2006

Analysis, Design and Development of a GIS Based Municipal Information System for Rajshahi City Corporation, Banglades

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Doctor of Philosophy

in

Geography & Environmental Studies

By

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BANGLADESH

January 2006

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A Dissertation Submitted to the Department of Geography & Environmental Studies, Faculty of Life & Earth Sciences, University of Rajshahi, in Fulfilment of the Requirement for the Degree of

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Dedicated To
My
Parents

Declaration

I hereby declare that, thesis entitled **"Analysis, Design and Development of a GIS Based Municipal Information System for Rajshahi City Corporation, Bangladesh"** is the result of my original research work submitted to the Department of Geography & Environmental Studies, Faculty of Life and Earth Sciences, University of Rajshahi, Bangladesh, under the supervision of Dr. Raquib Ahmed, Professor, Department of Geography & Environmental Studies, University of Rajshahi, Bangladesh in fulfillment of the requirement for the degree of Doctor of Philosophy.

I further declare that, this thesis has not been submitted in part or in full previously for any degree.

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Certificate

This is to certify that the dissertation prepared with authentic outputs achieved during the research on the thesis entitled "Analysis, Design and Development of a GIS Based Municipal Information System for Rajshahi City Corporation, Bangladesh" by Mr. Md. Mujibor Rahman for fulfillment of the requirements for Doctor of Philosophy in the Department of Geography and Environmental Studies, Faculty of Life and Earth Science from University of Rajshahi, Bangladesh.

It is further declared that this work has been carried out under my direct supervision. I consider it satisfactory as to its scope and contents.

(Raquib Ahmed)

Acknowledgement

I would like to express my sincere and heartiest gratitude to my supervisor Dr. Raquib Ahmed, Professor, Department of Geography & Environmental Studies, University of Rajshahi, Bangladesh for their constant inspiration, constructive guidance, cordial behaviour and untiring labour throughout the progress of this research work and preparation of the thesis. I am grateful for their intellectual ideas and productive supervision.

I express heartfelt thank to Professor and Chairman Dr. Abu Hanif Sheikh, former Chairman Late Professor Md. Ekramul Haque, and Professor Noor Mohammad, Department of Geography & Environmental Studies for their encouragement.

I would express my deep appreciation to officers of Rajshahi City Corporation, Rajshahi Development Authority, Record Room of Rajshahi Court, Rajshahi, Rajshahi University Central library, Seminar Library and GIS & Remote Sensing Laboratory of the Dept. of Geography & Environmental Studies for support to this thesis.

I would like to thank to Professor Dr. P. S. Roy, Dean, Indian Institute of Remote Sensing (NRSA), B. S. Sokhi, In-charge, Human Settlement Analysis Group, Indian Institute of Remote Sensing (NRSA), Dehradun, India and Dr. A. P. Subudhi, Director Jharkhand Space Application Center, Ranchi, Jharkhand, India for their intellectual ideas and encouragement.

I would like to thank to Mr. Abdullah Hel Baque, Deputy Register, Khulna University and Dr. Md. Rezaul Hoque, Associate Professor, Fisheries and Marine Resources Technology Discipline, Khulna University for their cordial help.

Last but not the least, I am extremely grateful to my parents, elder brothers and sister for their moral support and encouragement and special thanks to my wife Kazi Ruksana Sultana for her innocent understanding, love and patience.

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Abstract

Functional parameters of city administrators/managers and decision makers include a wide variety of data and information components. The rapid increase in cities' population and socio-economic functions has widened the horizon of the functional parameters and data platform significantly, particularly in the recent time. It is observable that in the early days, the decision makers' style of function was so simple that it required very few types of data. The data of those days were collected, maintained and organized in a very simple and straight forward way. But, now the situation is significantly changed. Impact of the decision whether it is correct or wrong goes to the distant sector of cities setup. In the present situation, it is observed that, while taking a decision, the required data and information is not often readily available. It is not necessarily true that the data is unavailable, rather the data is found to be inaccessible due to its disorganized maintenance. Also, the currently prevailing manual system does not permit error free quick retrieval of the data and quick effective decision-making. The system is also vulnerable to misuse and misappropriation. Now, the need of an efficient data base management system for the use of city administrator as well as for different users is very urgent. The present study aims to develop an efficient database management system that could be optimally utilized and used for proper City management and decision-making. City administration includes involvement of the government, semi-government authorities and the city corporation authority itself.

The data of both attribute and spatial type broadly include maps (mainly the cadastral), data related to various facilities and decision support. In fact, decision support data type is very closely related to the decision-maker for proper planning and implementation of decisions on the facilities. It is not realistic to develop a wider approach system in such a limited time by the researcher. So, the research project aims to cover a representative and selective database which is basically purposed to serve the need of a particular section of the city administration i.e., the Rajshahi City Corporation Authority. The Rajshahi City has been chosen since it is a single corporate body where quite a wide range of diversified functions are performed. However, the proposed system may be considered as a model approach. The model can be expanded, tested to cover the entire city administration by including necessary modifications and rectifications.

The development of computer and information technology and its successful application in every sector today, are well known and most impressive. In developing countries, urban planning and urban management involve large volumes of geographic data. At present, such information is mainly collected and stored in traditional handwriting documents, making subsequent retrieval very difficult. This system takes any inquiry into urban information base weeks, months or even years rather than minutes or hours, making the day-to-day planning task difficult. Existing system or information based is not able to scope with rapidly growing various municipal functions. A computer can facilitate the creation of a municipal information system that will allow easy storage, updating, retrieval and mapping of a wide range of information related to planning and management of municipal functions. The Geographic Information System (GIS) technology in planning can give planning a broader empirical function and more design flexibility; proper use of automation tools like GIS might improve plan quality considerably.

This study proposed the GIS based information system to be integrated in the municipality and made a conceptual model of the municipal database for Rajshahi City Corporation to run its functions effectively and efficiently. The various categories of land related data and how they interact to form a municipal database and described. The conceptual model is justified by applying it to the taxation system of Rajshahi City Corporation and total procedure to develop such a system like this. The successful development of prototype taxation system has proved the applicability of GIS in the municipality. GIS in developing countries like Bangladesh require some special attentions as it is impeded by the lack of appropriate data, technical support, political willingness and above all poverty.

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CHAPTER- 1

1.1 Introduction

In developing countries urban planning and urban management involve large volume of geographic data. At present, such information are mainly collected and stored in traditional handwritten documents, making subsequent retrieval and updating very difficult. It takes to query into urban information-base weeks, months or every year rather than minutes or hours, making the day-to-day planning task difficult. As a result, most planning and management exercises avoid proper analysis of relevant data. This system also promotes corruption and impedes accountabilities. Existing system of information base however, not able to cope with growing various municipal functions (Such as taxation, land records, water supply, solid waste management and housing etc).

Municipalities are few of the important tiers of local Government. The municipal bodies have a fairly comprehensive range of functional responsibilities and regulatory powers within their boundaries including health, accessibility/transport, primary education, garbage management, water supply, sewerage, planning and development control. Public organizations like municipalities experience a rapidly changing political environment that can cause radical differences in the way public employee's work (Thompson, 1966). The existing manual information system is not flexible enough to allow for changes in their work and in the information that they use and provide to other. This rapidly changing environment of public service also requires information system that are flexible enough to provide critical information to the policy - makers as their needs change almost daily (Burke, 1995).

Unfortunately, planners and decision-makers in Bangladesh have to perform their tasks without adequate information and research facilities necessary to support the planning and management of the municipal activities. In the last 30 years computers have undergone a marked revolution (Klosterman, 1994). Spectacular innovations in new spheres of application areas are taking place with the new development of the hardware and software technology. Computerization has marked a new era in human history by these innovations and applications that cover now almost every sphere of human activities (Quium, *et al.*, 1992)

Technological progress in the last few years has also removed many of the banners that inhibited the development of Geographic Information System (GIS) (Martin, 1989). It is

generally agreed that the potential of this technology to store, manipulate and display spatial data is considerable. However, the introduction of GIS technology involved the complex processes of managing municipal functions (Campbell, 1991). The computer system can facilitate municipal information system to allow easy storage, updating, retrieval and mapping of a wide range of information related to planning and management of municipal functions.

The single most distinguishing aspect of an urban geographic information system is its ability to integrate information from different sources and at different levels of responsibilities for an organization (Hearle, 1967). Geography itself is a common reference used by virtually every activity in local government. Maps and data associated with locations are resources used daily for delivering public service, managing public resource and setting public policy in all local governments units across the nations and throughout the world. Geographic Information System is used by many of these local governments to improve the quality of the decisions they make for the public good (Huxhold, 1991). The collection, organization, analysis and dissemination of large amount of spatial/attribute information are collectively referred to as "Planning intelligence" which is one of the major and most time consuming planning functions. Thus the planning community has welcome recent technological advancements such as the development of GIS (Seong, 1994).

As municipality, or city corporation is the important and vital political subdivision of a country, the image of the government depends largely on the performance of this local government. This study aims to analyze, design and develop a GIS based information system for particular organization. Rajshahi City Corporation has been taken for this purpose. Among all the functions and activities of Rajshashi City Corporation, the efficient management and proper use of the municipal information system are the most vital. An attempt will be made in this study to analyze, design and develop the municipal information system conceptually and a prototype of the total information sub system in detail.

1.2 Identification of problems

The situation analysis of the city has helped the researcher to identify the inherent problems in the overall management of the information system. Indeed, without an indepth observation it would be difficult to identify the problems in the management of data and decisions taken by the authority using the existing data platform. There is also another problem attached to the processing of the data that bridges the gap between the data and the decision makers. The significance and problems could, however, be organized in this way:

- The selection of the data is quite diversified. They are many in number and often not clearly identifiable by the end users.
- The collected data and the sources in most of the cases are maintained in traditional and manual method. The data records and documents are contained in ordinary hardcopy paper which is sensitive to environment, exposed to tempering, may be misplaced or misappropriated and liable to be damaged.
- Whatever the data available, the data sources and the standard formats of the data fields are not followed properly. The standard format is important when the data is compared over several time spans.
- Another significant problem is that there is no published list of the data sources that can be used by the end users, although the data sources are normally the government or the city corporation authority itself.
- A spatial set of data is sometimes available which the different researchers generate for their own specified purposes but is certainly much useful to the RCC authority. The nature, type and their sources are often neither known, nor easily accessible to the general users.
- Certain data collected by the city corporation and other organizations are not systematically done. During collection procedure no geographical area is followed systematically. Due to this problem, some times it becomes difficult to understand the related location specific problems and its magnitude specially.
- The data types, nature and their potentiality are not generally understood with full extent by the users. Due to this problem the data cannot be utilized with its full capacity.
- The logical relation between decision makers and other users and data sources is also not found. This stops and affects both smooth data movement and efficient decision-making.

- The maintenance of the data and storing of the data are not computerized. This is very important in the present day context. The use of the data is more complicated in nature. The data are often found to be lost as process. The computerized system helps repeated query, updating, easy data transfer from one place to another. Maintenance as well as efficient storing reduces time in operations and increases efficiency and accuracy in decision-making processes.

1.3 Objectives

Based on the above problems the specific objectives for the research is outlined below:

- To create and prepare an overall situation analysis of the city's existing data availability and the data base management system.
- To identify the possible nature of the use of the available data and identify their possible users and also include a logical relation and different levels of users for easy flow of the data and mechanism.
- To design and develop a GIS based conceptual model for development of a municipal information system.
- To identify the information needs and information flow among the different processes.

1.4 Rationale of the Research

The main objective of municipal government is to provide services to the citizens of the community. A municipality serves the community through several departments, each of which performs one or several urban management functions. With the process of urbanisation many departments have to be created to fulfil the extended complex services. A huge quality of information of different types is to be handled to perform all these operations. At present, the data are stored in paper filling system, which is very difficult for quick retrieval and necessary updating. Another common problem is to identify and manage these data. The existing system also cannot efficiently deal with the spatial data and it is very difficult to relate spatial and attribute data. GISs are characterised by their capacity to deal with huge amount of both spatial and attribute data (Aronoff, 1993).

Good decisions require good information (Rogers, *et al.*, 1965). The operation level of the government (the tax assessors, building inspectors, the meter readers' etc.) contains the people who work with and depend on data daily to perform their tasks. If the information is bad, inaccurate or out of data then their jobs are difficult to perform. Not all of those data that are created by the operations level of the municipality, however, are needed at the management level. The managers generally need summary information of the operational data. Instead of house-by-house or parcel-by-parcel data, managers need aggregate information. Even fewer data are needed for policy purposes less detailed but more integration, aggregation and flexibility are needed to meet the ever-changing information needs at the policy level (Alam, 1992).

The goal then in developing information system is to design once needed at the operation level of the municipality, but also with the necessary standard and flexibility to allow the data to be integrated with other data in different functions of the organisations and aggregated in summary form for assimilation at the management and policy levels. The data processor should strive to develop a system that not only improved the municipality, but can also be needs by the managers and policy makers to improve decision-making, planning and policy analysis. A GIS based municipal information system can facilitate or satisfy the above-mentioned requirements of the municipality (Harrison, 1992).

The GIS itself not only gives facilities quickly, efficiently and accurately but also organises and displays geographically (Burrough, 2001). Furthermore, a GIS also allows the planners to derive new information by integrating the spatial and non-spatial information. With a GIS, the planners can also query the urban database based on certain criterion and display the results on a map and study the spatial distribution of records or attributes.

A GIS will connect the map representation of the municipality or other jurisdiction with a database consisting of the individual or aggregated observations about the land or the human activities on it (Dokmeci, 1993). More advanced techniques and large data inputs have been added to analytical power through the use of GIS and complex models within it.

1.5 Advantages over the present system

The advantages of a municipal information system are manifold. Some of the most important aspects of it are given below:

- Topologically structured of GIS database can ensure reduction or elimination of data redundancy and considering only one base map for a municipality. One department develops and maintains the map while all other use it. This procedure makes it easier to produce quality map. Also multiple departments can share the cost for the base map preparation. Time saving is also realized through the interdepartmental cooperation.

- The data and time constraints can be reduced by implementing computerized system. Electronic field data record improves not only the field data collection process and the efficiency of MIS data acquisition, but it also boosts the efficiency of the collection of non MIS related data

- Data sharing and workload balancing within the departments can be achieved through MIS. Interdepartmental cooperation can be one of the most prominent advantages. Once the initial resistance is overcome, participants in the project would realize the benefits and would eager to share data and workload

- Wide array of data and their cumulative presentation help the managers to foresee the demand and supply situation of a community in the context of community facilities planning. The system also facilitates the decision making process by giving the managers more information in time, thus allowing administrators to more informed and quicker in decisions.

- Continuously changing environment requires frequent updating of informations. It is relatively easier to update information in a computerized database. Correction and updating of database can be done easily in a topologically structured database without any major involvement.

- Decision-makers need data within a short notice to take the decision quickly. As a decision support system, a GIS based municipal information system will provide easy and quick retrieval of information. Maps (in selected area/feature) in any scale and size can be produced in a short notice.

1.6 Municipality

Municipality means a town or a city or a district with its local government or local council. The basic form of a local government in Bangladesh, a municipal corporation is a political body organized in pursuance of state law consisting of the inhabitants of a designate area. A municipality may impose tax to raise its fund. Depending upon their size, the degree of self-government conferred by the state and the nomenclature adopted by the state, municipal corporations may be designated as cities or towns (Carr, 1992).

1.7 Information System

A centralized and generally computerized system of collecting, storing, updating and disseminating data that may be easily retrieved and organized for analysis. Information system can also be used to provide data for various types of statistical analyses or development of models (Fig. 1.1). An information system is defined to be a set of computer hardware and software, communication system, decision models and organizational procedures and practices, So, data are captured and assembled as to ensure data quality, transmission, processing and storage in accordance with a given performance criterion to assist decision making and planning (Grundstin 1966)

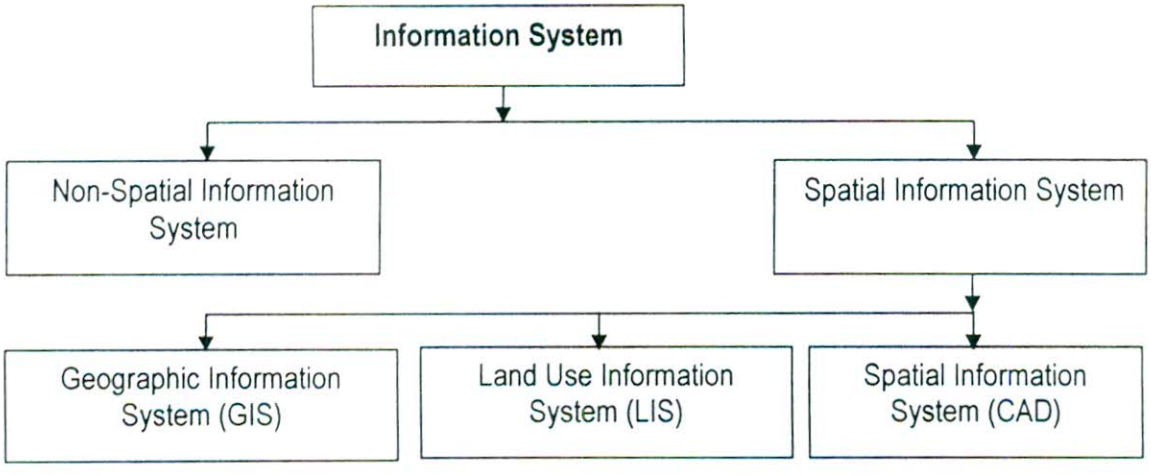


Fig. 1.1: A classification of Information System.

For the development of any country, it is necessary to have potential tools for proper and complete planning and decision-making. One of the requirements in this process is to build and maintain an up-to-date information system (Archer, 1987). As this information system is related to planning activity so it may be called a planning information system. At the national level, any planning concept is too basically decided on the basis of state planning and inter-state planning, which is further based on regions of state and inter regional level planning (Leorey, *et al.*, 1995). Municipal level planning is based on the urban level planning (Meadow, 1967). Hence, a planning information system is a four-tier structure consisting of:

- National Level Information System;
- District Level Information System;
- Municipal Level Information System; and
- Rural Level Information System

Municipal Information System covers wide spectrum of information related to area, population activities, Land use etc. Municipal information system is an integrated system of several sub-systems. Some of them are as follows:

- Land Information System;
- People Information System;
- Activity Information System;
- Services Information System;
- Finance Information System;
- Management Information System; and
- Traffic & Transportation Information System.

These Sub-systems further consists of several sub-systems.

1.7.1 Land Information System

This system contains the complete details related to land. It may have the following sub-system:

Land use Sub-system:

This sub-system contains the information related to land use, which can be further classified as:

- Natural Land use sub-system;
- Man Made Land use sub-system;
- Land Geology Land use sub-system; and
- Land Climate Land use sub-system.

This system will have the data file which are containing the data collected area wise which can be used to have analytical output as well as to generate maps (like thematic map)

This area under consideration is different from sub-system to sub-system but the units should be taken in such a way so that the relation between various data belonging to different sub-system can be established easily.

1.7.2 Natural Land Use sub-system:

In this sub-system the areas will be divided into a grid pattern which is essentially same as used by survey of Bangladesh. This grid information is based on latitude and longitude co-ordinate system. According to the proposal of area wise this size works out at 15 Sq. Km grids for regional level and 2 Sq. Km. grids for urban level. But, generally the data is collected ward wise and this is required to encode into grid storage pattern. But this coding is not so easy. Therefore, it is suggested that the grid should be divided into smallar units, which are compatible with the municipality boundaries. This sub-system will have a data file containing following data items:

- Geo code
- Land Identification Number
- Land use code area output (if, any)

In the land use code it will cover:

- Agriculture land;
- Barren/uncultivated land;

- Tree crops, garden;
- Orchared (plantation);
- Nurseries;
- Forest respect;
- Mining and quarrying; and
- Any other use.

1.7.3 Man Made land use sub-system:

This sub-system have been divided as man made urban land use sub-system:

Use of land and buildings

- Geo code;
- Ward number;
- Premises (land identification) number;
- Street number;
- Premises area;
- Number of residents;
- Ground floor use code and area (coding structure will also include the combination of mix use);
- First floor use code and area; and
- Similarly for each floor of that premises.

Owner and occupiers of lands and buildings

- Ward;
- Ward number;
- Premises number;
- Name (s) of owner (s);
- Address of owners;
- Name of occupiers;
- Address of occupiers;
- Period of occupiers;
- Last recorded sale or transfer on (date);
- Name (s) of previous owner (s);

- Address of previous owner (s); and
- Last recorded sale price.

Physical description of lands and buildings

- Geo code;
- Ward number;
- Premises number;
- Plot area;
- Boundary (length) North, South, East & West;
- Whether there is any construction on the plot;
- Covered area in each storey;
- Wall and roof type;
- Number of dwelling units;
- Carpet area on each floor;
- Total number of rooms;
- Number of rooms in each floor;
- Building plan sanction on (date);
- Latest dates of plan modification;
- Ref. no. for plan modification; and
- Draw back code.

Services to land and buildings

- Geo code;
- Ward number;
- Premises number;
- Sources of water supply (piped form rivers/wells/ponds/tanks/tubewells/hand pumps etc.);
- Whether water supply is metered;
- Quality of water (saline/hard etc);
- Type of sewage system; and
- Is electricity connection there?

1.7.4 Land Geology sub-system

In this sub-system data files will have following data fields:

- Geo code;
- Land identification;
- Soil classification code;
- Rock type code; and
- Engineering significance code.

1.7.5 Land Climate sub-system

- Geo code;
- Land identification;
- Temperature (monthly average);
- Rainfall (monthly average);
- Maximum rainfall in a day (for the whole year);
- Minimum rainfall in a day (for the whole year);
- Relative humidity;
- Wind direction/velocity;
- Air pollution present; and
- Types of pollution and sources.

1.7.6 People Information System

This system may contain the demographic characteristics and details of households. It may have following sub-system:

- People–population information sub-system;
- People–occupational information sub-system;
- People–socio economic information sub-system; and
- People–attributes (preferences) information sub-system.

1.7.7 Activity Information System:

This system contains the details of commercial and industrial activities. It may have sub-system like

- Activity-commercial information sub-system;
- Activity-industrial information sub-system

1.7.8 Services Information System:

The various types of services available should be included in this system, which may be listed as:

- Services-water information sub-system;
- Services-sewage information sub-system; and
- Services-electricity information sub-system.

1.7.9 Finance Information System

It may have the information-related finance, sources, expenditure, net prices of commodities etc.

1.7.10 Traffic & Transportation Information System

The details related to traffic load transportation facilities available be a part of this system. It may contain:

- Traffic-volume information sub-system;
- Traffic-parking facilities information sub-system;
- Traffic-noise level information sub-system;
- Traffic-O.D Information sub-system;
- Traffic-road Inventory information sub-system;
- Traffic-road designing information sub-system; and
- Traffic-accident information sub-system.

These sub-system and their associationship may be developed using almost same type to step, which are required to build any information system.

1.8 Conceptual Baseline

The application of computerized database system including GIS application, particularly in the field of urban studies, is not a very recent phenomenon. The technology in urban application started as early as in the late 60's at the School of Computer Graphic at Harvard. A very significant phenomenon of the technology is that it contains a very powerful database ensign that aids the technology by increasing its functional capabilities (Diamond, 1983). This was strongly supported by powerful and faster processor, computer memory management system and overall hardware architecture. One example is the computer's read-write memory system that increased from just 2MB in a PC in the late 1980's to more than 20 GB at present. This is very much essential to the handling of large volume of data. The other significant phenomenon is its display system. In just 20 years the change of the capacity to handle millions of colors for feature identification which is indeed very important, particularly for sensor applications and spatial data management. Other significant phenomenon is the introduction of various application software in the field of database management system and GIS technology. For example, dBase software. Once it was the number one database management system software in the world. At present it is owned by the Borland and Microsoft known as FoxPro and MS Access, the most powerful attribute database management system in the world, although the introduction of Oracle is more significant and revealing as a new solution to the database problem. The development of GIS software, noticeably its standard, was raised with the introduction of PC Arc/Info in the mid-eighties by ESRI in California. There was still some other GIS software such as the GIMMS of England (developed by Durhan University), UseMap of ITC etc. At present roughly there are about more than 5,000 GIS software used in various application in the world. But most important among then are PC Arc/Info, MapInfo, IDRISI etc. Although logical designing of the automated database management system is found to be used in the western world in various applications during the last about 20 years, its application and use is very recent in Bangladesh context. The western applications are mostly found in the cases of North America, Western Europe, Australia and one or two places in Asia such as Hongkong and India. Most of the applications have been found to maintain their attention focused particularly on the quicker and logical data searching, digital mapping and their integration. In fact, these are the most vital components of the present day database engines. The ideas could help elaborate and be examined by some specific case studies.

Geographic Information system is not a new technology in the world even in Bangladesh. GIS is an applied science and planners and decision-makers can make their tasks easier by using this technology (Huxhold, 1991). During the eighties and nineties, a large body of literature has appeared on application of GIS. Literature about the municipal application is very scanty. In our country this study is completely new and more probably a pioneer work. Different municipal agencies in northern America are using GIS based municipal assessment techniques for a long time. Access to the world information network is very much limited in this country. There is a lack of any sort of comprehensive study of municipal information.

Most of the literatures on municipal information system look mainly into the following issues:

- Advantage of incorporating GIS in municipal functions;
- Methodology of incorporating GIS in municipal information base ; and
- Database of a municipal information system.

Dengermond and Freeman (1984) offered a new perspective on the interrelationships among land and geographic data, which are used in a municipality. The various categories of land related data and how they interact to form a municipal database are described. The properly summarized data and the results of an In-depth study applied in a rigorous scientific methodology and approach for identification of a municipal database was emphasized. In describing this municipal model an attempt has been first made to develop a conceptual model to present without regard to the organizational structure, institutional context, or the way that entities are implemented within an existing municipality.

Kabir (1997) in his unpublished master's thesis has shown various urban applications of GIS. Among them, municipal tax assessment is a vital one. Different nations have their own taxation systems with their own criteria for assessment. He identified some basic criteria upon which tax is assessed. This study suggests that quality and efficiency of GIS based municipal taxation system is dependent on the scale, accuracy and its adaptability of data. An integrated type of taxation system, which incorporates a number of those characteristics, could be a facility by the use of LIS. Basically Kabir's study is a conceptual work.

Amer, Sliuzas and Sun (1993) produced a knowledge based urban valuation technique. This study assumed that the economic market value is the average cash payment, a sensible buyer would pay for the property in open market at the time of valuation. Since all the properties to be taxed are not on scale at the time of valuation. A methodology or model has been developed in this study. The valuation process involved the input and analysis of large amount property data, their location characteristics and comparison with scale information. Through the integration of a GIS with an expert system and statistical analysis tool, the automation of the whole processes of valuation was realized. In this study the property valuation model is not explained. The application of this model using GIS is not described. There is no guideline for the automation of this process.

Iaian Gault and David Peutheir (1990) has shown how the GIS capabilities in the information system have been managed in Birmingham city and **Strathclyde** Regional Council in England. They first identified information management issue on several points such as –

- Information system should be designed corporately ensuring that the need of all management levels and parts of the organization are made.
- The system should be able to provide each part of the organization with the information if it is required.
- Information has to be available for use selectively.
- The system should be integrated interactive and networked for better data mobility.
- The system should be able to provide information on a small area basis but should also have the flexibility about the whole range of spatial units.
- The data must be of good or at least defined quality.

Anthony Gar-on Yeh (1990) has developed a LIS for monitoring land supply system of Hongkong's spatial urban development. As Hongkong is a very land scarce city, monitoring landuse and land supply is very important for urban development. His attention was basically on the geographical units supported by land feature information. He integrated three systems viz Basic Mapping System (BMS), Cadastral Information System (CIS) and Town Planning Information System (TPIS) into one Geographical Information Retrieval System (GIRS) accessible by different types of end users.

In a study on Vermont in USA **Thomas L. Millerte** developed a GIS application made for the growth and management of the Vermont Regional Planning Commission. He identified the part into five sectors such as nature resources, land use planning and zoning public work transportation, parcel mapping appraisal and water/swear utilities. His levels of data were state level, local level and the city level. The sources of the data were again very much diversified such as from ortho photo base map, soil associate map to topographic map for relief features.

Kazuaki Miyamoto and other (1995) tried to develop Decision Support System for integrated Planning for the environmental development of metropolice. They gave ideas of an analysis system which was a new approach to integrated planning, landuse, transport and the environment in a developed metropolice.

F.S Wand, Richardson and Roddic (1995) developed an indepth very small area model on urban solid waste integrated management. For their model the considered components are as below.

- Demand models that describe demand of various waste management service in terms of waste generated practice grade recycling programs etc.
- Supply models that relate this systems operating characteristics.
- Impact models evaluation and the economic impact in terms of the cost providing system and environmental impacts
    - a useful friendly interface

They also demonstrate using their model, that it was capable to simulating a complex waste management system in an interactive user friendly ways and thus assessing user decision makers to evaluate various waste management obtain in terms of their economic and social impact.

Marquez and Maheepata (1995) developed a Decision Support System for planning and urban development and utility services. They had outlined that the system was facilitated by the through and evaluate in the involving landuse and the delivery of utilities such as water, gass, telephone and electricity.

In a study on **Vishkapatnan and Vizag** (1987) Sliuzas et. al. applied the information system for integration of data in one single format to be used in planning .He indicated a logical setup of different types of data and information (organized both horizontally and vertically) could be

used efficiently. He classified the basic urban data and information into five object-oriented groups (problem) viz, housing, water supply, other basic services–pollution, planning and implementation.

A very important work was carried out by **Olof Wastesson** on the Swedish setup. He carried a land data bank for collecting, storing, processing and presenting land related data. His system by now has got a legal status and has provided effective and economical system. The Major components are:

- Better data quality;
- Increase efficiency of the properly and land register authority;
- Relational data flows;
- Easy access to the context; and
- Enhance possibility to compile analysis and present the context of the real property and land register.

His overall functional diagram is given below:

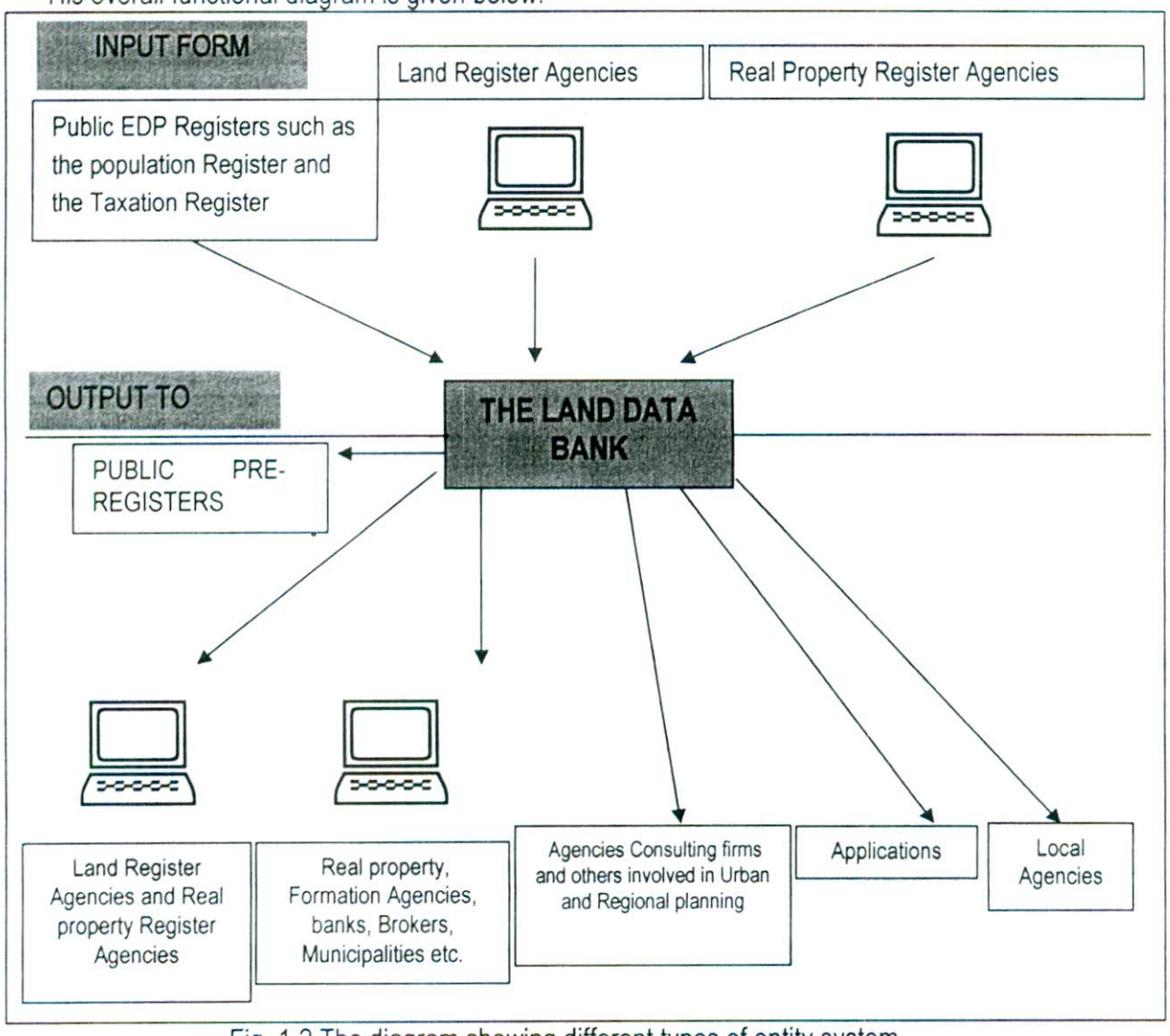


Fig. 1.2 The diagram showing different types of entity system.

System emphasises 15 logical databases. Within each database they are structured in post containing one or more segments on various levels (hierarchical structure). Each logical database was divided into several databases (a maximum of 16). This construction presented a division of data into 16 regions. The division has been carried out as such that each region contains data one or more countage. The databases can be tried in separate system. As a main result the system could produce different useful output such as linking of registrar, listing of real property units, various thematic mapping, various census mapping etc.

Scott Gibbons developed a pilot model of integrated database management system for Mirzapur city in India (Jan-Feb, 1999). The model tested the full range of application for identified diagrams and resolving administrative problems that have been unresolved for decades. In this process there was misconception about the database, operation and application of GIS in India that have been cleared. He identified that due to efficient system, the revenue system has been developed which was largely affected by manual record keeping in the pervious years.

Works in Bangladesh

Although different projects have been taken up by the government of Bangladesh and different foreign donors and development agencies relating to the advancement and modernization of country's database system of different sectors but particularly little has been completed distinctively in context to any urban center in Bangladesh.

In Bangladesh Hemayet Hossain (1995) did a pioneer work relating to the creation of modernized computerized system for land records. The basic problem of the land record system of Bangladesh is the disintegrated situation where everything is kept and maintained manually. The vital two components of this traditional system include *Mauza* maps (composed of several sheets of maps some times) and corresponding *Katian* and record of rights.

The system has been proved incapable of identifying access to ownership pattern of lands i,e, unable to trace a owner having lands in different locations apart.

Hossain has efficiently developed a single integrated system where the problem could be minimized. His entire system is outlined in the bellow diagram:

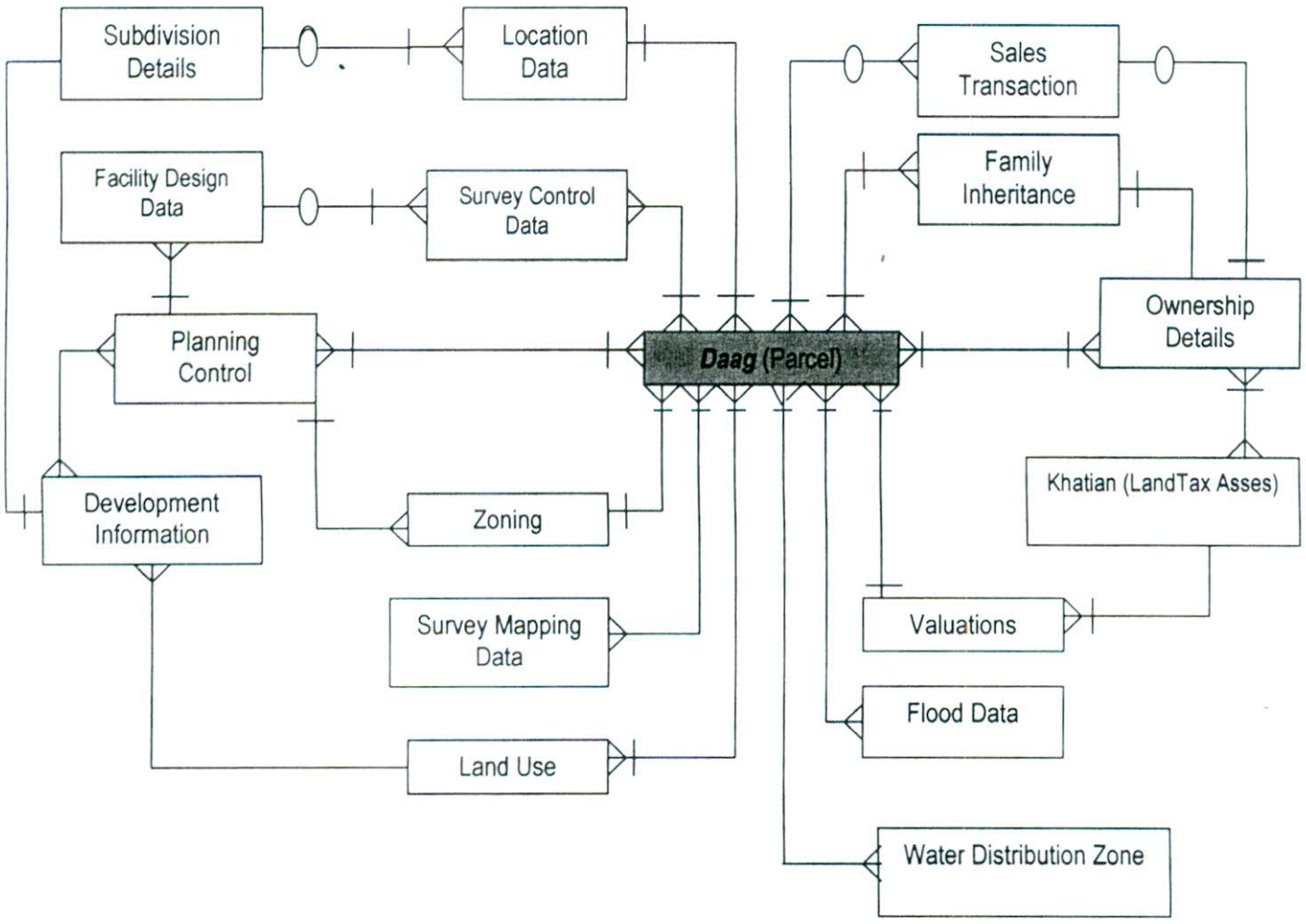


Fig.1.3 The diagram showing Integrated LIS for Bangladesh Cadastral System.

The above diagram has showed possible relationship that may exist between various entities in a multipurpose LIS database. At present there is many to many relationships between *Khatian* and persons i.e, the persons may be represented in more than one *Khatian* and again a *Khatian* may hold more than one person.

Ahmed, R (1997) created an integrated database system for Rajshahi city, where he classified attribute data into three types such as static, dynmaic and facilities. The maps were created in conventional method in different levels. The work was found significant at certain level because the system was efficiently used for the identification of city's Central Business District (CBD).

Rahman, M. M. (1999) which was on certain components of urban database management system for Rajshahi City Corporation did the only directly related work. He developed a model structure where the relation pattern of the decision-makers and end-users and the sources are indicated.

CHAPTER-2

City extent

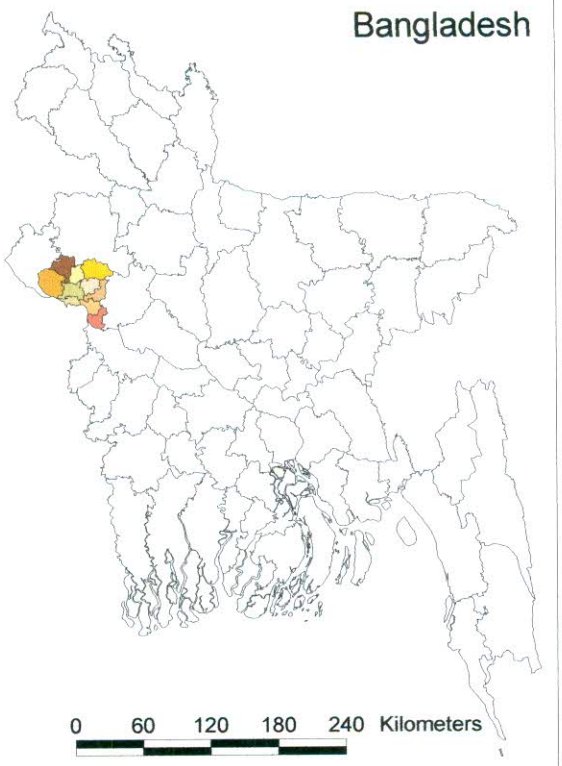
2.1 Introduction .

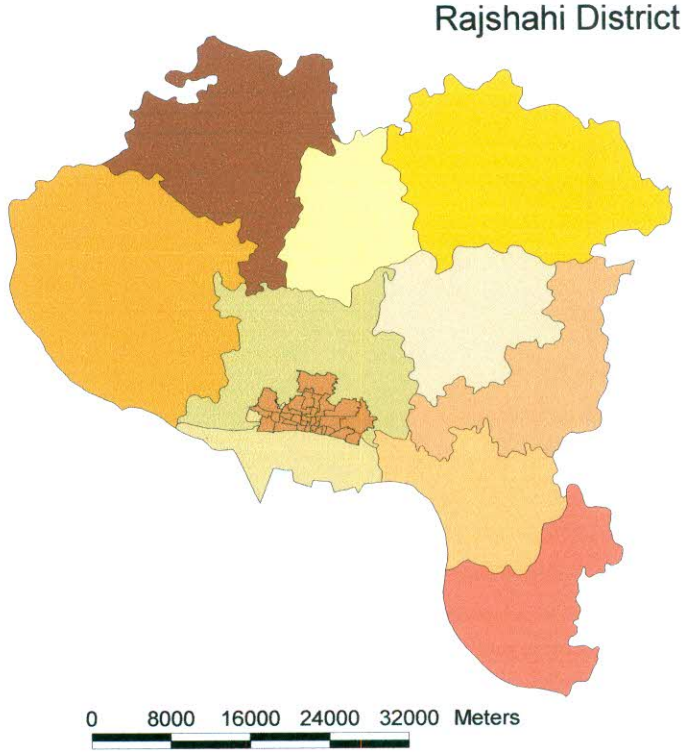
Rajshahi city is the headquarters of the Rajshahi division of Bangladesh comprising the north western districts lying west of the Jamuna river and north of the mighty Padma river. The ward 'Rajshahi' is commonly believed to mean 'royal territory', and it is a popular idea that the district was given this designation because it was the home of many 'Rajas Kings'. However, there are arguments among the experts about the origin of the name Rajshahi. The Bangladesh Gazetteer, Rajshahi (GOB,1976,p.1) refers to Professor Blochmann who thought that the name dates back to the beginning of the fifteenth century A.D. when this part of the country was ruled over the Raja Kans or Ganesh, the Hindu chief of Bhaturia (i.e. the country on both sides of the river Atrai in Dinajpur and Rajshahi). The Raja, expelling the Sultan of Gaur, became the king of Bengal and consequently has known as Raja-Shah i.e. a Hindu raja that ascended the Muslim throne, while his territory acquired the name Rajshahi.

