Urban Management Programme

Utility Mapping and Record Keeping for Infrastructure

David Pickering
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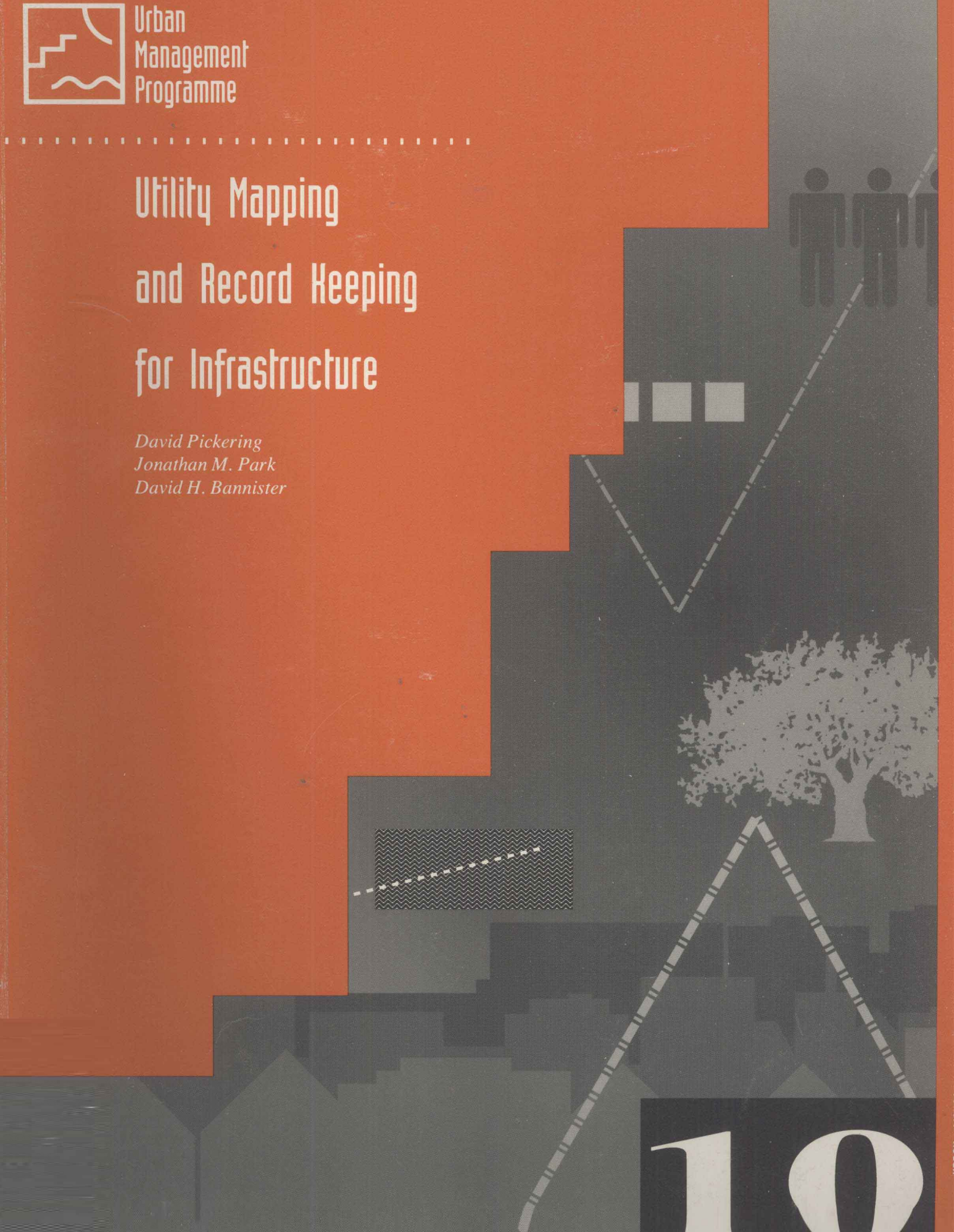

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The Urban Management Programme (UMP) represents a major approach by the United Nations family of organizations, together with external support agencies (ESAs), to strengthen the contribution that cities and towns in developing countries make towards economic growth, social development, and the alleviation of poverty. The program seeks to develop and promote appropriate policies and tools for municipal finance and administration, land management, infrastructure management, and evnironmental management. Through a capacity building component, the UMP plans to establish an effective partnership with national, regional, and global networks and ESAs in applied research, dissemination of information, and experiences of best practices and promising options.

