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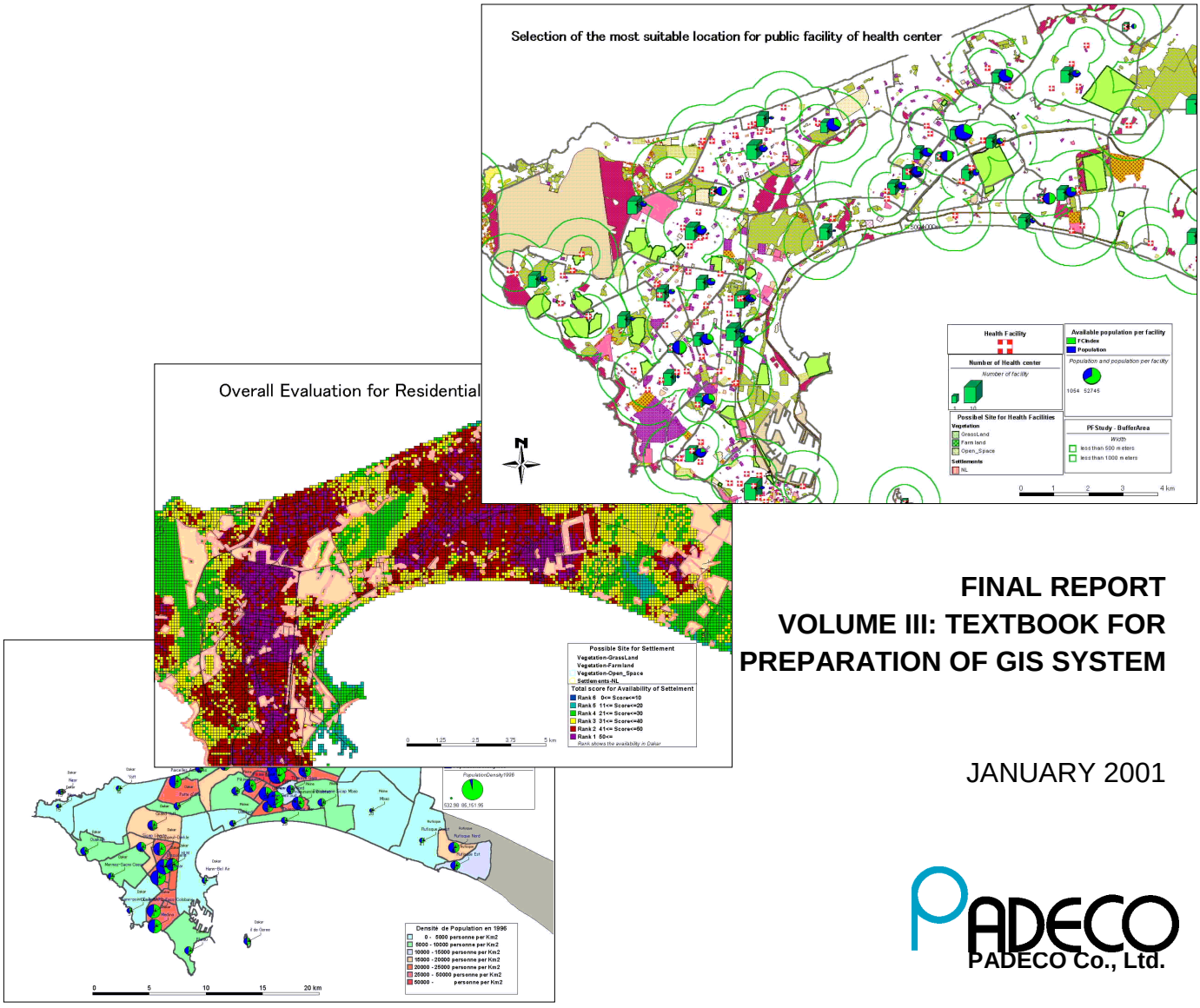
MINISTRY OF EQUIPMENT AND TRANSPORT
DEPARTMENT OF GEOGRAPHIC AND CARTOGRAPHIC WORKS
MINISTRY OF URBAN PLANNING AND HOUSING
DEPARTMENT OF URBAN PLANNING AND ARCHITECTURE

