THE KINGDOM OF THAILAND

BANGKOK METROPOLITAN ADMINISTRATION

STUDY ON ROAD IMPROVEMENT, REHABILITATION AND TRAFFIC SAFETY IN BANGKOK

FINAL REPORT

VOLUME V

ROAD INVENTORY
REVIEW ON ROAD ORGANIZATION OF BMA
OTHER STUDIES

MARCH 1987

JAPAN INTERNATIONAL COOPERATION AGENCY

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LIST OF ABBREVIATIONS

BMA	Bangkok Metropolitan Administration
CPD	City Planning Division, BMA
CMD	Construction and Maintenance Division, BMA
DD	Design Division, BMA
PPD	Policy and Planning Division, BMA
PPSd	Public Works Planning Sub-division, BMA
DPW	Department of Public Works, BMA
DDS	Department of Drainage and Sewerage, BMA
TED	Traffic Engineering Division, BMA
MOI	Ministry of Interior
OARD	Office of Accelerated Rural Development, MOI
OCMRT	Office of the Committee for the Management Road Traffic, MOI
OPP	Office of Policy and Planning, MOI
PWD	Public Works Department, MOI
TCPD	Town and Country Planning Department, MOI
TPD	Traffic Police Division, MOI
LDPD	License Division of Police Department, MOI
MOC	Ministry of Communications
DOH	Department of Highways, MOC
DLT	Department of Land Transport, MOC
ETA	Expressway and Rapid Transit Authority of Thailand
NESDB	National Economic and Social Development Board
SRT	State Railway of Thailand
MEA	Metropolitan Electricity Authority
AIT	Asia Institute of Technology
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
BS	British Standards
CAB	Cable Box
CBD	Central Business District
HCM	Highway Capacity Manual
MCI	Maintenance Control Index
MSL	Mean Sea Level
MTS	Mass Transit System
NECO	National Executive Council Order
PCU	Passenger Car Unit
PSI	Present Serviceablility Index
RAL	Richtlinien für die Anlage von Landstraßen
SSES	Second Stage Expressway System
STTR	Short Term Urban Transport Review

ROAD INVENTORY

1. ROAD INVENTORY

1.1 Introduction

Well-designed Road Inventory System enables any administrators to grasp readily the current states of roads and traffic conditions. This result makes road administration works improve qualitatively and easily as well, for instance, as follows;

- to implement road construction works without accidents due to ignorance of buried public facilities,
- to make the plan on road improvement works and road related facilities such as the common utility duct,
- to select the road locations or structures to be repaired, and to alocate budget properly.

Through these utilization of Road Inventory System, road administrators can achieve the benefits on road management as follows;

- to reduce the total cost for maintenance works,
- to reduce man-power for administration works, and
- to secure the higher service level of roads.

There are two types of the road inventory system within BMA. One is owned by the Right of Way & Land Acquisition Division of the Department of Public Works and the other is by the City Planning Division under the Office of the Permanent Secretary for BMA. The road inventories in these two systems are compiled and maintained manually in a form of table. The data items covered in both these inventories are similar but are limited in number. They are effective to grasp a general road condition, but seem not to be sufficient enough to cope with ever increasing social demands as to road management.

In this study, the use of computer was introduced to aid the operation of the compiling system, taking full advantage of the machine's effectiveness in updating and storing as well as in readily making access to the compiled data.

Road Inventory System which was named METROS (METropolitan ROad inventory System), was developed with up-to-date technics on a Relational Data Base Management System. Furthermore, in order to demonstrate the application methods of the system, a pilot inventory data base for the roads in Pathumwan and Bangrak districts was established.

1.2 Objectives

(1) Development of road inventory system

In order to manage road systems adequately and to carry out remedial works timely, availability of information on the road conditions is of great importance to road administrators. This part of the study is, with the aid of microcomputer, to develop a road inventory system in a form of data base which enables the road administrators to readily access their road conditions.

(2) Establishment of pilot road inventory

It should be noted that the objective of this study is to develop a data base system for road inventory (a system of data storage and retrieval) with a microcomputer but not to complete a road inventory itself, although a pilot road inventory for the road systems in Pathumwan and Bangrak districts, with the purpose to demonstrate the application method of the data base system to be developed and to train the maintenance methods as well.

The road inventory system was designed particularly with due attention that BMA staff can readily access to information essential for daily management works such as improvement, maintenance and administration of roads. The data to be included in the road inventory would cover information on roadway, structure, appurtenances of road, traffic data and traffic accident data. The information on public utilities laid or installed within the right-of-way should also be included.

1.3 Study Flow

The system development and associated works followed the study procedure shown in Figure 1.3.1. Contents of each work item are presented in detail in the later paragraphs.

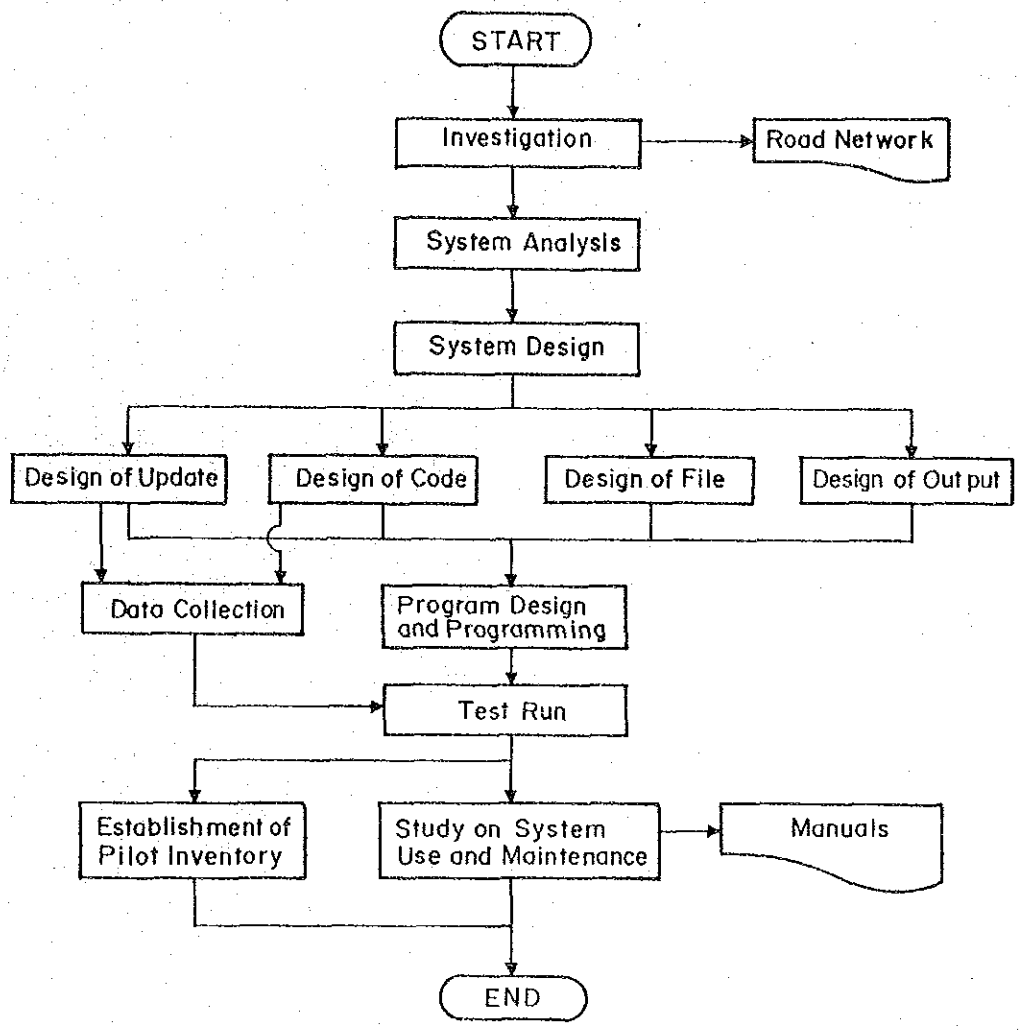


Figure 1.3.1 Study Flow

Investigation works included establishment of the study road network which was used in common with the other parts of this study, i.e. road improvement, traffic safety, etc. The design of output included determination of data items of frequent retrieval and their output layouts.

Test run involved slight modification of programs in terms of serviceability on operation using collected data. Study on system use and maintenance included preparation of manuals, and training for system maintenance.

The progress of major study items is summarized in Table 1.3.1.

Table 1.3.1 Study Schedule

Study Item \ Month	1985							1986							
	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8
System Planning	▬	▬	▬												
System Design			▬	▬	▬										
Programming				▬	▬	▬	▬								
Data Collection				▬	▬	▬									
Test Run						▬	▬		▬						
Study on System Maintenance													▬	▬	▬

1.4 Investigation

1.4.1 The State of Road Inventory

The inventory data of the City Planning Division covers main roads in the 24 districts of the BMA and their length totals 1152 Km. Data items of the inventory, which are approximately fifteen in number, are comprised of data on the geometry of the road, pavement and drainage facilities. It seems that data items of their inventory are unsatisfactory for repair work planning and traffic safety planning. Moreover, the inventory data was collected in 1980, and since then, however, it does not seem that data updating has been implemented periodically.

As for the data of the Right of Way and Land Acquisition Division, although the inventory survey forms have been completed, it appears that no reliable data has been gathered.

The forms of the above two inventories are shown in Appendix 1.4.1.

Hereafter, it is necessary to consider what information is required as road inventory data and to prepare an appropriate data format and to perform systematic data collection. The data essential for planning of road improvement, rehabilitation and traffic safety are information on; the geometry of roads, pavement structure, the road surface condition, structures such as bridges, repair records, land use along the roads, history of flood.

Some part of inventory data must be updated or appended every year. Since independent and interrelated data analyses are to be made, collected data must be stored in an adequate manner, otherwise, effective utilization of data can not be expected. For the majority of data, the use of a computer, which is prevalent nowadays, should be considered. However, some kinds of data are suitable for expression and storage in document or chart form.

1.4.2 Road Network

The road network for study had been determined in consultation with the BMA counterparts, mainly based on the road inventory by the City Planning Division.

The roads to be covered under the study are main roads located within the area encircled by the Middle Ring Road and certain extensions of some of

Figure 1.4.1 Study Roads

them stretching out across the Middle Ring Road. The location of the study roads is shown in Figure 1.4.1. The number of the study roads are 305 (thanon 230, soi 70 and trok 5), and their length totals 372 km in addition to the main roads under the other administrators than BMA as shown in Table 1.4.1.

This road network was used not only in the study of road inventory but also in common with the other parts of this study, i.e. traffic survey, road improvement, traffic safety. And also, road network maps are attached in the system manual as one of the results of this study.

Table 1.4.1 Study Road Length (m) by Districts and Administrators

District	BMA	DPW	DOH	ETA	Sub Total
Pra Nakhon	30,080				30,080
Pom Prab Sattru Pai	18,957				18,957
Pathumwan	31,859			3,300	55,159
Sampanthawong	6,713				6,713
Bang Rak	15,457	3,686			19,143
Yan Nawa	35,543	3,436		200	39,179
Dusit	51,067		4,070		55,137
Phya Thai	37,183		3,820	2,200	43,203
Huai Khwang	16,042				16,042
Phra Khanong	11,423			7,380	18,803
Bang Khen	13,041		6,369		19,410
Bang Kapi					-
Nong Chok					-
Min Buri					-
Lat Krabang					-
Thon Buri	10,200				10,200
Klong San	16,721	4,230			20,951
Bangkok Noi	18,354		3,550		21,904
Bangkok Yai	10,230	430			10,660
Pasi Charoen	5,200				5,200
Bang Khun Thian	1,515				1,515
Taking Chan					-
Rat Burana					-
Nong Khaem					-
Total	329,585	11,782	17,809	13,080	372,256

1.4.3 Fundamental System Plan

The relationship between a data base system and road inventory is schematically illustrated in a square drawn with dotted line of Figure 1.4.2. The interaction of the data base system with other study items, which are the study on road improvement, pavement rehabilitation and traffic safety, in this study is also shown in Figure 1.4.2.

The main processings of compiled data such as updating, retrieval and output are operated by Data Base Management System. This management system is also a means to transfer necessary data from the data base to rating methods of other study items. In addition to the Data Base Management System, interface systems which enable BMA staff to easily make use of the data base are essential to be developed.

