II. LITERATURE REVIEW

2.1. Geographic Information System.

GIS is a System of computer software, hardware, data, and human to help manipulate, analyze and present information that is tied to a spatial location, which is usually a geographic location. A geographic Information System (GIS) is a powerful tool for handling spatial data. It is used for storing, retrieving, maintaining, manipulating, analyzing, and producing the digital format of spatial data. Moreover, it could produce a spatial data in a hard-copy format (Aronoff, 1991).

In GIS environment, there are two types of common data that should be taken into account, spatial data and non-spatial data (United Nations, 1996). Spatial data provides information about the feature referred to geometrical orientation, size, and relative position from other features (United Nations, 1996). Non-spatial data is complementary information to spatial data, which provides some further information (United Nations, 1996).

A GIS is most often associated with a map view. A map, however, is only one of the following three ways you work with geographic data in a GIS.

- The Database View

It is a unique kind of database of the world, a geographic database (geo-database). It is an Information System for Geography. Fundamentally, a GIS is based on a structured database that describes the world in geographic terms.
• The Map View

It is a set of intelligent maps and other views that show features and feature relationships on the earth’s surface. Maps of the underlying geographic information can be constructed and used as windows into the database to support queries, analysis, and editing of the information. This is called geo-visualization.

• The Model View

It is a set of information transformation tools that derive new geographic datasets from existing datasets. These geo-processing functions take information from existing datasets, apply analytic functions, and write results into new derived datasets. Together, these three views are critical parts of an intelligent GIS and are used at varying levels in all GIS applications.

2.2. The Related Research

2.2.1. Multimedia Tourism Information in Bakosurtanal

Atlas center in Bakosurtanal Indonesia has completed one project about tourism information in East Java. The result of the research is computer software that provides tourism information in East Java. The software was built based on Macromedia environment with pictures and video file. It also provides these maps of tourism object. These maps can be zoomed but it is not an interactive map. It means the map cannot be clicked or queried. This system cannot run in network environment. So the tourism information cannot be distributed easily.

2.2.2. Web Tourism Information from East Java Tourism Department.

East Java Tourism department has developed a web site that provides tourism information of East Java. This web site provides tourism information in Internet environment so information can disseminate easily. But this web site is
unable to show tourism information with the map of interested objects. The address of this web site is http://www.eastjava.com.

2.2.3. Available Web-Based GIS

2.2.3.1. Mapzoom

This is one of research that was conducted by Computer Science at the University of Rochester.

![Mapzoom Interface](http://www.cs.rochester.edu/7egildea/map)

**Capability**

This Web-Based GIS produces static web maps with map image prepared beforehand. CGI script is used to zoom and pan the map. The advantage is fast data processing.

2.2.3.2. MapIt

MapIt is a server side web-application for raster maps. Navigation and points of interests are easily configured.
Capability

This Web-GIS was designed based on thick-client architecture. The Server provides raster data and the client using plug-in to display the map.

2.2.3.3. Demis

This Website was developed to support analysis and decision support projects in the field of water, traffic, air and energy. This focus has been to develop map based user interfaces.

Figure 2.3. Demis Interface (http://www.demis.nl/home/default.htm)
Capability

The map display by using Macromedia Flash technology with allow animation appear in Web browser. This map can be zoom in/out, queried point.

2.2.3.4. Chameleon

Chameleon is a distributed, highly configurable, environment for developing Web Mapping applications. It is built on MapServer as the core-mapping engine and works with all MapServer supported data formats through a regular MAP file.

Figure 2.4. Chameleon Interface (http://chameleon.maptools.org)

Capability

Chameleon is an open source Web-Based GIS packet. It is built on OpenGIS Consortium standards for Web Mapping Services (WMS). It incorporates the ability to quickly set up new applications from a common pool of widgets that can be placed in an HTML template file. These widgets provide a
fixed piece of functionality, but the representation of the widget is normally highly configurable.

2.3. Web-GIS Technology

Internet GIS, as the name suggests, relies on the wired or wireless Internet to communication. Web GIS is a Geographic Information System distributed across a networked computer environment to integrate, disseminate, and communicate geographic information visually on the World Wide Web over the Internet.

2.3.1. Web-GIS Architecture

2.3.1.1. Typical Architecture

In the architectural system of Web GIS, this service is similar to the client/server architecture of the Web. The geo-processing breaks down into a server-side and client-side task.

