.

1. How many seconds / minutes taken in accessing this page?
 - a) 1 second
 - b) 2 seconds
 - c) 3 seconds
 - d) 4 seconds
 - e) 5 seconds
 - f) more than 5 seconds
 - g) others: _____
2. How many seconds / minutes taken in querying this page?
(e.g. zoom in / zoom out, retrieve information)
 - a) 1 second
 - b) 2 seconds
 - c) 3 seconds
 - d) 4 seconds
 - e) 5 seconds
 - f) more than 5 seconds
 - g) others: _____
3. How do you rate this GIS application?
 - a) Very poor
 - b) Poor
 - c) Moderate
 - d) Good
 - e) Very Good
4. Have you counter any difficulties when accessing this page?
 - a) No
 - b) Yes (please specify: _____)
5. What do you think about the application interfaces?
 - a) Very poor
 - b) Poor
 - c) Moderate
 - d) Good
 - e) Very Good
6. What is your opinion about the application? Please give your suggestion(s) to improve this application
The tools provided make the map easy to navigate.
More info like places or buildings located in Klang Valley
should be added to make the web-page more informative

Thank you for your cooperation and best regards.

MapServer Application in GIS

Programme : IT

Village : A FYP LAB

Year : 5

Block : e

*Please complete all the survey questions.

* Please circle your answer accordingly.

1. How many seconds / minutes taken in accessing this page?

- a) 1 second
- b) 2 seconds
- c) 3 seconds
- d) 4 seconds
- e) 5 seconds
- f) more than 5 seconds
- g) others: _____

2. How many seconds / minutes taken in querying this page?

(e.g. zoom in / zoom out, retrieve information)

- a) 1 second
- b) 2 seconds
- c) 3 seconds
- d) 4 seconds
- e) 5 seconds
- f) more than 5 seconds
- g) others: _____

3. How do you rate this GIS application?

- a) Very poor
- b) Poor
- c) Moderate
- d) Good
- e) Very Good

4. Have you counter any difficulties when accessing this page?

- a) No
- b) Yes (please specify: _____)

5. What do you think about the application interfaces?

- a) Very poor
- b) Poor
- c) Moderate
- d) Good
- e) Very Good

6. What is your opinion about the application? Please give your suggestion(s) to improve this application

more interactive application to make it more interesting.

Thank you for your cooperation and best regards.

any difficulties when accessing the application

MapServer Application in GIS

Programme : CHE

Village : lab

Year : 4

Block : -

*Please complete all the survey questions.

* Please circle your answer accordingly.

1. How many seconds / minutes taken in accessing this page?

- a) 1 second b) 2 seconds c) 3 seconds
d) 4 seconds e) 5 seconds f) more than 5 seconds

g) others: _____

2. How many seconds / minutes taken in querying this page?

(e.g. zoom in / zoom out, retrieve information)

- a) 1 second b) 2 seconds c) 3 seconds
d) 4 seconds e) 5 seconds f) more than 5 seconds

g) others: _____

3. How do you rate this GIS application?

- a) Very poor b) Poor c) Moderate
d) Good e) Very Good

4. Have you counter any difficulties when accessing this page?

- a) No b) Yes (please specify: _____)

5. What do you think about the application interfaces?

- a) Very poor b) Poor c) Moderate
d) Good e) Very Good

6. What is your opinion about the application? Please give your suggestion(s) to improve this application

-too generic information

Thank you for your cooperation and best regards.

MapServer Application in GIS

Programme : IT

Village : -

Year : 3

Block : FYP lab

*Please complete all the survey questions.

* Please circle your answer accordingly.

1. How many seconds / minutes taken in accessing this page?

- a) 1 second b) 2 seconds c) 3 seconds
d) 4 seconds e) 5 seconds f) more than 5 seconds
g) others: _____

2. How many seconds / minutes taken in querying this page?

(e.g. zoom in / zoom out, retrieve information)

- a) 1 second b) 2 seconds c) 3 seconds
d) 4 seconds e) 5 seconds f) more than 5 seconds
g) others: _____

3. How do you rate this GIS application?

- a) Very poor b) Poor c) Moderate
d) Good e) Very Good

4. Have you counter any difficulties when accessing this page?

- a) No b) Yes (please specify: _____)

5. What do you think about the application interfaces?

- a) Very poor b) Poor c) Moderate
d) Good e) Very Good

6. What is your opinion about the application? Please give your suggestion(s) to improve this application

- Very interesting website
- Information provide by the application need to be more detailed.

