

INTEGRATING GEOGRAPHICAL INFORMATION SYSTEM
WITH E-COMPLAINT SYSTEM FOR PUBLIC ASSET MAINTENANCE IN
LOCAL AUTHORITY

LEONG WAI SING

UNIVERSITI TEKNOLOGI MALAYSIA

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LOCAL AUTHORITY

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A thesis submitted in fulfilment of the
requirements for the award of the degree of
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Dedicated to...

*My beloved dad now rest peacefully in heaven,
Thanks for giving me inspiration and strength to me for accomplishing this writing.*

*My mum, brother and sisters,
Thanks for the morale support throughout the entire period in completing this research.*

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ABSTRACT

Local authorities in Malaysia are responsible for maintenance of public assets worth billions of Ringgit. Thus, local authorities should have well-established management system to ensure that those assets are appropriately maintained for the benefits of local communities. Asset condition is a critical factor in decision making during asset maintenance process. Public complaints serve as one of the information sources to obtain the latest asset condition information. Nowadays, most of the local authorities used e-Complaint system as a platform for their customers to lodge their complaints on the services and public assets. However, utilization of present e-Complaint system is usually in tabular form and does not integrate with Geographical Information System (GIS). This research aims to provide GIS visualization for authorities and their stakeholders for easier identification of vulnerable asset types and locations. In this research, ArcGIS 9.3 was used to develop GIS based e-Complaint system for managing, integrating and facilitating the visualization of complaint data and spatial data. The research area includes all public assets under the jurisdiction of Johor Bahru Tengah Municipal Council (MPJBT). Two platforms namely ArcGIS desktop and web-based GIS were employed to display the outcome of the developed system. This system was used to analyse MPJBT complaint database for the year 2010 from selected residential areas and allow administrators to determine the concentration of complaints as well as vulnerable asset types and locations. GIS visualization including maps, graphs and attribute tables serve as a better platform to provide a better understanding for analysis of current situations which facilitate future planning. As a conclusion, GIS based e-Complaint system can help to enhance the effectiveness and efficiency of public asset maintenance by determination of the concentration of vulnerable assets and socio-economic status through the interpretation of GIS visualization methods.

ABSTRAK

Pihak berkuasa tempatan di Malaysia adalah bertanggungjawab untuk menyelenggara aset awam yang bernilai berbilion-bilion Ringgit. Oleh itu, pihak berkuasa tempatan seharusnya mempunyai sistem pengurusan yang mantap untuk memastikan bahawa aset-aset dapat dikekalkan bagi kegunaan masyarakat tempatan. Keadaan aset merupakan faktor kritikal dalam membuat keputusan semasa proses penyelenggaraan aset. Aduan awam merupakan salah satu sumber maklumat bagi mendapatkan maklumat keadaan aset semasa. Pada masa kini, kebanyakan pihak berkuasa tempatan menggunakan sistem e-Aduan sebagai platform bagi pelanggan-pelanggan mereka untuk membuat aduan mengenai perkhidmatan dan aset awam yang disediakan. Walau bagaimanapun, penggunaan sistem e-Aduan yang sedia ada biasanya dibuat dalam bentuk jadual dan tidak diintegrasikan dengan Sistem Maklumat Geografi (GIS). Tujuan penyelidikan ini adalah untuk menyediakan visualisasi GIS bagi pihak berkuasa dan pihak-pihak berkepentingan untuk memudahkan proses mengenalpasti jenis dan lokasi aset yang terdedah kepada risiko. Dalam kajian ini, perisian ArcGIS 9.3 digunakan untuk membangunkan GIS berasaskan sistem e-Aduan untuk mengurus, mengintegrasikan dan memudahkan visualisasi data aduan dan data spatial. Kawasan penyelidikan termasuk semua aset awam di bawah bidang kuasa Majlis Perbandaran Johor Bahru Tengah (MPJBT). Terdapat dua platform iaitu ArcGIS desktop dan GIS berasaskan web yang digunakan untuk memaparkan hasil sistem yang dibangunkan. Sistem ini digunakan untuk menganalisis pangkalan data aduan MPJBT bagi tahun 2010 dari kawasan-kawasan kediaman terpilih dan kawasan pentadbiran yang dibenarkan untuk menentukan penumpuan aduan serta jenis dan lokasi aset yang bermasalah. Visualisasi GIS termasuk peta, graf dan jadual atribut sebagai platform adalah lebih sesuai untuk memberi pemahaman yang lebih baik serta analisis situasi semasa bagi memudahkan perancangan masa depan dilakukan. Sebagai kesimpulan, sistem e-Aduan berasaskan GIS boleh membantu meningkatkan keberkesanan dan kecekapan penyelenggaraan aset awam khususnya penentuan penumpuan aset bermasalah dan keadaan sosio-ekonomi masyarakat setempat melalui tafsiran kaedah visualisasi GIS.

