THE DEVELOPMENT OF VGI APPLICATION FOR URBAN ROAD PROBLEMS

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This dissertation is dedicated to my family for their endless support and encouragement.

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ABSTRACT

In recent years new interactive web services are dramatically altering the way in which ordinary citizens can create digital spatial data and maps, individually and collectively, to produce new forms of digital spatial data that some term 'volunteered geographic information' (VGI). Furthermore due to recent convergence of greater access to Internet connections, the availability of Global Positioning Systems (GPS) at affordable prices, and more participative forms of interaction on the Web (Web 2.0) vast numbers of individuals are able to create and share geographic information. Due to this reasons many governments are considering how they can better engage with and accept citizen input online, particularly through the gathering and use of VGI. There are variety types of supplementary data that governments can collect by VGI systems. One of these types is digital photo (that captured by Geotagging). Geotagging is the process of adding geospatial data to different forms of media. This involves enriching various media (such as texts, photos or video) with location data; latitude, longitude, and altitude. Photos can prove volunteered report and give more useful information of problems to governments, so can be very useful for government. This study attempt to develop a process for volunteered reporting of urban road problems to local governments based on VGI System. Therefore, attempt to design and develop a Geoweb by using Google Map APIs and related tools and functions for running the process of volunteered reporting and Geotagging data to reports. Moreover, attempt to develop a database for store data by coding and connecting to browser-side. Finally test the process by importing some supposition reports and. This study could be extending database and adding Placemarks on the streamed BaseMap from Google for citizens to add and Geotag information.

ABSTRAK

Perkhidmatan laman sesawang interaktif yang aktif sejak kebelakangan ini memberikan peluang yang baik kepada masyarakat mereka peta dan data spatial digital, untuk menghasilkan data reruang digital yang dikenali VGI. Perkembangan yang memberangsangkan dalam dunia Internet dan kehadiran GPS pada harga yang berpatutan di pasaran, selain kewujudan laman-laman interaktif telah membantu menambahkan bilangan masyarakat yang berkeupayaan mereka dan berkongsi maklumat geografi. Mengambil kira perkembangan ini, semakin banyak institusi kerajaan mempertimbangkan penggunaan laman interaktif dalam mendapatkan input daripada masyarakat terutamanya dengan penggunaan VGI. Pelbagai bentuk data dan maklumat boleh diperolehi oleh pihak kerajaan dengan penggunaan VGI, dan satu darinya adalah foto digital yang diperolehi secara Geotagging. Geotagging merupakan satu proses memasukkan data geospatial ke dalam pelbagai bentuk media. Ini dilakukan dengan melengkapkan media-media tersebut (seperti teks, foto atau video) dengan maklumat kedudukan; latitud, longitud, dan altitud. Foto merupakan bukti yang paling baik dan maklumat paling berguna yang membantu pihak kerajaan menyelesaikan masalah-masalah yang dihadapi. Kajian ini menghasilkan prosedur pelaporan secara sukarela untuk isu-isu berkaitan jalan bandar yang diuruskan oleh pihak berkuasa tempatan berdasarkan sistem VGI. Seterusnya, menghasilkan Geoweb menggunakan Google Map APIs dan fungsi-fungsi berkaitan dalam melaksanakan pelaporan secara sukarela dan Geotagging. Kajian ini juga akan membina pangkalan data bagi penyimpanan maklumat dan dihubungkan ke browser-side. Beberapa percubaan dilakukan bagi menguji keberkesanan sistem VGI yang dihasilkan. Kajian lanjut boleh dilakukan bagi memperkemas dan memberi peluang kepada masyarakat untuk melengkapkan maklumat pelaporan, antaranya dengan menambahbaik pangkalan data dan membolehkan masyarakat memasukkan Placemarks.