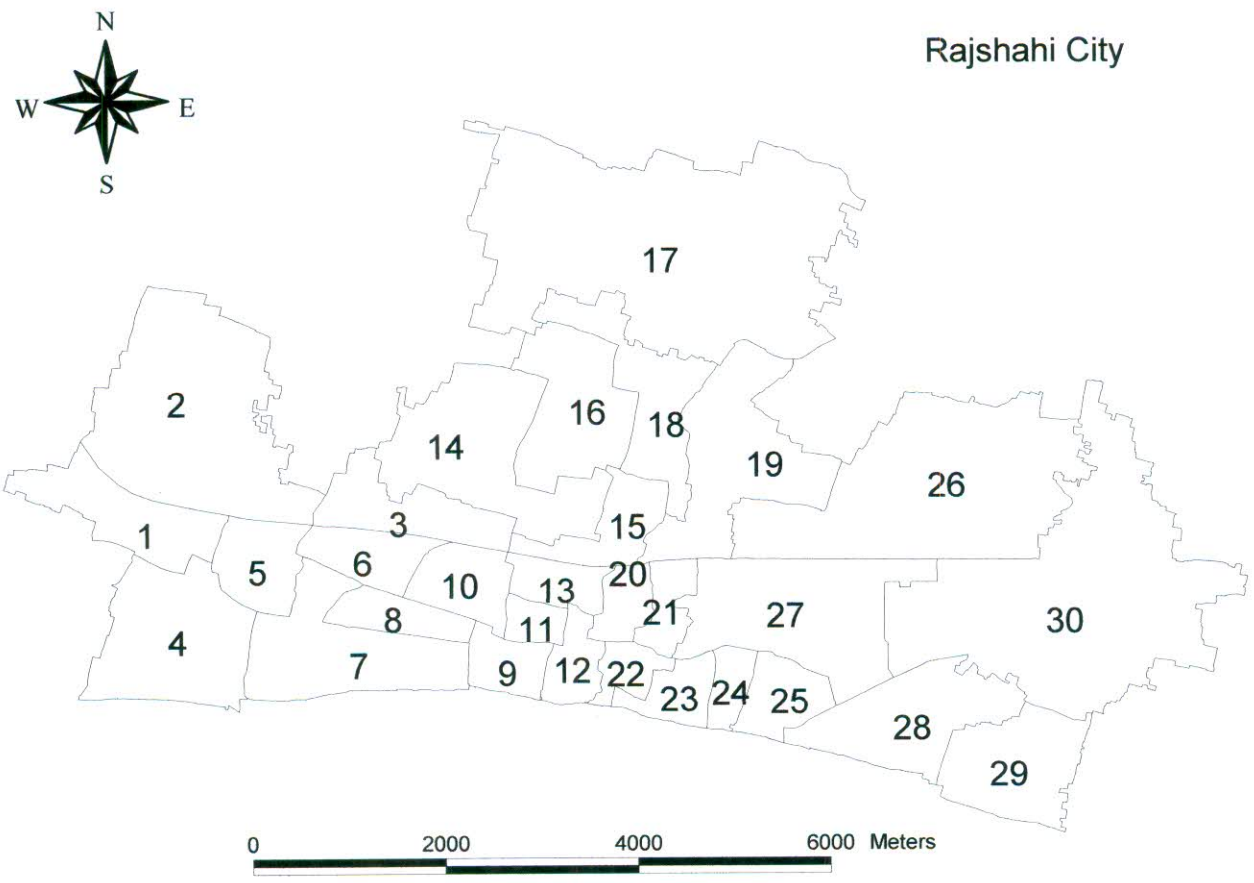
From a small city population of only about 40,000 in 1951 the city has currently grown into the fourth largest city in Bangladesh (Map 2.1). Its current population is over half a million. Its legal and administrative status has changed over the years paralleling its growth in population and importance in the national urban hierarchy. It became a municipality in 1876, a Municipal Corporation in 1987 and finally a Metropolitan City Corporation in 1992. The city is situated along the left bank of the River Padma and at a road distance of about 270 km from the capital Dhaka.

According to census data, the population has grown at about 6.4% per year over the past decade. The rapid growth rate is not likely to decline in the near future. At present conservative estimates of population projection for Rajshahi city in the year 2000 is around 0.9 million. Rajshahi city can be characterized as an administrative and educational center in an agriculture setting with trading and some industries. As an administrative center the city has grown over the years. From the mid fifties onwards, the growth increased due to the establishment of many educational and government institutions the services sector is the most important single employment generator of Rajshahi city. In the private sector trade and transportation are the most important economic activities while in the suburban, the agriculture sector plays an important role, too.

Location Map of the Study Area







Map No. 2.1

2.2 Physical Environment

The town occupies the flat alluvial land bordering the northern bank of the river Padma. The core area of the city consists of high land having ground elevation around 18.3 m with higher grounds situated along the bank of the river Padma which gradually slope down towards the north to a minimum level of 15.2 m at the northwest corner of the city corporation area. There are some lands depressions particularly to the north-west and also in some areas to the north-east. The plan view of the City Corporation area looks like an inverted `T', (Arephin, 1981) its maximum length along the east-west direction is about 13 Km and along the north-south is 8 Km.

Geologically, Rajshahi district is situated in the Bengal basin, a huge subsiding alluvial basin, filled in with huge quantity of sediments, deposited by the Brahmaputra and their many tributaries. The depth of the alluvium according to recent calculations is not more than 6,500 ft. physiographically, the Rajshahi District. As the rivers are still continually shifting their beds and frequently flooding large areas, they cause extreme variations in flow velocities. The grain size of the alluvial deposits varies to a large extent both laterally and vertically. In Rajshahi town area the subsoil is composed of a superficial clayey layer with a thickness of approximately 18m and below this there is a layer of fine sand, approximately 24m thick. Between 42 and 80m below the ground level, the subsoil consists of coarse sand with gravel; below this is a fine sand layer down to 95m.

Rajshahi City Corporation area is surrounded by two major rivers namely the Padma and Barnai khals of Barnai river which are connected with bags lying to the north -west and north - east corners of the corporation area. The Padma river borders the southern boundary of the corporation. The river Barnai is situated at about 6 km to the north of the city corporation and its branch canals are lying either on the north or on the north-east/west and are connected with beels, namely silinder and folier beel. The branch cannels of Barnai river are interconnected with a number of channels coming from the City Corporation after crossing the railway culverts of which the Dargarpara, Kalpana, Kazla and Satbaria are worth mentioning. All the north running branch khals of the Barnai play an important role in the drainage system of the Corporation area. In the peak monsoon season, the drainage water runs towards the north direction and during the remaining period of the year the runoff drains towards the Barnai river

on both directions i.e. the Padma and the Barnai rivers depending on the hydraulic conditions. The Barnai river lies in the Baral basin which discharges to the river Jamuna.

The weather in Rajshahi town is pleasant during October to February. The maximum temperature is observed during the month of April to October and the minimum temperature occurs in January. Summer begins from April and continues till October. Monsoon normally starts from June and continues till September. The annual rainfall is around 1400 mm. The maximum and minimum temperatures are 35°C and 6°C respectively. The maximum and minimum humidity are 90% and 5% respectively.

Old river-beds, ponds, marshes and streams with sluggish currents have a copious vegetation of vallisnera and other plants. Lands subjected to inundation have usually a covering of Tamarish and reedy grass. There are no forests. Usually higher grounds are covered with bamboo and grass. The banyan, pipul and semul may be seen. In some parts of the district, the mango crop is important. Palm, datepalm are common. Fauna includes wild cats, jackals, foxes, dogs and hares among others. Birds include wild fowls, ducks. teals, snipes, coots, plovers, sandpipers, pigeons etc.

2.3 Description of the wards

The city was composed of 30 administrative units or wards until recently. But, however, at present it has been raised to 35 administrative wards for the convenience of city administration. The urban administrative and spatial jurisdiction in Bangladesh is slightly different than that of the countryside. Below the level of the ward, there is another geographical unit known as *Mohalla*. Although not identical, *Mohalla* is considered broadly equivalent to the village in countryside. The ward is considered equivalent to a union in the countryside. But a city does not exactly correspond to any other unit in the regional base and in a way the cities are unique of its character. This is due to the special nature of the urban administrative system. Thus Rajshahi City has got its different wards and *Mohallahs* like other cities in Bangladesh. The geographical units are again different, sometimes based on purpose. In addition to the ward-system, Rajshahi City is also composed of 39 *Mauzas*. Each *Mouza* is composed of several cadastral sheets depending on the compactness of the use of land. For example *Mouza* number 10 (*Boalia*) is composed of 21 sheets. Until 1990 there were 12 *Mauza* in the Rajshahi urban area. The number of the wards was fewer in the beginning of this century. Increase in

the number of wards is directly related to the growth of population and land use. Below is the table showing present ward names, area and population:

Table 2.1: Ward particulars

Principal Identifier	Name of the Ward	Total population (2001)	Density 2001	Area (ha)	.....	N number
882201	Ward No–01	12700	4339	265	.....	.....
882202	Ward No–02	10031	2202	410	.....	.....
882203	Ward No–03	12980	1862	111	.....	.....
882204	Ward No–04	9441	4618	48	.....	.....
882205	Ward No–05	12800	6115	74	.....	.....
882206	Ward No–06	16338	5857	122	.....	.....
882207	Ward No–07	11708	3501	170	.....	.....
882208	Ward No–08	9334	4184	56	.....	.....
882209	Ward No–09	4881	4384	18	.....	.....
882210	Ward No–10	6274	3752	40	.....	.....
882211	Ward No–11	7217	4107	23	.....	.....
882212	Ward No–12	9707	4944	26	.....	.....
882213	Ward No–13	5964	2616	25	.....	.....
882214	Ward No–14	5639	2474	21	.....	.....
882215	Ward No–15	8403	3448	51	.....	.....
882216	Ward No–16	19942	4336	180	.....	.....
882217	Ward No–17	12835	4008	134	.....	.....
882218	Ward No–18	12493	3455	758	.....	.....
882219	Ward No–19	12736	3121	316	.....	.....
882220	Ward No–20	16256	2254	167	.....	.....
882221	Ward No–21	3475	8962	29	.....	.....
882222	Ward No–22	9307	3756	43	.....	.....
882223	Ward No–23	8018	3744	32	.....	.....
882224	Ward No–24	8431	3944	53	.....	.....
882225	Ward No–25	10268	4723	40	.....	.....
882226	Ward No–26	11702	5363	51	.....	.....
882227	Ward No–27	22111	1830	640	.....	.....
882228	Ward No–28	17749	5965	339	.....	.....
882229	Ward No–29	10989	6572	225	.....	.....
882230	Ward No–30	13655	4352	305	.....	.....

Source: BBS, 2001

2.4 Other physical infrastructures

Among the major physical infrastructures, the important are roads, railway line, embankment along the rivers and drainage system. The road network is somewhat star-like, radiating from the center of the city. There are three important arterial roads leading directly to the east (to connect Dhaka), to the west (to connect Nawabganj) and to the north (to connect Noagoan). There is an another important arterial road located in a half a circle about 2 to 3 Km away from the city center connecting all the roads from the city center. The area within this half circle is the most important considering land use. There are several connecting roads in between these road features creating a radial network system in communication. The subsequent further developments are following this pattern. The density of the road network decreases as distance increases from the city center.

The roads are of different nature, purpose and importance. Although most of the roads, whether narrow or wide, are metaled, there are still some unmetaled roads found in the neighborhoods. Some of the highway type roads such as the Natore Road and Grater Road already metaled are maintained by Roads and Highways Department. All other Roads currently belong to the City Corporation Authority. The roads have several components, such as its width, intersection, construction type, year of construction, traffic type etc.

The city protection embankment was constructed in the beginning of this century and aimed to protect the city and surrounding area from riverbank erosion and flood and is still serving the purpose. The embankment is used partially as pedestrian movement too. It is made up of earthwork and some of its length is concrete and iron meshed. The embankment is about 15 Km long. The railway line is extended east west and situated about 2 Km north of the city center. The city is connected to the Dhaka City, the capital of Bangladesh and to other parts of the country by road, railway and air.

The city is also facilitated by a partial drainage system to drain out the wastewater from the city to the depressed land in the northwest and in the northeast. Recent water logging in certain parts of the city has made the city authority think for an up-gradation and construct more wide and permanent drains of different depth to drain out wastewater.

2.5 Facility infrastructure

There are different types of services rendered to the city whether it is public or private by type. Some of these facilities such as the privately owned facilities are placed to render services to the users on payment. This type of private services include private clinics, professional services and even all the retail and wholesale shops of different types and business activities. The public facilities include government owned and different social organizations and run various services to the people. These include different government office locations, hospitals, post offices, educational institutions, different social organizations etc.

The geographical distribution of these two types of facilities generally reflects different patterns. For example government owned and public facilities are located, based principally on administrative decision and administrative convenience but the privately owned facility locations are located as a result of the interaction between various factors such as consumption need, communication network, land value etc. These types of locations are dynamic and change their positions as a result of centripetal and centrifugal forces present in the process of urban growth and redistribution of land uses. The private facilities have a tendency to concentrate on the central area. In fact, government and public facilities are also located in the core urban areas of the city. For example, government and public facilities maintain a bigger cluster of locations in the mid-western part of the city.

2.6 Administrative infrastructure

Mainly two authorities run the city's overall administration. One is the government's, divisional and districts level authorities of different types and level and the other is the City Corporation Authority. Both are equally important in their magnitude and their control coverage as well as necessity. To run the administration, City Corporation maintains a number of departments directly accountable to the Mayor of the RCC. The RCC's organogram (Fig. 2.1) indicates the levels and working parameters of the City Corporation. The government's administrative departments are many in numbers. They are divided into different sections of jurisdiction. For example, four metropolitan Thanas under the City Metropolitan Police Authority control law and order situation. A special branch of the Metropolitan Police Authority called Traffic Department controls City's traffic system. Environmental administration is taken care of by the Department of Environment's local office in the city. The electricity and telephone is administrated by the respective Power Development Board and Bangladesh Telephone and Telegraph departments' local authorities in Rajshahi City. The government departments' function more or less in a

coordinated fashion is generally supervised by the district administrative authorities parallelly. On principle their functional jurisdiction and nature do not overlap but under certain special conditions some functions are found to overlap, such as, the health facilities and lower level education system. Geographically, spatial jurisdiction belongs to both the administrative systems. For example the RCC's jurisdiction is limited within its 40 Km^2 and subdivided into 30 wards. But the Rajshahi Metropolitan Police covers an area bigger than the city corporation area. The administrative jurisdiction of the electricity, telephone and postal departments also differ slightly than that of RCC jurisdiction.

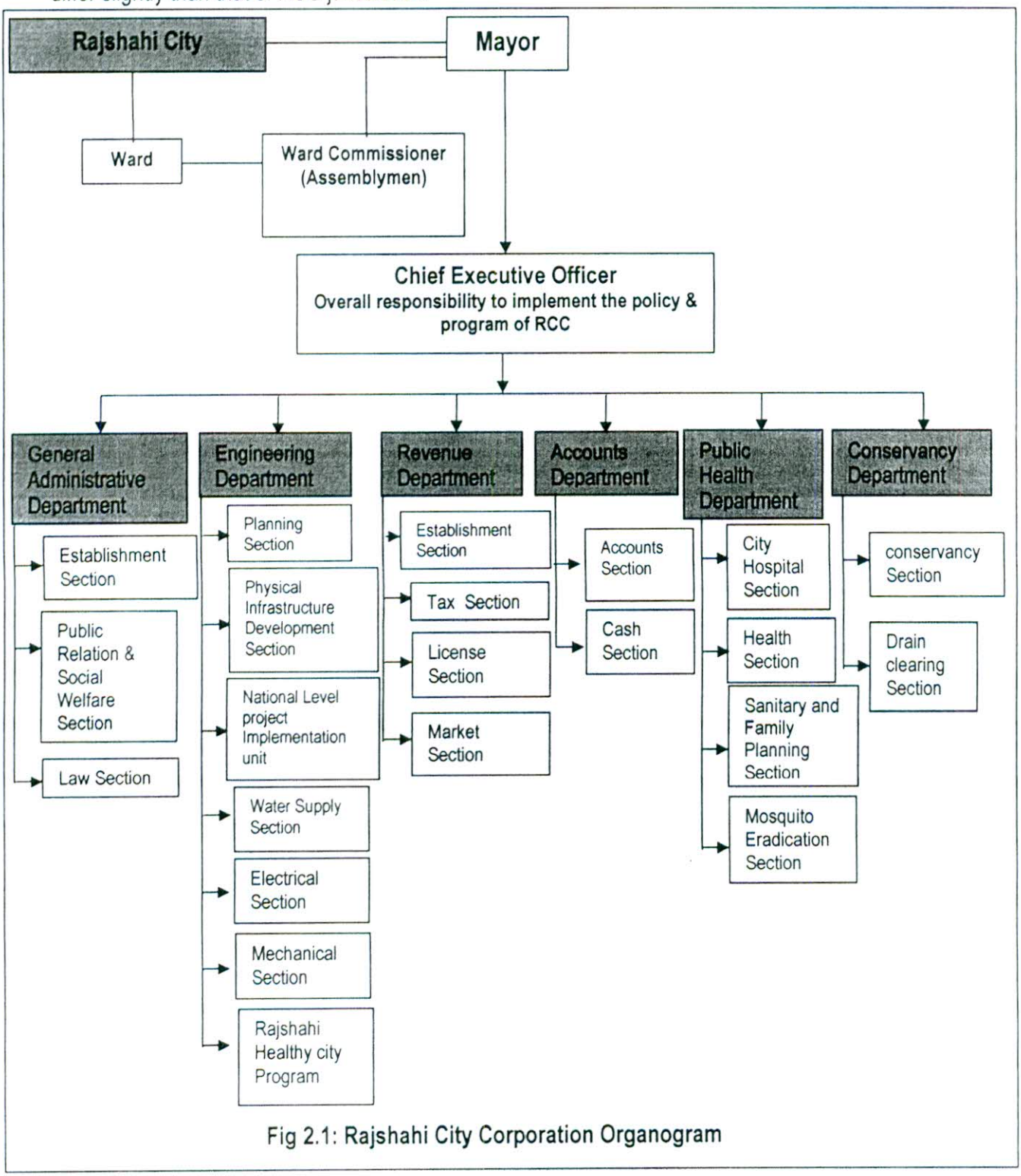


Fig 2.1: Rajshahi City Corporation Organogram

2.7 Financial infrastructure

The financial infrastructure includes the development sector and pertinent fund sources. The most important financial source for the overall development is the RCC. The RCC is responsible for the construction, development and maintenance of all the roads in the city, except one road (Greater Road), that is marked as the status of national highway controlled by the Roads and Highways Department under the Public Works Department. The City Corporation finances for the maintenance and development of water supply, sanitation and health services in the city. The money spent by the RCC comes from the RCC's own earnings through yearly tariff collection and government grants. The money spent for various developments by the government departments comes directly from government's exchequer. In recent years, it is observed that some non-government organizations spend a significant amount of money mainly in socio-economic and employment sectors in the city.

2.8 Socio-economic infrastructure

Socio-economic infrastructure is a very important component in the city structure. Optimum distribution of population is expected to ensure a safe and sound urban life. All kinds of activities functioning within the city rely on the composition as well as the structure of population. Uneven density and distribution of population make normal life haphazard. Socio-economic infrastructure characteristics include the population growth, composition and distribution, occupational status etc.

2.9 Population growth

The first population census was conducted in 1872 in the subcontinent. No population data of that time for Rajshahi City as well as for Bangladesh were available. However, in 1872 the population of Rajshahi city was estimated to be about 22,291. The general trend of population growth of Rajshahi city may be perceived from the Table 1.2. It is apparent that from 1872 to 1901, over a period of thirty years, the number of population in Rajshahi City remained almost static. During the period of 1901-1931, the growth rate of the city was markedly lower than the average growth rate of urban population of Bangladesh. During the decade 1931-1941 it was higher (Table 2.2). During the period of 1951-1991, the increase of population of the city was

found at an accelerating rate. And thus the population of the city now stands at about 0.7 million by the year 1996.

Table 2.2: Urban population growth of Rajshahi city and Bangladesh

Rajshahi city				Bangladesh		
Census year	Total Population	Intercensal variation		Total population	Intercensal variation	
		No	%		No	%
1872	22291	-------	--------	---	----	---
1881	19228	-3063	-13.7	---	----	---
1891	21407	2170	10.8	---	----	---
1901	21589	0182	0.85	702000	----	--
1911	23406	1817	8.4	807000	105000	14.96
1921	24598	1192	5.0	878000	71000	8.80
1931	27046	2448	10.0	1076000	198000	22.55
1941	40778	15732	50.6	1537000	461000	42.85
1951	39993	-1116	-2.7	1820000	283000	18.41
1961	56885	17223	43.4	2641000	821000	45.11
1974	96645	39760	69.7	6274000	3633000	137.56
1981	171600	74955	77.55	13228163	6954563	110.85
1991	294056	122456	71.36	22455174	7644041	69.75
2001	332054	402002	78.56	35224514	12769340	79.80

Source:

1. Census of Pakistan -1961, Vol-2, pp. 11-94
2. Bangladesh Population Census, 1974, bulletin–2, pp. 28-110.
3. Bangladesh Population Census, 1991, District vol. Rajshahi District.
4. Bangladesh Population Census, 2001, District volume.

2.10 Population distribution

The distribution and density of population in the city are shown in Table 1.3. In 1974 the total population of the city was 96645 (Table 2.2). According to 1981 census, the total population and the density of the city was 171,600 and 1022 respectively. In 1991 it reached to 294,056 and 1752 respectively. From 1981 to 1991, the city's population increased to 71.56 percent. Spatial variations are found in the distribution and density of population of the city (Map 2.2).

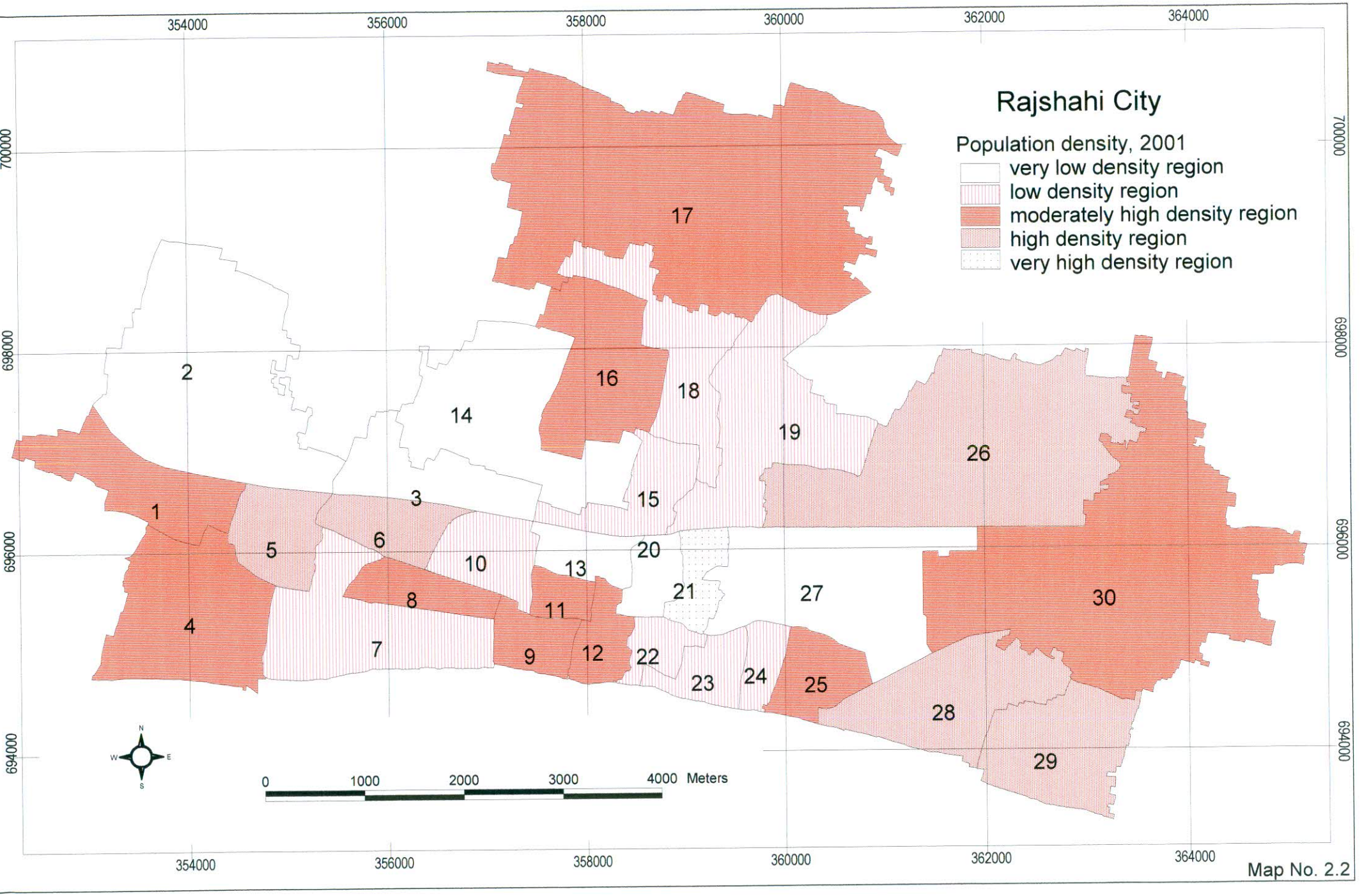
The city may be divided into three major regions such as: core region, semi-core region and the fringe region on the basis of land use pattern, intensity of development and relevant activities. It is perceived from the table that the core area, occupying 20.10 percent area of the city, includes 44.98 percent of the total population (Table: 2.3). The density of population is found to be 137 persons per ha. The density of population in the semi-core area, having 30.56% of the total area, is 65 persons per ha. Fringe area has a density of population of that is slightly lower.

According to the population density (Ward-wise) of Rajshahi City, the regions may be divided into five groups:

- Very low density region (0-19 persons per ha.)
- Low density region (20-39 persons per ha.)
- Moderately high density region (40-59 persons per ha.)
- High density region (60-79 persons per ha.)
- Very high density region (80-105 persons per ha.)

Very low density region: The regions, having a density of 0-19 persons per ha. have been categorized as the very low density regions. Very low density is seen to be extended eastward beyond the railway track and south of it. The western half of the city is generally characterized by very low density.

Low density region: Low density region, having 20-39 persons per ha is found near the embankment of the Padma river where the majority of the population live in different slums.


Rajshahi City
Population density, 2001
very low density region
low density region
moderately high density region
high density region
very high density region
354000
356000
358000
360000
362000
364000
700000
698000
696000
694000
1
2
3
4
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4000 Meters
Map No. 2.2

Moderately high density region: A single Ward No 11 is included in this region which includes the region- Hatemkhan (Shabzibazar), Hatemkhan (Panbahar), Malopara (Westem part), Rajarhata, Kadirganj (Western part of the graveyard), Matharpara, Kazikor para and Shahizipara.

High density region: High density regions are found in Ward No 6 and 25. The regions are Lakshmipur, Baharampur, Talaimari, (western part), and the southern parts of Raninagar.

Very high density region: Regions of this category are dominant in Boalia Para and Sultanabad of Ward No 20 and Sagorpara, Rampur Bazar and Ghoramara of the Ward No 22.

2.11 Population composition and structure

Population composition and structure include social and economic characteristics or attribute of population, age, sex, religion, occupation and income etc.

Age and sex structure: It represents the number of population of given age and sex in the area. The infant and adolescent population of this city constituted 42.24% of the total population belongs to economically dependant group.

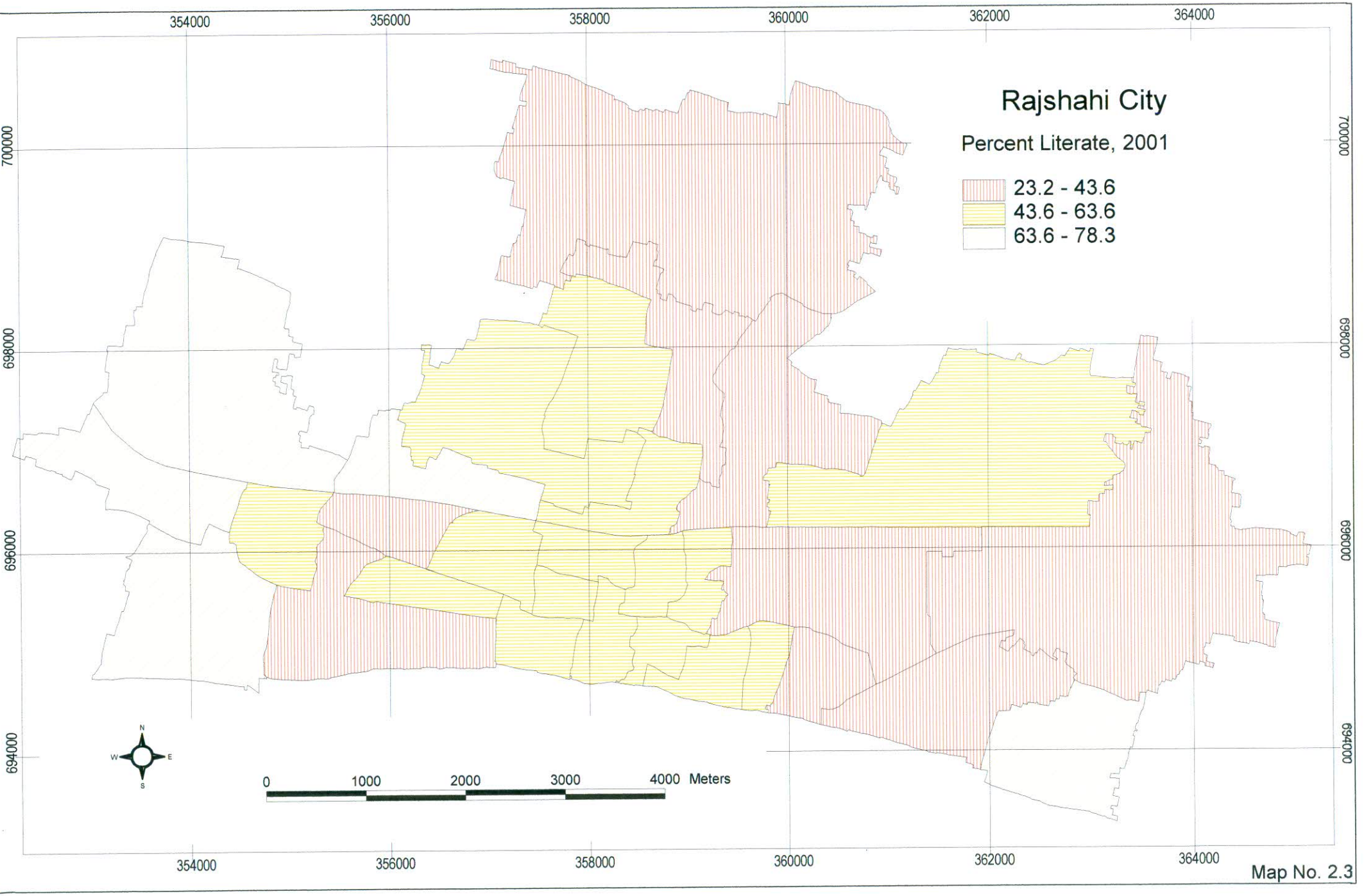
Sex ratio: In Bangladesh the sex ratio was 106 in 1991 while in Rajshahi city it was 111.15. The highest sex ratio estimated to be 172.79, is found in Ward No 07 and the lowest is 97.49 in Ward No 23.

Literacy : In Bangladesh a person who can write a letter in any language is termed as literate (1981, census). The UNDP (1997) report says that the literacy rate in Bangladesh was 37(1996). Literacy rate in Rajshahi City was estimated to be 59.60 percent (1991 census) in which the male and female constitute 65.57 percent and 34.43% receptively. Ward No 9 and 29 show the highest (78.2) and the lowest (23.2) literacy rate respectively (Map 2.3). The school going children population of 5-14 age groups constitutes 57.25 percent male and 49.1 percent female respectively. In 1981 it was 47.1 and 38.5 percent respectively. So there has been an overall improvement in school going children.

Table 2.3: Ward wise population density of Rajshahi City from 1991 - 2001

Ward no	Area (h)	Population 1991	Population 2001	Density 1991	Density 2001
01	265	11565	10986	44	41
02	410	5243	8677	13	21
03	111	6189	11228	57	101
04	48	8780	8167	183	170
05	74	9562	11073	129	150
06	122	13583	14133	111	116
07	170	7297	10128	43	60
08	56	8382	8082	150	144
09	18	4692	4222	261	235
10	40	6790	5427	170	136
11	23	6950	6243	302	271
12	26	9937	8397	382	232
13	25	6155	5159	246	206
14	21	6106	4878	291	232
15	51	6079	7269	119	143
16	180	3741	17251	21	96
17	134	10473	11103	78	83
18	758	-	10807	0	14
19	316	9285	11017	29	35
20	167	7741	14062	46	84
21	29	8528	7735	294	267
22	43	8755	8051	204	187
23	32	7554	6936	236	217
24	53	8355	7293	158	138
25	40	7897	8882	197	222
26	51	10547	10123	207	198
27	640	11593	19127	18	30
28	339	7465	15354	22	45
29	225	7527	9506	33	42
30	305	7380	11812	24	39

Source: BBS, 2001


Rajshahi City
Percent Literate, 2001
23.2 - 43.6
43.6 - 63.6
63.6 - 78.3
354000
356000
358000
360000
362000
364000
700000
698000
696000
694000
N
W
E
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1000
2000
3000
4000 Meters
Map No. 2.3

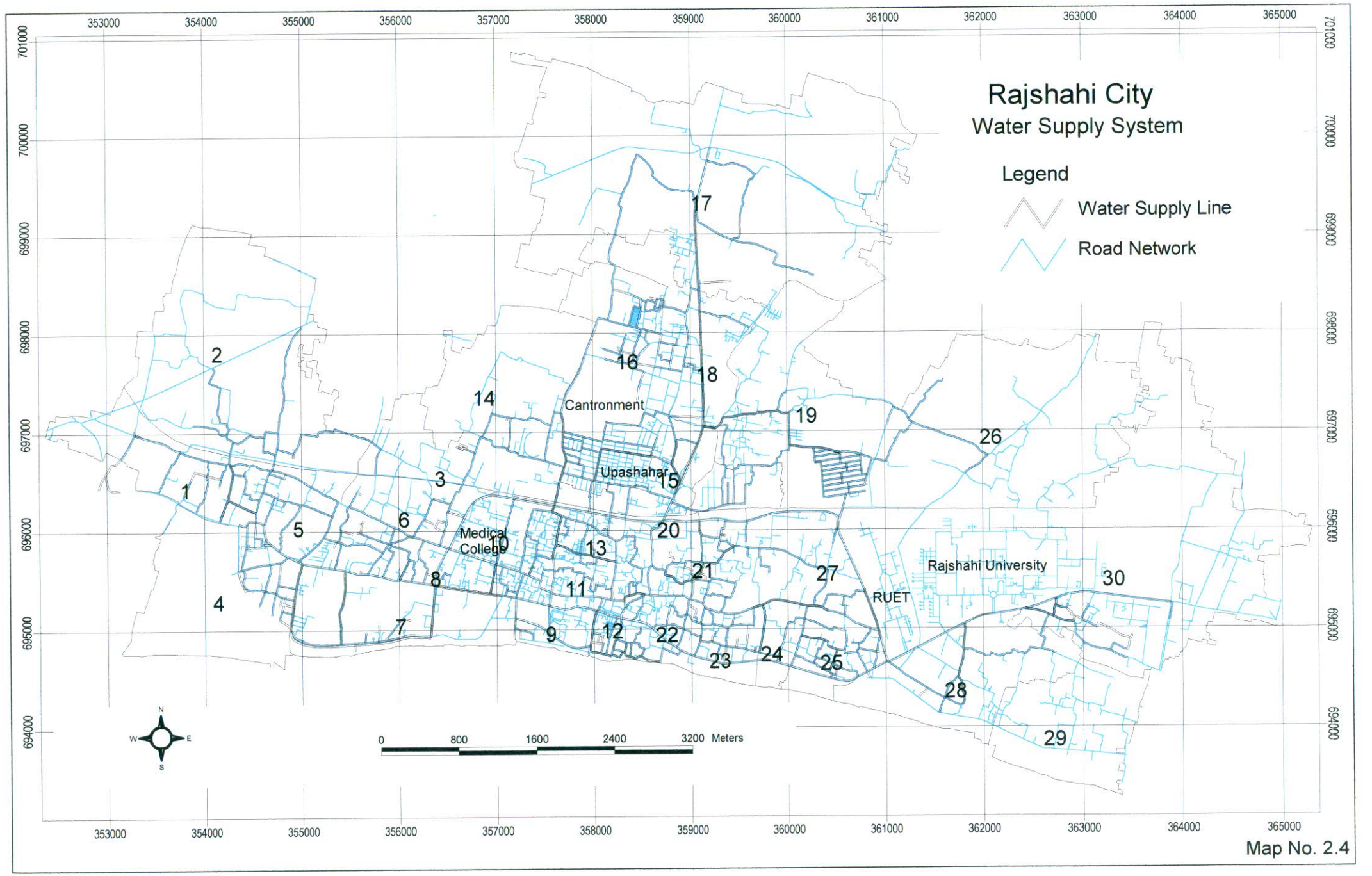
2.12 Urban Services & Amenities

The responsibility for the delivery of urban services at Rajshahi city mainly rests with the City Corporation. Other government agencies like the Rajshahi Development Authority (RDA), the Housing & Settlement Department, the Local Government Engineering (LGED), the Public Works Department (PWD), the Department of Public Health Engineering (DPHE), the Roads & Highways Department, the Power Development Board (PDB), the Telephone & Telegraph Board, the Directorate general of Health Services (DGHS) mainly take part in the development of the various services and amenities within the city. The city corporation is the main provider of the services like water supply, sanitation & drainage, waste removal, street lighting, primary health etc. Rajshahi Metropolitan Police (RMP) provides the law and order services to the city.

2.13 Water Supply

Ground water is the only source of water in the Rajshahi city water supply system. RCC operates 19 production tubewells. The underground water is drawn by these wells and pumped to the consumers. These tubewells are drawn producing 19940 m^3 /d of water. Some of the organizations /individuals have their own water sources like RUET, Rajshahi University etc. They use ground water as their source of water and collect water by wells. Existing piped water supply covers about 28% of the water and wells (Map 2.4). Rest of the areas fulfil their water demand from hand pump tubewells, ponds, cannals and ring wells and rivers. It is observed that most of the people of the RCC area depend on hand pump tubewell. Only about 18% of the people are enjoying piped water supply.

The water distribution system consists of 82.5 kms of pipelines with pipe sixes varying from 75mm to 250 mm. Water abstracted from sub-surface aquifers only is supplied through this distribution network with a total of 6040 houses and yard connections and 465 street hydrants/reservoirs. There are 5 overhead reservoirs in RCC water supply system, each of 675.0 m^3 (1.5 lac imperial gallons) of which only one is in operation. The present loss or wastage of Rajshahi water supply stands at 56%.


Rajshahi City
Water Supply System
Legend
Water Supply Line
Road Network
Cantronment
Upashahar
Medical College
RUET
Rajshahi University
1
2
3
4
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6
7
8
9
10
11
12
13
14
15
16
17
18
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694000

Map No. 2.4

The water quality moderately varies with the international as well as Bangladesh drinking water standards with respect to iron, manganese and hardness. Average concentrations of Iron, manganese and hardness have been found to be 0.60 mg/1, 0.88 mg/1 and 277 mg/1 respectively compared to WHO guideline values of 0.30 mg/1, 0.10 mg/1 and 200-500 mg/1 for drinking water. Furthermore, analyses of water from distribution system show the symptom of fecal pollution.

The only available surface water source is the Padma, a meandering river where thalweg shifting is a common phenomenon. In the recent years the flow of the Padma is declining during the lean period due to the withdrawal of water at upstream. The recorded minimum flow of the river shows a declining trend, 1770 m^3/scc in 1974 to only 261 m^3/scc in 1992. Furthermore large variation in surface water quality due to fluctuation of river flow makes surface water treatment provisions expensive. Considering all these factors, it has been proposed to abandon the possibility of withdrawing water from the river Padma at this stage. Ground water has been found to be the only reliable source of water supply for Rajshahi City. Present limited scale ground water source to meet the water model study indicates that withdrawal from ground water source to meet the water demand upto 2015 is possible. Provision of ground water treatment to remove excess iron, manganese and hardness has been proposed.

The water in the RCC area will mainly be based on water extraction from aquifers the negative environmental impact thus relates to the effect of this withdrawal on the static water levels. It was observed that there is sufficient water storage capacity in RCC area aquifers and are recharged by rainfall and water from rivers. Even at zero flow Padma, unless exceptional draught, it is expected that the recharged aquifers will be good and no significant change of static water level will occur. Due to adequate water supply volume of sewage will increase, proper emphasis is to be given to the sewerage system, other wise diseases will break out in the area. It is important to facilitate proper drainage of the spilled tap water.

It should be mentioned here that while the above study found the use of aquifers suitable for the time being, environmentals are very against it considering its long term effects. In view of the lowering of the water table in the country and especially in the North western Bangladesh, existing huge abstraction of ground water for agriculture and the widespread arsenic and other

dissolved chemicals (Fe, Mn,Ca, CO_3 , Cl) in the ground water, complete dependence on aquifers for the entire citys' water supply is essential undesirable and unwise.

2.14 Sanitation

Sanitation coverage in Rajshahi city is very limited with the majority using unsanitary facilitates. A recent survey (DPHE, 1994) has found that about 38% of the household have septic tanks including 20% having septic tanks without soak pits. Another 49% have pit latrines including both water sealed sanitary pit latrines (9%) and simple pit latrines (40) and 13% of the households use unsanitary means including open defecation. No community sanitation facility exists in Rajshahi. There are only four public toilet facilities, each with 5 seats located in the city core area. Each public toilet facility serves about 200 persons. RCC plans to construct more public toilet facilities. Within the slum areas the sanitation situation is even worse. About 82% of the slum population rely on unsanitary means including kutcha/open latrines, hanging latrines, buchet latrines, simple pits and open defecation. Only 18% use pour-flush latrines-about 13% have single pit pour-flush latrines and about 5% have twin off-set pour flush latrines.

Since water borne sewerage system does not exist in Rajshahi, Municipal involvement in sanitation is very limited. The maintenance of household latrines are household responsibility and municipal activity does not even include periodic inspection to ensure that latrines are kept sanitary. Households served with septic tanks do not have proper effluent disposal facilities and septic tank effluent discharging into surface drains or ditches is common.

Sanitation in Rajshahi city is entirely dependent on-site options such as septic tanks or pit latrines. However, in dense areas, i.e. in city core area and in Upashahar area, on site options may not always be suitable firstly because of too limited space and secodly, the soil infiltration capacity may not be sufficient to absorb continuously high quantity of waste water generated due to the improvement of water supply. This very often results in non-functioning of septic tank soak pits or latrine pits filling up too soon. User response to such problems is only disposing pit and septic tank sludge into the open environment sewerage system may not be viable due to high initial cost, medium cost small sewerage has been tried in Rajshahi.

2.15 Solid Waste Removal

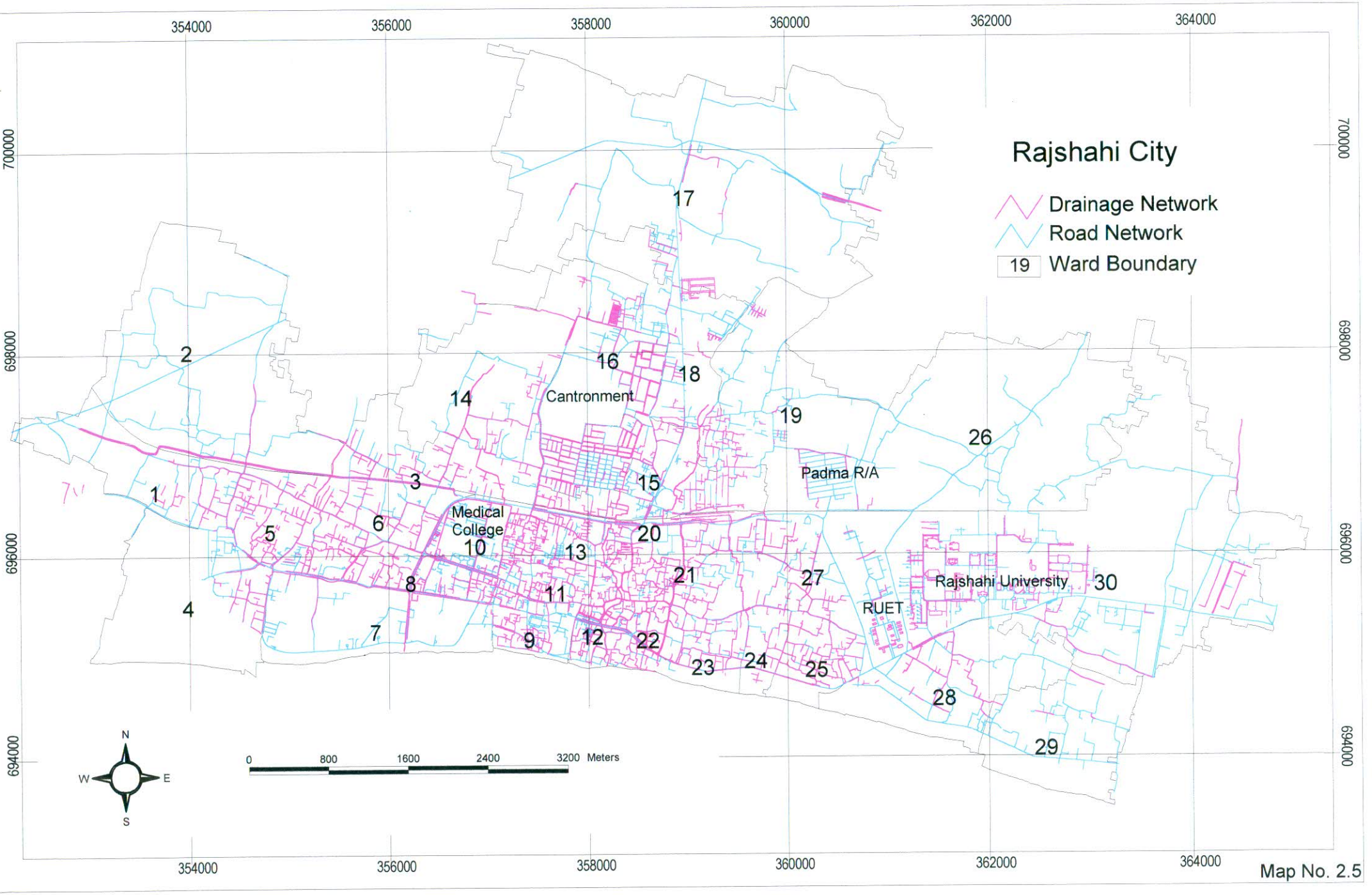
Solid waste management of RCC area involves conservancy activities of road sweeping drain cleaning, the provision of rubbish bins and collection and disposal of solid waste. There are 325 bins for rubbish collection throughout the city core area. These are made of brickwork and some are reinforced cement concrete. Most households use rubbish bins. Although quite a number of households throw solid waste on the roads, these are collected and transported by trucks regularly. In Rajshahi about a 100 tons of solid waste is collected everyday.