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE STUDY ON INFRASTRUCTURE INFORMATION MANAGEMENT SYSTEM OF THE DAKAR METROPOLITAN AREA IN THE REPUBLIC OF SENEGAL



FINAL REPORT
VOLUME III: TEXTBOOK FOR PREPARATION OF GIS SYSTEM

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ABBREVIATIONS

ADM	Municipal Development Agency
ARD	Regional Development Agency (Dakar Region)
ASECNA	Agency for Air Navigation Safety in Africa
BHS	Senegal Housing Bank
BHSO	Collectivity Assistance Bureau for Social Housing
CAD	Computer Aided Design
CETUD	Dakar Urban Transport Executive Council
CSE	Ecological follow-up Center
CUD	Dakar Urban Community
DAT	Department of Land Development (MEFP)
DAU	Division of Architecture and Urban Planning (Dakar Municipality)
DCES	Department of Education Facility and Construction (MEN)
DE	Department of Employment (MTE)
DEEC	Department of Environment and Historical Building (MEPN)
DEFCCS	Department of Water, Forest, Hunting and Soil Conservation (MEPN)
DGR	Department of Rural Engineering (MH)
DID	Department of Tax and Domain (MEFP)
DPRE	Department for Planning and Reform (MEN)
DPS	Department of Forecast and Statistics (MEFP)
DSA	Department of Agricultural Statistics (MA)
DSS	Department of Sanitary Statistics (MS)
DST	Department Communal Technical Service (CUD)
DTGC	Department of Geographic and Cartographic Works (METT)
DTM	Digital Terrain Models
DTP	Department of Public Works (METT)
DTT	Department of Land Transport (METT)
DUA	Department of Urban Planning and Architecture (MUH)
GIS	Geographic Information System
GPS	Global Positioning System
HAMO	Modern Housing Company
IEF	Water and Forest Inspection (MEPN)
IIMS	Infrastructure Information Management System
IMF	International Monetary Fund
ISRA	Senegalese Agricultural Research Institute
LAN	Local Area Network
MA	Ministry of Agriculture
MEAVF	Fossil Valley Development Study Mission
MEFP	Ministry of Economy, Finance and Planning
MEN	Ministry of National Education
MEPN	Ministry of Environment and Natural Protection

METT	Ministry of Equipment and Land Transport
MH	Ministry of Hydraulic Engineering
MS	Ministry of Health
MTE	Ministry of Work and Employment
MUH	Ministry of Urban Planning and Housing
ONAS	Senegal National Sewerage Office
PAD	Dakar Port Authority
PADDEL	Decentralization and Local Development Support Project
PADDUS	Decentralization and Urban Development Support Project
PDU	Urban Planning Master Plan
PUD	Detailed Urban Development Plan
PUR	Urban Planning Reference Plan
SCAT-URBAM:	Urban Land Development Company
SDAU	Development and Urban Planning Master Schema
SDE	Senegal Water Distribution Company
SENELEC	Senegal Electricity Company
SGPRE	Water Resource Management and Planning Company
SICAP	Cap-Vert Real Estate Company
SNHLM	National Moderate Rent Housing Company
SONATEL	National Telecommunication Company
SONES	Senegal National Water Exploitation Company
SOTRAC	Cap-Vert Mass Transit Company
UNICEF	United Nations Children's Fund
WAN	Wide Area Network
ZAC	Mixed Housing Development Zone

1. INTRODUCTION

This textbook has been prepared for the Department of Urban Planning and Architecture (DUA) for the purpose of introducing GIS to its officials.

