社会開発協力部報告書

No. 2

THE REPUBLIC OF INDONESIA
FEASIBILITY STUDY
ON
IMPLEMENTATION
OF
INTRA-CITY DIGITAL MICROWAVE
SUBSCRIBER SYSTEM

JANUARY 1989

JAPAN INTERNATIONAL COOPERATION AGENCY

THE REPUBLIC OF INDONESIA
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PREFACE

In response to a request from the Government of the Republic of Indonesia the Japanese Government decided to conduct the Feasibility Study on Implementation of Intra-city Digital Microwave Subscriber System in the Republic of Indonesia and has entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Indonesia a survey team headed by Mr. Tadaaki KOUGO of NTT International Corporation, from March to June and from August to September, 1988.

The team held discussions with the concerned officials of the Government of the Republic of Indonesia and conducted a field survey. After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the Project and will contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the Republic of Indonesia for their close cooperation extended to the team.

January, 1989

Kensuke Yanagiya

President

Japan International Cooperation Agency

LETTER OF TRANSMITTAL

Mr. Kensuke YANAGIYA
President
Japan International Cooperation Agency

Dear Mr. President:

I have the honor to submit to you our final report of the Feasibility Study on Implementation of Intra-city Digital Microwave Subscriber System in the Republic of Indonesia. It is our great pleasure to note that this assignment has been completed through the close cooperation between two governments of Japan and Indonesia.

The final report was prepared during the past 10 months by the Study Team organized by members of NTT International Corporation, and headed by Mr. Tadaaki KOUGO. It comprises a Summary, 10 Chapters and 10 Attachments.

In preparing this Report, our Team benefited a great deal of the cooperation from officials and experts of Japan International Cooperation Agency and other authorities concerned of the Government of Japan.

On behalf of the Study Team, I would like to express my deepest appreciation to the Republic of Indonesia including POSTEL/PERUMTEL and to other related agencies of the Government for the unlimited cooperation and assistance and the warm hospitality extended to the Study Team members during their stay in Indonesia.

We sincerely hope that this Report will be an important basis for the development of the Republic of Indonesia.

Yours truly,

January 1989

Ichiro YAMANOUCHI
President
NTT International Corporation

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Words and Abbreviation

CCIR	:	International Radio Consultative Committee
CCITT	:	International Telegraph and Telephone Consultative Committee
CIF	:	Cost, Insurance and Freight
CR	:	Calling Rate
DFA	:	Direct Feed Area
DLU	:	Digital Line Unit
EIRR	:	Economic Internal Rate of Return
FIRR	:	Financial Internal Rate of Return
GRDP	:	Gross Regional Domestic Products
JICA	:	Japan International Cooperation Agency
PERUMTEL	:	Telecommunication Common Carrier in Indonesia
PMC	:	Program Management Consultant
POSTEL	:	Directorate General of Posts and Telecommunications
P-MP System	:	Point to Multi-point System
P-P System	:	Point to Point System
REPELITA-IV	:	The 4th 5 year National Development Plan
REPELITA-V	:	The 5th 5 year National Development Plan
RK	:	Rumah Kabel (Cross Connection Cabinet)
Subscriber Station	:	The subscriber building where a Microwave Subscriber System will be installed and plural subscribers are existing
SER	:	Shadow Exchange Rate
SWR	:	Shadow Wage Rate
WITEL	:	Regional Bureau of PERUMTEL

SUMMARY

SUMMARY

1. General

The purpose of this Study is to confirm the technical and economic feasibility of the application of a Digital Microwave System for a subscriber network in Jakarta.

From the results of the Study, it can generally be said that in Jakarta, the capacity of facilities in the Switching Center is relatively sufficient as compared with those of the outside plant and that existing subscriber lines have some problems as regards the quality of telecommunication services.
This means that most problems lie in the subscriber network rather than the other facilities.

The reason why the subscriber network has the problem is that installation of the subscriber network in Jakarta requires a great deal of difficult work such as forecasting of a rapidly increasing demand, cable construction in very complex areas with a high building density, acquisition of space, etc.

In view of the above situation, it is urgently necessary to provide a subscriber network for the purpose of meeting the telephone demand.

2. Technical Study

1) Establishment of criteria for basic approach of the Study

a) Study in harmonious coordination with PMC Option financed by World Bank Loan and PERUMTEL's own Finance

b) Subscriber Stations to be investigated;
- Subscriber Stations with five (5) or more floors or ten (10) or more line units
- Important Subscriber Stations (Hospitals, Communication Agencies, etc.)
- Subscriber Stations having poor quality

. Subscriber Stations with difficulties in construction of conventional Cable Subscriber System

c) Period of the Study is up to 1994

d) Specific characteristics of Jakarta
- Climate
- Future City Planning

2) Conduct of Field Survey concerning the following Subscriber Stations, Switching Centers and Outside Plant

. Subscriber Stations : 420
. Switching Centers : 32
. Outside Plant : Within subject area

3) Study Items

a) Demand forecasting up to 1994 taking into consideration future city planning, building construction planning and other factors

b) Comprehension of the existing situation and conditions for :
- Switching Center
  . Number of unoccupied terminals in switching equipment
  . Extra space for additional equipment
  . Traffic status
- Outside Plant
  . Lead-in Cable
  . Primary Cable
  . Cable Duct

c) Establishment of conditions regarding application of radio system
- Analysis of Weather Data
- Frequency Applicability

4) System Application

Based on the above Field Survey and Study, justification and selection of the applicable system was conducted for the introduction of a Microwave Subscriber System.

a) Features of Microwave Subscriber System

- Short period / Easy Installation and Easy Relocation
- Easy Maintenance and Operation
- Advantageous installation cost as compared with conventional Cable Subscriber System in case of long distance between the Base Station and Subscriber Station
  (However, the distance is limited by rainfall intensity and frequency.)
- Number of line units which can be used in this system is limited by:
  . Space for antenna installation
  . Capacity of the system
  . Interference between radio channels
- The application of this system is limited by visibility of line of sight between Base Station and Subscriber Station

b) System to be used

i) P-MP System: For scattered Subscriber Stations having a small number of line units
   - Frequency: 14.5 ∿ 15.35 GHz
   - Capacity : 158 ∿ 179 channels/zone
     24 channels/set
   - Radius of Radio Zone: 4.1 km

ii) P-P System: For Subscriber Stations that require a medium number of line units and whose distribution is concentrated at one location
   - Frequency: 17.7 ∿ 19.7 GHz
   - Capacity : 120 channels/set
   - Radius of Radio Zone: 4.2 km

The system configuration of each of the above is shown in Fig. 2-1.

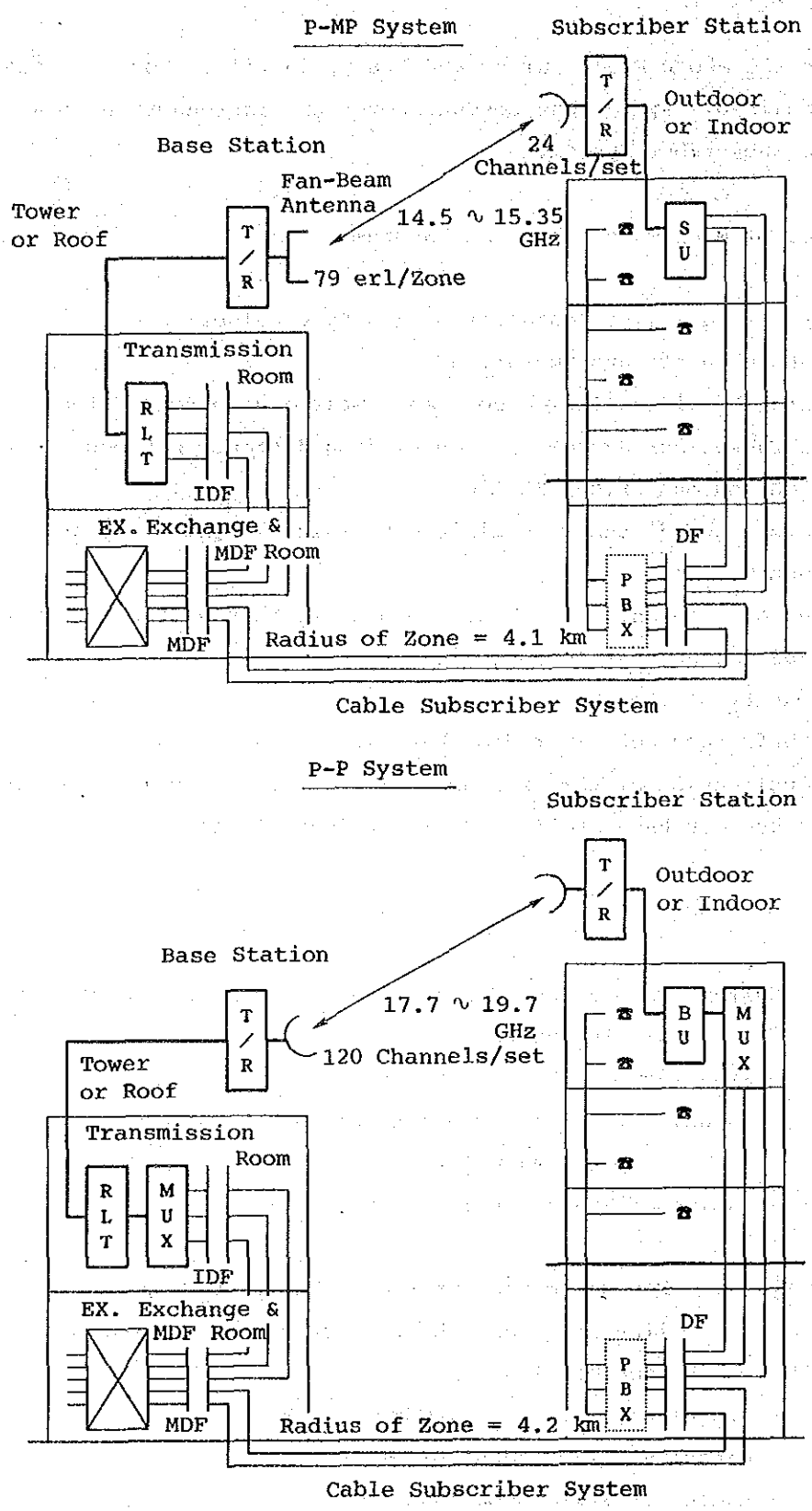


Fig. 2-1 System Configuration

c) Criteria for System Application

Efficient establishment of Areas and Base/Subscriber Stations was studied based on the following criteria:

i) Areas

. For P-MP System: Areas which include three (3) or more Subscriber Stations having an increase of 10 ∿ 48 line units, and two (2) or more applicable Subscriber Stations with selection factors

. For P-P System: Areas which include at least one (1) applicable Subscriber Station having an increase of 49 ∿ 600 line units

Subscriber Stations with selection factors defined by the following points:

- Important Subscriber Stations
- Subscriber Stations whose cost of Microwave Subsciber Station is cheaper than that of conventional Cable Subscriber System
- Subscriber Stations whose quality of existing subscriber lines is poor
- Subscriber Stations which present difficulties for the construction of a Cable Subscriber System

ii) Base Stations

. Existing Switching Centers are to be used as Base Stations.

. Maximum number of line units to be used in a Base Station is to be approx. 4800.

iii) Subscriber Stations

. Applicable Subscriber Stations are those indicated in para. i) above.

. The applied system is selected by the number of applied line units.

- For P-MP System: 48 or less line units
- For P-P System : 49 ∿ 600 line units

3. Project Establishment

In accordance with the System and criteria established in the technical study, the concept of the project was studied to determine the scale, method and cost.

1) Scale of the project

a) Subject Areas

18 areas: ANC, CAW, CPP, CPE, GB-1, GB-2, JT, KAL, KB, KT-2, PLM
PSR, PLT, RMG, SM-1, SM-2, SLP, TBT

The areas and applied systems are shown in Fig. 3-1.

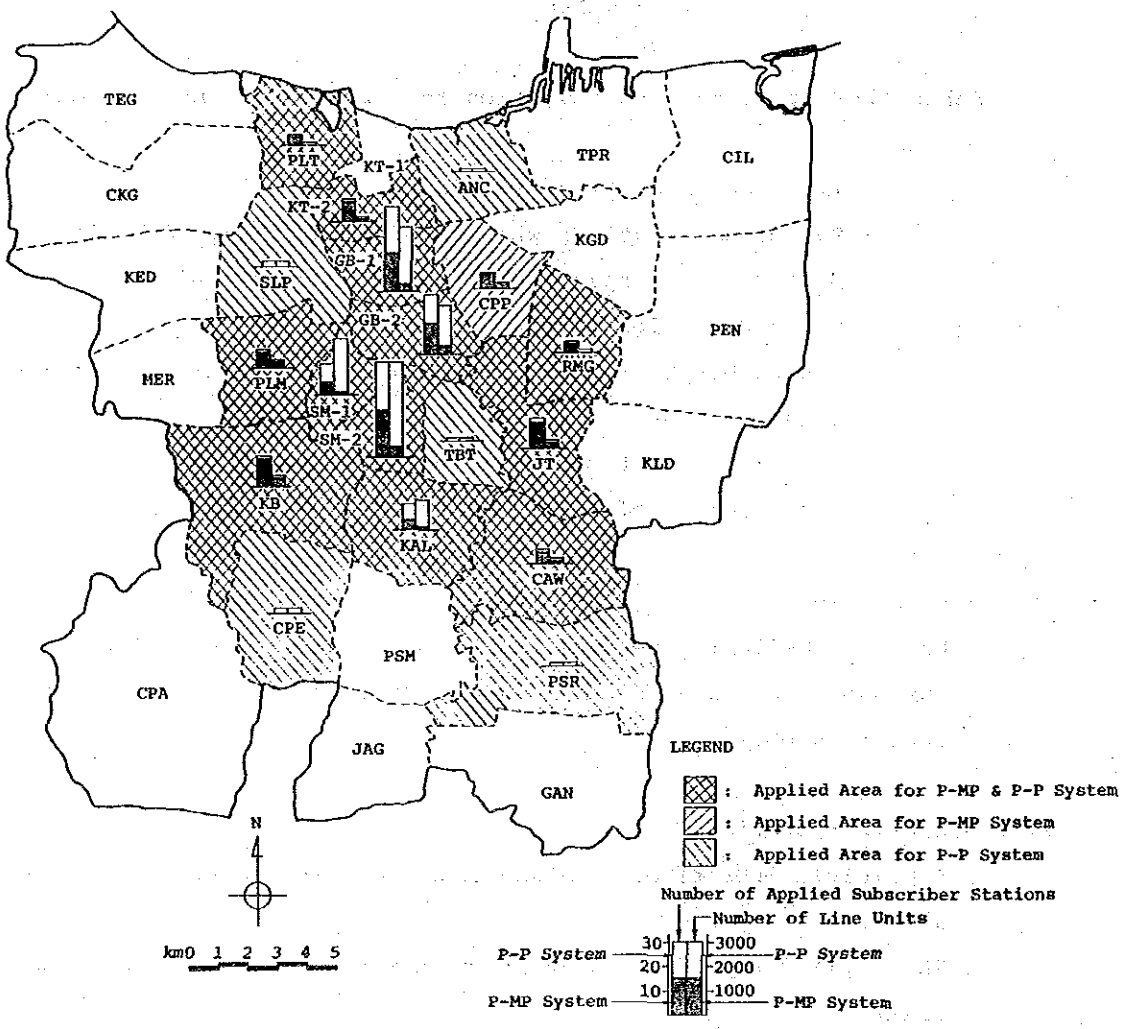


Fig. 3-1 Application Areas

b) Number of Subscriber Stations/Line Units

Subscriber Stations: 189 — P-MP System: 111
P-P System: 78

Line Units: 14,420 — P-MP System: 2,417
P-P System: 12,003

The number of Subscriber Stations and line units included in the subject areas was decided with due consideration of the system performance for each P-MP and P-P System. The annual trend of each is shown in Table 3-1.