Road sweeping is done every day. The main roads are cleaned daily early in the morning. Collection of swept materials and its well managed in the main roads and commercial and bazar areas. Presently there are 372 sweepers working in the Rajshahi City Corporation and out of which 250 are engaged in road sweeping. There are many surface drains mostly covered by slabs and are not cleaned regularly, hence waterlogging occurs.

Solids including the sludge from drains are transported by hand push carts or rickshaw vans to the main road rubbish bins. These are then transported to the dumping site at choto-Banagram about 4.5 km away from the city center. There are 30 push carts, 20 rickshaw vans, 8 tracks including one trailer engaged for this purpose. On average the trucks make 20/24 trips to the dumping site. Disposal site is used for temporary dumping of wastes. After a few days when the wastes are decomposed, these are auctioned to private parties for use as fertilizer. The major part of the solid waste is generated from vegetable component, Plastics, Polythene bags, bones, broken glass, construction wastes are present in small percent. Industrial waste does not play any significant role.

2.16 Drainage

The existing drainage facilities of Rajshahi city is poor. Out of 118 km of drains, 33 kms are primary khal/drain, 43 kms are secondary and 42 kms are tertiary. Of this 118 km. kutcha drains are found to be 64 km of which 8.34% is in good condition; remaining 54 km of the total drains are pucca of which 63% is in good condition. There are 7 major khals serving as the arterial drainage system for Rajshahi City Corporation area (Map 2.5). These khals are flowing from south to north. Most of these khals are silted up, filled with garbage, shrubs, vegetation etc. In many places, the waterway is obstructed with intrusion, constriction and constructions. All these obstructions have resulted in decreasing the discharge capacity and in many places water is simply stagnant causing environmental hazards.


Rajshahi City
Drainage Network
Road Network
19 Ward Boundary
354000
356000
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364000
700000
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696000
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Cantronment
Medical College
Padma R/A
Rajshahi University
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Map No. 2.5

2.17 Domestic Electricity & fuel

ADB study (1996) found that only 57 percent of the households within the City Corporation had electricity. The domestic fuel supply situation however is worse. The city gets its supply of natural gas in gas cylinders. The supply of these is insufficient.

2.18 Commerce and Industry

Rajshahi is mainly an educational and administrative center. The provision of these two services catering to the needs of the people of Rajshahi division are its main economic life line. The total population of the city about 24% are over the age of 10 years. Of the population of 10 years of age and above, 31% percent do not have any work. They may be students or dependants. About 2% look for job and about 29% percent work at their own home. The rest 38% are the real workers in the city. Almost half of these (51.40%) are service-holders and another 33% are engaged in commercial activities. Only a minor proportion of workers in Rajshahi city is in the industrial sector. The following table (Table 3) indicates the relative importance of the various sectors in terms of job providers.

While the service sector is the dominating sector of the economy, there is no recent data on the kind of services and the relative importance of various services. However, a 1982 study indicates that out of the people engaged in service, about one third i.e. 33.42 percent are in administration and defense sectors, education sector takes up another third (31.52%). various specialization professions take up about 17%, financial services take 8.42% and working in private companies takes up 9.52 of the job seekers.

Table 2.4 Distribution of various Professions in Rajshahi City, 2001

Profession	Percent
Service	51.40
Business & Commerce	33.24
Industry	4.47
Construction	2.37
Agriculture	5.45
Other	1.25

Source: BBS, 2001

Inspite of the predominance of the service sector, there are, however, a few important industries in the city. There is also reasonable scope for expansion of the industrial sector of the city. Thus is especially true in the backdrop of the upcoming regional changes with the imminent opening of the Jumuna bridge.

2.19 Industrial Structure

Because of its location in the border area and traditionally being away from the country's main transport network and the inadequate development of infrastructure facilities discourage the development of heavy industries in Rajshahi (Table 2.5). Nevertheless, the city boasts of a few large industries mainly based on its agriculture raw materials resources. The heavy industries structure of the city is dominated by a few large industries. Among these are a jute mill, a sugar mill, a textile mill, a silk mill, a dairy industry and a match factory. There are also a significant number of small industries mainly set up with the help of BSCIC. The sectors represented are rice mills, oil mills, flour mills, saw mills, silk weaving mills and printing presses. Here is a table showing the kind of industries that exists in Rajshahi city at the present time. The information was taken from the Rajshahi Chamber.

Table 2.5: Industrial structure of Rajshahi City

Industrial Sector	Number of units	No. of Workers
Silk-Medium	20 to 10	upto 100
Silk-large	1	upto 250
Rice Mill	3	upto 60
Brass Metal Industry	1	upto 30
Pharmaceutical	4	upto 60
Flour Mill	4	upto 60
Match Factory	1	upto 100
Zarda Factory	1	upto 30
Printing Press - Offset	4	upto 20
Printing Press - Old	12	varies
Gold Storage	4	varies

Source: Rajshahi Chamber, 2005.

Small Business within the City: To get an idea of the commercial structure of the city dates from the time, when the city trade license register was analyzed. It revealed that the city had licensed 4875 units of various type of trades and businesses in 1995-96. Out of these, 282 were workshop category. This includes all types of small factory, mills including food-processing concerns. Hotels, restaurants and tea stalls are the next numerous business. There were 115 such businesses in the city corporation area. Other types of business are (Table 2.6) printing presses, residential hotels, bakery & confectionery, steel furniture, wooden furniture and silk cloth printing.

Table 2.6: Small Trades within the City Corporation.

Types of Business	Number
Workshop / Factory	282
Wooden Furniture	11
Steel Furniture	18
Hotel / Restaurant / Tea Stalls	115
Residential Hotels / Boarding	28
Bakery / Confectionery	20
Food Processing	2
Silk Cloth Printing	15
Printing Press	36
Total	4875

Source: Rajshahi City Corporation Records, 2005.

2.20 Present land use Pattern

Land is a key element of human existence and development. It is one of the most fundamental natural resources. In view of competition in human economic activities, certain parts of land are covered with certain features. This coverage of land by any activities or feature is popularly termed as land use. The term land use has been attempted to be defined differently from various perspectives by different scholars. Land use is an expression of man's management of land to produce his earnings. Landscape changes in time and hence gives dynamism in the process.

As there was no planning for Rajshahi City's land use in the past, the city has developed in its own way. Initially the Rajshahi Development Authority (RDA) made a Master Plan of Rajshahi City's land use. The distribution and the pattern of land uses of Rajshahi city (based on the 1952 boundary) by RDA in 1984 showed the following pattern of land use (Table 2.7).

Table 2.7: Land use categories of the Rajshahi city, 1984

	Land use category	Area (h)	Percentage
1.	Residential	540	33
2.	Open space and water bodies	340	21
3.	Agriculture and horticulture	260	16
4.	Road, embankment public utility	240	14
5.	Education	170	10
6.	Recreation, administrative, commercial & industrial	100	6
	Total	1560	100

Source: Rajshahi Master Plan. Final Proposed Report, RDA, 1984

2.21 Land use change in the city

With the progress of time the population as well as the area of the city increased. As a result there has been an increase in economic activities resulting in multifarious types of land uses. Nevertheless, no special pattern of land use could be possible to develop as the ecological process of urban functions are in the middle stages of their operation.

Attempt has been made to identify some broad land use zones on the basis of predominant use (Map 2.6). A brief description of the existing land use categories of the city is given below (Table 2.8):

Table 2.8. Generalized Landuse categories in Rajshhai City, 2005

Sl. no.	Landuse	Area in Hectres	Area in Acres	%
1	Agricultural	925.10	2285.96	18.03
2	Assembly	30.20	74.62	0.58
3	Business & Marcantile	179.10	442.56	3.49
4	Char	180.50	446.02	3.51
5	Educational	469.70	1160.65	9.15
6	Healthcare	9.00	22.23	0.17
7	Industrial	34.10	84.26	0.66
8	Miscellaneous	17.20	42.50	0.33
9	Mixed	10.80	26.68	0.21
10	Open Space	49.70	122.81	0.96
11	Padma River	344.00	850.04	6.70
12	Residential	1636.12	4042.93	31.89
13	Restricted	98.90	244.38	1.92
14	Road	190.70	471.22	3.71
15	Storage	5.80	14.33	0.11
16	Vacant	608.40	1503.38	11.86
17	Water Body	340.50	841.39	6.63
	Total	**5129.82**	**12676.04**	100

Residential use:

Within the city residential land use (about 5264.15 acres) constitute the highest land area cover, which is about 43.89% of the total area. Residential use includes detached single-family housing, flats or apartments, mess/boarding houses, Informal housing areas. Most residential areas are found in informal form. Density of population in urban area is much low (12 persons/acres or 3042 persons/km, BBS, 1991) compared to other metropolitan cities (in Khulna, 38 persons/acres or 9463 persons/km) of the country. Ward no. 29 is the most densely populated (23 persons/acres) within the city area, while ward no. 5 and 6 have the lowest density with only 6 persons/acre.

Table 2.9: Population density comparison between two city corporations- Khulna and Rajshahi, 1991-2001.

City Corporation	Average density of population (person per unit)			
	1991		2001	
	Per Sq. Km.	Per Acre	Per Sq. Km.	Per Acre
Khulna	1396 persons	6 persons	9463 persons	38 persons
	KCC Area: 40.25 sq. km.		KCC Area: 70.10 sq. km.	
Rajshahi	5559 persons	22 persons	3042 persons	12 persons
	RCC Area: 29.83 sq. km.		RCC Area: 96.98 sq. km.	

Source: BBS-1991, 2001.

Ward no. 9, 22, 23, 24, 12, 20 and 13 located in central and old part of the city. Residential acres close to the main activity areas are in the form of transformation into commercial use. These include areas like Rajarhat, Malopara, Sultanabad, Seroil, Kadirganj, Ranibazar and Ghoramara. The residential areas in (ward no. 10, 8, 7, 5, 6, 4, 3, 1 and 2. Ward no. 4 the western old parts of the city accommodate public housing. While ward no. 2, 3 and 4 have more private housing. Bahrampur, Horogram, Purbapara, Nagarpara. Natunpara and Daspara are important housing areas in this part of the city.

Exclusive but limited planned residential areas have been developed by the RDA and HSB. But due to good serve facilities and environmental houses in planned residential areas are being threatened by non-residential uses. Planned residential areas are Upashahar Housing Esate, Padma Residntial Area, Parijat Residential Area. Except a handful of planned residential areas almost all housing areas are characterised by spontaneous type development. Spontaneous housing areas develop on incremental basis on individual initiatives.

The one of the major characteristic features of urban residential land use growth is that it follows mainly the access routes and takes shape in areas that have comparatively better service facilities with higher elevation. However, due to presence of large vacant land there is still huge scope for infilling in the city area.

Educational:

Rajshahi city is famous for education and its facilities. A substantial part of this area lies within the city that constitute about 895.84% of the city area constituting about 7.47%. major educational facilitates in the city include, a University, a medical college and RUET, polytechnical and technical institute for vocational education and teacher's training college. There are 59 primary schools, 23 secondary schools, 10 colleges (including higher secondary level) and 04 madrashas.

Institutional:

Institutional areas cover nursery, kindergarden, orphanage and similar uses, childcare home, school, hostel, jail, mental hospital, custodial institution including borstals and reformatories. There uses are usually urban based. Institutional category of land use constitutes about 15% of the city area.

Healthcare:

Healthcare is an important land use of the city area. In Rajshahi this category of facilities include a medical college hospital, TB hospital, infections diseases hospital, jail hospital, police academic hospital, railway hospital, combined military hospital, BDR hospital, upazilla health complex. Other health facilities are christian mission hospital, city lions eye hospital and large number of private health facilities. These facilities cover only 0.71% of the city area.

Assembly:

Assembly category covers all land use and activity areas of public gathering mostly covered spaces. This category of uses cover cinema, auditorium, theater all kinds of assembly hall, prayer halls including mosque, temple, church, restaurant, community center, mazar and museum etc. that are found primarily in the city area. This category constitute about 0.71% of the city area.

Business/mercantile:

Major land uses under this category are, all categories of retail and wholesale areas and shopping areas of all categories and ribbon commercial developments along the major roads. Shahed bazar is the commercial hub of he city area. The low profile of this category clearly indicates low level of economic activities in the city area. Rajshahi city has 08 daily bazars and a few shopping centers like New Market and shaheb bazar. Shaheb Bazar, Kadirganj Bazar, Rani Bazar are the important wholeseal markets within the heart of the city. Kadirganj bazar and Rani Bazar are well known for rice wholesale. Shahib Bazar sells almost all kinds of household goods on retail and wholesale basis. Rani Bazar sells vegetables on wholesale basis. There are, however, a few permanent Bazars in the city area (Table 2.10).

Table 2.10: Daily bazars in the city area.

Name of the daily Bazars	Type of trading
RDA market	- all categories of household items are traded in wholesale and retail.
Shaheb Bazar	- all categories of household items are traded in wholesale and retail.
New Market	- all categories of household materials are traded in wholesale and retail.
Laxmipur Bazar	- retail trading.
Horogram Bazar	- retail trading.
Binodpur Bazar	- retail trading.
Upashahar Bazar	- retail trading.
Kadirganj Bazar	- wholesale and retail, mainly rice market.
Rani Bazar	- vegetable wholesale market.

Industry:

Industrial use has a very small place in the city area. This is because of sluggish growth of industries in the city and its environs. There is an industrial estate developed by BSCIC but most of its plots are yet to have industrial establishments within them. Major industrial concerns are one textile industry, jute mill, sugar mill and a few silk sari factories. Most of these industries are located close to the city. Industrial land use constitutes only 0.20% of he city area.

Storage:

Very little storage areas have been identified in the city area. Storage facilities include, arats in bazars, godowns in market and industrial areas. This category 0.18% of the city area.

Unused/vacant:

Unused or vacant land is a characteristics of urban landscape. The land owners keep their land vacant as long a they do not fetch expected profit, either by means of their productive use or disposal through sale. As a slow growth city Rajshahi has large areas of unused/vacant land. This land can be used to accommodate growth city population for a long time. Identified unused/vacant land in the city is about 5.78%.

Sports and recreation:

Sports facilities is a major land use in the urban context that includes, playground and stadium, park including amusement park, areas of public gathering for recreational purpose. These land uses form about 1.50% in the city area.

Table 2.11: Formal parks in Rajshahi city

Type of facility	Name and Location	Remarks
Park	Central park (Shahid Kamruzzaman park), Srirampur	Managed by RCC
Park	Bhubonmohan Park	Managed by RCC
Park	RDA Park, Pdma housing	Managed by RDA

Source: RCC, RDA, 2005.

Table 2.12: Playgrounds in Rajshahi City

Sl no.	**Name of stadium/play ground**	**Location**
1.	Shahid Kamruzzaman Divisional Stadium	Terokhada
2.	Rajshhai Zilla Stadium	Seroil
3.	Rajshahi University Stadium	Rajshahi University
4.	Shahid Habibur Rahman Hall Field	Rajshahi University

5.	Dashmari High school Field	Kazla, Motihar
6.	Rajshahi Patkal High Field	Katakhali, Shyampur
7.	Maskatadighi Commercial School Field	Shyampur, Motihar
8.	Rajshahi Government Madrasha	Pathapara
9.	Rajshahi Collegiate College Field	Dargapara
10.	Rajshahi Government College Field	Dargapara
11.	Seroil Government High School Field	Seroil
12.	Rajshahi Medical College Field	Laxmipur
13.	New Degree Government College Field	Kazihata
14.	Physical Training College Field	Sapura
15.	Helanabad Girls Government High School Field	Helanabad
16.	Rajshahi Satellite Town High School Field	Sapura

Source: 1. Rajshahi Krira Office, 2005.

2. Rajshahi University, 2005.

3. General Secretary, Rajshahi Divisional Krira Sangsdtha, 2005.

Major open spaces in the city are three stadiums, 24 playgrounds, 3 parks and large riverside bundth used by the public for afternoon roaming.

Water body:

The water body category includes river, khal and large number of water bodies including ponds. There are large numbers of ponds in the city. Presently city's ponds and other water bodies are used for washing purposes thus they save huge water of the city corporation that it would have had supplied without these ponds. However, these water bodies are very likely to disappear with the advent of urbanization when demand for land will increase and exiting build able land will be exhausted. In the city area water body constitute 3.74%.

Mixed Use:

Mixed use areas are those where mainly, commerce and office uses are combined with residential developments. Mixed land use is a common character of all urban centers of the

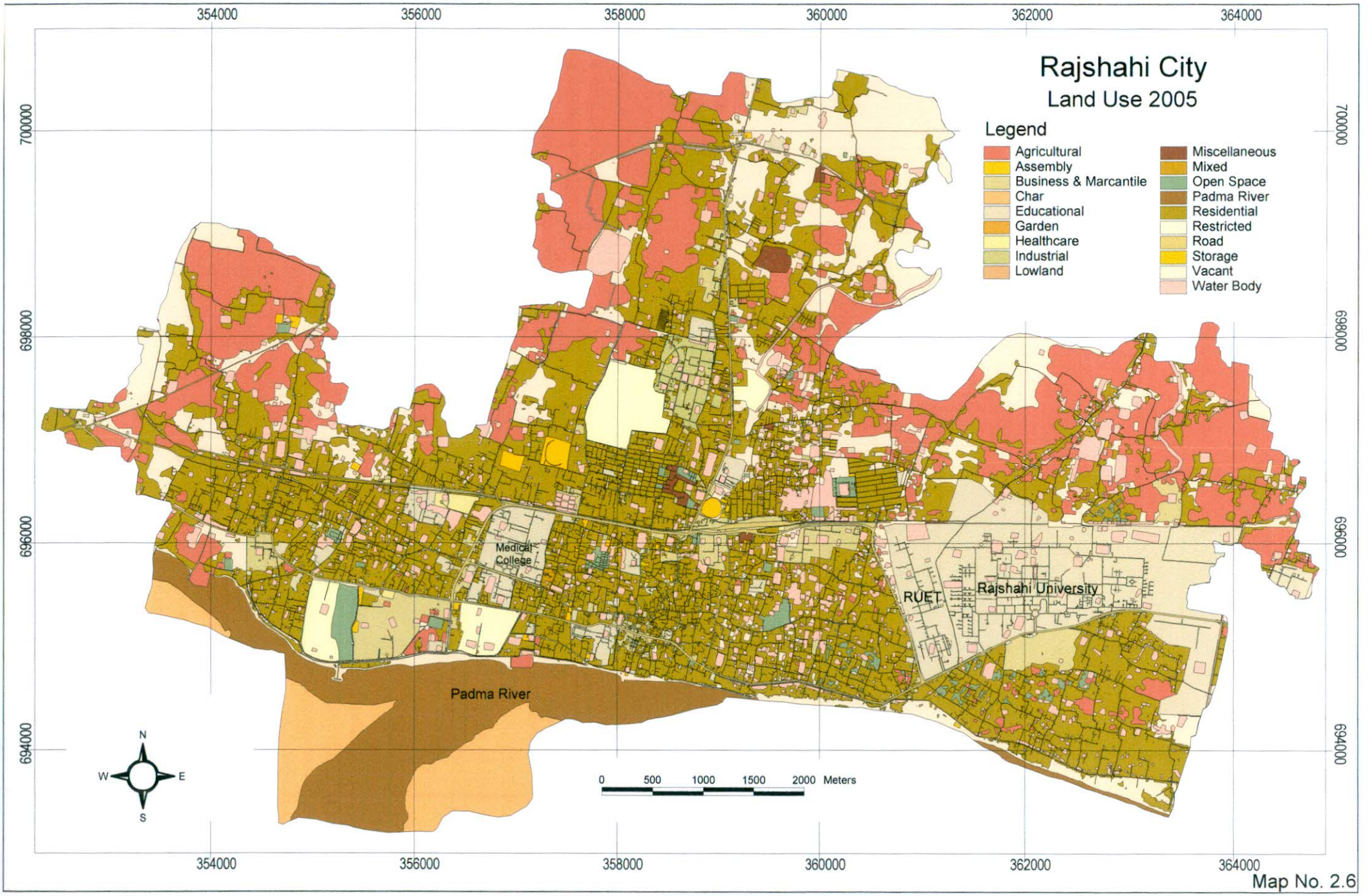
country. Two main reasons are found to be behind such land use development. First absence of planned urban growth and second, lack of control of development in urban. There is no land use plan that the development authority shall follow to guide appropriate growth of land use. There is serious lack of effective control of development. Most structures are informal who handle care for permission before development. The authority lacks in effective control due to mismanagement. The mixed land uses are a made up to a variety of land uses. usually, residential land use is encroached by non-residential land uses, like commercial and office uses that include institutional and administrative uses. The degree of such encroachment depends on the location of the area. If the area is closer to the city enter than the encroachment will be faster. In such areas commerce gradually takes over residential use. However, other non-residential uses are also evident. In Rajshahi like, other urban centers of the country mixed use is prominent all over the city area. Even the residential estate of public sector agencies like RDA are also being encroachment by non-residential uses, mostly officers and institutions. Allured by higher rent the landlords prefer to let their houses to such non-residential uses.

Restricted Areas:

Restricted areas are military and para-military installations, police line, Ansar establishments. This category has been found about 2.67% in the city area.

Agricultural land:

The second largest coverage of land of Rajshahi city is the agricultural areas that include 31.60% of the total land. This figure of agricultural land use indicates the development of the city at a slower rate that is a common situation in all the medium size urban centers in the country.


Rajshahi City
Land Use 2005
Legend
Agricultural
Assembly
Business & Marcantile
Char
Educational
Garden
Healthcare
Industrial
Lowland
Miscellaneous
Mixed
Open Space
Padma River
Residential
Restricted
Road
Storage
Vacant
Water Body
354000
356000
358000
360000
362000
364000
700000
698000
696000
694000
Medical College
RUET
Rajshahi University
Padma River
N
W
E
S
0 500 1000 1500 2000 Meters

Map No. 2.6

2.22 Social Problems

The social problems related to urbanization phenomena are yet to be very actual felt in Rajshahi city. The pressures of high urban density and over-urbanization and uncontrolled development are not yet the order of the day. As the current rate of urbanization has indicated, it has a long way to go for urbanization. However, the problems of slums and squatters, street crime and urban violence, prostitution, drug abuse, deviant behavior etc. are all present in the city- but not to an extent to raise immediate alarm. The citizens are well aware of these and others problems. This is indicated by the fact that the different measures/programmes for dealing with these have already been launched by the Government, NGOs and the Community groups. The Rajshahi City Corporation, the social Welfare Department and Women & Children Affairs Department of GOB, and leading NGOs have progammes for helping slum dwellers, drug addicts, street children, abandoned children, destitute women and others. The services are extremely limited in comparison with the actual need.

2.23 Natural Calamities

The area comprising Rajshahi City in the past experienced natural hazards like river erosion, flood, tornadoes, famine and earthquakes. Because of the unpredictable nature of the river Padma the city area was vulnerable to erosion. The first city protection embankment was constructed in the year 1855. Since then the embankment was extended and strengthened over successive years in response to the damages done to it by the river. At present it is in stable lying within the zone of seismic activity and suffered somewhat severely from the earthquake of 1897. In the district Rajshahi the shockwaves were severe, specially on the eastern side, but the loss of life was comparatively small. The damage of property, was great. The loss of pucca houses in Rajshahi City was more or less damaged. Earth fissures occurred throughout the district and the roars were badly wrecked in places. a cyclonic storm with a velocity of about 70-80 mph accompanied by heavy rain swept Rajshahi and suburban areas in the afternoon of 17th April 1969 causing widespread demage to 13800 homesteads. More than a lakh person became homeless. The total number of persons killed was 27 and more than 150 persons were injured in the tornado.

CHAPTER-3

Database System

3.1 Existing database system

The existing database systems used and maintained by the City Corporation is traditional and manual. Maintained database system is divided into two types. One is the map of different scales and of different themes and the other is tabular data of different types.

3.1.1 Maps: The most important and commonly map used by the Rajshahi City Corporation is the detailed city map. The map is based on Cartesians coordinate and with a scale of 1:50,000. The map was prepared in 1997 and shows roads, drain network, ward boundaries, important landmark features and major government offices and places in details. The map is not updated to the present time. A detailed updated road network map (as in 1995) has been prepared by the Department of Geography and Environmental Studies, Rajshahi University under a separate research project. This map is digital and transformable to any scale.

The city maps of similar general nature are also available with the Rajshahi Development Authority (RDA), Metropolitan Police, Public Health Engineering, Public Works Department, Telephone and Telegraph Department, Power Development Board, Local Government Engineering Department (LGED), Deputy Commissioner's Office etc. These maps in addition to general nature, include some amount of spatial information as required by the users. These maps are generally 1 inch to 8 miles and around. The significant problem of all the above maps is the error in the shapes of the maps where it has been found to vary from map to map quite prominently.

Rajshahi City Corporation prepared another set of maps which shows different and detailed features of the ward separately. The map scale varies from 1 inch to 8 and 16 miles. The maps were prepared by DDC, Dhaka in 1997. The maps are available only in hardcopy and includes roads, drains different features and even prominent structure in details. The map has a reasonable detailed information since they are of relatively larger scale.

Rajshahi Development Authority (RDA) has prepared a land use map of 16 inches to 1 mile scale in 1981. The map shows generalized land use pattern of the city and was used for the preparation of master plan of Rajshahi City. But the formal Master Plan of the city is not yet

completed. A very important map base of this city is the *Mauza* maps maintained by the District Commissioner's record room. A good number of maps are available (but not all) with the City Corporation too. The maps are commonly known as Cadastral maps. Each *Mauza* is composed of several sheets, depending on the size of the *Mauza* as well as compactness of the parcel (plot). There are 39 *Mauzas* to complete the existing city corporation area. The maps are generally 64 inches to a mile scale but there are certain *Mauza* maps of 32 inches and even 16 inches to a mile scale. These Cadastral maps are known as RS (Revision Survey) maps prepared in 1964 by the Survey of Pakistan. The similar type of maps was also prepared in 1954 which is known as CS maps (Cadastral Survey) and the earliest known maps of this type are known as SA (State Acquisition) maps produced in 1927. It is important to note that these maps are not well updated and the recent RS maps are prepared based broadly on the earlier maps, except in the change of scale. This problem has appeared to influence on real estate dispute, which is a common phenomena in the Rajshahi City as well as in other cities of the country. Recently under Land Records Modernization Project of the Directorate of the Land Records of the Government of Bangladesh, the maps are being converted into digital format. There is also a proposed project for preparing cadastral maps of the country including the urban centers using Total Station and GPS technology. This project of preparing cadastral maps of the country will be the last cadastral survey in this country and there will be no further cadastral survey in the history of Bangladesh. The modifications and updating of the parcels will be done as frequently as needed and these will be done by computerized LIS system in the computer database only.

The *Khatian* (record of rights) parallel to the cadastral maps is maintained by the District Commissioner's record room. These are the real attribute database in a highly traditional data base format (in the language of computer of course). These records contain the data relating to the ownership of the parcel, succession, amount of land, occupation status, use of land and tax. This is the base for resolving disputes among the owners. The city corporation collects its revenue based on these records and the parcels.

There are various other types of attribute data sets collected and maintain by City Corporation and other government and non-government agencies. The City Corporation uses these data whenever they find it necessary. A list of the data sources is available in Appendix 1.1. The data sets are not properly geographically formatted and not integrated among each other. As a

result the maps cannot be used accurately. For example, one important database currently used by RCC is given below:

বহি নং 113 ফরম নং -১০ রশিদ নং - 11206

রাজশাহী সিটি কর্পোরেশন, রাজশাহী।

রশিদ ফরম (প্রতিলিপি কার্বণ দ্বারা পূরণ করিতে হইবে)

ওয়ার্ড নং.................. মহল্লা .... এ্যাসেসমেন্ট রেজিষ্টার হোল্ডিং নম্বর..................

কর দাতার নাম : জনাব / বেগম..

নিম্নের বিবরণানুযায়ী নির্ধারিত ট্যাক্স বাবদ টাকা ....(কথায়).................................মাত্র পাইলাম

	বকেয়া বাকী বাবদ	বর্তমান বৎসর ১৯৯৯-২০০০				মোট
		১ম কোয়ার্টার	২য় কোয়ার্টার	৩য় কোয়ার্টার	৪র্থ কোয়াটার	
		টাকা	টাকা	টাকা	টাকা	
হোল্ডিং কর						
কঞ্জারভেন্সী রেট						
ওয়াটার রেট						
লাইটিং রেট						
ওয়ারেন্ট ফি						
সারচার্জ						
মোট টাকা						
রিবেট						

সর্বমোট

তারিখ ঃ.......................... আদায়কারীর স্বাক্ষর মেয়র/প্রশাসক

Fig. 3.1: A sample copy of the Tax bill form of Rajshahi City Corporation

This is the municipal tax system for the parcels. The data contain some selected fields but apparently lack some data fields that are thought to be necessary for evaluation, environmental perception and change analysis. The databases do not contain useable geographical linking facilities. The City Corporation uses its own personnel database which is indeed a non geographical data base. This is mainly for the personal administration. A location parameter of the personnel and the attaching facility to general map database may enhance the administrative arrangement and work efficiency.

3.1.2 Computerized database frame

As the focal analysis and management decisions under the database management system are maintained by the City Corporation, the modeling of the system frame should essentially be limited within the frame of the objective and purpose of the study. The situation analysis already revealed a condition of the availability of data and their sources, types and usability. Now it would look into more details of the frame of the system.

3.2 Database Design and Organization

Based on the assessment of the city management framework and sectional information needs, it becomes evident that the database for the study has two components:

- Spatial data consisting of maps from Cadastral and also conventional sources.
- Non-spatial data consisting of numeric attributes in respect of socio-economic characteristics from census and other sources.

Further, all spatial data will be on a standard reference and all non-spatial data will be on the administrative hierarchy of Plot-Ward-City. This aspect is of importance from the database point of view.

3.3 GIS – core of the database:

The Geographical Information System (GIS) is the core of the database as both spatial and non-spatial databases have to be handled. The GIS offers efficient utilities for handling both these datasets and also allows for the spatial database organization; non-spatial datasets organisation-mainly as attributes of the spatial elements; analysis and transformation for obtaining the required information; obtaining information in specific format (cartographic quality outputs and reports); organization of a user-friendly query-system (Burrough, 2001).

In the present study, Arc/Info GIS software has been used as the core of the spatial database. Arc/Info is a modular and vector based for creation, organization, storage, retrieval, analysis, display, query and for making cartographic quality outputs in the form of maps and generation of statistical tabular reports. The spatial data is organized using topological data model while the non-spatial attribute data is stored using a database management system. Arc/Info software has different modules and many of these have been used for organizing the database.

3.4 Database Design and Organization

With the two types of datasets to be organized in Arc/Info GIS database, it was felt necessary to evolve a set of design parameters that would have to be adopted for the database organization. The database design guidelines not only are for a systematic database organization but also for providing a level of flexibility for enhancement/upgradation

/improvement (Hawrsyszkiewycz, 1984). Based on these guidelines, the spatial and non-spatial database elements could be organized into the total database.

3.5 Design aspects of the database

The following design elements have been considered:

a) **Spatial data domain:** The Spatial data will be mainly from Cadsatral sheet and other conventional sources. Most of these Cadsatral map sets follow the Survey of Bangladesh (SOB) Latitude and Longitude coordinate system (as is given in the SOB maps), the spatial database needs to follow the standards of the SOB map sheets. Considering the fact that the database has to be organized at a city level, it becomes essential to create the spatial database commensurate to 1: 990 scales.

b) **Impact of study area extent:** The study area covered in 285 non-overlapping SOB map sheets at 1: 990 is scale. However, the extent in certain mapsheets is partial as against the full extent in certain mapsheet. As a result, it is essential to adopt a standard registration procedure for the database. This is done by the use of tic points or registration points in the GIS. These tic points were the–four corners of the SOB mapsheet at 1: 990 scales. Unique identifiers for each tic point helps in locating and registering the database. This scheme is a "shared method of method of points where each tic is a part of more than and" mapsheet. This helps in the map joining/ mosaicking and sheet-by-sheet data digitization process.

c) **Co-ordinate system for database:** The co-ordinate system for the study area database needs to be in appropriate units that represent the geographic features in their true shape and sizes. As the SOB 1:990 graticule has been adopted for the database, it is essential to have the same coordinate/ projection system that SOB adopts. All cadastral sheets on 1:990 scale adopt the BTM (Bangladesh Transverse Marketor) projection system. Further, the units of the BTM projection are represented in actual ground distances- meters. Thus, for the RCC database also the BTM projection are represented in actual ground distances meters. Thus, for the database also the BTM projection has been adopted and the co-ordinates are in meters. To define the BTM projection for the district, the registration points have been used. The latitude-longitude and their corresponding BTM coordinates. The unit of meter have been used as to obtain accurate area, length and perimeter values for the GIS operation.

As a result all spatial inputs are referenced to the SOB map sheet graticule and thus allow for integration of datasets.

d) **Map library design:** GIS allows for the organization of a map library- a collection of spatial dataset partitioned in to a rectangular shaped region called-a tiles mode. As the SOB map – sheet was a standard reference for the spatial data the SOB graticule was adopted for tile mode of organization in RCC. The horizontal and vertical organization of the spatial data in the database. This tile mode of spatial data organization has the following advantages:

- Definition of the standard projection system for which SOB projection system is made use. So there is no need for repeated operation of building the projection into the system;
- Data sets are spatially referenced to SOB map-sheet graticule and thus can be retrieved at the sheet level;
- Data aggregation to higher levels is also possible on a sheet - by- sheet basis. For example, the data of one tile can be abstracted for any scale; and
- Consistency of the database is maintained as spatial data elements are well referenced.

e) **Defining attribute data dictionary**: The data dictionary is an organized collection of attribute data files containing information on the feature attribute codes used for the data base. The dictionary contains descriptions of the attribute code for each spatial data element.

f) **Spatial data normalization**: As in a normal database, a process of normalization of the spatial data is also essential to identify master templates and component templates. This normalization process ensures that the coincident components features of the various elements are coordinate limiting overlay sliver problems. This also ensures the redundancy in digitization process as master templates are digitized only once and form a part of all elements. The following features have been identified as a first order normalization:

- Plot boundary.
- Road.
- Settlement.
- Water body.

Thus, each spatial element in the database will have these master template elements and the features themselves.

g) **Non- spatial data domain**: The non- spatial datasets are available at the levels of administrative units- City, Ward and plot. The plot is the lowest unit at which the non- spatial data is available and thus it is essential to organize the non-spatial data at the plot level. This plot level data is also aggregated with ward level and city level by a process of abstraction.

h) **Spatial and non-spatial data linkage**: All the spatial data sets have an associated attribute table where the detailed attribute of each feature is recorded. There are two major linkage aspects involved:

- For all spatial data sets other than administrative maps, the linkage is achieved through the data dictionary feature code.
- For administrative maps-plot and ward maps, the linkage is achieved on a one- to-one relation based on unique code for each plot or the ward. This code has been identified as a sequential number for the 1400 plots in the ward. This link-code also is related to the census ward number on a one - to one basis. Thus the internal organization of the spatial plot/ ward boundaries is flexible to relate to the non-spatial database on a one-to-one basis because of the co-relation to census ward data to plot data.

3.6 Integration of Plot boundaries:

One of the important aspects of integrated area-level planning for ward/city is the thematic natural the tabular socio-economic data and the thematic natural resources data. These two discrete datasets have different characteristics. The socio-economic and developmental data is mainly the data collected by the census that is on a ward wise basis. This dataset is based on a plot-ward-city hierarchy and is mainly tabular. As against this, the thematic data on natural resources is based on a spatial framework. These datasets follow the SOB sheet graticule and thus are based on the BTM projection system. An integrated planning exercise would require that these two datasets be combined together to derive meaningful plan inputs. The integration would be to:

- Merge the attributes of the plots and the natural resources for generating plan scenerating plan scenarios;

- Spatial representation of the-spatial tabular attributes of the plot;
- Amenability to aggregate and abstract the plot attributes and the natural resources to the plot-ward-city and SOB graticule (for example 1:990 scale); and
- Generate the plot/ward-wise information of natural resources for tabular updating.

The methodology of plot boundary integration to SOB map-base is as follows:

- SOB cadastral corners were used as registration points and created into coverage. The ward and plot boundaries were digitized into GIS database;
- Base map on plot-wise basis on 1:990 scale with a set of control points was prepared for each plot in the ward;
- Ward-wise boundaries of each plot were projected into the base map (prepared as started above) optically and boundaries transferred on 1 to 1 basis;
- The transferred ward boundaries were then digitized; and
- After digitization and proper organization of ward boundaries, each ward code was encoded to represent census code.

3.7 Spatial database organization

The spatial database has been created in Arc/Info and to database organization involved the process of identifying content of the spatial data and also the actual process creating the database in Arc/Info.

3.8 Spatial data elements

In order to obtain the information sets, different types of input data sets have been identified. These input data would be mainly thematic maps. Most of the data sets are on 1:990 scales.

The primary elements of the spatial database are given below:

- Administrative Map: Showing the boundaries City/ward/plot for the study area;
- Transportation Network Map at 1:990 scale that will sheet details of railways, road/ highway etc. The detailed road networks are to be as National highways, state highways, District Roads and other District Roads;
- Significant Elevation Points. These points have been adopt for field survey using RTK GPS methods more than 100m distance selection of appropriate elevation points have been incorporated for the map; and
- Land use/ cover map showing Land use level details. As of the objective is to analyze the change in land use over time-period, it was essential to incorporate multi-database land use maps into the database.

A set of secondary elements has been derived from the primary elements for the different analyses. All these derivatives have been generated using the GIS package. While the exact process of deriving these elements are described in the relevant sections, the secondary elements include:

3.9 Spatial database creation

As described in earlier section, the SOB graticule on 1:990 scales has been used for organizing the spatial database. In total there are 284 nos. of 1:990 map- sheets for the city area and these individual map - sheets have been used for digitizing various themes into the database. The procedure adopted for the spatial database creation (Fig. 3.1) is described below:

a) **Master template creation:** As discussed earlier, a master template is created as a reference layer and consisting of the city boundary theme digitization.

b) **Thematic map manuscript preparation**: Based on the SOB graticule of 1:990 scales, the different theme oriented information is transferred from the base map to a mylar/ transparent sheet. Spatial data manuscripts are mylars consisting features that are to be digitized. These manuscripts were prepared on a sheet- by - sheet basis for digitization. These manuscripts consist "instructions" for digitization- which include:

- registration point locations and identifiers;
- feature codes as per the dictionary defined earlier;
- feature boundaries;
- tolerance specifications; and
- any other digitization instructions.

c) **Digitization of features:** The theme features of the spatial dataset are digitized using the GIS package. The master registration- point reference is used for the digitization. The theme digitization is done as component into a copy of the master template layer.

d) **Coverage editing:** The digitized coverage is processed for digitization errors such as dangles, constituting the overshoots or undershoots, and labels for polygons. This constitutes obtaining a report of these errors and then manual editing of these features. Finally the coverage is processed for topology which has also to be done on a map- sheet basis.

e) **Appending of map**: Sheets thematic features: The next step in the procedure is the appending or mosaicking of the different map- sheets into a single theme map for the whole district. The graticule of registration points are used for this purpose.

f) **Attribute coding verification**: The attribute codes for the different categories are then verified and additional attributes- feature-name, description etc. are added into the feature database.

It is only after this procedure that the theme coverage is ready for updation into the map library and also for analysis. Fig: 3.1 shown the procedure for spatial database creation.

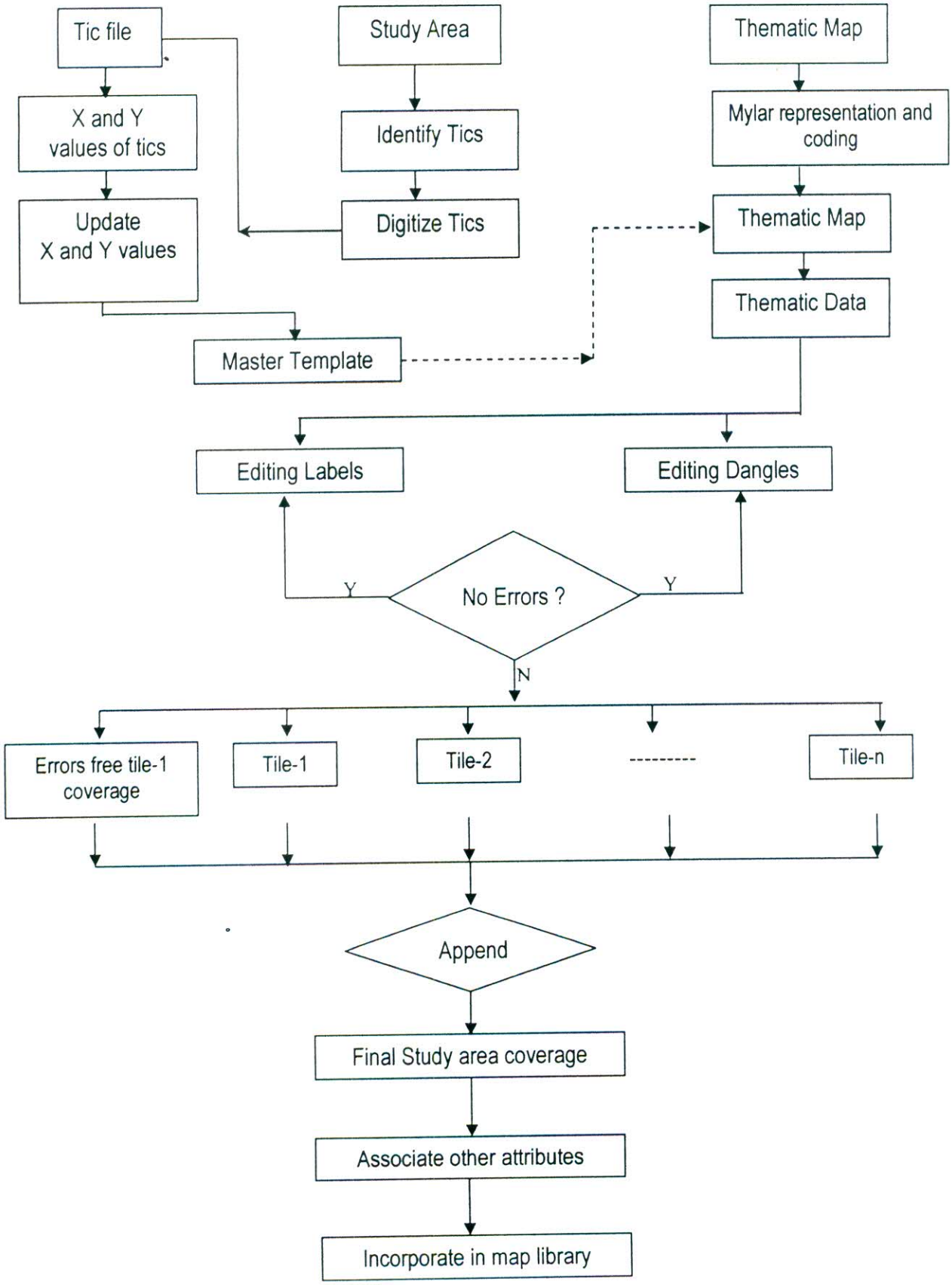


Fig: 3.2 Steps for spatial database creation

3.10 Non- spatial data organization

One of the elements of design is organization of ward- wise data on various developmental and infrastructure aspects. Towards this end, the RCC collectorate provided the plot- wise data existing on the City. A part from this, census data from the District census abstract for RCC was computerized using a FoxPro interface module developed for the purpose. Thus the non-spatial data has been adopted from the above two sources.

3.11 Census database organization

A FoxPro interface module was developed for the census data capture. It is a user-friendly module for easy entry and editing of census data and organization into a database and is based on the Plot-Ward hierarchy of the City. To this and it makes use of a primary file containing plot-wise names and their census code as listed in the census abstract. The module can be directly used for entering the census data in sector-wise databases that are created as secondary files. These secondary files are related to the primary file of villages based on the census village code as the key-item.

3.12 Linkage of spatial and non-spatial data

The GIS allows for the thematic features and the non-spatial features to be related and linked based upon a defined relationship. The linkages are more pertinent for the plot wise data and their abstraction to either plot-or city-level. The ward-boundary theme of settlement theme represents the spatial distribution of wards of the settlements. A one to-one relationship can be defined for each of the ward/settlement entity and the non-spatial data for the ward / settlement. Based upon this relationship, different relations have been defined for the access/retrieval/analysis of the non-spatial data. The relation in the GIS is a method of relating the same spatial entity to different non-spatial entities based on a link-key (Harrison, 1992). Thus, for the non -spatial datafiles that have been organized for the 30 ward (as described earlier), relations have been defined using the census code as the link- key item. The concept of the linkage for the database has been shown in Fig: 3.2.