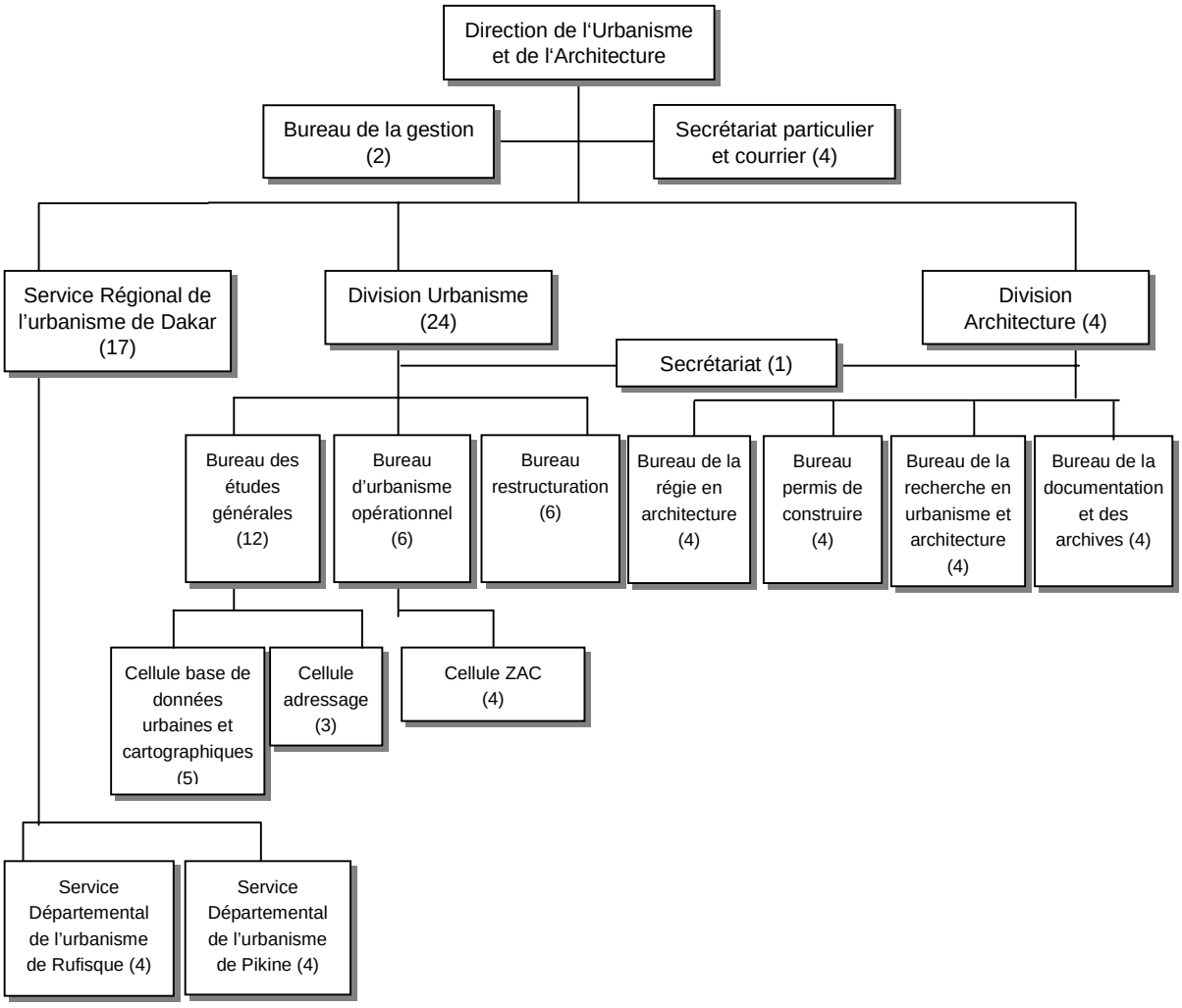
2 Review of DUA's Tasks

First of all, we will attempt to capture the scope of DUA's tasks, and next make a detailed investigation into the eventual application of GIS.