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LIST OF SYMBOLS AND ABBREVIATIONS

2D	2-Dimensional
3D	3-Dimensional
3G	Third Generation
AJAX	Asynchronous JavaScript and XML
API	Application Programming Interface
C2G2C	Citizen-to-Government-to-Citizen
COGO	Coordinate Geometry
CSS	Cascading Style Sheets
G2C	Government-to-Citizen
GI	Geographic information
GIS	Geographic Information System
GML	Geography Markup Language
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GUI	Graphic User Interface
HCLS	Health Care and Life Science
HTML	HyperText Markup Language
ICT	Information and Communication Technologies
KML	Keyhole Markup Language
LBS	Location Based Services
MMS	Multimedia Messaging Service
MPJBT	Majlis Perbandaran Johor Bahru Tengah
NCGIA	National Center for Geographic Information and Analysis
NES	Notification and Editing Service
OSM	OpenStreetMap

PC	Personal Computer
PET	PolyEthylene Terephthalate
PHP	PHP hypertext preprocessor
PPGIS	Public Participation GIS
RSS	Rich Site Summary
SQL	Structured Query Language
UAV	Ukrainian American Veterans
UCGIS	University Consortium for Geographic Information Science
UGC	User-Generated Contents
URL	Uniform Resource Locator
VGI	Volunteered Geographic Information
WMS	Web Map Service
XML	Extensible Markup Language

CHAPTER 1

INTRODUCTION

1.1 Introduction

As broadly defined by Goodchild and Glennon (2010), Geographic Information System (GIS) is a system that of consists software, hardware, and procedures that can help to manage, manipulate, analyze, model, represent and display the Georeferenced data in order to find a solution to the multifaceted problems that are mostly related to planning and managing the resources. At first, in 1960, GIS was introduced and since that time, it has been an important tool in public business and administration. It is because of its capability in storing, retrieving, analyzing and displaying the vast volumes of the spatial data.

GIS has the capacity to be utilized in public administration for planning the issues related to infrastructures and transport, as well as it can be applied in designing the utilities and operation, tax assessment, public safety, disaster management, and sustainable development. GIS can be also employed in business for managing vehicle fleets, analyzing the market areas, profiling the customers, and providing advanced Location Based Services (LBS). GIS has been widely implemented and used in the sectors such as financial services, retailing, insurance, media, and real estate. It can be also used in other areas, including education, military, and natural resources (Maguire, 2007).

Some applications of GIS include mapping quantities and densities, mapping locations, finding the routes and distances, and predicting and monitoring the changes.

Firstly, GIS was an application that was mainly used in military and government sector. It was because they needed mainframe computers running UNIX based operating systems. In business, their use was restricted because they were highly expensive and needed a specialized operator. When in the late 1990s, desktop GIS applications were introduced (e.g., Map Server and PARC Xerox), the situation changed, because it was capable of being run on PCs. After that, web GIS applications such as the MapQuest and the Google Maps (GoogleMap, 2005) were introduced globally to users, which allowed them to gain access to very detailed maps; they could have all data only by a web browser. In recent years, mobile devices appeared and the mobile GIS applications become attractive to users. Architecturally, recently some new trends have appeared such as semi-automatic web service composition, integrating GIS and cloud computing, easily creating reconfigurable applications.

1.2 Geoweb

With appearance of the information and communication technologies (ICT), especially the Internet, major digital changes have occurred globally. These changes have made a big revolution in concept and usage of the maps. Today, creating the geographic information and maps is no longer only for the professionals of the field. This situation is partly because of a development happened for Geoweb (Herring, 1994). It refers to combining the Web, geographic information, and geospatial technologies. Nowadays, the Geoweb relies mainly on Web 2.0 infrastructure, and it is a main core for its organization. Naturally, since it offers dynamic and interactive maps, it is considered as participatory. The spatial practices and technologies, on one hand, have converged and combined in order to obtain the complementarily; on the other hand, the Web has developed and become more mature. It is based on global actions, open networks, information sharing, and collaborative work (Tapscott and

Williams, 2007). Consequently, the Geoweb is a collective platform that is built on the tools, practices, and data that are generated by users and operators, and where the location-based contents could be easily shared.

Geoweb and other geospatial applications have prepared a cartography with some novel characteristics that is accessible to two billion users of the Internet (Sample, 2008). As a result, according to logic of data spatial organisation, the content itself is becoming increasingly georeferenced in the digital geographic spaces. Today, the geographic information is a Web-resource (Scharl and Tochtermann, 2007). These combinations occurred for hypertext systems and geographic information systems caused the management of spatial data to be highly efficient.

