Chapter Three: Research Methodology

3.1 Introduction
3.2 Case Study
3.3 Data Collection Techniques
  3.3.1 Review of Literature
  3.3.2 Interview
  3.3.3 Observation
  3.3.4 Searching Record and Documentation
3.4 System Development Methodology
  3.4.1 Structured Systems Analysis and Design Method (SSADM)
  3.4.2 Prototyping
  3.4.3 Justification for Using the Selected System Development Methodology for CW-MSLD System
  3.4.4 Map Digitizing
  3.4.5 Entity Modeling and Normalization
  3.4.6 Data Process
    3.4.6.1 Data Flow Diagram (DFD)
3.5 Prototype Development Tools
3.6 Summary
Chapter 3

3.1 Introduction

The aim of this chapter is to justify a methodology for the development and documentation of this dissertation. This chapter reviews a number of system methodologies and modelling techniques utilized in CW-MSLD System.

3.2 Case study

Cadastral system is a very important system and it requires efficient data management tools. The case study has been used to understand how the cadastral system operates and interacts within the legal framework. An important objective of this research is to design and develop a web mapping prototype for CIS that will evaluate the effectiveness of DCDB and helps the author to define the strengths and weaknesses of the system before recommending any solution.

The term cadastral refers to legal, social, economic and culture in the country. The cadastral in one country may differ from another as the environment may be different. In addition, the case study in GIS application is different from other systems where about 80% of data collocated is obtained from the map. The map type, scale and resolution should be determined based on the map features that are needed to solve the problem and develop the application or system.

A cadastral system is a big system and it has attributes and geographic data. Before starting to develop a cadastral system by using GIS techniques, one needs to convert an analogue map to a digital map for the pilot area that is chosen. The hard-map scale 1:1000 for urban area is scanned in black-white, 300 dpi resolution by A0 scanner. This scanned picture file is inserted in Arc/Info and digitized on screen and digital map will be obtained after a
sequence of processing steps (digitizing steps is explained in detail on Chapter Five – Section 5.2.3). This research will not solve all cadastral system problems. The focus of this research is to develop a computerized information system prototype for the cadastral office in Tripoli-Libya. This cadastral office in Tripoli-Libya is used as a case study in this research thesis. This office presently uses a manually method to do work which leads to some of problems that the author had mentioned in the problem statement (Section 1.2).

Therefore, the author selected a subset from Tripoli city in Libya. The subset is approximately 30 km² and a pilot study was carried out in this area. The purpose of the pilot study was to develop a prototype cadastral information system that would be used in an urban environment.

### 3.3 Data Collection Techniques

Requirements capture or data collection techniques have been used to collect data. A technique is a set of steps and a set of rules which defines how a representation of an information system is derived and handled using some conceptual structure and related notation (Smolander et al., 1990). There are many techniques used to capture, collect, and process data to achieve all the objectives and goals of the project with clear understanding of the problem situation. The techniques used to collect data for this research are as follows:

#### 3.3.1 Review of Literature

A literature review is very important component of any research study. It is the use of ideas in the literature to justify the particular approach to the topic, the selection of methods, and demonstration that this research contributes something new (Hart, 1999). As mentioned in
Chapter two, the legal and concepts of cadastral system and Cadastre 2014 vision have defined the basic and standard of cadastral system. Furthermore, previous projects were reviewed in order to determine suitable features and functionalities for this research. The properties for previous projects have been summarized in Table 2.3.

### 3.3.2 Interviews

Interview is a way of finding out is information that is needed to develop the system. The analyst discusses the system with different stakeholders and builds up an understanding of their requirements. Stakeholders must be given a starting point for discussion. This can be a question, a requirements proposal or an existing system (Kotonya and Sommerville, 1998).

In this research, a total of three interviews were held with a number of staff members which included the Head of land register department, Registration officer, Surveyor. These interviews were particularly important to collect valuable information, which enabled me to set the system requirements more clearly. These are several important questions that the author asked during the interview to open the discussion:

**Q) How does the cadastral office deal with the customer?**

A) The cadastral office work with the notary who applies for his/her customer. The customer comes just when the certificate is ready to be collected. The customer needs to sign a documents before obtaining his or her certificate.