Though changes in the organization to combine related information sections can be expected, the essential functions of the DUA are shown on the basis of this current organization

The organization chart of the Department of Urban Planning and Architecture is shown in Figure 2.1

Figure 2.1 Organization Chart of DUA



Source: DUA

2.1 Urbanization Division

(1) Office of General Study

The duties of this office are:

a) Urban Planning and Studies

This office is primarily concerned with the following study and planning functions:

- Basic Urban Planning (plan directeur d'urbanisme)
- Basic Urban Development Planning (schema directeur d'aménagement)
- Detailed Urban Planning (plan d'urbanisme de detail)
- Reference Urban Planning (plan d'urbanisme de référence)

Realization of plans occurs through collaboration between local authorities and DUA'S regional offices.

For the preparation of future plans, they collaborate with Office of Urban Operations. The Basic Data and Cartography Section takes charge of basic aspects, and Office of Urban Opperation takes charge of detailed aspects. Documents prepared by the Basic Data and Cartography Section are maintained in this section, as sometimes they provide information in response to requests of other offices in the DUA or other organizations. For example, concerning urban transport, in response to the request from CETUD (Urban Transport Executive Committee in Dakar) or DTT (Direction of Land Transport) they provide information such as land use, and coordinate for planning.

b) Amending or drafting laws concerning urban planning

The Basic Data and Cartography Section is responsible for obtaining information from various sections, divisions, or concerned organizations, and identifying problems with the urban planning. When problems are found, this section then studies the options of amending or drafting laws, proposing bills, and submitting these bills to the government.

c) Research and study

This section sometimes leads various research activities related to urbanisation in Senegal

d) Responding to complaints concerning urbanism

This section tries to reach solutions to problems concerning urbanism. However, the enquiries are infrequent.

There are two sections in the office:

a) Basic Data and Cartography Section

This section is responsible for preparation and maintenance of the urban and cartographic database, and elaboration of urban development studies.

b) Adressage Section

Adressage means the assignment of an address by giving a number to each entrance to a building. In fact, no system of addresses currently exists in Senegal. However, this is in process. A project is currently under implementation by the Municipal Development Agency (ADM) in collaboration with the municipalities and the Regional Urbanization Service. The DUA is supporting the project by formulating an addressing system plan.

(2) Office of Urban Operations

This office has three primary duties:

a) Elaboration of detailed urban plans (PUD)

The plans are drawn up in consultation with the Director of Urbanization or documents handled by the Basic Data and Cartography Section.

b) Study and planning of public facilities and infrastructure

This office is in charge of distribution of parcels of land for the establishment of public facilities under urbanization projects, working in collaboration with the Basic Data and Cartography Section for reference materials.

Public facilities include the following:

- primary schools
- public marketplaces
- the Grand Mosque
- sports grounds
- healthcare facilities
- SENELEC Agency
- Agencies of SONES and SDE
- Pharmacies
- Post office

- SONATEL Agency
- Telecommunications office
- Churches
- Secondary schools
- Islamic Institute
- Police department
- Bus stations
- Service stations

Ordinarily these facilities would be set up by competent authorities in collaboration with the DUA. The same process is applied concerning infrastructure.

c) Guidance of application

This office provides advice on completing documents to the applicants for use of residential lots, certificates of rental housing, etc.

There is also a section within the office:

a) the ZAC Section

This unit makes and carries out plans in the style of ZAC (Concerted Development Zone).

(3) Office of Urban Restructuring

The purpose of this office is to carry out plans for the restructuring of spontaneously-settled residential areas. Usually the areas to be restructured are selected by the Government, and the Office of Urban Restructuring carries out the development plans. However, sometimes the DUA receives requests for assistance directly from the districts, and then prioritizes them in terms of need.

2.2 Architecture Division

(1) Office of Architecture Services

This office helps public services and local authorities to prepare architectural plans for the implementation of their projects. Sometimes due to lack of financial means, private persons or associations can request services from this office instead of having to hire the services of private design firms.