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LIST OF ABBREVIATIONS

2D	-	Two-Dimension
3D	-	Three-Dimension
bmp	-	Bit Map Picture
CM	-	Corrective Maintenance
CPU	-	Central Processing Unit
CSS	-	Cascading Style Sheets
csv	-	Comma Separated Values
dBASE	-	Distributed Bandwidth Allocation/Sharing/Extension
DDR	-	Double Data Rate
et al.	-	and others
etc	-	et cetera
G2C	-	Government-to-Citizens
G2B	-	Government-to-Business
G2G	-	Government-to-Government
GB	-	Gigabyte
GHz	-	Gigahertz
GIF, gif	-	Graphics Interchange Format
GIS	-	Geographical Information System
GUI	-	Graphical User Interface
HTML	-	Hypertext Markup Language
ICT	-	Information and Communication Technology
ID	-	Identity Document
IEE	-	Internal Efficiency and Effectiveness
IIMS	-	Integrated infrastructure-asset management system
IT	-	Information Technology

JKR	-	Public Works Department of Malaysia
JPEG, jpg	-	Joint Photographic Experts Group
KB	-	Kilobyte
Km ²		Square Kilometer
MB	-	Megabyte
MBJB	-	Johor Bahru City Council
MHA	-	Malaysian Highway Authority
MMS	-	Multimedia Messaging Service
MPJBT	-	Johor Bahru Tengah Municipal Council
MS	-	Microsoft
NSW	-	New South Wales
PAS	-	Publicly Available Specification
PC	-	Personal Computer
pcx	-	Personal Computer eXchange
PM	-	Preventive Maintenance
png	-	Portable Network Graphic
RAM	-	Random Access Memory
shp	-	Shapefile
SMS	-	Short Message Service
SQL	-	Structured Query Language
STARS	-	Sistem Talian Aduan Rakyat Selangor
SUK	-	Setiausaha Kerajaan
UAEU	-	United Arab Emirates University
UK	-	United Kingdom
UML	-	Unified Modelling Language
URA	-	User Requirement Analysis
UWIC	-	University of Wales Institute, Cardiff
WGS 1984	-	World Geodetic System 1984

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CHAPTER 1

INTRODUCTION

1.1 Background

Nowadays, most people utilized public assets such as community buildings, food premises, streetlights and the road network in their daily life. The purpose of establishing public assets by government agencies is to make the communities' life easier. These assets are considered as a fundamental to the economic, social and environmental well-being of the community. In addition, public assets not only help to shape the character of local areas but also influence the quality of life for local people (Bolton Council, 2009). Local authorities are responsible for providing “sustainable” services and maintaining a life style for their communities (The Local Government & Municipal Knowledge Base, 2010a). Aberdeen Group (2006) stated that about 87% of respondents have reported that asset maintenance is very important to their organizations.