Table 3-1 Annual Trend of Number of Subscriber Stations/Line Units

System	Number of	1989	1990	1991	1992	1993	1994
P-MP	Subscribers	93	97	101	103	110	111
System	Line Units	760	1,041	1,325	1,635	2,083	2,417
P-P	Subscribers	49	57	62	67	71	78
System	Line Units	4,466	5,981	6,970	8,672	10,111	12,003
Total	Subscribers	142	154	163	170	181	189
	Line Units	5,226	7,022	8,295	10,307	12,194	14,420

2) Implementation Schedule and Method

a) Implementation Schedule

The final target date for completion of all work is the end of 1994. However, work is to be divided into four (4) phases, because each phase should be conducted whenever actual demand arises as shown in Table 3-1 and 3-2. Meanwhile, the first phase of the work will include the following portions:

. Subscriber Stations: Both P-MP and P-P System will cope with demand up to 1991
. Base Stations : P-MP System will cope with demand up to 1994
P-P System will cope with demand up to 1991

The detailed implementation schedule is shown in Table 3-2.

Table 3-2 Project Implementation Schedule

		MONTH NUMBER	-14 -13 -12 -11	-10 -9 -8 -7	-6 -5 -4 -3	-2 -1 1 2	3 4 5 6	7 8 9 10	11 12 13 14	15 16 17 18	19 20 21 22	23 24 25 26	27 28 29 30	31 32 33 34	35 36 37 38	39 40 41 42	43 44 45 46	47 48 49 50	51 52 53 54	55 56 57 58
		CALENDAR YEAR	1989			1990			1991			1992			1993			1994		
		MONTH	1 2 3 4	5 6 7 8	9 10 11 12	1 2 3 4	5 6 7 8	9 10 11 12	1 2 3 4	5 6 7 8	9 10 11 12	1 2 3 4	5 6 7 8	9 10 11 12	1 2 3 4	5 6 7 8	9 10 11 12	1 2 3 4	5 6 7 8	9 10 11 12
	EVENT / SERVICE ITEMS					▲ CONTRACT FOR CONSULTING SERVICE		▲ CONTRACT OF PROJECT	▲ COMMENCEMENT OF INSTALLATION WORK		▲ COMPLETION OF WORK COMMENCEMENT OF SERVICE									
												▲ *2) BY PERUMTEL			▲ *2) BY PERUMTEL			▲ *2) BY PERUMTEL		
P M C	I. PMC OPTION 1) DESIGN 2) TENDER/EVALUATION/AWARD 3) CONSTRUCTION		———	———	———	EXPECTED SCHEDULE					*1)									
PERUMTEL'S TASK	II. SELECTION OF CONSULTANT 1) PREPARATION/APPROVAL OF TOR, S/L, L/I 2) TENDER 3) EVALUATION/AWARD/APPROVAL			———	———	———														
CONSULTANT'S TASK	III. 1) SURVEY, ENGINEERING DESIGN AND RECEIVING PERMISSION 2) SELECTION OF CONTRACTOR 3) SUPERVISION OF DETAILD DESIGN 4) WITNESSING FACTORY TEST 5) SUPERVISION OF INSTALLATION WORK 6) WITNESS ACCEPTANCE TEST					———	———	———	———	———	----									
CONTRACTOR'S TASK	IV. 1) IMPLEMENTATION DESIGN 2) MANUFACTURING 3) TRANSPORTATION 4) EQUIPMENT INSTALLATION a) BASE STATION NO. 1 GROUP NO. 2 GROUP NO. 3 GROUP b) SUBSCRIBER STATION NO. 1 GROUP NO. 2 GROUP NO. 3 GROUP 5) CABLE AND OTHER a) BASE STATION NO. 1 GROUP NO. 2 GROUP NO. 3 GROUP b) SUBSCRIBER STATION NO. 1 GROUP NO. 2 GROUP NO. 3 GROUP 6) TEST 7) TRAINING a) FACTORY (CLASS ROOM) b) LOCAL (CLASS ROOM) (ON THE JOB) 8) ONE YEAR MAINTENANCE ASSISTANCE																			

Note: *1) DEPEND ON SCHEDULE FOR CABLE MANUFACTURING, APPROVAL FOR EXCAVATION AND FINANCE ARRANGEMENT
*2) PERUMTEL SHALL DIRECTLY CONDUCT THIS WORK AS OPTIONAL WORK TO THE CONTRACTOR'S CONCERNED
3) ——— : CONTINUOUSLY EXECUTED
---- : OCCASIONALLY EXECUTED

b) Installation Work

Installation work of equipment and other associated materials in each phase is to be conducted in accordance with a priority order due to the importance of Subscriber Stations to be relieved by this system as shown in Table 3-3.

Table 3-3 Priority Order of the Area

Priority Order	Name of Area
No.1 group	SM-2, SM-1, GB-1, GB-2
No. 2 group	KAL, KB, SLP, CPP, PLM, JT
No. 3 group	PLT, CPE, PSR, RMG, KT-2, CAW, ANC, TBT

3) Total Project Cost

Total cost including contingency necessary for implementation of the Project is:

Rp. 32,369 million

Meanwhile, the breakdown of foreign/local currency of the above total cost is:

Foreign Currency Portion: ¥2,269 million

Local Currency Portion : Rp. 4,009 million

(Exchange rate: ¥ 1 = Rp. 12.5)

4. Project Evaluation

The financial and economic feasibility of the Project is to be evaluated, including the effect of the system introduction in Jakarta.

1) Financial and Economic Analysis

The Project was evaluated by using the internal rate of return method for benefit and cost in order to confirm the feasibility of the Project from a financial and economic point of view.

As a result of the Study, the following data was obtained:

Financial Internal Rate of Return: 24.9%
Economic Internal Rate of Return : 36.9%

In addition, it was also identified that the additional revenue by this Project is expected to be about Rp. 7,500 million per year, and a high rate of return could be obtained whenever considering fluctuation factors such as an increase of average revenue per subscriber line and cost escalation due to inflation.

The result of analysis is shown in Table 4-1.

Table 4-1 Sensitivity Analysis

	Condition	FIRR (%)
Basic Case	Where no variation of revenue/cost	24.9
Revised Case	Where revenue increases at 3% a year	27.7
	Where total cost increases by 10%	21.9
	Where inflation escalates at 7.5% a year	21.9

2) Effect of System Introduction

When this System is introduced, the following benefits can be expected.

a) Reduced waiting: About 50% of total waiting of subject subscribers by the end of 1989

b) Improvement of poor quality lines: About 1,500 line units

c) Development of Telephone Utilization

- Possibility of ensuring emergency communications especially for important Subscribers
- Possibility of coping with the provision of temporary/emergency lines
- Development of economic activity

3) Overall Evaluation

In consequence, it was demonstrated that this Project is feasible and will be highly beneficial due to the actual implementation.

5. Recommendations

Telecommunications, especially for subscriber lines are indispensable for modern economic and social development.

As seen from the results of technical study and the financial and economic analysis contained in the report, this Project is feasible as a public telecommunication service project. In a national economic sense also, its implementation is desirable.

The recommendation is hereby made that all selected Subscriber Stations (189 Subscriber Stations) in 18 Areas explained in para. 3 of this summary should be implemented as planned, and in strict accordance with the implementation schedule.

Followings are the main points of recommendations as regards the Project execution and technical aspects related to the implementation of this project.

1) Recommendations for Project Execution

a) Harmonious project execution with the other projects which are now being conducted by PERUMTEL in Jakarta

b) Direct management and supervision of the work by PERUMTEL concerning the work from the second to fourth phases which is explained in para. 3 of this summary

c) Acquisition of advance permission by PERUMTEL for the installation of equipment/material for the system in Subscriber Stations

d) Alternative Project Implementation Plan

It is also possible that the following three (3) cases will be adopted as an alternative project implementation plan with due consideration of various kinds of surrounding circumstances and conditions for the implementation of this Project.

① Alternative Case 1 .... only No. 1 group (SM-2, SM-1, GB-1, GB-2)

② Alternative Case 2 .... only No. 1 and No. 2 group (SM-2, SM-1, GB-1, GB-2, KAL, KB, SLP, CPP, PLM, JT)

③ Alternative Case 3 .... only SM-1, GB-1 and GB-2 of No. 1 group

2) Recommendations on Technical Aspects

a) Antenna Towers

Antennas to be used for this Project are to be installed on existing towers and/or towers now under construction in Subject Switching Centers.

If towers are not available for this Project, the areas for tower construction shall be considered.

b) System

i) Common Antenna

For the purpose of efficient application of the P-MP System, antennas are to be concentrated as much as possible for common use.

ii) Enlargement of System Capacity

To effectively accommodate a large number of line units in Subscriber Stations, a larger capacity system is to be considered and added during the actual implementation stage.

c) Countermeasures for Electric Power Failure

For the purpose of efficient operation of the system, an uninterruptible power supply system is considered for use in each Subscriber Station.

d) Public Telephone

In case that public telephones are connected to the Microwave Subscriber System, the public telephone signalling should be considered.

e) Details of the state of such facilities as switching equipment, MDFs, etc. will be investigated and confirmed in detail.

CHAPTER 1

INTRODUCTION

CHAPTER 1 INTRODUCTION

1.1 Background to the Study

1) *Background*

Although the telecommunications facilities in the Republic of Indonesia have been gradually improved by past expansion programs, the existing facilities are far from adequate to meet increasing business, administrative, residential and other demands for telephone and other services.

Recently, particularly in Jakarta city, industrial / commercial activities and related urban development have been increasing rapidly and insufficient telephone service is becoming a crucial problem for almost all business activities in Jakarta.

In the REPELITA IV Program and subsequent Long Term Programs, Jakarta city is a major target for telecommunications facilities expansion. For the successful implementation of this expansion, it is vitally necessary to provide each kind of facility, e.g. Switching equipment, outside plant, and microwave facilities, in a well-coordinated manner. To achieve this aim, the biggest current problem in Jakarta city is in the construction of a subscriber network and it is the most behind schedule of the related facilities. The reason why the subscriber network has a problem is that installation of the subscriber network in Jakarta requires a great deal of difficult work such as forecasting rapidly increasing demand, construction of cable lines in very complicated and building-crowded areas, acquisition of space, etc. A great deal of money and time is usually required to resolve these difficulties.

On the other hand, in recent years, due to state-of-the-art technology, digital microwave systems have made rapid advances, and several systems for subscriber networks in terms of construction cost, time and facilities transfer at a later date are being developed. Radio systems are efficient in areas where cable construction is difficult or where the building density is high, and also in areas where urgent public/business demands are increasing.

Against this background, the Republic of Indonesia and the Japanese Government agreed to cooperate in the implementation of a feasibility study on the Intra-city Digital Microwave Subscriber System (hereinafter referred to as "Microwave Subscriber System") in Jakarta (hereinafter referred to as "the Study") in 1987.

2) Dispatch of Preliminary Study Team

In accordance with the agreement between the Republic of Indonesia and the Japanese Government, the Japanese Government decided to carry out an investigation concerning the applicability of a Digital Microwave System for Subscriber lines especially in Jakarta city, and arranged for Japan International Cooperation Agency (hereinafter referred to as "JICA") to carry out the investigation.

Prior to the investigation by the Feasibility Study Team, JICA dispatched a Preliminary Study Team to the Republic of Indonesia for the period of November 16 to November 28, 1987.

The Preliminary Study Team made a status quo investigation of Jakarta city and examined the required scope and contents of the Study.

Based on the above Study, the Preliminary Study Team discussed with competent authority of the Republic of Indonesia and reached an agreement to establish the Scope of Work on November 27, 1987.

3) Dispatch of Feasibility Study Team

Based on the Scope of Work determined during the preliminary study, JICA organized a Feasibility Study Team (hereinafter referred to as "JICA Study Team") who carries out the Study during the period from March 7, 1988 to January 11, 1989.

1.2 Description of the Study

1) Objective of the Study

To confirm the technical and economic feasibility of implementing an Intra-city Digital Microwave Subscriber System in Jakarta, up to the year 1994.

2) Subject of the Study

The areas and Switching Centers to be studied are shown in Fig. 1-2-1 and Table 1-2-1.

Within the areas and Switching Centers shown in Fig. 1-2-1, the following applicants and specific areas were considered to be the subject of the Study on the introduction of the Microwave Subscriber System.

a) Those where cable construction is extremely behind schedule and switching capacity has not yet been fully utilized.

b) Those where the situation is almost the same as in a) above, and where there is a high concentration of waiting applicants, such as in high-rise buildings.

c) Those which require high reliability in telecommunication services such as important facilities, public facilities, etc.

d) Those where existing cable networks have a high failure rate or where there are difficulties in cable network construction.

e) Those where the demand for digital subscriber services is expected to rise in the near future.