(2) Office of Construction Permits

This office develops both terms of reference and plans for construction projects. They make judgments as to sensitive areas, for example, Almadies, Plateaus, etc.

a) Urbanization Certificates

An urbanization certificate is an official document issued by the DUA in compliance with local authorities to determine the type and kind of building allowed to be constructed on land to be acquired or already acquired.

b) Construction permits

Construction permits are authorizations approved by the competent organization which are stamped on architecture plans with a registration number and a date.

In principal, The demands are treated at the Regional Service of Urbanism and afterward send to DUA for approval. All the large scale projects and projects in the Dakar Plateau are examined by the DUA.

(3) Office of Research in Urbanization and Architecture

This office is engaged in the promotion of local material.

(4) Office of Documentation and Filing

This office is in charge of collection, treatment, and diffusion of information in the habitation field.

2.3 Other Principal Organizations

(1) Management Office

This office takes care of personnel management and administrative affairs.

3 Examination of Functions for GIS

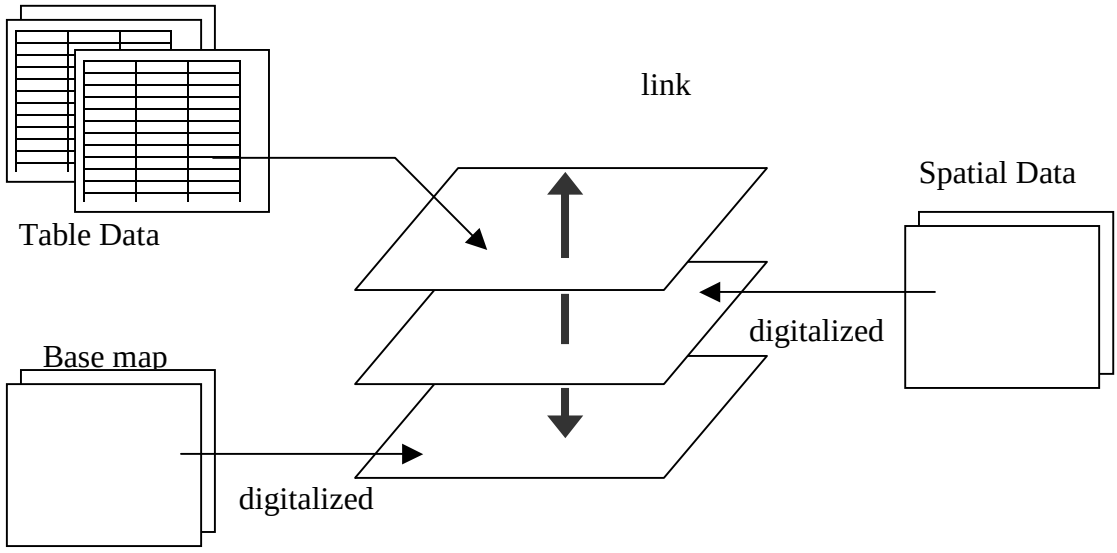
(1) What is GIS?

GIS is the abbreviation for Geographic Information System. The GIS system consists of three types of digital data: base map, spatial data and table data. Base map can be considered as a digitized blank map; spatial map is a digitized map including location information such as facilities information, roads for bus service, land use plans etc.; and table data is general data such as statistics.

A GIS system can indicate location as coordinates, such as the spatial data, and therefore various data can be linked together by the coordinates. This enables a complete analysis linking together various spatial and table data describing characteristics of a location or a site found in a map.

The Structure of the GIS system concept is shown in Figure 3.1.