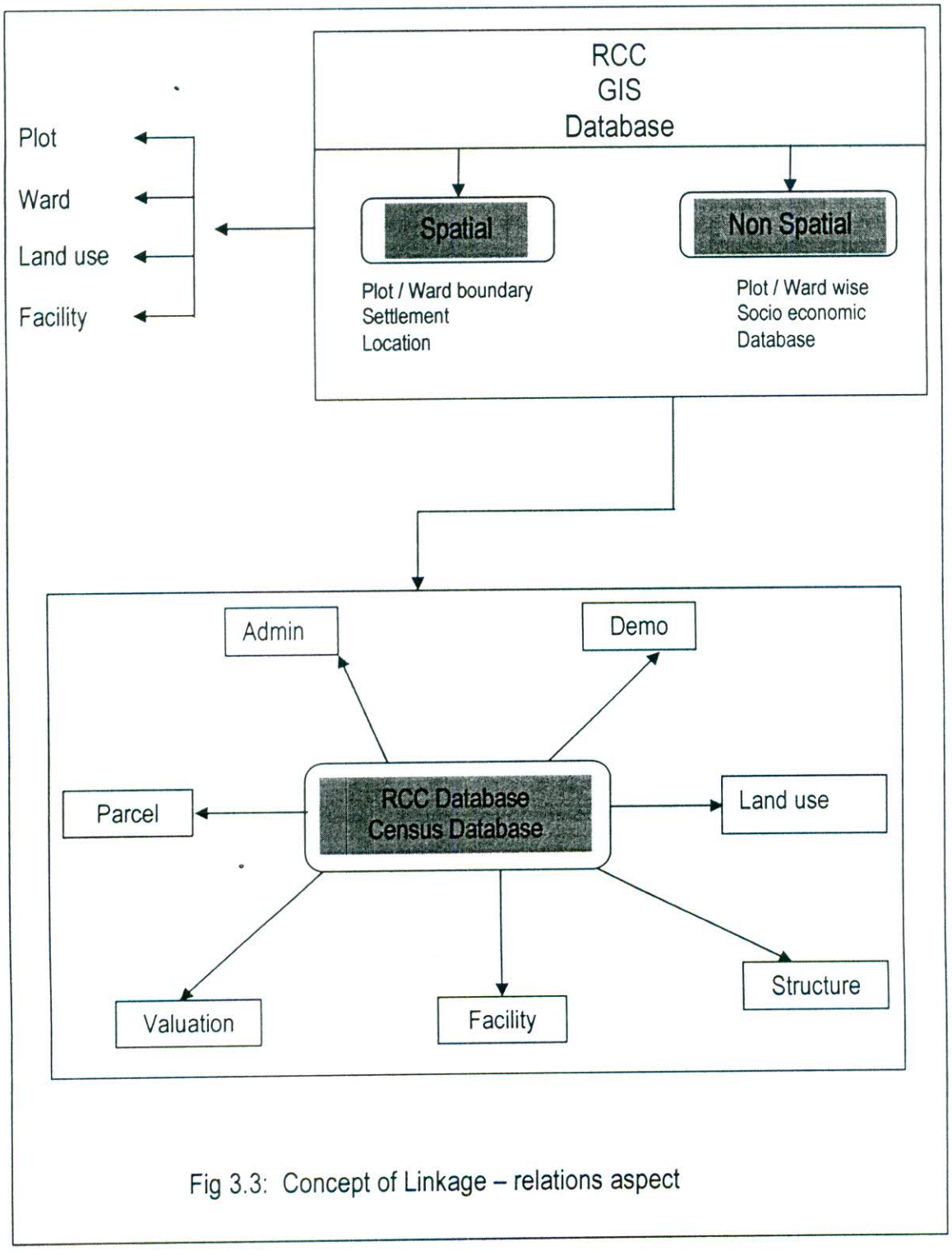


Fig 3.3: Concept of Linkage – relations aspect

A part from this, the ward -plot hierarchy has also been 'forced' into all thematic datasets so as to be able to extract plot-wise theme feature information- spatially and as tables.

3.13 Database updating and linkages

Both the spatial and non-spatial database will have to be updated frequently so as to have the latest data for the further analysis/modeling. Some of the data elements could be relatively static and thus could be created once and updated only when there are changes. Such elements are mainly- administrative boundaries (city/ward/plot), elevation points, drainage etc. However, the data elements that have to be more frequently updated are as follows:

a) **Spatial database**: The updating of the spatial database will have to be based mainly on the inputs form record room, census data as also from the periodic surveys carried out by different agencies.

b) **Non- spatial data**: Most of the non-spatial data is based on the census records and thus would be updated once every 10 years. However, it would be more proper if some of the non- spatial data is available more frequently - say, once every five years so as to be optimal for the planning process. A ten year schedule is not commensurate with the on- going development, as the database needs to be updated for intermediate developments in a more frequent manner. Otherwise, data of a decade would be used for a planning process and suggesting developmental plans which would have already taken place. The present set of non- spatial data includes the 1981 census data on a plot-wise basis and these need to be updated with the 1991 census data-whenever the data is available.

Exchange of data from the GIS database to other computerized databases at City level can be done so as to be able to provide data for further use. This exchange would mean:

a) A non - spatial data exchange, as the RCC does not have the capability to handle data in spatial format. In case the capability to handle spatial data is available then the spatial data exchange can also be visualized.

b) Non-spatial representation of all datasets in the GIS database. This non- spatial representation of data could be on a plot-basis or ward-basis.

c) Conversion of the GIS database into compatible-formats so that the data can be ported and used on the computer system.

CHAPTER-4

4.1 Background and Basic Concepts

A geographic information system comprises of several elements, including hardware, software, users, procedures and data. GIS applicants select the hardware and software that meet their needs, the staff members are trained, procedures are developed and the organization evolves so that the new technology is incorporated in day to day planning activities (Grundstin, 1966). However, as the procurement and transition into the technology occurs, the ultimate success and ability of the system to provide the decision makers with quality and usability of the data that reside in the system. Municipality has various types of functions indicated earlier to perform. For the efficient service it needs a large amount of data. So the municipal database is required to develop in such a way that the data can effectively and efficiently be used. For this purpose a GIS based conceptual model for municipal database is proposed in this chapter.

In general, each data set is stored optimally for a particular application or set of applications and accessing the data set from another application area can give rise to identification and security problems. Some municipal data is confidential and accessing such data must be restricted. Some data are sensitive and even the fact that such data must be collected and stored so that these must not be made generally available.

It would be possible to store all data in a centralized database, holding all data and supporting all applications. Another alternative is to store individual information layer in their concern department with the capability to link then when necessary. However, these imply that the data structure used would be a composite, not optimized for any application, which would almost certainly cause performance problems. Such a database would simplify the security considerations since all access would be controlled centrally (Howe, 1983). In general, such a solution would not let to an optimal system.

This research provides a description of various categories of data and how they interrelate with one another to comprise a municipal database. Municipal functions or tasks and the types of data, which support them, comprise the vital elements of municipal operations. An examination of these generic tasks, together with the manual data bases which are used in support of these functions, provide the fundamental framework

upon which a "conceptual model" of geographic data entities with their relationships in a municipality is to be built. This understanding may then is directed into database and information system designs an implementing planning (Huxhold, 1991).

Statistically, we are watching the emergence of a large urban work force for whom employment is needed so that they can join the established tax paying citizens and enjoy the benefits of urban living. Common sense would suggest involving the ever-growing poor urban population in a work force for the continuous construction of shelter and provision of services needed in each town and city, and providing them with an appropriate urban environment for the future (Arville, 1970). Such an approach has many advantages for the people themselves, the town administrations and the local economics. Such as approach would also require new models of urban and housing development companies at the local level, as part of a national housing and urban financing system (ISTR, 1974).

Throughout the last two centuries in Europe and America, town and city building and re-building was a major industry in itself, improving and increasing land and property values, increasing the property tax payable as an increased source of income for the municipality. Lesson form that period it however indicates that *laissez–faire*, unregulated urban growth and construction leaves an intolerable burden on the next generation to sort out.

Recognizing the urban system also means identifying all the quantifiable interacting components parks, including the urban poor, which go to make up the single corporate entity representing the particular town, municipality or community, whether a large urban conglomerate or a rural service center. As an example Fig. 4.1 gives an outline of the several component parts which can be measured, which interact upon one another in a quantitative way, and which can be finally assembled in the type of computers which are readily available in the market today.

We have such computers available in the market, so the time has come for planners to be precise in specifying how they want to use it. The first requirement that comes to mind is the data base for the town, fed into the computer and updated regularly as required, from which information required can be graphically

displayed in map form, sometimes in three dimensional representation, in color and immediately printed out for the particular user.

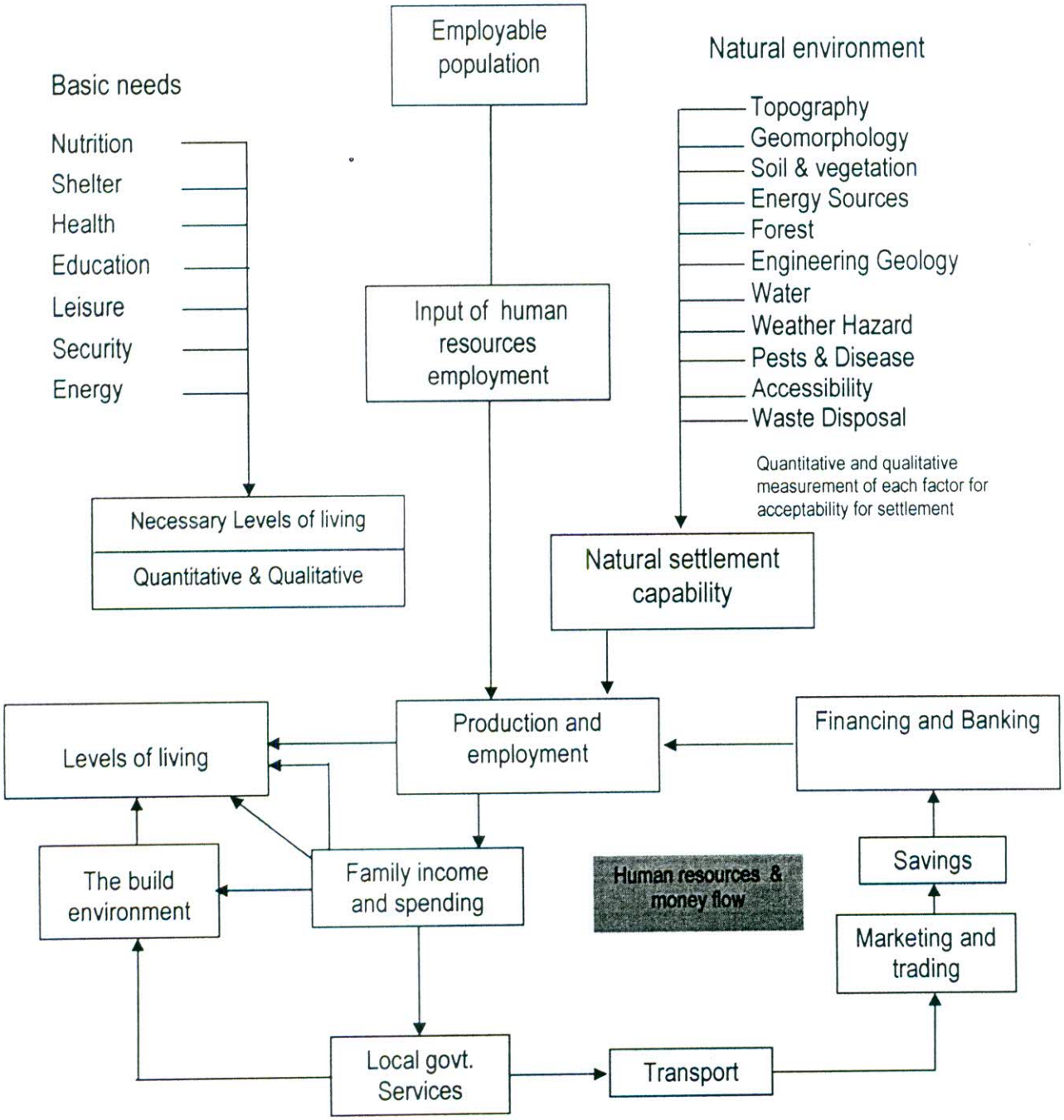


Fig: 4.1 Components of Municipal Information Systems.

Such a data base would presuppose a map showing every parcel of land or building reasonably accurate dimensions that could be used as the town's cadastre, or property register for valuation and tax purposes (Zwart, 1986). What is imperative is that the official planners come to a unified decision as to what information should be stored in the computer for the management of the town planning system.

The land Information system was the basis on which the other three-information system; resources, activities and people, were spatially related (Fig. 4.2). This outline, with appropriate adjustment, may have some application for the town planning needs in Bangladesh.

Ultimately, the planning commission may wish to start measuring the role of towns and cities in national economic growth (Chowdhury, *et al.*, 1992). This would mean identifying a model of a town as if it were a corporate entity in itself. It could equally be envisaged that the planning commission would need to quantitatively measure the economic performance of that corporate entity in relation to, or compared with, all the other corporate settlements in the administrative level (Dangermond, *et al.*, 1987). This would mean establishing comparative indicators of the economic performance of each town in the context of the natural living environment in which they are situated. If the authorities wanted to measure the levels of living of each settlement, related to measures of basic human needs, and compared with the resultant circles of living, then the model outlined in fig 4.1 could be used an a basic for quantifying the several elements involved. One agency or another assembles all the Information listed in one form or another, but rarely is it synthesized into one model.

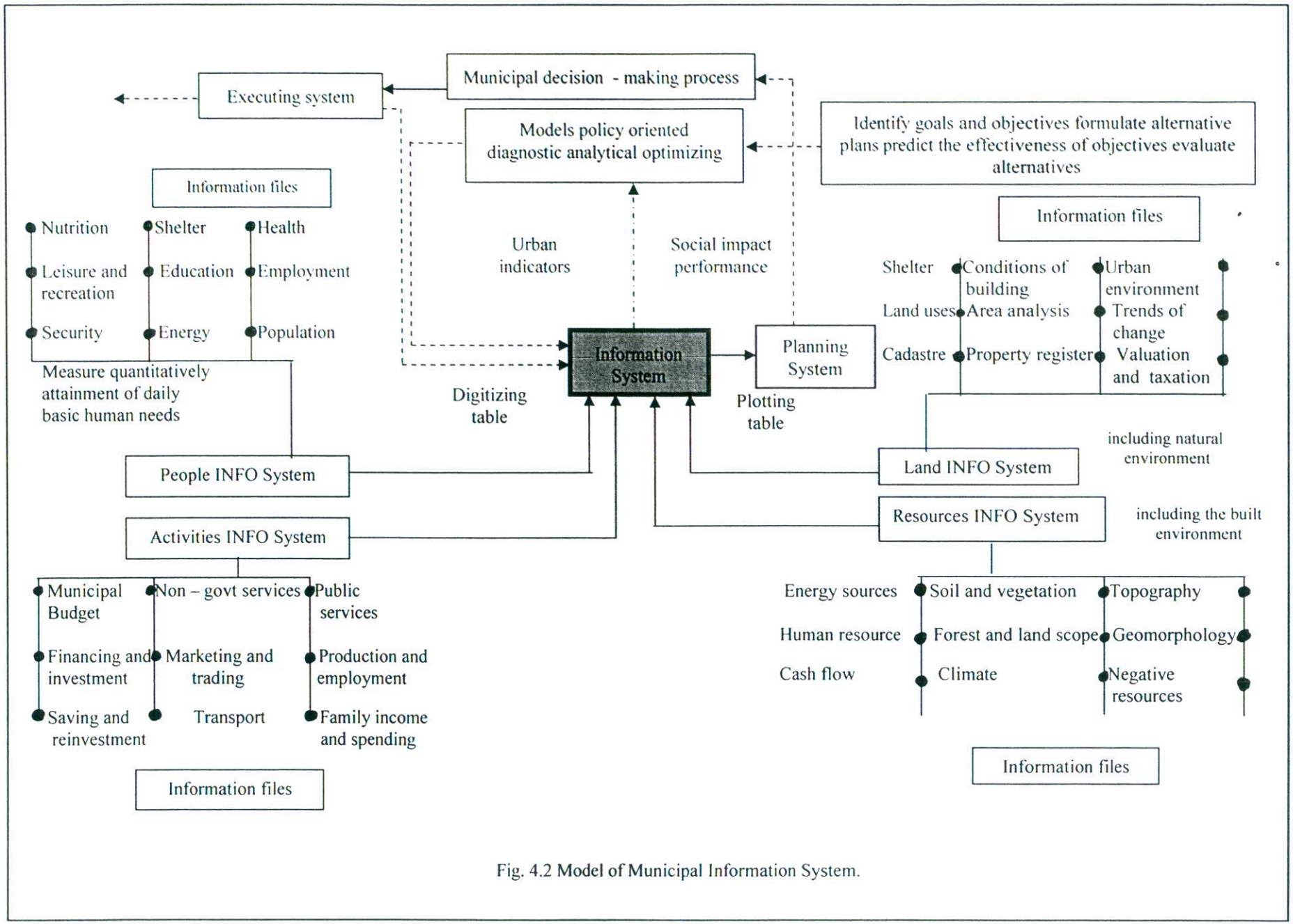


Fig. 4.2 Model of Municipal Information System.

4.2 Conceptual Model and Hierarchy of the system

The municipalities act defines various obligatory functions that the municipal planners and the administrators have to discharge. After studying this act a conceptual model of a computerized municipal Information system has been constructed (Fig. 4.3). The hierarchy of the system would consist of a number sub system Graphic sub systems containing information in graphic form such as urban land use information, management Information and topographical Information sub system Graphic cum non-graphic sub-system: a cadastral information sub system, Non-graphic sub-system: people information, finance information and monitoring information sub-systems (Weiner, 1967). The present study concentrates only on the graphic aspects of the urban land use, cadastral, management and topographic information sub-systems.

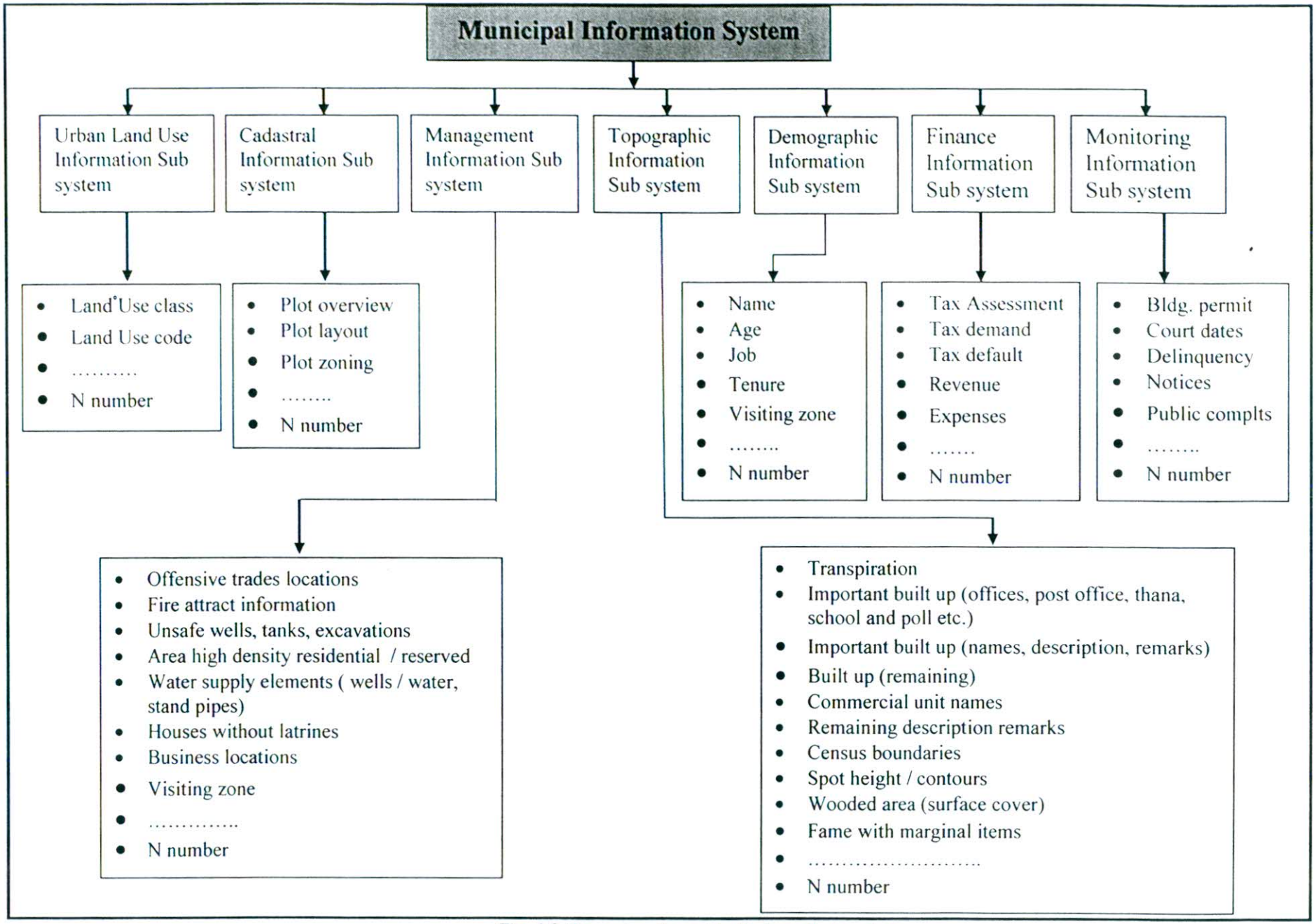


Fig. 4.3 Hierarchy of municipal information system.

4.3 Data components

In a conceptual sense nine components are identified for the municipal data model of Rajshahi City Corporation each of which may be conceived of as containing a series of data entities. The nine basic components are as follows:

- **Base Map:** Base maps include geodetic control data, landmarks and topographic elevation contours. Building footprints layer may include in this component. These provide a framework and reference for integrating all of the other manuscripts and overlays for a particular geographic location. Geodetic control data give the absolute location in the form of X,Y coordinates, whereas contours are provided in the form of line drawings of topographic elevations and altitudes.
- **Environmental Data:** This data or component consists of several layers related to environment such as layers of soils, geology, vegetation, landform, hydrographic, slope, and related geographic features. In a typical municipality, these layers are used to associate the suitability and capability of land for various types of uses.
- **Network Facilities Data:** This data component consists of layers, which indicate information for locations of roadways, utilities and infrastructure, layouts (i.e. lines for water, sewer, cable television, gas, electric, hydro, sidewalks, fire hydrants, utility poles, etc.). These maps are typically used for reference in grading and construction of facilities.
- **Structure data:** These are the architectural and engineering drawings of the buildings. These highly detailed engineering records are considered in evaluating cartographic activities within the municipality.
- **Land records data (Parcel data):** These maps provide the basic drawings of land ownership boundaries for all public and private lands. Parcel maps are typically maintained at a variety of scales and may range from very precise to very general "cartoon maps" (which shows only schematic layouts of the basic land cadastre).
- **Utilities data:** These layers hold information on the location of utility facilities. It includes tube wells, water pumps, electric transformers etc.
- **Street network file:** This is typically a topological street network file providing intersection numbers, street names, Link numbers of each street, address ranges of the streets and the polygon the right side and left side of the street. This street base files provide a linkage between address data and street faces that surround a municipal block, By using the concept of address geo-coding, parcel data may be matched with the street network to create street tabular data.

- **Area Data:** Area data bases comprise with the polygon outlines of blocks, enumeration areas and various administrative boundaries such as school districts, police districts, census summary district, zip codes and so on. These maps correspond directly to the area tabular data described above.
- **Planning Related Data:** Any planning activity requires some special data, which should keep in separate layers. Planning related data component contains layers of urban land use, development plan land use, zoning, special district / precinct, special planning areas, special management areas etc.

For each category data component, data are stored in the form of maps and tables. A geographic identifier, links the two forms of data, is a unique ID number. Each map in the database represents one type of data (such as road locations) for the entire geographic coverage area of the database. The maps proposed for each of the nine database categories of the municipal database are summarized (Table 4.1). The associated tabular data contains such information as the name of each street, the length of the each section of street, the address range, etc (Table 4.2).

Table: 4.1 Proposed data layers for GIS based RCC Information System

Data components	Example of map layers
Base map data	• Control points • Topographic contours • Land marks • Building footprints
Environmental data	• Soils map • Floodplain map • Noise level map • Streams and water bodies • Flood zones
Network facilities data	• Sewer system • Water system • Electrical cabling • Telecommunications • Wastewater collection
Structure data	• Structure map
Land records data or parcel data	• Lot boundaries • Land parcel boundaries • Easement and right of ways • Street widening setbacks • Parcel exceptions
Facilities and utilities data	• Tube wells • Water pumps • Electric transformers and phone booths • Fire hydrants • Fire stations • Schools, colleges, and libraries • Hospitals • Markets etc
Street network data	• Road centerlines • Road intersections • Street lights • Street trees
Area data	• Demographic areas • Tax rate areas • School districts • Emergency service areas • Police districts • Zip codes
Planning related data	• Land use map • Development plan land use • Zoning restrictions map • Special district \ precinct • Development plan areas • Special management areas

Table: 4.2 Required data layers for each functions of Rajshahi City Corporation.

Departments	Functions of the RCC	Base Map	Environmental	Network facilities data	Structure data	Land record data	facilities and utilities	Street network data	Area data	Planning related data
Public Work	• Construction and Maintenance of roads and Infrastructure	✓		✓		✓		✓		
	• Roads and Infrastructure Maintenance	✓		✓		✓		✓		
Revenue	• Tax assessment and collection	✓			✓	✓	✓		✓	✓
	• Lease of commercial building and shopping centers	✓			✓	✓			✓	✓
	• Tolls from the markets				✓	✓				
Public Health	• Roads and drainage cleaning			✓		✓				
	• Collection and disposal of domestic garrbage and night soil			✓			✓	✓		✓
	• charitable dispensary					✓	✓		✓	✓
Water Works	• Street hydrants			✓			✓		✓	✓

CHAPTER-5

Taxation Sub-System of RCC

5.1 The origin of the fiscal cadastre

The fiscal cadastre may be defined as an inventory of land parcels that provides the information necessary to determine the value of each parcel and the tax due on it. The applications of the fiscal cadastre are, however, more widespread and related to a variety of land management functions. There are three major steps in operating the fiscal cadastre. Firstly, it is necessary to discover and identify all parcels that are to be valued. Secondly, each land parcel must be classified and its value is determined. Thirdly, the taxes must be collected from those who are responsible for the property. The actual person or persons who must pay the tax may not necessarily own the property. The fiscal register may, however, be a primary source of evidence as to the true owner. There should therefore be a connection between the management of the fiscal registers and the so-called juridical cadastre.

The earliest cadastres were developed for taxation purposes. Rudimentary cadastral arrangements have been traced to the early agricultural settlements along the Tigris, Euphrates, and Nile Rivers, where revenues for the Pharaohs and the priesthood were met principally by an assessment of land income as revealed by the cadastral survey (Gerkard, 1991). The tax was based on the principle that all land belonged to the king and all those who cultivated his land had to pay taxes in the form of rent. In later times, the Greeks and the Romans developed elaborate land records and survey systems in support of land taxation. The functions served by the fiscal cadastre are as follows:

- Information base for property taxation;
- Support in financial allocation programmes;
- Monitoring and support for land market;
- Aid to land use development control; and
- Provision of land information.

Modern fiscal cadastral systems can be traced to the tax mapping of the Italian province of Milan and Mantua between 1720 and 1723 (Gerkard, 1991). Following this the Austrians carried out a cadastral survey between 1785 and 1789 of the entire territory included within the

Austro-Hungarian Empire (Dale, *et al.*, 1989), In 1807 Napoleon appointed the mathematician Delambre to chair a commission whose task was. To survey more than 100 million parcels, to classify these parcels by the fertility of the soil, and to evaluate the productive capacity of each one; to bring together under the name of each owner a list of the separate parcels which he owns to determine, on the basis of their total productive capacity, their total revenue and to make of this assessment a record which should thereafter serve as the basis of future assessment.

Much of the impetus for the development of fiscal cadastres in Europe in the eighteenth and nineteenth centuries has been attributed to the French physiocrats. They argued that, since landed property is capable of producing an income over time and is the basis of all wealth, the revenues necessary for administering the state should be derived from taxing that wealth at source, namely by taxing the land (Yeh, *et al.*, 1992). This approach became widely accepted in Europe, where most state revenues were obtained by levying a ground tax. This tax was ultimately based on the estimated taxable revenue of each parcel, the amount depending on the particular use of the land (Dale, *et al.*, 1989). The physiocrats` methods later provided much of the stimulus for large-scale tax mapping in North America and elsewhere, since maps are a means by which all properties can be identified and recorded (Hanigan, 1987).

5.2 The creation of fiscal cadastres

The fiscal cadastre is an instrument for administering land tax policy. Although primarily a support for land value and property taxes, the data that it records can be used in the determination of other forms of tax, such as those imposed on personal wealth or income derived from real estate. The data also provide fiscal information for the expropriation of land for government purposes and for revenue transfers between different levels and departments of government (Maggo, 1994).

The creation of a fiscal cadastre entails a number of operations as below:

5.3 Creating a fiscal cadastre

- Identify all properties;
- Classify each property;
- Analysis market data;

- Value each property;
- Identify owners and tax payers;
- Prepare valuation rules;
- Send bills and collect taxes; and
- Establish appeals procedures.

All of these must be carried out with the framework of the law. These include:

- The identification and mapping of all properties that are to be subject to tax. A primary requirement for an efficient and efficient fiscal cadastre is a set of current property maps that provide an index for compiling and maintaining valuation information. The maps are necessary to ensure that all parcels are identified and that no parcel is taxed more than once. The approximate size, shape and location of the parcel as depicted on the map, may be used in the actual valuation process.
- The classification of each property in accordance with an agreed set of characteristics relating to such matters as its use, size, type of construction and improvements.
- The collection and analysis of relevant market data. This may include data on sales prices, rental changes or building maintenance costs, together with details of the dates when these applied.
- The determination of the value of each parcel in accordance with one or more of the principles outlined under 'valuation methods'
- Preparation of the valuation roll.
- Billing and collecting, which are the tasks of notifying the individual property taxpayer what he has pay and collecting the appropriate taxes
- Appeals procedures.

5.4 Site Information

The information required to develop and maintain a fiscal cadastre may be collected directly through surveys and indirectly from other sources, such as the land registration office for details of ownership and sales price and the planning office for building permits. In many jurisdictions, for example affidavits attached to property conveyancing documents provide the

primary source of sales data. These site information are of different types but can broadly be classified as below;

5.5 Site information: Site/location

- Topography;
- Soil characteristics;
- Usable land area;
- Building setback requirements;
- Landscaping;
- Cul-de-sac location;
- Corner location;
- View;
- Street and allew access;
- Railroad and waterway access;
- Available utilities;
- Distance to shopping;
- Nearby nuisances; and
- Zoning.
- .....

Building Size:

- Ground floor area;
- Total floor area;
- Leasable area;
- Volume;
- Building height;
- Ceiling height;
- Clear span;
- Number of stories; and
- Number of apartments.
- .....

Design

- Intended use;
- Architecture style;
- Shape of building;
- Roof type; and
- Story height.
- .....

Shape

- Floor area/perimeter ratio;
- Number of corners.
- .....

Construction quality

- Quality of materials;
- Workmanship; and
- Architecture.
- .....

Construction materials

- Foundation;
- Framing;
- Floors;
- Wall;
- Ceilings; and
- Roofs.
- .....

Other building features

- Number of rooms by type;
- Heating, ventilation, air conditioning;
- Plumbing of facilities;
- Fireplaces and similar amenities;

- Additions and remodeling;
- Porches and patios;
- Swimming pools;
- Shelters for automobiles;
- Elevators; and
- Power equipment.
- .....

The valuation process depends upon the availability of such site data as the frontage, depth and width of the parcel, its topography shape and area, the drainage and soil conditions, and details of any off-site improvements in a site survey, all properties in a jurisdiction may be visited in a systematic and cyclical fashion or individual parcels may be visited on a sporadic basic.

5.6 Objectives of Taxation of RCC

The objectives of any taxation sub-system of RCC are partly political and partly administrative. According to the objectives of RCC the tax should:

- be seen either to serve clearly identifiable social objectives or else to produce significant sums of revenue;
- be exclusively controlled by the political authority imposing the tax;
- be administered in a way that is understood both the taxpayers and by their political representative;
- be relatively simple and cheap to collect;
- distribute the tax burden in a way that is seen to be equitable;
- encourage high and stable levels of employment; and
- ensure the best allocation and use of resources.

5.7 Nature of Taxes in RCC and its Process

The resources of municipality can be divided into three groups-intemaly raised revenues, the government grants, and loans and advances. This study deals with the internal revenue, more specifically the land based or property based revenues. This includes tax on houses, rates for electricity, water and conservancy, and urban immovable property transfer tax and latter on is not concern of this study. One tax and three rates are collectively known as "Holding Tax'. Land and building within the municipality boundary are subject to tax and three rates are for street lighting, water and conservancy services (Archer, 1986).

In case of owner occupancy when it is difficult to assess the rent, a value is imputed from the rents of similar properties (buildings in the locality. All properties are assessed for taxation except places of worship and dilapidated structures having annual rental value of Taka 50 or less.

5.8 Preparation of a valuation list

For the purpose of levy taxes or rates mentioned earlier, the municipal corporation prepares a valuation list of all buildings within the municipal corporation and such list is prepared by an assessor appointed for this purpose, The assessor, after making such enquires as may be necessary, determines the annual value.

The process of taxation is guided by the municipal corporations (Taxation) Rules, 1986 and model Tax schedules for detailed administration of these taxes. The model Tax schedules provide the maximum rate that can be imposed for each of the rates and the house tax (Barr, *et al.*, 1984). The rate of holding tax of RCC are given below (MOL, 1989a):

(a) For rented buildings:

(i) The annual value shall be taken to be gross annual rental value minus two month's rent as maintenance allowance; and if the property is mortgaged to the government Bangladesh House Building Finance Corporation, scheduled banks or any other financial institutions under registered instrument for

securing funds for construction or purchase of the same, then the annual interest payable on account of such mortgage–debt shall also be deducted.

(ii) If the monthly rental value of any building appears to be abnormally high or unusually low, the assessor, while determining annual value, may consider that value, which buildings and lands of similar description and with similar advantages in the locality may be let-out.

(b) For owner occupied buildings: The annual value is deemed to be the probable annual rent at which the buildings and lands of similar description with similar advantages in the locality may be let out or at 7 percent of the value of the building on the date of assessment plus ground–rent for the land comprised in the building, whichever is less, minus the following:_

(i) Two months rent, of one-sixth of the annual value, as the case may be as the maintenance allowance;

(ii) 40 percent of the annual value after deduction of the amount mentioned in item (i).

(iii) if the property is mortgaged to the government, HBFC, scheduled bank or any other financial institution for securing funds for its construction or purchase of the same, then the annual interest payable on such mortgaged debt.

(c) For rented and partly occupied buildings: The annual value of the rented portion shall be calculated in the manner as specified in clause (a) And that of the occupied portion as in clause (b) The total process can be summarized in the following way-

The assessment is made in the following manner,

1. A whole year's (twelve months) rental income is estimated;
2. Two months' rent income is deducted for helping the owner to cover maintenance cost;
3. Any mortgage interest associated with the parcel is deducted. Loans received from any officially recognized institutions (banks) are considered in this case;
4. An additional 25 percent of the ten-months' rent is deducted in case of owner-occupancy.

The assessor may, by notice in a prescribed form, require the owner or the occupier of a building or land to furnish him within one week with true and correct returns of the rent or annual value there of in forms B and A true and correct description of the building containing such particulars as the assessor may direct, and the assessor may enter, inspect and measure any such building at any time between sunrise and sun-set (Ahmed, 1989):

The above rules of assessing holding tax can be presented in statement form for the convenience

Holding tax assessment for a rented building

Annual value (AV) = (monthly rent *12)- two months rent (maintenance cost)

if the parcel is mortgaged to the bank the annual interest would be deducted form the annual value.

Net holding tax = AV* 15%

Here, 15% represents that the rate of holding tax 15% on the annual value in the RCC area.

Holding tax assessment for an owned occupied building

The annual value for an owner occupied building may be collected from the probable tent of the building and lands of similar description and with similar advantage in the locality. Another method for assessment of owned occupied building is also prescribe in the rules, but due to data unavailability the first mentioned method are used for the assessment of owned occupied building.

Holding tax assessment for both owned occupied and rented building

Annual value (AV) = (monthly rent *12)–Two month rent (maintenance cost)

If the parcel is mortgaged to the bank the annual interest would be deducted form the annual value.

Net holding tax = (25% *AV) * 15%

To specify the tax the following details are needed for the valuation process:

i) Holding number;

ii) Name and address of the owner;

iii) Number of the structure;

iv) Building dimensions;

v) Materials used in the structure;

vi) Number of the floors;

vii) Use of the Structures;

viii) Proportion owner occupied; and

ix) Annual rent.

5.9 Preparation of Assessment List

The assessment list may contain all of the data needed in the valuation process and also the following data. According to MOL 1989b the following items are:

a) the annual value of the building or land;

b) the amount of tax or rate payable for the year (each tax or rate to be shown separately)

c) if the building or land is exempted from assessment, a note to that effect.

After every live yearly reassessment of properties, an assessment list is prepared. The Mayor or any authorized officer authenticates the same by putting signature on each page of the assessment list.

The taxpayers are then free to inspect the assessment list. Any party who disagrees with the amount of the valuation can file review petition in the form prescribed for this purpose. A sub-committee appointed by the corporation hears these cases. If the outcome of the decision to the sub-committee is not satisfactory to a person, he may file appeal to the controlling authority within one month of receipt of the order. The decision of the controlling authority is final Three registers are maintained for tax administration in the municipality. They include-

1) a valuation register

2) an assessment register and

3) a demand register or payment register

The valuation register contains information or every holding on two assessments-the current and the previous one regarding the value in amount. description of the structure and resident status. The assessment register contains all these information plus everything about changes

in ownership and changes in assessments made after the hearing of appeals. The third register contains payment information.

For the convenience of tax collection the corporation is divided into blocks. circies mahallas or sectors; One two or three circles are placed in charge of one collector who collects the taxes of that circle through contracts with the taxpayers. The payers are however free to pay taxes at the office counter also.

5.10 The 'E - R' Model

The design of an 'E-R' model, which will be treated in this chapter, involved the following key steps:

- Identification of entity types,
- Identification of relation types,
- Drawing of an E-R diagram
- Determination of attributes and value types in such a way that a set of fully–normalized table (skeleton table) is obtained.

Once the E-R models have been drawn, the result can be translated into physical storage structured. Then application and query language will be utilized for this purposes FoxPro relational database management will be used to implement those steps.

Identification of the Entity types:

Having analysis the different system uses and the steps involved in the design of 'E-R' model in particular for the land tax department purposes and identity all relevant entities Fig 5.1. The entities are as bellow.

1. District
2. City
3. Ward
4. Parcel
5. Building
6. Owner
7. Tax class

8. Soil unit
9. Parcel/owner
10. Parcel/soil unit

Note that entity no 9 (parcel/owner) and no10 (parcel/soil unit) were created because the parcel and owner relationship as well as the parcel and soil unit relationship are M:N (many-to-many relationship)

5.11 Identification of the relation types. The 'E-R' diagram and the Enterprise rule:

Based on the general overview of the Rajshahi City Corporation and its development, it is shown clearly that each city is divided into wards and wards are divided into parcels. This means that:

- The relationship between district and city is 1:N (one-to-many) and both sides are obligatory.

The 'E–R' diagram showing this relationship is as follow:

The enterprise rule is that:

1. A district must have at least one city.
2. A city must belong to a district.

- The relationship between city and ward is also 1:N (one-to-many) and both sides are obligatory.

The 'E–R' diagram showing this relationship is as follow:

The enterprise rule is that:

1. A city must have at least one a ward.
2. A ward must belong to a city.

- The relationship between Ward and Parcel is 1:N (one-to-many) and both sides are obligatory.

The 'E–R' diagram showing this relationship is as follow:

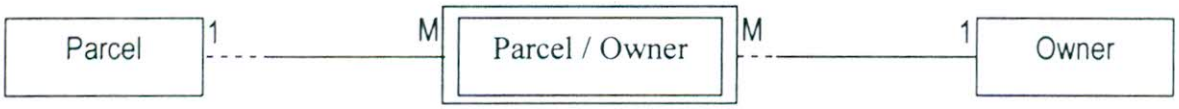
The enterprise rule is that:

1. A ward must have at least one parcel.
2. A parcel must belong to a ward.
3. A parcel may be urban or Agriculture.

Other analysis shows that:

- The relationship between parcel and owner is M:N (many-to-many) and both side are non-obligatory.

The 'E-R' model diagram showing this relationship is as follows:

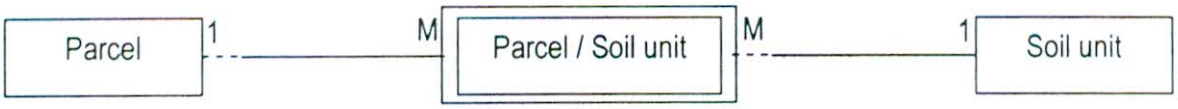


The enterprise rule is that:

1. A parcel may be owned by one or more owners.
2. A person may own one or more parcels.

- The relationship between parcel and soil unit is also M:N (many-to-many) and both sides are non-obligatory.

The 'E-R' diagram showing this relationship is as follows:



The enterprise rule is that;

1. A parcel may belong to more than one soil unit.
2. One soil unit may have more than one parcel.

- The relationship between parcel and building is 1:1 (one-to-one), where parcel is non-obligatory and building is obligatory.

The 'E-R' diagram showing this relationship is as follows:

The enterprise rule is that:

1. A parcel may have a building;
2. A parcel should not have more than one building;
3. A building must belong to a parcel;
4. The parcel owner must own the building; and
5. No building is allowed on agriculture land.

- The relationship between parcel and tax class is 1:N (one-to-many), where parcel is non obligatory and tax class is obligatory.

The 'E-R, diagram showing this relationship is as follows:

The enterprise rule is that:

1. A tax class must belong to a parcel;
2. A parcel may belong to one tax class;
3. One tax class bill for one person; and
4. If more than one person for a tax bill:
   * The person with higher share will receive the bill.
   * else if equal share, the person on top of the list will get the bill
5. Agricultural parcels which are in erosion and forest areas are exempted from land tax.

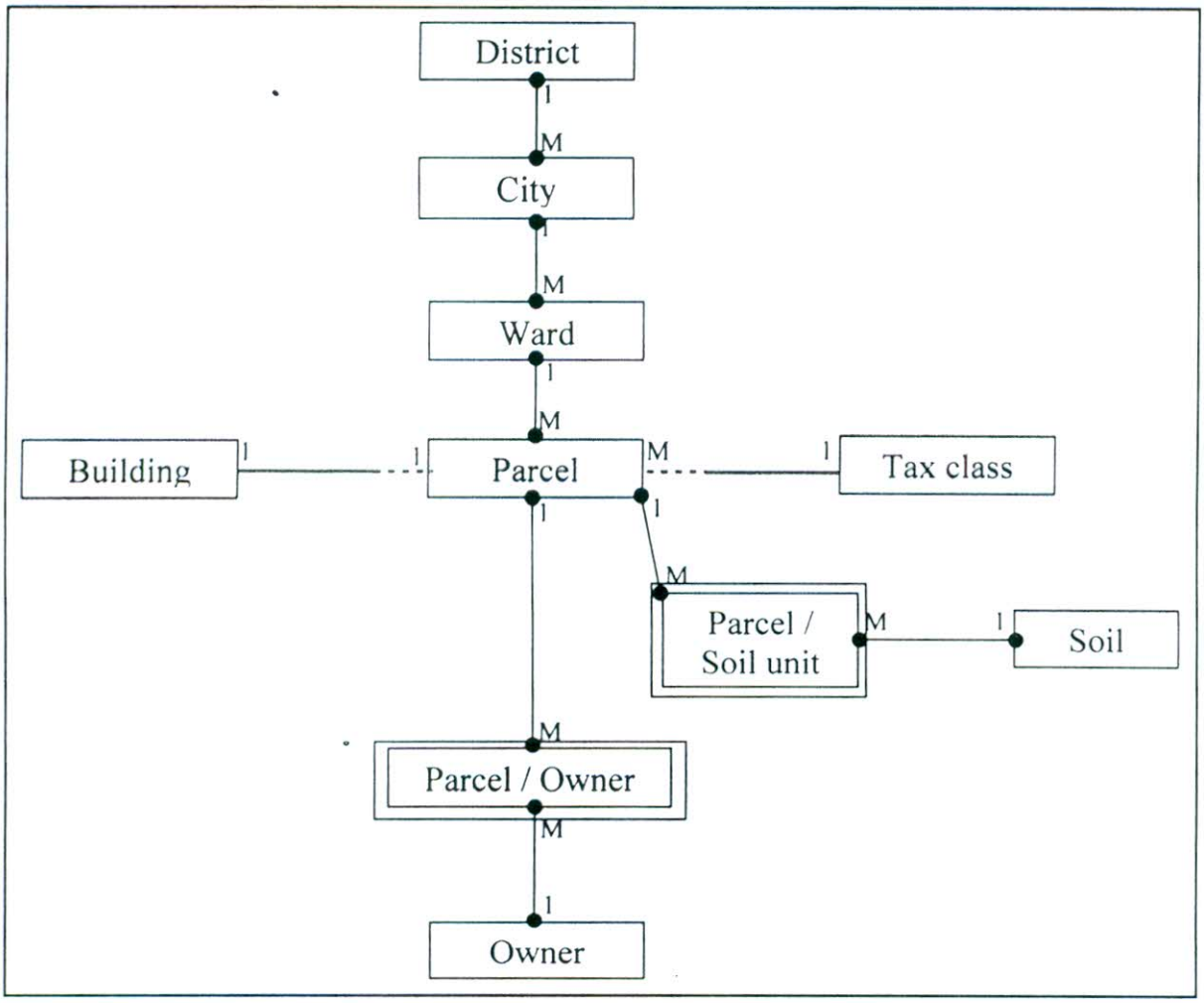


Fig 5.1 The Final 'E-R' Model of Rajshahi City Corporation

As a summary the 'E-R' model is outlined in following diagram and the enterprise rules are listed below:

1. A district must have at least one city;
2. A city must belong to a district;
3. A city must have at least one city;
4. A ward must belong to a city;
5. A ward must have at least one parcel;
6. A parcel must belong to a ward;
7. A parcel may be urban or Agriculture based;
8. A parcel may own by one or more owners;
9. A person may own one or more parcels;
10. A parcel may belong to more than one soil unit;

11. One soil unit may have more than one parcel;
12. A parcel may have a building;
13. A parcel should not have more than one building;
14. A building must belong to a parcel;
15. The parcel owner must own the building;
16. No building is allowed on agriculture land;
17. A tax class must belong to a parcel;
18. A parcel may belong to one tax class;
19. One tax class bill for one person;
20. If more than one person for a tax bill; and
    * the person with higher share will receive the bill.
    * else if equal share, the person on top of the list will get the bill
21. Agricultural parcels which are in erosion and forest areas are exempted from land tax.

