

Figure 1.2: Workflow for the Adjustment of Cadastral Network.

c) Running Adjustments

Adjustment calculation network will be performed to determine the coordinates of control station and all points in the network by performing the least square adjustment. The adjustment was done by setting some acceptance criterion for Chi-Square test, error factor and error propagation, residual and standard deviation of the observation and the tolerance of misclosure for 1st Class or 2nd Class surveys. Weight to input data can be done by both independently and by category method.

A minimum constraint method will be applied as the simplest technique used in Least Square Adjustment. The StarNet program is for a general purpose and rigorous least squares analysis program designed to adjust 2D and 3D survey networks.

d) Analysis of Adjustment Output

The output consists of adjusted coordinates files and statistical analysis of the adjustments.

a. graphical facilities

- i. To plot the network including error ellipses of the adjusted points and relative error ellipses between stations.

b. Output listing

- i. Observations/data input.
- ii. Location/corrections gross blunders in input file.
- iii. Strength of the observations data analysis.
- iv. Determination of the accuracies of the coordinates.

c. Adjustment Statistical analysis which include

- i. Adjusted coordinates.
- ii. Report on Chi-Square Test whether adjustment failed or passed If Chi-Square Test at 5% level passed lower/upper bound, the result will accepted.

1.7 Report Chapters

This report is arranged in six Sections. **Chapter 1** deals with the background and the objectives of this project. The scopes as well as approaches that have been utilized in undertaking the project are also reviewed.

In **Chapter 2**, reviews the cadastral survey system in Malaysia. It starts with the ideas and clear explanations of existing cadastral system. Then, briefly introduces about Digital Cadastral Database and a new Cadastral Coordinated System in Malaysia. The last part of this chapter elaborates on the Third Class survey data.

Chapter 3 deals with the Least Square adjustment technique in adjustment of cadastral network.

Chapter 4 presents the cadastral network adjustment and the results achieved from the adjustment. The Least Square Adjustments carried out and discuss the steps of the adjustment procedure in detail with some criterion of acceptance.

Chapter 5 deals with the analysis of results for this project. This section provides information on adjustment process including the adjustments result of third class data.

Chapter 6 concludes the overall adjustment process on dealing with Third Class survey. Recommendations for further study are also highlighted.

CHAPTER 2

OVERVIEW ON THE CADASTRAL SURVEY SYSTEM IN MALAYSIA

2.1 Introduction

A Cadastre is normally a parcel based, and up-to-date land information system containing a record of interests in land (e.g. rights, restrictions and responsibilities). It usually includes a geometric description of land parcels linked to other records describing the nature of the interests (Figure 2.1), the ownership or control of those interests, and often the value of the parcel and its improvements. It may be established for fiscal purposes (e.g. valuation and equitable taxation), legal purposes (conveyancing), to assist in the management of land and land use (e.g. for planning and other administrative purposes), and enables sustainable development and environmental protection (Lau, 2004; Abdullah Hisam, 2004)

Closely connected to the cadastre is a cadastral survey, which is simply defined as a survey of boundaries of land units. Cadastral surveying aims at defining and guaranteeing legal property boundaries, determining coordinates of all measured points to give information on the size and nature of land use.

Cadastral is a methodically arranged public inventory of data concerning properties within a certain country or district, based on a survey of their boundaries. Such properties are systematically identified by means of some separate designation. The outlines of the property and the parcel identifier normally are shown on large-scale maps which, together with registers, may show for each separate property the nature, size, value and legal rights associated with the parcel. It gives an answer to the question where and how much (Lau, 2004)