Figure 3.1 Formation of GIS System Concept



Source: JICA Study Team

(2) Establishment of GIS

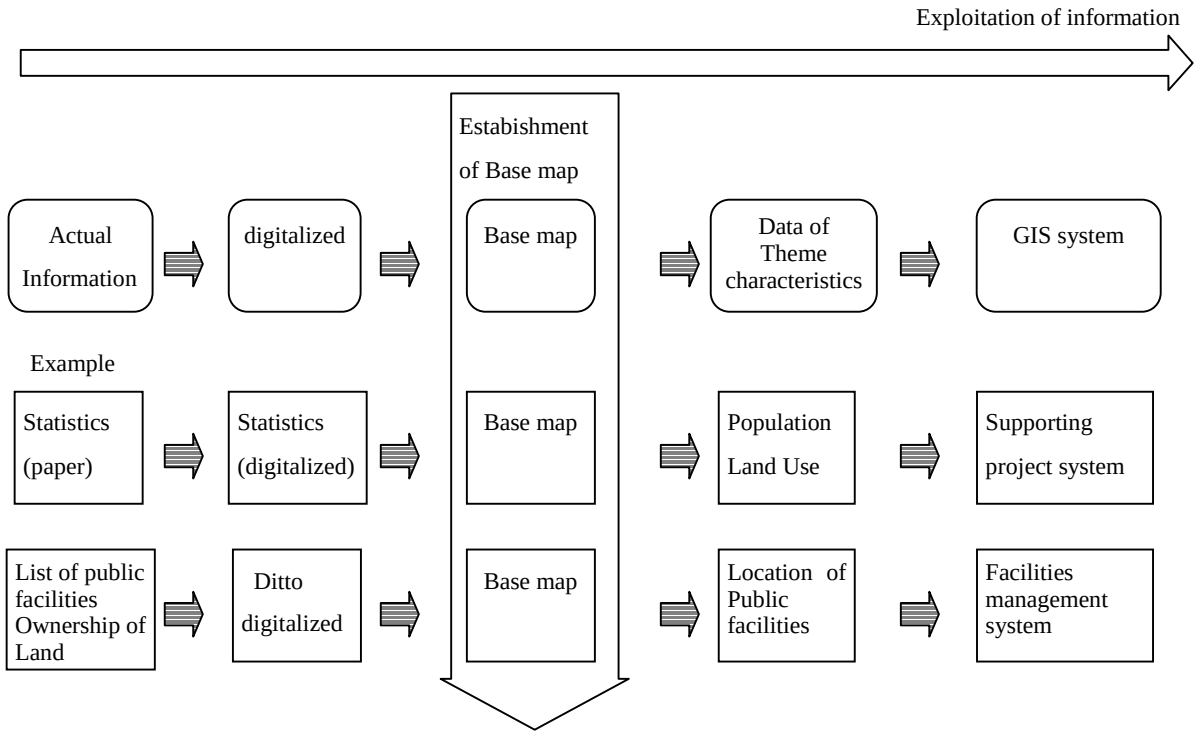
The concept of establishing a GIS is shown in Figure 3.2.

The establishment of the base map is shown by one vertical arrow, and supplemental data is shown by horizontal arrows. Supplemental data can be classified to the extent possible, according to the characteristic of the theme. The base map should always be digitized, and supplemental data should be digitized after careful selection of information.

To establish a GIS system as a work-supporting tool, it is necessary to classify the actual information concerned. According to the structure of GIS, information can be classified into 2 categories:

1 Base map: basic information for all tasks.
2 Supplemental data: information tools selected and classified according to task

Figure 3.2 Concept of Establishing GIS



Source: JICA Study Team

(3) Improvement of Work Efficiency by GIS

Efficiency is another point to be considered for the introduction of GIS. The significant amount of time saved by utilizing the GIS system is an important aspect of prioritizing work types that can be applied to GIS.

As shown in Figure 3.2 above, there is work involved in inputting information to be digitized on the left side of the figure, and then on the right side there is work involved in preparing output in readily utilizable form.

To consider efficiency, the time used for input of information should be balanced with output frequency. A way of attaining high efficiency is to have clear thematic data for which a steady frequency of use is expected, and a small quantity of data for input.

4 Functions of DUA and Potential Application of GIS

This section demonstrates how to examine the functions of the DUA, and how they pertain to GIS in order to assign the priorities upon which the system will be composed.