Therefore, these assets must be properly maintained so that they continue to support the delivery of a wide range of government services in fulfilling the social, economic and environmental needs of the community. Asset management by government agencies has been placed for many years to manage and ensure that these assets can deliver the services that the community required. Thus, local authorities need

to get the latest condition information of public asset for maintenance purpose using variety of ways:

- a) Complaint - Feedback and complaint about public asset from community.
- b) Schedule - Checking asset condition by following the schedule.
- c) Warranty period - Checking asset whether it reaches its expiry date.

e-Government is the use of information and communication technology by local government as a delivery channel to provide citizens, business partners and organizations with more convenient access to government information and services. Besides that, e-Government is not only delivering services and information to citizens, but the interaction and feedback of citizens are considered a vital part of e-Government. Recently, e-Complaint is widely used to communicate with customer dissatisfaction in many organizations. The number of complaints as a range of indicator measures the customer satisfaction of quality service delivery to citizens. Furthermore, complaints or feedbacks given by community provide the latest facility status to local government in order to improve the asset maintenance efficiency. Therefore, many local authorities had adopted the electronic version of complaint system to handle complaint cases and also to provide an easy way for citizens to lodge complaints against services of local authority (Abdishakur Awil Hassan, 2010). In addition, public complaints can have a positive impact on delineating necessary actions for the management of public assets in local authorities (Carvalho and Fidélis, 2011).

Government works deal with non-spatial data as well as spatial data. For example, local government owns many geographical assets such as roads, streetlights, traffic lights, buildings, bus stations, etc. These types of asset are best managed by a system that relates assets through maps and intelligent location processing. Therefore, Geographical Information System (GIS) can be used to capture, store, analyse, manage, and present data of public assets that are linked to location. However, GIS alone cannot solve all problems related to planning process, thus the integration of GIS and information and communication technology (ICT) tools can offer the spatial data infrastructure for developing decision making process (Amit Kumar, 2004).

Furthermore, GIS tools have become user-friendly and easier to use. For example, local governments use GIS to store spatial information and analyse problems about public assets and recommend solutions to improve planning, management, operation, and maintenance.

Complaint cases that relate to geographical asset are best managed by a GIS based e-Complaint system. The integration of GIS and e-Complaint system will enhance the performance of e-Complaint system to handle those complaint cases about public assets. This will enable users to perform spatial query, spatial analysis of concentration of complaint and vulnerable asset types in GIS visualization.

1.2 Problem Statements

The asset management process becomes progressively complex and difficult because public assets are increases in amount and value from time to time. Maintenance of public asset becomes one of the main concerns of local authorities. This is because maintaining of public asset is an important contribution to local priorities including education, health, social inclusion, community safety and sustainable development (Bolton Council, 2009).

Nowadays, many local governments using e-Complaint service as a channel to communicate with citizens about their dissatisfaction of the public facilities service provided. Feedback and complaint from public are very important to local government in order to improve their governance and services, and also maintaining public asset. In the past few years, many researches focused more on the design of online complaint management system to enhance citizen initiated contact (Abdishakur Awil Hassan, 2010; Razulaimi Razali *et al.*, 2011; Alcock, 2008) and complaint handlings (Gulland, 2007; Cho *et al.*, 2002; Gilly and Hansen, 1985; Brewer, 2007). However, there is still

lack of research done on the impact of e-Complaint system on the public asset maintenance especially for local authority.

Moreover, the concentration of complaints against the condition of public asset itself is the main concerns of the local authority for improving asset management in term of effectiveness of delivery service. In addition, complaints are used as one of the information sources to provide a useful indicator for the perception of public asset service quality as well as a tool for the evaluation of asset performance in terms of public asset management. Carvalho and Fid éis (2009) stated that complaints were used as indicators for the proposed analysis due to complaints themselves had their origins in the dissatisfaction of, and inconvenience caused to, local actors (citizens and institutions among others) in respect of the asset maintenance issues found in the local authority.