The Skeleton Tables

The skeleton tables represent as entity with a full description of its associated attributes are listed as follows:

RCC (mun_id, mun_name).

Parcel (parcel_id, mun_id, tax_z_id, tax_c_id).

Owner (parcel_id, owner_id, owner_name, F/H_name, GIP_code).

Tax_rate (tax_class, Tax_rate).

Structure (struc_id, storied, floor_area, materail_class, dev_status, cons_year, rent_yaer, parcel_id).

Struc_use (struc_id, parcel_id, use_id).

Road (road_id, type, length, area name, maintaince by)

Drain (drain_id, type, length, capacity, area name, flow direction, maintaince by)

Electric pole/line (electric pole/line_id, type, length, capacity, area name)

Telephone pole/line (telephone pole/line_id, type, length, area name)

Dustbin (dustbin_id, type, capacity, area name, maintaince by)

Tubewell (tubewell_id, type, area name, maintaince by)

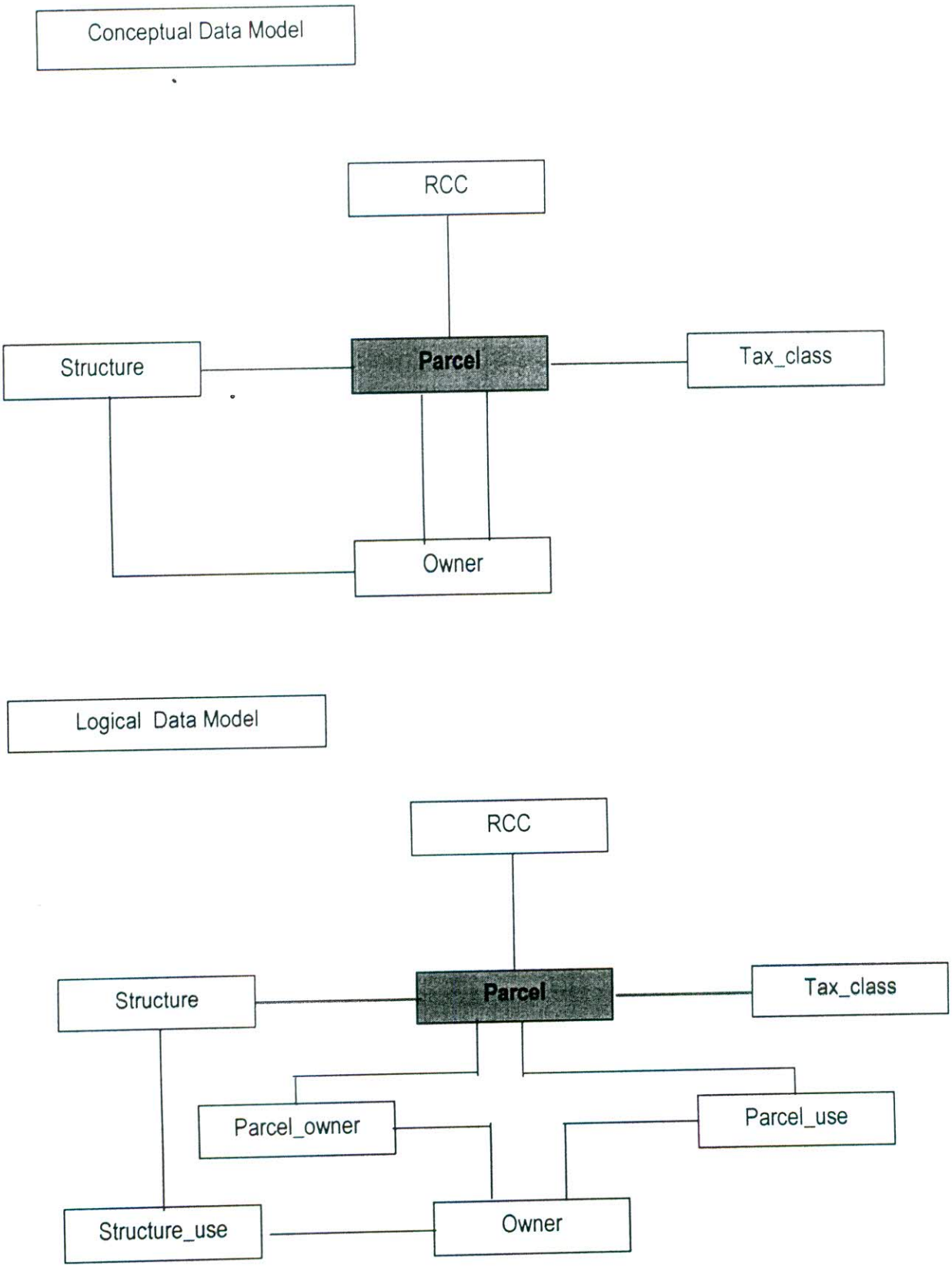


Fig. 5.2 The conceptual and logical data model.

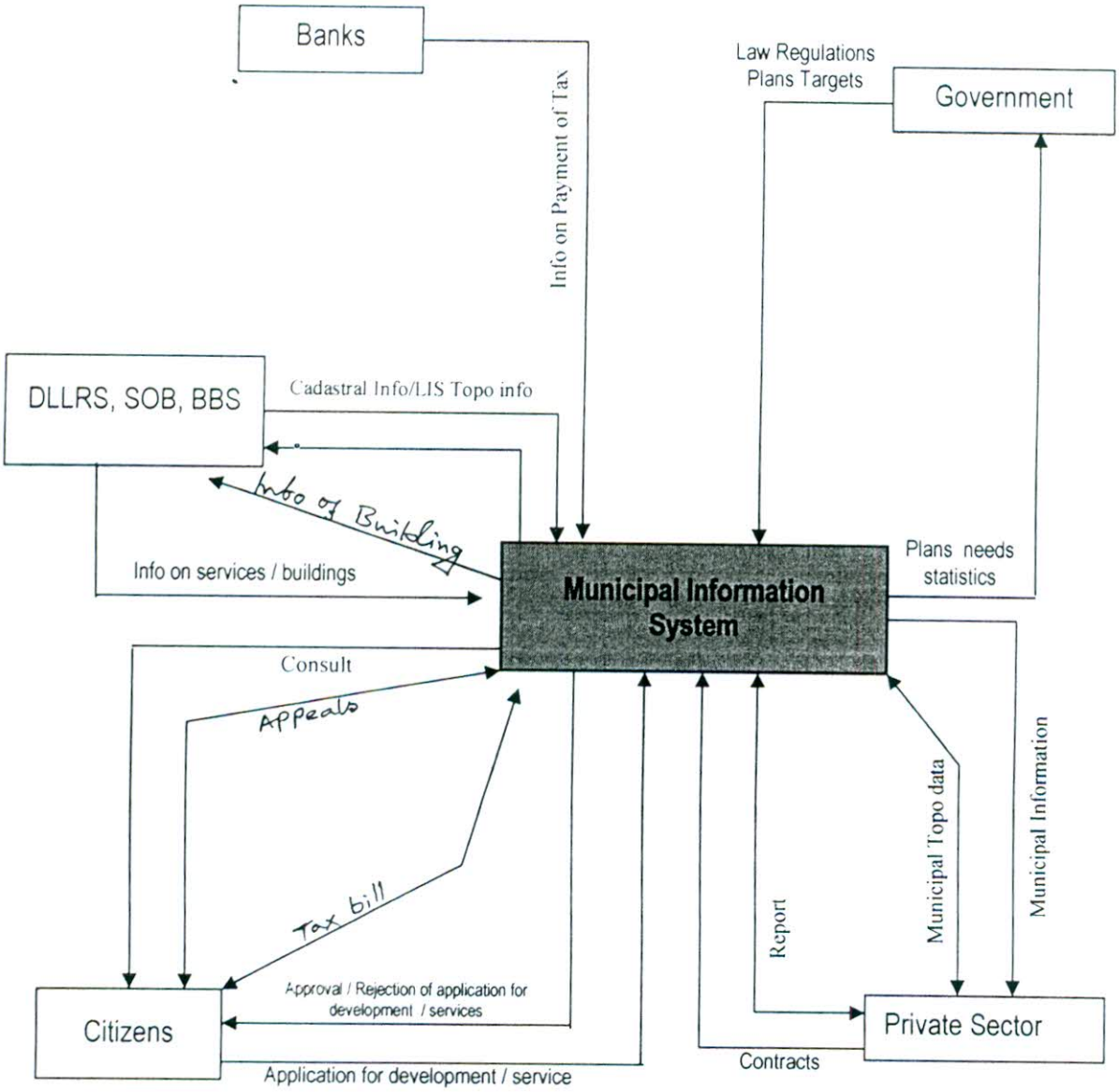


Fig: 5.3 The context diagram of municipal Information system

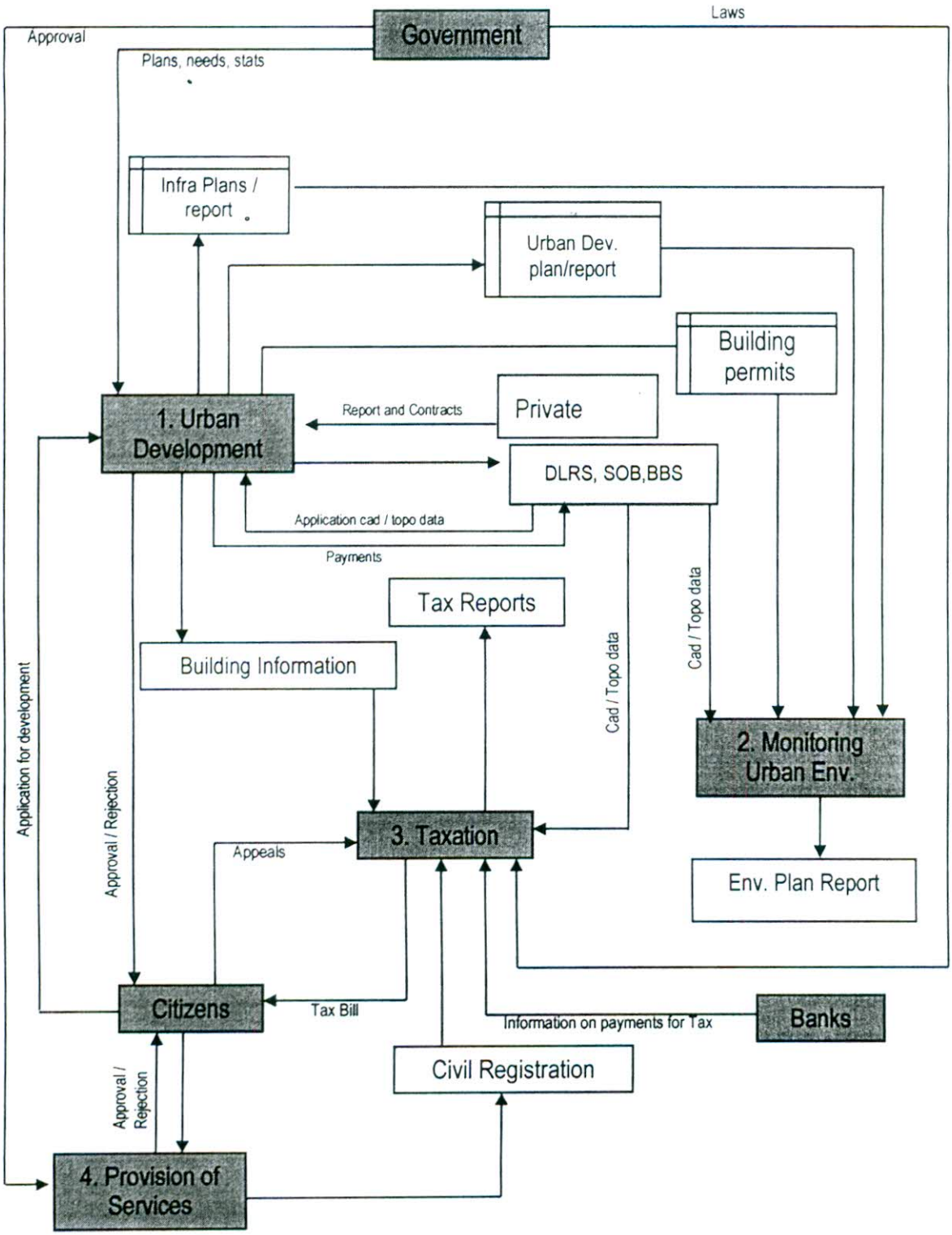


Fig: 5.4 The level diagram of municipal information system

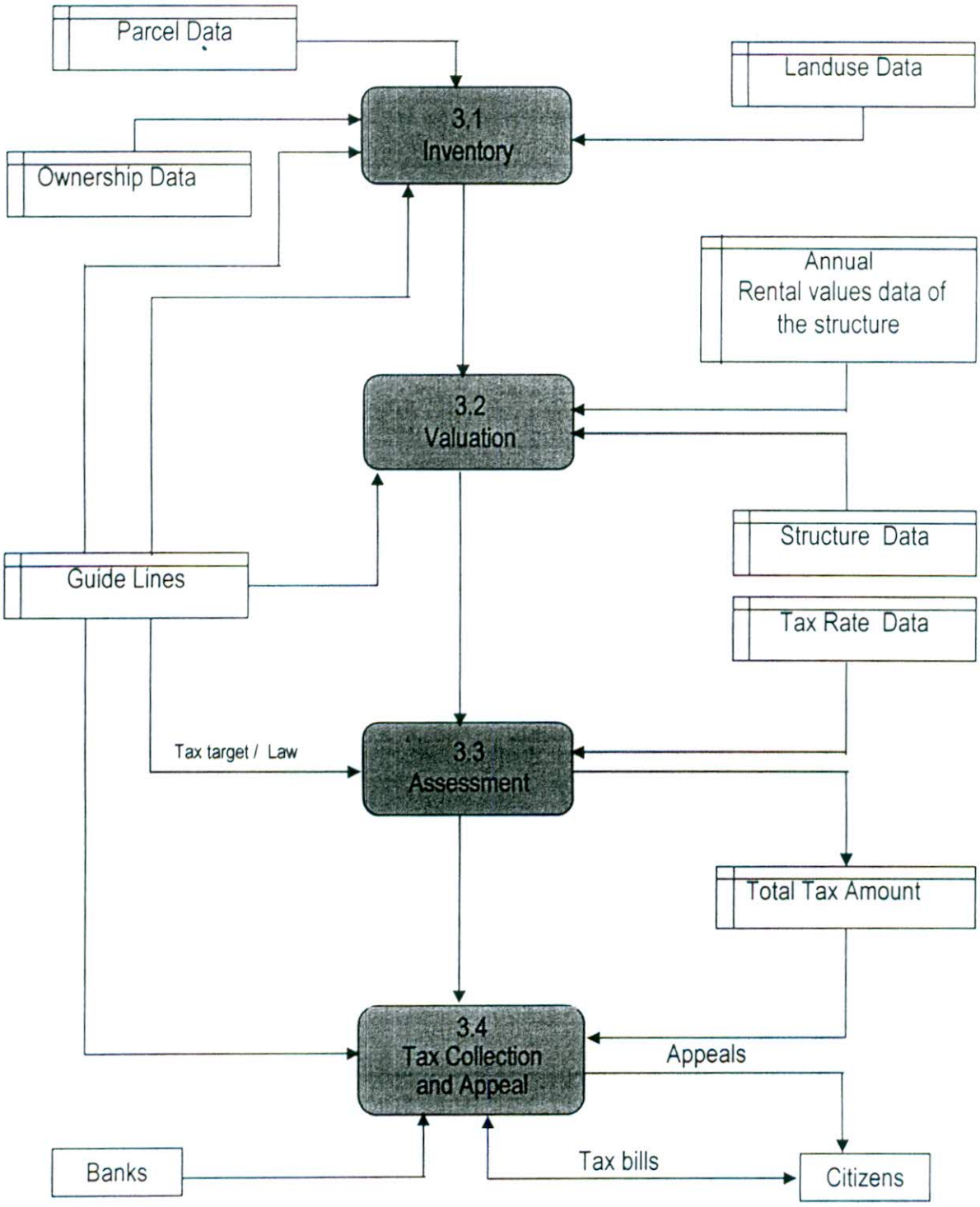


Fig: 5.5 The data flow diagram for taxation system

The Inventory Section

In order to prepare the tax bill it is necessary to get a list of all taxable parcels and their owners to whom the bill will be addressed. This is done with the help of the Land Registration Department from where a list of all parcels in the Rajshahi City Corporation will be obtained. These parcels will be sent for urban and agriculture valuation from which the two taxable classes urban and agriculture can be separated. The agriculture parcels in turn are compared with the erosion & flood hazard map to check they include parcels within that area. In which case those parcels will be exempted from land tax. Then, the preparation of statistics of the area must be done viz. Number of parcels under each category, area and number of parcels which are not taxed and total area under each category must be computed. Data Flow Diagram (DFD) is outlined in fig. 5.6.

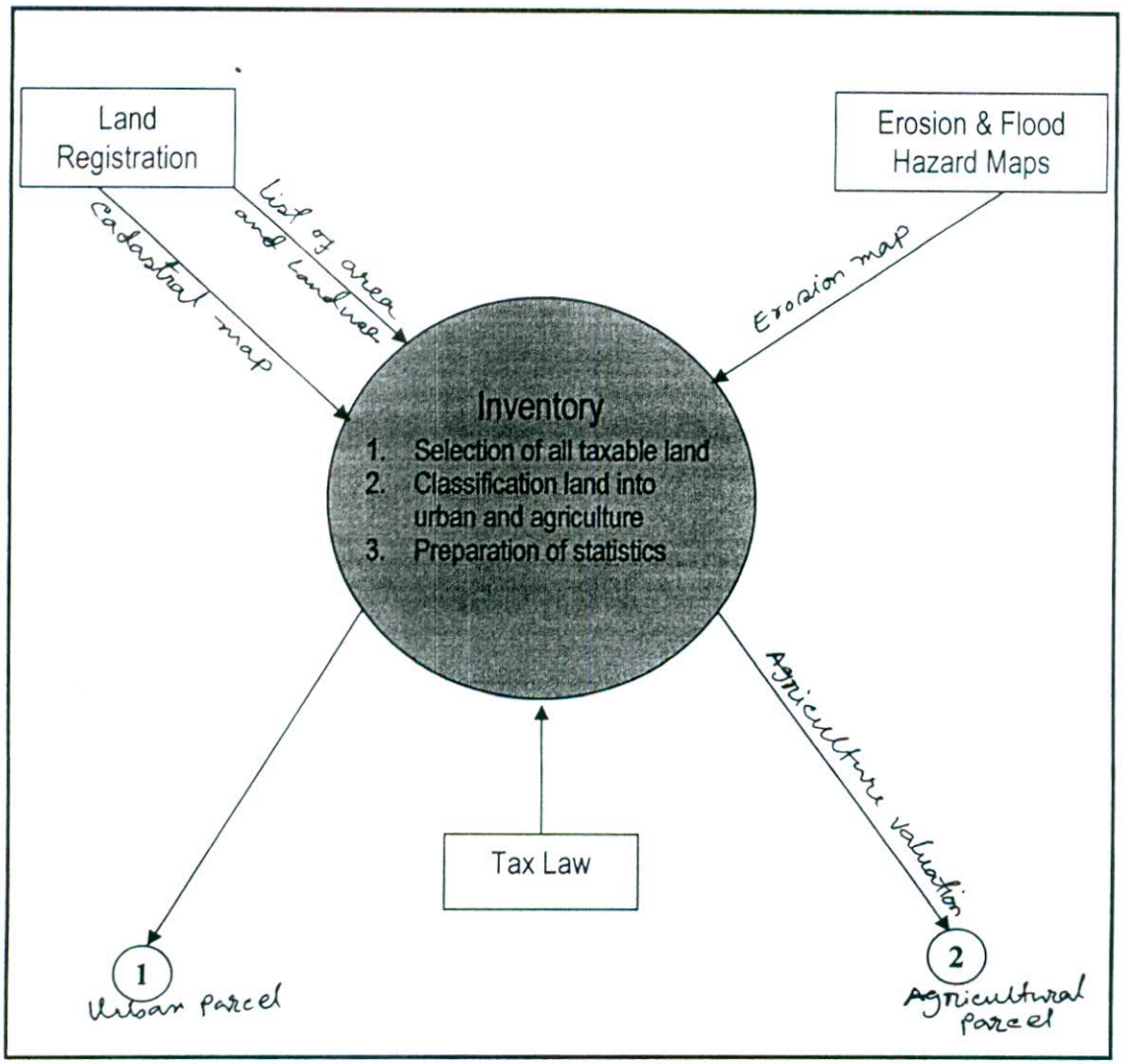


Fig. 5.6 The data flow diagram of the Inventory section.

The Valuation Section

Valuation of all parcels in the Rajshahi City Corporation is node in this section. They are guided by valuation maps, valuation rules & laws. All the parcels should be categorized into 3 classes for each group and one class for non taxable parcels. The valuation section should provide for computing:

- The average value (market price) per square meter for each class.
- The total area of the parcels belongs to each class and the list of the parcels belongs to each group.

Data flow diagram is outlined in fig. 5.7.

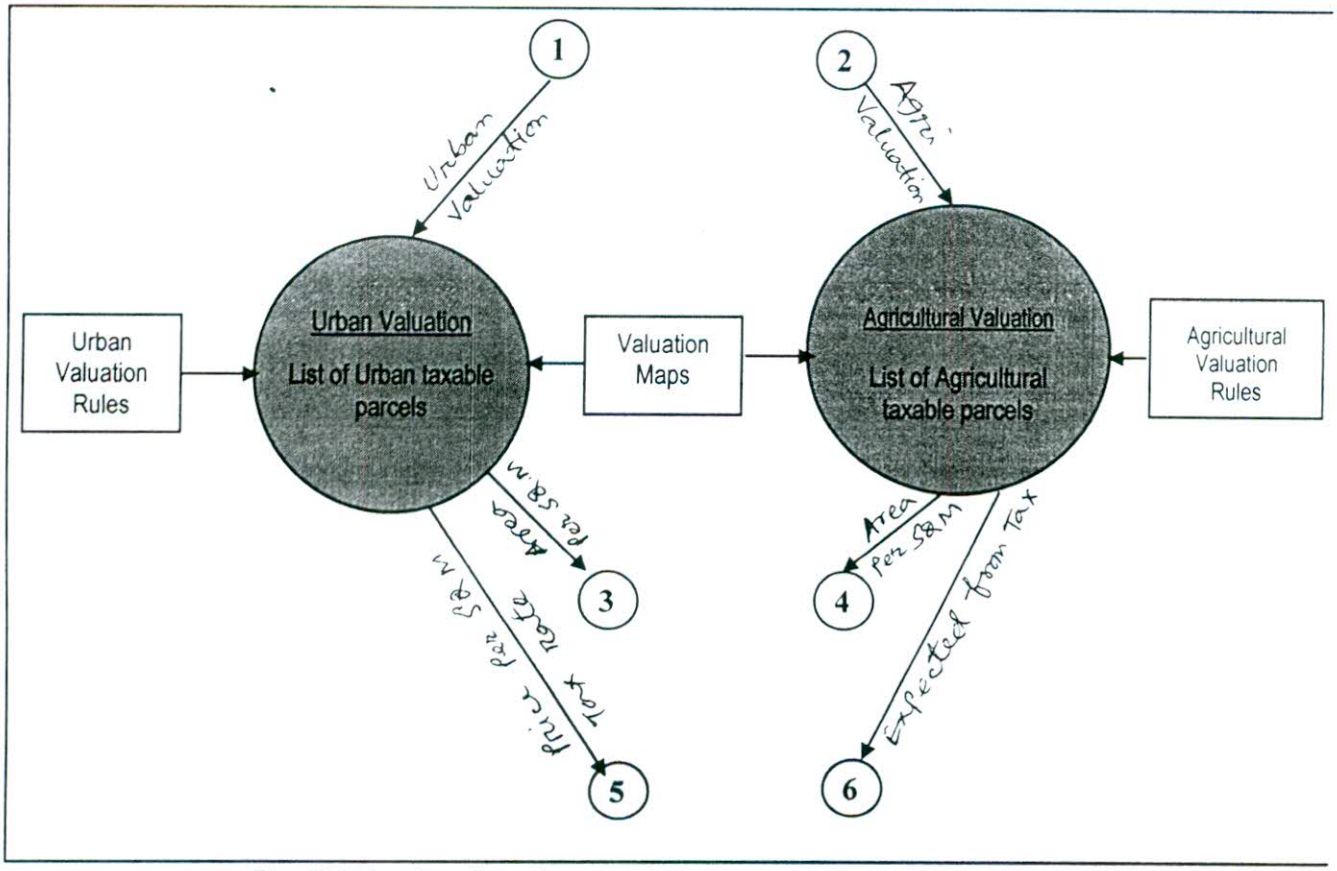


Fig. 5.7 The data flow diagram of the valuation section

The Assessment Section

The assessment section has to fulfil the primary objective viz. funding adequate revenue for the central government to finance development programs, by fixing the tax rates for the six different classes (U1.U2,U3) such that the total amount of tax to be collected will be as that required. This will have to be done within the tax laws and rules and regulations imposed by the Government. Data flow diagram is outlined in Fig 5.8.

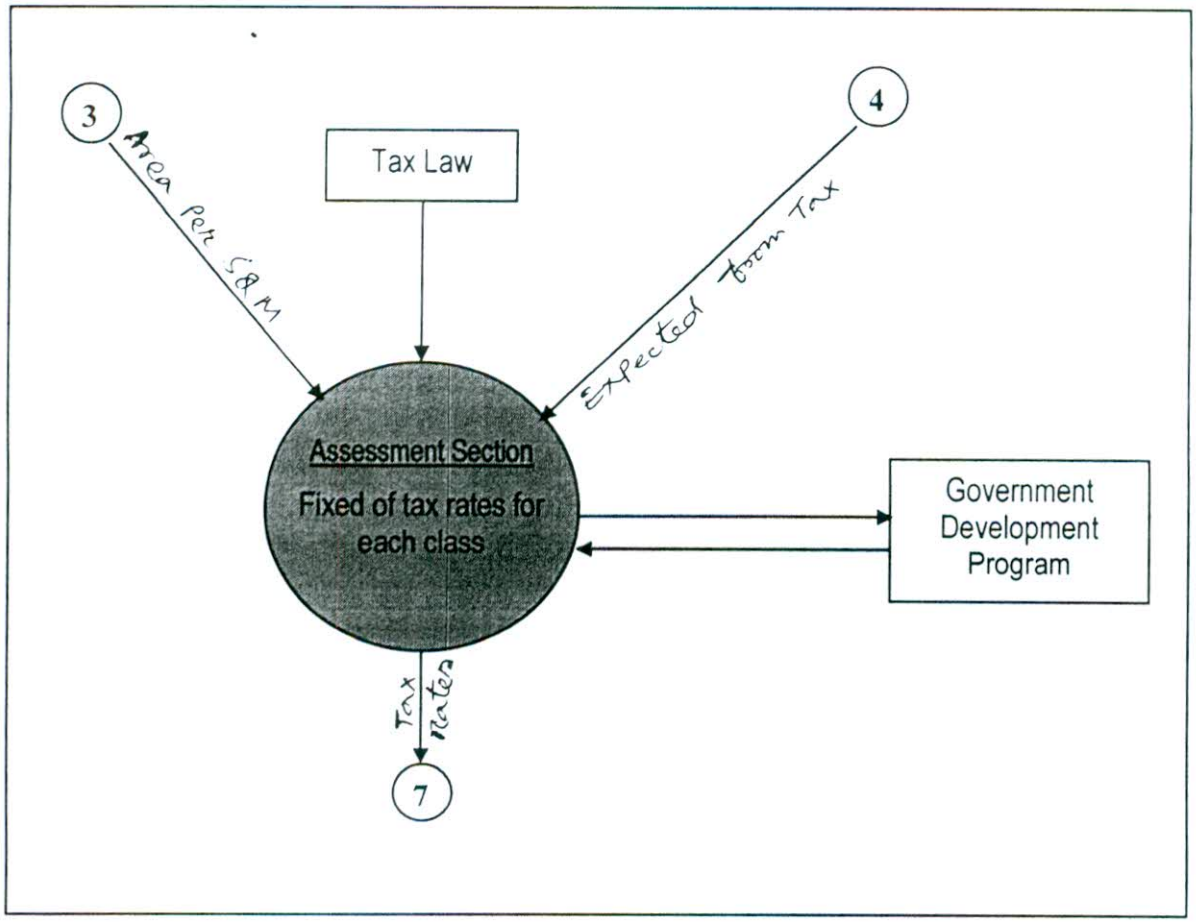


Fig. 5.8 The data flow diagram of the assessment section

The Tax Collection & Appeal Section

Tax Collection

The taxes are payable at the maximum of four quarters per year-each quarter of three months duration. The rules provide a rebate of 10% if the entire tax is paid within the first quarter and a 5% rebate if the respective quarterly payments are made within that quarter. A 5% penalty is imposed on every delinquent tax no matter how late the payment one month or five years.

The taxpayers are supposed to pay the taxes within the same year the tax is meant for. He can however, pay any area taxes within the official time period, the corporation first issues demand notice to the defaulters to pay taxes within fifteen days. If the taxes are not paid within this period, a Distress Warrant can be issued, which allows the municipality to sell all or a portion of

defaulter's movable property at auction on the spot or afterwards depending on the value of the property. There is also provision under Rule 38 of Taxation Rules to recover the taxes from the occupier, if any, in the event of default by the owner, by attachment of any rent due by such occupier to the owner.

This section will use all relevant data to prepare and mail tax bills (assign) to taxpayers. The payment can be made in favour of a unique bank a/c number in any bank. A last date of payment is given after which the data of defaulters will be sent to the fiscal court for necessary action. A tax payer has the option of appealing complaining only after he/she makes payment, which should be investigated with others sections. The fiscal court can then order the sale of the property or impose a penalty plus an additional rent above the delayed tax value. Tax payers can be of the following categories:

- The tax payer who pays his/her bill but who does not appeal.
- The tax payer who pays his/her bill but appeals subsequently.
- The tax payer who does not pay his/her bill and does not appeal.
- The tax payer who does not pay his/her bill but appeals.

of these categories, only the first two will be considered as appeals and appeals will only be considered if the payment is made.

Data flow diagram in this section is outlined in fig. 5.9 and the propose format of a tax bill is illustrated in fig. 5.10.

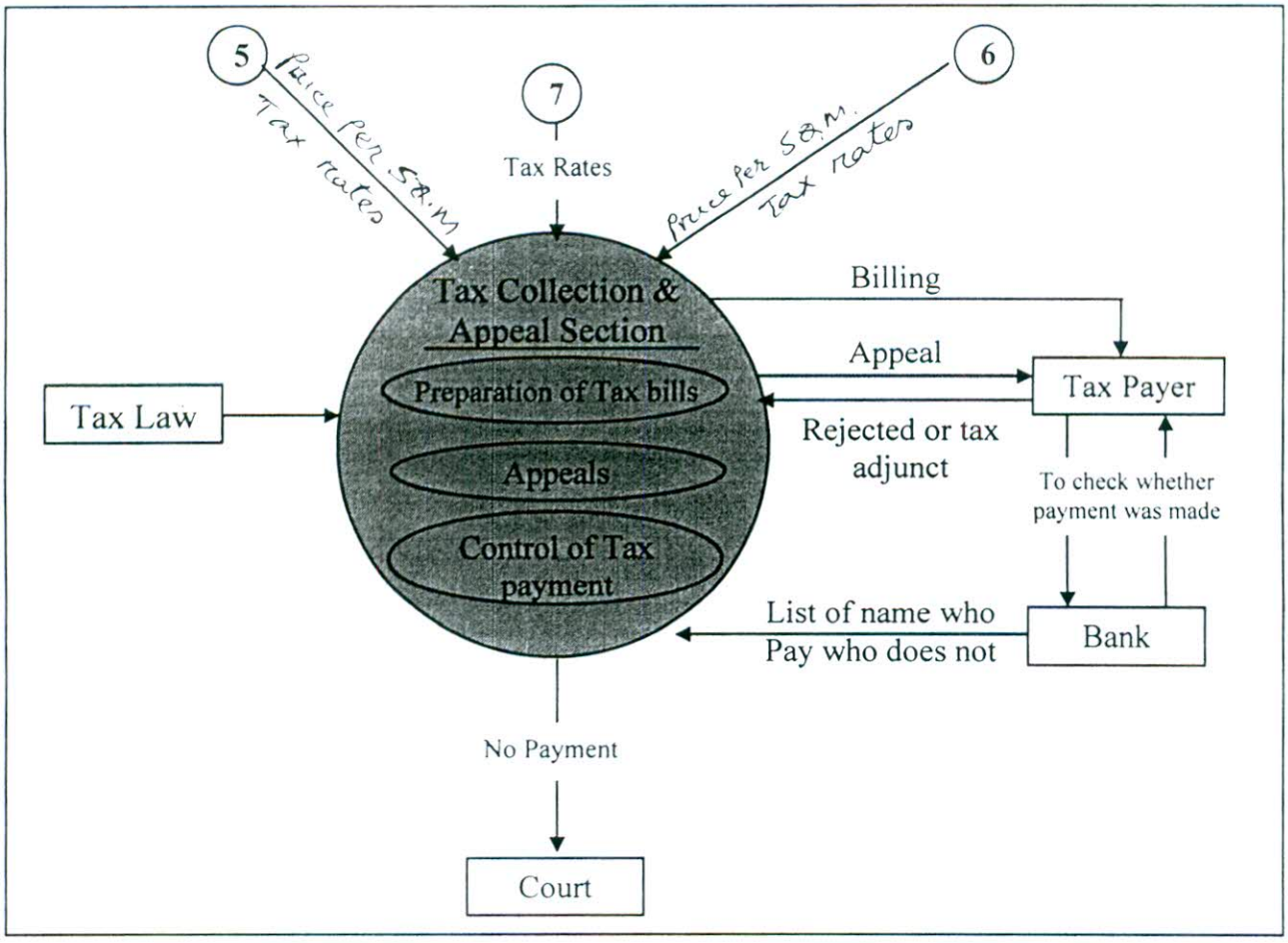


Fig. 5.9 The data flow diagram of the tax collection & appeal section

Parcel ID #	Area sq. m	Price per sq. m	Value	Tax rate	Tax amount	Name	Address

Parcel Owned

ATTENTION: Last date of payment .....

Fig. 5.10 The proposed format of a tax bill for Rajshahi City Corporation.

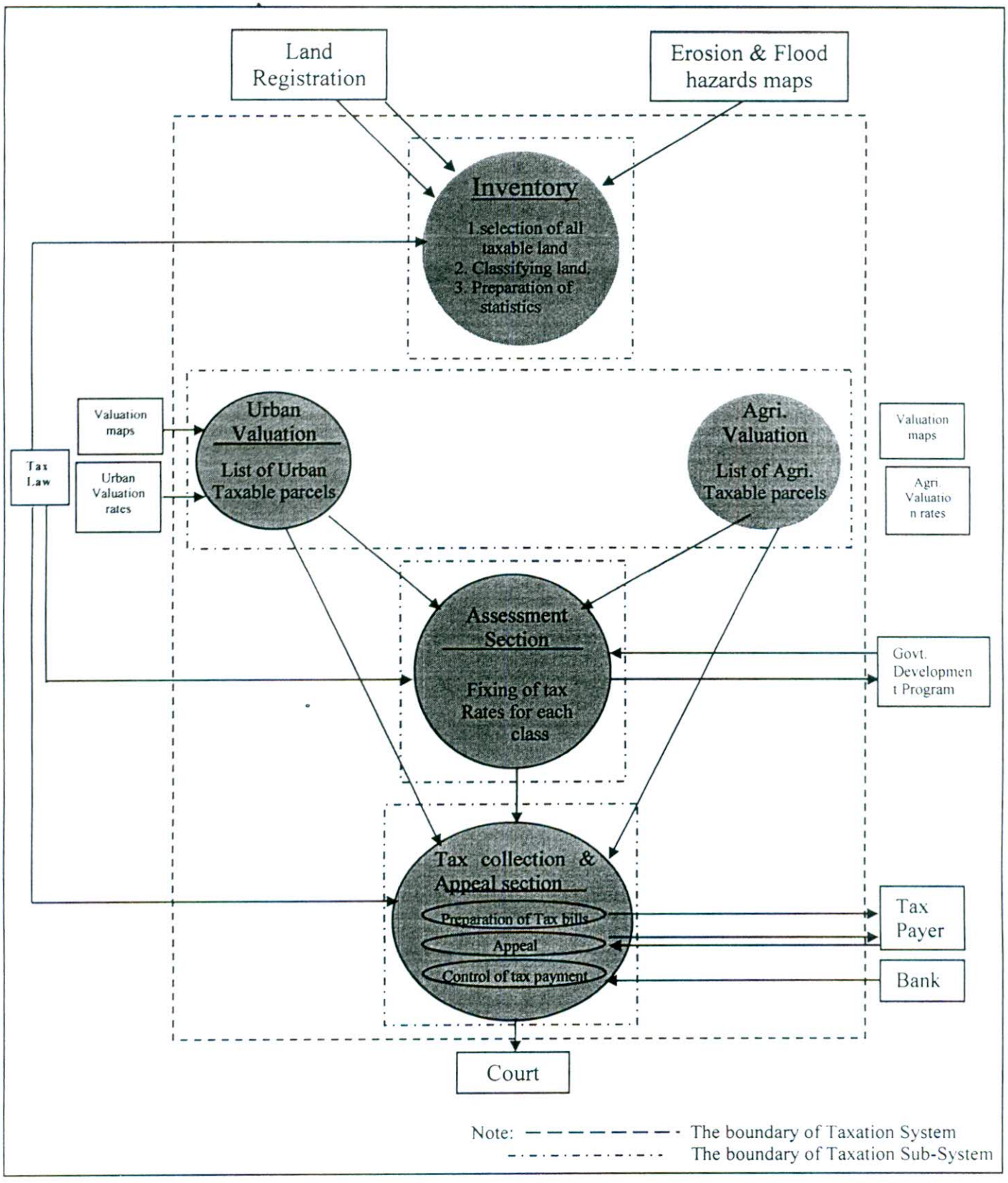


Fig. 5.11 The data flow diagram of the Land Tax Department.

CHAPTER-6

Database Design for Taxation sub-system

6.1 Background

The objective of this study is to create a taxation sub-system for Rajshahi City Corporation. At first a conceptual design of the information system is prepared for the RCC. As taxation is the most sophisticated and important sub-system of RCC, it is considered for the detailed design. The whole system requires the following steps-

- Building the database;
- Performing the analysis; and
- Presenting the Result

6.2 Building the data base

This is the most important part of a Geographic Information System (GIS) analysis. Building the database includes-

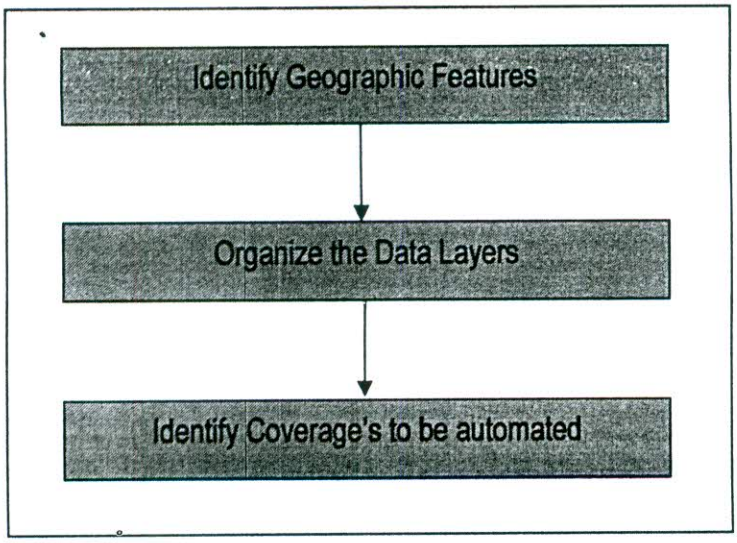
- Database design
- Data automation
- Data management

6.2.1 Database Design

Enterprise rules, entity relationship diagram and skeleton tables are the primary task for database design which is known as data model.

The following figure shows the procedure for the database design-

Figure: 6.1 Steps of database design



Taxation is a sub-system of information system of RCC. An overall database has been described in the previous chapter. Table 4.1 and 4.2 show the required features, data layers and coverage etc. Form the table 4.1 it is found that for the taxation process the data components involved are land records data (parcel data), area data, structure data, planning related data and their associated tabular data. These data components consist of several map layers. All map layers are not needed for the taxation purposes. From the discussion of the previous chapter about taxation process of RCC, the required maps can be selected. They are area boundary maps indicating tax zones and their related tabular data such as total parcels, parcel map and its related tabular data such as ownership data, built up area of each parcel etc, structure map and its related tabular data such as area of the structure, type of the structure, age, stories, percentage of owner occupied, planning related maps (Land use map, zoning restriction map) etc.

6.2 Data Automation

The next step in building the database is to automate the data; that is to convert features on a map to digital format on the computer. The steps involved in data automation are described below–

Spatial Data input into Arc/Info

In Arc/Info, a digital map is called coverage and the process of capturing spatial data manually is called digitizing. Automating the spatial data requires-

- Preparation of manuscripts for automation;
- Capture features from a map manuscript; and
- Evaluate the quality of the data captured.

Spatial Data Preparation

A digitized version of all types of map manuscripts selected earlier is digitized. It is needed to make sure that the data in the coverage just digitized is free form spatial errors. Specifically it is needed to ensure that data are topologically structured as per the rule of the relational modeling, such as-

- All features that should have been digitized, really were (free from missing of data);
- All features are there, should be there (no extra data);
- The features are in the right place and the arcs have the correct shape (data is accurate);
- Features that should connect are actually done;
- All polygons have one, and only one label point; and
- All features are within the outer boundary.

To assure the above requirements the following steps are taken-

- Constructing topology;
- Identify errors; and
- Reconstruct topology.

After the shown operation, all the coverages should be made spatially correct and ready to have descriptive information (i;e attributes) joined to its features.

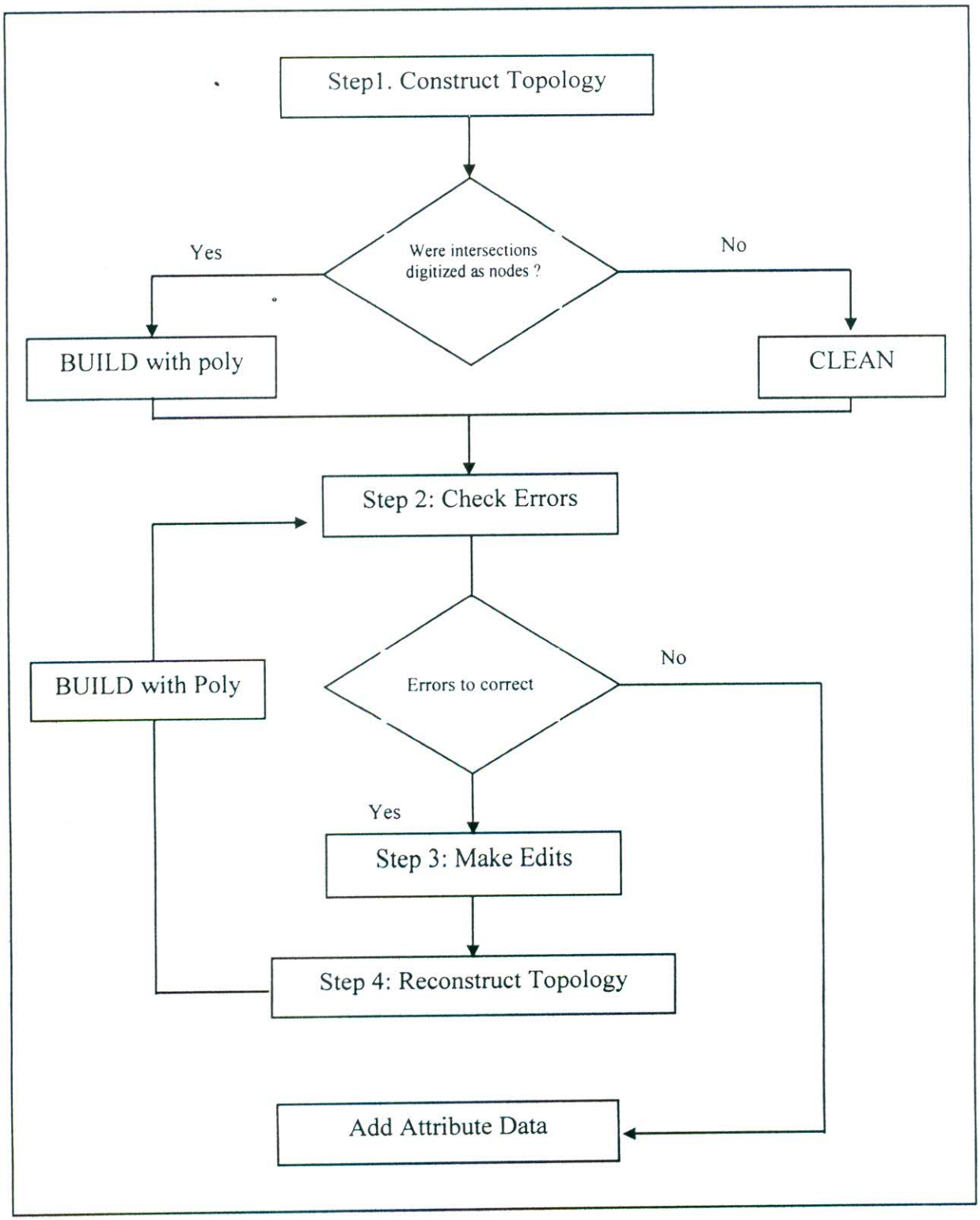


Fig. 6.2 Correcting spatial data for polygon coverage.