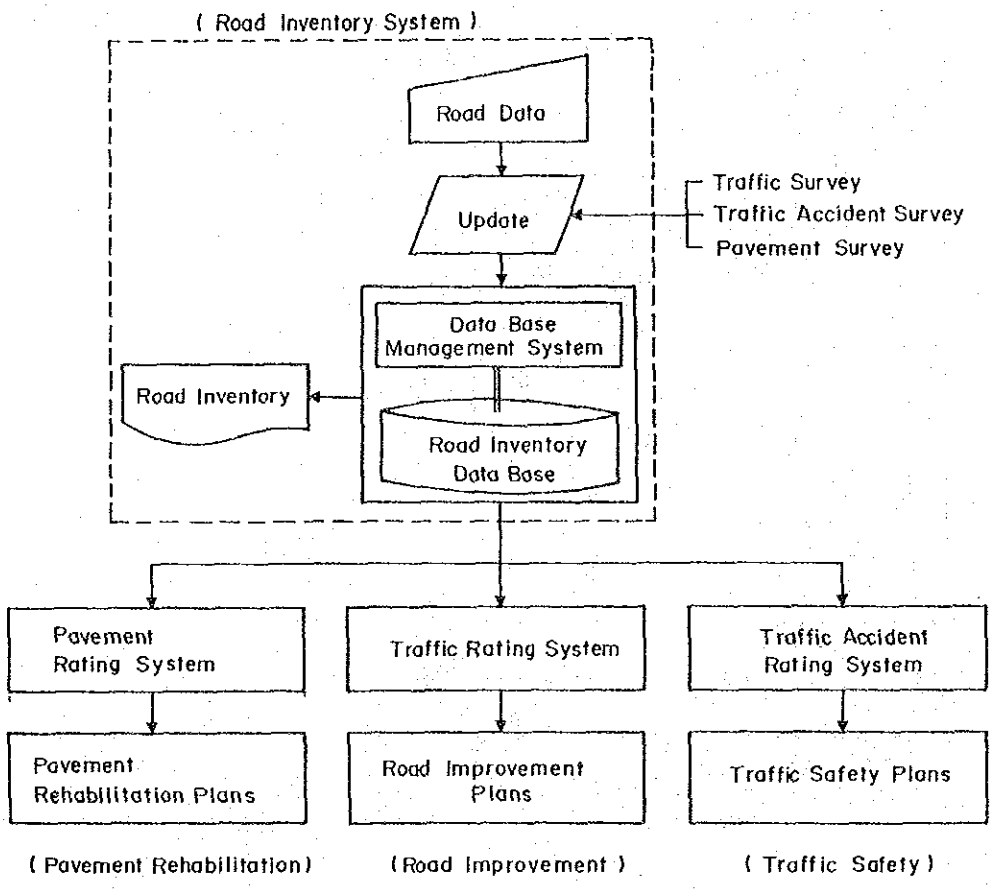


Figure 1.4.2 Fundamental System Flow

1.4.4 System Requirements

The road inventory system should be designed taking other study items, which are necessary information on the rating systems, and BMA's requirement into account.

The necessary information which are employed in the rating methods were discussed to determine the data items of road inventory. They are presented in the later sections of this report.

BMA's requirements for the system were discussed mainly in view of;

- data items to be stored in the data base,
- easier usage for utilization of the system, and
- road network to be adopted in the study.

Results of the discussion were reflected to determine each study items of the road inventory.

1.5 Development of Road Inventory System

1.5.1 System Analysis

(1) Control link and node system

1) Control link and node

To interlink the data on road and traffic conditions with the locations of mid-block section of roads, the road network shall be subdivided into a number of control links with nodes at both ends of each link. The subdivision shall be made in such a way that the characteristics of each control link in terms of road and traffic conditions could be assumed homogeneous in the light of engineering and administrative practices. In case of arteries in urban areas, major intersections can be generally considered to be nodes of a control link. Where a road segment between intersections is not uniform, for example, due to abrupt changes of width, it will be further divided into two or more control links.

Consequently, a control link is defined by nodes at both ends of a given control link.

2) Definition of node

Primary Node and Secondary Node

For a practical purpose, nodes in data base system are divided into two, i.e. "Primary Node" and "Secondary Node". Primary nodes correspond to intersections, while secondary nodes represent those which divide a road segment between intersections into two or more control links as necessitated, for instance, in the case of abrupt changes of road width or boundary of districts.

However, both primary node and secondary node are treated equally in the system.

Figure 1.5.1 illustrates the concept of control links, and primary and secondary nodes. The primary nodes are coded with 3 digits plus three zero (0) while secondary nodes with 4 digits plus two zero (0).

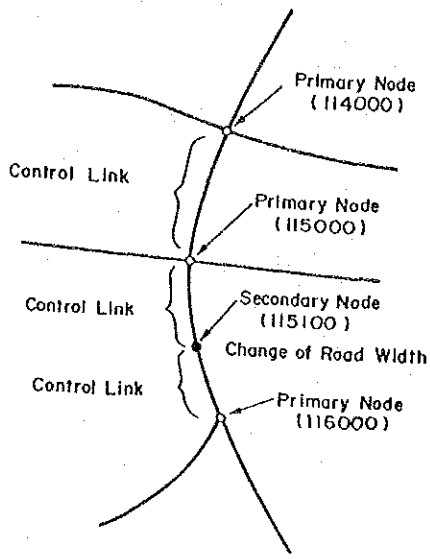


Figure 1.5.1 Illustration of Control Links and Nodes

Start Node and End Node

Among two adjacent nodes, the one with the smaller number is to be "Start Node" and the other with the larger number is to be "End Node", respectively.

It is defined that the words "right" and "left" are used to show right-hand-side and left-hand-side of the control link when facing towards the end node with the larger number, respectively.

3) Coding of node

The nodes in the study roads were in principle coded according to the following rule set out below;

- to code the nodes on a road with sequential number,
- to code the nodes in ascending order from the central part to the outer part of the study area and
- to code the nodes on each road with a different initial figure from other roads.

The number of primary nodes was approximately 400. And the number of control links in the study roads of 372 km was in the order of 800.

The road and traffic data obtained in the other parts of this study were compiled together with the code numbers set out in this road network, so that related data could be interfaced whenever necessary.

The methods on the establishment of control links and the node coding system are presented in detail in the system manual with road network.

(2) Data base

In the road inventory, a data base for control links is a main feature. And basic information on all the data items were filed in this data base. However, for some data items like bridge and pavement, more detailed information which cannot be stored in a single data base file in terms of effective computer usage, are often required to attain adequate road managements. Therefore, besides a data base for control links, the following five (5) data bases were developed.

- Bridge
- Pedestrian Bridge
- Pavement
- Public Utility
- Intersection

These data bases are capable of covering information on objects such as the ones illustrated in Figure 1.5.2.

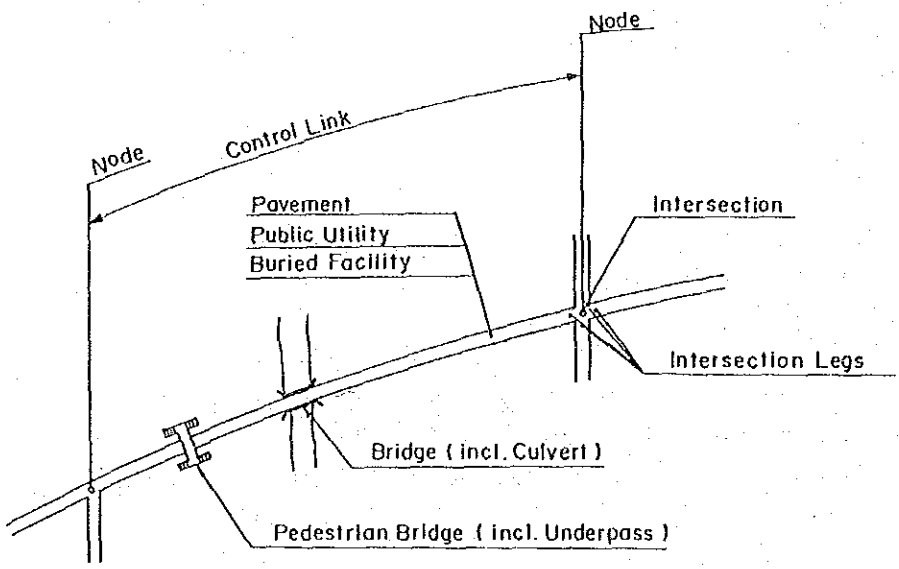


Figure 1.5.2 Illustration of Compiled Data

In the case of bridge, for instance, information on bridge in a control link data base is only number of bridges existing on a given control link. Detailed information on the bridges such as length, type, construction year were filed in Bridge Data Base.

Although, these data bases were developed separately, their systems were designed in such a way that all the data bases could be interfaced with the code numbers as key identifiers in a control link data base.

(3) Data items

The data in the METROS data base covers information on roadway, structures, appurtenances of road, public utilities laid or installed within the right of way, traffic data and traffic accident data, in due data base file.

Bridge Data Base was designed so as to be capable of storing data on culverts, and Pedestrian Bridge Data Base to store data on pedestrian underpass as well.

The number of data items for the above six (6) data bases are as follows;

Control Link	:	84 items
Bridge	:	27 do.
Pedestrian Bridge	:	23 do.
Pavement	:	23 do.
Public Utility	:	35 do.
Intersection	:	43 do.

Final data items, which had been taken BMA's requirements and the rating methods into account, are presented in detail in Appendix 1.5.1 to Appendix 1.5.11 in form of table for every data base file.

(4) Key identifier

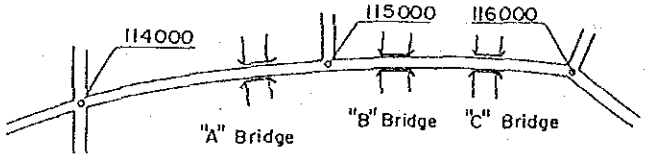
A data base file is similar to a table which is a collection of records consisting of several fields as explained in the following paragraph.

A record is distinguished by key identifiers which specify a particular data record from others. Each one of data base file start off with one set of items consisting of one to four of key identifiers at the head of each record, as shown in Table 1.5.1. Thus, a collection of data consisting of several data items with unique key identifiers, is called "record" in a data base file.

Table 1.5.1 Key Identifier

Data Base Files	Key Identifier			
	(1)	(2)	(3)	(4)
Control Link (A)	Start Node	End Node		
Control Link (B)	Start Node	End Node		
Control Link (C)	Start Node	End Node		
Bridge	Start Node	End Node	Sequential Number	
Pedestrian Bridge	Start Node	End Node	Sequential Number	
Pavement	Start Node	End Node	Sequential Number	
Public Utility	Start Node	End Node	Sequential Number	
Buried Facility	Start Node	End Node	Kind of Facility	Sequential Number
Intersection	Node			
Intersection Leg	Node	Adjacent Node		
Code	Code Index	Code		

In case of bridge data base file, for example, one record compiles a collection of data on one bridge. When there are two bridges in one control link, data on those bridges are filed in two separate records as illustrated in Figure 1.5.3. They are distinguished by sequential number in one control link. In case of constructing a new bridge within a control link where there have been already bridges, new sequential number for the new bridge should be arranged next to the current number.



		Key Identifier			Data				
		Start Node	End Node	Seq.No.	1	2	3	...	n
Record 1	"A" Bridge	114000	115000	1				...	
Record 2	"B" Bridge	115000	116000	1				...	
Record 3	"C" Bridge	115000	116000	2				...	

Figure 1.5.3 Illustration of Bridge Data Base File

1.5.2 System Design

(1) Hardware and software environment

Hardware

METROS can be operated in the following hardware environment.

Microprocessor System ; NEC N5200/05MKII (768 KB)
Hard Disc Unit ; NEC N5257-11 (20 MB)
Printer ; NEC N5233-61(Dot Matrix Printer)

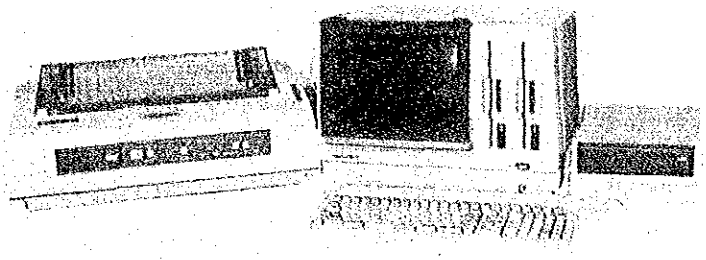


Figure 1.5.4 Hardware for METROS

This hardware system has a capacity sufficient enough to accommodate all data for the whole major roads in Bangkok.

Software

METROS requires the following software environment.
Operating System ; MS-DOS V 2.11
Database Management System ; dBASE II V 2.4

METROS is designed by means of dBASE II which is a Relational Database Management System. MS-DOS is an operating system to load dBASE II.

(2) Data Base Management System

A road inventory system should be structured in such a way that it is possible to;

- establish data initially,
- append information for new control links and/or nodes,
- alter or delete information stored in data base,
- extract information from data base,
- edit reports,
- calculate such as summing up numerical data and count the number of data records.

In order to realize these points, in addition to shorten the developing period of the system as well, dBASE II is used.