So far, most of e-Complaint systems used by local authorities in Malaysia did not integrate geospatial data and public asset complaint attribute information in an integrated system. Instead, geospatial data normally kept separately with complaint information in different departments. This has caused difficulties in managing asset maintenance since the present e-Complaint system normally provides information in tabular form only. Therefore, there is an urgent need to investigate the use of geospatial information to be integrated with the present e-Complaint system. Will such system able to improve efficiency and can be used for decision making with regards to public asset maintenance?

1.3 Aims of Research

The overall aim of this research is to integrate GIS with e-Complaint system in order to provide better information and service to local authority in terms of

maintaining the public asset as well as to enhance the effectiveness and efficiency of asset management.

1.4 Research Objectives

The specific objectives of this research are:

- i. To review the importance of public asset maintenance, and the development of e-Complaint system in the local authorities.
- ii. To integrate GIS and e-Complaint system to produce prototype GIS based e-Complaint system for Johor Bahru Tengah Municipal Council (MPJBT).
- iii. To test and validate the GIS based e-Complaint system with respect to public asset maintenance.

1.5 Research Questions

The objectives of the research are to review the e-Complaint system in local authority and to develop a GIS based e-Complaint system to enhance decision making with regard to public asset maintenance. For this purpose, several research questions were prepared and to facilitate research findings. Table 1.1 shows the research questions based on each objective of this research.

Table 1.1: Research questions

Objectives	Research Questions
I	<ul style="list-style-type: none"> i. What is public asset? ii. What is asset maintenance? iii. What is the importance of public asset maintenance in local authorities? iv. What is complaint? v. What is the purpose of e-Complaint? vi. Why we need e-Complaint in public asset maintenance? vii. What are the developments of e-Complaint system in local authorities? viii. How e-Complaint system is designed and used in local authorities?
II	<ul style="list-style-type: none"> i. What is the database design of integrated GIS and complaint database? ii. What is the system design of GIS based e-Complaint system? iii. How to integrate GIS and e-Complaint system?
III	<ul style="list-style-type: none"> i. How is the system tested and validated? ii. What are the effects of using GIS based e-Complaint system in dealing with public asset maintenance? iii. How many applications will be tested using the developed system? iv. How to test and validate the developed system can be made with respect to the applications of: <ul style="list-style-type: none"> a. Public asset maintenance b. GIS visualization c. Concentration/distribution of complaints d. Socio-economic

1.6 Conceptual Framework

Figure 1.1 illustrates the conceptual framework used in this research. There are number of ways used by local authorities to maintain public assets such as schedule, warranty period, public complaint and others. Public complaint is one of the important information sources to update and maintain asset. With the e-Government initiative, e-Complaint is one of the e-Services in which the government interacts particularly with complaints from the citizens. Nowadays, most of local authorities have their e-Complaint system, but the present systems only operating based on tabular information without integration with geospatial information. A number of studies on the use of GIS for asset maintenance have been carried out; however, those studies do not focus the integration of GIS with e-Complaint system. Therefore, a study is needed to investigate the use of GIS and its integration with the present e-Complaint system in order to improve decision making process with regards to public asset maintenance.