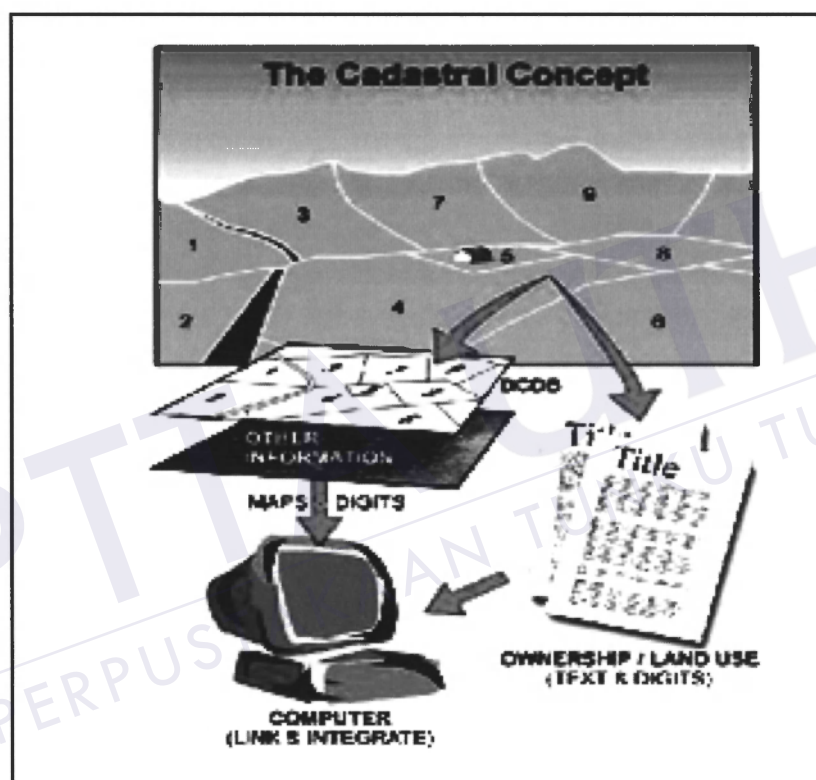


Figure 2.1: Cadastral Concept (Lau, 2004)

The DSMM modernization program began in the early 1980's. After a successful pilot project for computerization exercise was completed in 1995, nationwide implementation of the Computer Assisted Land Survey (CALs) system has taken place. The CALs system not only enables electronic processing of cadastral survey but also introduced, for the first time ever in the history of the department, the concept of a Digital Cadastral Database (DCDB) (Abd. Majid et al., 1998). DCDB holds digital cadastral base-maps that are used for Geographical Information System (GIS) and other related applications (Lau, 2004).

2.2 Cadastral System in Malaysia

Cadastral system in Malaysia is still rooted in the 19th century to serve the judicial cadastre (legally recognized record of land tenure) and the fiscal cadastre (primarily for valuation and taxation). Cadastral system is based on the dimensions of each lot and its relative location with respect to adjacent lots. Peninsular Malaysia is a federation of States, each of which is responsible for its own land matters. Most states adopt the Torrens System of registration administered by the State Land Offices, however cadastral system are controlled by the Department of Survey and Mapping Malaysia (DSMM) (Abdullah Hisam, 2004)

2.2.1 Existing Cadastral Coordinate System

Location, boundaries and coordinates of land parcel are the important information in cadastral database. The boundary is determined by the bearing and distance or respected coordinates. In the existing cadastral system, bearing and distance of a boundary line are emphasized and shown on the Certified Plan (CP) (Lau, 2004).

Works by Lau (2004) have shown that Malaysia has an excellent system, providing a more secure basic for land and property ownership. The cadastral system consist of the surveying and recording mechanism in order to describe such information, for example area, location and boundary line of a given lot (Abd. Majid, 1997). The demarcation and delineation of the boundaries are also part of a cadastral survey aimed at defining the parcels on the ground and securing for the reestablishment of the boundary in case the marks disappeared (Abdullah Hisam, 2004).

2.2.2 Cadastral Surveying

Cadastral Survey is a survey carried out to produce a cadastral plan. A cadastral plan may be defined as a map or plan which identifies a particular parcel of land for purposes of ownership and registration and thereby shows the boundaries with a degree of accuracy as defined in the registration governing the holding of land and transfer of title.