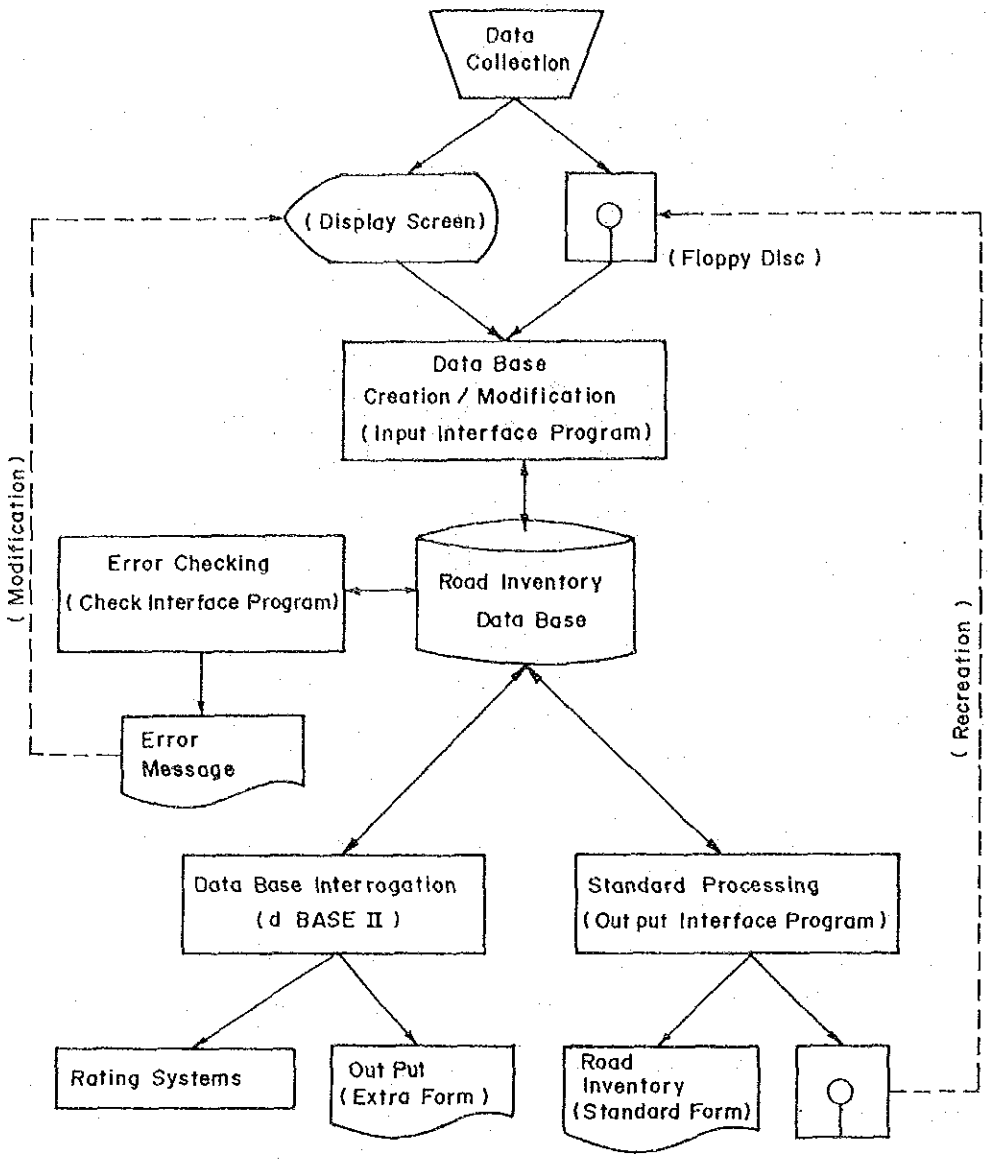


Figure 1.5.5 System Flow

The output Interface Program consists of two components supporting output processes. One enables prompt retrieval of data items in frequent use and to output in the standard forms, and the other supplies the back-up floppy disc to recreate the data base, as a protection against possible unexpected erasure of necessary data due to wrong usage.

Besides the process using above mentioned interface programs, dBASE II is also capable of wide variety of processing such as the retrieval of data, editing the report and output data according to the user's requirements.

In order to access the data base easily, as the above three interface programs provide the query statements on next processes on display screen, both users and maintainers of the system can operate the system only by answering to them.

As the precautionary measures against possible unexpected erasure of a part or the whole system due to wrong usage, recovery system were prepared.

(4) Design of file

1) Data base files

The six (6) data bases, in addition to the code file which supplies character data corresponding to a given code number, are stored in eleven (11) data base files as listed in Table 1.5.2.

As the number of control link data, eighty four (84) items in total in one record, exceeds the limitation (32) of dBASE II, they are stored in three files.

There are two data base files for the public utility data base. One of them, "Public Utility", compiles the data on the existence of the whole facility in one road cross section, and the other, "Buried Facility", compiles the detail data on each buried facility.

The data in the intersection data base composed of two components, data of "Intersection" itself and each "Intersection Leg", are also stored in two separate files.

Table 1.5.2 Data Base Files

Data Base	Name of Data Base File	Number of Item	Record Length (Bytes)
Control Link	Control Link (A)	31	70
	Control Link (B)	31	123
	Control Link (C)	26	118
Bridge	Bridge	27	168
Pedestrian Bridge	Pedestrian Bridge	23	148
Pavement	Pavement	23	132
Public Utility	Public Utility	16	110
	Buried Facility	19	151
Intersection	Intersection	13	79
	Intersection Leg	30	108
Code	Code	3	51

2) Structure of data base file

A data base file is similar to a table as shown in Figure 1.5.6. Table consists of columns and rows. Columns are called field which correspond to the data items. Rows are called records which correspond to one collection of data belonging to common key identifier, such as data of one control link in control link data base file. Consequently, a data base file is a collection of records which consists of some fields.

	Field 1	Field 2	Field 3	Field 4	.....	Field n
Record 1						
Record 2						
Record 3						
⋮						
Record m						

Figure 1.5.6 Structure of Data Base File

When the same field name is used among the data base files, dBASE II can interface data among corresponding data base files as if being in one data base file.

(5) Function of interface programs

1) Update

Preparation of coding sheets

Separate sheets for the ten (10) data base files besides code file were prepared to fill in the new data records. Appendix 1.5.12 to Appendix 1.5.21 are sample coding sheets which are already filled out.

The data input into a computer are displayed on a computer screen in the same patterns of data arrangement as those in the coding sheets, as shown in Figure 1.5.7 for the bridge data base.

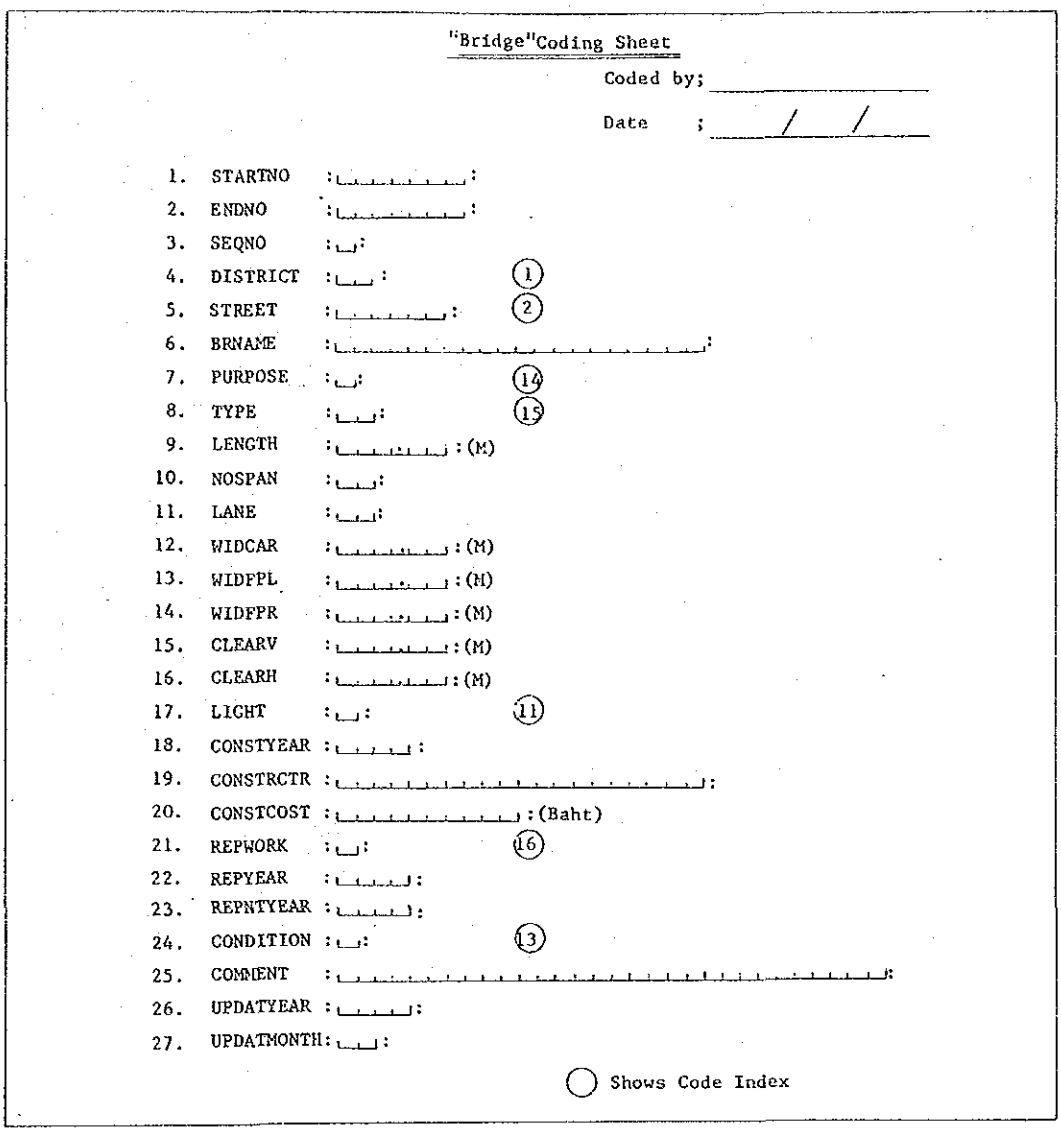


Figure 1.5.7 Coding Sheet for Bridge

Scheme of updating

Since getting through a password which protects the data base from erroneous inputting, Input Interface Program was designed so as to provide the process such as follows;

Append; to add new data records, such as new control links, in data base file,

Alter ; to change data in old data records which are already stored in data base file,

Delete; to erase stored data records from a data base file, e.g. in case of

combining two or more control links into less number of control link.

2) Error check

Check Interface Program provides an error message for erroneous data in data base files such as follows;

- Key Identifier;
  Items of key identifier, which distinguish a data record from others, should be filled with a unique value in the correct order for every data record in a data base file. Key identifiers are checked on the existence of blank, order and duplication.
- Code;
  Any code item should correspond to the correct code defined in the code table. When an inputted code does not correspond to the correct code, the system provides error message as "wrong code".
- Numerical Value;
  The system can check the logical relations of several set of values such as the number of lanes on right side, left side and their total in one road cross section, in a data base file.

The above error message, if erroneous data is detected, are presented on both display screen and printer. Otherwise, the system provides message as "No error detected" on both devices when no erroneous data is detected.

Causes and countermeasures for the erroneous data are presented in further detail in the system manual.

3) Output

Standard output forms

Output Interface Program is designed to extract the information from the data base easier than the direct use of dBASE II, for frequent daily use on data items of retrieval and their output layouts. The format of thirteen (13) standard forms are provided by the system as shown in Table 1.5.3.

Figure 1.5.8 is an example of output form which was used for the bridge data base. General presentation of output layout is explained below;

- Title of list is arranged at the first line,
- Name of each item is written in the defined name in the METROS system,
- Outputted data corresponding to a given item, which is shown in shadowed

portion, are presented next to the name of item.

Table 1.5.3 Standard Output Forms by Interface Program

Name of Output Form	Source File	Output Device	Remarks
ROAD DATA LIST (I)	Control Link (A),(B)	PR	Common data
ROAD DATA LIST (II)	Control Link (A),(C)	PR	For DD and CMD
ROAD DATA LIST (III)	Control Link (A),(B)	PR	For CPD and RLD
ROAD DATA LIST (IV)	Control Link (A),(B),(C)	PR	For TED
ROAD DATA LIST (V)	Control Link (A),(B),(C)	PR	All item
BRIDGE DATA LIST	Bridge	CS,PR	All item
PEDESTRIAN BRIDGE DATA LIST	Pedestrian Bridge	CS,PR	do.
PAVEMENT DATA LIST	Pavement	CS,PR	do.
PUBLIC UTILITY DATA LIST	Public Utility	CS,PR	do.
BURIED FACILITY DATA LIST	Buried Facility	CS,PR	do.
INTERSECTION DATA LIST	Intersection	CS,PR	do.
INTERSECTION LEG DATA LIST	Intersection Leg	CS,PR	do.
CODE LIST	Code	CS,PR	do.

Note; PR : Printer CS : Computer Screen

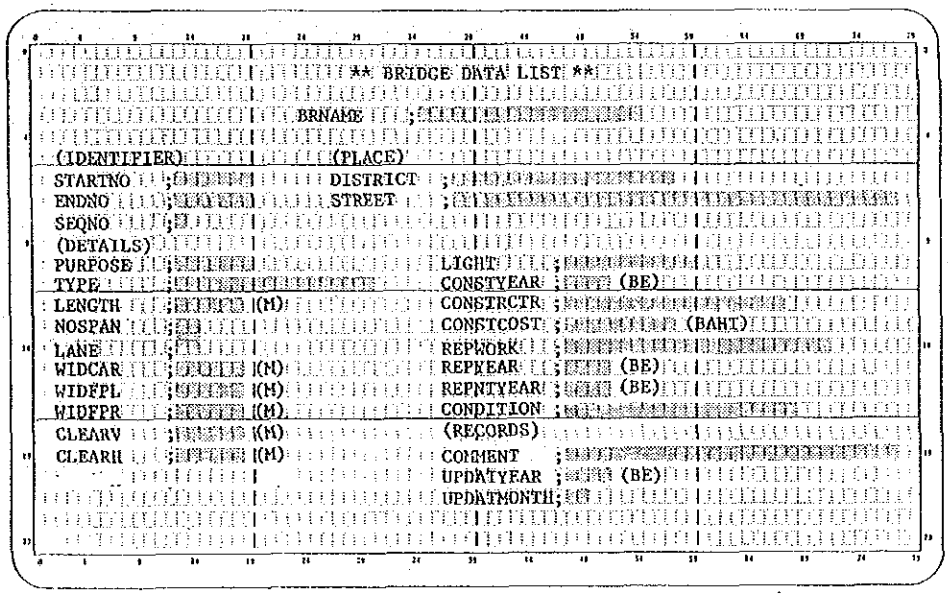


Figure 1.5.8 Output Form for Bridge

Other eleven (11) forms, besides the bridge and code, are presented in Appendix 1.5.22 to Appendix 1.5.32.