The following four aspects need to be considered when assessing the applicability of GIS to the functions of the DUA:

- Availability of spatial data;
- Availability of table data that can be linked to spatial data
- Job efficiency
- Daily usage of the system.

Considering the above, the daily work of DUA is classified into the following task groups:

(1) Study and planning
(2) Examination and approval of applications
(3) Document management
(4) Administration

Each of these is assessed for application to GIS as follows.

(1) Study and Planning

Since the majority of the tasks require comprehensive information and spatial data, voluminous amounts of information must be input in order to set up the GIS and utilize it effectively. Urban planning maps are a very useful source of comprehensive information, although their frequency of use by the DUA is not so high. If the DUA collaborates as a user with other organizations, and clarifies the use of the information, the potential use of GIS could be high.

Table 4.1 Application of GIS for Study and Planning

Necessity of spatial information	Necessary Necessity depends upon type of task
Existence of table data	If program utilization is clarified, table data can be made.
Time required to input program data	Excessive
Frequency of use	Uncertain If program for system utilization is not clarified, frequency of use will be low or nonexistent
Possibility of application	Moderate
Applicable Functions of DUA	- Studying and Planning of urban plans - Study and planning of public facilities and infrastructure - Amending or making laws concerning urban planning - Adressage - Research and study

Source: JICA Study Team

(2) Examination and Approval of Applications

The task of data updating and referencing is performed daily, indicating a high need for systematization.. The extent and type of data preparation for the system is clear, and data is available in the form of existing application documents that can be labeled.

Table 4.2 Application of GIS to Examination and Approval

Necessity of spatial information	Necessary
Existence of labeled data	Existing Existing format of applications
Time required to set up data file	Minimal
Frequency of use	Almost daily renewal and reference of data
Application for system	High
Applicable functions of DUA	- Approval of urbanization certificate - Examination and approval of construction permits - Examination to select districts for restructuring of spontaneous settlements

Source: JICA Study Team

(3) Document Management

Although there is much useful information, examination of the conditions of access to the information by various offices and sections of DUA is needed for the application of GIS.

Table 4.3 Application of GIS to Document Management

Necessity of spatial information	- none
Existence of table data	- none
Time required to set up program data	- Unclear
Frequency of use	- Necessary to clarify demand of other divisions or sections
Application for system	- Necessary to clarify demand of other divisions or sections
Applicable functions of DUA	- Document management of DU and DA - Diffusion of information

Source: JICA Study Team

(4) Administration

This type of work is done without spatial data. Therefore the GIS system does not apply to this function.

Table 4.4 Application of GIS to Administration

Necessity of spatial information	- N/A
Existence of table data	- N/A
Time required to set up program data	- none
Frequency of use	- N/A
Application for system	- N/A
Applicable functions of DUA	- Administration (N/A)

Source: JICA Study Team

Following the above study of the DUA's functions, a summary is presented in the following table, excluding complementary work and isolated work that are beyond the purpose of continuous use of the system.

Table 4.5 Functions of DUA and Their Potential for Application of GIS

Necessity of Spatial Info.		Input data		Output data		efficiency
		Characteristics	time	Characteristics	frequency	
Studying and Planning						
Studying and planning of urban plans	Necessary	Various information Land use plans / Traffic conditions / Road network Time span to renewal of data is long. Quantity of input data is extensive.	Excessive	- General urban problem examination system. - IIMS can be considered a part of this system. Many criteria should be added to the system. - Other criteria data should be examined.	Cannot be fixed	low
Study and planning of public facilities and infrastructure	Necessary	Location of public facilities and infrastructure Knowledge of all facilities is needed, so additional information is required.	Moderate	Public facility location system Public facility location data Infrastructure location data	Cannot be fixed	moderate
Amendment or drafting laws	Potentially Necessary	Various information needed.	Excessive	Analysis of various topics.	Cannot be fixed	low
Examination and approval						
Approval of certificate of urbanization	Necessary	Applicant / date of application / location of site / purpose of application /	Minimal	Same as input data and Contents of Certificate (Standard of dimension of site and construction)	daily	high
Examination and approval of construction permits	Necessary	Applicant / date of application / location of site Dimension of construction	Minimal	Same as input data	daily	high
Examination to select districts for restructuring	Necessary	Date of application Criteria data Needs to be simplified and digitized	Moderate	Examine and select system	intermittent	moderate
Document management	—	—	—	Potential application undetermined.	—	—
Administration	Not Necessary	—	—	—	—	—