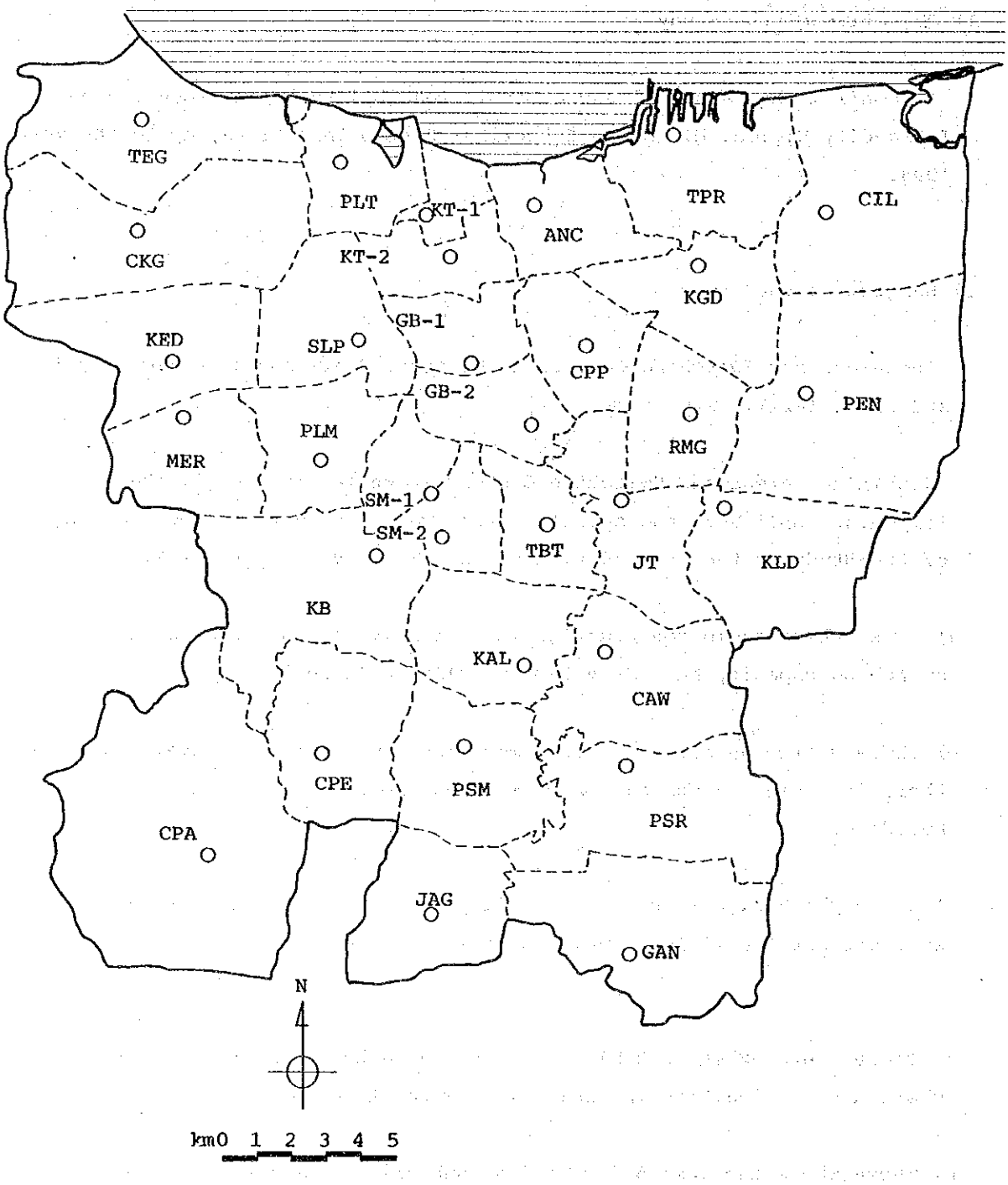


Fig. 1-2-1 Areas and Switching Centers Covered by Study

Table 1-2-1 Switching Center Abbreviations

No.	Abb.	Name	No.	Abb.	Name
1	ANC	Ancol	17	KLD	Klender
2	CAW	Cawang	18	KT-1	Kota-1
3	CPP	Cempaka Putih	19	KT-2	Kota-2
4	CKG	Cengkareng	20	MER	Meruya
5	CIL	Cilincing	21	PLM	Pal Merah
6	CPE	Cipete	22	PSM	Pasar Minggu
7	CPA	Ciputat	23	PSR	Pasar Rebo
8	GB-1	Gambir-1	24	PEN	Penggilingan
9	GB-2	Gambir-2	25	PLT	Pluit
10	GAN	Gandaria	26	RMG	Rawamangun
11	JAG	Jagakarsa	27	SM-1	Semanggi-1
12	JT	Jatinegara	28	SM-2	Semanggi-2
13	KAL	Kalibata	29	SLP	Slipi
14	KB-1	Kebayoran Baru	30	TPR	Tanjung Priok
15	KED	Kedoya	31	TBT	Tebet
16	KGD	Kelapa Gading	32	TEG	Tegal Alur

3) Contents of the Study

a) Investigation of existing telecommunication facilities and demands

b) Collection and analysis of necessary data and information for the Study

c) Telephone demand forecast up to 1994

d) Establishment of radio zones and system, including selection of a system which is appropriate to the Microwave Subscriber System

e) Technical study on the Microwave Subscriber System

f) Justification of application areas/stations including cost comparison between the Microwave Subscriber System and Cable Subscriber System

g) Project cost estimation and implementation plan

h) Financial and economic analysis of the Project

i) Maintenance and operation guidelines

1.3 Feasibility Study Team, etc.

JICA organized a Feasibility Study Team composed of members of NTT International Corporation (NTTI), and at the same time established an Advisory Committee to give technical and other appropriate advice to the Feasibility Study Team throughout the Study period as regards the progress of the Study as compared with the schedule.

The names and duty-in-charge of the Feasibility Study Team members and Advisory Committee are in Table 1-3-1 and Table 1-3-2.

Table 1-3-1 Feasibility Study Team

Name	Responsibility	Affiliated to
Tadaaki KOUGO	Survey Leader and Demand Forecasting	Deputy General Manager Project Department Project Management Division NTT International Corporation
Seisaku BABA	Demand Forecasting	Manager Project Department Project Management Division NTT International Corporation
Akira ITAGAKI	Radio Plant (Planning) Engineering	Manager Project Department Project Management Division NTT International Corporation
Osamu FUJIWARA	Switching Plant Engineering	Manager Project Department Project Management Division NTT International Corporation

Name	Responsibility	Affiliated to
Tomio NAGAOKA	Radio Plant (System) Engineering	Deputy manager Project Department Project Management Division NTT International Corporation
Yoshio FUJITA	Outside Plant Engineering	Engineer Project Department Project Management Division NTT International Corporation
Hidenobu KOBAYASHI	Financial/Economic Analysis	Economist Project Department Project Management Division NTT International Corporation

Table 1-3-2 Advisory Committee

Name	Position	Period	Place of Employment
Noboru YOSHIDA	Chairman	63.2.15 ∿ 63.7.14	Deputy Director Telecommunication Systems Division Ministry of Posts and Telecommunications
Hidekazu TANAKA	Chairman	63.7.14 ∿	Deputy Director Frequency Planning Division Telecommunications Bureau Ministry of Posts and Telecommunications
Haruo AZAMI	Member	63.2.15 ∿ 63.10.14	Special Advisor International Cooperation Division Communication Policy Bureau Ministry of Posts and Telecommunications

Name	Position	Period	Place of Employment
Norio SEKI	Member	63.10.14 ∿	Special Advisor International Cooperation Division Communication Policy Bureau Ministry of Posts and Telecommunications
Ryukichi IMAI	Member	63.2.15 ∿	Ditto
Kinichi UMEYA	JICA	63.2.15 ∿	Japan International Cooperation Agency

1.4 Study Program

The Study program was conducted in seven (7) phases in accordance with the Scope of Work and schedule concluded between the Government of the Republic of Indonesia and the Preliminary Study Team.

1) Preparation

Preparatory work consisted of the collation and analysis of data which has already been collected, formulation of basic criteria for the Feasibility Study and preparation of the Inception Report.

2) Field Survey-1

Field Survey-1 was carried out during the period from March 22 to June 4, 1988.

The main work items during Field Survey-1 were as follows :

a) Before starting the investigation, explanation and confirmation of the Inception Report was performed by POSTEL / PERUMTEL and the JICA Study Team, and minutes of the meeting for the above were prepared and signed by both parties on April 14, 1988.

b) Data and information necessary for the Study was collected from the authorities concerned and firms in the Republic of Indonesia.

c) Demand was investigated, in order to establish the actual existing demand for the Subject Subscriber Stations.

d) Observation and investigation of Switching Centers was conducted to establish the existing situation and suitability for the subject system, considering the demands and traffic within each Switching Center.

e) Observation and investigation of the outside plant was conducted to establish the present situation regarding existing cable and facilities.

f) Preparation and explanation of the progress report, as well as confirmation of the basis of design for the subsequent Study was accomplished and minutes of the meeting for the above were prepared and signed by both parties on June 4, 1988.

3) Work in Japan-1

Based on Field Survey-1, the primary Study and data analysis were carried out during the period from June 5 to August 4, 1988 as shown below :

a) Analysis of data for demand and demand forecasting

b) Analysis of data for Switching Centers and outside plant

c) Analysis of weather data

d) Cost comparison between the Microwave Subscriber System and Cable Subscriber System

e) Primary Study for selection of Base Stations and Subscriber Stations which are suitable for the Microwave Subscriber System.

f) Preparation of the Interim Report

4) Field Survey-2

Field Survey-2 was carried out during the period from August 5 to September 22, 1988.

The main work items during Field Survey-2 were as follows :

a) The Interim Report was explained, and confirmation of the result of the Study during Work in Japan-1 was made, and minutes of the meeting were prepared and signed by both parties on August 13, 1988.

b) A detailed investigation was conducted into the Switching Centers and Subscriber Stations which were focused on and selected by the Study during Work in Japan-1.

c) A detailed investigation of cable routing and the situation regarding existing cable facilities was made.

d) A line-of-sight investigation was conducted by using mirrors between the Switching Centers and Subscriber Stations.

e) The present status of the Study was explained, and confirmation of the selection criteria for Subscriber Stations and fundamental conditions was made, and minutes of the meeting were prepared and signed by both parties on September 20, 1988.

5) Work in Japan-2

Based on Field Survey-2, the final Study and data analysis were carried out to establish the following :

a) Data Analysis and Final Study

. Demand analysis and final Study

. Final system selection suitable for the Microwave Subscriber System

. Final Selection of Base / Subscriber Stations and Areas

b) Study of the operation and maintenance organizations after installation of the Microwave Subscriber System.

c) Project implementation plan and schedule from engineering to installation including technology transfer.

d) Feasibility Study from an economic and financial point of view.

e) Preparation of the Draft Final Report as a result of the above studies.

6) Presentation of the Draft Final Report

Presentation and explanation of the Draft Final Report was made to the competent authorities of the Government of the Republic of Indonesia during the period from November 18 to November 30, 1988, and minutes of meeting were prepared and signed by both parties on November 28, 1988.

7) Work in Japan-3

After presentation with explanatory comments of the Draft Final Report, the Final Report was prepared in Japan and presented by mail to the Government of the Republic of Indonesia.

This brought the feasibility study and related services to a successful conclusion.

1.5 Competent Authorities and Personnel

Below are listed the personnel concerned in the Project in DITJEN POSTEL, Ministry of Tourism, Post and Telecommunications, and PERUMTEL, the Project implementing entity.

1) POSTEL

Sri Slameto	Deputy Director General
Tjaroso	Director of Engineering
Soeharsono	Director of Operation
Koesmarihati Sugondo	Chief of Planning Program
Soedarpo	Chief of Text & Data
L. Woerfiendrti Soedarmoro	Chief of Frequency Management
Banbang Setiawan	Chief of Transmission Division

2) PERUMTEL

Saleh Gunawan	Development Program (∿ Oct. 1988)
Suroto Hfadisumarto	WITEL IV (∿ Oct. 1988)
Bajoe Narbito	BINPROSENTEL
Agus Budi T.	Ditto
Wisnu A Marantika	BINPROSISTEL (∿ Oct. 1988)
Angger Pramudito	BINPROSISTEL
Mulia Tambunan	Ditto
Lumumba Sirait	Ditto
Dedi Mutakin	BINPROJARTEL
Syarif S.	Ditto
Asmari	BINPROTRATEL

CHAPTER 2

GENERAL CONDITIONS IN JAKARTA

CHAPTER 2 GENERAL CONDITIONS IN JAKARTA

2.1 Situation in Jakarta

1) General

Jakarta is located on Java Island, one of the most important islands of the Indonesian archipelago and as the capital of the Republic of Indonesia Jakarta is one of the biggest cities in Indonesia alongside Medan, Surabaya, Ujungpandang, Semarang and Jogyakarta.

Most Government Administration Office headquaters are located in Jakarta, indicating the importance of the city as center of industrial and commercial activities, including international and national trade. Jakarta is divided into five (5) middle class municipalities as administrative districts, thirty (30) districts and 236 villages, of which one district and four (4) villages are located on several islands of the Seribu archipelago in the Gulf of Jakarta, part of the Java sea. Jakarta, Jogyakarta and Aceh are called special provincial areas, in which the governor administers the city as an autonomous area.

2) Geography

Jakarta has an area of about 590 km^2, according to the total number of service areas covered by Switching Centers surveyed this Study. The Jakarta area is bounded by on West Java province to the south, east and west, and by Java sea to the north and the Ciliwung river runs through the center of the city.

The nearest non-active volcanic mountain from Jakarta is Salak Mountain, about 70 km to the south. Jakarta has no lakes, and there are many fish-ponds or dykes which are used for inland fishery industries or in recreation grounds. As mentioned before, some of the islands in the Seribu archipelago belong to Jakarta; Thus Jakarta has both a mainland area and an open sea area.

3) Climate

There are two seasons in Indonesia, a rainy and a dry season. These seasons correspond to the wind flows influencing the Indonesian archipelago.

In the dry season which lasts from June until September, the winds affecting Indonesia come from the Australian continent and have a low water vapour content: in the rainy season, winds are from the Asian continent and Indian Ocean until March.

The average wind velocity throughout the year for Jakarta is around 1.6 knots, with a high of 1.9 knots and a low of 1.3 knots. The temperature throughout the year is within the range of 23.2 ∿ 32.7 degrees Celsius, with an average humidity of 76.3%. The average rainfall is 230.4 mm in the rainy season and 85.2 mm in the dry season. Table 2-1-1 showing the climate data of Jakarta.

Table 2-1-1 Climate of Jakarta (1986)

Month	Temperature (Celsius)	Humidity (%)	Rainfall (mm)	Wind Velocity (Knots)
January	30.7 ∿ 23.4	82	396.5	1.4
February	31.7 ∿ 24.2	79	174.0	1.7
March	32.0 ∿ 23.8	78	178.4	1.5
April	31.8 ∿ 24.1	80	273.7	1.5
May	32.7 ∿ 24.2	77	190.0	1.5
June	32.0 ∿ 23.8	76	157.4	1.3
July	31.3 ∿ 23.2	77	131.4	1.9
August	32.5 ∿ 23.4	71	8.4	1.8
September	32.4 ∿ 23.6	72	43.6	1.5
October	32.5 ∿ 24.0	74	147.5	1.5
November	32.4 ∿ 24.1	74	64.3	1.6
December	31.6 ∿ 23.8	76	172.8	1.8

Source: Biro Pusat Statistik, Statistik Indonesia 1986

Natural disasters, such as floods mostly occur during the rainy season. Tectonic earthquakes occur over the whole of Indonesia area, 300 ~ 400 times per year with an intensity of more than 4 on the Richter scale, but

Jakarta is very rarely affected, because the source is very great distance away.

4) Population

The total population of Indonesia in 1985 was approximately 165 million with a rate of increase of 2.15% per year in the period 1980 ∿ 1985. In 1985 Jakarta had a population of about 7,920,000 people, with the number increasing at the rate of 3.93% per year. From this figure, the population in Jakarta is 4.8% of the total population of the Republic of Indonesia, although the total area of Jakarta is only 0.03% of the total area of Indonesia. So density of population of Jakarta is 13,365 person per km^2, as a result of estimation from data on 1980 which reach of 11,023 person per km^2.

Table 2-1-2 shows the population of Jakarta from 1985 to 1990.

Table 2-1-2 Population of Jakarta (1985 ∿ 1990)

Year	1985	1986	1987	1988	1989	1990
Population	7,913,525	8,218,140	8,533,705	8,806,573	9,199,109	9,549,682

Source: Biro Pusat Statistik, Statistik Indonesia 1987

5) Future Development in Jakarta Area

Jakarta has a greater trend toward development than other cities in Indonesia. For instance, Jakarta is now constructing new outer ring roads bounding the east, west, north and south of the city, and the construction of new high rise buildings in the center of the city is proceeding at a fast pace.

Because of the trend of increased population mentioned before, the construction of new housing facilities is proceeding to meet the high demand. Table 2-1-3 shows new housing facilities constructed by REI, the organization of Indonesian Real Estate Companies, Perumnas, a state-owned company for the construction of housing facilities, and BTN, a state-owned bank for financing a housing development.