Retrieval and output device

Output Interface Program is designed in such a way that it is possible to process readily as follows;

- retrieve districts and/or streets,
- select the output form among the standard forms, and the output device to be either display or printer.

(6) Design of code

The structure of "code" for the road inventory, i.e. twenty five (25) items such as district and street, were determined and code table was prepared in the system manuals. The details of code items are described in Table 1.5.4.

Some code items which are available for the other part of this study, traffic and road improvement studies for instance, are used in common with that of the road inventory.

(7) System recovery

As any users are allowed to access the road inventory data base by means of dBASE II, though limitation of usage are described in the manual, it is possible to erase and/or modify the data base files due to the mishandling etc. The system is designed in such a way that system maintainer can restore the data base files by back-up floppy discs which are provided for the system through Output Interface Program.

Some mishandlings on hardware system are possible to bring the mechanical break down or obstruction on software. After recovering from the mechanical obstruction, maintainer can recreate the Road Inventory System to the original states by means of back-up floppy discs of software and data base files.

Table 1.5.4 List of Code Items

Code Index	Item	Digits		No. of Records	Remarks
		Input	Output		
1	District	2	20	24	
2	Street	6	40	319	
3	Road Class	2	15	8	
4	Road Administrator	1	7	4	
5	Type of Road Cross Section	2	7	12	
6	Land Use	2	32	12	
7	Existence of Bus Route	2	15	5	
8	Surface Type	1	31	8	
9	Traffic Regulation	2	17	8	For Direction
10	Parking Prohibition	1	17	3	
11	Existence of Facilities/ Appurtenances	1	12	2	
12	Type of Guard Fence	1	8	3	
13	Conditions	1	21	6	
14	Purpose of Crossing	1	7	5	
15	Type of Bridge/Culvert	2	18	23	
16	Type of Repairing Works	1	24	5	
17	Existence/Location of Public Utilities	7	7	--	1/0 distinction code
18	Kind of Buried Facility	2	20	13	
19	Type of Duct	2	20	13	
20	Surface Use	2	22	18	
21	Intersection Type	1	20	4	
22	Existence of Traffic Control Facilities	1	15	4	
23	Prohibition of Turning	3	3	--	1/0 distinction code
24	Existence of Channel	2	20	4	
25	Arrangement of Traffic Signal	9	9	--	1/0 distinction code

(503 Rec.)

Digits of Output shows the maximum number of characters in a given code item.

1.5.3 Program Design and Programming

(1) Structure of programs

In order to satisfy the system requirements which are described in the former sections, the flow of the program and its processing method were examined under the limitation of hardware and software, i.e. MS-DOS and dBASE II.

Almost all programs were written in the English-like dBASE II language as command files. Other part of programs were written in MS-DOS commands to connect processes written in dBASE II. As the results, the programs are composed of more than one hundred subroutines and program size reached 540 kilo-bytes in total, as shown in Figure 1.5.9 and Table 1.5.5.

Further detail explanation on the structure and flow of the program are presented in the system manual with list of program statements as an extra issue.

(2) System operations

All the efforts on system development were focused on easy access by users. As a result, users can operate the system by answering to the query statements shown on the computer display for daily use such as output and data maintenance, since every subroutine programs is coordinate connected with the main program as shown in Figure 1.5.10.

There are three major flows on operations as illustrated in Figure 1.5.10. One of them, "METROS", is process which are supported by Interface Programs on update (input), error check and output, as explained in the previous sections. Second one, "dBASE", is comprised of the direct use of dBASE II for outputting by users and process for data base recovery which are supported by developed system programs. Last one,"MS-DOS", is process under the MS-DOS modes which provide system recovery and other general uses such as structural calculation in Fortran language.

The colored initial screen, shown in Figure 1.5.11, appears promptly after turning on the power switch of the computer, and leads users readily to operate for outputting and maintaining the system.

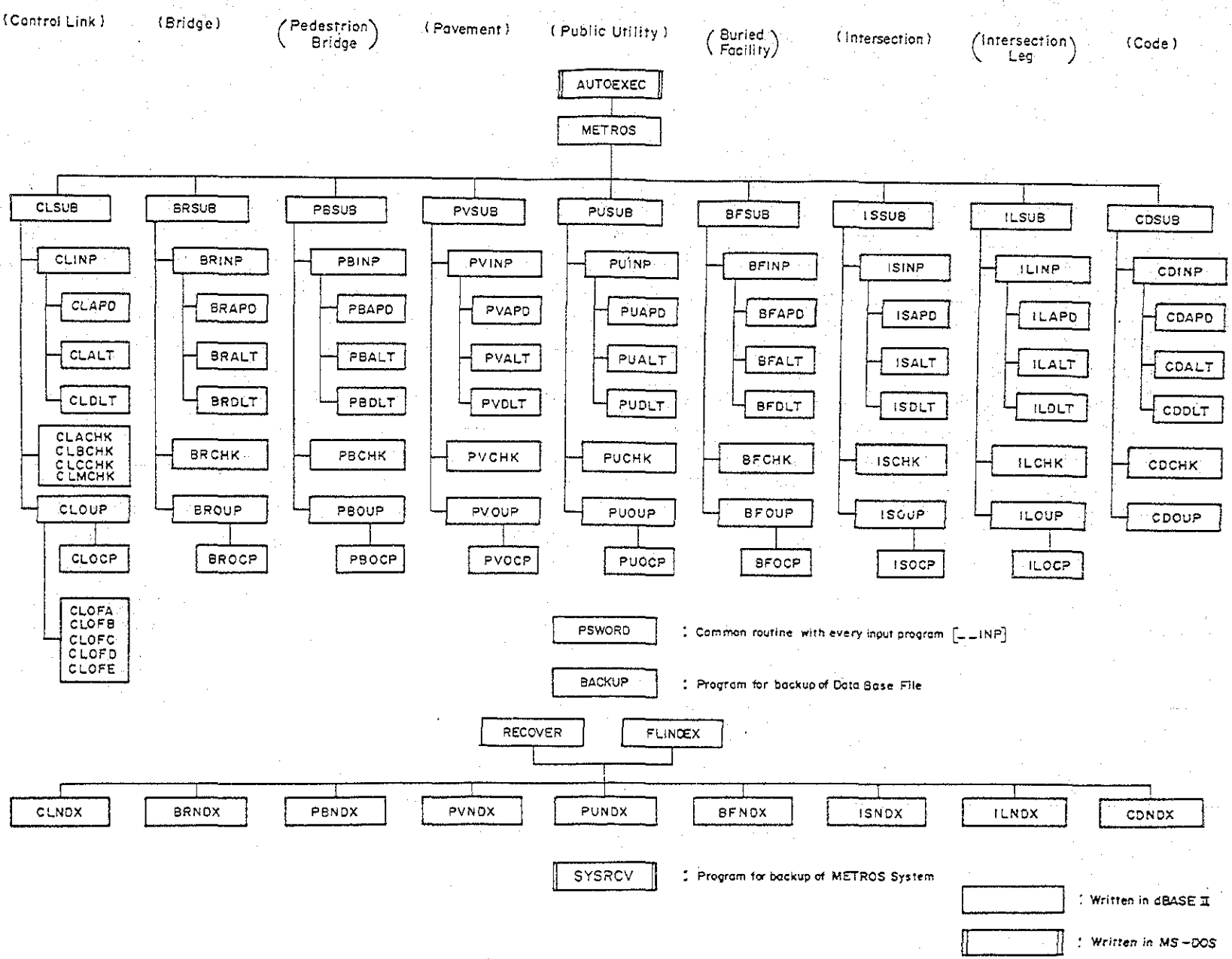


Figure 1.5.9 Program Structure and Name

Table 1.5.5 Program Size (Bytes)

	Control Link (CL)	Bridge (BR)	Pedes-trian Bridge (PB)	Pavement (PV)	Public Utility (PU)	Buried Facili-ty (BF)	Inter-section (IS)	Inter-section Leg (IL)	Code (CD)	Sub Total (Bytes)	Remarks
AUTOEXEC	-	-	-	-	-	-	-	-	-	2,432	
METROS	-	-	-	-	-	-	-	-	-	5,760	File Selection
Process Menu (SUB)	2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	23,040	Process Selec-tion
Input (INP)	1,280	1,280	1,280	1,280	1,280	1,280	1,280	1,280	1,280	11,560	
Password	-	-	-	-	-	-	-	-	-	640	
Append (APD)	17,792	7,936	7,552	7,424	6,400	6,912	6,016	8,192	4,480	72,704	Input Program
Alter (ALT)	17,408	7,424	7,040	6,912	6,016	6,656	5,504	7,552	4,096	68,608	
Delete (DLT)	14,208	6,784	6,400	6,400	5,760	6,144	5,248	6,784	4,480	62,208	
Check (CHK)	22,016	3,712	4,096	5,120	2,304	4,096	2,432	4,608	1,536	49,920	Error Checking
Output (OUP)	11,264	19,328	19,072	18,816	16,640	17,792	13,312	19,712	9,344	145,280	
Output Copy (OCP)	9,984	1,792	1,664	1,664	1,280	1,408	1,152	2,048	-	20,992	Output Program
Output Form (OF)	53,376	-	-	-	-	-	-	-	-	53,376	
BACKUP	-	-	-	-	-	-	-	-	-	5,632	
RECOVER	-	-	-	-	-	-	-	-	-	6,656	Data Base Create
FLINDEX	-	-	-	-	-	-	-	-	-	2,432	File Indexing Main
Indexing (NDX)	512	512	512	512	512	512	512	512	512	4,608	
SYSRCV	-	-	-	-	-	-	-	-	-	384	