**Q) What are the required documents for registering the property (cadastral or estate)?**

A) The required documents to accept from the customer are as follows:

1- Original deeds,
2- Photocopy from contract between the seller (old owner) and buyer (new owner). The contract should be signed by two witnesses and notary (lawyer). The contract must be registered in courts. Many cadastral have ownership problems and it may have a “compliant file” from other person. In this case, the court does not stamp and give a register number for the cadastral to complete the ownership transfer.

3- The blueprint for deeds should be from 1/1/2000 year or above because the city has new planning and the deeds must be stamped from Urban Planning department.

5- Request letter saying the property is not mortgaged to government or a bank.

5- Application form filled by notary and it is signed by customer and Notary.

**Q) What are the types of ownership transfer’s for the properties (cadastral)?**

A) There are three types of ownership transfer for property (parcel/building) as shown clearly in a Table 3.1.

<table>
<thead>
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<th>Table 3.1: Types of Ownership Transfer</th>
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**Q) What are the more recurring problems when registering real estate or a cadastral?**

A) Actually, there are a lot of problems when you register some of the cadastres in the office. The first problem is parcel shifting because the old measure is done by people without referring to a surveyor and the oldest buildings in the city have been built without
plan. The second problem is the boundary disputes that happen between neighbours and there are many complaints and cases on this problem. The surveyor is able to fix this problem by measuring the parcels and carrying out a field survey for them. If agreement cannot be reached then the case goes to court.

**Q) What are the problems that the staffs face in their daily operation with the current system?**

A) There are two types of staff, i.e. the registrar in land department and the surveyor in survey department. In the land register department, the staff felt that it is difficult to find specific file during a short time. A duplicate file for a parcel is not safe. In additional, it is very hard to produce reports for any parcel cases, because they need to go through all the files to get data or information. In the surveyor’s office on the other hand it is difficult to use pencil and hard map to add and update parcel data on map. You can imagine how the map would looks like if alterations are made year after year.

**Q) What are your requirements for the new system?**

A) Since there are many weakness of using the manual system. The new system should address all the weaknesses in the current system. CW-MSLD System should enable the staff to search for parcel information by clicking the parcel on map or entering parcel number. The system is able to register a parcel based on a particular report from the survey department. The system should enable the staff to transfer the ownership information. Finally, the managerial staff should be able to issue a cadastral certificate for the registered cadastral.
3.3.3 Observation

An observation can give useful insight into problems, work conditions, bottlenecks and methods work (Avison & Fitzgerald, 2006).

A few visits were made to the Tripoli cadastral office concerned to make personal observation on the existing system and the process flow that occurs within cadastral surveying. Really, it is difficult to understand surveyors without observing them through their work at office such as measure parcel area and determine parcel boundaries.

3.3.4 Searching Records and Documentation

Searching records and documentation may highlight problems, but the analyst has to be aware that documentation may be out of date (Avison & Fitzgerald, 2006). Since the Tripoli cadastral office is a service office, it has a few types of application forms to be completed by the notary and there are specific records used for storage on real estate. These application forms and records had guided the developer to design the system database and interfaces more clearly.

3.4 System Development Methodology

Methodology is defined as the analysis of the procedures used in a particular field. Avison and Fitzgerald (2006) elaborate that a methodology will consist of phases, and sub-phases, which will guide the systems developers in their choice of the techniques that might be appropriate at each stage of the project and also help them plan, manage, control and evaluate information systems projects.

It is very important to define the method which should be used to do the research in the early stage. There is a need to apply a formal systems methodology in carrying out the
system development in this research. The author will follow the Structured Systems Analysis and Design Method (SSADM) with prototyping model as the main guide for development in this research.

The Research methodology defined here is based on the methods, techniques, and tools used to capture and collect analysis data from a variety of information sources. Define the system requirements by analyzing existing systems. This is done in the literature review.

### 3.4.1 Structured Systems Analysis and Design Method (SSADM)

SSADM – waterfall model is a conventional approach that enforced discipline and systematic manners. It is commonly used in developing computer projects in UK. SSADM is a highly structured and documented methodology and there are five phases.