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ABSTRACT

Any attempt to improve, or even maintain, the standard of living in rapidly developing urban areas cannot go forward without adequate municipal infrastructure and utility services. Inadequate or poorly managed services limit urban economic development in several ways;

- exposing segments of the urban population to health risks;
- limiting economic productivity when services are cut-off or unreliable;
- adding financial costs to individuals and enterprises through unnecessary property damage, and;
- creating additional economic costs from congestion of transportation and communications systems.

The economic and efficient delivery of infrastructure services in turn, depends on effective planning and management. Without proper information, spatial and otherwise, the quality of service delivery, financial performance, and the ability to plan can be eroded. Information from maps, and records, based largely on records of utilities and infrastructure facilities, contributes not only to efficient services, but also to the operation and maintenance of assets, and to the sensible planning of extensions and new works. Any serious lack of such information can adversely affect the economy, the quality of life, public health, and the environment.

This discussion paper reviews recent developments in the field of urban infrastructure recording and mapping, a number of issues that need to be addressed, and some actions that could be taken to improve recordkeeping systems. Although the emphasis here is on map and records for utilities basic municipal infrastructure services, particularly those with underground networks, some aspects of the discussion apply to urban management information systems in general. The central point is that the standards of records and information systems in municipalities and utilities often fails to meet the needs outlined above. Any organization that expects to run an efficient day-to-day operation and to manage and develop its services effectively must know what assets it has, where they are, their condition, how they are performing, and how much it costs to provide the service.

As the discussion makes clear, adequate records are essential not only for infrastructure management, but to assess deficiencies and to engage in forward planning. As the need for satisfactory recorded information continues to grow, countries must decide how to deal with a number of related institutional, organizational, and technological issues, including questions of awareness and responsibility. This discussion paper examines those issues and some options for addressing them. The options range from national initiatives to measures that could be taken by municipal departments and utilities on their own or in cooperation with other local bodies.

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FOREWORD

This discussion paper has been prepared for the infrastructure management component of the Urban Management Programme (UMP). Since its inception in 1986, the UMP has become an important member of the UN family of organizations and other external support agencies. It works to strengthen the contribution that cities and towns in developing countries can make toward economic growth, social development, and the alleviation of poverty.

Phase 2 of the UMP (1992-96) is concerned with capacity building at both the country and regional levels and with facilitating national and municipal dialogue on policy and program options. It emphasizes a participatory structure that draws on the strengths of developing country experts and expedites the dissemination of that expertise at the local, national, regional, and global levels.

The main goal of the UMP in Phase 2 is to build the capacity for infrastructure management, municipal finance and administration, land management, urban environmental management, and poverty alleviation by means of three interactive processes:

- City and country consultations. The UMP brings together national and local authorities, private-sector networks, community representatives, and other actors to discuss specific problems within the UMP's subject areas and to propose reasoned solutions.

- Regional panels and technical cooperation. To ensure sustained and effective support for the activities to follow country consultations, the UMP is establishing regional offices, each headed by a regional coordinator, in Kuala Lumpur for the Asia and Pacific region, in Accra for Africa, in Quito for Latin America and the Caribbean, and in Cairo for the Arab States. From 1993 to 1996 the UMP will gradually build up regional panels of urban management expertise for each of the program's five areas of concern, which will provide the structure needed to institutionalize the UMP's capacity-building objective over the long term. Developing countries will be able to draw on this pool of expertise for technical advice on a sustained basis.

- Global support and synthesis. Nucleus teams in Nairobi and Washington, D.C., support the regional panels and national institutions by synthesizing lessons learned, conducting state-of-the-art research, identifying best practices, and disseminating program-related materials. The present paper is part of a series of management tools produced by the UMP.