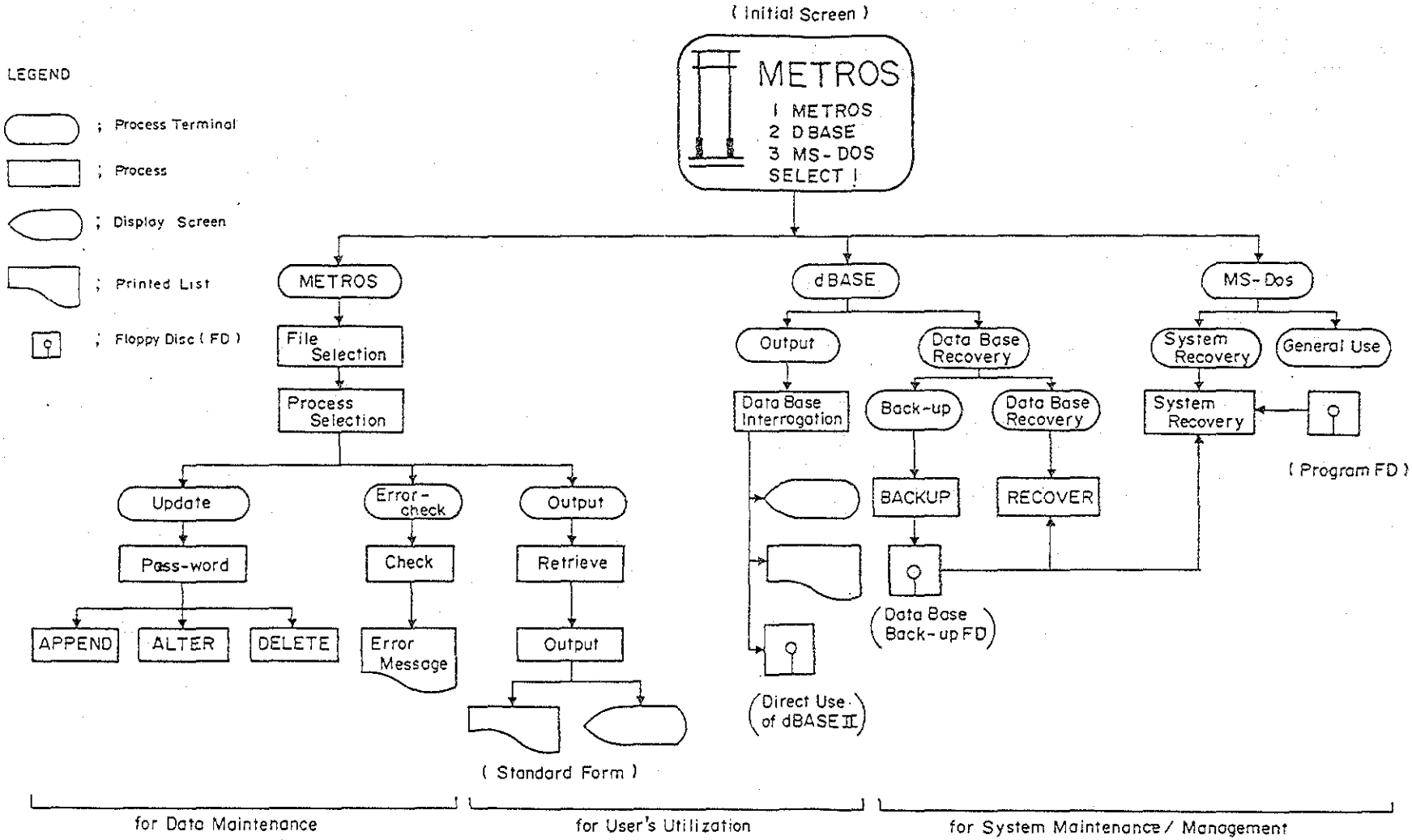


Figure 1.5.10 Operation Flow

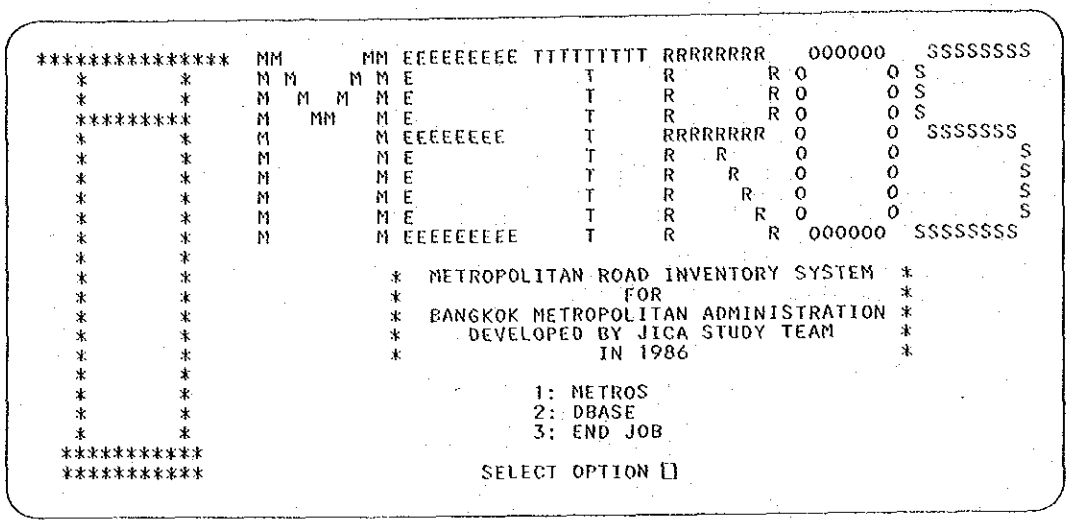


Figure 1.5.11 Initial Screen of METROS

Operation procedures and methods are presented in further detail in the manuals which comprise of two separate issue, i.e. "Users Manual" for outputting by users, and "System Manual" for system maintenance by maintainer.

(3) Exclusive area for METROS

Total size of programs including data base management system and operating system reached 1.30 mega-bytes consisting of three parts as follows;

METROS Program	; 0.54 mega-bytes	} 1.30 mega-bytes
dBASE II	; 0.18 do.	
MS-DOS	; 0.58 do.	

In order to secure the system from possible unexpected erasure of both the above programs and the data base, with the current data volume of 0.68 mega-bytes, the whole system is stored in the directory (E) which is an exclusive area for the METROS in the hard disc. The directory (E) is designed to preserve the capacity of ten (10) mega-bytes.

As the expected data volume of data bases for roads in the whole Bangkok is estimated to be less than three times the current data volume, totaling three point three (3.3) mega-bytes including METROS program and operating system.

(4) Test run

Developed programs, which are the interface programs and the system recovery programs, were confirmed to function as designed, using the collected data for the pilot road inventory.

Some slight modifications of programs were made in terms of the better serviceability of system operations for users.

1.6 Establishment of Pilot Road Inventory

1.6.1 Pilot Area

In order to demonstrate the practical application methods and to verify the functions of the developed data base system as well, a pilot road inventory for the road systems in the Pathumwan and Bangrak districts was established. (Those two districts are sometimes referred to as "Pilot Area" in this report).

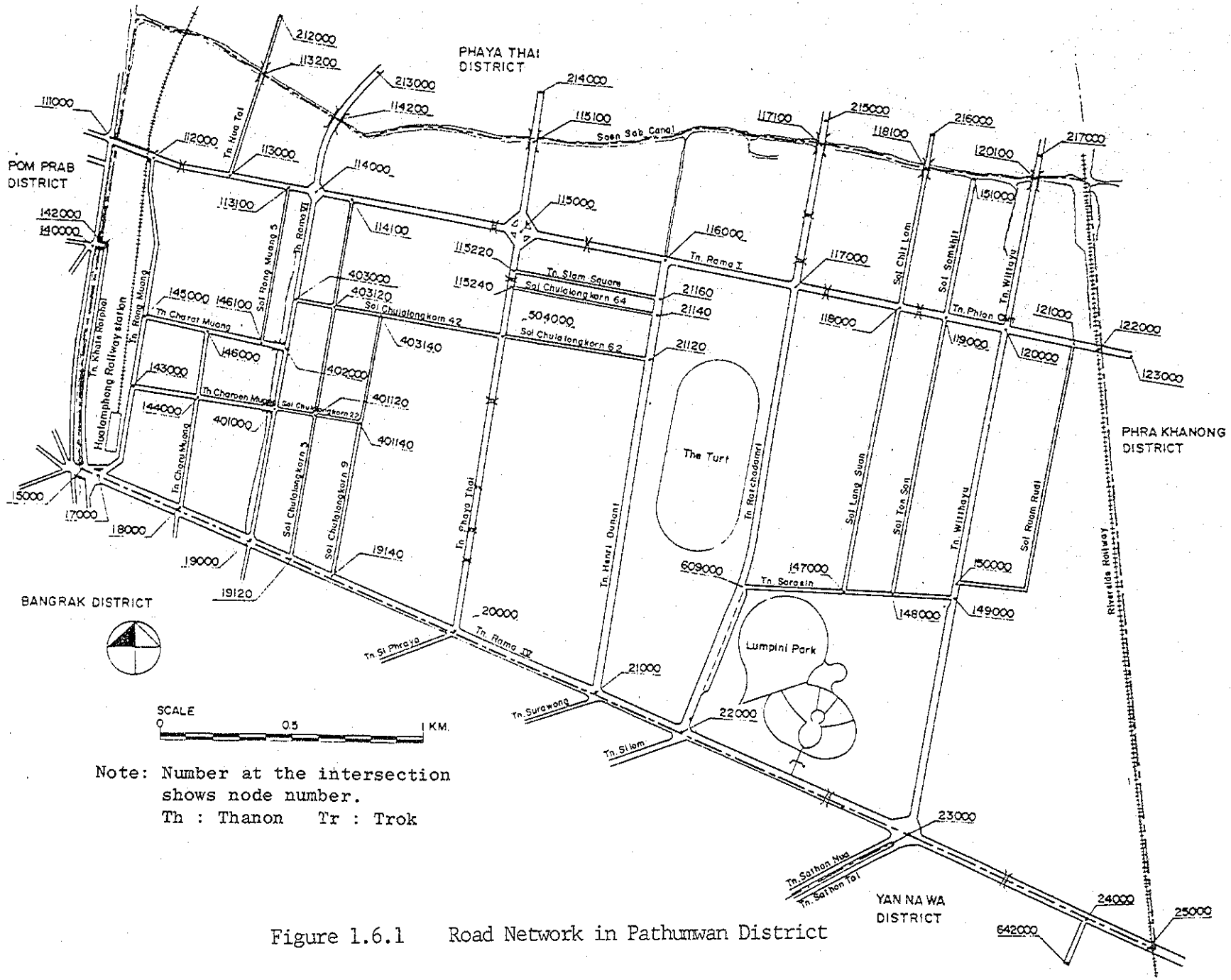
For this purpose, the road network in those two districts were reconfirmed and the secondary nodes were coded as shown in Figure 1.6.1 and Figure 1.6.2. The number of control links and other major structures in the Pilot Area are as follows;

		(Pathumwan district)	(Bangrak district)
Control Links	;	83	68
Nodes	;	43	40
Bridges	;	13	5
Pedestrian Bridges	;	14	0
Total road length	;	35159 m	19143 m

Collection of full data items on the roads have been tried in the same way that BMA staff will finally operate and maintain the system when the works of system development is completed. Data in the data bases were founded on the latest inventory which BMA and other related authorities possessed. In addition, some data were collected by the Study Team in cooperation with BMA's counterparts.

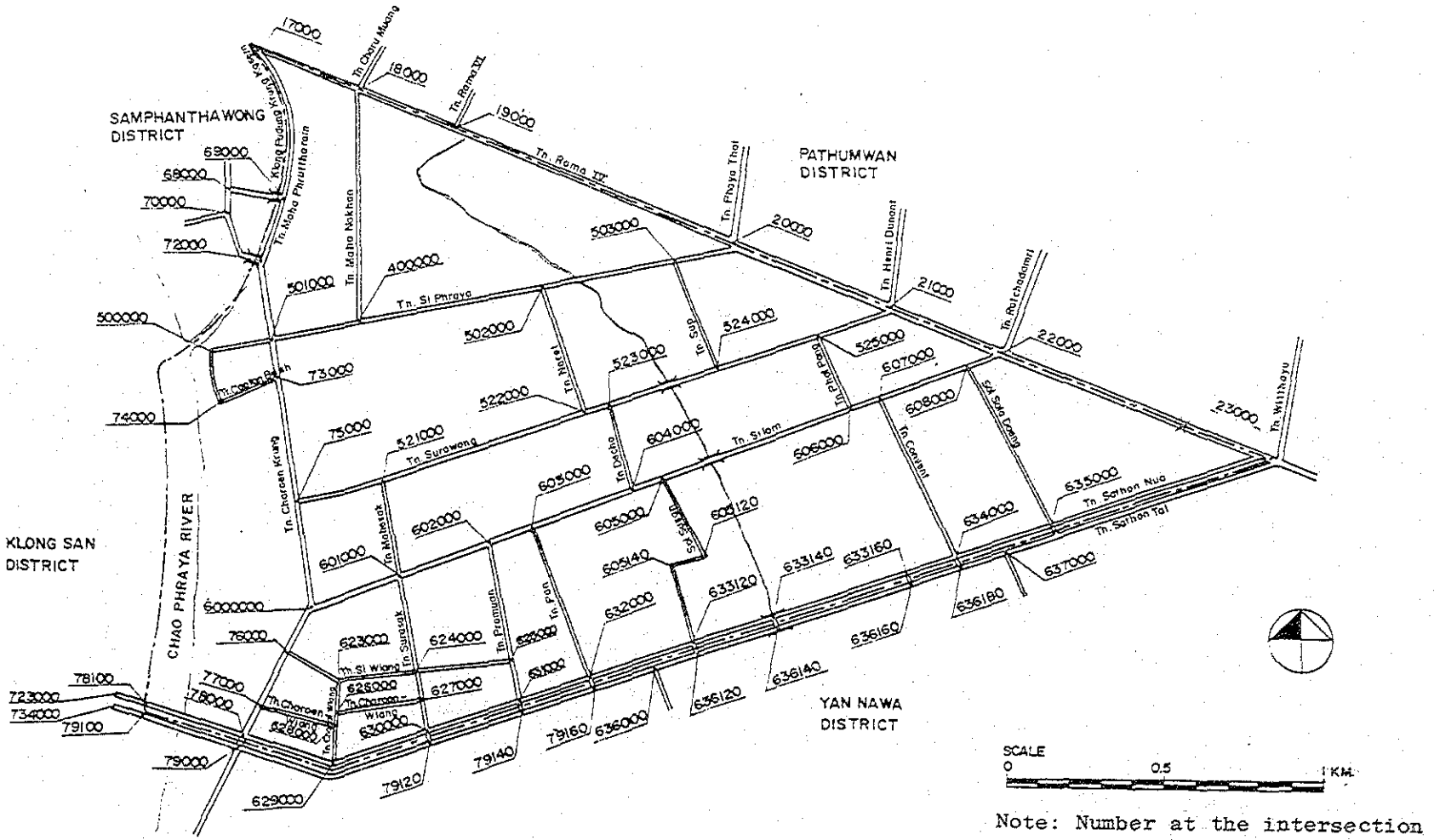
However, as there is currently no source data for buried facility data base file which was added according to the request of BMA, data on these facilities are to be inputted later when they will be available.

Moreover, some data could not be collected due to the shortage of source data. Those data which are not presently available, will be incorporated into the data base when they will be collected. As a result, the current number of records of the data collected in the Pilot Area is approximately 1,100.



Note: Number at the intersection shows node number.
Th : Thanon Tr : Trok

Figure 1.6.1 Road Network in Pathumwan District



Note: Number at the intersection shows node number.