Table 2-1-3 Housing Development by REI and BTN

Description	Unit	1982-1983	1983-1984	1984-1985	1985-1986	1986-1987
R.E.I	Each	14,376	94,206	2,901	6,780	8,300
B.T.N	Each	-	-	-	-	22,693

Source: REI

Area	Medium Size	Small Size	Apartment Type	Total
Jakarta	7,141	1,228	2,840	11,209
Depok	8,346	12,521	-	20,867
Bekasi	8,424	3,132	-	11,556
Tanggerang	4,462	3,504	-	7,966
Bogor	936	1,024	-	1,960

Source: REI

This new development of housing facilities, public buildings, roads industries etc. represents a residential area where is growing year by year, while other areas such as inland fishery industries, agriculture, poultry, rice paddies and horticulture are not expanded. The utilization of land in Jakarta is given in Table 2-1-4.

Table 2-1-4 Utilization of Land in Jakarta

Year	House Compound	Garden	Dyke	Water Pound	Not Utilized	Grown Wood	Estates	Wet Land
1984	32,294	8,284	1,141	226	508	-	60	8,330
1985	23,517	6,121	156	127	1,529	264	60	7,920
1986	19,495	5,622	117	117	1,503	-	121	7,680

Source: Biro Pusat Statistik, Statistik Indonesia 1985

Also the administrative areas of Jakarta are being further extended, mainly in the south, east, west areas of Jakarta. The newly developing areas are called JABOTABEK areas, an abbreviation for Jakarta-Bogor-Tanggerang-Bekasi, where Bogor represents south on developing areas such as Depok, Cinere, Bintaro etc., Tanggerang represents west on developing areas such as Meruya, Kedoya, Tegal Alur etc., and Bekasi represents east on developing areas such as Penggilingan, Klender, Bekasi etc.

2.2 State of Telecommunications

1) Present State of Telecommunications in Jakarta

Jakarta is the biggest user of telecommunication services with approximately 34% of the total number of subscribers for the whole of Indonesia, which reached a figure of 880,000 in July 1988.

During the evaluation carried out first stage of this Study, it was identified that there is a large amount of switching equipment which can relieve high demand in its own service area; especially for high-rise buildings and big subscribers (direct feed service area) the number of waiting applicants are approaching 192,000. The waiting ratio is about 63.6% of the total number of subscribers installed in Jakarta, which is around 300 thousand subscribers.

2) Measures to Deal with Present State of Telecommunications

In view of this situation, POSTEL has adopted a policy of optimization and improvement of the existing telecommunication facilities, and has already decided to introduce a new system for developing new telecommunication facilities, looking for a break-through to greater efficiency, low investment and quick action to satisfy this high demand, together with the REPELITA-IV program aimed at the improvement of *telecommunication facilities in Jakarta.*

3) Further Development Plans for Telecommunications

In the next five-year development plan "REPELITA-V", which will end in 1994, it is planned for Jakarta to have 1,162,000 subscribers, i.e. 44.2% of the planned total for the whole of Indonesia of 2,627,000 subscribers. In this REPELITA-V plan, a five existing Switching Centers are planned to be modified and new Switching Center also planned to be built in the Cinere sub-district in order to meet this target.

2.3 Organization of Telecommunications Authorities Concerned

1) Ministry of Tourism, Posts and Telecommunications (hereinafter referred to as MTPT) supervises two directorate generals; one is posts and telecommunications, and the other is tourism.

In this Study, the Directorate General of Posts and Telecommunications (POSTEL) has responsibility with regard to the JICA Study Team.

An organization chart of MTPT is shown in Fig. 2-3-1.

2) Perusahaan Umum Telekomunikasi (PERUMTEL)

The headquarters of PERUMTEL is located in Bandung with twelve (12) WITELs under direct control of the headquarters; nationwide telecommunications services except mobile telephones and paging are offered.

Organization of PERUMTEL is shown in Fig. 2-3-2.

3) WITEL-IV

WITEL-IV is one of twelve regional telecommunications bureaus and controls the Jakarta area.

Organization of WITEL-IV is shown in Fig. 2-3-3.

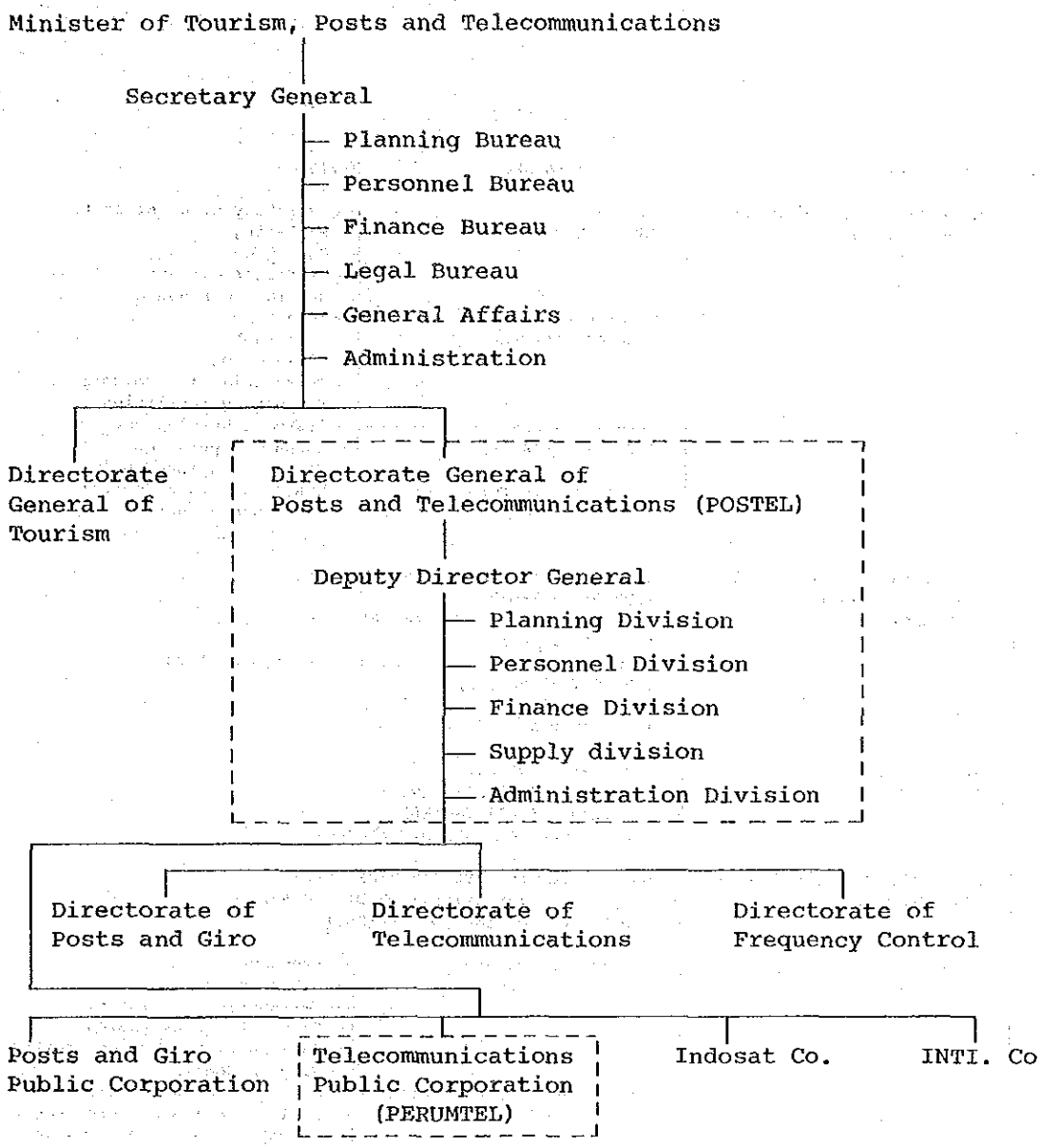


Fig. 2-3-1 Organization Chart of Ministry of Tourism, Posts and Telecommunications

As of August, 1988

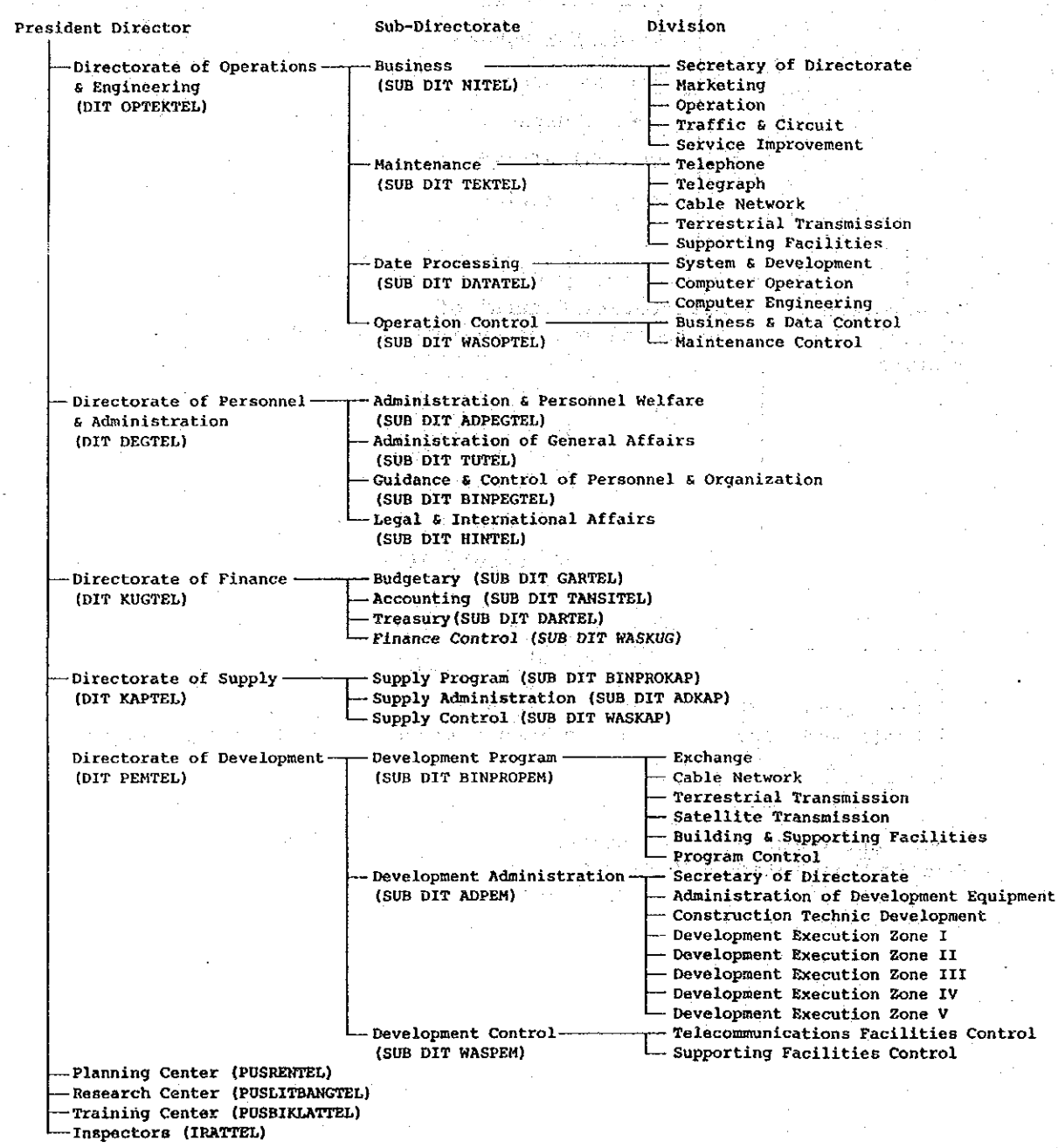


Fig. 2-3-2 Organization Chart of PERUMTEL As of August, 1988

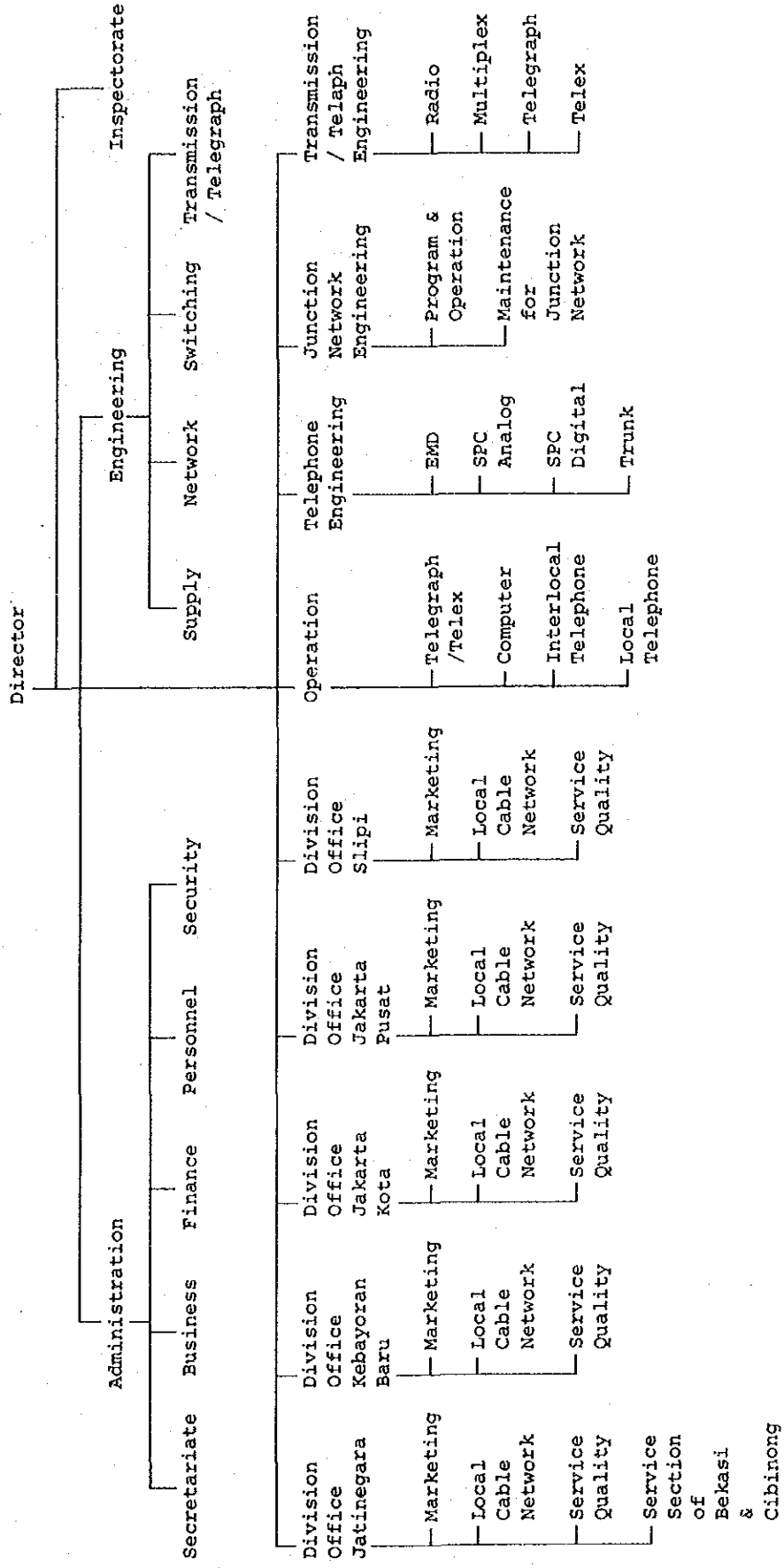


Fig. 2-3-3 Organization Chart of WITEL-IV As of August, 1988

CHAPTER 3

BASIC APPROACH OF THE STUDY

CHAPTER 3 BASIC APPROACH OF THE STUDY

3.1 General

The Study was conducted with due consideration given to the objectives of the Study and other conditions stipulated in Chapter 1 and also to good cooperation with other projects such as the PMC option project now conducting design of a Cable Subscriber System and the Long and Medium Term Plan for Telecommunication Network in JABOTABEK Area now being studies by JICA.