**i) Feasibility Study**

A preliminary study is undertaken before the start of this project. This phase looks at existing systems and highlights the main problems and presents alternative solution. Subsequently, the management studies the alternative solution from different perspective and it looks at technical, human, organization and economic cost. The project then it agree to the next stage of developments i.e. requirement analysis.

**ii) Requirements Analysis**

This phase looks in more detail at existing systems to determine the problems with current methods and come out with requirements for the new system. The information and data from users are obtained by using certain data collection techniques (*see Section 3.3 in this chapter*).
iii) System Specification

In this phase, the analyzer defines the user requirements and carries out the technical analysis to find out how the new system can be improved. Furthermore, the functional and non-functional requirements are defined and the data model and data structures are constructed and explained in detail.

iv) Logical System Specification

In this phase, technical system options and logical designs are defined in parallel. In technical system options, hardware and software requirements are defined pertaining to performance, security, and services level requirements that the system wishes to meet. For the logical design enquiry processing and system dialogues are defined.

v) Physical Design

At this phase, a physical database design is created by converting the logical data model to the physical data model. In additional, a set of program specification is further created.

3.4.2 Prototyping

The prototyping method was formally introduced to the information system community in early 1980 to overcome the weakness of structured analysis methods. Haag et al.(2006) state that prototyping is the process of quickly putting together a working model “a prototyping” in order to test various aspects of a design illustrate ideas or features and gather early user feedback. Prototyping is often treated as an integral part of the system design process where it is believed to reduce project risk and cost.

The main purpose for developing prototype is to help users and developers understand the requirements for the system, which are requirements elicitation and requirements
validation. The analyst builds the prototype and evaluates it with the user. Next the analytic system development would to see if it fits the user requirement.

3.4.3 Justification for Using the Selected System Development Methodology for CW-MSLD System

After having studied the system development methodology and techniques which should be used for development of the system, the developer found that a combination between SSADM and prototyping is a good system development methodology. That because the user requirements are fuzzy and the system is complex.

Firstly, prototyping is used to determine the initial or basic requirements for the system i.e. the user requirements. Prototyping enables easy communication between the users and the developer and therefore it can reduce communication problem that commonly exist in requirement gathering. During this period, the user can give a feedback to the developer about their ideas and the system interfaces for the proposed system, this lead to reduce the time and costs for developing the system and improve system usability.

In this way, the delivered system will be more accurate on the user requires. One the main weakness for this method is the management problem whereby it is very hard to set deadlines for completing the system.

Secondly, SSADM becomes a structured methodology when it is combined with the prototyping model; the resulting approach on system development is more disciplined and provides more guidance. This step by step approach gives a clear vision and understanding of the various stages that we need to conduct during developing the system. SSADM allows
the correction of development errors before it proceeds to the next phase and hence there will be fewer errors at the final phase. Figure 3.4 shows SSADM and Prototyping for CW-MSLD System.

![Diagram of SSADM and Prototyping for CW-MSLD System](image)

**Figure 3.4:** SSADM and Prototyping for CW-MSLD System

### 3.4.4 Map Digitizing

This research has two types of data: non-geographic data (attribute data) and geographic data (special data). Non-geographic for land registration such as owners’ name, description...
of building, type of owner and so on which can be captured and collected by using the above technique. Geographic data can be obtained by using the map digitizing. Map digitizing is a process for converting raster data (map) into vector data (digital form) by using GIS software like Arc/Info. Map data used by GIS are collected from existing maps, aerial photos, satellite image, and other sources. The map data for this research obtained from:

- Shari Az-zawiyah Street satellite image (QuikBird resolution: 60cm) from Libyan Center for Remote Sensing & Space Science.
- Shari Az-zawiyah street hard copy map scale (1:1000) from Libyan Survey Department.

This transformation from raster map to vector map allows the storage, retrieval, and analysis of the mapped data to be performed by the computer. Chapter 5 will explain more about the map digitizing and how to analyze it.