The information on the land shall enable the boundaries to be re-demarcated on the ground with a degree of accuracy as defined in the registration. A cadastral plan is based on the results of a survey meeting the requirements prescribed under the National Land Code 1965 and Licensed Land Surveyors Act 1958. Any survey that relates to or makes connection to any boundary or survey reference mark is also cadastral in nature.

A Study by Abd. Majid et al., (1998) has shown that under the existing cadastral system, the dimension of any land parcel is determined by the bearing and distance of its boundary lines. The area of the parcel is then computed from the surveyed bearings and distances of the related boundaries. However, in some cases, the dimension of the boundary lines is often represented by scaled distances only, particularly in areas where information could only be obtained from old cadastral survey records. For such areas, its perimeter is usually defined by second class standard surveys and part of their internal boundary lines were defined by third class surveys.

In Malaysia, cadastral surveys are carried out by government officials and private surveyors or by a combination of both. The task of cadastral surveyors includes the followings:

1. Cadastral Surveying include:

- i. The geometrical data, especially the size, shape and location of each land parcel.
- ii. Definition, identification, demarcation, measuring and mapping of new or changed legal parcel boundaries.
- iii. Re-establishing lost boundaries.
- iv. Resolving disputes over boundaries or other interests in real property.
- v. Gathering and recording of data about land parcels, even where the records do not form part of an official cadastre.

2. Survey Recording

Checking or examination of the results of the cadastral survey carried out by them including:

- i. Entry of the information in registration books
- ii. Check on land policy matters
- iii. Legal matters
- iv. Technical matters

2.2.3 Classification of Surveys

The classification of cadastral survey practices in this country is based on the degree of accuracy required and the methods used as being outlined in the Survey Regulations (1976). According to Survey Regulation 1976, cadastral survey practice was divided into three classes:

- i. First Class surveys comprise of standard and other traverses which are required or may be used in extension of the trigonometrical data for the control of Second Class or other surveys and include surveys for title within towns and villages.

- ii. Second Class surveys comprise of circuit traverses, minor controls and connections, and all other surveys for title in country areas not surveyed by Third Class method.
- iii. Third Class surveys comprise of the surveys of the internal boundaries of a group surveys in rural areas, the circuit being controlled by Second Class surveys. They also comprise of surveys for rights-of-way in rural areas and, in some cases, subdivisional surveys of lots previously surveyed by Third Class methods.

The instructions for the execution of First Class surveys are given in Appendix I and II whilst instructions for the execution of Second and Third Class surveys are given in Appendix III (Survey Regulation, 1976). Table 2.1 shows the permissible closing errors for First and Second Class surveys.

Table 2.1 : Permissible Closing Errors for First and Second Class surveys

Misclosure	First Class survey	Second Class survey
Angular	00' 10" per station with a maximum different of 01' 15"	00' 20" per station with a maximum accumulation of 02' 30"
Linear	1 in 8,000	1 in 4,000

(Source: Survey Regulations, 1976)

The summary of the permissible closing errors for Second Class and Third Class surveys is shown in Table 2.2, while the nearest value of recorded bearing and distance (field and CP) are given in Table 2.3 (Abd. Majid et al., 1998).

Table 2.2 : Permissible closing errors for Second and Third Class surveys

Misclosure	Second Class	Third Class
Angular	2' 30"	5 ' 00"
Linear	1 : 4,000	No mathematical limit but shall be able to plot to the scale in final plan

(Source: Abd. Majid et. al., 1998)

Table 2.3: Nearest value of recorded bearing and distance (in field book and on CP)

	Second Class		Third Class	
	Bearing	Distance	Bearing	Distance
Field Recorded	10 "	0.01 links	10 "	0.01 links
Field Adjusted	10 "	0.01 links	1 '	0.1 links
Certified Plan	30 "	0.01 links	1 '	0.1 links

(Source: Abd. Majid et. al., 1998)

Meanwhile on the Certified Plan, the scaled distances for some boundary lines of the internal lots are given to the nearest 1 link. (Abd. Majid et al., 1998).

2.3 Third Class Survey

The Third Class cadastral survey data is represented in two method:

- i) By true value. The Third Class bearing can be referred to the Demarcation Field Book.
- ii) By scale line. This is a computed value where its based from Second Class or First Class perimeter survey.