In the process of developing the Web 2.0, a part of geographic information is generated and made accessible to all users, according to online Cartography 2.0 format (Haklay *et al.* 2008). It shifted from the consultation to the interaction with the geographic contents, and this shift caused the volunteered geographic information concept to be emerged. This concept made a characterization for the location-based user-generated contents (UGC) (Goodchild, 2007a). Today, all users of the Internet are equipped with the user-friendly, simplified, ergonomic tools so that they could read and write the maps more easily (Cramptom, 2008). Maps that are accessible on the Internet are not limited like before to only the professional uses. According to the features of Web 2.0, maps are widely accessible for all users.

The considerable shift that has occurred in the process of producing and using maps is named Web-Mapping 2.0 (Haklay *et al.* 2008). These have been resulted from various advances occurred in technology benefitting more from the Internet (especially 2.0) rather than the RSS, XML and AJAX. Due to new-generation languages, Geoweb technologies provide some structures with higher flexibility, communication protocols with higher openness, and a more widespread interoperability. The available cartographic API (e.g., Bing Maps and Google Maps) helps numerous basic data to be displayed (addresses, topography, satellite images, and roads), and it constitutes the base maps of Geoweb. The concept of Mashup is

combining data that are collected from different sources. It is noticeable that API are not limited only to viewing; they provide us with numerous other tools that enable the users manipulate the spatial data (updating, editing, enhancing and qualification). Consequently, all of the users are capable of creating personal maps (dynamic or static) and customizing maps (type of data, scale and feature implementation). For all types of the available Web contents (e.g., links, videos, photos, etc.), the geographical location could be established by means of various means (e.g., Geocoding and Geotagging). Additionally, because of development of the mobile uses and GPS (e.g., 3G and Wifi), a Geoweb has been provided on which the mobility practices of the users are based. Novel mapping environments has been generated due to this large on-line user-oriented cartography, in which the interactivity of the data is as important as content. This developments that have been occurred in mapping Web services that support building and diffusion of the VGI, makes a considerable modification to the strategies that are applied in producing the geographic information.

1.3 Volunteered Geographic Information

As Goodchild (2007b) stated, the term Volunteered Geographic Information (VGI) is employed for designating all of the user-generated contents that is related to the earth's surface. More popular examples include GPS tracks embedded in cars and the points like coffee bars, restaurants, and so on. VGI has various applications enabling the users to browse the information in different media (e.g., documents, text, videos, pictures, etc.). There is a link between the information and a location on a map. This linking is performed through a spatial reference.

One of the most well-known VGI initiatives is the OpenStreetMap. It is a general-purposed, editable and free street map that is built by some collaborative methods. In this application, the users are easily capable of uploading new streets by the GPS tracks or they can make a desired modification to the existing information. It is aimed mainly at extending the OpenStreetMap's geographic coverage to the whole world.

The successful servicing of Wikipedia that is an online multilingual encyclopaedia caused the WikiMapia initiative to be emerged. However, WikiMapia is focused on preparing the information that is firmly related to a certain geographic location (i.e. about regions, lakes, cities, towns, etc.). It provides a map interface for browsing the content. The users are capable of creating the bounding boxes, or they can create more detailed polygons in the bounding boxes. Additionally, the users are capable of inserting title, description, and link to Wikipedia pages to provide more information about the item. Users are easily able to choose the language they wish.

The Google Maps with its geographic interface to search engine of the Google, makes users capable of creating the VGI in form of all-purposed personal map. These types of maps known as 'My Map' are a collection of polygons, lines, and points associated with the media items such as html documents, text, videos, photos, and so on. Such maps' contents could be searched by the other users who select the option of 'search user created contents'.