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EXECUTIVE SUMMARY

i. Any attempt to improve, or even maintain, the standard of living in rapidly developing urban areas cannot go forward without adequate municipal infrastructure and utility services. Inadequate or poorly managed services limit urban economic development in several ways:

- exposing segments of the urban population to **health risks**;
- limiting **economic productivity** when services are cut off or unreliable;
- adding **financial costs** to individuals and enterprises through unnecessary property damage; and
- creating additional **economic costs from congestion** of transportation and communications systems.

ii. The economic and efficient delivery of infrastructure services, in turn, depends on effective planning and management. Without proper information—spatial and otherwise—the quality of service delivery, financial performance, and ability to plan can be eroded. Information from maps and records, based largely on records of utilities and infrastructure facilities, contributes not only to efficient services, but also to the operation and maintenance of assets, and to the sensible planning of extensions and new works. Any serious lack of such information can adversely affect the economy, the quality of life, public health, and the environment.

iii. This discussion paper reviews recent developments in the field of urban infrastructure recording and mapping, a number of issues that need to be addressed, and some actions that could be taken to improve recordkeeping systems. Although the emphasis here is on maps and records for utilities and basic municipal infrastructure services, particularly those with underground networks, some aspects of the discussion apply to urban management information systems in general. The central point is that the standard of records and information systems in municipalities and utilities often fails to meet the needs outlined above. Any organization that expects to run an efficient day-to-day operation and to manage and develop its services effectively must know what assets it has, where they are, their condition, how they are performing, and how much it costs to provide the service.

iv. As the discussion makes clear, adequate records are essential not only for infrastructure management, but to assess deficiencies and to engage in forward planning. As the need for satisfactory recorded information continues to grow, countries must decide how to deal with a number of related institutional, organizational, and technological issues, including questions of awareness and responsibility. This discussion paper examines those issues and some options for addressing them. The options range from national initiatives to measure that could be taken by municipal departments and utilities on their own or in cooperation with other local bodies.

Creating an Awareness of Record Keeping

v. A key issue identified in this discussion is the need for greater awareness of what is required to create and maintain up-to-date and accurate records. This need is evident at all levels of government, from the national through the municipal, down to individual managers in municipalities and utilities. Adequate and appropriate records are required by all levels of management in a utility if it is to provide an effective and economic service and to adequately maintain its asset base.

vi. Two means of increasing awareness of the importance of record-keeping are briefings and training sessions among staff. Such sessions can be used to explain why records are important for planning purposes and for countless other tasks of urban management. For example, senior managers need data to guide investment planning and asset management; they are needed to monitor the amount and quality of information on which applications for funding of infrastructure projects are based. Records are crucial to satisfying customer needs and have a direct connection to the quality of service provided. Utility mapping also effects safety, particularly in cases in which the utility handles an inherently dangerous product (such as gas or power) or because the service, if compromised, may affect public health (for example, if water is contaminated).

vii. In many developing countries, resources, especially skilled staff, are in short supply. It often happens that persons in one utility who have few if any reliable plans will recognize the need for them, whereas those in another utility, although they have good plans will play down the need for them, not recognizing their value. A possible solution is for municipalities or utilities to work together to promote awareness by nominating one of their members to coordinate and encourage activities in this direction. Within the utility or municipal department, a staff member may be encouraged to champion this cause. What is most important, however, is that management recognizes the need to maintain and up-date records and that adequate resources and attention are devoted to these tasks.

Institutional and Legal Issues

viii. Many urban areas lack the legal framework to encourage utilities to establish recording systems. Even where such a framework exists, it often applies to a single service or utility; therefore the systems used by different services and utilities are not compatible. Furthermore, few mechanisms have been established for the exchange of information between utilities and municipal organizations before excavations are started. As a result, underground installations and streets suffer greater damage from such excavations than would otherwise be the case.

ix. Proposals have been put forth in some countries to develop a legal framework for making records more compatible across municipal and utility boundaries and services. Even where legal requirements have been enacted, however, they vary between the different utilities and services. There is little consistency as to scale, although boundaries between utilities and other services often overlap. The main reason for lack of uniformity is that each utility has developed within the legislative framework for its own function with little thought being given to compatibility with

others. At the least, authorities should consider introducing common map scales, location referencing, and standard symbols.