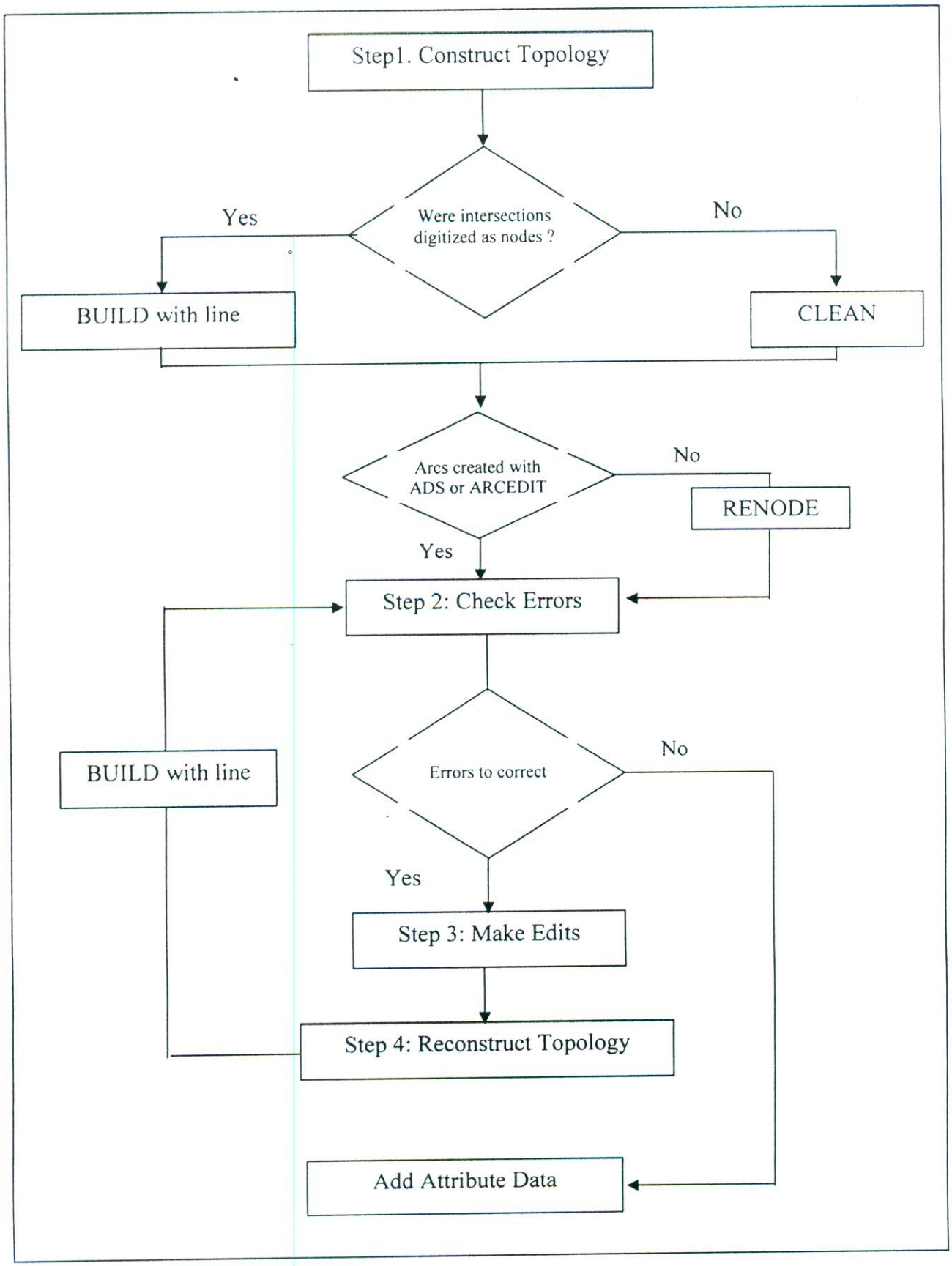


Fig. 6.3 Correcting Spatial data for Line coverage

Adding Attribute Data

After development of automation spatial database and its correction and creation of Topology attribute data need to be automated and are linked to the spatial database. To do this it is essential to add descriptive attributes to the land use coverage. This includes the following steps:

- Creation of a new data file to hold the attributes using Arc/Info;
- Adding the attribute values to the data file using Arc/Info; and
- Joining the data file to the feature attribute table for the coverage using Arc/Info.

6.2.3 Managing the Database

This is the last step of building the database and ensuring its functionality the database prepared according to previous analyzed way needs additional criteria for developing a usable geographic database. They are

- Recording all geographic features using real- world coordinates;
- Storing all related coverages in one common coordinal system; and
- Referencing features of each coverage against features in associated coverages.

6.3 Performing Geographic Analysis

Geographic analysis allows real-world applications by developing and applying models. Such modeling illuminates underlying trends in the geographic data and thus makes new information available. GIS enhances this process by providing tools, which can be combined in meaningful sequences to develop new models (Worral, 1990). These models may reveal new or previously unidentified relationships within and between data sets. Thus increasing our understanding of the real world the steps below outline the basic procedure for geographic analysis.

- Objectives and criteria selection;
- Data preparation for spatial operation;
- Performing spatial operation;

- Data preparation for tabular analysis; and
- Perform the tabular analysis and presenting the result.

i) Objectives and criteria selection

The study objective is to automate the taxation system, which can facilitate the user by all types of query functions. such as–

Identification of tax payment condition or tax delinquent area
- Identification of valuation list
- Identification of assessment list
- Identification of payment condition
- Tax delinquent area identification

ii) Data preparation for spatial operation

After the successfully design and implementation of the geographic database, all of the needed coverage is now ready for analysis. From the total database for RCC the coverages needed for the above objectives are taken into one project or directory. The required coverages are identified according to the current system of tax collection of RCC, which is discussed in the previous chapter. According to the current taxation system of RCC required maps are identified in the table no the needed coverages are-

1. Base map
2. Tax area map
3. Structure map
4. Parcel map
5. Landuse map

maps are shown in the nest pages.

iii) Performing spatial operation

Data are now prepared for the spatial operation to obtain the objectives. Overlay operation is necessary in this context. Polygon overlay is performed with the maps mentioned in the

previous point in by one. Then composite map is produced. Polygon overlay is a spatial operation which overlays one polygons and their polygon attributes are joined to derive new data relationships. PC Arc/Info command UNION is used for this overlay.

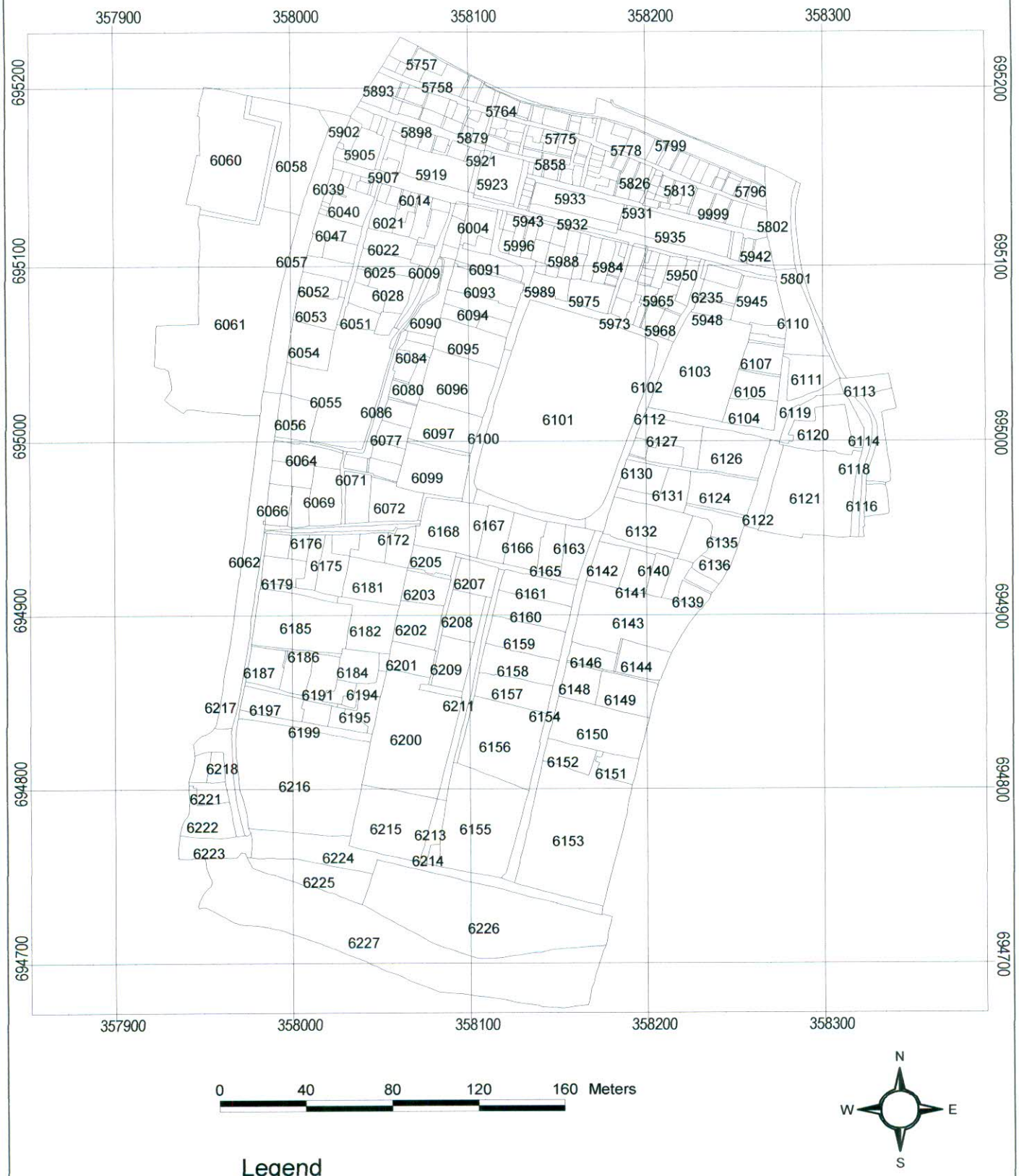
iv) Data preparation for tabular analysis

The main objective have been achieved by tabular analysis, which have been shown in maps as a result. Before tabular analysis, analysis needs to make sure that the feature attribute table contains all the items, needed to hold the new values that the analyst will create. The ADDITEM have been used here to add additional items to an existing PAT and AAT file for this study ArcView and FoxPro are used for the tabular operation. The results of tabular analysis is given the map no. 6.1, 6.2, 6.3, 6.4, 6.5, and 6.6.

According to present system of taxation, two extra columns are required. In one column property valuation result is input. Which is done manually, in another column the assessment result is shown. So data preparation for tabular analysis involves adding two items which will contain the result of tabular analysis.

Rajshahi City

Parcel map of the Bolia mouza



0 40 80 120 160 Meters

N
W E
S

Legend

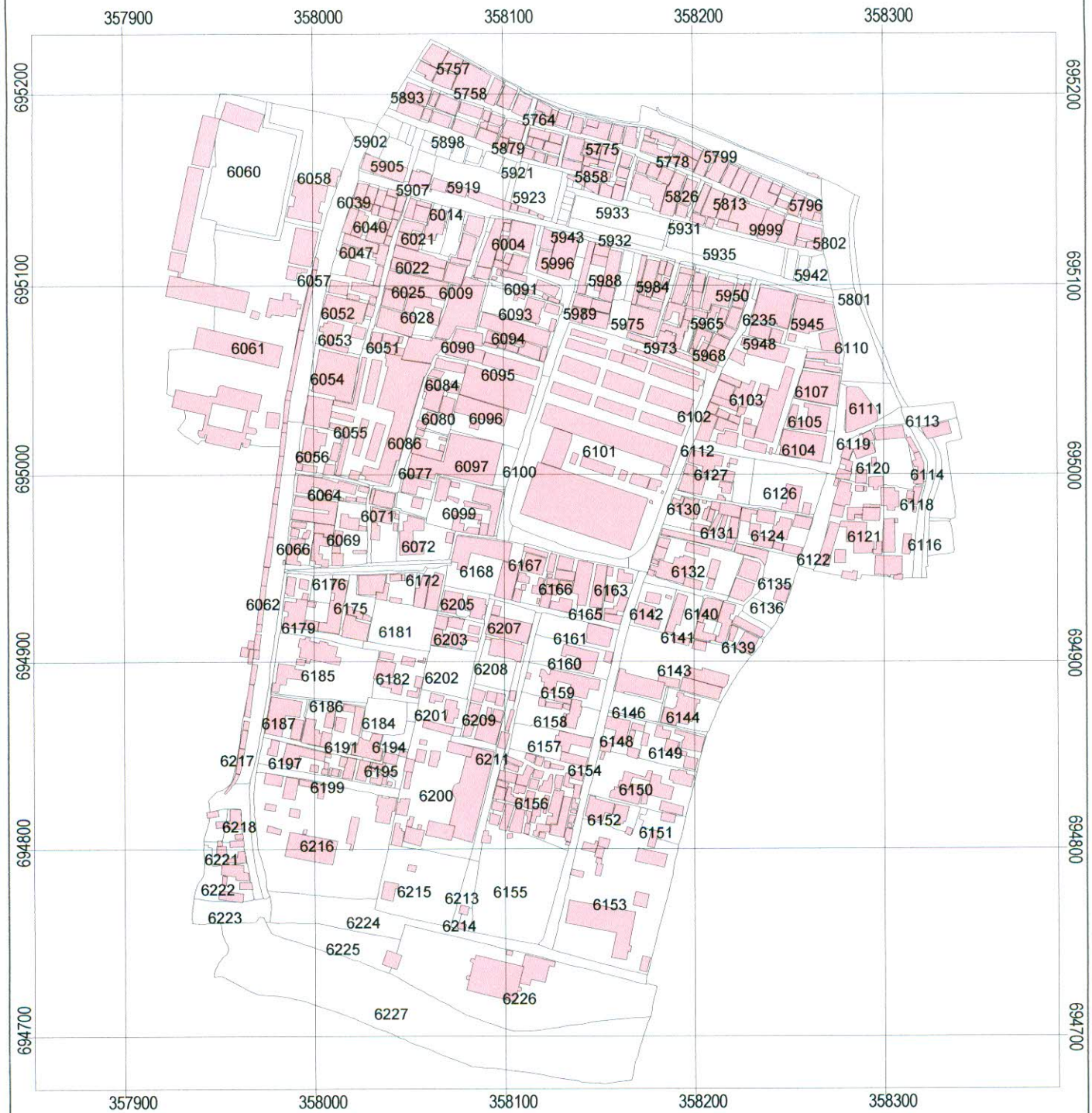
6226 Parcel boundary

Map No. 6.1

Rajshahi City

Parcel map of the Bolia mouza

Parcel Showing Structure



0 30 60 90 120 Meters

N
W E
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Legend

6226 Parcel boundary

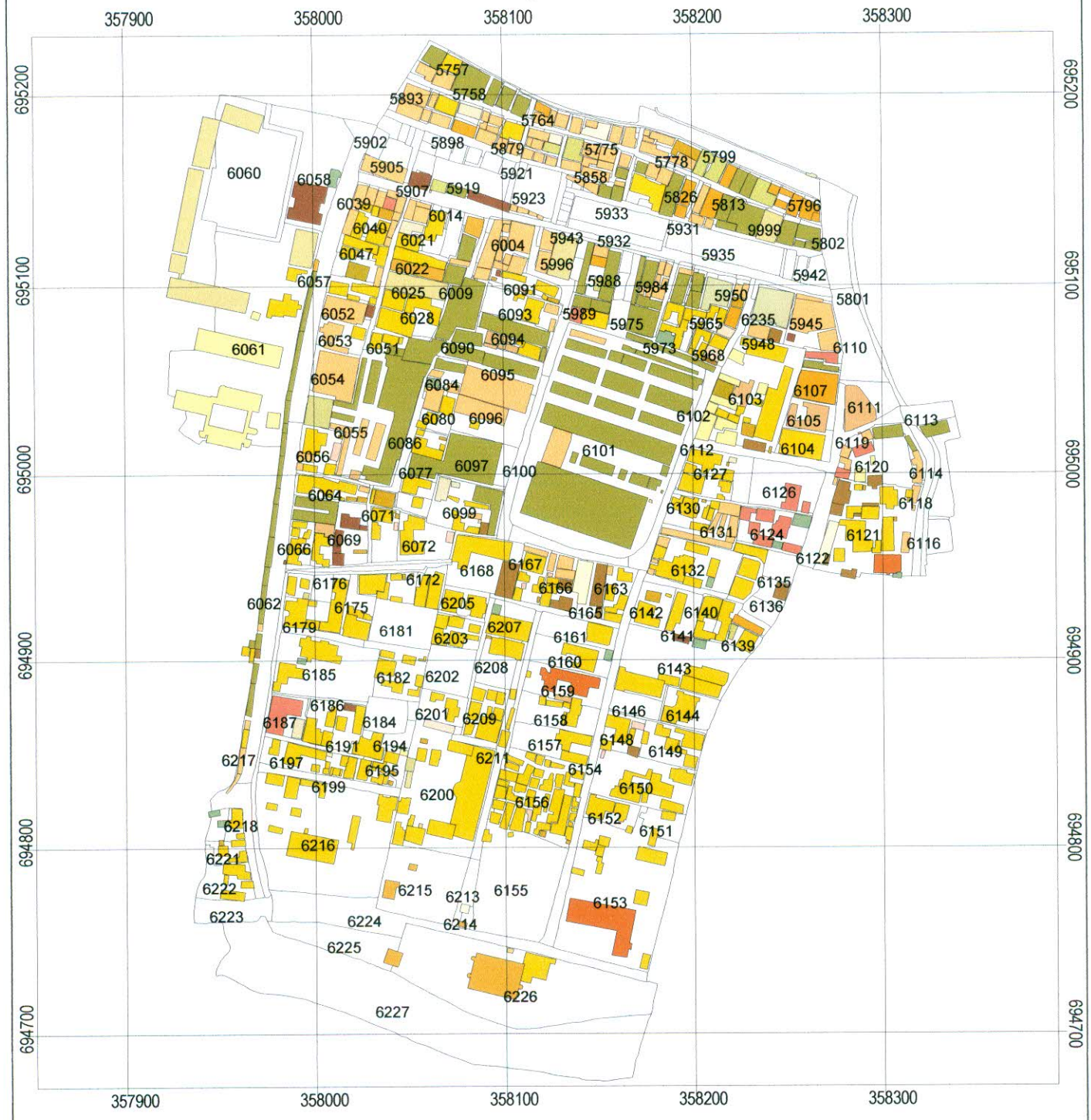
Structures

Map No. 6.2

Rajshahi City

Parcel map of the Bolia mouza

Parcel Showing Use Structure



Legend

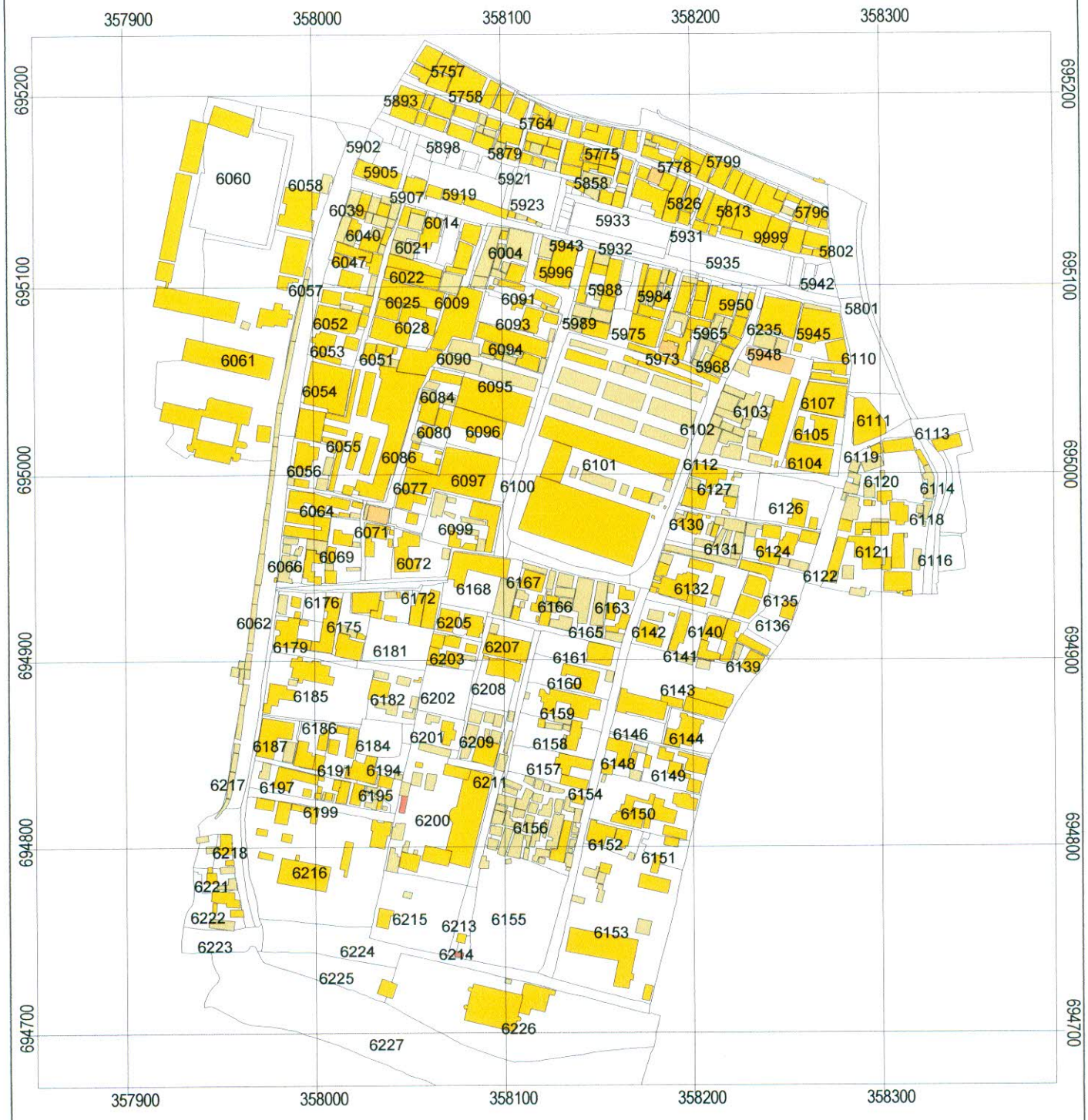
6226 Parcel boundary

Market

Map No. 6.3

Rajshahi City

Parcel Showing Types of Structure



0 30 60 90 120 Meters

N
W E
S

Legend

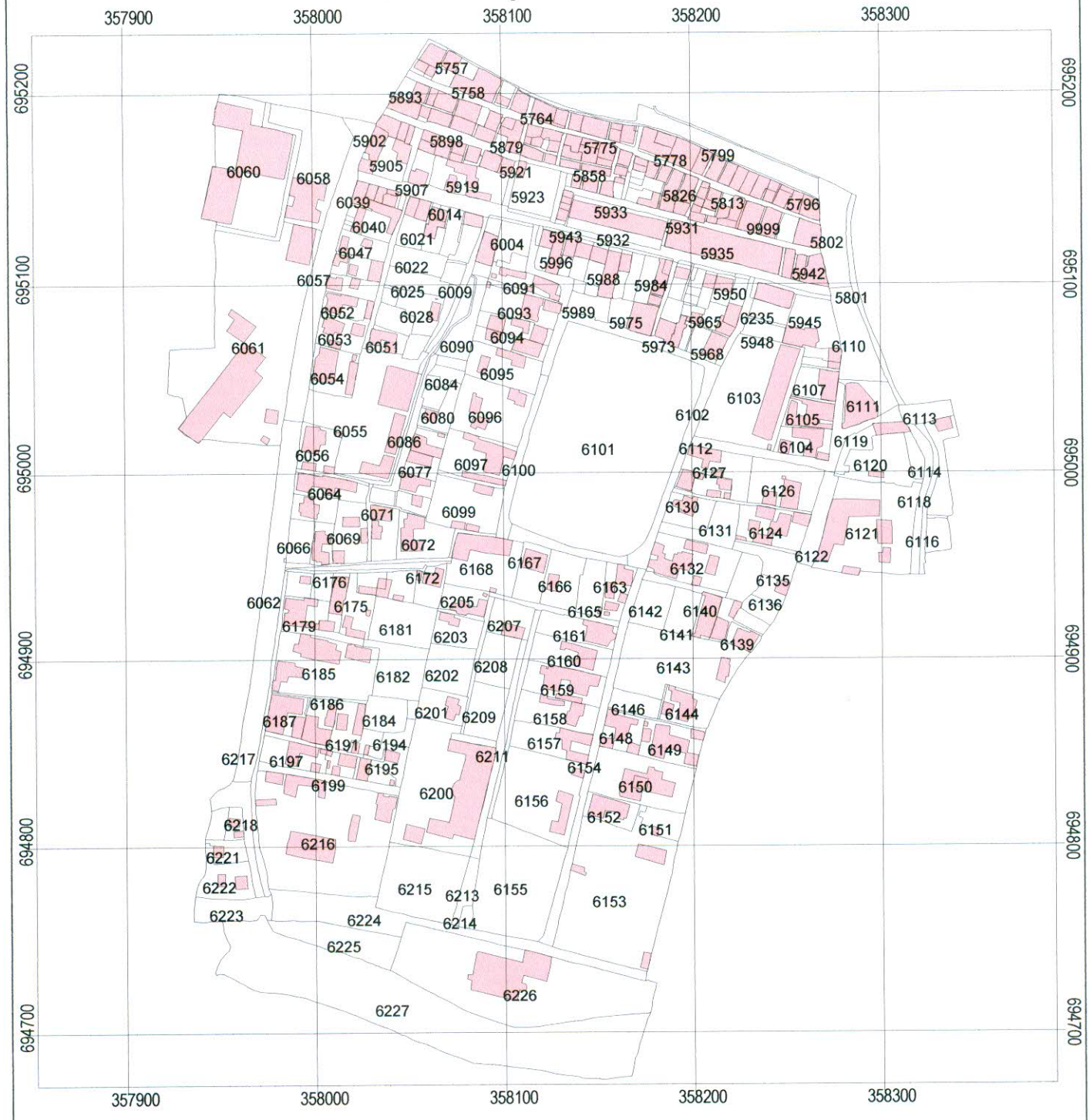
- Pucca
- Semi Pucca
- Chatai
- Under Construction
- 6226 Parcel boundary

Map No. 6.4

Rajshahi City

Parcel map of the Bolia mouza

Parcel Showing Land use of 1962



0 30 60 90 120 Meters

N
W E
S

Legend

6226 Parcel boundary

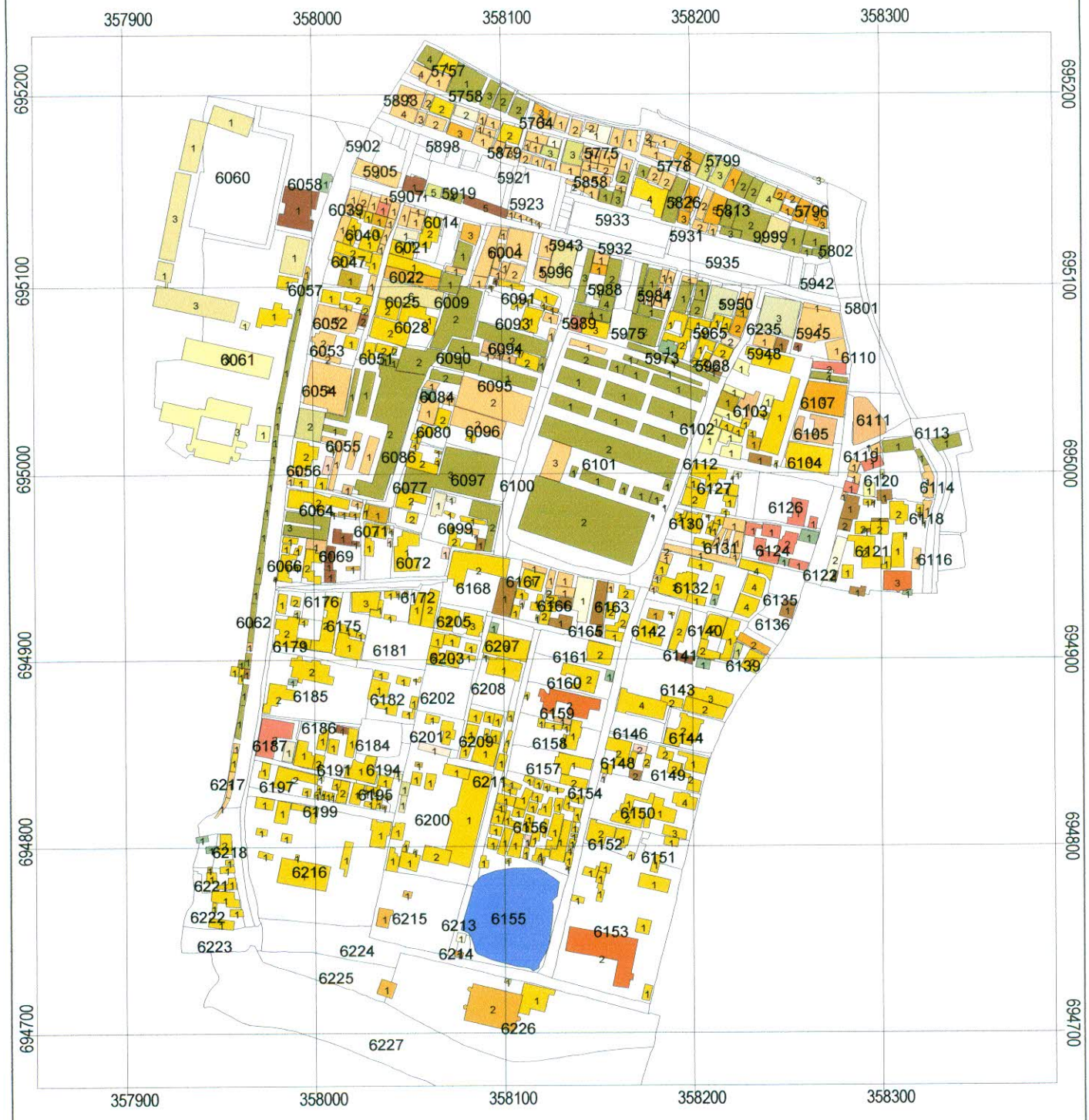
Uses

Map No. 6.5

Rajshahi City

Parcel map of the Bolia mouza

Parcel Use 2005



0 30 60 90 120 Meters

N
W E
S

Legend

6226 Parcel boundary

2 Market

Map No. 6.6

6.4 Tabular analysis and presentation of result

After the two items (named valuation and tax assessment) have been created and data for valuation item is input, calculations for the tax assessment can be made. At first a look-up table for the tax rate according to land use and area code has been made. Then this look-up table is joined with the table of composite map. As a result new item tax rate is produced. Now tax assessment column is filled in with the calculation command of Arc\Info tables module. In this study the process is done in FoxPro. The equation is

Tax assessment–Tax rate* Valuation

By using this formula tax assessment is done for each owner of the parcel. The result is shown in the map no. 6.7.

Calculate Holding Tax

ArcView software was used for the calculation of the holding tax for different type of occupancy. For the calculation of annual value of rented building the following steps were following in ArcView software:

- First, QUERY BUILDER tool was used to select the building which occupancy type was rented building;
- In the FIELD CALCULATOR tool the monthly rent for each building and he number of flats were multiple to get the annual rent for the building;
- Using the FIELD CALCULATOR tool, two month's rents were deducted as the maintenance allowance form the annual rent. The result was the annual values for each building; and
- The annual value was then multiple to the .15 in the FIELD CALCULATOR tool as the percentages of holding tax on annual value are 15%.

It is not easy to calculate the structures, which have owned occupancy. For that purpose, similar types rented building in the same locality was selected. Then, the rents of those buildings were stored in the rent field for owner occupied building. Then the following process is followed:

- QUERY BUILDER was used to select the owner occupied building;
- In the FIELD CALCULATOR tool the monthly rent for each building and the number of flats were multiplied to get the annual rent for the building;

- Using the FIELD CALCULATOR tool, two month's rent and 40% of he annual value had been deducted. The result of this calculation was the annual value for each building; and
- As the percentages of holding tax on annual value are 15%, the annual value was then multiple to the .15 in the FIELD CALCULATOR tool.

For the calculation of annual value of rented and party owner occupied building the following steps were pursued in ArcView software.

- First, QUERY BUILDER tool was used to select the buildings which occupancy type was rented and party owned occupied building;
- In the FIELD CALCULATOR tool the monthly rent for each building and the number of flat were multiplied to get the annual rent for the building;
- Using the FIELD CALCULATOR tool, two month's rent and 25% of the annual value has been deducted. The result was the annual value for each building; and
- The annual value was then multiplied tot he .15 in the FIELD CALCULATOR tool as the percentages of holding tax on annual value are 15%.

After the computation, the holding tax of a particular building is available to its related database, the database also has the information about the name, occupation, age, income, number of storied, number of flats, monthly rental value etc. Due to high rent, some computation results are very high. To reduce the abnormality of the tax value of those building and lands of similar description and with similar advantages in the locality are taken into consideration and normalize the high tax value. After the refinement the lowest holding tax assessed is 325 tk. and minimum holding tax found 13,500 tk. for a five-storied building.

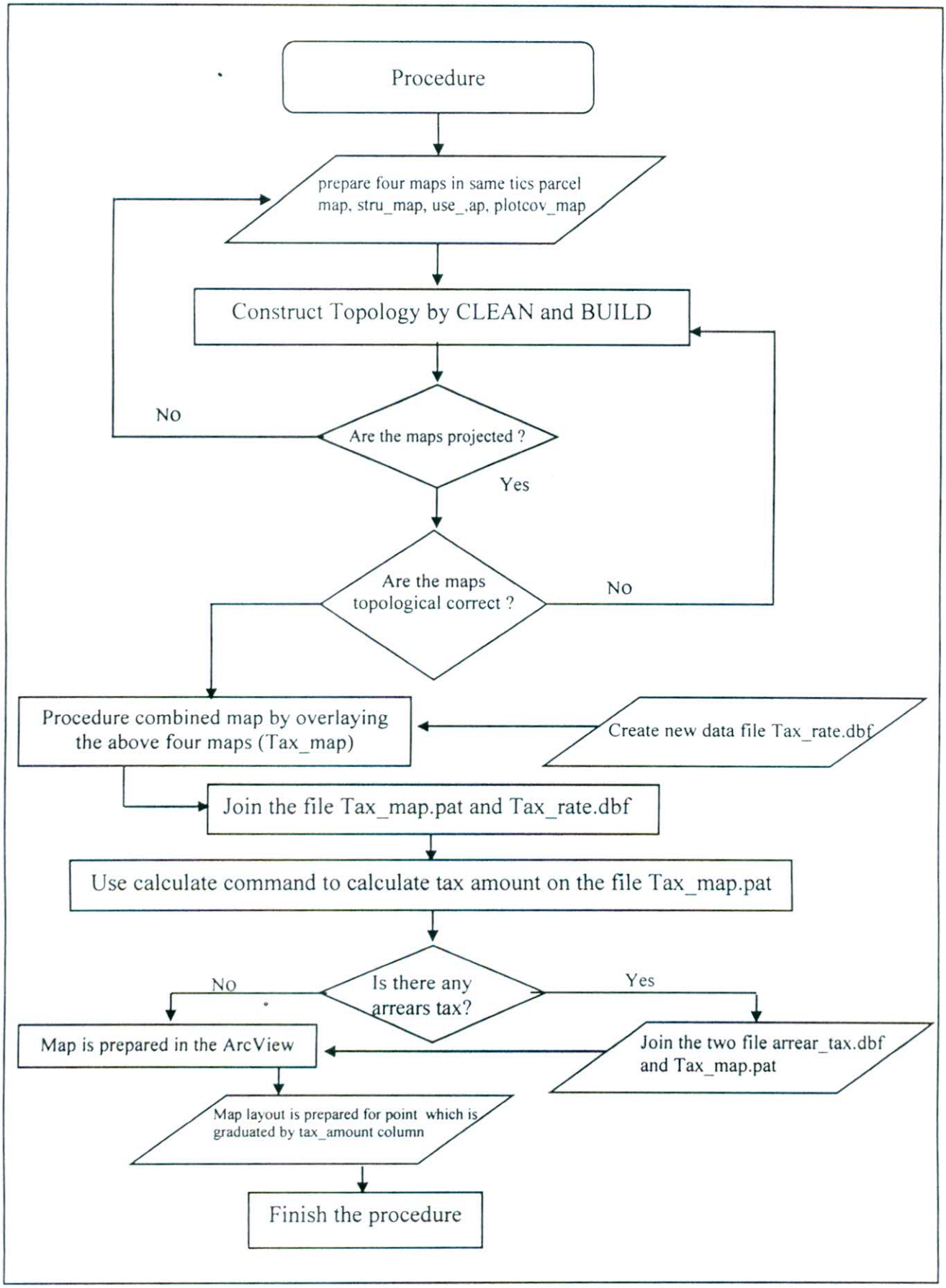
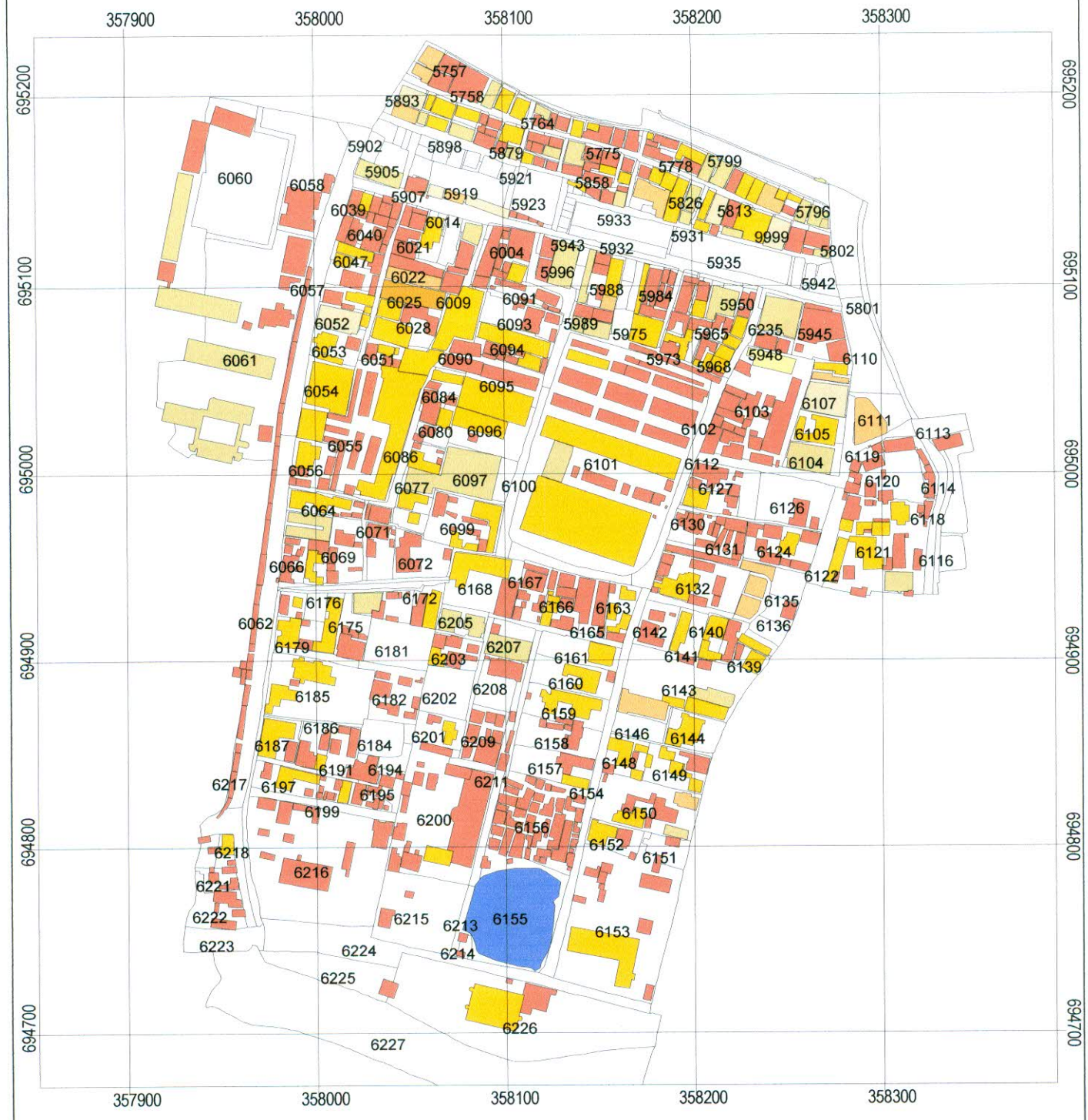


Fig. 6.4 Flow chart showing the final output (Tax assessment map) preparation Procedure.

Rajshahi City

Holding Tax



Legend

Holding tax class (in taka)

- 4000
- 4500
- 5000
- 5200
- 6000
- 7000
- 10000
- Pond
- 6226 Parcel boundary

0 30 60 90 120 Meters

N
W E
S

Map No. 6.7

A table is prepared where the due tax of the owner is presented. The table contains only two columns:

Owner-id	Due tax
B102000	2000.00
L0534400	1000.00

This table is joined to the table of composite map where the assessed tax is present. By using this joint table tax delinquent area can easily be found out. Total tax=Due Tax + Assessed Tax. By using this formula another item is created which represents the present status of tax that has to be paid by every individual owner.

The created database can be used for various essential data query functions. ArcView can be very helpful in this regard. Such as if someone opens the composite map, he may want to know about any particular owner. Then he may identify this with just clicking the mouse on the particular parcel. Then all the data about the selected parcel with the data about owner will be shown in the screen in a tabular format. In the same way from the tabular data, geographic data can also be founds. Such as someone opens the tabular data of the total area. If he wants to know the location of the parcel in the map of a particular owner, he will have to just select the particular row of that table. Then the concerned parcel will also be selected and highlighted in yellow color on the screen. It may be necessary to visualize the photograph of a vacant parcel or a specific area. Then is also possible in ArcView. The HOTLINK command is the key command in this respect. For the identification purpose authority may need to check the photograph of a parcel owner. This also can be done easily by using the HOTLINK command.

CHAPTER- 7

Integration of GIS Based Information System and Municipal Instrumentalization

7.1 Introduction

Information is an essential part of any developmental activity. Right information at the right time is the heart of the physical planning process which requires a vast information base. The traditional way of data collection, storing and analysis cannot meet the challenges of the present and future needs of physical planning (Bruijn, 1988). Some of the problems that arise in the process of municipal development are due to the lack of data/information to planners and decision makers at the right time and in the right form as well as its proper analysis and synthesis at the initial stage of the planning exercise. Most of the planning organizations have not yet built up strong information bases which are so essential for the formulation of evaluation of feasibility reports on municipal development projects, for making socio-economic cost benefit studies, for the evaluation and monitoring of development projects and for exercising financial and budgetary control to channelize development in the desired way (Innes, *et al.*, 1993). The adoption of modern information technology in the form of computers, aerial photographs etc has become unavoidable in the present state of rapid urbanization that is taking place in Bangladesh and other developing countries (Hossain, 1992).

The model (shown in Fig. 7.1) relating to an integrated GIS based municipal development information system has been designed to meet the needs of typical planning organizations such as development authorities, town planning departments. Municipal corporations and improvement trusts. Each planning organization will have 18-20 different departments/sections with different responsibilities in plan preparation implementation and development management and each section has 6-7 broad areas of data collection, storing, analysis and synthesis to interchange with other sections for inter-agency monitoring and co-ordination at the right time. The names of the departments/sections that need to be set up within a planning organization, details of broad areas of data under each department/section are given here.