VGI is able to concern huge amounts of data, and it can find applications in different domains. Additionally, VGI becomes increasingly omnipresent, with the capability to create the Geotagged videos, photos, or messages directly from the smart phones whose GPS application has been enabled. (Goodchild, 2007c)

1.4 Background

The types and needs of current and potential users of geospatial technology in the government vary greatly. GIS users range from casual consumers of geospatial data and services to those employees who are GIS professionals charged with the support, development, use, and maintenance of data, applications, and services, whether they are delivered via GIS servers, data warehouses, the desktop, or mobile devices.

Government agencies collect and publish spatial and tabular data, which are used quite widely. In the past, GIS exclusively rely upon paper map as the source of

information. In recently years, a great deal of spatial information is available in digital format through Internet web sites. Some of these data are free. But most of them are so expensive. Usually data collection spend majority of all process cost and government try to produce it by better methods.

As Goodchild (2007b) stated, data collection is split into data capture (direct data input) and data transfer (input of data from other systems). There are two main types of data capture:

- **Primary data sources** are those collected in digital format specifically for use in a GIS project. Digitizing, Scanning, Other point measurements, Census data, GPS collections, Aerial photographs and Remote sensing data are the best examples of this type. Often, digital data for a GIS project is not available, so it must be created from other existing sources like paper maps. Digitizing is the process where features on a map or image are converted into digital format for use by a GIS. Scanning: Existing data printed on paper or PET film maps can be digitized or scanned to produce digital data. A digitizer produces vector data as an operator traces points, lines, and polygon boundaries from a map. Scanning a map results in raster data that could be further processed to produce vector data. Survey data can be directly entered into a GIS from digital data collection systems on survey instruments using a technique called coordinate geometry (COGO). Positions from a global navigation satellite system (GNSS) like GPS can also be collected and then imported into a GIS. Remotely sensed data also plays an important role in data collection and consist of sensors attached to a platform. Sensors include cameras, digital scanners and LiDAR, while platforms usually consist of aircraft and satellites. Recently with the development of Miniature UAVs, aerial data collection is becoming possible at much lower costs, and on a more frequent basis.

- **Secondary data sources** are digital and analogue datasets that were originally captured for another purpose and need to be converted into a suitable digital format for use in a GIS project. In other word, all primary data

from other projects are secondary data for new projects. The best groups of data exist for governments are available data from the governmental departments. Also Internet map servers, commercial data and data from other GIS users.

1.5 Problem Statement

As said above, there are two main types of data capture that are primary data sources and secondary data sources. But data collection based on these methods are time consuming, tedious, incomplete and expensive process. In addition, majority GIS data captured, take a long time and in emergency situation be out of use. The most important issues of traditional data collection are:

- **Cost of data collection:** As we know data collection can spend 15–50% of the total cost of a GIS project and if staff costs are excluded from a GIS budget, then in cash expenditure terms data collection can be as much as 60–85% of costs

- **Time of data collection:** Especially in emergency situation this issue make a big problem for governments and they spend more time for data collecting

- **Completeness of data collection:** Traditional data sources usually cover large area coverage, but inevitably there are gaps. Aerial photogrametry and remote sensing there exist a space in between the images (gaps) and this issue is always time consuming and expensive.

In other word, current practice in data acquisition, especially in road problem reporting is irrelevant due to time consuming and high costs. Road maintenance need many control groups and volunteered reporting in this area is so slow and expensive. In addition technological development (GPS, Satellite, Mobile phone, etc.) provide new tools to speed up the operation volunteered public problems reports. New

platform such as web-GIS, Google Earth and Geoweb has been proven as new way of communication and interaction between Citizen and Governments. The Volunteered Geographic Information System is one of the solutions.

Nowadays, citizens, who can compile and interpret, can be the sensor and the source of captured supplementary data. By using device, such as mobile phone, communication system, or other advanced technology, people can share what they have seen and felt based on VGI System. These information will include location, feature, time and images. It interest government to have useful information as this will assist the government in planning and evaluation. Although the data collected are free, fast and rich but without good quality. The government doesn't need to ask their employees to go out and survey as this information is provided by volunteered citizen. Traditionally web users like to share information of issues that relate to the government volunteerally.