Figure 1.6.2 Road Network in Bangrak District

1.6.2 Study Area

Data items for the rating methods were collected from the study area extending in 16 districts in addition to the Pilot Area. These data were stored in the control link, intersection and intersection leg data base files.

The number of data items for the rating methods which were employed in the studies of road improvement, traffic safety and pavement rehabilitation, in the above three data base files are as follows;

Control Link	;	32 items
Intersection	;	9 do.
Intersection Leg	;	25 do.

The roads in the study area were reviewed to determine the secondary nodes at the points of abrupt changes of road width and/or boundary of the districts. As a result, the number of nodes including both the primary and secondary nodes was 412 and the number of control links was 606. The total road length, not including the pilot area, was approximately 318 km.

Source data, as same case as that of the pilot area, were founded on the latest inventory which BMA possessed. Furthermore, some data were based on the results of traffic survey and traffic accident survey conducted by the study team.

1.6.3 Road Inventory Data Base

Collected data in the study area which includes the pilot area were compiled in the road inventory data base. And the whole compiled data have been checked through the check interface program and corrected by the input interface program. The number of collected data are presented by districts and kinds of data base in Table 1.6.1.

The total volume of data base files by collected data reached 0.68 megabytes including some vacant items which were due to the shortage of source data. As a result, however, they are only the half volume (1.30 megabytes) for the whole software to operate the road inventory system.

Table 1.6.1 Number of Collected Data

Data Base / District	Control Link	Bridge	Pedestrian Bridge	Pavement	Public Utility	Intersection	Intersection Leg
Pra Nakhon	102					1	4
Pom Prab Sattru Pai	53					1	5
Pathumwan	83	13	14	78	84	33	116
Sampanthawong	34					0	0
Bang Rak	67	5	0	67	68	39	124
Yan Nawa	46					7	12
Dusit	124					12	44
Phaya Thai	73					15	52
Huai Khwang	17					3	11
Phra Khanong	30					7	22
Bang Khen	17					5	19
Bang Kapi							
Nong Chok							
Min Buri							
Lat Krabang							
Thon Buri	22					3	10
Klong San	34					0	0
Bangkok Noi	26					3	11
Bangkok Yai	23					1	4
Pasi Charoen	1					0	0
Bang Khun Thian	2					1	3
Taling Chan							
Rat Burana							
Nong Khaem							
TOTAL	754	18	14	145	152	131	437

Note : Pathumwan and Bangrak districts are objective area for the detail pilot road inventory.

1.6.4 Examples of Practical Application

In this section, examples of practical application are presented for the road administration works, based on the assumed motivation of the works. Examples of practical application are abundantly presented for road improvement planning, rehabilitation planning as well as traffic safety planning on roads in the system manual.

Example 1

Supposing that the geometric form of Rama I street in Pathumwan district is needed for studies on some assignments of road improvement. In this case, ROAD DATA LIST (I), listed in Table 1.5.3, is available by standard processing. Retrieval conditions are Pathumwan district and Rama I street by codes of 3 and 181006, respectively. Then, printed list can be obtained in a form of table as shown in Figure 1.6.3.

Example 2

For the purpose of traffic safety planning, supposing that the relationship between the number of accidents and traffic facilities is necessary at the intersection in Pathumwan and Bangrak districts. Traffic facility is categorized into traffic signals, flashing lights, traffic signs and not-installed in the code table.
The direct use of dBASE II is available in this case on counting the number of intersections and summing up the number of accidents by the above four categories as shown in Figure 1.6.4.

*** ROAD DATA LIST (I) ***

DISTRICT;Pathumwan
STREET ;Tn. Rama I

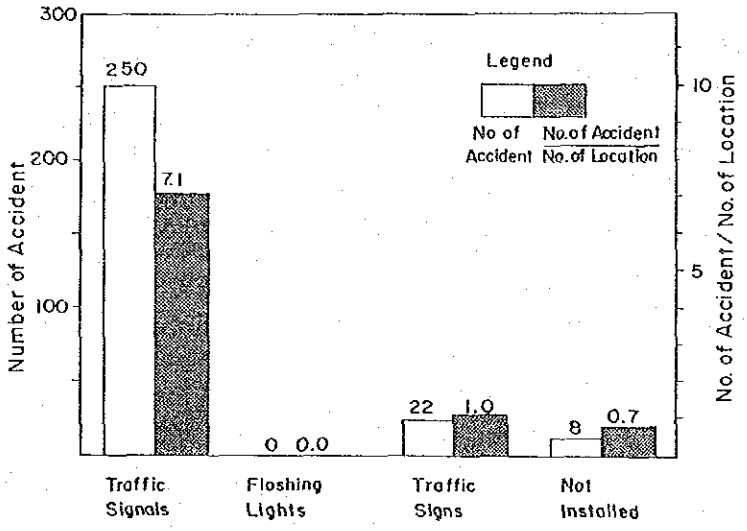
NOTE;UNIT OF DATA ARE METERS OR SQUARE METERS

STARTNO	ENDNO	CROSTYPE	PAVETYPE	LENGTH	WIDROW	WIDCARL	WIDCARR	WIDMED	WIDFPL	WIDFPR	WIDSLDL	WIDSLDR
111000	112000	Type 10	Asphalt Concrete	165	27.50	9.25	9.25	0.00	4.00	5.00	0.00	0.00
112000	113000	Type 12	Asphalt Concrete	270	27.50	9.25	9.25	0.00	4.00	5.00	0.00	0.00
113000	113100	Type 12	Asphalt Concrete	214	27.50	0.00	19.50	0.00	4.00	4.00	0.00	0.00
113100	114000	Type 12	Asphalt Concrete	86	27.50	0.00	19.50	0.00	4.00	4.00	0.00	0.00
114000	114100	Type 12	Asphalt Concrete	85	27.50	0.00	18.50	0.00	4.00	5.00	0.00	0.00
114100	115000	Type 12	Asphalt Concrete	605	27.50	0.00	18.50	0.00	4.00	5.00	0.00	0.00
115000	116000	Type 12	Asphalt Concrete	563	27.50	0.00	18.50	0.00	4.00	5.00	0.00	0.00
116000	117000	Type 22	Concrete overlayed with Asphalt	480	29.00	0.00	18.00	0.00	6.00	5.00	0.00	0.00
			SUB TOTAL LENGTH;	2466								
			TOTAL LENGTH;	2466								

Figure 1.6.3 Sample Output of Road Data List (I)

```
. USE INTSCTFL
. COUNT FOR (DISTRICT=3.OR.DISTRICT=5).AND.CONTROL=1
COUNT = 00035
. SUM ACCIDENT FOR (DISTRICT=3.OR.DISTRICT=5).AND.CONTROL=1
  250
. COUNT FOR (DISTRICT=3.OR.DISTRICT=5).AND.CONTROL=2
COUNT = 00004
. SUM ACCIDENT FOR (DISTRICT=3.OR.DISTRICT=5).AND.CONTROL=2
 0
. COUNT FOR (DISTRICT=3.OR.DISTRICT=5).AND.CONTROL=3
COUNT = 00022
. SUM ACCIDENT FOR (DISTRICT=3.OR.DISTRICT=5).AND.CONTROL=3
  22
. COUNT FOR (DISTRICT=3.OR.DISTRICT=5).AND.CONTROL=4
COUNT = 00011
. SUM ACCIDENT FOR (DISTRICT=3.OR.DISTRICT=5).AND.CONTROL=4
  8
.
```

(1) Screen by dBASE II



(2) Further Explanation by Hand

Figure 1.6.4 Sample Use for Traffic Safety Planning

Example 3

Supposing that the total length and pavement area of carriageways by pavement type are needed for statistics use in Bangrak district. In this case, the direct use of dBASE II is available to obtain summing up value as shown in Figure 1.6.5, which are explained below.

	Road length	Pavement area
Concrete	9771 (m)	142993 (m^2)
Asphalt concrete	9219 (m)	82139 (m^2)
Total	18983 (m)	225132 (m^2)

```
. USE PVMNTFL
. SUM SEGLENGTH,AREACAR FOR DISTRICT=5
  18983   225132
. SUM SEGLENGTH,AREACAR FOR DISTRICT=5 .AND. TYPCAR=1
  9771   142993
. SUM SEGLENGTH,AREACAR FOR DISTRICT=5 .AND. TYPCAR=3
  9212   82139
.
```

Figure 1.6.5 Sample Output for Statistics Use

1.7 System Maintenance/Management Works

1.7.1 Maintenance/Management Flow

Maintenance/management works essential for the METROS are comprised of three parts, i.e. data maintenance, system maintenance and system management, as shown in Figure 1.7.1.

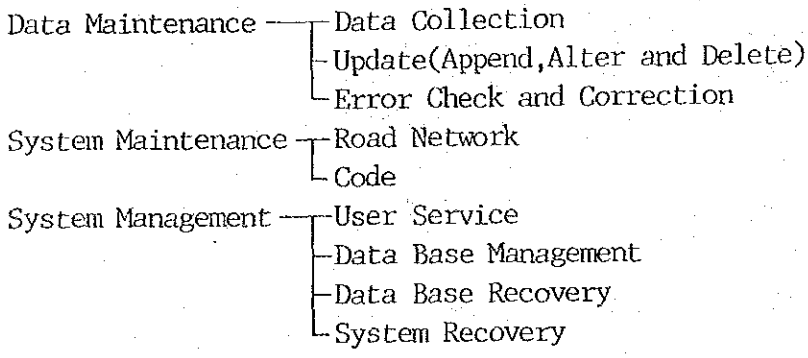


Figure 1.7.1 Maintenance/Management Works for METROS.

A work flow for the former two works, data and system maintenance, is illustrated in Figure 1.7.2.

There are three major routines in Figure 1.7.2. First one is a routine for updating data base file depending on such as new installation, repair works and inspection. Second one is a routine for modification of data with accompanying modification of road network, on account of alteration of arteries and/or expansion of road network. Last one is data base recovery which is composed of providing back-up floppy discs and recreation of data base by them.

1.7.2 Data Maintenance

(1) Data collection

In order to supply the latest information to users, METROS data base should be systematically maintained and updated, and periodically as well.

Main causes of updating are modification and/or appending data due to;

- expansion of road network and alteration of old network,
- new installation or removal of facilities, such as

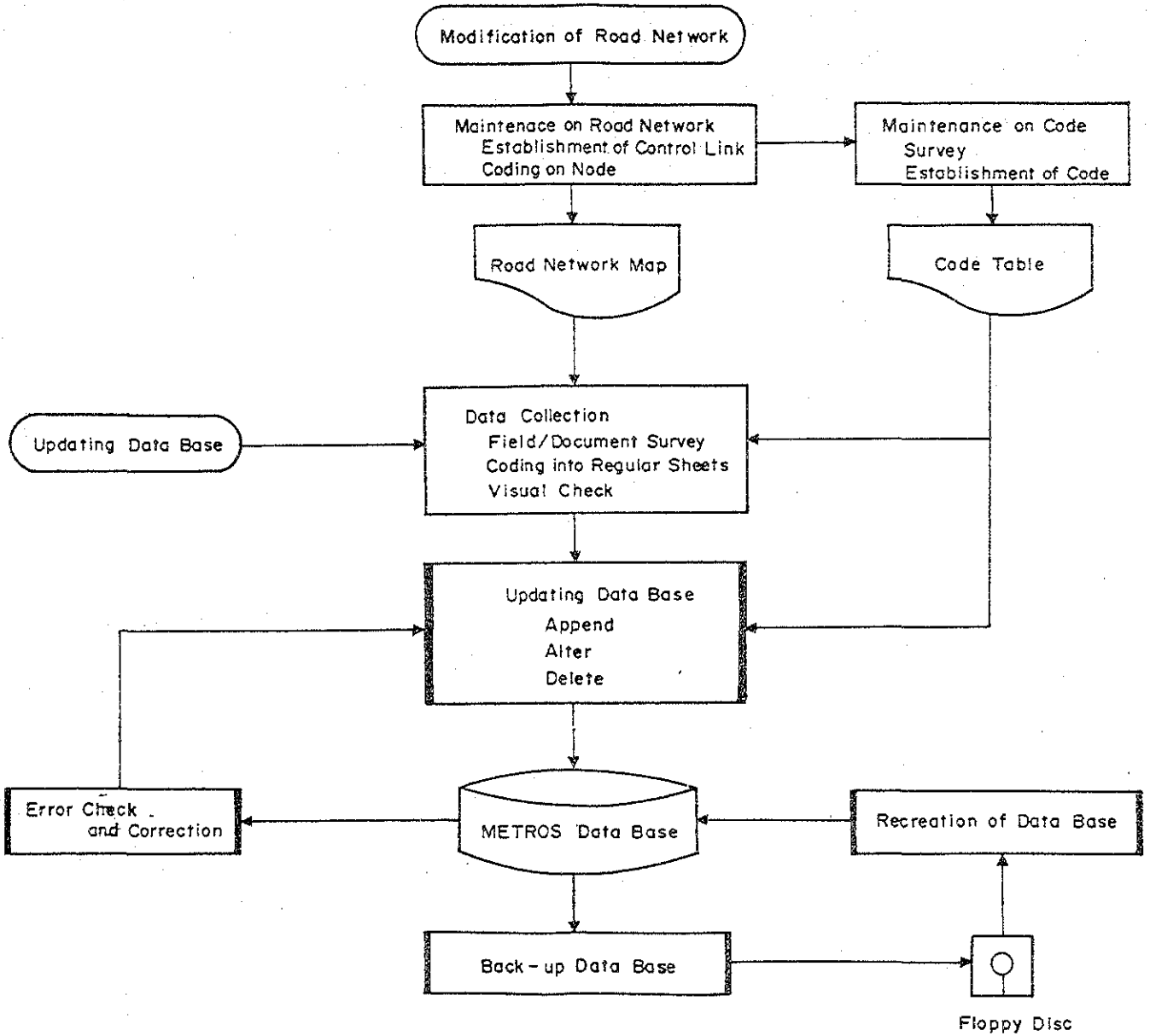


Figure 1.7.2 Data and System Maintenance Flow

appurtenances,
public utilities,
traffic management facilities,
bridges,
pedestrian bridges.