Thank you for your cooperation and best regards.

e) Very Good

MapServer Application in GIS

Programme : 15
Year : 5

Village : 4
Block : F

*Please complete all the survey questions.

* Please circle your answer accordingly.

1. How many seconds / minutes taken in accessing this page?
a) 1 second b) 2 seconds c) 3 seconds
d) 4 seconds e) 5 seconds f) more than 5 seconds
g) others: _____
2. How many seconds / minutes taken in querying this page?
(e.g. zoom in / zoom out, retrieve information)
a) 1 second b) 2 seconds c) 3 seconds
d) 4 seconds e) 5 seconds f) more than 5 seconds
g) others: _____
3. How do you rate this GIS application?
a) Very poor b) Poor c) Moderate
 d) Good e) Very Good
4. Have you counter any difficulties when accessing this page?
 a) No b) Yes (please specify: _____)
5. What do you think about the application interfaces?
a) Very poor b) Poor c) Moderate
d) Good e) Very Good
6. What is your opinion about the application? Please give your suggestion(s) to improve this application
Good for beginners like me.

Thank you for your cooperation and best regards. *(Signature)*

MapServer Application in GIS

Programme : IS

Village : 74

Year : Foundation

Block : 0

*Please complete all the survey questions.

* Please circle your answer accordingly.

1. How many seconds / minutes taken in accessing this page?

- a) 1 second b) 2 seconds c) 3 seconds
d) 4 seconds e) 5 seconds f) more than 5 seconds
g) others: _____

2. How many seconds / minutes taken in querying this page?

(e.g. zoom in / zoom out, retrieve information)

- a) 1 second b) 2 seconds c) 3 seconds
d) 4 seconds e) 5 seconds f) more than 5 seconds
g) others: _____

3. How do you rate this GIS application?

- a) Very poor b) Poor c) Moderate
 d) Good e) Very Good

4. Have you counter any difficulties when accessing this page?

- a) No b) Yes (please specify: _____)

5. What do you think about the application interfaces?

- a) Very poor b) Poor c) Moderate
 d) Good e) Very Good

6. What is your opinion about the application? Please give your suggestion(s) to improve this application

The I haven't encounter this type of application
before. I think this is a good application

Thank you for your cooperation and best regards.

MapServer Application in GIS

Programme : CVE

Village : C

Year : 3

Block : F

*Please complete all the survey questions.

* Please circle your answer accordingly.

1. How many seconds / minutes taken in accessing this page?

- a) 1 second b) 2 seconds c) 3 seconds
- d) 4 seconds e) 5 seconds f) more than 5 seconds
- g) others: _____

2. How many seconds / minutes taken in querying this page?

(e.g. zoom in / zoom out, retrieve information)

- a) 1 second b) 2 seconds c) 3 seconds
- d) 4 seconds e) 5 seconds f) more than 5 seconds
- g) others: _____

3. How do you rate this GIS application?

- a) Very poor b) Poor c) Moderate
- d) Good e) Very Good

4. Have you counter any difficulties when accessing this page?

- a) No b) Yes (please specify: no map at first time)

5. What do you think about the application interfaces?

- a) Very poor b) Poor c) Moderate
- d) Good e) Very Good

6. What is your opinion about the application? Please give your suggestion(s) to improve this application

Thank you for your cooperation and best regards.

MapServer Application in GIS

Programme : IT
Year : 4

Village : 5
Block : E

*Please complete all the survey questions.

* Please circle your answer accordingly.

1. How many seconds / minutes taken in accessing this page?
a) 1 second b) 2 seconds c) 3 seconds
d) 4 seconds e) 5 seconds f) more than 5 seconds
g) others: _____
2. How many seconds / minutes taken in querying this page?
(e.g. zoom in / zoom out, retrieve information)
a) 1 second b) 2 seconds c) 3 seconds
d) 4 seconds e) 5 seconds f) more than 5 seconds
g) others: _____
3. How do you rate this GIS application?
a) Very poor b) Poor c) Moderate
d) Good e) Very Good
4. Have you counter any difficulties when accessing this page?
 a) No b) Yes (please specify: _____)
5. What do you think about the application interfaces?
a) Very poor b) Poor c) Moderate
d) Good e) Very Good
6. What is your opinion about the application? Please give your suggestion(s) to improve this application

Thank you for your cooperation and best regards.