According to Survey Regulations (1976), the instruction applied for Third Class surveys was referred to the S.G. Circular No. 6/59 and as amended by S.G. Circular No. 5/66.

In StarNet survey adjustment, the Chi Square test can fail if exceeding the upper bound or the lower bound. When the Chi Square test fails by exceeding the upper bound, this indicates that its may have excessive residuals or its have misstated the observation standard errors by setting them too small. When the Chi Square test fails by exceeding the lower bound, this condition usually indicates that the residuals are smaller than what is expected relative to the applied standard errors (Starplus, 2002).

2.4 Digital Cadastral Database (DCDB)

The Digital Cadastral Database (DCDB) is a spatial representation of the legal land parcel boundaries within South Australia. It comprises approximately 920,000 land parcels, together with their legal identifiers. The DCDB was created to rationalize map based record maintenance within government and provide a single source of up-to-date mapping.

The DCDB also provides a common and spatially consistent boundary framework for client use that promotes consistency among dependent data sets; thus facilitating improved data integration and analysis across government. The DCDB is the fundamental reference layer for spatial information systems in South Australia (Abdullah Hisam, et al., 2006).

According to Lau (2004), DCDB is the digital spatial database, which has been derived primarily from paper map. Basically the database gives a graphical representation of the cadastral fabric. They are dynamic due to daily changes in the cadastral framework through the subdivision and the land tilting processes. Cadastral data derived from the surveyor that identify lot information with unique UPI's are stored in three text files, since lot numbers are not unique within a state or even a mukim (several villages). A UPI consists of State ID, town/mukim ID, and Lot ID that become unique in the country.

A complete Digital Cadastral Database (DCDB) can depict all land parcels in its cadastral fabric, including all privately owned, leased and State lands, roads, rivers and reserves. The DCDB would be a key component of the nation's spatial data infrastructure and provide one of the core spatial data sets, which would be able to be integrated with other spatial data sets. The DCDB can provide the legal definition of land parcels, and the boundary coordinates that it maintains would serve as contributory evidence to that effect. Each parcel would have a unique identifier that links the parcel on the cadastral map to the land register, apart from enabling cross-referencing to other information needed. The DCDB is based on coordinates determined by ground survey. The storage of data in the DCDB would be in an appropriate form that will allow for easy creation and updating as well as the flexibility of the use of information, including for the creation of mapped products (Abdullah Hisam et al., 2006). DCDB consists mainly of three different files or layers, being represented by three entities such as cadastral lot, boundary mark and boundary stone. All entities are represented by unique spatial objects for geographical representation; polygon for cadastral lot, point for cadastral mark as well as polyline for boundary line (Abdullah Hisam, 2004)

The DSMM modernisation programme began in the early 1980's. After a successful pilot project in computerizing its cadastral operation in the state of Johor, the initial phase of computerization exercise was completed in 1995 with the Nationwide implementation of the Computer Assisted Land Survey (CALs) system. The CALs system not only enables electronic processing of cadastral surveys but

also introduced the concept of a Digital Cadastral Data Base (DCDB). Eventually, the enhancement process was carried out with the upgrading of the Mini-CALS to the Cadastral Database Management System (CDMS) (Abdullah Hisam, et al., 2006).

Being the government agency organization responsible for all cadastral survey activities in the country, DSMM has undertaken the initiative to create and maintain the National DCDB (NDCDB) as well as the dissemination of digital spatial information to the end users. With the widespread proliferation of Geographic Information Systems (GIS) and the recently launched National Infrastructure for Land Information System (NaLIS), the database that forms the basic building block of a GIS is becoming increasingly significant. It was estimated that about 5.5 million cadastral lots need to be converted into digital form for the creation of the future NDCDB for the whole Peninsular Malaysia. (Abdullah Hisam, et al., 2006).