- maintenance on variable data, such as
  land use,
  conditions of pavement,
  marking,
  lighting,
  bridge,
  pedestrian bridge,
  flood record,
  traffic data,
  traffic accident data.
- maintenance on invariable data (strictly saying, there is no invariable data in the METROS), which are to be updated due to possible road management works such as repair and improvement works. They are;
  appurtenances,
  public utilities,
  traffic management facilities,
  bridges,
  pedestrian bridges,
  pavement,
  traffic management,
  intersection,
  intersection leg,
  traffic control facilities and
  others.

These data to be updated should be collected by means of field survey and/or document survey from the authorities related to its data items.

Data for the METROS are often related to many authorities. They are;

in BMA, Department of Public Works,
City Planning Division,
Department of Drainage and Sewerage,
Traffic Engineering Division,
District Offices,

in MOI, Public Works Department,
Office of the Committee for the Management on Road Traffic,

Metropolitan Electric Authority,
Metropolitan Water Works Authority,
Town and Country Planning Department,
Expressway and Rapid Transport Authority of Thailand,

in MOC, Department of Highways,
Telephone Organization of Thailand,
and others.

Coding methods are presented in further detail in the System Manual with coding sheets.

(2) Updating

This part of data maintenance works are mainly operations of computer which are provided by input interface programs. Operation characteristics are presented in further detail in the System Manual.

(3) Error check and correction

In order to prevent compiling incorrect data into the METROS data base, maintainers are requested to check the inputted data after inputting them into data base file and/or periodically, through check interface programs. Immediate correction for erroneous data should be required in view of the reliability of the data base.

Operation characteristics of the above process, causes and countermeasures against incorrect data are presented in further detail in the System Manual.

1.7.3 System Maintenance

Other than data maintenance works as above mentioned, the following maintenance works are required as essential tasks to preserve the METROS system. Procedures of these works are presented in further detail in the System Manual.

(1) Road network

When road network are modified on account of alteration of arteries and/or expansion of road network, maintenance works on road network should be required.

Essential tasks for modification of road network are as follows;

- field survey, if any
- establishment of control link,
- coding on node,
- preparation of new road network map, and distribution to the possible users,
- custody of originals on road network map.

(2) Code

When new control links are generated, modification of code file and code table are required in the code of street name. Essential tasks for code file and table are as follows;

- field survey on street name, if any,
- establishment of code,
- appending code file,
- preparation of code table and distribution to the possible users.

1.7.4 System Management

Apart from maintenance works for data and system, there are some important works to obtain the best result from the METROS system, which are system management works as presented below. Methods and procedures of these works are presented in further detail in the System Manual.

(1) User service

There are two kinds of tasks to assist users who extract information necessary for administration works on road.

1) Distribution of road network and code table

After modifying road network and/or code table, they should be distributed to users as soon as possible. However, both modification and distribution may be better to be carried out periodically, for instance, once a year.

2) User orientation and training

In order to utilize the system widely for the practical administration works, it is essential to orient and train possible users in BMA periodically. Besides, maintainer of the METROS should provide the technical response to daily users references.

(2) Data base management

1) Management on updating

Updating data base files should be implemented periodically and all at once as well, so as to preserve user's reliability and serviceability of the METROS.

2) Management on data volume

There are two kinds of memory devices in this system, which are back-up floppy disc and hard disc.

Data for back-up are stored into two separate floppy discs. Capacity of each volume is 1.25 mega-bytes which has enough volume to store the above data base files for major roads in the whole Bangkok area.

Total volume, which comprises of data base, METROS programs and operating

system, is expected to reach 3.3 mega-bytes. The directory (E), which is an exclusive directory for the METROS in hard disc, has a vacant capacity of more than 7 mega-bytes. However, maintainer should inspect periodically the existence of user's private files and capacity in use in directory (E), and should also erase useless files after obtaining user's approval if any.

(3) Data base recovery

Whole procedures and methods to maintain the METROS are described in detail in the manuals. However, an unexpected erasure due to wrong usage is possible by both users and maintainers.

A protection for the above erroneous usage and mishandling are data base recovery works as follows;

- creating back-up floppy disc by all means after updating data base file including code file,
- keeping back-up floppy disc in custody under suitable conditions as presented in the System Manual,
- recreating the data base file using back-up floppy disc whenever necessary, for instance, in case of wrong usage as above mentioned or failing updating new data.

(4) System recovery

Other than wrong usage or mishandling, it is possible to occur obstruction due to mechanical or electric accidents, and the METROS can not be operated. In this case, METROS system should be recreated from the beginnings through the regular procedures by maintainer.

1.8 Associated Manuals

In order to utilize the METROS effectively and as well as general use of the computer, following manuals with relation to the data base system were prepared in extra issues.

- USERS MANUAL
  Operational characteristics of the METROS, and dBASE II in brief, for users to extract information from its data base.

- SYSTEM MANUAL
  Maintenance and management characteristics of the METROS for maintainers.

- dBASE II MANUAL
  Operational characteristics to extract information by means of the direct use of dBASE II, and general use of dBASE II as the data base management system.

- MS-DOS MANUAL
  References on the operating system for dBASE II, and general use of the computer.

- OPERATION MANUAL (N5200/05 MK II)
  Operating and maintenance methods for hardware.

The first two manuals includes the basic operating and maintenance procedures for hardware. And brief contents of them are presented in Appendix 1.8.1 to Appendix 1.8.2.

REVIEW ON ROAD

ORGANIZATION OF BMA

2. REVIEW ON ROAD ORGANIZATION OF BMA

2.1 Introduction

It may be easy to understand that carefully arranged organizational structure and well-trained staffs are two vital components of management efficiency of any of the organization, which can also apply to road management and its organizational structure of BMA.

The objective of a review on road organization of the BMA is to provide with useful comments and ideas to the BMA for its functional improvement and administrative efficiency.

The review has been made in this study on the BMA's organization on road management from the standpoints of 1) compliance with the rapidly changing social and economic and technological environments, 2) improvement of administrative performance, and 3) upgrading of personnel capability. The review has been conducted mainly from the functional viewpoint of road planning, design, implementation, maintenance, traffic management and traffic safety improvement, by defining the existing organizational structures, staffings and work procedures of relevant BMA departments and divisions relating to road management, such as Dept. of Public Works (DPW), City Planning Division (CPD), Traffic Engineering Division (TED) and District Offices, by means of interviews to and discussions with the BMA counterparts for identification of the problem areas. With the same context, some interviews have been made to some agencies of the central government taking part in the management of BMA administered roads, such as Ministry of Interior, Ministry of Communications and NESDB.

However, it is to be mentioned that the review has been limited mainly to the BMA organization, in particular the road administrative organization, because of the limited time factor of this study.

The functional review of the organization structure comprises the study on "Line Function" pertaining to a set of work flow ranging from planning, survey, design, implementation and maintenance of road management, and on "Staff Function" regarding technical standards, development of data base and its updating system, material and engineering test system and training programs which are the back-up functions for the effective management of line function.

During the review, special attentions have been paid to such matters as the output of this study could be fully utilized by BMA staffs.

2.2 Existing Organization and Functions on Road Management

(1) Agencies Outside the BMA

1) Ministry of Interior (MOI)

a) Public Works Dept.(PWD)

The functional responsibilities of PWD are mainly for;

- Construction and maintenance of the bridges on the Chao Phraya River
- Construction and maintenance of the tertiary roads in the various provinces of the country which do not include the roads in the BMA area.

b) Expressway and Rapid Transit Authority of Thailand (ETA)

ETA is a autonomous public organization which is responsible for the planning, research, construction and operation/maintenance of the toll Expressway and the Mass Transit System.

At present, ETA is operating a part of the First Stage Expressway System (FES) with the revenue length of 16.8 km. and is constructing the rest of the FES which is scheduled to be complete by the end of 1987. The Second Stage Expressway System (SES) is now under the detailed design stage and a part of the SES to link the loop is sanctioned for construction and the rest is to be open for concession to the private sector participation for construction and operation.

Regarding the Mass Transit System to cater for the transport needs in the BMA area, it is still in the planning stage and no set schedule for implementation is given.

c) Town and Country Planning Dept.(TCPD)

TCPD is a department of MOI, responsible for the overall urban and regional planning of the country including the structural development planning of the BMA area, which needs close coordination with the City Planning Division (CPD) of the BMA.

d) Office of the Committee for Management of Road Traffic (OCMRT)

This office is acting as the secretariat of the Committee for Management of Road Traffic which is responsible for formulation of the traffic

control and management systems for the whole country, especially for the BMA area based on the study on road traffics and accidents.

The function to develop and promote an area traffic control system in the BMA area will be transferred from this office to the BMA very soon, together with the transfer of staffs.

e) Police Department (PD)

One of the responsibilities of the PD is to enforce the traffic laws and regulations within the BMA area, which is assumed by the Metropolitan Police Bureau (MPB) and under MPB, Traffic Police Division (TPD) is implementing this function.

The recordings of the road traffic accidents in the BMA area are being taken by and kept at the district offices of the PD in that area, and these records are seldom forwarded to various outside agencies relating to road management.

2) Ministry of Communications (MOC)

a) Dept. of Highways (DOH)

DOH is responsible for construction and maintenance of the national and major provincial highways of the country, and also in charge of the roads with a length of about 160 km within the BMA area.

b) Dept. of Land Transport (DLT)

DLT is responsible for issuing the driving and vehicle licenses for commercial types and, also for administration of the road transport industry such as Bangkok Metropolitan Transit Authority (BMTA) and the private road transport operators.

c) Bangkok Metropolitan Transit Authority (BMTA)

BMTA is responsible for the passenger transport of the BMA area by a huge number of bus operations, but at present it is far from self-sufficient in terms of financial status.

BMTA has already been commissioning several franchises to the private sector for some of its bus operations.

3) Office of the Prime Minister

a) Infrastructure Projects Division, National Economic & Social Development Board (IPD/NESDB)

IPD/NESDB is responsible for the overall policy and strategy for infrastructure projects including those of transport sector of the country and the BMA area, together with formulation of their macroscopic development plans.

These policy and strategy and macro development plans on road and its transport are disseminated to the departments and divisions in charge of road and transport administrations in MOC, MOI and the BMA, for working out the action plans.

b) National Safety Council (NSC)

NSC is responsible for the planning of the road traffic safety policy and strategy as one of its functions, which is closely coordinated with NESDB and other central committees concerned with the road and road traffic management.

4) Other institutions

a) In addition to IPD/NESDB, NSC and OCMRT, there are several committees as the central policy bodies directly concerned with the road and road transport in the Bangkok Metropolis, such as Greater Bangkok Transport Committee (GBTC), chaired by the Deputy Prime Minister, Land Transport Policy Committee (LTPC), chaired by Communication Minister, etc. There will be another national level committee directly concerned with traffic, housing and water resources in the Metropolitan area.

However, at time of this study, their clear functions have not been identified.

b) There is also an institution, Thailand Development Research Institute (TDRI), engaging in various development researches in the country to include the research on urban transport, and their approach to the road and traffic managements seem fairly academic.

(2) Organization for Road in BMA

1) Dept. of Public Works (DPW)

According to the Royal Decree issued in 1977, the responsibility of DPW was defined at the sections 29, 30 and 31 of the Decree which state as the following;

DPW has authority of all works for buildings and civil works from planning, design, to construction and maintenance, construction control, right of way and land acquisition in Bangkok Metropolis by administration of the Director and controlled by the Permanent Secretary of the BMA. This Department is composed of;

- Office of Secretary
- Design Division
- Construction and Maintenance Division
- Public Works Planning Sub-Division
- Construction Control and Supervision Division
- Building Control Division
- Right of Way and Land Acquisition Division

2) Traffic Engineering Division, Office of the Permanent Secretary (TED)

TED is at present organized under the Permanent Secretary and is responsible for the various works pertaining to the traffic engineering such as research, planning and the implementation of the traffic management including traffic safety in the BMA area. This Division comprises 11 sections such as Administration, Traffic System, Parking Control, Traffic Evaluation and Education, 3 Road Facilities, Area Traffic Control, and 3 Outstation Signals.

Description and Illustration of the major functions of DPW and TED are shown in Appendix 2.2.1.

3) District Office

There are 24 district offices in the BMA organization and in each district office there is a section responsible for the minor construction and maintenance of the minor roads in the area where the office is responsible. These road construction and maintenance works are closely coordinated with DPW.