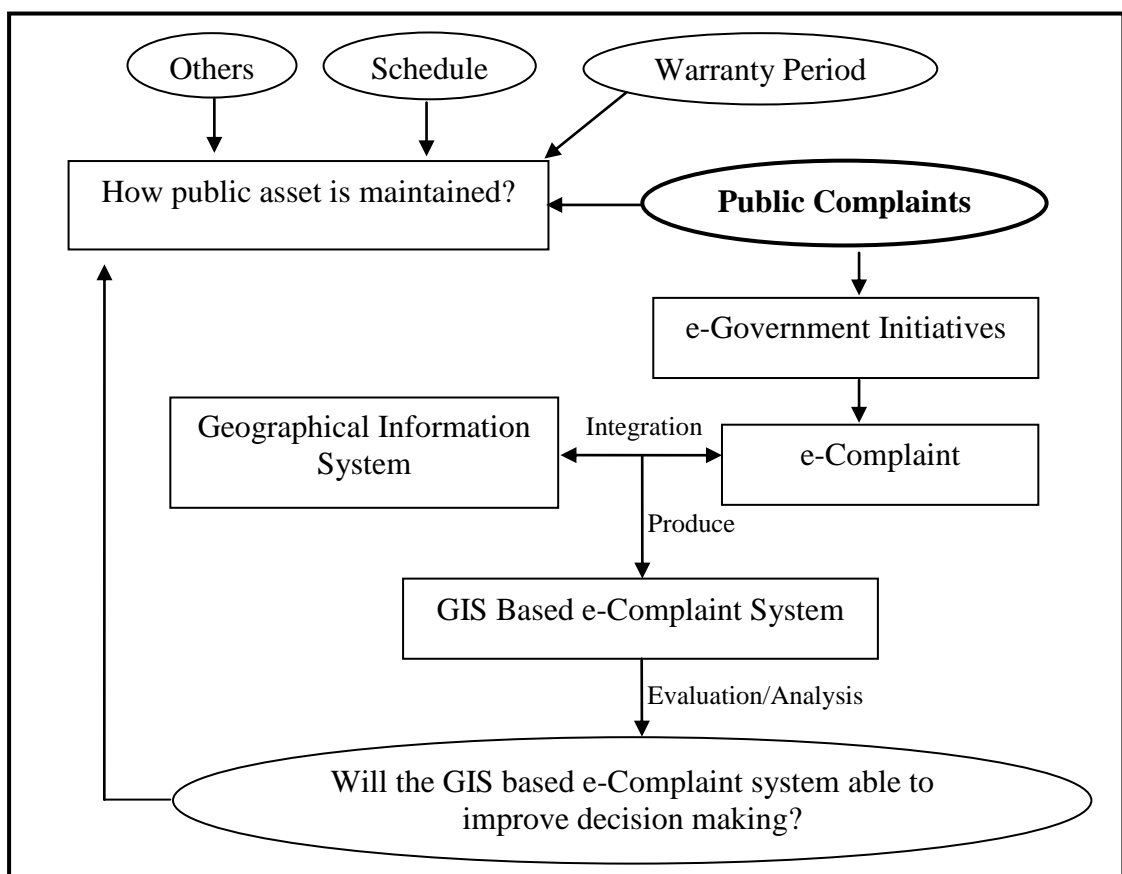


Figure 1.1: Conceptual framework for the research

1.7 Research Scope

The scope of this research may include the study area, data, hardware as well as the software being used.

1.7.1 Study Area

The area chosen for this research includes three residential areas known as Taman Universiti, Taman Bukit Indah, and Taman Perling, which are situated in MPJBT administrative boundary area. Figure 1.2 shows the chosen study areas. These three residential areas were chosen because the areas had a higher number of complaint cases in the year 2010 (Ali Ramli, 2011) and also consists of various types of public assets. This research is focused on the asset categories and asset types as shown in Table 1.2.