A client typically is a Web browser. The server-side consists of a Web server and a Web GIS software programming. The client requests a map or some geo-processing over the Web from the remote server. The server translates the request into an internal code and invokes the GIS functions by passing on the request to the Web GIS software. The software returns the result that is reformatted for interpretation by the client browser application itself or with additional functionality from a plug-in or Java applet. The server then returns the result to the client for display, or sends data and analysis tools to the client for use on the client-side.
The interface consists of WWW pages with HTML forms, which interact with the WWW server through CGI requests. This requires all functionality to reside at the server, reducing user friendliness, as every little function requires a network transmission and thus, increased network traffic and time delays between user and server. The forms are combined with images functioning as buttons and image-maps to provide the user functionality that includes data retrieval and image manipulation.

**Web Server and Data Server:** Internet server is software, which provides GIS functionality to users over the Internet. Data server is used to store data. It can be updated and secure (*Finley et al., 1998*).

A **map server** is a component that generates maps, fulfills spatial queries, and delivers symbolized maps. A client based on the user’s request. The map server can be split into smaller parts to provide specific services. That is, each server could be specialized into one particular function or service.

A map server generally has seven basic functions (*OpenGIS WMS specifications)*:

- To provide a symbolized map based on user’s request.
• To answer basic queries about the content of the map and the attribute of spatial features.
• To extract data from a database based on the criteria on the user’s request.
• To perform spatial analysis such as buffering, feature overlay, spatial search, and network analysis.
• To communicate with other programs about the availability of services and data, such as what maps it can procedure and which of those can be queried further.
• To provide an interface for associating default symbols with a data set for use by clients with data publishing capability.
• To invoke other map servers to perform other analyses. This is referred to as a cascading map server in OGC’s WMS specification.

The output of the map server can be in one of three forms: a simple map image (GIF, JPEG etc); a graphic element map or a map composition comprising one or more overlays with predefined colors, styles, legends, and so on; a filtered raster and/or vector data in a form that can be manipulated (query, pan, zoom) on the client.

2.3.1.2. Thin Client Architecture

The thin client architecture is used in typical architecture. In the thin-client system, the clients only have user interfaces to communicate with the server and display the results. All the processing is done on the server actually as shown in figure 2.5. The server computer usually has more power than the client, and manage the centralized resources. Figure 2.6 shows schematic communication between Web browser, Web server and GIS server in thin client architecture. On
the Web server side, there are some possibilities to realize the GIS connection to the WWW: CGI, Web server application programming interface (API), Active server page (ASP), Java Server pages (JSP), PHP, etc.

Advantages of this architecture:

- The system can be totally controlled in Server side.
- Data updating is easy.
- Latest version can be kept.
- It is generally cheaper.
- Integration is possible.

Disadvantages of this architecture:

- Local needs are not responsive.
- It has large data volume (size of the database)
- Users use a browser and it takes long time to download new HTML frame.
- Vector data does not appear in client side: browser without additional plug-in can not read vector files.

2.3.1.3. Thick Client Architecture

In general, a Web browser can handle HTML documents, and embedded raster image in the standard format. To deal with other data formats like vector data, video clips or music files, the browser's functionality has to be extended. Using thin client architecture, the vector files could not be used. To overcome this
problem most browser applications offer a mechanism that allow third tier program to work together with browser as a plug-in.

The user interface functionality has progressed from simple document fetching more interactive applications. This progress is as follows: HTML, ActiveX, Java script to enhance user interface capabilities, Java applets to provide client-side functionality. Fig 7 shows the schematic communication between Web browser, Web server and GIS server in thick client architecture.

![Figure 2.7. Thick Client Architecture (Alesheikh & Helali b2001)](image)

Advantages of this architecture:

- Document/graphics standards are not required.
- Vector data can be used.
- Image quality no restricted to GIF and JPEG.
- Modern interface is possible.

Disadvantages of this architecture:

- Users is required to obtain additional software
- Platform/browser and additional software may not be compatible.