4) City Planning Division, Office of the Permanent Secretary (CPD)

As one of its functions, CPD is responsible for the planning and review of the urban development plan of the Bangkok Metropolis with exchange of infonmation and data with TCPD, and other departments and divisions in the BMA.

CPD has Transportation and Infrastructure Planning Section, City Planning Control Section and Mapping Section in addition to various research and city planning sections. which have constant coordination with DPW on various aspects.

5) Dept. of Policy and Planning (DPP)

This Dept. is responsible for the formulation of overall and sectoral development and improvement policy and plans of the BMA, and also for the evaluation and appraisal of the various infrastructural development projects in their planning and its implementation progresses.

DPP functions with close coordination with DPW, CPD and other related depts. of the BMA organization on road administration.

2.3 Brief Consideration on the Duty and Organization of BMA

A brief review and consideration on the duty and organizational structure are presented from the standpoint of planning, implementation and maintenance of roads.

(1) Newly arising duties

One of the most urgent and significant needs for the BMA is to implement functions for planning, implementing and maintaining traffic control system in Bangkok. The agency responsible for traffic management/control, as stated before, used to belong to OCMRT and TED/MOI, but this responsibility is expected to be transferred to the BMA. Since the BMA has no experience to this type of duty, establishment of the function and appropriate organizational structure to meet with this duty is urgently needed.

To cope with this situation, the BMA is recruiting some staffs from OCMRT and TED/MOI, which is evidently the most reasonable and effective measure as the first step. However, the BMA shall be well prepared for the future need to have sufficient manpower of well-trained personnel to maintain the traffic management/control system, such as 1) system engineer and analyst for data collection, analysis and modification/maintenance of the system programs (if the system is computer controlled) and 2) engineer/technician to maintain the system devices (hardware). Without these personnel, the system will not perform as expected because these types of systems usually need fine adjustments to the actual conditions and quick response to mechanical/electrical/electronical disorder.

It is the matter of course to establish training program for the personnel engaged in the actual routine operation of the system. It should be also noted that good discussion should be held periodically between police agency and the BMA road engineers to ensure efficient performance and further development and expansion of the system.

(2) Utilization of output this Study

The output of this study would result in most meaningless if appropriate measures are not taken. For example, "Road Inventory System" initiated by this study needs constant feeding of up-to-date data. If data of the Inventory are not renewed at proper times, the system will become out-of-date and cannot function as planned.

Followings are the prescriptions for utilizing the results of this study;

1) Road inventory system

The existing data have been inputted to the system in the process of system development. However, the data of most districts, except Pathumwan and Bangrak whose data were collected or renewed by the Team and the counterparts of the BMA, many data were out of date or even lacking. Thus, the renewal of old data and collection of lacking data are absolutely necessary to let the system work as intended.

To fulfill this need, the following arrangement of personnel/organization is considered to be required.

a) Data collection

A team of engineer/technicians should be in charge of data collection. Part of work may be shared by district offices. If any part of the work is to be assigned to district offices, due attention shall be paid to secure the uniformity of the data collected.

b) Data inputting

Since the volume of data to be inputted is expected to be substantial volume, a few staffs are required for data compilation/inputting. To obtain the maximum efficiency, these staffs should specialize in this work, and thus should be well trained for data inputting and handling of the computer. To start with, some of the counterpart engineers can be the instructors of the training.

c) Organizational unit on inventory data

It is advisable to carefully consider the assignment of the responsibility for preparation of the inventory data to a certain organizational unit within the BMA, because of its professional expertise required for such works and extensive utilization of the data by the various departments and divisions concerned.

2) Traffic safety plan

In order to fully utilize the outcome of this study regarding traffic safety plans there are two recommendations as the following;

a) Promotion of safety measures

Extensive application of the proposed "Identification Criteria for Hazardous Sections" shall be practiced for review and planning of the safety measures at the locations in question. In this study, 10 hazardous locations were selected from 61 candidate roadway sections and 51 candidate intersections within the study area bordering by the Middle Ring Road, and the typical safety measure to each hazardous location has been planned out. Therefore, similar safety measures shall be worked out to the remaining 102 locations for implementation. Furthermore, in parallel with the upgrading of the level of traffic safety by implementation of various safety measures at these locations, review and modification of the proposed Identification Criteria shall be worked out to meet with such upgraded level.

With regard to the traffic safety planning, it is fundamental to coordinate with the Police Dept., and for this purpose it is necessary to establish communication network with Metropolitan Police Bureau, Traffic Police Division and District Police Stations. At the same time, it is recommended to post adequate number of personnel in TED who are responsible for collection of traffic accident data from these police agencies and diagnosis of these data including preparation of collision diagram.

Apart from above recommendation, a Technical Guideline was presented for use of actual implementation. It is to be pointed out that consistency of a set of measures to the major safety plan is indispensable, and the technical standard stated in the Guideline shall be strictly adhered. For effective follow-up of the recommendation, it is proposed for the Traffic Management Division of TED to have a function to rationally deal with the traffic accident data.

b) Function dealing with traffic accident

The main function dealing with traffic accident shall be 1) collection and maintenance of the traffic accident data and their analyses, 2) formulation of the traffic safety plan based on 1), 3) periodic collection of the new accident data in cooperation with the police agencies and updating and analyses of such data, 4) revision and modification of Identification Criteria every 5 year, and 5) review and application of the technical standards to the various safety measures.

3) Pavement rehabilitation

In order to keep the road pavement in good condition and to cater for safe and smooth traffic, it is very important to practice the well-planned and periodic pavement rehabilitation. For this purpose, identification of the existing pavement conditions shall be prerequisite and to implement the pavement rehabilitation at proper time by adequate methods. For realization of such purpose with practical manners, M.C.I. Method was proposed.

a) Utilization of Technical Guideline and M.C.I. Method

For utilization of the proposed M.C.I. Method for a certain period of time, it is necessary to practice the followings;

- Pavement Survey
  To conduct the comprehensive pavement survey on all the remaining roads in the BMA area, in addition to 111 sections conducted in the study, identifying the cracking, rutting, bump, longitudinal roughness, etc. which should be the input data for pavement evaluation by M.C.I. method.
- Periodic pavement survey
  After the establishment of the comprehensive pavement survey, it is necessary to carry out the effective maintenance of the road pavement based on the correct identification of the existing pavement conditions by continuous periodic surveys, which are recommended to be done every three years.
- Application of pavement survey method
  The pavement survey method by M.C.I. can be applied to the construction control and supervision for the new and re-construction of the pavement. This type of application shall be kept in mind and to be developed further.
- Technical guideline for pavement rehabilitation
  The Technical Guideline for pavement rehabilitation proposed in this study was basically aimed at pavement designs, but it is suggested that this guideline shall be modified to meet with the various local conditions taking into account the local materials available, soil and climatological conditions, etc.

b) Organization for implementation of recommendation

For realization of above 4 recommendations, it is suggested that a section is to be arranged for pavement control (for promotion of M.C.I. Method and application of Technical Guideline, etc.) within Construction and Maintenance Div. of DPW. At the same time, a team specialized in the survey engineering of the pavement conditions is to be formed up in Material and Research Div., DPW.

As for the supervision and control of the new pavement construction, the needed survey shall be carried out either by this newly formed survey engineering team (Material & Research Div.) or by contractors, with supervision by Construction Control and Supervision Div.

4) Road improvement

In order to continuously keep a proper service level of the road to facilitate smooth and safe traffic flow on the existing road network, improvement of the road section or intersection where the traffic bottleneck occurs shall be implemented by the most suitable measure in terms of engineering and economic aspects for optimum utilization of the limited financial resource.

For this purpose, as the first step identification of the traffic bottleneck sections on road was proposed by application of the Rating Method, which shall be well understood for practical application by the traffic engineers of the BMA and be disseminated to the field engineers for bottleneck identifications other than those clarified by this study. This Rating Method shall be updated and modified in proportion to the improvement of road service level in terms of traffic congestion, which might require profound insight and perspective to be attainable through careful study and discussion among the BMA engineers.

The second step for road improvement is the planning of various alternatives, on which this study proposed the planning method and procedure. It is to be pointed out that the planning shall be based on the maximum benefit to the traffic with the minimum capital expenditure which shall be quantified both by physical improvement effects and by economic benefit.

It is strongly recommended that a set of works from identification of the road section to working out the most suitable measure for road improvement shall be executed before implementation with very close coordination of the

Public Works Planning Sub-Division and the Design Division with cooperation of other divisions concerned.

(3) Comments on organization improvement

It is natural that the existing organizations shall be expanded, improved, squeezed-down, reorganized or completely changed in accordance with the changing socio-economic activities and needs of the BMA's overall community which is showing by far more complexed development than before with very rapid urbanization of the Metropolis.

Followings are some of the comments on the organizational structures for road management from engineering approach.

1) Public Works Planning Sub-Division

It is proposed that this sub-division will be promoted to the Division in DPW, under which there will be two (2) sub-divisions. The functions and responsibilities to be assumed by these divisions will be;

a) Road Planning Sub-Division

This sub-division shall be responsible for all the research, planning and coordination functions on roads in the BMA area, which will be broken down as the following.

- Administration Section
  responsible for secretarial works, similar to other administrative sections, such as filing, general works of budgetary, financial, accounting and procurement jobs within the sub-division.

- Macro Planning Section
  responsible for 1) various road-related researches and studies such as network, inventory, road transport, transport economics, traffic environment and their statistics, etc., 2) preparation of policy alternatives in long range perspective plan for road development, improvement and maintenance, and 3) monitoring and evaluation of Five Year Development Plan for road.

- Road Planning Section
  responsible for 1) formulation of the five year and annual development, improvement and maintenance plans for roads including budgetary requirements, 2) monitoring and evaluation of the progress

of the road works programmed and implemented in the fiscal year, and 3) coordination with other divisions and departments of the BMA and other agencies of the central government, such as DOH, ETA, PWD, etc.

- Technical Standard Section
  responsible for research, development and dissemination of the various engineering technologies pertaining to road and its structures and related cost estimation. Also, based on these, preparation of all standards and guidelines on road.

b) Public Work Planning Sub-Division

This sub-division shall be responsible for all the research, planning and coordination functions on the overall works of DPW, except on road, which will be broken down as the following.

- Administration Section
  responsible for secretarial works, similar to other divisions.

- Public Works Planning Section
  responsible for 1) researches and studies on the public works excluding road, such as building, land, etc. on their social, economic and environmental impacts, 2) formulation of policy and strategy and plans for long range, middle term and annual development, improvement and maintenance of public works including budgetary requirements, 3) evaluation of work progress and coordinations.

- Technical Standard Section
  responsible for research, development and dissemination of the various technologies pertaining to building, land and other facilities excluding road, and their cost estimation. Also responsible for preparation of the technical standards and guidelines relating to above.

- Training Section
  responsible for training and education of the staffs in DPW detailes of which are described in the general view.

To assume above responsibilities and functions, substantial increase in qualified staffs will be needed.

2) Design Division

It is suggested that in order to keep with the progress of the current technological and engineering expertises which have different professional disciplines between architecture and civil engineering, this division is to be separated into two divisions, Architecture Design Division and Engineering Design Division, so that each division can proceed on each professional function under each qualified division director.

3) Material and Research Sub-Division

In compliance with the technological progress in designs and constructions, it is suggested for the BMA to have an independent and separate Test and Research Laboratory in the long run, but for the time being, to set up a Material and Research Division in DPW.

The main functions of this division are to 1) strengthen the existing material and soil testings and 2) to practice such surveys as the pavement conditions and traffic conditions, and 3) to test the quality of the traffic safety devices. Furthermore, this division is to carry out the researches on the various structures and environments (air, noise, etc.), and to engage in the system analysis on the works of DPW with all the relevant data kept and analyzed at this division.

4) Construction and Maintenance Division

It is observed that this division has the capacity and capability of maintenance of the bridges on the Chao Phraya River, if such responsibility and proper amount of budget may be transferred from PWD, MOI to this department.

5) Maintenance Center

The Maintenance Center of DPW is recommended to strengthen it functions to have two (2) additional centers to the existing three (3) centers located in West, North East and South East parts of the Metropolis to cope with the increasing demand on road maintenance in the Metropolis where rapid urbanization is progressing.

The locations of these 2 additional centers will be in north west and central parts.

6) District Offices

As to the public works section in each district office, it is observed that more effective and closer coordination are to be needed with DPW headquarters of the BMA for identification of the road sections to be improved or rehabilitated or to practice normal maintenance. As to the idea to combine the Maintenance Center with Public Works Section of the district office where the center is located, this idea shall be deleted because of the difference in scales of both the units.

7) Traffic Engineering Division (TED)

TED might be promoted to a department from division. At time of this promotion, the department shall consist of 3 divisions, namely; Traffic Management Div., Traffic Operations Div. and Traffic Signal Div., together with Office of Secretary for administrative purpose. Since there are so many works and programs closely related with those of DPW, it might be appropriate for this division to be within DPW as a temporary arrangement until the time of department promotion.

It might be advisable for TED to set up several committees at the operational level for better communications and consensus among the diversified organizational units on the overall policy and strategy of this division.

8) Other Function

In addition to the existing road and traffic related functions, the BMA may initiate a review on the new functions such as planning, construction and maintenance of the bridges on the Chao Phraya River.