x. To promote the exchange of information before excavations start, governments might consider introducing legislation that would permit all the municipal services and utilities that work in an urban area to establish and operate a single information system. Another option for municipalities might be to set up a common clearinghouse for inquiries and to issue digging licenses. Such licenses might also be an effective way of controlling digging activities, particularly in big cities. A partial mechanism is already in place in some cases. For example, a municipal authority may require a utility to inform it of any work being planned on highways. Such a requirement is mainly a regulatory measure designed to keep the authority abreast of what is happening within its sphere of influence. Such a measure, however, can only be of real use if the notification is passed on, or when suitable records are available and comparable.

Organizational Issues

xi. Of the organizational issues identified in this discussion, one requiring immediate attention concerns the allocation of responsibility for records within the individual utility or municipal department. Who is responsible for collecting and processing data and the methods to be used are often unclear. Where the tasks are defined, they are often given low priority, and the responsible unit is rarely provided with sufficient staff and financial resources to carry them out.

xii. One solution would be for the responsibility for records and information systems to be assigned to an existing department such as operations, planning, or new works; or to a separate department created specifically for this purpose. The difficulty is in persuading utility organizations to disregard financial and personal interests and work together in this regard. Because the municipality represents some legal power within the municipal boundaries, it might be the only official body that can encourage all the concerned parties to agree on how to solve the matter according to local circumstances.

xiii. Where the responsibility for overall control has been allocated, decisions must be made concerning who is to carry out each aspect of the work involved. These tasks can be grouped into the following categories:

- obtaining, collecting, and processing the information;
- building up and maintaining the data base; and
- disseminating the information to the people and organizations that need it.

xiv. The responsible department may be fully involved (that is, it may send its own staff into the field to measure up and gather information), or it may delegate the various tasks to other sections or staff members. In the latter case, the central department would simply coordinate the activities and monitor the completeness and accuracy of the input. Even if the department is fully involved,

it could appoint another section, or even an outside body, to carry out the auditing and quality control.

Technical Issues

xv. As this discussion makes clear, readily available maps and coordinated reference systems are vital components of municipal and utility information systems, particularly for service and asset data. A fundamental rule for urban planning in general is that strategic decisions can only be as good as the maps and information on which they are based.

xvi. **Base Maps**. Two types of base maps are in common use, topographic and cadastral maps. Cadastral maps show details such as property boundaries and are generally most useful for land information and registry. Geographical detail tends to be limited, and features such as buildings are often not shown. The value of such maps to utilities is not great. Topographic maps have much more geographic detail, usually including roads and buildings, and hence are of more value to utilities. Certainly, the utilities that lay pipes and cables along streets and make connections to buildings rely on such maps as the background for their records. However, a single set of topographic maps cannot possibly meet the requirements for all the utilities.

xvii. Several questions need to be considered where base maps are concerned, beginning with who should provide them. This responsibility may be placed with a central government ministry or department, a national agency, or even an outside contractor. If a national approach is not chosen, then a municipality may have to make its own arrangements. It can either seek a solution alone or work in association with other bodies. The cooperating bodies may work in the same areas or have other common interests.

xviii. Decisions will also have to be made on matters such as the preferred scales for maps, the features and level of detail to be shown at each scale, and the manner of production (from ground survey, aerial photography, or a combination of the two). Map updating will be another concern, as is how often updating will need to be done and how these updates should be presented and distributed. Also important is the question of how costs will be met and whether a subsidy from the center is appropriate.

xix. **Record Maps**. The record situation in developing countries varies from one city to another and from utility to utility. Where record systems do exist, they should be checked for completeness, quality, and usefulness.

xx. **Data Sources and Collection**. Whether supplementing existing systems or starting from first principles, authorities must address technical issues such as how to identify and collect the data. In building up the record data base, they will have to obtain the relevant data in various ways. These are likely to include actual measurements of locations and possible levels of assets in the field, abstraction of details from "as-built drawings," and the gathering of further information from ad hoc sources such as random drawings, archived material, and local knowledge.

xxi. In summary, however, it is now widely recognized that technology alone will not guarantee a better information system. A technology cannot be applied successfully without a sound management policy. Such a policy would deal with institutional and organizational matters such as mandates and linkages, legal frameworks, technology strategies, human skills development, and financial management. Although in this paper the issues identified and the options put forward are grouped under separate headings, in practice these issues overlap and solutions interact. For example, training is a key issue on which many options, if selected, are likely to have an impact.