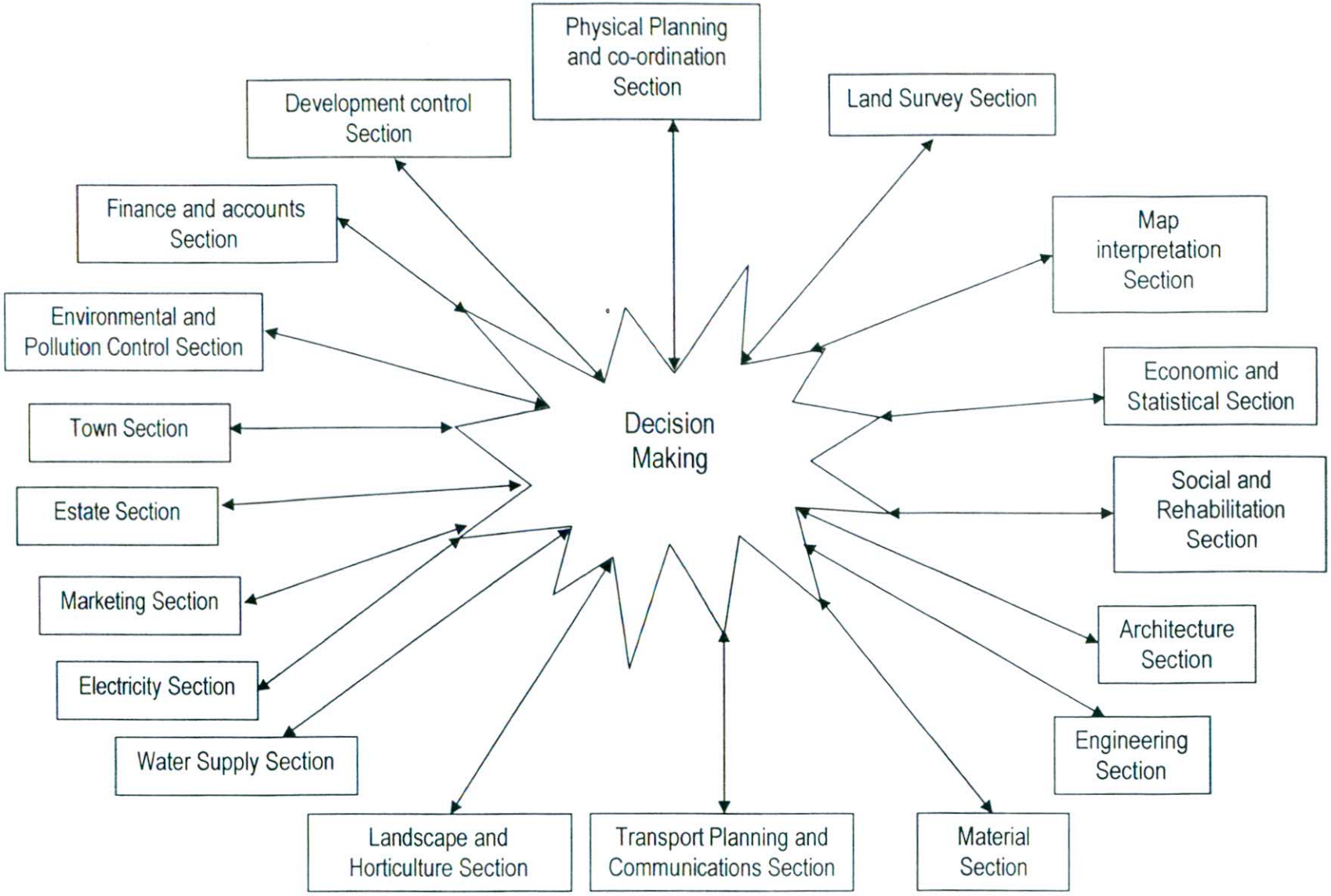


Fig. 7.1 Flow diagram of integration of GIS based information system and municipal instrumentalization.

1. Physical planning and co-ordination section

- Planning principles and basic concepts;
- Planning standards (data bank);
- Planning models;
- Planning maps (data bank);
- Land allotment process;
- Land use analysis;
- Review and monitoring of development plan.

2. Land survey section

- Notified area land survey numbers and detailed areas;
- Survey map (data bank);
- Land in physical possession, survey numbers and areas;
- Land under processing and mitigation;
- Detailed site analysis and survey details.

3. Map section

- Interpretation of map;
- Data bank of maps;
- Plotting of maps, settlement distribution, natural resource base and land use pattern at regional level;
- Mapping of natural drainage area and ground water availability;
- Location of faults and fractures, violation of development controls;
- Identification of sources network;
- Estimation of traffic and parking needs;
- Regional transport network.

4. Economic and statistical section

- Basic demographic data analysis;
- Rates for different land use (data bank);
- Financial feasibility of layouts, schemes etc.;

- Record of potential employment opportunities in relation to growth of commercial growth, service industries and major industries.

5. Social and rehabilitation section

- Record of people affected by the project;
- Compensation package;
- Social welfare programmes;
- House health record;
- Public heath measures.

6. Architecture section

- Design principles and standards;
- Urban design forms;
- Data bank for building design drawings;
- Computerized alternative architectural designs.

7. Engineering section

- Basic engineering data;
- Appropriate technology;
- Computerized engineering design alternatives;
- Standard rates for calling tenders;
- Cost estimation of words, scheduling and programming of projects;
- Data bank for naps and detail drawings;
- Computerized awarding of contracts;
- List of registered contractors;
- Review and monitoring of ongoing works.

8. Material section

- List of building materials;
- Specifications of different materials;
- Procurement process and rate of purchase;
- List of different materials supplied by contractors;
- Process of issuing of different materials;

- Existing stock of materials.

9. Transport planning and communications section

- Basic planning principles and concepts;
- Basic traffic data and analysis;
- Regional transportation network;
- Communication network;
- Mathematical modelling;
- Design standards for roads, bridges, culverts, intersections, rotaries and islands;
- Scheduling, monitoring and review of ongoing projects;
- Traffic management,.signal system and sign boards.

10. Landscape and horticulture section

- Location of parks, gardens, nursery, playgrounds, green belts;
- List of existing different types of flora and fauna in the planning area;
- Stock of new seedling varieties;
- Manure and water requirements and standards;
- Scheduling of plantation programmes and monitoring of plant growth;
- Material requirement for maintenance.

11. Water supply department/section

- Location of water supply lines, storage tanks;
- Source of water supply, quantity, availability and time;
- Scheduling of water supply hours;
- Existing supply, demand and future estimation of demand;
- Monitoring of construction of water supply lines.

12. Electricity department/section

- Location of electricity main lines, feeder lines and substations;
- Source of electricity supply points, distribution network;
- Existing supply and demand, estimation of future demand and supply;
- Scheduling of electricity supply hours;
- Monitoring of construction of electricity lines.

13. Marketing section

- Computerized allotment of houses and plots;
- Final record of land use, rates, name of the party and areas demarcated;
- Exiting stock of houses and plots.

14. Estate section

- Handling over of houses and plots;
- List of old structures, safety index and possible repairs;
- Maintenance of buildings and repairs.

15. Town services

- Management of schools, hospitals and other facilities;
- Garbage collection, network, methods and techniques;
- Wastage available quantity and recycling process;
- Appropriate technology for recycling process.

16. Environmental and pollution control section

- Soil types, location and mapping;
- Climate, ecological features;
- Flora and fauna, carrying capacity of the environment;
- Resources: recycling methods and techniques;
- Keeping track of chemical materials, stock points and movement in the planning area;
- Monitoring of industrial pollution;
- Monitoring and control of traffic pollution.

17. Finance and accounts section

- Allocation of funds to various schemes and projects;
- Time and flow of money to various works;
- Scheduling of payments to contractors;
- Collection of development/service charges;
- Collection of repayment of housing loans.

18. Development control section

- Serenity of building plans;
- Granting of occupancy certificates;
- Monitoring of approved and unapproved cases;
- Computerized scheduling of site inspection visits before stipulated time;
- List of the registered architects;
- Regularization and demolition of the unauthorized structures.

All the departments/sections mentioned, data areas and their inter-coordination and decision making processes have been shown in Figure 7.1. There will be one master data file and different data files under particular sections. Updating of the database will be done by the respective sections. In all there will be integrated data model which will provide integrated planning design, financial feasibility, scheduling and programming of work, monitoring and review, development control and management, directions to the planners and decision maker to take rational decisions at the right time and in the right direction. The following data flow diagram has been designed and developed to meet the needs of the physical planning and co-ordination sections and the development control section.

- data dank for physical planning;
- financial feasibility of layouts and schemes;
- monitoring and review of development plan;
- computerized scrutiny of building plans;
- computerized granting of occupancy certificates and regularization of the unauthorized structures.

7.2 Data band for physical planning

The data flow diagram has been designed by incorporating all planning standards and planning parameters to consider for plan preparation and implementation. It provides a ready reference to planning standards, availability of land under different land uses, plot dimensions, location, accessibility, details of adjoining plots, floor space index (FSI) details, rate per square meter, state of condition, allotment, lease date, time limit for construction, building plans approval/disapproval, date of building completion, occupancy granted/refused and for any other remarks (Haque, 1992).

Whenever there is a clarification needed for any land use, it is possible to get the answer from this programme by giving special instructions in an intreactive mode with computer, such as how many plots, with their dimensions., are available under a particular land use. This programme will help the allotment of plots more quickly and more efficiently. In addition, the immediate allotment process can be reviewed and the database updated. An allotment order along with the demarcation certificate will be printed with all land use details. If the required land is not available, the computer gives appropriate messages indicating the reasons for this. The working process of the data flow diagram has been given in Figure 7.2

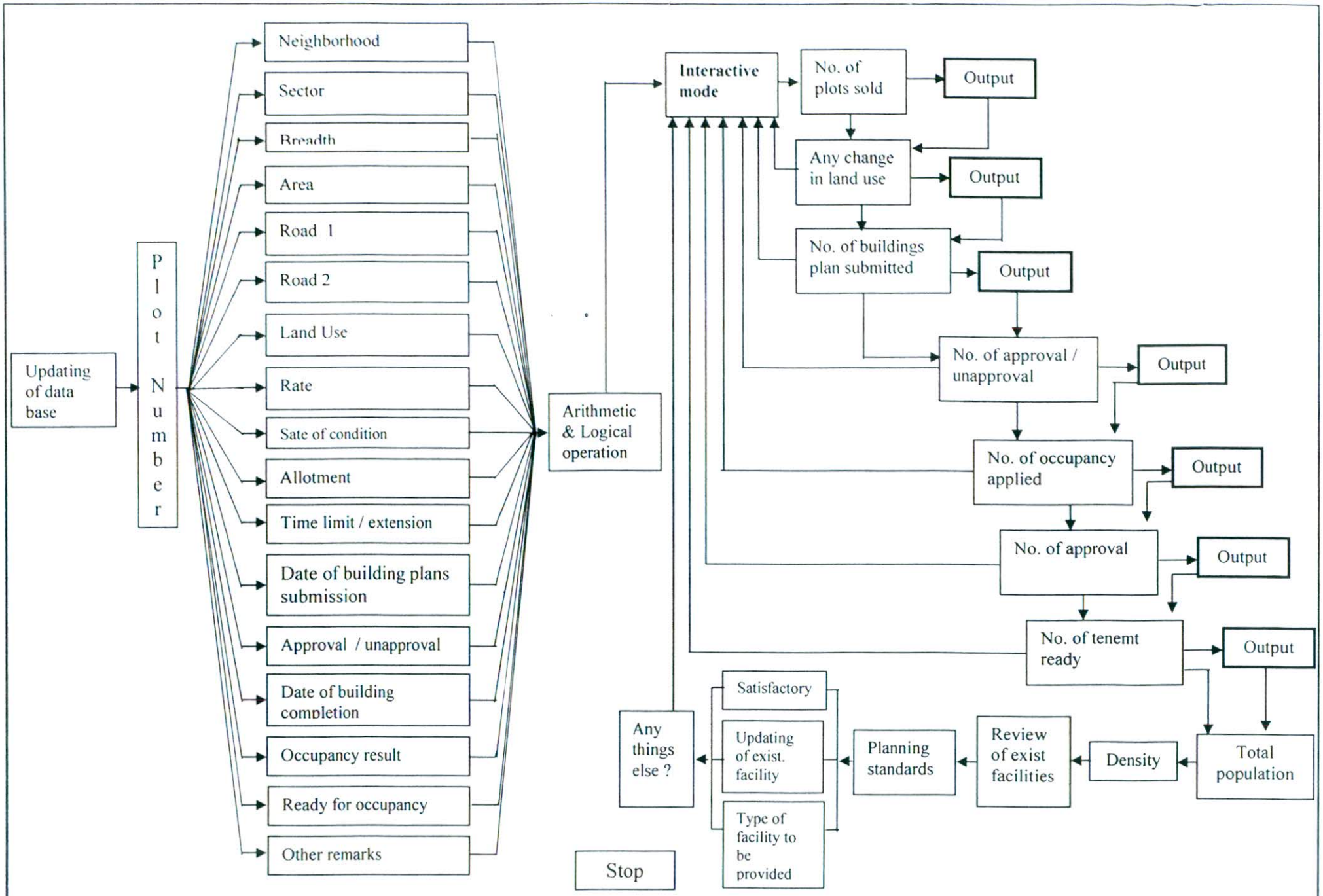


Fig. 7.2 Data bank for physical planning

7.3 Financial feasibility of development plan

A study of financial feasibility is the most crucial requirement for successfully implementing any planning project. The entire project planning depends on its financial feasibility and cost of infrastructural development. Even though the planners prepare different design alternatives of layouts and schemes, financial feasibility analysis takes a great deal of time and the planners are not able to know the financial implications of a project until a separate feasibility study is carried out. If the project is not financially sound , the planners have to change the entire layout and once again to review its financial feasibility. This is a continuous process involving a large number of manual calculations, until a satisfactory answer is obtained. The planners may not always have the time to do such financial feasibility studies with different development plan alternatives. This is where a computer is proved invaluable. It can be effectively used to get immediate answer regarding the financial implication of any development plan, layout or scheme, by giving a good feedback on design alternatives, thus providing an opportunity to planners to select the best design alternative (Hossain, *et al.*, 1998).

The data flow diagram has been designed by incorporating all planning data and land use analysis such as project area, land in acquisition, preliminary works and surveys, roads, pathways, water supply, sewerage, storm water drainage, street lighting, aboriculturc, and other facilities, namely, schools, hospitals, bus-stands, shopping complex, community center, etc as well as total saleable area and project period, to be considered under different heads for detailed financial analysis. By entering this planning data it is possible to obtain the cost of infrastructural development per square meter and, with nominal administrative expenditure, the reserved saleable price for that type of land use (Islam, *et al.*, 1989). If the output is not satisfactory, by changing the data of rates a satisfactory financial analysis can be obtained. The data model also generates the alternative pricing systems for different land uses (Islam, *et al.*, 1989). After final output is reached, the computer prints the entire financial report in the required from for the use of decision-makers. The working process of the data flow diagram is given in Figure 7.3

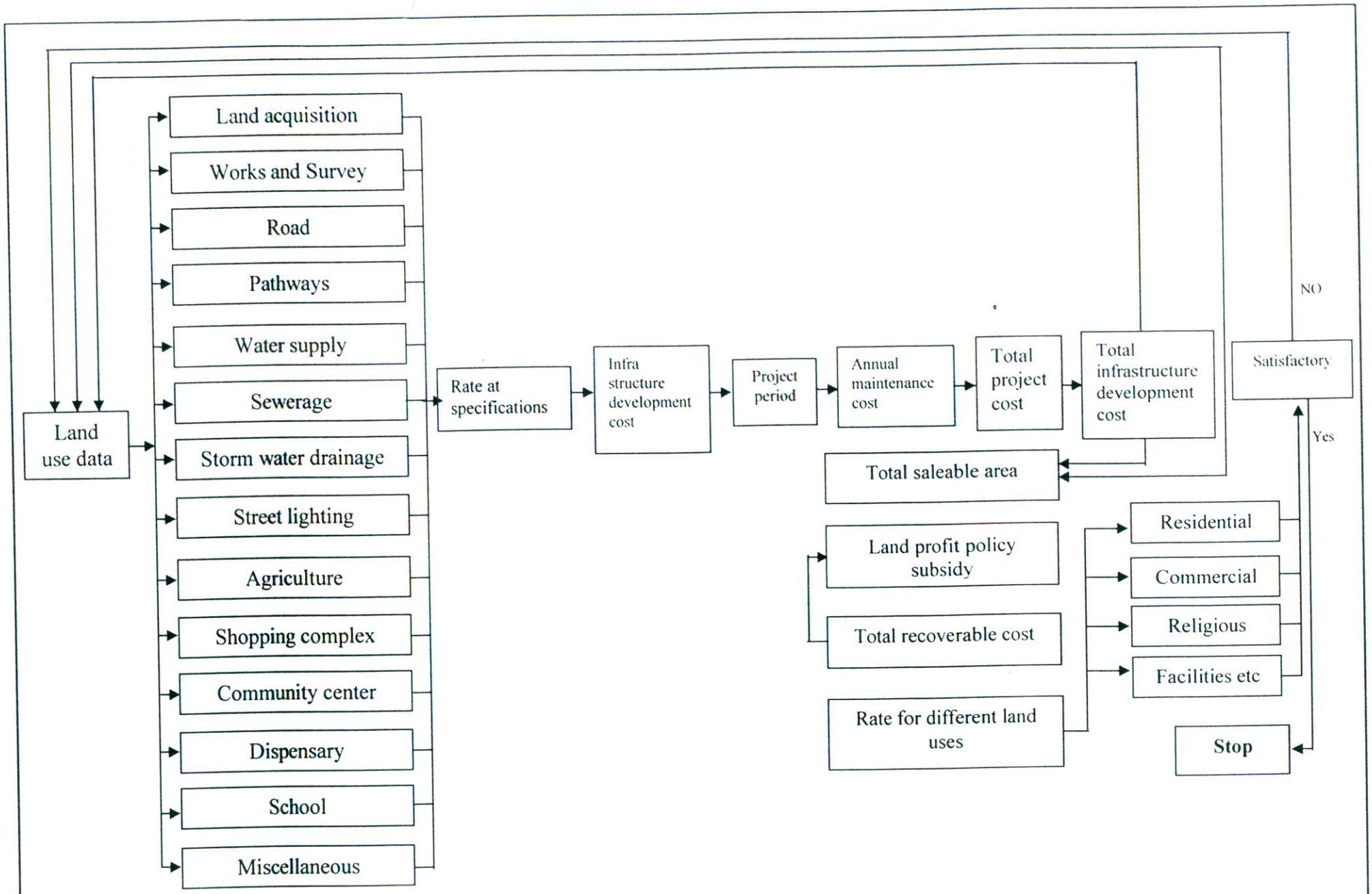


Fig. 7.3 Financial Feasibility of Development Plan.

7.4 Monitoring and review of development plan

Monitoring and review of development plan is no longer a routine, traditional process and a repetitive job. It is in fact a highly technical exercise that requires managerial skills. Monitoring of plan implementation has to be viewed in the context of the planning process (Lakerveld, 1992). The planning process involves an analysis of the situation, setting of goals and objectives, generation of development plan alternatives, selection of an alternative that is cost effective, implementation and monitoring of implementation, and finally feedback and review thus again redifining goals and objectives. Monitoring and review of development plan implementation has to be seen in this context. Monitoring of a development plan is a must during the course of its implementation, because so many agencies are involved in the implementation process that co-ordination is a most crucial task for the planners to perform (Larsson, 1991). There is no efficient system of monitoring and reviewing such a plan in any of the development authorities and municipal corporations in the country. Unless a development plan is backed by an efficient system of monitoring and review, its success is doubtful. It is not possible to build such an efficient system with the help of a computer.

The data flow diagram has been designed and developed to meet the requirements of any typical area development plan, layouts and schemes. After preparation of a plan and during its course of implementation, planners need to know the latest data on the implemented plan to decide on future planning strategies and to provide necessary facilities, services and utilities for the increasing population in the planning area. The following data may be required for this purpose.

- how many people have bought plots;
- their places of origin;
- religion;
- the number of plots sold for different land uses;
- the number of applications for building permission;
- the number of approved/unapproved cases;
- how many people have starred construction;
- monitoring of construction;
- the number of applications for occupancy certificates;

- the number of approved/unapproved cases;
- the number of buildings completed in a year;
- the number of tenements ready for occupation;
- the total population of the area, density calculation, and day to day working efficiency of the facilities, services and utilities in the planning area.

With the duly updating of the data base and with the information made available to the concerned sections, the other planning parametres will also be updated and the total population and density calculated on a continuing basis. Accordingly, with the increasing population, all the facilities, services and utilities will be monitored and reviewed by this package programme, and appropriate messages will be printed on the computer terminal indicating the type of facilities, land uses and utilities to be provided or upgraded. The working process of the model has been given in the Figure 7.4

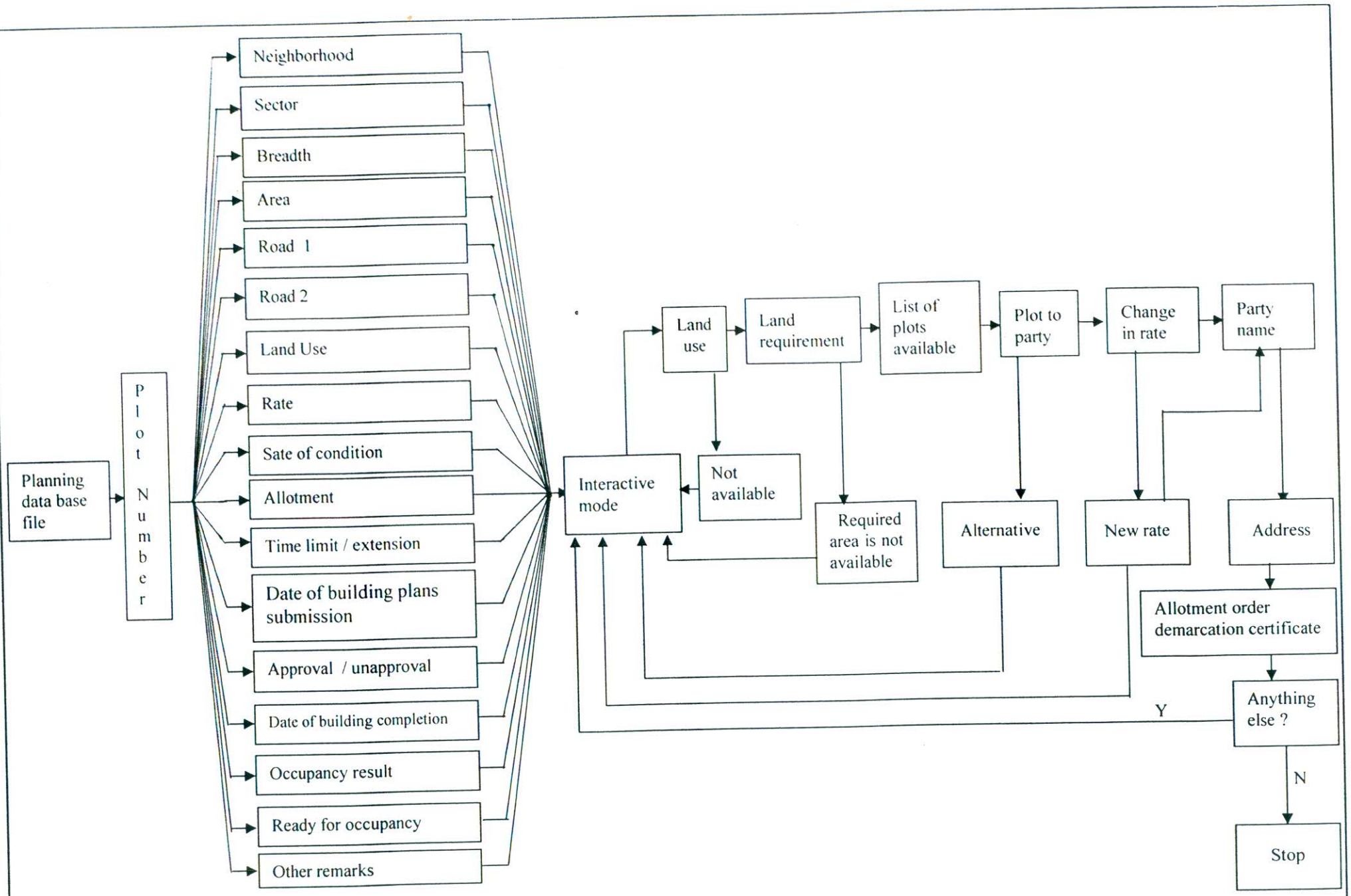


Fig. 7.4 Computerized monitoring and review of development plan

7.5 Computerization of building plans scrutiny

The purpose of the enforcement of building bye-laws and regulations is to promote a better quality of life in towns and cities. The need of computers in the enforcement of building bye-laws and regulations has been discussed here in detail.

Violation of building bye-laws is very common in plotted development areas. In order to construct buildings on plots, owners have to submit their building plans to the competent authority for approval. In any municipal corporation or development authority one will find a large number of building plans awaiting approval (GOB, 1984). Often applicants bring pressures of various kinds on the competent authority to get these approved as soon as possible. Some of the given reasons are to get building loans from banks, advancement of monsoon, water shortage, power problem, increasing materials cost, etc (Sani, 1987). Generally, it is difficult for the competent authority to dispose of all the cases quickly because of reasons such as lack of manpower, lack of time, unillustrated building drawings, poor quality drawings, etc.

If on sanction is forthcoming within 60 days of the submission of building plans, these plans are deemed as approved. Some plot owners while submitting building plans simultaneously start construction of the building anticipating approval according to the submitted plans, which may not be granted in all cases because of some violation of the bye-laws. During this 60 days time limit, construction work may go up to plinth level or above. If the plan is rejected, it is difficult to make any alterations in the structure and it is termed as an unauthorized construction. One can find significant numbers of such cases in town and cities, contributing to the degenerating quality of the physical environment (Wegener, 1994).

Generally, building bye-laws are violated owing to two reasons. The first reason is that the owner deliberately builds on more area than permissible for monetary gains. And the second reason is owing to the contractor's mismanagement and the use of unskilled laborers at the work site. The construction may not be according to plan. It is possible to control such unauthorized constructions to a certain extent by introducing computerized scrutiny of building plans and monitoring the system by providing quick and efficient service to the public.

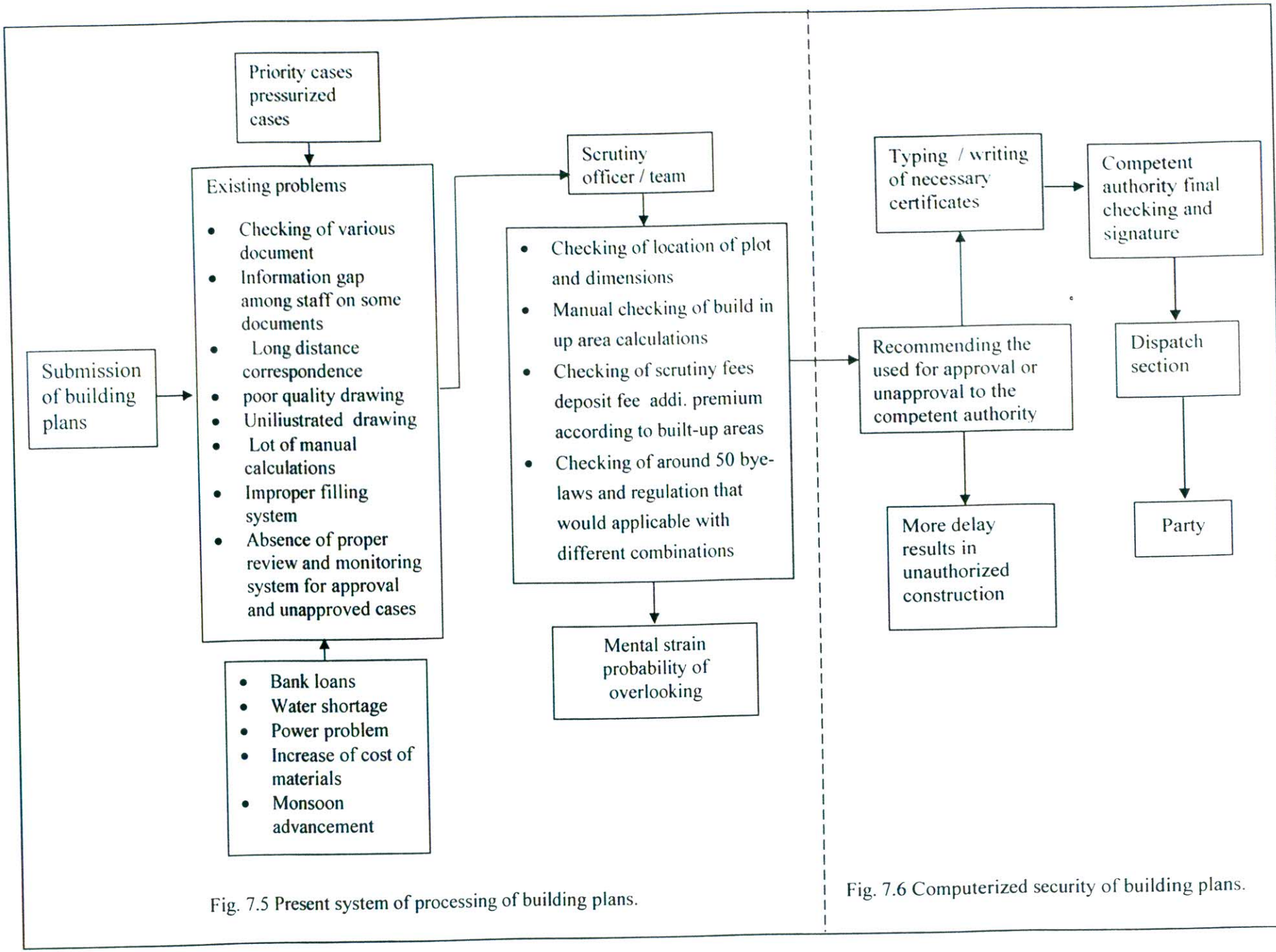


Fig. 7.5 Present system of processing of building plans.

Fig. 7.6 Computerized security of building plans.

7.6 Computerized regularization of unauthorized structures

The purpose of the enforcement of building bye-laws and regulations is to promote a better quality of life in towns and cities. However, the violation of building bye-laws is very common resulting in unauthorized structures which are lowering the quality of the physical and social environment of towns and cities (GOB, 1982). In the process of regularization of unauthorized structures the competent authority has to face the following problems:

- lack of detailed stored information on the extent of violations in each respect;
- a great deal of effort system checking, comparing and doing various calculations;
- converting the various violations into monetary penalties, special concessions or even demolition; and
- difficulty in deciding on a compromise solution, of finding out different alternatives with a view to regularising the case.

To overcome the problems, a computer can be used to work out a compromise solution, with different alternatives, and to increase the efficiency of the unauthorized structure regularization process. An unauthorized structure regularization index has been prepared by taking the extent of different violations of unauthorized structures. The index places the violations in any of the three categories: (i) special concessions, (ii) monetary penalty, and (iii) demolition. This index has been incorporated in the package in simple mathematical equations and logical arguments. A data coded format has been designed which is part of the package providing details of the extent of violations of building bye-laws and regulations, which will be filled when site inspection is carried out by the competent authority (MOL, 1982).

All the data given in the data format will be fed into a computer. Before getting the final verdict of the computer, all the data will be cross-checked 4 to 5 times in the programme to avoid any manipulation of data. The programme performs arithmetical and logical operations with the entered data and checks the extent of violations of the time limit, built-up areas, required fees to be paid, front near and side margins, minimum room dimensions and areas, the area of light and ventilation, widthwise, depthwise, division of site, dimensions, height controls, staircase details, balcony area and *chajja* projections, compound wall details, etc (Raman, 1989).

According to index conditions and standard building bye-laws and regulations, the entered data will be processed and result will be printed immediately along with necessary certificates indicating the case under the three categories: the special concession, monetary penalty amount to paid in rupees and the parts to be demolished for regularization of the unauthorized building structure.

With the above package any number of unauthorized building cases can be regularized with a short span of time.

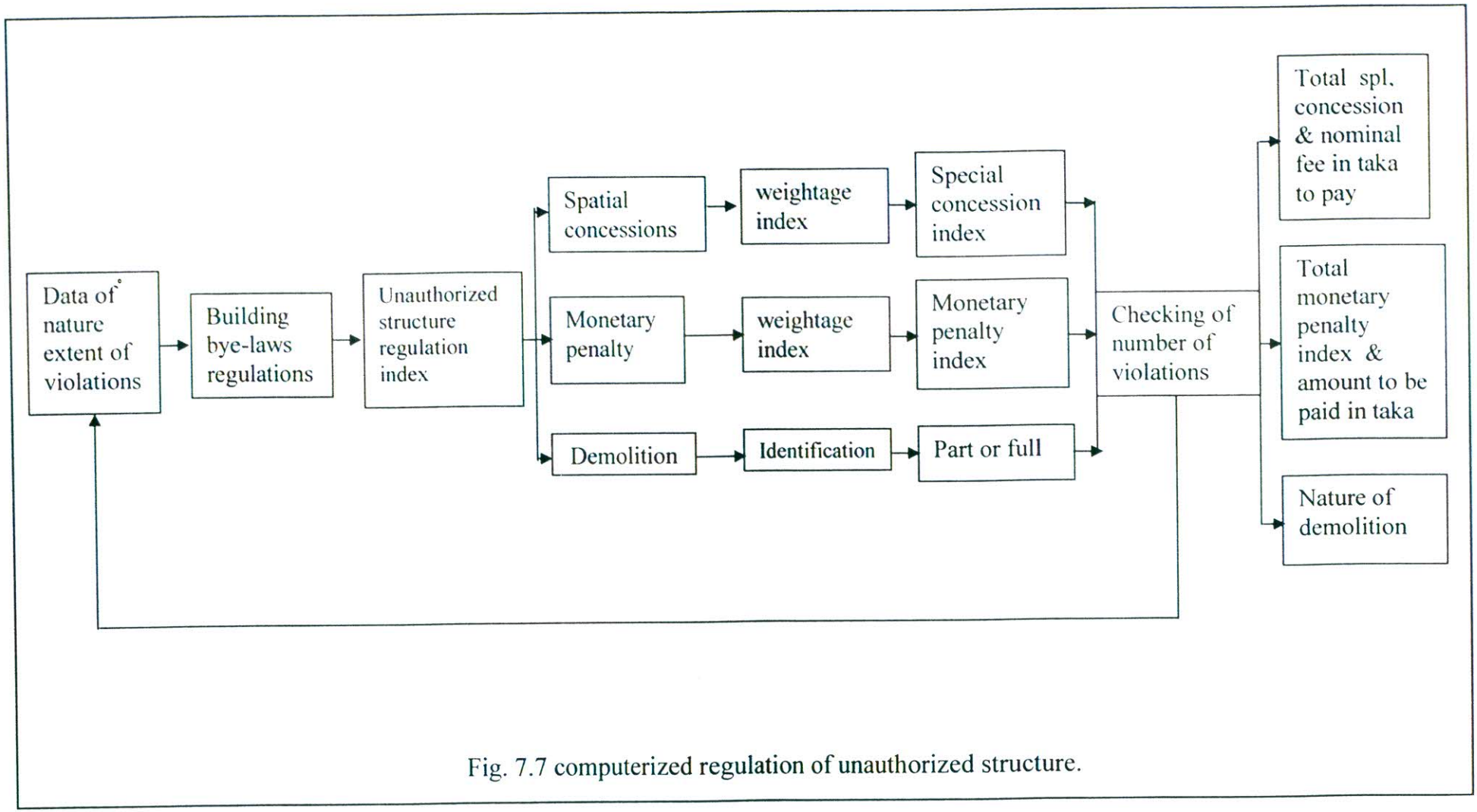


Fig. 7.7 computerized regulation of unauthorized structure.

7.7 Results

Planners and decision makers in Bangladesh have to perform without adequate access to information and research facilities necessary to support the planning and management of the land and related resources. The effects of this are more apparent in fast growing urban centers which are usually characterized by poor housing environments, traffic mismanagement, unbalanced and insufficient distribution of utilities and services and generally incompatible and haphazard urban development.

This inadequacy specifically refers to the problem of storing, retrieving and analyzing land and related information. At present, such information is mainly collected and stored in traditional hand written documents, making subsequent retrieval very difficult. Any inquiry into the urban land information base therefore takes weeks or months rather than minutes or hours. As a result most planning and management exercise avoid proper analyses of relevant data.

A computer system can facilitate the creation of a Land Information System (LIS) that will allow easy storage, updating, retrieval and mapping of wide range of information related to planning and management of land resources. With the help of a computer and relevant data management and analytical software, a planner/researcher can easily carry out relevant analysis and present findings on land development and utilization, population, housing and shelter, transport, the local economy, environment, and other relevant aspects to support better planning and management of the urban land resources. LIS can also help in many day-to-day administrative activities of the urban government such as traffic management, property conveyancing, property, valuation, tax and rates collection, issuance of building permits/contacts, management of utilities and services etc.

Manual system:

(i) The existing manually maintained land information system is seriously inadequate to support effective and efficient land administration;

(ii) The ever-decreasing size of parcel means the creation of unusable and unserviceable land parcels.

(iii) The lack of controls in land use;

(iii) The unregulated development of human settlement areas causing increase of cost of provision of infrastructure services;

(iv) Because of increasing demand for land, land transaction has increased many folds but corresponding changes have not taken place in the records and maps; and

(v) Land forgeries are rampant through the tampering of records.

A modern LIS will provide a more effective and easily accessible cadastral and land register that can help;

(i) better information base for planning and management;

(ii) better specification of nights and security of tenure;

(iii) better possibilities of finance;

(iv) easier implementation of policy;

(v) better steering and control;

(vi) better land assessment and taxation;

(vii) better administration;

(viii) improves map production;

(ix) lesser disputes and litigation;

(x) easier transaction of land;

(xi) stimulation of land market;

(xii) security of credit; and

(xiii) achieve better land reform.

It is important that land parcels are easily and uniquely identifiable in a LIS. The system of reference should be;

(i) easy to understand;

(ii) easy to remember;

(iii) easy to use;

(iv) permanent, not requiring change in case of scale;

(v) capable of being updated at subdivision or amalgamation ;

(vi) unique and with perfect correspondence between records and ground;

(vii) accurate and unlikely to be transcribe in error;

(viii) flexible enough to be used in all forms of land administration; and

(ix) economical to introduce and maintain.

Land database feature relationship:

The diagram above shows possible relationships that may exist between various entities in a multipurpose LIS database. At present there is many-to-many relationships between khatians and persons, that is a person may be represented in more than one khatian and again a khatian may hold more than one person. In order to simplify the khatians and ease the establishment of family level khatian. Bangladesh Government has proposed to prepare one person one khatian. However, as has been explained before, under a computerized LIS khatians (accounts) can be prepared at any level, as long a suitable identifier exists for that level.

Issue for modernization of land administration:

As can be from the findings of this study, that even a minimum LIS based on microcomputer can bring in significant benefits in regard to land registration and land administration in Bangladesh. A computerized LIS will:

(i) provide efficiencies to governments in the management of land;

(ii) increase government revenue, through land tax;

(iii) provide the basis for efficient establishment and management of infrastructure services, i.c. water, roads, electricity, etc;

(iv) cost savings to government through a reduction of land disputes; and

(v) assist in the development process of Bangladesh.

CHAPTER-8

8.1 Conclusion

From the observation and discussion obtained form the research certain thoughts have justifiably appeared. These are outlined below:

Implementation of GIS in any organization is not an easy task. Most of the initiative of GIS implementation falls in developing countries. Most failures are related to institutional issues, resistance to change, and lack of political support, insufficient funding and the fact that GIS innovation results in a radical change in information flow within an organization. The user need assessment is a vital component of GIS implementation within a municipality. Exploring potential data sources, integration of the GIS with more traditional information management within the municipality and promoting an understanding of spatial information and analysis capabilities early-on are critical research success.

Planners and decision makers in Bangladesh generally perform their jobs without adequate access to information and research facilities necessary to support the planning and management of the land and related resources. The effects of this are more apparent in fast growing urban centers which are usually characterized by poor housing environments, traffic mismanagement, unbalanced and insufficient distribution of utilities and services and generally incompatible and haphazard urban development.

This inadequacy specifically originates from to the problem of storing, retrieving and analyzing land and related information. At present, such information is mainly collected and stored in traditional hand written documents, making subsequent retrieval very difficult. Any inquiry into the urban land information base, therefore takes weeks or months rather than minutes or hours. As a result most planning and management exercise avoid proper analyses of relevant data.

A computer system can facilitate the creation of a Land Information System (LIS) that will allow easy storage, updating, retrieval and mapping of wide range of information related to planning and management of land resources. With the help of a computer and relevant data

management and analytical software, a planner/researcher can easily carry out relevant analysis and present findings on land development and utilization, population, housing and shelter, transport, the local economy, environment, and other relevant aspects to support better planning and management of the urban land resources. LIS can also help in many day-to-day administrative activities of the urban government such as traffic management, property conveyancing, property, valuation, tax and rates collection, issuance of building permits/contacts, management of utilities and services etc.

The existing manually maintained land information system is seriously inadequate to support effective and efficient land administration, the ever-decreasing size of parcel means the creation of unusable and unserviceable land parcels, the lack of controls in land use, the unregulated development of human settlement areas causing increase of cost of provision of infrastructure services, because of increasing demand for land, land transaction has increased many folds but corresponding changes have not taken place in the records and maps and land forgeries are rampant through the tampering of records.

A modern LIS will provide a more effective and easily accessible cadastral and land register that can help: better information base for planning and management, better specification of rights and security of tenure, better possibilities of finance, easier implementation of policy, better steering and control, better land assessment and taxation, better administration, improves map production, lesser disputes and litigation, easier transaction of land, stimulation of land market, security of credit and achieve better land reform.

It is important that land parcels are easily and uniquely identifiable in a LIS. The system of reference should be: easy to understand, easy to remember, easy to use, permanent, not requiring change in case of scale, capable of being updated at subdivision or amalgamation, unique and with perfect correspondence between records and ground, accurate and unlikely to be transcribe in error, flexible enough to be used in all forms of land administration and economical to introduce and maintain.

The diagram given earlier shows possible relationships that may exist between various entities in a multipurpose LIS database. At present there is many-to-many relationships between *Khatians* and persons, that is a person may be represented in more than one *Khatian* and again a *Khatian* may hold more than one person. In order to simplify the *Khatians* and ease the

establishment of family level *Khatian*. Bangladesh Government has proposed to prepare one person one *Khatian*. However, as has been explained before, under a computerized LIS *Khatians* (accounts) can be prepared at any level, as long a suitable identifier exists for that level.

A computerized LIS will: provide efficiencies to governments in the management of land, increase government revenue, through land tax, provide the basis for efficient establishment and management of infrastructure services, i.c. Water, roads, electricity etc, cost savings to government through a reduction of land disputes and assist in the development process of Bangladesh.

A municipality serves the community through several departments, each of which performs one or several urban management functions. A huge quality of information of different types is to be handled to perform all these operations. At present, the data are stored in paper filling system, which is very difficult for quick retrieval and necessary updating. Another common problem is to identify and manage these data. The existing system also cannot efficiently deal with the spatial data and it is very difficult to relate spatial and attribute data. GISs are characterised by their capacity to deal with huge amount of both spatial and attribute data (Aronoff, 1993).

Good decisions require good information (Rogers, *et al.*, 1965). The operation level of the government (the tax assessors, building inspectors, the meter readers' etc.) contains the people who work with and depend on data daily to perform their tasks. If the information is bad, inaccurate or out of data then their jobs are difficult to perform. Not all of those data that are created by the operations level of the municipality, however, are needed at the management level. The managers generally need summary information of the operational data. Instead of house-by-house or parcel-by-parcel data, managers need aggregate information. Even fewer data are needed for policy purposes less detailed but more integration, aggregation and flexibility are needed to meet the ever-changing information needs at the policy level (Alam, 1992).

The goal then in developing information system is to design once needed at the operation level of the municipality, but also with the necessary standard and flexibility to allow the data to be integrated with other data in different functions of the organisations and aggregated in summary form for assimilation at the management and policy levels. The data processor

should strive to develop a system that not only improved the municipality, but can also be needs by the managers and policy makers to improve decision-making, planning and policy analysis. A GIS based municipal information system can facilitate or satisfy the above-mentioned requirements of the municipality (Harrison, 1992).

A created GIS based system will connect the map representation of the municipality or other jurisdiction with a database consisting of the individual or aggregated observations about the land or the human activities on it (Dokmeci, 1993). More advanced techniques and large data inputs have been added to analytical power through the use of GIS and complex models within it.

Topologically structured GIS database can ensure reduction or elimination of data redundancy and considering only one base map for a municipality. One department develops and maintains the map while all other use that. This procedure makes it easier to produce quality map. Also multiple departments can share the cost for the base map preparation. Time saving is also realized through the interdepartmental cooperation.

The data and time constraints can be reduced by implementing computerized system: Electronic field data record improves not only the field data collection process and the efficiency of MIS data acquisition, but it also boosts the efficiency of the collection of non MIS related data

Data sharing and workload balancing within the departments can be achieved through MIS. Interdepartmental cooperation can be one of the most prominent advantages. Once the initial resistance is overcome, participants in the project would realize the benefits and would eager to share data and workload

Multidimentational array of data and their cumulative presentation help the managers to foresee the demand and supply situation of a community in the context of community facilities planning. The system also facilitates the decision making process by giving the managers more information in time, thus allowing administrators to more informed and quicker in decisions.

Continuously changing environment requires frequent updating of informations. It is relatively easier to update information in a computerized database. Correction and updating of database can be done easily in a topologically structured database without any major involvement.

Decision-makers need data within a short notice to take the decision quickly. As a decision support system, a GIS based municipal information system will provide easy and quick retrieval of information. Maps (in selected area/feature) in any scale and size can be produced in a short notice.

Now a days all the planning activities need to deal with a large amount of digital and spatial data and maps, charts and reports. Unfortunately, in different government and semi-government agencies of Bangladesh, most of these data were kept in the form of paper documents and maps without any georefence.