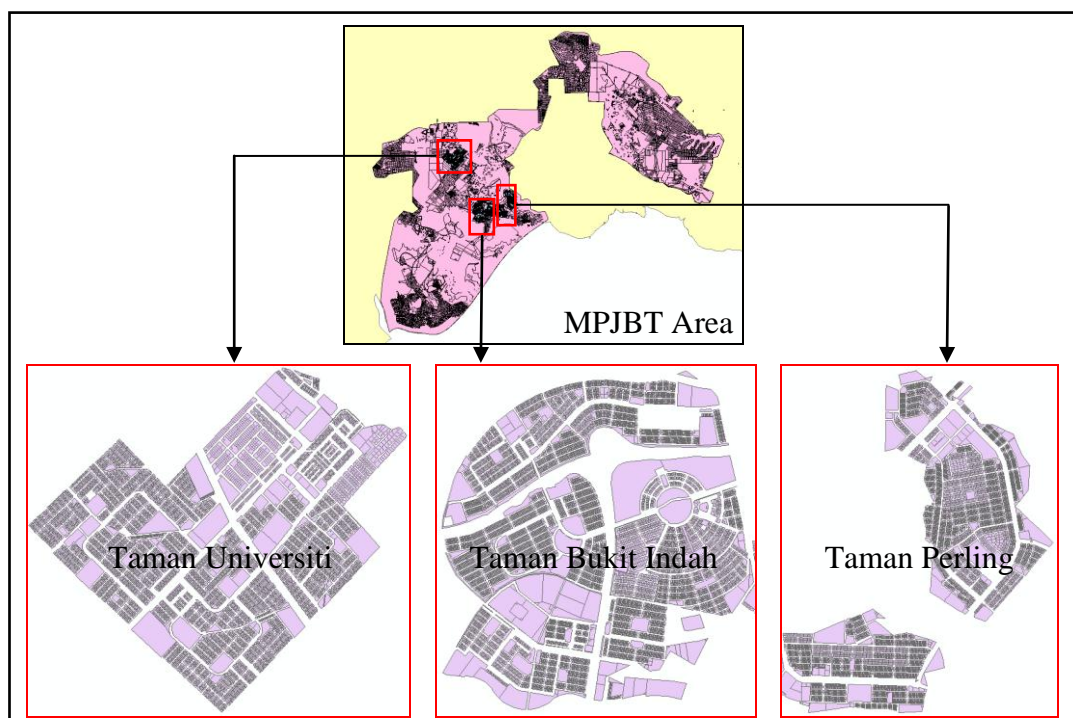


Figure 1.2: The study areas

Table 1.2: Asset categories and types

Asset Categories	Asset Types
Building	a) Community Hall b) Food Premises c) Public Market d) Public Toilet
Civil and Infrastructure	a) Bridge b) Bus Stop c) Parking Lot d) Public Phone e) Road f) Sewerage and Drainage g) Signage h) Street, Traffic and Decorative Lights
Landscape	a) Hut b) Plant c) Playground/Recreation Park

1.7.2 Hardware

The hardware used in this research is a personal computer with the following specifications:

CPU: Intel(R) Core (TM) i5, 2.4 GHz
 RAM: Kingston DDR3 4GB
 Storage Space: 120 GB
 Graphic Card: NVIDIA GeForce GT 330M
 Operating System: Windows 7 Home Premium

1.7.3 Software

The softwares used in this study are as follows:

- Adobe Dreamweaver CS3
 - used to create webpage by using html language.
- ArcGIS 9.3
 - used for data error checking as well as to modify existing geodatabase and map display.
 - used for database integration.
- MapGuide Open Source 2.2
 - used to develop web-based GIS.
- Microsoft Office Excel 2007
 - used for complaint data editing.

1.7.4 Data

The data used for this research are:

- a) Primary data
 - the design and development of e-Complaint system in local authority
 - complaint management procedure
 - asset maintenance procedure
- b) Secondary data
 - complaint database 2010
 - cadastral lots and road networks in shapefile

1.8 Innovation from Research

This research aims to review the existing e-Complaint system in MPJBT and to develop GIS based e-Complaint system to enhance the performance of public asset maintenance. GIS based e-Complaint system can be used to analyze complaint cases related to spatial features. A GIS based e-Complaint system allows administrators to determine the concentration of complaints, and vulnerable asset types and location using GIS visualization. GIS visualization including maps, graphs and attribute tables serve as a better platform to provide a better understanding and analysis of current situation which facilitates future planning. The developed system will also help to improve asset management efficiency by saving time, cost and manpower in the management process. In addition, it will help to prolong asset life cycle with regular and proper maintenance procedures based on complaints and analysis made using GIS database.

1.9 Research Methodology

There are number of procedures and phases of research methodologies adopted to complete the project. Figure 1.3 shows the outline of the methodology adopted for this research. The methodology is divided into six phases including Problem Formulation, Data Acquisition, Design of GIS Based e-Complaint System, Implementation of GIS Based e-Complaint System, System Testing and Validation, and Conclusion and Recommendation. Detailed description of phases can be found in the following sections.