Strategic Options

xxii. The paper explores such options for improving the management of infrastructure information, records, and mapping. Such options include those for determining the best institutional structure for record keeping and mapping, how to develop human resources, and frameworks for making best use of the technology available. The discussion is based on practical solutions that have been tried in the past, as well as how to assign tasks, conduct training, and create record systems. Finally, a sampling of maps and case studies of work undertaken in several developing country cities are included as illustrative material.

xxiii. In summary the paper concludes that there is little doubt that improvements in utility mapping and record keeping are cost effective, improve the efficiency of the utility concerned, and indirectly raise the quality of life of those living in urban areas.

CONTENTS

TABLES

BOXES

FIGURES

I. INTRODUCTION AND DEFINITIONS

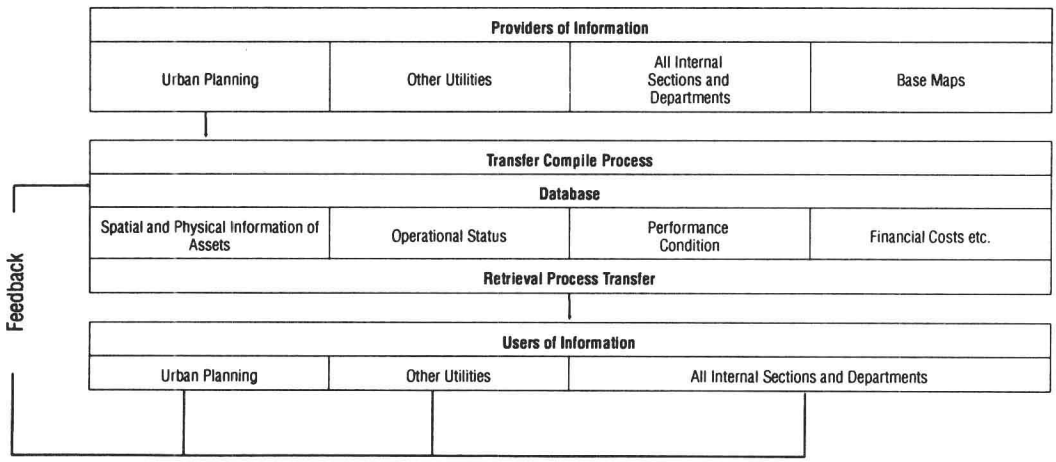
1.1 The infrastructure and services needed to support urban areas, both established and developing, may be provided by a variety of organizations, depending on the arrangements in place. Those arrangements will have been influenced by the country's history and its more recent policies. In some countries the infrastructure and local services may be the responsibility of the municipality, whereas in others they may be handled by separate utility companies or by state or national agencies or boards. Often a combination of such bodies is involved, and in many cases their operational boundaries do not coincide. In this paper, all such relevant bodies are alluded to, even where reference is made only to municipalities, utilities, or services.

1.2 Staff at all levels of a municipality or utility require accurate information to enable them to develop the infrastructure and provide the services that urban populations require. As indicated below, the collection and processing of this information has to be managed properly.

1.3 Usually an organization will be required to call upon a variety of providers and sources of information in order to manage its affairs efficiently. It will have to arrange to collect and sort this information so as to build up and maintain an effective data base. Facilities will have to be established for this purpose, so that anyone requiring information will know that it is available and can readily be abstracted in a usable format. Because the data base will have to be kept up to date, arrangements need to be in place to allow users to feed information back into the system. For example, if when excavating down to a sewer authorities find its diameter differs from that indicated in the records, then a correction should be fed back to the information system. Similarly, if a water consumer moves from one house to another, this information needs to be registered in the system so that bills can be issued correctly and on time.