In addition, as a basic approach of the Study, the following points were considered throughout all phases of the Study.

1) The following documents were taken into consideration as general guidelines for the Study:

   --- Strategic Development Plan (1986)
   --- Fundamental Technical Plan (1985)
   --- Long Term Planning for Development of Telecommunication (JICA, Feb. 1987)

2) Specific Characteristics of Jakarta

   --- Heavy Rainfall
   --- Sophisticated and high-density city organization and future city plan
   --- Increasing number of waiting applicants and delay in providing cable subscriber lines

3) Justification of Microwave Subscriber System in comparison with the other systems such as Cable Subscriber Systems in early stage of the Study.

4) Coordination of this Study with other projects such as PMC option and PMC main, and contact with the other organization concerned.

5) For the purpose of the effective promotion of the technology transfer to counter parts and smooth execution of this Study, the Study should be carried out together with counterparts via on-the-job training and on a man-to-man basis.

6) Cooperative work with local engineers and staff for the smooth execution of Field Survey, collection of data and acquisition of various kinds of permission.

3.2 Investigation and System Design

Investigation and system design were carried out based on the following guidelines during all stages of the Study:

1) Subscriber Stations to be investigated

a) Subscriber Stations with five (5) or more floors or ten (10) or more circuits

b) Subscriber Stations involving construction difficulties

--- Those where excavation at crossroads will be necessary for cable laying

--- Those where excavation along inside of the road will be necessary for cable laying

c) Important Subscriber Stations such as hospitals, newspapers and communication agencies

d) Poor quality Subscriber Stations

--- Subscriber Stations which are identified as the Subscriber Stations having poor quality subscriber lines as the result of interviews

--- Subscriber Stations which were regarded as being poor quality Subscriber Stations in PERUMTEL's data.

e) Subscriber Stations necessary for temporary and emergent utilization

Meanwhile, regarding item c) and d), Subscriber Stations with four (4) or less are included in subject of investigation.

2) Demand Forecast

Demand forecast is studied up to 1994 in this Study.

3) System Design

a) Standard

CCIR and CCITT is referenced for system design.

b) System Parameters

System parameters to be studied are in the range of the following:

i) Frequency	: 2-26 GHz	
ii) Capacity	: P-P system	
per set		30-120 channels
in Subsciber	P-MP system	
Station		8-48 channels

Meanwhile, the system applied for the Study should be existing and/or underdevelopment.

c) Termination

When applying the Microwave Subscriber System to Subscriber Stations, its application, in principle, is to be terminated at the Switching Center.

d) Frequency Use

Frequencies used by the Microwave Subscriber System should be established by taking into consideration the geographical distribution of

Subscriber Stations, rainfall conditions in Jakarta and frequency allocation.

3.3 Cost Calculation

For the purpose of cost comparison between the Microwave Subscriber System and Cable Subscriber System, the cost of each system is calculated in the following way:

1) Microwave Subscriber System

a) The cost of the Microwave System is estimated on the basis of similar existing radio systems.

b) Components included in this cost estimation are all materials and equipment up to the Main Distribution Frame (MDF) in the Switching Center and the Distribution Frame (D.F) in the Subscriber Station.

c) The installation cost of the above is also included in the cost estimation.

2) Cable Subscriber System

a) The cost of the Cable Subscriber System is estimated for each of the following cases:

① Metallic Cable Subscriber System

② DLU system, classified into:

---- PCM-30 System

---- Optical Fiber System

b) Other conditions of cost calculation for the Cable Subscriber System are the same as for the Microwave subscriber System mentioned above.

CHAPTER 4

PRESENT SITUATION ANALYSIS

CHAPTER 4 PRESENT SITUATION ANALYSIS

In this chapter, data and information obtained is analyzed and evaluated for demand forecast/technical study purposes.

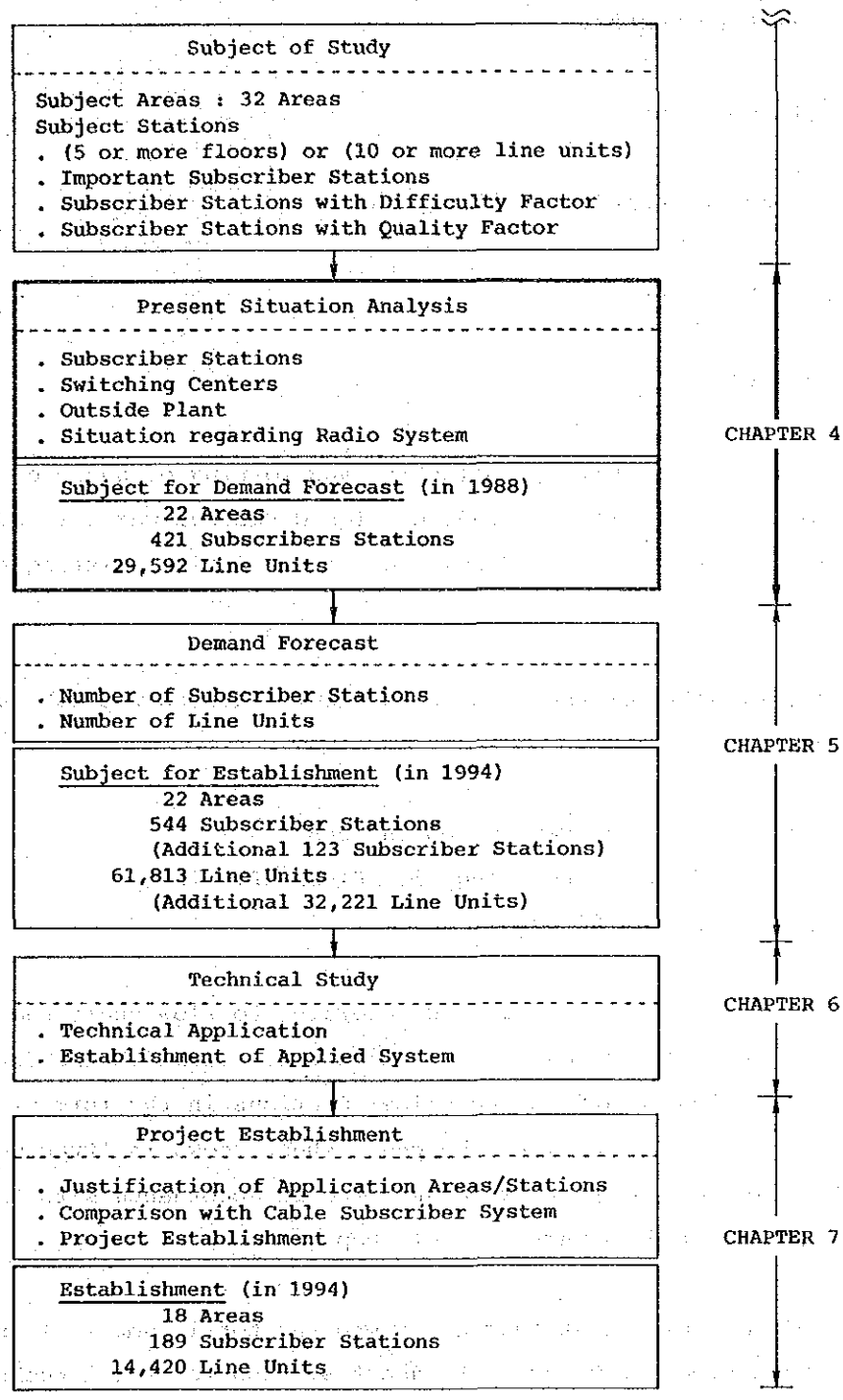


Fig. 4-1 Project Establishment Flow

Data and information obtained was analyzed to establish the existing situation regarding the following items:

--- Subscriber Stations

--- Switching Centers

--- Outside Plant

--- Situation regarding Radio System

4.1 Subscriber Stations

1) Data Collection

Prior to the Field Survey, collection and sorting of basic data for Subscriber Stations from the undermentioned sources was carried out concerning name/uses of buildings and their location/existing subscriber lines.

As a result, data for about 900 Subscriber Stations was tabulated as the subject of the Study.

--- Surveyed List by PMC Option in 1988
--- List of Existing Buildings in DKI JAKARTA In 1984
--- 1987 Telephone Directory

By using the above basic data and according to flow chart shown in Fig. 4-1-1, a Field Survey was carried out to establish the detail of the present situation regarding Subscriber Stations in the form of interviews in accordance with the check sheet shown in Attachment-2 and Subject Subscriber Stations were selected in accordance with the criteria stipulated in para. 3.2 of chapter 3.

The result of this investigation showed the total number of existing subject Subscriber Stations to be about 420 and the total number of their existing line units to be 29,600.

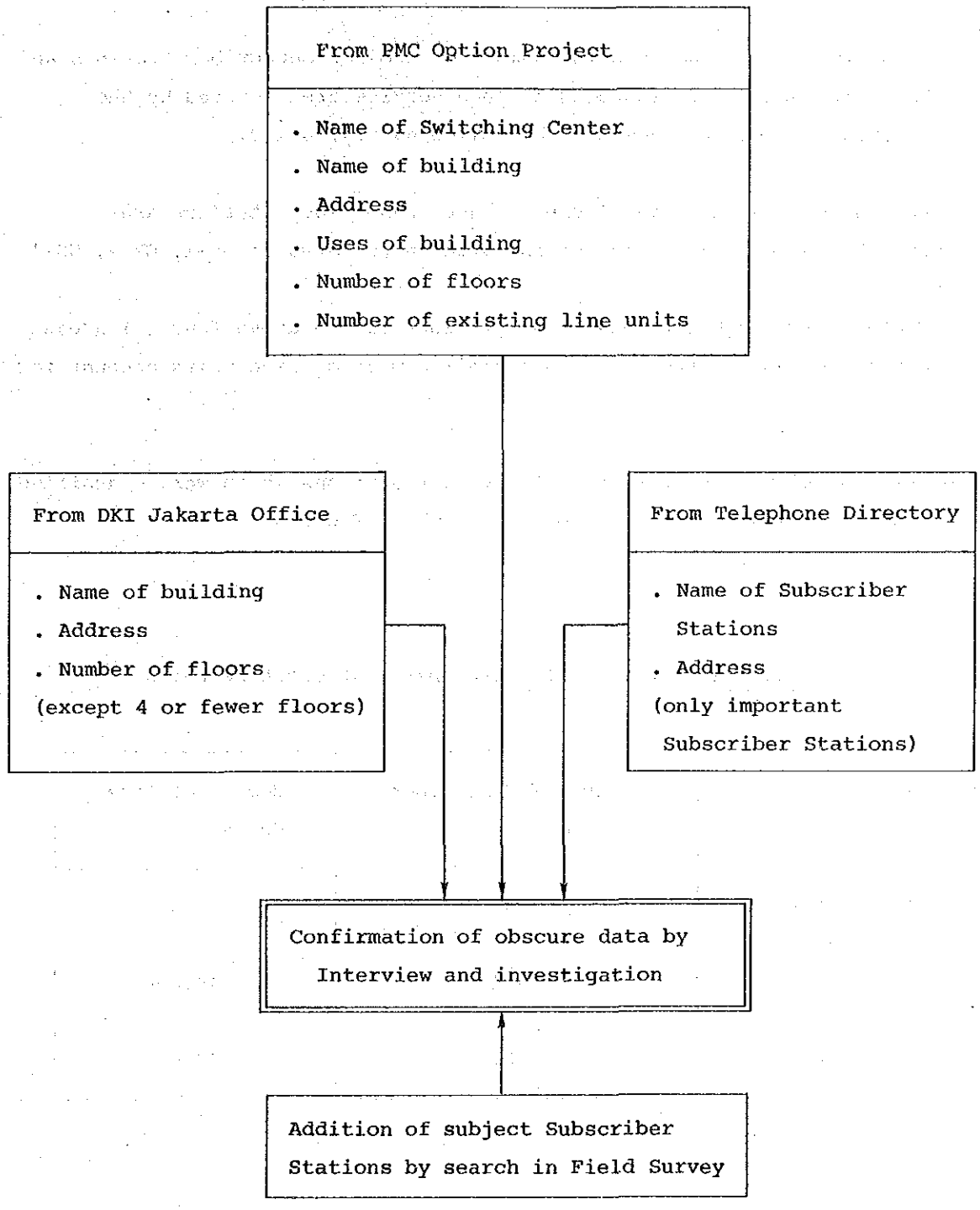


Fig. 4-1-1 Flow Chart of Data Collection

2) Distribution of Subject Subscriber Stations and their Line Units

a) Distribution of the existing number of subject Subscriber Stations and their line units corresponding to each service area covered by the Switching Center are shown in the following Fig. 4-1-2.

As can be seen in above figure, subject Subscriber Stations are distributed in 22 area and concentrated in the area of GB-1, GB-2, SM-1 and SM-2.

The number of subject Subscriber Stations in the above four (4) areas account for 48% of the total, and their number of line units account for 71%.

b) Present situation of subject Subscriber Stations which were classified into the following two (2) types as shown in Table 4-1-1.

Table 4-1-1 Number of Subscriber Stations/Line Units

Class	Number of Subscriber Stations	Number of Line Units
Important	37	588
Large	384	29,004
Total	421	29,592

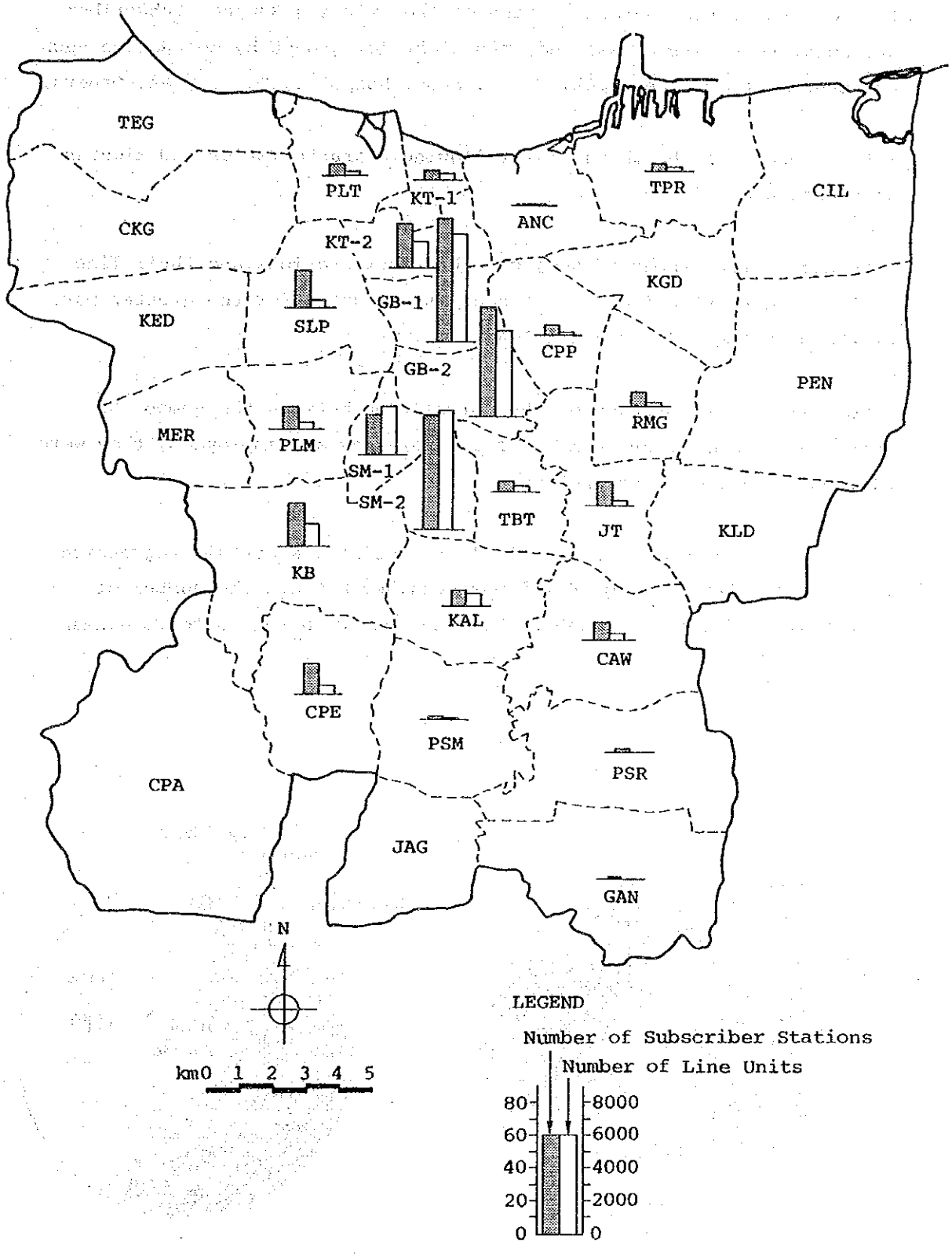


Fig. 4-1-2 Distribution of Subject Subscriber Stations and their Line Units in 1988

c) To determine the characteristics of the existing subject Subscriber Stations, they were classified into eight (8) groups by occupation such as Government, Office, Bank, Hotel, Shop, Hospital, Factory and Others.