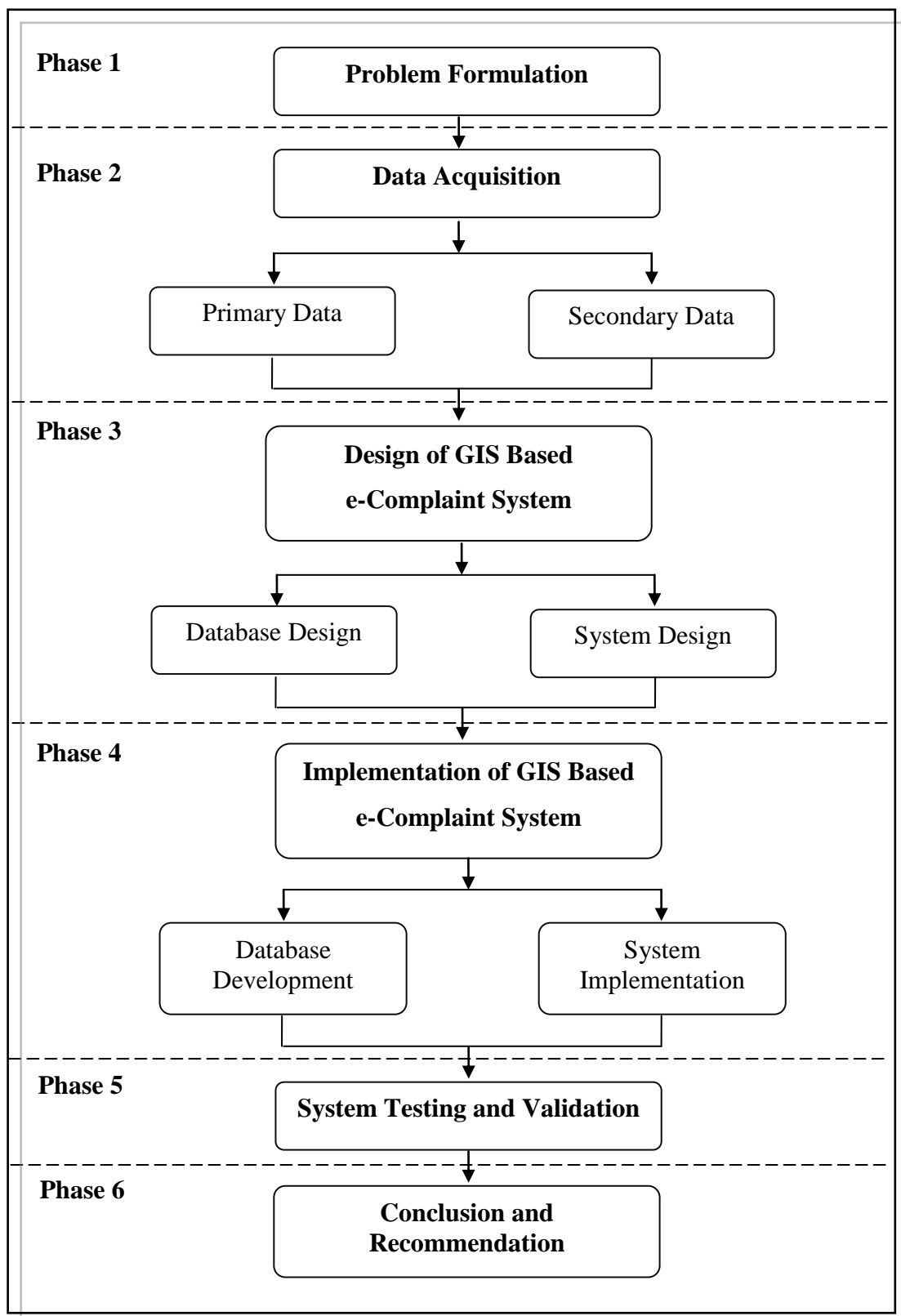


Figure 1.3: Phases in methodology used in this research

1.9.1 Problem Formulation

Problem formulation is the first stage of the research as to study the suitability and feasibility of the uses of GIS and e-Complaint for public asset maintenance in local authority. The activities include reviewing previous studies made by researchers, developments of e-Complaint systems in local authorities and searching relevant references to formulate problem statement, research aims and objectives, and scope of the study. In addition, the importance of public asset maintenance and e-Complaint in local authorities are also reviewed.