2.3.2. Geo Data Transfer

Except attribute data, a decisive question for using GIS in the Internet is the data format (Vector or raster), which is used to transfer data to client. For data transmission to the client, map is converted into no space raster or a suitable vector format. When raster data is transferred, a standard Web browser without extension can be used, since Web browser display GIF or JPEG. That means the
data on the server has to be converted to raster format. The data volume due to the known image size and the original data on server is safe as only an image is sent to the client. The disadvantage of using raster data is the lack of comfort of handling and regarding cartographic aspects. Because of low vector data volume, it transmits faster than raster. Vector data handled by a standard Web browser with extended functionality (plug-in, applet etc). The user gets more functionality with vector data. For example, single objects can be selected directly or highlighted. One more advantage of using vector data sent over Web could be three to four times less than the amount of raster data needed for equivalent resolution resulting in faster response time and greater productivity (Nayak, 2000). Disadvantage of vector data are manufacturer dependence, as well as, changing data volume; the amount of data varies with the selected area. To avoid data redundancy in client side, dynamic generalization must be provided.

The choice of transferring data form (vector or raster) varies with application and the existing infrastructures. Software products, which offer optional transferring of vector or raster data, may provide advantages. They may allow a pre-selection with raster data, and afterwards, loading of the actual vector data with the possibility of subsequently local process (Leukert & Reinhardt, 2000).

Different consortia are developing future standard formats for transferring data over Internet. The Open GIS consortium procedures Geography Markup Language (GML). GML shall enable the transport and storage of geographical information in eXtensible Markup Language (XML). Geographic information includes both properties and the geometry of geographic features.
(www.opengis.org). The W3C submits Scalable Vector Graphics (SVG), which is a language for describing two dimensional vector and mixed vector/raster graphics in XML (www.w3c.org).

2.3.3. Web Map

There are three kinds of Web map: Static map, Dynamic map and Interactive map.

- **Static map:**

  A static map publish refers to embedding maps as graphic images like GIF, JPEG and PNG inside an HTML page. The map images are usually used as a visual presentation to illustrate the points inside the HTML text. But the map image itself is not intelligent. That is, the map image is a static image displayed on the Web browser. The user cannot click on it to zoom to a certain area or get more information. A static map publishing does not support feature data at the client side and does not have map-rendering tools. To publish a static map image, you can save a ready-made map as a graphic map image format and embed it inside an HTML page. In addition, Acrobat's PDF is another popular method to publish static maps on the Web. A static Web map also can provide additional information by creating hyperlinks from "hot spots" on the map image to other Web pages.

- **Dynamic map**

  It automatically generates and refreshes Web map images as scheduled or when new data become available. Examples are weather maps, environmental pollution monitoring maps, time-zone maps and flight-line maps. Because dynamic Web maps are regenerated to refresh the Web page image, facilities may be provided for users to pan and zoom the map display.
Interactive map

It is generated in response to a user’s query for specific data types. Examples include interactive yellow pages, direction-finding pages or other address-mapping services available on the Web. Users enter an address, ZIP code, state or other geographical name and a map is generated to show the location or region requested. The geographic location is found by querying a geographic database for the user-specified geographic name or by matching the address to a geographic location. The maps also can have “hot spots” for hyperlinks to other Web pages.

2.3.4. Web-GIS Development Cycle

Several strategies have been proposed to provide successful implementation of Web GIS (Alesheikh & Helali b2001). The implementation strategies have been scientifically assessed and modified so that the requirement of project can be met with minimum cost and time. Web GIS development cycle consists of eight steps starting with requirement analysis and ending with end using, maintenance.

![Web-GIS Development Cycle](image)

Figure 2.8. Web-GIS Development Cycle (Alesheikh & Helali b2001)
2.3.5. Web GIS Advantage & Disadvantage

2.3.5.1. Advantage

- Using the WWW as a user tool for formulating requests for the available data sets and using WWW servers for generating responses to such requests.

- It has become a standard format or language for Internet and World Wide Web applications; HTML was adopted as a means to organize text, integrated with graphics and other features.

- GIS computation power residing at the server side can be brought to the user without the need of buying expensive GIS software and associated hardware.

- The WWW environment is a multimedia environment, allowing easy integration of many types of information, and one of its most essential features is the possibility to inter-link documents in a variety of ways.

- The Internet is a cheap, (almost) device-independent standard user interface environment.

- GIS development integrated with the WWW has the potential to reach many people who needs or share spatial data.

2.3.5.2. Disadvantage

Web GIS is not without its faults. The primary problem is speed; GIS relies on extensive use of graphic. Connection speeds over the Internet can make heavy use of graphics intolerably slow for users. Other problem is limitation of GIS function.
2.4. Available Web-GIS Software Component

There are several Web GIS softwares to enable user obtaining spatial information via Website. Some of them have been listed with their descriptions as below.