As a result of the above, the following characteristics and figures were obtained.

Regarding the number of subject Subscriber Stations and their line units, Government and Office categories accounted for the greater part as shown in Figs. 4-1-3 and 4-1-4.

To clarify the tendency of the correlation between the number of existing line units and number of floors/areas and employees, they were plotted on graphs by occupation.

From the viewpoint of statistical probability, a certain regression equation as shown in Fig. 4-1-5 was obtained between the number of line units and floors of Subscriber Stations with regard to Government and Office.

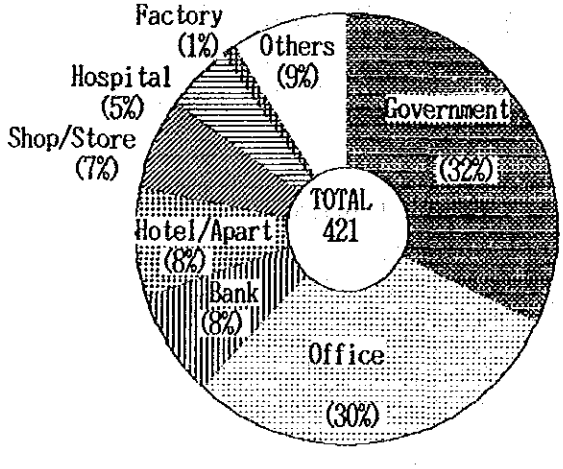


Fig. 4-1-3 Subscriber Stations

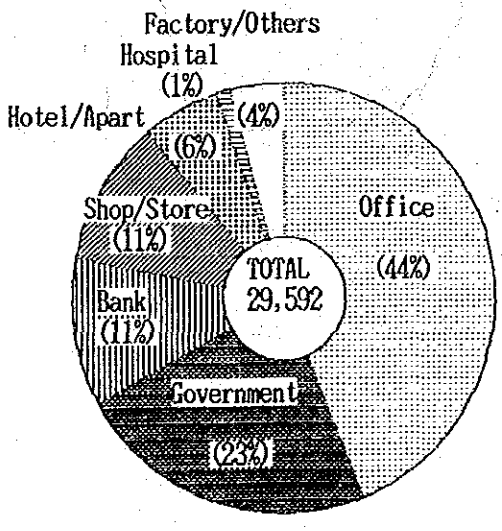
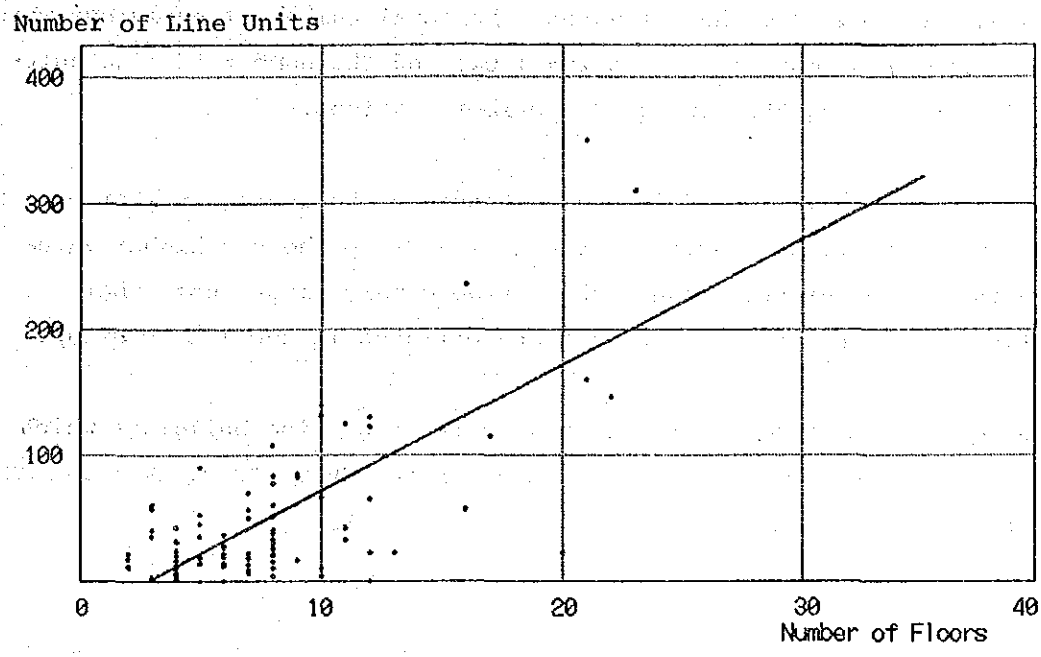


Fig. 4-1-4 Line Units of Subscriber Stations

Government

Regression Equation : y = -28.4720 + 10.0061·X

Correlation Coefficient : 0.77



Office

Regression Equation : y = -39.8877 + 16.9543·X

Correlation Coefficient : 0.86

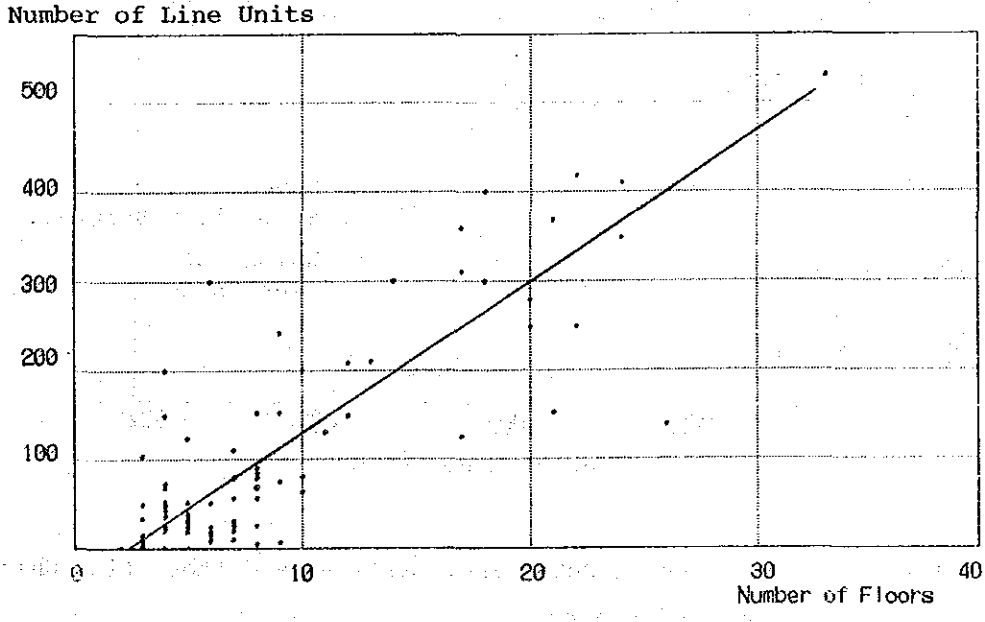


Fig. 4-1-5 Correlation between Number of Line Units and Floors

d) The distribution of subject Subscriber Stations by number of floors in the building is shown in Fig. 4-1-6 and building distribution in Fig. 4-1-7.

As can be seen from these figures, the total number of buildings which have five (5) or more floors is 294 (70%) and the number of line units is 23,004 (78%) among the subject Subscriber Stations.

As can be seen in Fig. 4-1-6, as a tendency the average number of line units per Subscriber Station in the 1 ∿ 4F group shows a higher value than the 5 ∿ 8F group, because the extraordinary large Subscriber Stations ie. Bank, Shop are mainly concentrated in the 1 ∿ 4F group.

As regards geographical distribution, the high-rise buildings which have 13 or more floors are concentrated in the GB-1, GB-2, SM-1 and SM-2 areas.

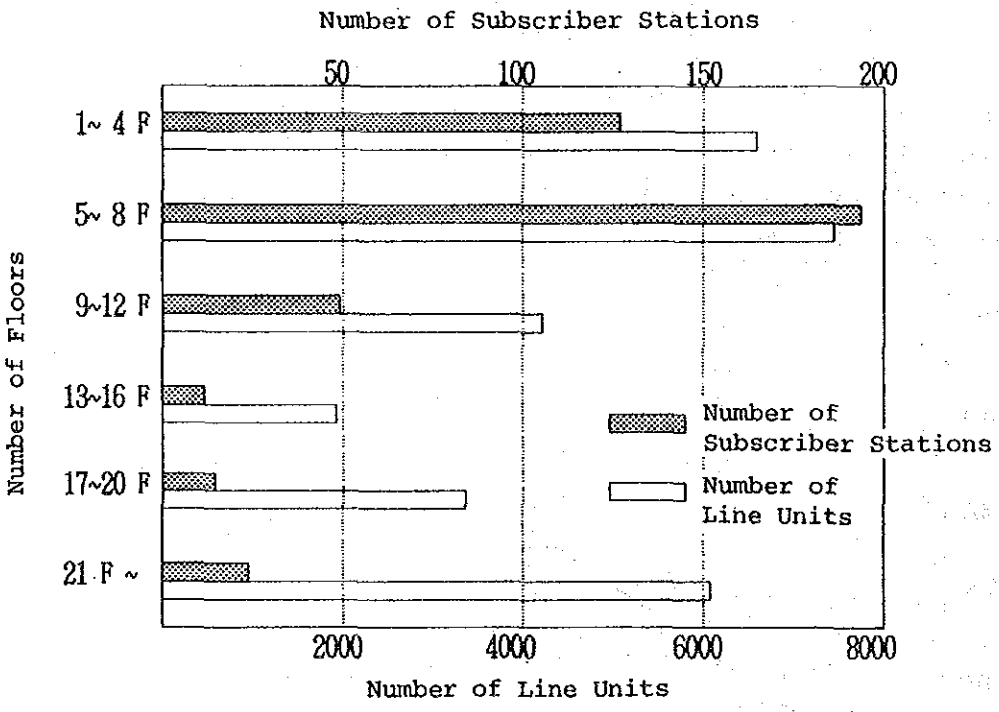


Fig. 4-1-6 Distribution of Subscriber Stations and their Line Units by Number of Floors

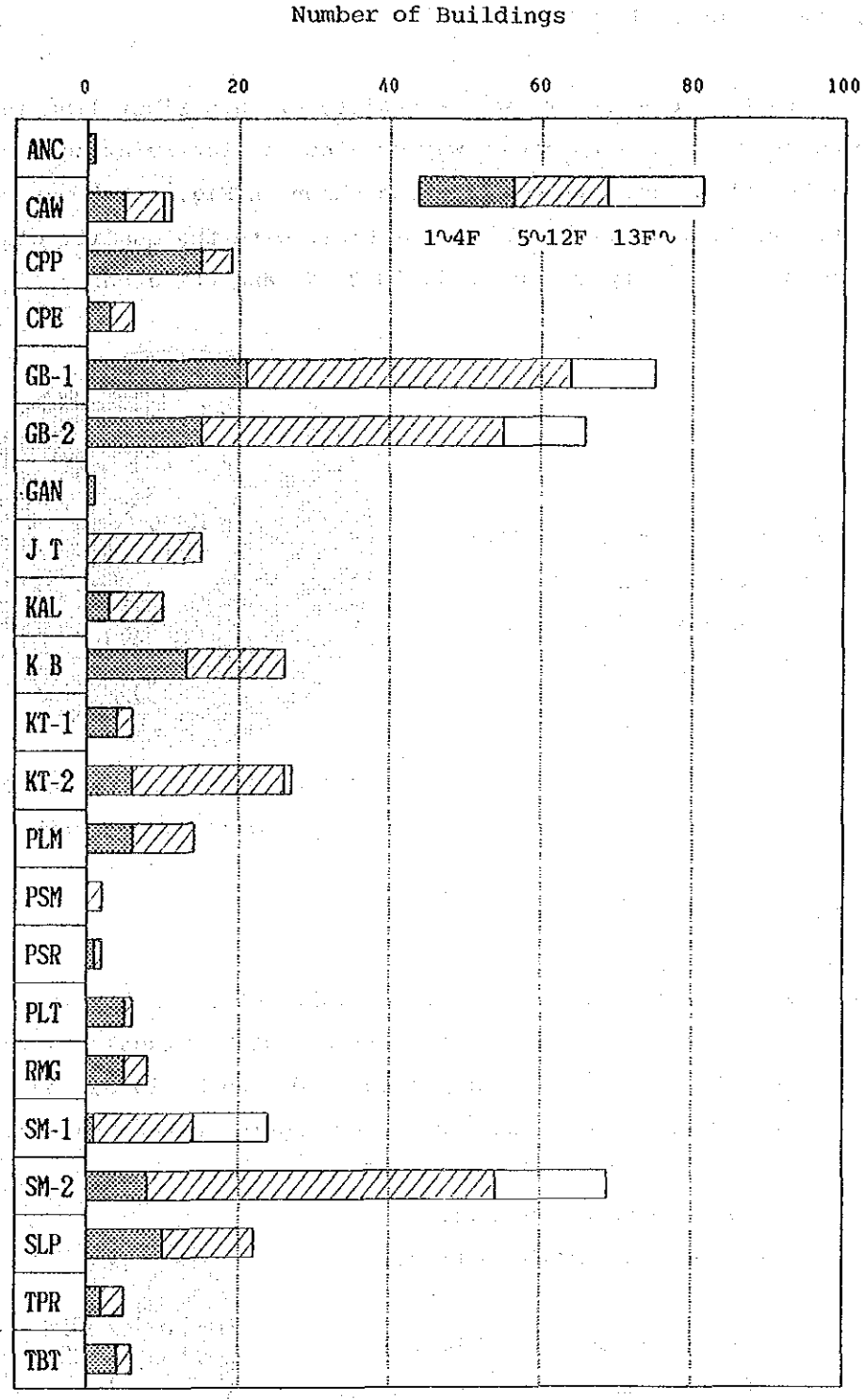


Fig. 4-1-7 Distribution of Buildings by Area

3) Quality of subscriber line

As a result of evaluation of the quality of subscriber line in accordance with the data which was obtained by interviewing Subject Subscriber Stations, the distribution shown in Fig. 4-1-8 was confirmed. Meanwhile, it was confirmed that problems with the quality of subscriber line occur especially in the SM-1, SM-2, KB and PLM areas.