### 3.4.5 Entity Modeling and Normalization

Entity Modeling or Entity Relationship Model (ER-Model) is a common technique used to model data requirements for information system in many methodologies in a top-down approach in graphical form called ER diagram (Bagui and Earp, 2003). This approach is commonly used in relational database design (RDBMS) but there are limitations to the ER model. ER model enhanced (EER) to include superclass/subclass relationships, type inheritance, specialization and generalization, and constraints. The Normalization process comes after having completed the ER-Model. Normalization is a set of rules to eliminate data redundancy and to remove potential update anomalies which arise from inserting, modifying and deleting data (For more detail see Chapter 5- Section 5.3.1.2).
3.4.6 Data Process

3.4.6.1 Data Flow Diagram (DFD)

DeMarco (1979) states that DFD as a network representation of a system. The system may be automated, manual, or mixed. The DFD portrays the system in terms of its component pieces, with all interfaces among the components indicated.

DFD is one of the essential techniques in structured system methodologies and adapted by others methodologies. DFD is a graphic diagram for representing data process flow in the analysis phase. It makes dissections between users and developers very easy and users can understand problem domain and clear dissections will lead to good development of the system requirements. (*For more detail see Chapter 5- Section 5.2.2.1*).

3.5 Prototype Development Tools

Olle et al. (1991) defined the tools as a computer-based application which supports the use of a modeling technique. Tool-supported modeling functionality includes abstraction of the object system into models, checking that models are consistent, converting results from one form of model and representation to another, and providing specifications for review.

i) **Microsoft Word** is main word processing software. It is used for documents.

ii) **Microsoft Visio** is a drawing software used to draw DFD of the system. Since several DFDs of the system need to be drawn, it is easier to use Visio than using the traditional way of drawing the DFD by using the Microsoft Word.

iii) **Microsoft Excel** is used in producing the bar graph.

iv) **Arc/Info** is the complete GIS product to build a comprehensive desktop GIS. As a de facto standard for GIS professionals, ArcInfo provides tools for data integration and management, visualization, spatial modeling and analysis, and high-end cartography.
It supports single-user and multi-user editing and automates complex workflows. This software is from ESRI and it used to gather, build, manage data, and analyze geographic relationships, discover new information, and produce publication-quality maps for cadastral office which can be used as cadastral index map (ESRI, 2005).

v) **MySQL** is an open source RDBMS that relies on SQL for processing the data in the database. MySQL provides APIs for the languages C, C++, Eiffel, Java, Perl, PHP and Python. MySQL is most commonly used for web applications and for embedded applications and has become a popular alternative to proprietary database systems because of its speed and reliability (Syreching, 2002). In this research, the author will use MySQL 4.1 to create non-geographic database and manage all database in the system.

vi) **PHP** is a reflective programming language originally designed for producing dynamic web pages. It is server-side application software but it can be used from command line interface or in standalone graphical applications and it is open source language (Converse, T et al., 2004). The developer selected PHP 5.0 as the main programming language to develop the prototype in this research.

vii) **JavaScript** is an interpreted programming or script language from Netscape. It is used in web site development as server side to do such things as automatically change a formatted date on a web page, cause a link to a page to appear in a popup window and cause text or a graphic image to change during a mouse rollover (Veer, 2005).

viii) **Apache 2.2**: The Apache Software Foundation (ASF) is an open-source software projects. The Apache HTTP is a project of ASF aimed at creating a robust, commercial-grade, and freely-available source code implementation of an HTTP (Web) server (Mohammed, 2002).
ix) **MapServer 4.10** is a CGI program that sits inactive on your web server. When a request is sent to the 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. It is open source software. It can be greatly extended and customized, and it can be built to support many different input data formats and output types. Figure 3.5 below shows a typical of MapServer application.

![Diagram of MapServer](http://ms.gis.umn.edu/new_users/msappdiagram/view)

**Figure 3.5** Typical of Map Server application

x) **Rosa Applet** is open source that designed with web mapping application to improve server-side web application by adding simple features on the client-side.

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1 Source: http://ms.gis.umn.edu/new_users/msappdiagram/view
3.6 Summary

This chapter has discussed the research methodology, research techniques, and research tools which are used in this dissertation. Research methodology produces the main guidelines for developing CIS in the cadastral office by using GIS techniques. The research techniques are used to collect and capture requirements from end users who were interviewed and observed during work time. Map digitizing is used for data conversion and to create DCDB. The literature review is used to study the previously related research, and other techniques for analysis and process data. The research tools are software package used to develop the computer system.