The development of computer and information technology, and its successful application in every sector of society today is well known and most impressive. Like all other sectors, planners also needs an automated information system like Geographical Information System (GIS) capable of dealing with spatial database to make their task efficient and effective. For which a digital and georefence data and information are very much needed. A comprehensive GIS includes software and hardware used to capture, store, organize, manipulate, analyze and display spatially referenced information. GIS are constructed in layers with each layer containing different geographic information. Easy manipulation and display of information helps to facilitate the decision making process by allowing planners to customize the maps and models produced. Spatial data collection and georefence digital mapping have now become very easy with satellite based advanced survey techniques using Global Positioning System (GPS) and develop them in a Geographical Information System (GIS).

Parallel to the change in the database management system towards a modernized method in the western cities, the need for such system is now understood increasingly for Rajshahi City Corporation too. It is found that a significant area of jurisdiction (socio-economic and relating to environment) has been included in the City Corporation authority. These have widened their functional area although their existing infrastructure is not sufficient enough to handle the situation.

The data base sources to be used by the city corporation is extremely diversified and distributed to the places which are not always well linked to the RCC authority. This is essentially due to inter-departmental isolation and improper administrative condition. Its another reason is that the City Corporation has insufficient control over the city's multi-dimensional functional components. Since the city area is incorporated into defined geographical units many of its functions and systems are different form that of the country side. Importance of city authority's complete control may be considered seriously.

The available data are very much different in nature (which is quite justified) but does not maintain continuity in its system to follow for a long time series. So the importance of maintaining proper data field structure is to be considered. This is very important for integration of different data platform into a single relational database. A digital relational database is thought to be the only option since this has been proved to be extremely efficient in an automated system for information management super structure.

The spatial databases are also found to be isolated from each other. This has slowed the examination, viewing and taking decision using different types and levels of maps in the present situation. So the integration of all types of maps (of all types of geographical features and layers) of the City of Rajshahi must be well integrated to form a single multidimensional database system.

An efficient classification and categorization of the attribute databases and spatial databases of different types have been done in the present study. After careful observation of the present situation and pertinent problems, the experimental models have been suggested those may be used to construct a modernized and idealized city database management system. Some workable structure for the functional frame has also been outlined. The entire system has been model based on an automated computerized system, which includes geographical information and data base management system.

The created system has tried to leave same scopes so that future modification in the city's system can be appropriately accommodated in future.

The suggested model and ideas derived from the study is an experimental outcome. It is believed that the system should improve the present situation but, however, efficiency can be

achieved only after careful use of the present proposed system. The knowledge revealed may potentially be used for Rajshahi as well as for other cities too.

8.2 Recommendations

1. Valuation system update

In the present taxation system, valuation is done mainly, depending on the experience, efficiency and honesty of the valuation officer. Scope of dishonesty remains in this issue. This can be eliminated by a knowledge based urban properties valuation system proposed by an researcher. In most cases, the amount of tax is paid basing on the economic market value of the property (land and improvements to the land). Therefore, the correct determination of the value of a property is crucial to ensure equity and fairness of taxes. For the research, it is assumed that the economy market value is the average cash payment a sensible buyer would pay for the property in open market at the time of valuation. Since not all the properties to be taxes are on sale at the time of valuation, a methodology or model must be developed which can be used to determine the market value for each individual taxable property.

The values determined for property taxation purpose are mostly composed of two parts: building value and land value. In this research manneh (1992), using the Danish land valuation system as a basis, developed two related models:

i) The building valuation model:

Building value = A*B-D

Where, A= total building floor area.

B= replacement cost per unit area.

D= depreciation

ii) The land valuation model:

a multiple regression analysis is used here for land valuation. The general formula is as follows:-

Land value = $A_1 X_1 = A_2 X_2$

The implementation of the regression analysis for land valuation requires the following steps:-

i) Classification of land valuation, the land is firstly classified according to its use. a homogeneous land use unit (one type of land use only) forms the nucleus on the land valuation system and is called a "land valuation unit".

ii) Identification of factors affecting land values: forms empirical knowledge, factors affecting land values have to be identified, such as accessibility, distance to public facilities etc.

iii) Statistical analysis of all properties sold during a year prior to the valuation. This process is to determine whether the identified factors actually have any correction with the land market values and if so to determine the nature and degree of the correction. It has been found that the degree of correction differs according to the land use.

iv) Calculate total and values using the result of the regression analysis for each of land use.

From the above description, it is clear that the design of such valuation models require good knowledge and experience of local factors influencing property values. The valuation process involves the input and analysis of large amount of property data, their locations, characteristics and comparison with sales information. If done manually, this repetitive valuation process can easily become very time consuming and tedious. He adopted of fast and reliable valuation methods are therefore desirable. Through the integration of a GIS with an expert system and statistical analysis tools, the automation of the whole process of valuation was realized.

2. Institutional or Organization Modification:

Institutional issues more than any others, determine the effectiveness and pace of development. They directly affect the design and implementation of any system and are themselves affected by its development. The current organizational structures of R.C.C. has to recognize to adopt this system properly. An inevitable concomitance of computerization is the need reorganization. Legislative reform is often required before a modern municipal information system. Long term co-operation and communication with political organizations needs to be developed for logistical reasons and to serve the broader areas of education, research and public relations.

3. Management issue

Institutional problems derive from the external relations between a municipal information system and its environment. The internal problems are the concern of managements. The single most effective way to improve the quality of existing system is, in almost every case, to improve the quality of its management. Better management skill, better management education and better management information are essential of any strategy for progress. Management must acquire and uses appropriate technology and management will invariably need to introduce new personnel arrangement.

4.Data standards and exchange

Data should be kept in such a way that these can be used by various government departments. Data exchange between various related departments should be ensured so that cost and can be reduced. Data security is also a vital factor for the municipality. Restriction should be maintained on the data accessibility. In general, there is a lack of current data, especially for urban areas in developing countries. The quality of available data is another essential issue of GIS. A GIS can generate accurate information only if their databases are built on accurate data to begin with. Even sophisticated GIS techniques will, only yield a waste or false output if it is supplied with incomplete or inaccurate data.

5. Pricing of related instruments

Decline in price of hardware is not sufficient where other accessories are still expensive. PC technology is most often the appropriate choice for municipal scale projects in Bangladesh. It is also important to evaluate the user needs, and choose the hardware appropriate for it. Expensive software like Arc/Info is not essential if automated database is not considered.

CHAPTER-9

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CHAPTER- 10

Appendices

Appendix 1.1: List of data sources:

Description of the Data	Possible data source and collection procedure
House hold number	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Total population	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Total population between 0-9 years	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Total population between 10-17 yea	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Total population between 18-64 yea	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Total population between 65+above	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Tribal population	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Floating population	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Attending school between 5-9 years	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Attending school between 10-14	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Attending school between 15-24	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Not married	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Married	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Widow / separated	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Married woman between 15-44	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Total male population	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.

Description of the Data	Possible data source and collection procedure
Total Female population	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Total Literacy rate	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Literacy rate for male population	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Literacy rate for male population	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Muslim population	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Hindu population	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Buddhist population	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Christian population	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Population of other religious	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Population not working	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Population engaged in house hold activities	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Population engaged in cultivation	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Population engaged in Agriculture – non crop activities	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Population engaged in manufacturing activities	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Population engaged in business activities	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Population engaged in others activities	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Literacy rate of youth (between 10-29 years)	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Illiterate youth (10-29 years)	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.

Description of the Data	Possible data source and collection procedure
Dwelling units	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Institution	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Business institution	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Household leave kutcha houses	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Household leave semi pucca houses	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Household leave pucca houses	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Households use potable water	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Households gets income from Agricultural land	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Households gets own house	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Households gets cottage industry	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Households with at least one literate person	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Tribal House holds	Population census, 2001, Bangladesh Bureau of Statistics, vol-1.
Private clinics	Personnel of private clinic (by interviewing the concerned person
Primary schools	Thana Primary Education Office, Boalia, Rajshahi
Collages	Collages (by interviewing the concerned persons)
Madrashas	Madreshas (by interviewing the concerned persons)
Dust bins	Draft Drainage Master Plan Report of RCC, Rajshahi
Drains	Draft Drainage Master Plan Report of RCC, Rajshahi

Description of the Data	Possible data source and collection procedure
Post offices	Post Master General Office, Rajshahi zone, Rajshahi
Letter boxes	Post Master General Office, Rajshahi, Rajshahi
Police stations	Metropolitan Police, Rajshahi zone, Rajshahi
Police Faris	Metropolitan Police, Office, Rajshahi
Kutcha Bazers	Kutcha Bazer (by personal visit)
Traffic signal posts	Visit the concerned traffic signal posts)

Appendix 1.2:

Projection System:

- Geodetic reference (Projection System) : BTM (Bangladesh Transverse Mercator)
- Projection parameter

: Scale factor	:	0.9996
Central meridian	:	90° E
False easting	:	500,000m
False northing	:	-2,000,000m
Latitude of origin	:	0° (equator)

- Spheroid : Everest 1830

Semi-major axis a	:	6,377,276.345m
Semi-minor axis b	:	6,356,075.413m
Inverse flattening 1/f	:	300.8017

- Datum shifts from WGS84:

Rotation x	:	0.00
Rotation y	:	0.00
Rotation z	:	0.00
Translation x	:	-283.729m
Translation y	:	-735.942m
Translation z	:	-261.143m
Scale	:	0 ppm

- Reference vertical datum : mPWD (Public Works Department), Bangladesh

GPS Survey Technique

The Global Positioning System (GPS) is worldwide all-weather radio-navigation and positioning system formed from a constellation of 24 satellites and their 5 nos. ground control & monitor stations. GPS receivers use these US Navigation Satellites for Timing and Ranging (NAVSTAR) to calculate positions accurate to mater of meters. GPS receives radio waves, modulated for positioning, transmitted by a maximum number of 24 satellites, which enables to work out the distance between satellite and observation points. By receiving radio waves from four satellites simultaneously it is possible to find out the three-dimensional co-ordinates and time (UTC) of the observation point with an accuracy level which can not be conceived in traditional ground survey. The facility of GPS has been utilized in different kinds of ground surveys including geodetic, topographic and hydrographic survey in the recent times. Differential Global Positioning System (DGPS) and Real-Time Kinematic Global Positioning System (RTK-GPS) are different versions of GPS technology, each with its own range of applicability and accuracy level. GPS based surveying has a number of advantages over conventional surveying methods. These are:

- Highly accurate
- Very fast
- Line of sight not required
- Unified 3-dimentional global co-ordinate system (x,y,z) output
- Digital/Computerized data storage, processing facility

Differential Global Positioning System (DGPS)

To obtain precise position from a GPS receiver, we used techniques called "Differential GPS". This involves at least two GPS receivers. One is stationary, at a known point or bench mark; we call this the "Base or Reference" receiver/unit and the other rover receiver/unit. The base unit ties all the satellite measurements into a solid local reference i.e. known point or bench mark. The Base receiver measures and records the timing errors and then transmit correction information to the other receivers those are roving around. The roving GPS receivers, possibly moving at an unknown point, calculates precise position by using the signals it receives from the satellites, and the correction information receives via radio from the Base. The correction information could be transmitted through online radio communication system or could be

incorporated by off-line data processing software. Differential GPS usually gives about 6one meter accuracy. A Typical DGPS set-up for topographic survey is shown in Figure-1.

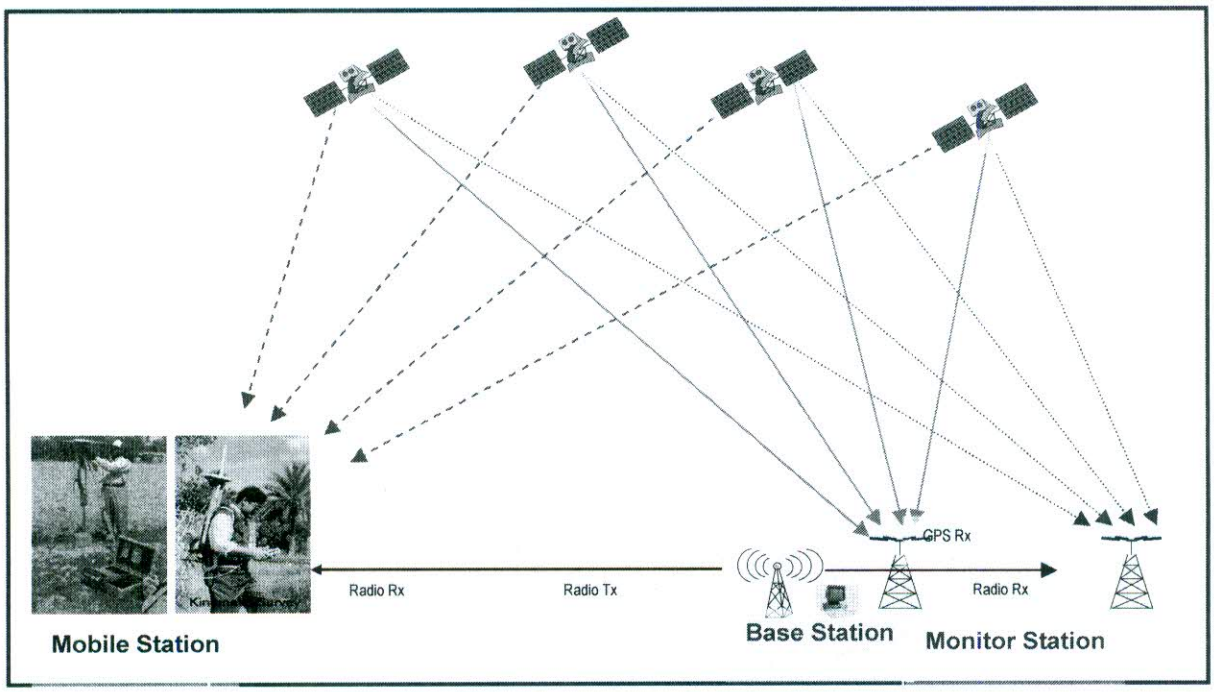

Figure-1: Typical DGPS Set-up for Topographic Survey

Real Time Kinematic GPS

RTK is a special form of Differential GPS that gives about one hundred times greater accuracy. The GPS system uses a coded signal from which a receiver derives distance and thus position. The GPS satellite provides the equivalent of tape measure from space. The tape labeled tick marks at ~300m intervals (the C/A code), as well as unlabelled lick marks at ~20m intervals (the carrier). A GPS receiver can measure the code to one-meter (1m) precisions, and the carrier to one-centimetre (1cm) precision. A receiver that can compute the "Labels" on the carrier can then deliver centimetre position accuracy. This is what RTK does. A Typical RTK static survey set-up for a session is shown in Figure-2.

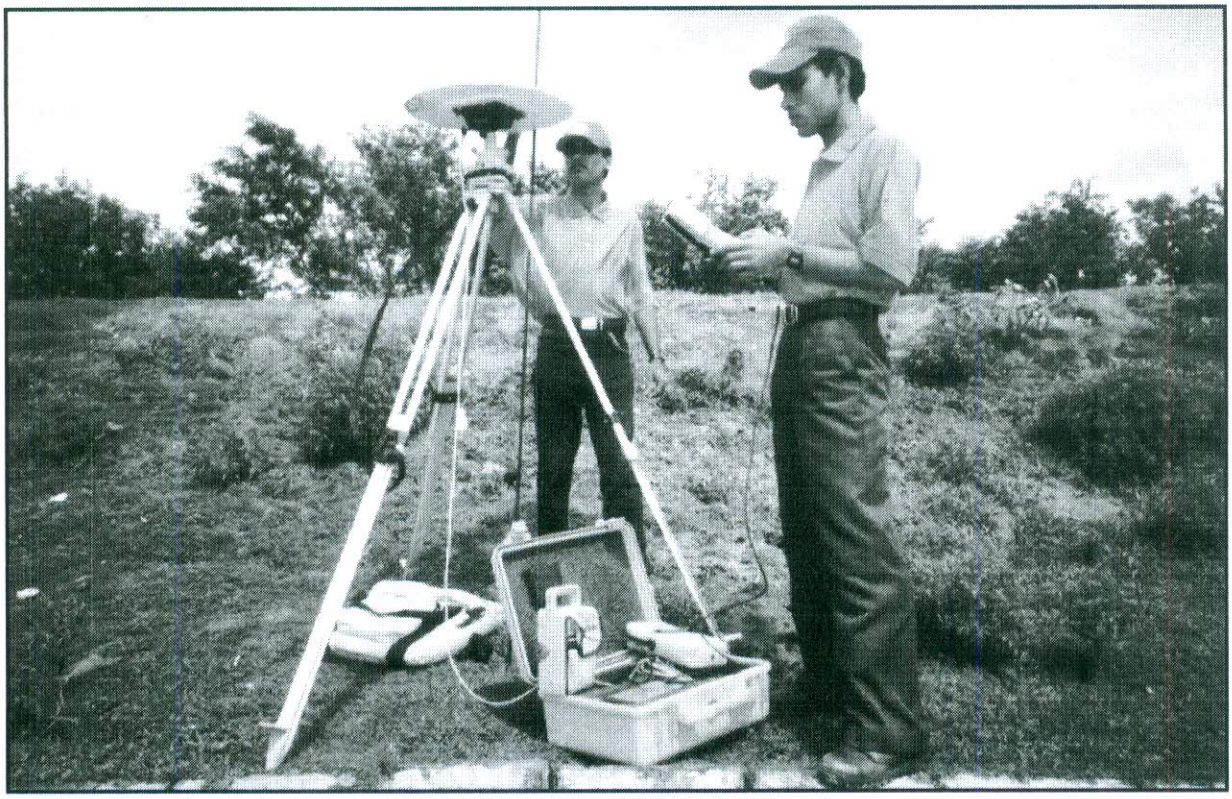

Figure-2: Typical RTK static survey set-up

Total Station Survey Technique

Electronic Total Station is a combination of electronic theodolite, distance meter and level with on-board computer having graphic icon menu with LCD display and built-in MS-Dos operating system, which can measure and store the positioning data of a target point in digital form. It consists of a microprocessor with special software for operation, data capture, storage & processing, transmission and receiving to/from a computer. The data can be stored in internal memory or in external memory card. It transmits ledger beam towards the target where a reflector (i.e. prism) is placed and receives the reflected beam by which calculate the distance, bearing and 3-D coordinate of that target point with respect to the reference points whose coordinates are known. The total station data quality is depends on the precision accuracy of the initial points of TS survey i.e the two known points (station and back point) used by the total station to calculate the remaining surveyed co-ordinates. So, to get

the georeference co-ordinate by total station survey, the initial points of total station survey must be recorded by precise GPS survey i.e TS survey must be supported by GPS survey. A typical TS survey set up for land level survey is as below (Figure-3):

Figure 3: Typical Total Station Survey Set-up for Land Level Survey.

Methodology of Survey and Mapping:

Establishment of Reference Station for DGPS Survey

One reference station for Differential Global Positioning System (DGPS) survey was established using RTK-GPS static survey and baseline network adjustment technique. Available JICA BMs in the project area and its periphery were used as reference BM for establishment of DGPS reference stations (Table-3). This DGPS reference station has been used for recording and transmitting differential correction for DGPS rover units.

Establishment of Bench Marks (BM)/Control Points (CP) Network

A network of 21 permanent Bench Marks (BM)/Control Points having georeference and elevation with respect to mPWD datum (northing, easting and RL in mPWD) was established in

the project area to carry out the total physical feature and topographic survey activities. The BMs have been installed with uniformly distributed in the total project area. Establishment of reference BMs of the project comprises the following item of works:

- Construction and Installation of BM pillars.
- Establishment of Co-ordinate of BM Pillars (x, y, z i.e latitude,longitude & RL in mPWD)

Constructions and Installation of BM Pillars

The BM pillars were constructed and installed before the survey work start. The construction design of the pillars was approved by the client. The R.C.C BM pillars were installed with uniformly distributed in the total project area. The tentative locations of the BMs were selected as per suggestion of the client. Later on the location and the number of BM pillars were selected by a comprehensive reconnaissance survey of the area. The corresponding surveyed value will be marked on the face of each BM pillars later on. A sample photograph of such BM pillars is presented as Figure-4. The detailed list of the BMs with location description is presented in Table-1.

Figure-4: Sample Photograph of BM

Establishment of Co-ordinates (x,y,z) of BM Pillars

To establish the horizontal co-ordinate (northing and easting) and elevation (in mPWD) of BM Pillars, an extensive survey works with most modern and sophisticated satellite based electronic equipment like duel frequency RTK-GPS was carried out. The total work comprises the following items:

- Selection of reference BM (x, y, z)
- Baseline survey and network adjustment.

Table-1: List of Bench Marks with Location Description

Bench Mark ID	Location	Location description
BM01	Bagdhani	Western side of the pond near Bagdhani High School, Paba, Rajshahi.
BM02	Modhusunpur	South-East corner of the play ground of Modhusunpur Non-Govt. Primary School, Paba,Rajshahi.
BM03	Sabsar	North side of Sabsar High School, Paba, Rajshahi.
BM04	Darusha	Mid-West side of Play ground of Darusha High School, Paba, Rajshahi.
BM05	Duari	Beside the road Adjacent to Duari Govt. Primary School, Paba, Rajshahi.
BM06	Valam	South-West corner of the play ground of Valam Bhobanipur High School, Paba, Rajshahi.
BM07	Hatgodagari	North-East corner of the play ground of Hatgodagari High School, Paba, Rajshahi.
BM08	Sitlai Station	Beside the Abandoned Rail line located 200m south-east side from Sitlai Railway Station, Paba, Rajshahi.
BM09	Bara Baria	North-West corner of play ground of Bara-Baria Non-Govt. Primary School, Paba, Rajshahi
BM10	Paba Upazila	On the JICA Pillar located in front of the TNO Residence of

		Paba Upazila Parishad Campus.
BM11	RDA Campus	Inside the North-West corner of the Boundary of RDA office, Motihar, Rajshahi
BM12	Purapukur	West side of the field of Kabi Kazi Nazrul Islam College, Paba, Rajshahi.
BM13	Dahapara	South side of the road bridge towards Mohendra from Horian Sugar Mill, Rajshahi.
BM14	Baneshwar	Beside the Rajshahi-Natore Highway 1 km west from Baneshwar, Puthia, Rajshahi.
BM15	Kanaidanga	Beside the road towards Kanadanga 100m apart from Rajshahi-Chapainawabgonj High way, Paba, Rajshahi
BM17	Rajshahi Court	Inside the boundary of Shahid Miner near Rajshahi Court Campus, Rajshahi.
BM18	Shah-Mokdum College	Beside the embankment near Shah Mokdum College, Rajshahi.
BM19	BIT Campus	Inside the play ground of BIT campus, BIT, Rajshahi.
BM20	Choumohoni	East side of the field of Choumohoni Shahid Ziaur Rahman College, Chak Kapasia, Charghat, Rajshahi.
BM21	Joypur	South side of the field of Joypur Govt. Primary School, Charghat, Rajshahi.
BM22	Charghat	Eastern side of the Sluice gate near Charghat, Charghat, Rajshahi.

Selection of Reference BM

Selection of reference BM is essential for establishment of BM network. Reference BM provides georeference (x, y) and elevation (z) with respect to a datum. For geo-referencing of the BMs the available 3 nos. JICA BMs in the project area and its periphery were used as reference, for elevation

adjustment (z mPWD) two SoB (Survey of Bangladesh) BMs available in the project area, suggested by the client were used as reference BM. The location and the detail of the reference BMs are enclosed as Table-2.

Table-2: Reference BMs

Reference BM ID	Physical Location	Latitude (N) DD°MM'SS.sssss"	Longitude (E) DD°MM'SS.ssssss"	Height	Used for
JICA-1369	Paba Upazila Parishad, Rajshahi	24°24'53.87173"	088°36'41.93355"	-38.200 m ElpHt	Horizontal Adjustment
JICA-333	Kakonhat Railway Station, Paba, Rajshahi	24°30'24.44304"	088°28'19.18996"	-26.080 m ElpHt	Horizontal Adjustment
JICA-1433	Arani Railway Station, Charghat, Rajshahi	24°17'27.76743"	088°52'48.24559"	-37.940 m ElpHt	Horizontal Adjustment
SoB-729	BIT, Rajshahi			18.9496 m PWD	Vertical Adjustment
SoB-6232	Upozilla Parishad, Paba, Rajshahi			17.2689 m PWD	Vertical Adjustment

Baseline Survey and Network Adjustment

Twenty one numbers of Bench Mark have been established applying static survey using two dual frequency RTK GPS receivers and network adjustment technique (Table-3). In total of 56 numbers of baseline have been surveyed

The Baseline survey, simultaneous data collection in static mode at two or more fixed points using two or more duel frequency GPS receivers. The measurement network for baseline survey was planned by connecting the BM points to be established and the selected reference BM points (known Latitude, longitude and ellipsoidal height) available inside and around the project area. A line connecting two measurement points is known as baseline. It is important to emphasis that the configuration of network was based on practical considerations rather than

requirements of an ideal network. The network design of baseline survey of the area is shown in Figure-4.

The GPS measurements consist a simultaneous static measurement with dual frequency GPS receivers at the ends of a baseline concerned. Measurement or logging time for a session is usually one hour. During the measurements the GPS receivers at the two points record the information or data (Latitude, Longitude, Ellipsoidal Height) on the configuration of available satellite at the time, which at the end of day's work was processed using Trimble Geomatic Office software. The summary result of baseline survey are as below:

- Total no of Bench Marks : 21
- Total no of base line : 53
- Total numbers of Closing loops : 34 of triangles.
- Data logging in Each of the session : 1 hour or more.

If results from the field measurements found unacceptable, measurements were repeated. The verified results of each baseline were stored for the subsequent network adjustment. After completing

the baseline survey, network adjustment was done with respect to the known values (Latitude, Longitude, and Ellipsoidal Height) of selected reference BMs. The adjustment module of Trimble Geomatic Office software was used for network adjustment. After network adjustment the precise co-ordinates (Latitude, Longitude, and Ellipsoidal Height) of each BM was obtained (Table-5).

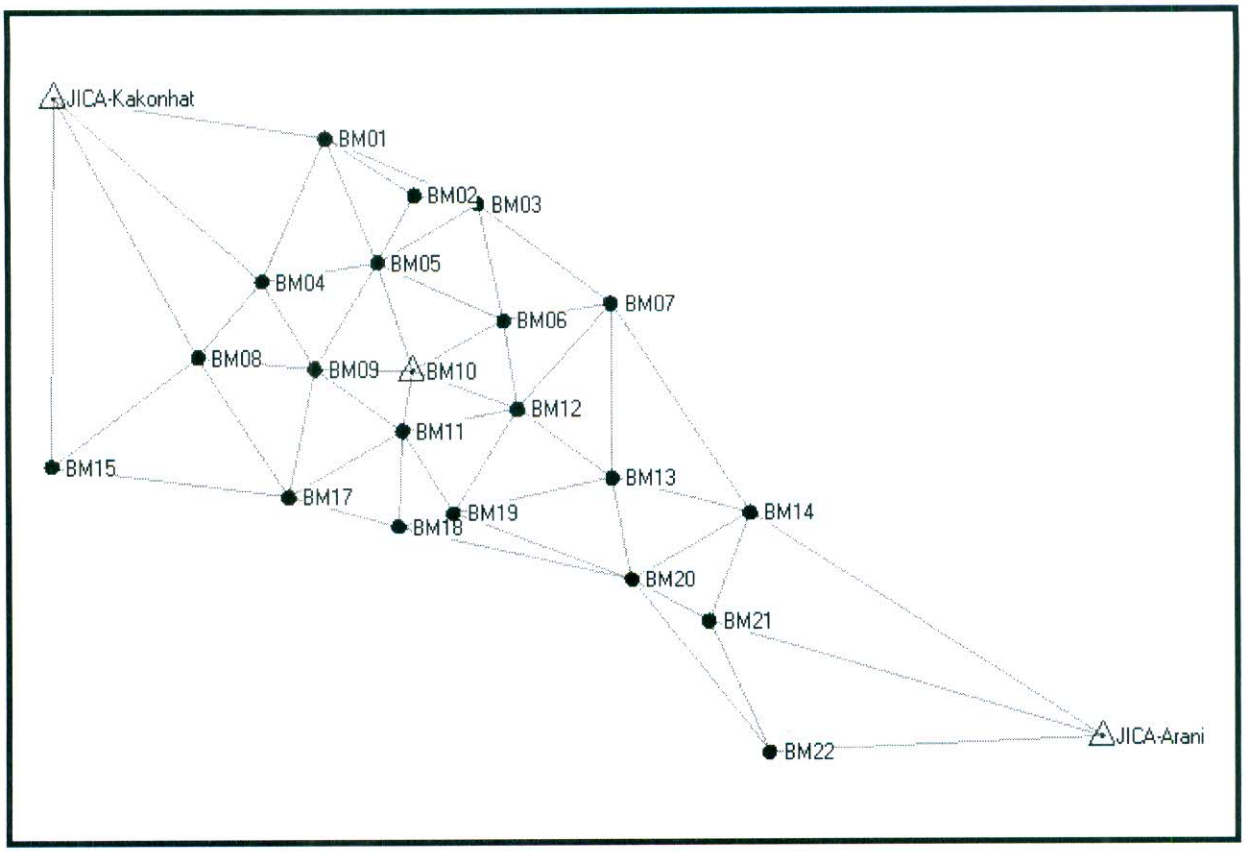

Figure-5: Network design of baseline survey of the area.

Table-03: List of BMs of RCC area.

BM ID	WGS-84			BTM		Reduce Level
	Latitude (N) dd°mm'ss.sssss"	Longitude (E) dd°mm'ss.sssss"	Ellp.ht (m)	Easting (m)	Northing (m)	PWD (m)
BM01	24°29'38.82613"	88°34'37.89834"	-39.965	356117.760	709380.560	15.717
BM02	24°28'29.55526"	88°36'43.22627"	-40.229	359624.284	707213.797	15.461
BM03	24°28'20.24264"	88°38'11.22758"	-39.848	362099.011	706902.679	15.820
BM04	24°26'41.83701"	88°33'10.88727"	-38.797	353611.457	703961.456	17.040
BM05	24°27'06.40961"	88°35'51.97204"	-39.079	358155.361	704670.665	16.690
BM06	24°25'55.69719"	88°38'48.92404"	-39.698	363116.845	702445.875	16.052
BM07	24°26'18.55259"	88°41'18.29406"	-39.602	367330.175	703108.457	16.108

BM08	24°25'08.17258"	88°31'42.84975"	-38.513	351101.629	701106.278	17.419
BM09	24°24'55.46389"	88°34'25.47943"	-39.227	355678.330	700667.442	16.670
BM10	24°24'53.87173"	88°36'41.93355"	-38.200	359521.349	700579.438	17.629
BM11	24°23'41.77769"	88°36'28.50085"	-38.263	359120.723	698365.529	17.636
BM12	24°24'09.25643"	88°39'08.69646"	-38.409	363641.855	699166.228	17.409
BM13	24°22'46.71030"	88°41'22.12926"	-38.236	367376.576	696591.038	17.608
BM14	24°22'05.19096"	88°44'34.87188"	-39.112	372795.351	695263.671	16.708
BM15	24°22'54.27832"	88°28'20.30422"	-34.207	345351.144	697049.100	21.883
BM17	24°22'19.98338"	88°33'50.05926"	-36.977	354631.122	695894.914	19.014
BM18	24°21'43.83000"	88°36'24.11510"	-36.001	358960.749	694738.558	19.935
BM19	24°22'01.30322"	88°37'40.44284"	-37.949	361116.872	695254.637	17.967
BM20	24°20'40.19190"	88°41'50.38512"	-38.406	368136.158	692691.792	17.503
BM21	24°19'48.48622"	88°43'38.42634"	-38.233	371166.400	691073.112	17.673
BM22	24°17'05.26356"	88°45'04.32368"	-36.911	373542.353	686030.478	19.046

Development of Local Geoid Model

A Geoid is a representation of the earth surface over which the earth's gravity is constant. If the value of earth gravity on the geoid is the value of the gravity on the average sea level, then the geoid represent the mean sea level of the corresponding area.

With the output co-ordinates of the BMs in latitude, longitude and ellipsoidal height from the network adjustment result, a network of geoid points was established for the project area. However, to be a precise geoid model the ellipsoidal heights were converted to the corresponding geoidal heights. Furthermore, in order to develop the Geoid Model of the project area in terms of a functional datum i.e. PWD, it was required to determine the heights or levels of the BMs in PWD datum.

As in Figure-7 in the context of Bangladesh, the PWD datum or height is equivalent to orthometric height and could be calculated from the corresponding geoidal height and ellipsoidal height. The corresponding mathematical relation is shown below:

$$N = H + h$$

Where, N = Geoidal height, H = Orthometric height, h = Ellipsoidal height

Some scientist measured the earth's gravity in a grid of several kilometres all over the world and then made a mathematical model, which is known as "World Geoid Model".

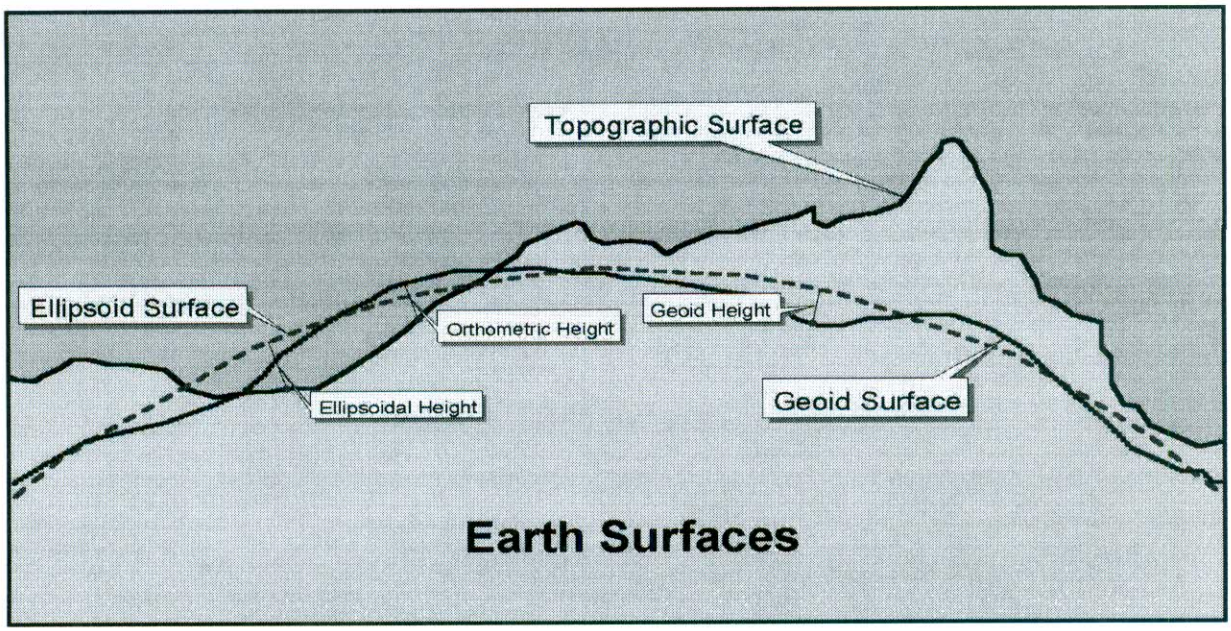

Figure-6: Earth Surfaces (Topographic, Ellipsoidal & Geoid)

To establish a relationship between the ellipsoidal height (h) & geoidal height (N) of a area, the relationship between the world geoid model and local land topographic (undulation) characteristics of that area was required. The following procedure was applied for that purpose:

Using the network adjustment data of baseline survey as input the "World Geoid Model" the geoid separation or geoidal height (N) for each of the surveyed points i.e. BM was obtained. Then the orthometric height (H) was calculated by using the above equation. With the combination of "World Geoid Model" and the surveyed data, a new model was developed known as "Local Geoid model for the project".

Secondly it was needed to make a relationship between the orthometric height (H) and the local datum (PWD). To do so, few numbers of BMs those covers the boundary conditions of Local Geoid Model were surveyed with respect to PWD datum from one or more reference BM available in the project area. Then an input data file for the "local geoid model" which consists of Latitude, Longitude, Ellipsoidal height, and m PWD height was prepared. Incorporating this input file to the Local Geoid Model a relationship data file was established between the orthometric height (H) and local datum (PWD). This data file is known as "local model input data file".

Finally, if the Latitude, Longitude, and Ellipsoidal height of a particular point (whose local datum i.e. PWD datum is unknown) is used as input to this "Local Geoid Model" in association with the local model input data file, then the mPWD height of that unknown point could be calculated by the model.

This local geoid model has been used for establishment of secondary control points (SCP) for supporting the total station survey i.e to get georeference co-ordinate by total station survey.

Appendices 1.3: Plot information of ward no 12 (Ranibazar area)

Mohalla	N_H_no	P_H_NO	ROAD	N_H_OWNER	N_F_H_OWNE	FLOOR	F_TYPE	STRUCTURE	OWN_P	OWN_S_P	OWN_K	RENT_P	RENT_S_P	RENT_K	OWN_C_P	OWN_C_S_PU	OWN_C_KATC	RENT_C_PUC	RENT_C_S_P	RENT_C_KAT	TYPE_W_CO	HB_LOAN
Ranibazar	1	1/1		Late Sayad Ali	Late.Sayad Obed Ali	2	Pucca	Pucca	1960												1/2	
Ranibazar	2	2/2		Mohsina Begum	Late.Moazzem Hosen	2	Pucca	Pucca	800						500						3/4	
Ranibazar	3	4/4		Saidul Islam	Late.Roushan Ali	3	Pucca	Pucca	2400												3/4	
Ranibazar	4	7/7		Md.Saidul Islam	Late.Roushan Ali	1	Pucca	Semi Pucca		1500												
Ranibazar	5	10/8		Md.Fani Mian	Late.Dobiruddin	3	Pucca	Pucca							663			1324			1/2	
Ranibazar	6	5/5		Joinal Abedin	Late.Dobir Uddin	1	Katcha	Katcha			300											
Ranibazar	7	New		Topon Chandra	Late.Joncheswar Roy	4	Pucca	Pucca	2091									2091			3/4	2078000/R U K
Ranibazar	8	11/A/New		Pulak anjan Chowdhury		2	Pucca	Pucca	402	103											1/2	
Ranibazar	9	12/9		Bivuti Bhushan Chowdhury	Late.Endu Bhushon Chowdhury	2	Pucca	Pucca	600												3/2	
Ranibazar	10	12/10		Bivuti Bhushan Chowdhury	Late.Endu Vushan Chowdhury	2	Pucca	Pucca	1500									1500				
Ranibazar	11	9/7/KHA		Zubaida Begum	Shahid Nojibar Rahman	2	Pucca	Pucca	1600												3/4	
Ranibazar	12	13/12		Md.Farman Ali	Late.Foez Uddin Mandal	1	Pucca	Pucca	500						70						1/2	
Ranibazar	13	14/13		M.A Kuddus	Hazi Md.Rezatullah	1	Pucca	Pucca	336												3/4	
Ranibazar	14	15/14		Hazi Md.Rezatullah Mandal	Late.Yusuf Mandal	2	Pucca	Pucca	740						370						3/4	
Ranibazar	15	16/15		Habibur Rahman	Alhaj Zaidur Rahman	3	Pucca	Pucca	1600									800				
Ranibazar	16	20/16/C		Harunujjaman	Late.Dewan Siddiq Hossain	2	Pucca	Pucca										780				
Ranibazar	17	18/16		Abdul Bashar	Late.Dewan Siddiq Hossain	2	Pucca	Pucca	380									380				
Ranibazar	18	21/16/D		Selina Sultana	Saiful Islam	2	Pucca	Pucca										380			3/4	
Ranibazar	19	17/16		Begum Hamida Banu	Late.Dewan Siddiq Hossain	2	Pucca	Pucca	475									475			3/4	
Ranibazar	20	19/16/B		Hamidujjaman	Late.Dewan Siddiq Hossain	2	Pucca	Pucca	190									570			3/4	
Ranibazar	21	22/17		Late Mirza Abul Hamid	Late.Mirza Mahatab Ali	2	Pucca	Pucca	1000									1000			1/2	
Ranibazar	22	23/22		Rahima Khatun	Late.A.Kader	1	Pucca	Pucca										600				
Ranibazar	23	27/25/A		Abdul Mannan Ali	Late.Dr.Abdus Sattar	3	Pucca	Pucca				3000									1/2	
Ranibazar	24	24/23		Mrs.Waheda Sattar	Late.Dr.Abdus Sattar	2	Pucca	Pucca				4400									1/2	
Ranibazar	25	25/24		Late.Shaikh A.Bashir	Late Shaikh A.Aziz	2	Pucca	Pucca	350			350									1/2	
Ranibazar	26	26/25		Sidhir Gobinda Mitra	Borode Gobinda Mitra	1	Pucca	Pucca	240												3/4	
Ranibazar	27	28/26		Johura Fatema	Late.Aminul Islam	2	Pucca	Pucca	1000			1000	480								1/2	
Ranibazar	28	29/27		Elahi Bakhs Ding	Nur Bakhs	3	Pucca	Pucca	1500			3000									3/4	
Ranibazar	29	30/28		Badrul Amin		1	Pucca	Semi Pucca					1000								1/2	
Ranibazar	30	31/29		M A Bari	Late.Niamat Shaikh	2	Pucca	Pucca	1200												3/4	
Ranibazar	31	32/31		Late Moksed Ali	Late.Ishak Ali	3	Pucca	Pucca	2000			1000									1/2	
Ranibazar	32	8/7/A		Dr Debashish Roy	Nimelendu Roy	1	Pucca	Pucca	500												1/2	

Ranibazar	33	219/208		Nur ahan	Md Korban Ali	2	Pucca	Pucca	900			900									1/2	
Ranibazar	34	33/32		Jahanara Khatun	Late.Mokbul Hosen	2	Pucca	Pucca	1000			1000									3/4	
Ranibazar	35	34/33		Md.Arif Shah	Late.Pohuta Shah	1	Pucca	Semi Pucca		400												
Ranibazar	36	39/38		M A Kafi Shah	Late.Giusuddin Shah	1	Pucca	Pucca	404												1/2	
Ranibazar	37	37/36		Nur Jahan	Late.Luthfar Rahman	2	Pucca	Pucca	1400												3/4	
Ranibazar	38	38/37		M A Kader Ding	Late.Moazzwm Ali	1	Pucca	Pucca	1000												1/2	
Ranibazar	39	36/35		Rezina Akter Banu	Abl Hosen	2	Pucca	Pucca	2200												3/4	
Ranibazar	40	35/34		Nurunnahar	M A Sobhan	2	Pucca	Pucca										1800			3/4	1050000/Agrani B.Raj (S B)
Ranibazar	41	New		Golenur Begum	Samsul Huda	1	Pucca	Pucca	450			450										
Ranibazar	42	41/40		Md.Abul Hosen	Late.Barkatullah	2	Pucca	Pucca	396												1/2	
Ranibazar	43	42/41		Md.Altaf Hosen	Hazi A.Goni	2	Pucca	Pucca	1260												1/2	
Ranibazar	44	43/42		Late A Hamid	Late. Paran Munshi	0																
Ranibazar	45	44/43		Late A hamid	Late.Paran Munshi	2	Pucca	Pucca	240												3/4	
Ranibazar	46	45/44		Late A Hamid	Late.Paran Munshi	0																
Ranibazar	47	49/A		M A Mannan	Late.A Hamid	3	Pucca	Pucca	789			1570									3/4	700000/I F I C Bank
Ranibazar	48	46/45		Md.Golam Mostafa	M A Rakib	1	Pucca	Pucca	720												1/2	
Ranibazar	49	47/46		Banabihari Roy		1	Pucca	Pucca							350							
Ranibazar	50	48/47		M A Kader	Late.Sanaullah	1	Pucca	Pucca							800						1/2	
Ranibazar	51	50/49		Mahtabuddin Ding	Late.A.Gafur Biswas	1	Pucca	Pucca	850				380								3/4	
Ranibazar	52	49/48		Chuni Lal	Late.Radha Charan	1	Pucca	Pucca	600												1/2	
Ranibazar	53	51/50		MANDIR		0																
Ranibazar	54	55/A		Late Nitai Roy		2	Pucca	Pucca	1500			1500									3/4	
Ranibazar	55	54/A		Samsul Alam	Late.Farman Ali	1	Pucca	Pucca	600												1/2	267400/S B C/Raj
Ranibazar	56	54/B		Awal Khan	Late.A Rahman	3	Pucca	Pucca	900			1800									1/2	
Ranibazar	57	55/54		Tareni Mitra	Late.Gopal Mitra	1	Pucca	Pucca	240												1/2	
Ranibazar	58	57/56		Tareni Mitra	Late.Gopal Mitra	1	Pucca	Pucca	130													
Ranibazar	59	56/55		Sree Ardhendu	Late.K Bandhu	2	Pucca	Pucca	240			900										
Ranibazar	60	58/57		Omraw Ali	Late.Amir Ali	2	Pucca	Pucca	450												1/2	
Ranibazar	61	59/58		Omraw Ali	Late.Amir Ali	1	Pucca	Semi Pucca		56												
Ranibazar	62	60/59		Md.Ahad Ali	Late.Rahim Bakhs	1	Pucca	Semi Pucca		200												
Ranibazar	63	61/60		Ahmad Ali	Ahad Ali	1	Pucca	Pucca	120													
Ranibazar	64	62/61		Md.Wahedullah	Md Ibrahim Hosen	2	Pucca	Pucca	930												3/4	
Ranibazar	65	63/62		Jointa Kumar	Late.Khitish	1	Pucca	Pucca	250												3/4	
Ranibazar	66	63/62		Moti Mira Rani	Omio Das	1	Pucca	Pucca	100													
Ranibazar	67	63/62		Binoy Kumar	Late.Khitish	1	Pucca	Pucca	200													