1.9.2 Data Acquisition

Data acquisition focuses on the collection of primary data and secondary data. Primary data such as e-Complaint system design, complaint management procedures, development of e-Complaint system in local authorities through interviews and questionnaires among various local authorities. Secondary data includes complaint database 2010, cadastral lot and road network in shapefile format of MPJBT area. All these data are collected from MPJBT and other relevant sources. Detail explanation on data collection activities is discussed in Chapter 4.

1.9.3 Design of GIS Based e-Complaint System

This stage is to develop the GIS based e-Complaint system to meet its requirements. The primary deliverable of system design is a technical specification document which includes the details of system inputs, outputs, user interfaces,

hardware, softwares and procedures. System design can be categorized into four categories namely Conceptual Design, Logical Design, Physical Design and Web Interface Design.

On the other hand, database design also plays an important role in this stage. An accurate and well-organized database requires a proper database design because it is very important for end users. Inappropriate database design will lead to the failure of the database. Database design is divided into three phases which are conceptual design, logical design and physical design. Detail explanations of system design and database design phases are discussed in Chapter 4.

1.9.4 Implementation of GIS Based e-Complaint System

This stage is divided into two parts namely database development and system implementation. Database development includes data restructure, database construction, coordinate system conversion, data cleaning, and creating domain and subtypes. The activities of system implementation include model builder creation, database integration, generate frequency statistics and relationship classes. Detail explanation of each activity is discussed in Chapter 5.

1.9.5 System Testing and Validation

This stage is to test the input, process and output of GIS based e-Complaint. Besides that, the developed system will be validated into two types of applications; public asset maintenance and socio-economic. Detail explanation on system testing and validation is discussed in Chapter 6.

1.9.6 Conclusion and Recommendation

This stage concludes the research based on research objectives, research findings, limitations of the research and recommendations for further research.

1.10 Thesis Outline

In this research, it covers seven chapters which are Introduction, Literature Review, MPJBT e-Complaint System, Design of GIS Based e-Complaint System, Implementation of GIS Based e-Complaint System, System Testing, Validation and Discussion, and Conclusion and Recommendation.

Chapter 1 Introduction

This chapter consists of introduction, research background, problem statements, research objectives and questions, scope, conceptual framework and innovation from research.

Chapter 2 Literature Review

This chapter focuses on two main parts namely related topics and related studies, and current issues based on e-Complaint services provided by various local authorities. Overall review is made on various topics including GIS, e-Government, e-Complaint and public asset maintenance.

Chapter 3 Johor Bahru Tengah Municipal Council e-Complaint System

This chapter focuses on the design and development of MPJBT e-Complaint system which includes input, process and output of the system. The advantages and disadvantages of the existing system and flow of complaint management are explained in detail.

Chapter 4 Design of GIS Based e-Complaint System

This chapter discusses the concept and the flow of GIS based e-Complaint system design and database design.

Chapter 5 Implementation of GIS Based e-Complaint System

This chapter discusses methods used to run the process of data editing, database construction, and GIS and e-Complaint system integration to produce the findings of this research.

Chapter 6 System Testing, Validation and Discussion

Chapter 6 discusses the input, process and output of the developed system. In addition, testing and validation of GIS based e-Complaint with respect to public asset maintenance and socio-economic applications are also discussed.

Chapter 7 Conclusion and Recommendation

This chapter concludes the issues discussed, research methods and findings, research limitations and recommendations for further research.

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