2.4.1 DCDB Data Structure Overview

Overview of the DCDB data model are based on model developed by DSMM. A data model is a formal definition of the data required in a GIS. The data model can take one of several forms namely, a structured list and an entity-relationship diagram. The purpose of the data model, and the process of specifying the model are to ensure that the data has been identified and described in a completely rigorous and unambiguous fashion. The data model will allow the formal specification for the entities, their attributes and all relationships between the entities for the GIS. There are four steps involved in the database development which are external assessment, conceptual modeling, logical design, and physical database (Abdullah Hisam, 2004)

DSMM has undertaken the initiative to create and maintain the national DCDB as well as the dissemination of digital spatial information to the end-users. Due to the shortage of manpower, the Department has planned to contracting-out the data capture process to populate its DCDB. DSMM has standardized the out-source format for data capture process to populate its DCDB. Table 2.4 show the standard Malaysian digital out-source format that need to be followed by the contractor or Licensed Surveyor firms while Table 2.5 shows the DCDB data structure. The out-sourced datasets act as an input data in the Cadastral Data Management System (CDMS). CDMS will function as "mechanism" used to populate the DCDB and will provides a window as a single point of access from any PC within the network, to information in any of the database (Abdullah Hisam, et al., 2006).

Table 2.4 : DCDB Out-Source Format

	File 1		File 2		File 3	
	Lot		Lot Boundary		Footnotes	
	Field.Desc	Char	Field.Desc	Char	Field.Desc	Char
1	UPI	16	UPI	16	Cert. Plan No.	12
2	Centroid X Coord	12	From Mark Desc.	13	Name of Approver	35
3	Centroid Y Coord	12	From Stone No.	10	Name of Surveyor	35
4	Area	16	From X Coord	12	Survey File No.	18
5	Unit for Area	3	From Y Coord	12	Land Office File No.	18
6			From Coord Type	1	Survey Completed	10
7			Bearing	9	Data Approved	10
8			Distance	10	Standard Sheet No.	20
9			Unit For Distance	3		
10			To Mark Desc.	13		
11			To Stone No.	10		
12			To X Coord	12		
13			To Y Coord	12		
14			To Coord Type	1		
15			Class of Survey	1		
16			Survey Line Code	2		
17			Survey Value Code	2		
18			Cert. Plan No.	12		
19			Remark	12		
File Name	JOBREF.LOT		JOBREF.BDY		JOBREF.NOT	

(Source: Abdullah Hisam, 2004)

Table 2.5 : DCDB Data Structure

No	File 1		File 2		File 3	
	Lot		Boundary		Stone	
	Field.Desc	Char	Field.Desc	Char	Field.Desc	Char
1	Negeri	2	Approved Date	8	Point Key	19
2	Daerah	2	Parcel key	16	Approved Date	8
3	Mukim	2	Bearing	9	Marks Desc.	13
4	Seksyen	3	Distance	11,3	Serial	8
5	Lot. No	7	Unit For Distance	2	Coord.type	1
6	Area	16	Class of Survey	2	Coord.East	10
7	Unit for Area	3	Line Code	8	Coord.North	10
8	Approved Date	8	Line Type	1	S.Comment	45
9	Status	1	Entry Mode	1	Status	1
10	Lock ID	11,0	Plan.No	12	GID Shape	11,0
11	GID Shape	11,0	Fnode	19		
12			Tnode	19		
13			Adj.Parcel	16		
14			Status	1		
15			GID Shape	11,0		
	LOT.SHAPE		BOUNDARY.SHAPE		STONE.SHAPE	

(Source: Abdullah Hisam, 2004)

2.5 Coordinated Cadastral System (CCS)

Coordinated cadastral system (CCS) is a new cadastral concept in Malaysia driven by the advancement in the integration on information in the fields of GPS, GIS and LIS . Coordinate-based cadastral system simply means that coordinates are given legal significant entity. Bearing and distance are, therefore only a means by which the final adjusted coordinates are derived (Lau, 2004).