Poor: Subscriber Stations often experience problems such as cross-talk, noise, and disconnection etc.

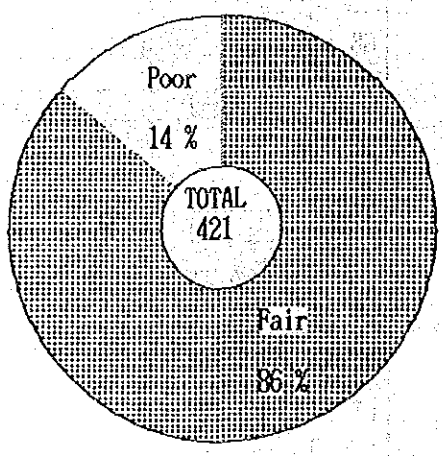


Fig. 4-1-8 Distribution of Poor Quality Subscriber Stations

4) Visibility

Visibility checks to confirm line of sight between Subscriber Stations and Switching Center were carried out by visual observation during Field Survey-1 and by mirror tests during Field Survey-2. As a result of the above, the following figures were obtained.

Visible: Visible between Subscriber Station and Switching Center

Invisible: Invisible between Subscriber Station and Switching Center.

Obscurity: Unconfirmed during Field Survey

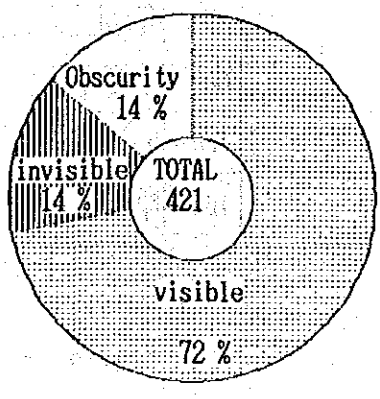
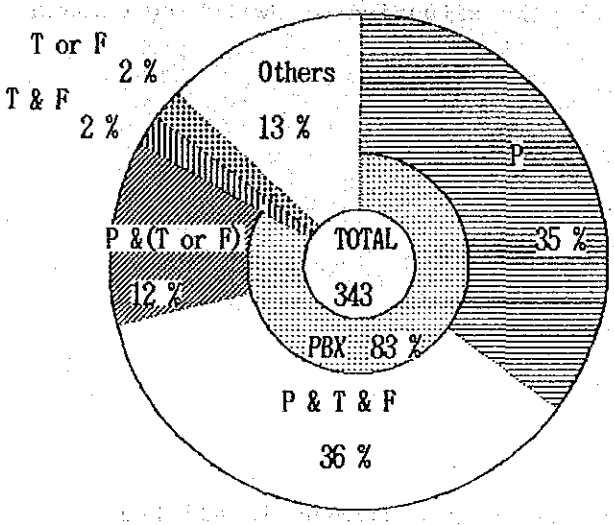


Fig. 4-1-9 Visibility of Subject Subscriber Stations

5) Terminal Equipment Situation

The distribution of subject Subscriber Stations with a PBX, telex and facsimile is shown in Fig. 4-1-10. The number of Subscriber Stations with a PBX is 83% of the total number of Subscriber Stations interviewed. Subscriber Stations with telex and/or facsimile account for 52% of the total.



where :

P : PBX

T : Telex

F : Facsimile

Others : only direct telephone line

Fig. 4-1-10 Terminal Equipment Situation

4.2 Switching Centers

In the case of the Study on the possibility of introducing a Microwave Subscriber System, the following points regarding Switching Centers need to be checked and confirmed in determining them to use as Base Stations of the Microwave Subscriber System. For this purpose, data collection and investigation was carried out for thirty two (32) subject areas. (The number of Switching Centers is 33, owing to JT area has two Switching Centers as JT-1 and JT-2.) The situation of Switching Centers is refer to Attachment 3.

--- Switching Equipment
--- Calling Rate
--- Equipment Installation Space
--- Visibility
--- Power Supply Equipment

1) Switching Equipment

Comprehensing the capacity of the switching equipment in all the Switching Centers is one important factor in investigating the feasibility of introducing a Microwave Subscriber System. Accordingly, for all the Switching Centers, it is important to know the total number of unoccupied terminals and the originating calling rate. As a result of analysis of the data obtained and with due consideration of the above, the following figures and tendencies were established.

a) Unoccupied Terminals

The relation between the total capacity of the switching equipment and the number of unoccupied terminals is shown in Fig. 4-2-1.
Meanwhile, the following statement can be made due to Fig. 4-2-1.

i) The Switching Centers with few unoccupied terminals are as follows:
PLT, GAN, KLD, JT-1

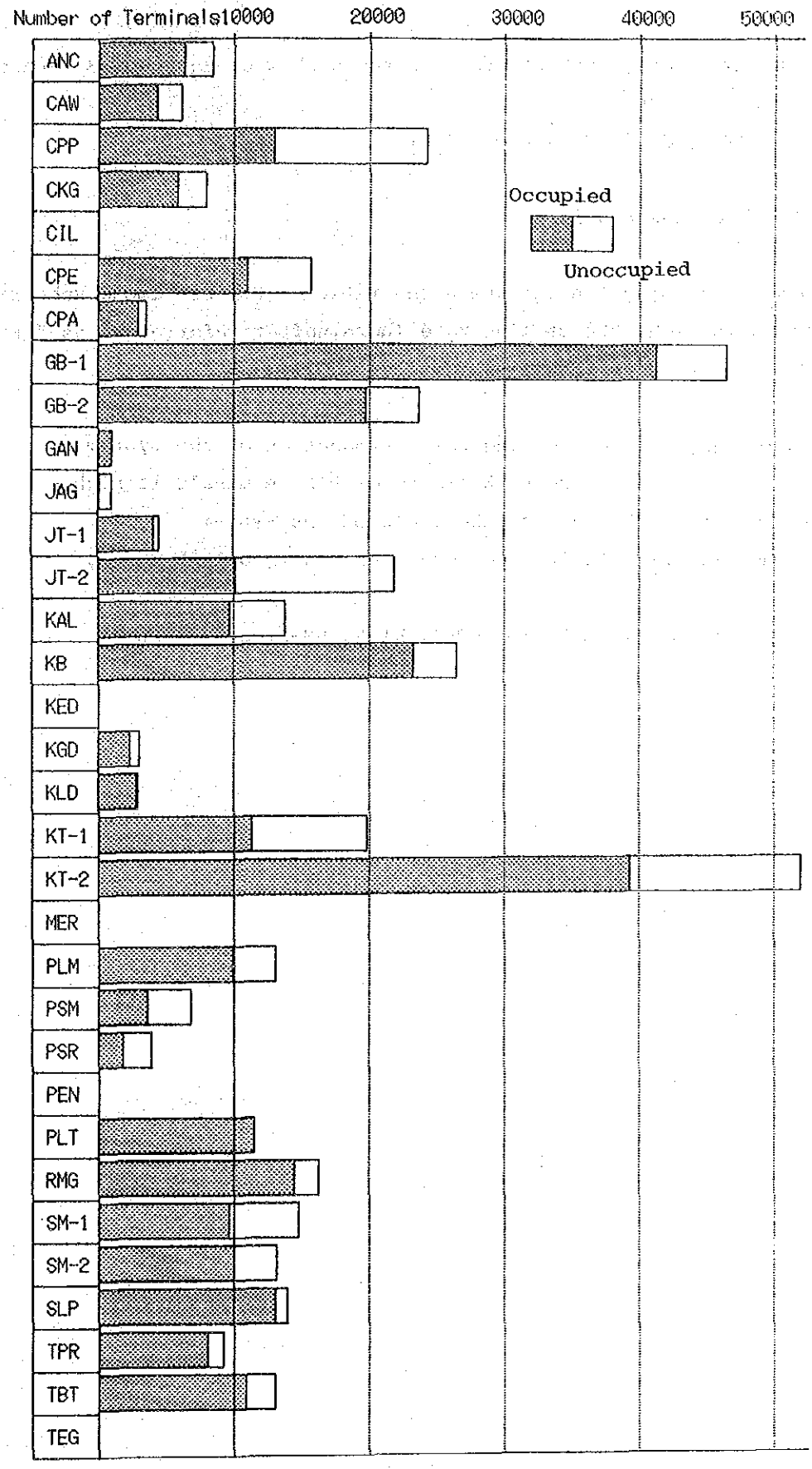


Fig. 4-2-1 Unoccupied Switching Center Terminals

ii) The Switching Centers with a large number of unoccupied terminals are as follows:

KT-2, JT-2, CPP, KT-1, SM-1

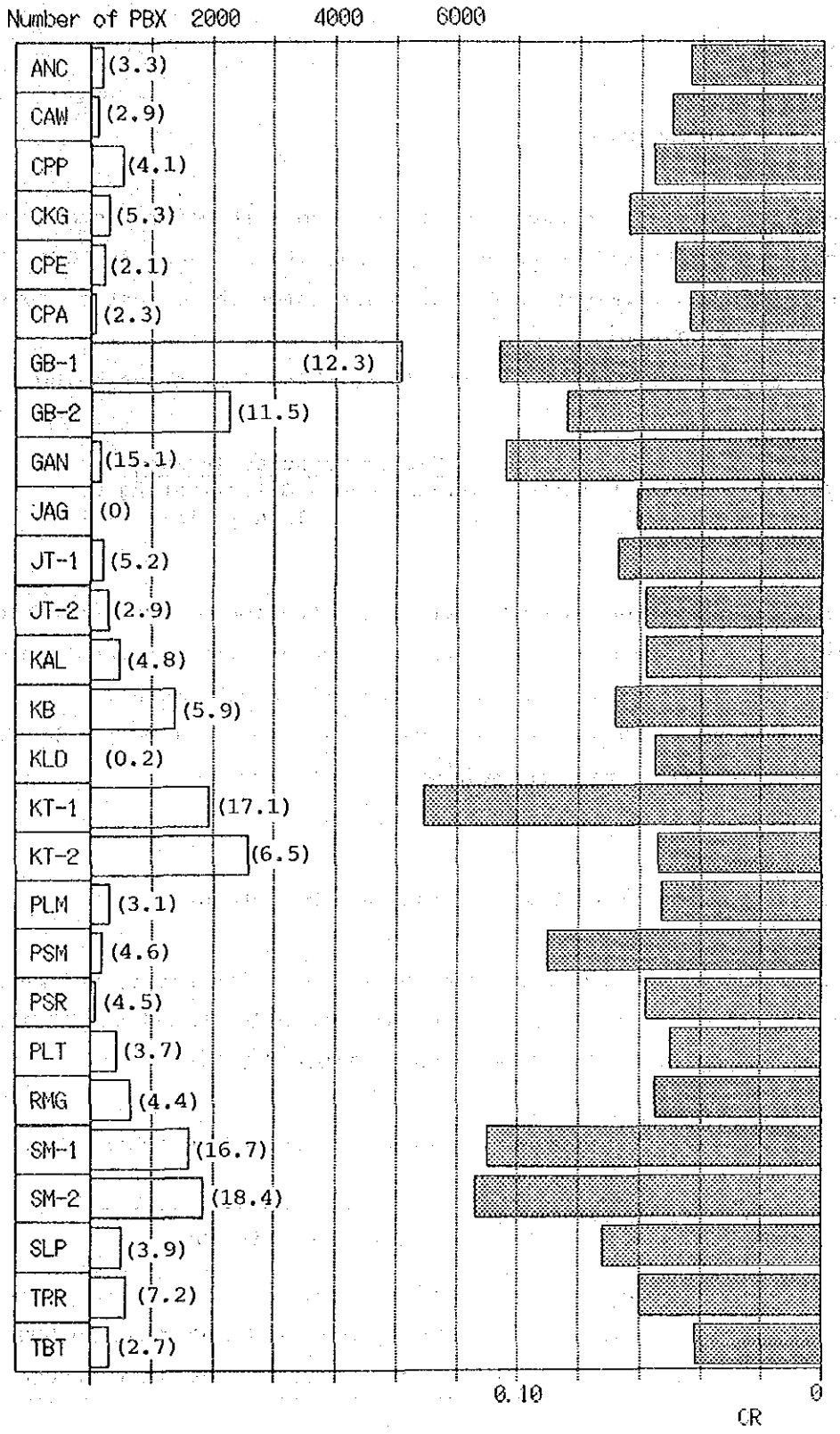
b) PBX Subscriber Stations

In the Switching Centers where the ratio of PBX use among Subscriber Stations is high, the calling rate (hereinafter referred to as "CR") tends to be high as shown in Fig. 4-2-2.

Accordingly, in considering the introduction of the system to Switching Centers where the ratio of PBX terminals is high, attention should be paid to the scale of the system.

The Switching Centers concerned are shown below:

GAN, GB-1, GB-2, KB, KT-1, KT-2, SM-1, SM-2, TPR



Note: ( ): The Ratio of Line Units for PBX in each Switching Center

Fig. 4-2-2 Relation between Number of PBX Terminals and CR

2) Calling Rate

a) Applied Calling Rate

In determining the capacity of a Point-to-Multipoint System (hereinafter referred to as P-MP System), it is necessary to estimate originating and terminating CR which indicates the extent of "busyness" of subscriber lines.

The capacity of the P-MP System is calculated as shown below.

$$\text{Capacity of P-MP System (Number of Line Units)} = \frac{\text{System Capacity (erlang)}}{\text{Originating and Terminating CR (erlang / line unit)}}$$

In this Study, regarding to existing situation of subject Subscriber Stations as described in para. 4.1 of Chapter 4, the percentage of the Subscriber Stations with a PBX is about 83% of the total.

Accordingly, in this case, the PBX CR is to be defined as the CR used for calculation of the capacity of the P-MP System.

The applied PBX CR is verified as below.

b) Classification of Applied Calling Rate by Category

According to the capacity of each Switching equipment, Switching Centers are classified into three (3) categories based on CCITT GAS HANDBOOK Supplement No. 1 as shown in Table 4-2-1.

Table 4-2-1 Standard for Classification of switching Centers

Category of Switching Center	Number of Line Units
Large	10,000 or more
Medium	1,000 or more and less than 10,000
Small	Less than 1,000 or Remote Exchange

When applying these criteria to the subject Switching Centers and the calling rate (originating/terminating) of PBX, the classification is shown in Table 4-2-2 and 4-2-3.

Table 4-2-2 Classification of Switching Centers

Category	Switching Centers
Large	CPP, CPE, GB-1, GB-2, JT-2*, KAL, KB, KT-1, KT-2, PLM, PLT, RMG, SM-1, SM-2, SLP, TBT
Medium	ANC, CAW, CKG, CPA, KGD, PSM, PSR, TPR
Small	CIL, GAN, JAG, JT-1*, KLD

* Note: JT-1 is planned to be combined with JT-2.