2.4.1. MapServer 4.8

MapServer was originally developed by the University of Minnesota (UMN) ForNet project in cooperation with NASA and the Minnesota Department of Natural Resources (MNDNR). Presently, the MapServer project is hosted by the TerraSIP project, a NASA sponsored project between the UMN and consortium of land management interests.

In its most basic form, MapServer is a CGI program that sits inactive on your Web server. When a request is sent to MapServer, it uses information passed in the request URL and the Map File to create an image of the requested map. The request may also return images for legends, scale bars, reference maps, and values passed as CGI variables.

Figure 2.9. MapServer Architecture (University of Minnesota)
MapServer is not a full-featured GIS system like other Desktop GIS softwares. It excels at rendering spatial data (maps, images, and vector data) for the web. MapServer also can use layers from other map servers on the Internet as long as they are Web Map Servers (WMS).

2.4.2. ArcView Internet Map Server

ArcView Internet Map Server (IMS) is a program specially designed to run ArcView applications over the Internet. IMS has two parts. First, there is the Internet map server (IMS) itself, that enables ArcView GIS communicate with a Web server. The second part is the ESRI Map Web Server extension and is installed on the Web server platform. It enables the Web server to communicate with one or more ArcView GIS sessions running on one or more development platforms, administer these connections and balance the server load between them.

2.4.3. Autodesk MapGuide 4.0

Autodesk’s MapGuide 4.0 is a piece of software for Webmap publishing, from simple thematic Webmaps to full-fledged multimedia Webmapping applications. The suite of Autodesk MapGuide consists of the Server, the Author and the Viewer. The Server handles requests for maps and data from either the Author or the Viewer. The Author is a piece of software for the creation and publishing of maps according to pre-set display specifications. The Viewer is a plug-in for map display and lets the client perform many actions locally.

2.4.4. Intergraph Geomedia Web Map 3.0

Intergraph’s Windows-based GeoMedia Web Map (GWM) enables the dissemination of geographic information, combined from multiple data sources, to
be distributed through smart Webmaps over an Intranet or over the Internet (Intergraph, 1999a). The software is designed to serve geographic information to users running Windows and a standard Web browser.

2.5. Database

Database is a collection of non-redundant data, which is shareable among different applications representing needs of individual or group users (Laurini, 1996). The organization of database can be described in terms of records, fields, and keys. Record is a group of related fields that stores data about a subject (Power, 2000).

2.6. Database Model

Database model is a collection of conceptual tools for describing data, data relationships, data semantics, and consistency constraints. There are several types of database model.

2.6.1. Relational Model

RDBMS (Relational Data Base Management System) is a database based on the relational model developed by E.F. Codd. A relational database allows the definition of data structures, storage and retrieval operations and integrity constraints. In such a database the data and relations between them are organized in tables. A table is a collection of records and each record in a table contains the same fields.

Properties of relational tables:

- Values are atomic
- Each row is unique
- Column values are of the same kind
• The sequence of columns is insignificant
• The sequence of rows is insignificant
• Each column has a unique name

Certain fields of a table may be designated as key of that table. This key is used to identify and search record of a table. A join operation can be performed to select related records in the two tables by matching values in selected fields. The relational database model is based on the relation algebra

2.6.2. Hierarchical Model

The hierarchical data model organizes data in a tree structure. There is a hierarchy of parent and child data segments. This structure implies that a record can have repeating information, generally in the child data segments. Data in a series of records, which have a set of field values attached to it. It collects all the instances of a specific record together as a record type. These record types are the equivalent of tables in the relational model, and with the individual records being the equivalent of rows.

2.6.3. Network Model

The popularity of the network data model coincided with the popularity of the hierarchical data model. Some data were more naturally modeled with more than one parent per child. So, the network model permitted the modeling of many-to-many relationships in data. In 1971, the Conference on Data Systems Languages (CODASYL) formally defined the network model. The basic data-modeling construct in the network model is the set construct. A set consists of an owner record type, a set name, and a member record type. A member record type
can have that role in more than one set; hence the multi-parent concept is supported.

2.6.4. Object-Oriented Model

Object DBMSs add database functionality to object programming languages. They bring much more than persistent storage of programming language objects. Object DBMSs extend the semantics of the C++, Smalltalk and Java object programming languages to provide full-featured database programming capability, while retaining native language compatibility. A major benefit of this approach is the unification of the application and database development into a seamless data model and language environment. As a result, applications require less code, use more natural data modeling, and code bases are easier to maintain. Object developers can write complete database applications with a modest amount of additional effort.