Source: JICA Study Team

5 System Generation

5.1 System Proposals

This Study established the Infrastructure Information Management System (IIMS), based on GIS, for DUA as well as DTGC. The initial IIMS established by this study contains a large number of spatial data files linked with non-spatial attributes data files. Four sub-systems of the IIMS are proposed to be used by DUA for its administrative as well as planning activities. The four sub-systems are:

1) Urban Sector Information Reference Sub-system
2) Urban Development Control Sub-system
3) Urban Planning support Sub-system
4) Residential site Evaluation Sub-system

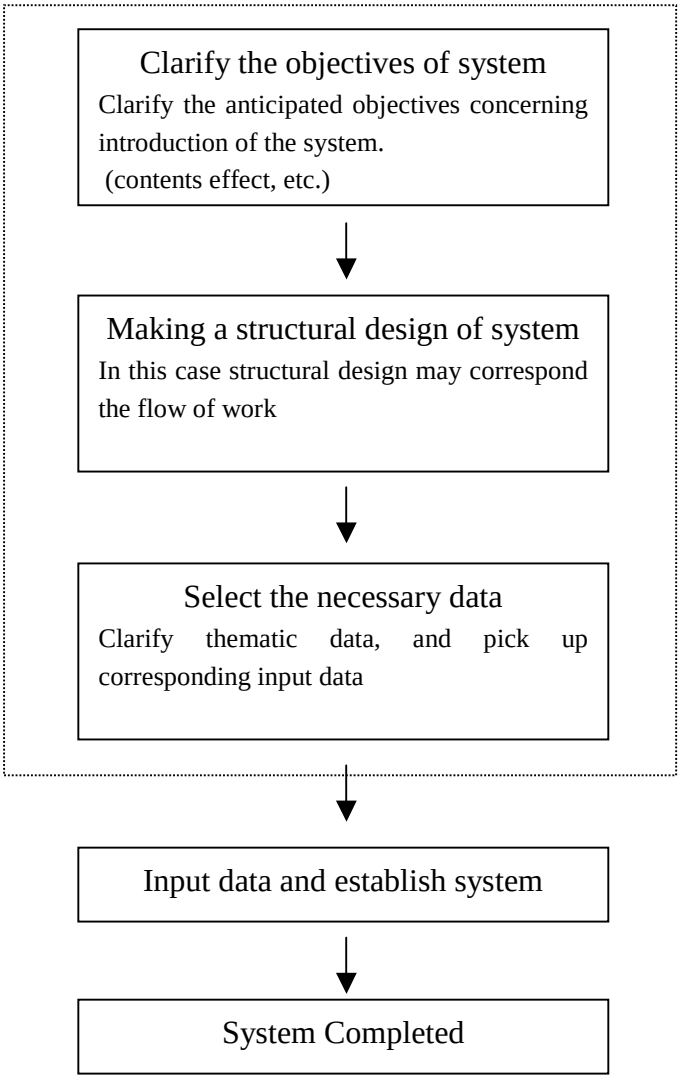
These sub-systems have been chosen to demonstrate how the IIMS can be applied to cases with different objectives of urban planning and management in Dakar. They are also arranged in the order of complexity in operation; they are chosen to demonstrate the use of IIMS at various levels of sophistication and associate operational difficulty.

Details of the example sub-systems are presented in Volume I Main Text Chapter 5.

5.2 Approach to system preparation

The approach to preparing the system is shown in Figure 5.1.

Figure 5.1 Approach to prepare the system



Source: JICA Study Team