Chapter Five: System Analysis and Design

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5.1 Introduction

This chapter does further study of the proposed system analysis and generate the possible models. In analysis phase, the analyzer can understand the needs of the system requirements. The analysis process has to be done properly because many errors in developing systems come from insufficient analysis. Then, it discusses data model design for the system based on the user requirements to develop the fully functional system. In the next stage, the system architecture for system prototyping will be produced.

5.2 System Analysis

The main two components in the system analysis are requirements specification and requirements structuring. Requirements specification is divided into several parts: user requirements, hardware requirements, software requirements, functional requirements and non-functional requirements.

DFD, Data Dictionary, and EERD are techniques used to represent requirements structuring and it gives a clear description of the system for both user and system developer.

5.2.1 Requirements Specification

Requirements specification is done to help the author to understand the system and it can be used as reference for developing the CW-MSLD System. Once the author can determine the requirements for the proposed system then the development of the system can be done successfully.

5.2.1.1 User Requirements

- CW-MSLD System should enable the staff to search the parcel or building by selected the parcel from map or enter Parcel ID or owner’s name.
The user interface should be simple and easy to use.

The system is available in a website in an Internet environment.

The system should enable the staff to register and update real estate data.

System should enable the staff to transfer ownership.

Staff can update the customer “owner” information.

System should enable the user to see some information on the map like parcel areas and the public places name’s and area.

System should be able to issue cadastral certificate to real estate “cadastral”.

System should be able to register the staff who issued the cadastre certificate.

### 5.2.1.2 Hardware Requirements

To develop the CW-MSLD System, the author recommends the following hardware to support this system. The following are the minimum requirements for this project:

- Intel Pentium IV Processor 1.7 GHz.
- 20 GB hard disk.
- 512 MB RAM.
- 4.7 GB DVD-Rom drive.
- 17” SVGA monitor (helps to do map digitizing).
- Mouse.
- Keyboard.
- Color Printer.
- Scanner for scanning the hard map.

### 5.2.1.3 Software Requirements

The required software for developing this system is listed in Chapter Three (Section 3.5 Prototype Development Tools).
5.2.1.4 Functional Requirements

Functional requirements describe what a system does or is expected to do. It is often referred as its functionality (Bennett et al., 2002). It is the activities that the system must perform. The basic functional requirements in this system are:

- Allow the registered staff to login into the system.
- Allow the staff to register building or parcel fund on the cadastral map only.
- Allow the staff to add new owner.
- Allow the staff to transfers ownership.
- Allow the staff to check registered information before issuing a certificate.
- Allow the manager of land register department to issue certificate.

5.2.1.5 Nonfunctional Requirements

Non functional requirement are those that describe aspects of the system that are concerned with how well it provides the functional requirements (Bennett et al., 2002). The basic Non functional requirements in the system are as follows:

- The user interface should be simple.
- Ease to use of the Graphical User Interface (GUI).
- Able to connect to WAN network via Internet environment.
- Security considerations: an authentication and authorization process is vital to CW-MSLD System to protect its use from unauthorized users to access the cadastral information.

5.2.2 Requirements Structure

Requirements structure is a method which structures the data and information gathered and it gives a clear description of the current system operations and the new system requirements by modeling it in diagrams form for easy determination and understanding.
The author has defined two structuring methods for this research which are process and conceptual modeling.

5.2.2.1 Process Modeling

Process modeling represents the processes involved in a system graphically in the form diagram. Functional decomposition is the basic technique for process modeling i.e. it breaks a complex problem into more successive layers of more manageable and comprehensive pieces, resulting in a hierarchically structured function chart that describes the problem and/or solution (Borysowich, 2007). As we have mentioned in chapter three, DFD techniques have been selected to represent process modeling for CW-MSLD System. DFDs show how data moves through an information system but does not show program logic or processing steps (Shelly et al., 1998).

i) Element of Data Flow Diagram (DFD)

There are four elements used to represent data process in DFD. These are representing processes, data flows, data stores, and external entities. There are different superficially versions of DFDs but in practice the difference are relatively miner. This research use Gane and Sarson version.