There are many method, data type, model and scope to use VGI for data collection. This study attempt to design a Geowebsite for citizen to act as a sensor to volunteered report urban road problems and build up a Geovisualization platform for and conceptual Geotagging model and develop applications for Geotagging text and photo to explain problems. So main questions of this study are:

- How can we customize and modify Volunteered Geographic information System for urban road problems?

- How can we develop Geoweb for Geovisualization volunteered reporting of urban road problems using photos based on VGI?

1.6 Aims of Study

This study aims to provide an extensive background section that covers Geotagging and VGI as well as insight into current Geoweb technology. This includes the background, describing the techniques used to identify how we can use

this process for specific VGI process. This case study is to develop of application for volunteered reporting of urban road problems to local governments by using photos based on VGI System. Finally design a Geowebsite by using Google Map Maker as Geoweb recourse, import some supposition report and scratch, test, enhance and deploy the applications and the whole process involved.

1.7 Objectives of Study

The objectives of this study are:

1. To conduct user requirement analysis for indentifying a process of development VGI application for volunteered reporting for urban road problems using photos.

2. To design and develop a Geospatial Mashups using Geoweb 2.0

3. To provide a Geovisualization platform for citizen to act as a sensor by providing Geowebsite for reporting urban road problems.

4. To develop Geotagging applications for tagging texts and photos to volunteered reports by reporters.

1.8 Scope of Study

The study will basically involve web contents and functions, which are both the foundation of building Mashups. The web resource is Google map maker. In addition, use some APIs including a No formal APIs web resource that is HTMLs and some Web APIs like PHP server/local host and ect. Understanding the steps to building the Mashups is helpful for design, evolution and testing for the interface. Finally, the log-in page would be connected to the database.

1.8.1 Study Area

The study area is Majlis Perbandaran Johor Bahru Tengah (MPJBT). MPJBT is local authority in Johor state which administrates the central parts of Johor Bahru City. MPJBT covers an area about 303.48 km sq. lies within the Lat long of 2.5 N, 102.816667 E. The study area of this research is only urban roads. Figure 1.1 shows the study area of this research.