1.4 Figure 1-1 shows such a record system. Here, only a few compartments are listed under each heading for the sake of clarity, but in reality, the system will be considerably more complex. For instance, it will also include the public and users of the service.

Figure 1–1. Schematic of a typical management information system



1.5 In setting up a records system, management will need to know where to obtain any given type of data that they may need to run their utility effectively. This means that a very large number of items will have to be entered into the system, and these may have to be gathered from a wide range of external organizations, utilities, and companies operating in the urban area concerned. In addition, a full store of information will have to be gathered from all sections of the utility itself. Various problems will also have to be addressed in maintaining these records, as indicated in the following extract from the record keeping manual of the Mexico City Water Authority:

1.6 A variety of infrastructure sectors are considered in this paper, and, as mentioned earlier, the exact scope covered by any one agency will differ from city to city and country to country. For purposes of discussion, however, it is possible to make some general observations on the basis of the core utilities and municipal services shown in Table 1-1.

Table 1–1. Service sectors considered in this paper

Drainage	surface water
Electricity	transmission and distribution
Gas	piped distribution
Public buildings	
Sewerage and low cost sanitation	
Telephone systems	
Urban roads, bridges and road furniture	
Waste collection and disposal	solid refuse
Water supply	distribution

1.7 Most of the utilities covered by this paper will have associated assets, networks, and route systems that enable them to provide their services to the public, commerce, and industry.

1.8 Table 1-2 indicates the great variety of records that utilities and municipal services may need (examples are included in Annex A) to manage infrastructure. Most of the information is related to "locations" (areas, zones, systems, buildings, and so on) and can be referenced spatially. Hence, it can be kept on map-based record systems. Whatever record system is used, it is vital to understand the interrelationship between the principal categories of information so that any single piece of information will only need to be collected and entered once.

1.9 The types of records included in Infrastructure Management have been identified. Table 1-3 indicates the wide range of departments that rely on these records.

1.10 In addition to using records for its own purposes, the staff of a municipal or utility office will need a store of information to respond to inquiries from the users of their services and from other outside organizations. Examples of such external communications are shown in Box 1. Staff should record these incoming complaints and inquiries in the information system together with details of any action taken. Although it need not be the case, complaints from users of the service

and the public may often be the first indication that all is not well with the utility's services or the operation or maintenance of its installations.

Table 1–2. Types of records

Category of record	Information
Maps to various scales	Annotated to show assets, networks
Schematics	How networks are configured/operate
Details	Plans/sketches of particular features, junctions, controls
Inventory of assets	Location, use, design
Standards and policies	Levels of services, environment, quality that should be provided
Conditions of assets	State of structures, pipes, cables
Performance of assets	Treatment/carrying capacities, quality of product, losses/leakage
Status	Assets in use, on stand-by, or stood down
Customer details	Connections to/users of systems, consumptions, passengers carried
Expenditure	Accounts/costs of construction, purchases, operating, maintenance, renewals
Income/revenue	Sources of, charges, customer accounts
Maintenance	Details of preplanned (routine) and reactive (emergency) servicing, repairs, rehabilitation

Table 1–3. Users of records within a utility

Types of record	System operation	Maintenance	Revenue	Finance	Planning	Design	Construction
Maps	X	X			X	X	X
Schematics	X				X		X
Details	X	X				X	
Inventory of Assets		X		X	X		
Standards		X					
Condition	X	X					
Performance					X	X	
Status	X		X				
Customers	X		X		X		
Expenditure		X		X			X
Income	X		X	X			
Maintenance	X	X					
Complaints	X		X		X		

Box 1. Types of external inquiries requiring the use of records

How often should the refuse be collected from my house?

My gas bill is too high; the meter reading must be wrong.

The water pressure at my house is too low.

Why didn't the bus come yesterday morning?

Why is the electricity off and when is it coming back on?

When are you going to repair the road outside my hotel?

We are building 200 houses; please connect a water supply and tell us where to lay the drains.

I'm not paying your bill as my property is not connected to your sewer.

We are putting up a factory can you supply electricity and also extend bus route to bring in the workers.

Our contractor is laying cables underground, what pipes and cables have you in the street and where are they and how deep?