ii) DFD Level

The DFDs show the data process in different levels according to degree of abstraction required. The high DFD level is called context diagram. It is contains the main process and shows the interfaces between the system under development and the external entities. The next level called the level1 gives more details compared to high level. The Level1 process should describe only the main functional areas of the system. Next, the Level2 diagram comes to describes more details to than the level (level1). DFD has top-down characteristics.
iii) Data Dictionary

The data dictionary defines every data flow (arrow), process, external entity, and data element that the researcher has used in DFD. In other words, Data Dictionary is an organized description list or table of data elements, data structures, data flows, and data stores. *Complete DFD diagrams and Data dictionary for CW-MSLD System are stated in Appendix I and II.*

5.2.2.2 Conceptual Data Modeling

Conceptual Data Modeling is the first stage in the process of Top-down database design. This model is used to show definitions, structures and relationships between data. Data model is important and it needed for data elements in database designing, programs and even the user interfaces. It should make it easy to see the overall picture of the organization.

An Enhanced Entity Relationship model (EERD) is used in this research. That is because the cadastral system is very complex and a normal ERD can not represent the system clearly. EERD can represent such as generalizations and specializations (class hierarchies). The notation version used for this is BACHMAN notation. *To see a full EER diagram for CW-MSLD System please refers to appendix III and Table Structure appendix IV.*

5.2.3 Map Digitizing

Map digitizing is the main process used to convert an analog map into a digital form (X, Y coordinates) by geographic information system (GIS) software. At this point, the map can be stored and displayed in a computer. The real world objects are represented as shapes “Polygon”, lines “Arc”, and points “Node”. Using digitizing software requires precise
pointing for selecting objects and the accuracy of work is very important in the digitizing process. The selection tools are mouse and screen for presenting map.

In this research, the developer scanned the map and is used the mouse and screen to digitize the map manually (one by one) by using Arc/Info software. The main steps for digitizing a map are as follows:

5.2.3.1 Map Layers Definition

The real world is very complex and very wide and maps in general are not able to project or describe in detail all the features found in it. Maps layers however are able to identify human problem in relation to objects and physical features. The main features in this research are parcels, buildings and roads. The roads help to describe the boundary and address of a parcel.

5.2.3.2 Map Projection Definition

According to Boslstad (2005), maps are flat, but the surfaces they represent are curved. Projection is processing to transfer three-dimensional space onto a two dimensional space. In order to transfer the information onto a flat surface one can convert the geographic coordinates into an X and Y coordinate system, where X is longitude and Y is latitude. Figure 5.1 shows the representation of map projection.
The coordinate system in map source is used in UTM projection. UTM is a commonly coordinate system used for large scale and it UTM divides the earth into 60 Zones and the standard line is a meridian (Mitchell, 2005), the study area “Tripoli” is in zone 32. Figure 5.2 shows the representation of UTM zone map.

5.2.3.3 Map Geo-referencing Definition

The first step in the digitizing process defines the geo-reference point for the area since all information must be linked to the Earth’s surface. The geo-reference in this study is taken from intersections of grid line for four corners of map scale 1:1000 for urban area this is appended in appendix Input Data Map (VI):

i) Identify x, y coordinates in meters.

ii) Registering a map is done by clicking on control points (TIC) on the map from screen and transfer scanned map to real coordinates. The control points refer to longitude and

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1 *Geo-reference*: The word was originally used to describe the process of referencing a map image to a geographic location.
latitude and this is saved in a table. Figure 5.3 shows the reference control pointes coordinate for a pilot study in this research study.

![Figure 5.3: TIC points for Shari Az-zwiyah subset (Tripoli-Libya)](image)

### 5.2.3.4 Digitizing and Topology

The Digitizing process starts after the user has scanned the map and registered it. The following steps are carried out:

i) Zoom in to specific areas on screen and trace the objects “features” as points, lines or polygon on the map. For example in the parcel layer (coverage file), we trace the boundary of parcel to draw line from the center of line boundary on map. The result will be a new polygon.

ii) Identify the ID for every parcel and building that is stored in the database.

iii) Arc/Info software allows to correct and create geographic object

iv) The topology used represents the structuring of coordinate data that answers the following questions and is explained by this example below.

- Where is it? Location (X, Y coordinate).
What is it next to? Adjacency (line 1 goes from node a to node b, Polygon P1 is left line 2 and right line 1). Figure 5.4 shows the illustration of topology idea.