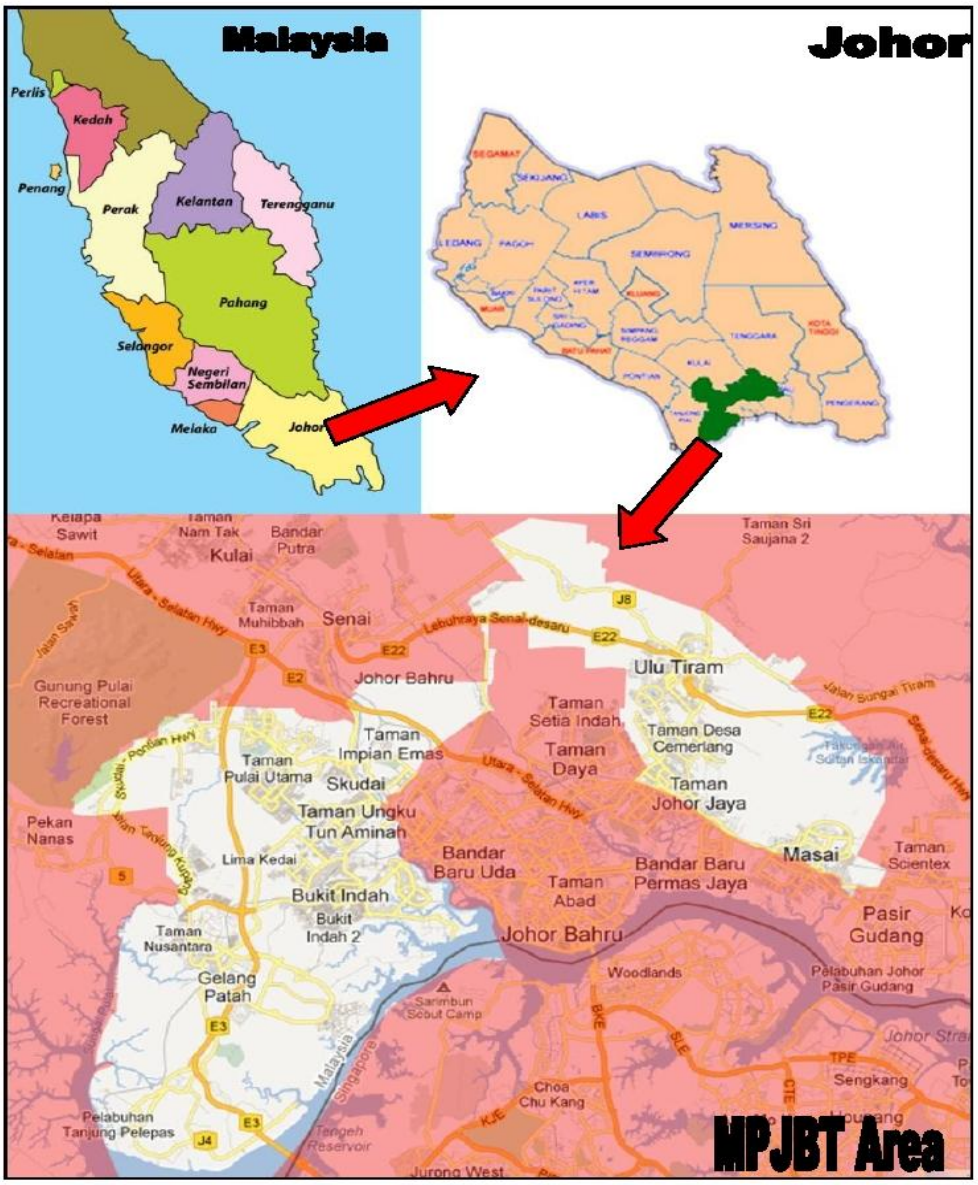

Figure 1.1: Study area, Urban Roads of MPJBT
(Source: http://www.map.google.com)

1.8.2 Data

The basemap which serves as the foundation for all subsequent and provide the location reference or context for an application. In this study, the basemap will be embedded from Google map into interface. The basemap as basic data includes:

- MPJBT shapefile boundary (.shp)
- MPJBT roads network (.shp)
- Johor roads network (.shp)

1.9 Research Methodology

The proposed methodology for this research is based on the problem statement, research aim and objectives previously stated. To carry out the study, several considerations must be made:

- Indentify the problems to solve and define the objectives to accomplish.
- Complete User Requirement Analysis using questionnaire as to know how people report urban road problems to government and how can we improve this application by using photos based on VGI System.
- Searching for web resources needed and evaluating each resource by its quality and usefulness per the project requirements by the programming interface and the requirements to mash it up.
- Develop a GeoMashup interface for Geovisualization of urban road problems data by MPJBT citizens.

- Develop the application for Geotagging to tag photos and texts to located problems.

- Publishing the contents and functions needed for the Geovisualization. Organizing the contents and function to basemap (Google Map), operational layers (MPJBT boundary and urban roads boundary) and tools.

- Developing database and connecting it to browser-side.

- Evaluation the applications and whole process.

1.10 Significance of the Study

VGI is contributed by or sourced from the citizens as a process of a two way 'citizen-to-government-to-citizen'. Through citizen contributions of VGI, governments are able to create potentially a two-way conversation with their citizens. It can be a sign of the government's responsiveness to the citizens' specific concerns. One of the best benefits of VGI to the government is receiving information about public problems. As mentioned above, this method is fast, free and useful. This study will use this potential volunteered in reporting roads problems. By using VGI government can receive a big amount of volunteered reports that is fast and free. It also serves as an avenue for the citizen to report their dilapidated roads easily.

1.11 Organisation of the study

To achieve the study objectives shown in section 1.7, the study is structured as follows. Chapter 2 review the concept of VGI phenomena, Web Mapping Service, Web 2.0 and Geography 2.0, Mashups, PPGIS and Neogeography in Geography 2.0 and Geotagging. Chapter 3 focused on methodology used for the study, while chapter

4 shows the results and analysis obtained. Chapter 5 concludes with discussion and recommendation. The structure of the thesis is shown in figure 1.2.