According to Lau (2004), the focus to this concept are:

- ii. The availability of the abundance of survey control stations whose coordinates are given with respect to geocentric datum.
- iii. The adoption of single coordinate projection system for the whole country.
- iv. Application of rigorous network adjustment technique so that a unique pair of coordinate (N, E) and their respective accuracy information can be defined for every cadastral boundary marks.

There are many advantages of the CCS (Lau, 2004):

- i. It employs an authentic whole-to-part adjustment concept.
- ii. It makes GPS and GIS compatible since coordinates are the basic Input/Output unit of such system. A geocentric datum can be determined in a global sense for a country such as Malaysia.
- iii. It facilitates the use of rapid data acquisition and storage, processing and management technique.

According to Ghazali and Abd. Majid (2004), one of the characteristics of the envisaged model of CCS for Peninsular Malaysia is the system that has a Common National Coordinate System with two aspects, the geocentric datum and geocentric-based map projection system. The other characteristics of the model of CCS of Peninsular Malaysia have also been studied: Cadastral Control Infrastructure that is based on highest geodetic order with adequate density (Abd. Majid Kadir et al., 2002); a complete and layered Digital Cadastral Database (DCDB) designed according to an appropriate data modeling technique with a unique parcel identifier and Cadastral Survey Practice based on least square adjustment technique and employing the survey concept of "whole-to-part" (Abd. Majid Kadir et al., 2002). As in any major reform involving the cadastre, it is clear that it will be a long-term undertaking that involves not only the technical issues but primarily concern the socio-economic aspects. While in Ghazali and Abd. Majid (2004), has looked into the legal and organizational aspects of the CCS implementation for Peninsular

Malaysia, there has been no study that addressed the socio-economic aspects of the system.

2.6 National Digital Cadastral Database (NDCDB)

Development of national digital cadastral database (NDCDB) is an extension of the feasibility study on the implementation on CCS conducted by DSMM and UTM. The concept of NDCDB is the existing State DCDB that adopt Coordinated Cadastral Database (CCDB) as control for transformation and adjustment of the database in geocentric RSO coordinate system. The least square adjustment technique will be employed to replace Bowditch rules of traverse adjustments. Figure 2.2 shows the concept of NDCDB (Lau, 2004).

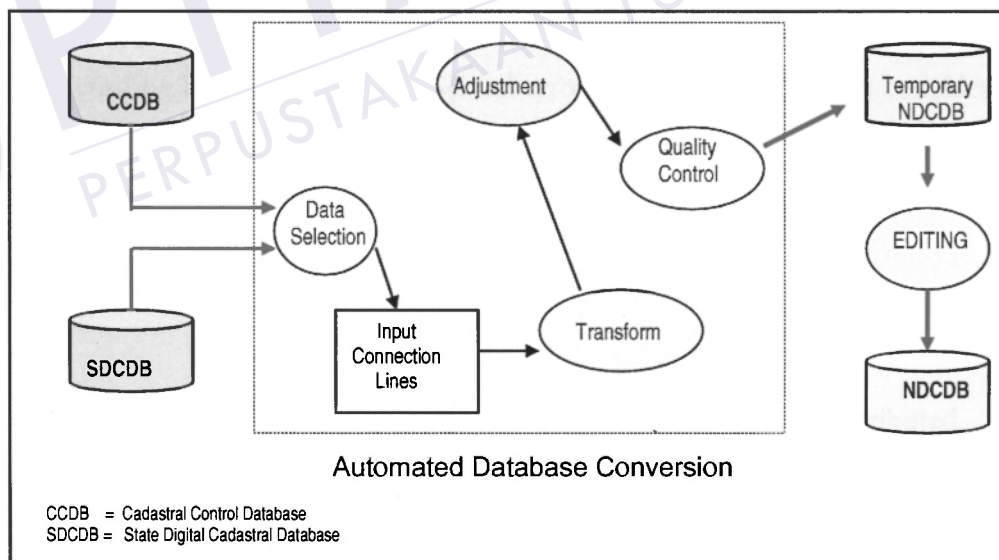


Figure 2.2. Development of a National Digital Cadastral Database (NDCDB) (Lau, 2004).

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