Is it inside or outside? Containment (Polygon P1,P2).

How far is it from something else? Connectivity (point a connect to point b).

Figure 5.4: Illustration of topology idea

5- The digitizing process often has errors and Arc/Info have provides help to correct error and cleaning up coverage file.

6- Ending of digitizing, result in three files. For example in Parcel layer have parcel.shp, parcel.dbf, and parcel.shx.

- shp file (geometry): stores geographic objects such as parcel shapes “polygon”.
- dpf file(database): stores data about geographic objects such as Parcel ID, parcel area ...
  etc.
- shx file: stores index number that links parcel.shp file and parcel.dpf file.

By creating these three files, the layer will be ready to link with other attribute information like the owner data file.

5.3 System Design

In the logical design and physical phases, the author is concerned on the creation of the CW-MSLD System while implementing the requirements and constraints gathered during the analysis phase. The system design is separated into two parts:
5.3.1 Logical design

Logical design is the development of the CW-MSLD System based on understanding of how the system will operate. During this phase, the users will know how the system will look like. The author will described all the systems’ inputs, outputs and interfaces that will appear in the system and display through diagram a brief view of the proposed system to the user.

In logical design, the author is only concern in designing and developing interfaces “web pages”, reports, and message dialogues based on user requirements and priorities to create the interfaces, reports, and message dialogues.

5.3.1.1 System Interface Design:

The produced webpage and reports would be need in new CIS. Interface design is very important for the user because the user often judges the quality of the system with it. The system has a friendly user interface which is designed by using GIS techniques. This interface has real coordinated cadastral map that provides useful and relevant information for the users. The cadastral map is interactive map. The three layouts interface design is given below:
Figure 5.5: Interface layout for Cadastral Index Map web page

Figure 5.6: Interface layout for Register and Update Estate
To see a full scale of User Interface Design, please refer to appendix V- CW-MSLD System User Guide.

5.3.1.2 Databases Design (Logical Data Modeling):

In the first stage of logical modeling the conceptual schema will map the logical schema. The conceptual schema done in the analysis phase and the author designed EERD data model is capture the essential data that needed to be stored and the relationships between elements. But this is not the final phase for database design. The logical schema becomes to a normalized representation of the conceptual schema by minimizing redundancy in the data and leveraged relational concepts.

i) Normalization

“Normalization is a formal technique used to evaluate the quality of a relational database schema. It usually determines whether a database schema contains any of the “wrong”
kinds of redundancy and defines specific methods to eliminate that redundancy”, (Satzinger et al., 2004).

The 1NF, 2NF, 3NF, and BCNF steps of Normalization were applied onto data model relations whenever necessary. The database relations, attributes, and primary keys were determined at the end of this operation. Therefore, the tables are normalized.

ii) Table Structure

Table structure contains information of the fields and data type of each table. Besides that, it also shows the relations between each table and the access type, size, record description, data type and range of each data used in the database. A full scale of table structure can be referred in appendix IV.

5.3.2 Physical Design

Physical design is often concerned with databases, programming and development of the system environments. During this time, the author tries to design the most appropriate design that will satisfy the requirements gathered by the users and their system internal and external environment.

5.4 CW-MSLD System Architecture

The selection of system architecture or development approach can be critical in ensuring that a system will meet changing demands of an organization. Therefore, scalability and the total cost are important factors which should be considered here.

The system architecture for implementing this project is web mapping client/server application system. This system architecture is chosen based on system analysis and CIS
framework understanding. The CW-MSLD System Client-Server architecture is depicted in Figure 5.8.

![Figure 5.8: CW-MSLD System Architecture](image)

CW-MSLD System architecture consists of three main tiers that show the interaction between application function that is transmitted. The tiers are client side (users), web server apache (middle tier), and server side (information management tier). The server side manages all system parts which are map server (CGI), PHP script, map files and database (GIS data and Non GIS data).
5.5 Summary

In this chapter, the researcher has defined and specified the data requirements, structure, and system design. Requirements structure has been defined by DFD, data dictionary and EERD techniques. Besides that, the map layers have been defined and digitized. By setting a clear requirement for the system it can prevent determine the scope in future and it can be used to measure the performance of the system and find out of the system developed had met with the previous planned or set requirements.