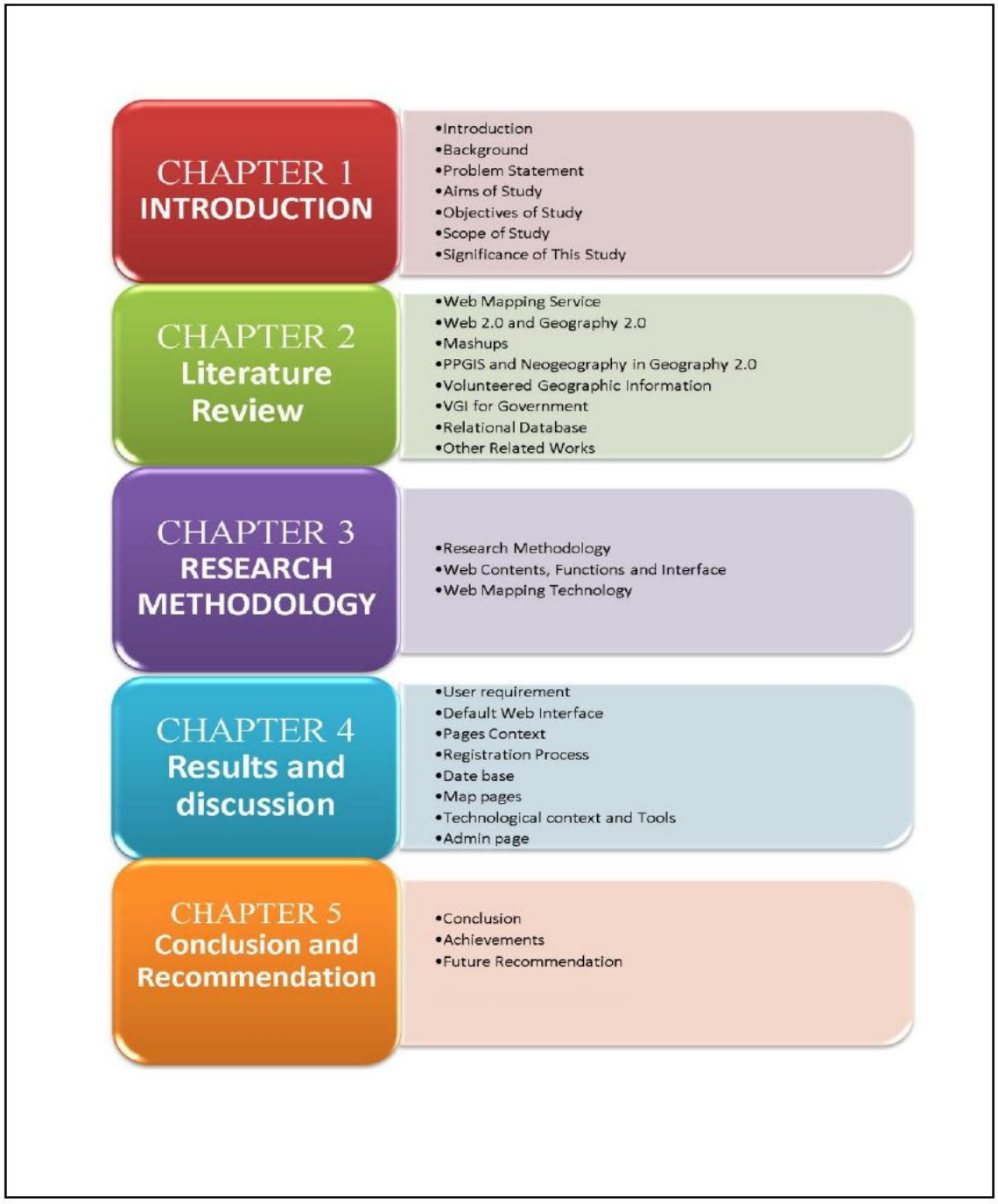

Figure 1.2: Structure of the Study

1.12 Summary

This chapter discussed number of relevant studies in relation to Volunteer Geographic Information. It also discusses the methods of data collection by the government and issues that relate to the traditional data collection. It also defined Aim, objective, scope, methodology and significance of the study.

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