Table 4-2-3 Classification of Calling Rate

Category	Calling Rate
Large	0.50 (0.24 + 0.26)
Medium	0.44 (0.22 + 0.22)
Small	0.40 (0.20 + 0.20)

Note: (Originating + Terminating)

c) Justification of Applied Calling Rate

PBX calling rate based on CCITT standards is justified by the following two methods:

- Comparison with the measured CR of PBX in PRX

- Comparison with the measured Originating/Terminating CR

i) CR of PBX

Based on the data on the measured originating and terminating CR of PBX subscriber lines in PRX switching equipment in subject Areas, the CR value changes from 0.3 to 0.5 erlang / line unit and the average CR of each category was calculated as shown in 4-2-4.

On the other hand, the CR value of CCITT standards changes from 0.4 to 0.5 erlang / line unit.

Table 4-2-4 CR of PBX for each Category of Switching Center

Category	CR
Large	0.46 erl./line unit
Medium	0.43 erl./line unit
Small	---

Moreover, the utilization of PBX switching equipment has a big share as shown in Attachment-2, and is widely distributed in subject Areas.

Accordingly, considering traffic variation and worst case traffic conditions, it is justifiable to apply the CR based on CCITT standards for CR of PBX.

ii) Originating/Terminating Calling Rate

The originating/terminating CR in each Switching Center is estimated from the CR of each category of Subscriber Station based on CCITT standards.

If the estimated originating/terminating CR (CRE) can be closely approximated to the measured value of originating/terminating CR (CRM), the value of CR based on CCITT standards is applicable to the CR of each category of Subscriber Stations.

The CRE for each Switching Center can be calculated by the following equation.

$$\text{CRE for each Switching Center} = \frac{\sum \left| \text{Number of Terminals corresponding to each Category of Subscriber Station} \times \text{Estimated CR of each Category Subscriber Station} \right|}{\text{Number of Total Terminals in each Switching Center}}$$

Where, the CRE of each category of Subscriber Station is shown in Table 4-2-5.

Table 4-2-5 CRE of each Category of Subscriber Station

Category of Subscriber Station	Category of Switching Center		
	Large	Medium	Small
General (Residential)	0.04	0.03	0.02
General (Business)	0.10	0.08	0.13
Payphone	0.14	0.11	0.16
PBX	0.24	0.22	0.20
Others	0.04	0.04	0.04

Unit : erlang / line unit

Reference: CCITT GAS 6 Handbook, Supplement No. 1

The value of CRE was calculated by the above and CRM in each area is indicated as shown below.

Table 4-2-6 CRE and CRM

Area	CRE	CRM
ANC	0.055	0.044
CAW	0.065	0.050
CPP	0.073	0.056
CGK	0.056	0.064
CIL	-	-
CPE	0.053	0.049
CPA	0.042	0.044
GB-1	0.103	0.106
GB-2	0.097	0.089
GAN	0.087	0.104
JAG	0.073	0.061
JT-1	0.066	0.067
JT-2	0.073	0.058
KAL	0.065	0.058
KB	0.071	0.068
KED	-	-
KGD	0.045	-
KLD	0.051	0.055
KT-1	0.116	0.131
KT-2	0.089	0.054
MER	-	-
PAL	0.061	0.053
PSM	0.047	0.090
PSR	0.051	0.058
PEN	-	-
PLT	0.071	0.051
RMG	0.070	0.055
SM-1	0.094	0.110
SM-2	0.105	0.114
SLP	0.067	0.072
TPR	0.073	0.060
TBT	0.065	0.042
TEG	-	-
AVERAGE	0.071	0.069

As can be seen in Table 4-2-6, it is identified that the CRE is closely approximated to the CRM.

Accordingly, it is justifiable to apply the CR based on CCITT standards for the CR of PBX.

d) Establishment of Applied Calling Rate

The CR for each Switching Center is applied by the classification of Table 4-2-2. The applied CR distribution for each Switching Center is shown below.

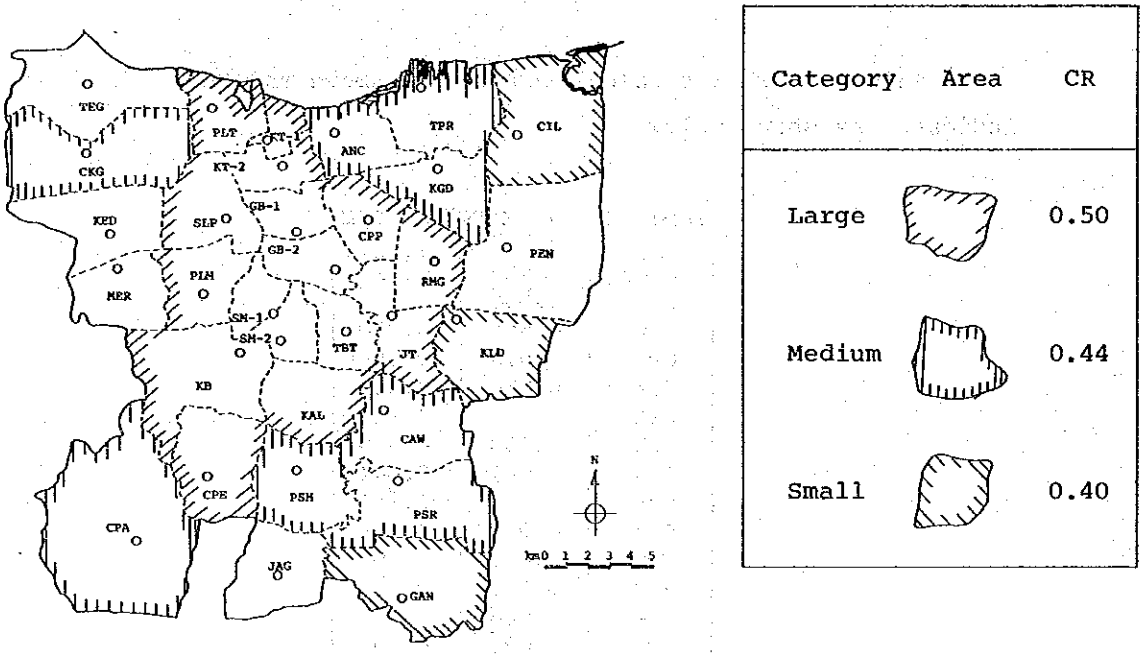


Fig. 4-2-3 Applied CR Distribution for each Switching Center

3) Equipment Installation Space

a) Indoor Equipment Installation Space

In this Study, it is assumed that the PCM room, transmission equipment room, or radio equipment room is considered as space for indoor equipment installation for the Microwave Subscriber System.

As indicated in Table AT3-1 of Attachment-3, the present situation regarding indoor equipment installation space, it is that almost all Switching Centers were expected to have sufficient space for installation of the additional radio equipment.

b) Outdoor Equipment Installation Space

The present situation regarding equipment installation space is indicated in Table AT3-1 of Attachment-3.

Judging from the above, the space for outdoor equipment installation seems to be sufficient at present in almost all Switching Centers.

4) Visibility

Visibility checks by visual observation and mirror tests from Switching Centers were carried out to check the line of sight to each Subscriber Station.

As can be seen in Table AT3-1 of Attachment-3, almost all Switching Centers have a clear line of sight except for followings:

a) Switching Centers which present difficulties in providing a clear line of sight:

CAW, CPE, SM-1, TPR

b) Switching Centers which are obstructed in at least two (2) directions.

GB-1, JT-1, KAL, PSM

5) Power Supply Conditions

In this Study, it is assumed that DC power is to be supplied from the rectifier to the PCM, transmission or radio equipment as shown in Fig. 4-2-4.

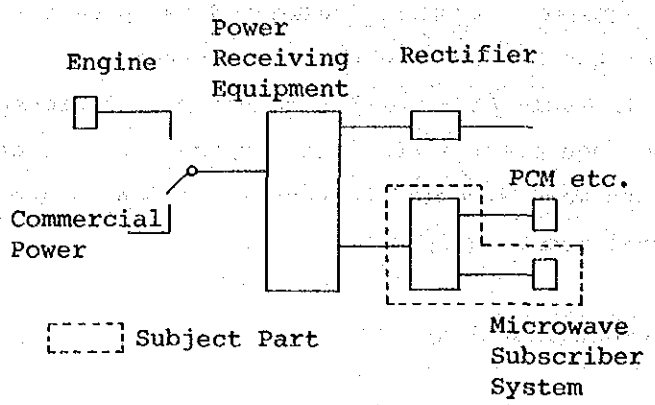


Fig. 4-2-4 DC Power Supply in the Study

The present conditions for DC power supply from rectifier of PCM equipment, transmission equipment, or radio equipment can be seen in Table AT3-1 of Attachment-3. Considering the normal consumption in amperes and the capacity of the rectifier, it seems that there is almost no problem concerning DC power supply except for GB-1.

GB-1 will be required an expansion of rectifier concurrent with introduction for Microwave Subscriber System because the rectifier of transmission and radio equipment has no remainder capacity.

4.3 Outside Plant

To establish the situation regarding Outside Plant, especially for the existing Cable Subscriber System, the following items were investigated and analyzed using plant records and various other kinds of data.

1) Cable

a) Situation of Leads-in Cable

The relation between number of leads-in cable pairs and demand is shown in Fig. 4-3-1.

From a macroscopic point of view, it can be seen that the number of leads-in cable pairs exceeds number of demand in most of the Switching Centers.

In fact, however, there seems to be some difference between demand and distributed primary cable pairs in areas where demand is rapidly increasing.

From the above situation, it seems that the number of cable pairs cannot always satisfy the demand for a subscriber line to each Subscriber Station.

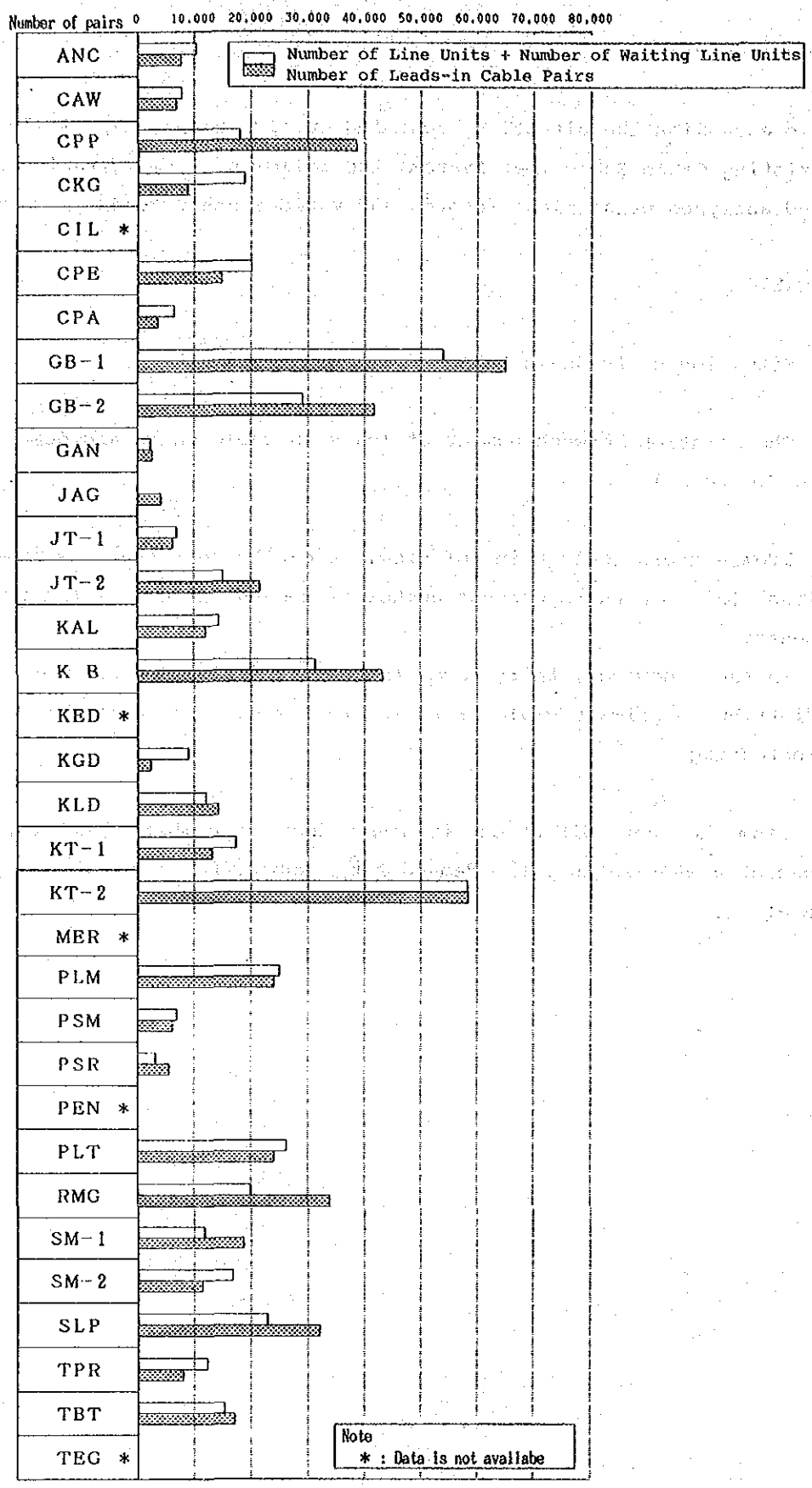


Fig. 4-3-1 Situation regarding Leads-in Cable Pairs

b) Situation regarding Poor Quality of Primary Cable

The ratio of poor quality for unused primary cable pairs is shown in Table 4-3-1.

As can be seen in Table 4-3-1, it was considered that the quality of unused primary cable pairs in the KT-1, SM-1, CPE, CPP and TPR Switching Centers, in particular is not good as compared with the other Switching Centers.

In the KT-1, SM-1 and TPR Switching Centers, the primary cable is badly worn, so that the ratio of poor quality pairs is higher.

Table 4-3-1 Ratio of Poor Quality

Name of S.T.O	Poor Quality Ratio %
ANC	28.2
CAW	8.1
CPE	34.6
CPP	35.7
GB-1	15.0
GB-2	4.6
JT	20.5
KAL	18.7
KB	20.7
KT-1	90.1
KT-2	14.3
PLM	1.0
PLT	9.1
PSM	10.7
RMG	25.7
SLP	14.0
SM-1	52.7
SM-2	26.6
TPR	32.6
TBT	3.5

c) Situation regarding Primary Cable

As a result of the Study on primary cable based on plant records and demand data, the tendency was identified for the primary cable capacity to be insufficient in GB-1, GB-2, KAL and SM-2 which consist of Subscriber Stations with a large amount of demand.

This means that Subscriber Stations with a high level of demand cannot use branching cable from the existing primary cable in the same way as those with a small level of demand because the primary cable must be installed directly from the Switching Center in case of Subscriber Stations with a high level of demand.

2) Cable Duct

a) Broken Ducts to be repaired

Based on data regarding broken ducts obtained from PERUMTEL, via the cable constructor, a study was carried out of the cable duct route which is necessary for a cost comparison with a Microwave Subscriber System.

As a result, the ratio of spans with broken pipes was assumed to be 17% of the total which will be used for cable expansion to meet the demand forecast.

b) Areas where construction is difficult

In accordance with the criteria stipulated in para 3.2 of Chapter 3, areas presenting construction difficulties were investigated and listed as shown in Attachment-5.

c) Situation regarding Cable Duct

As a result of the study for cable duct, the same tendency as in the case of primary cable was identified.

That is to say, the cable duct facilities in ANC, GB-1, KAL, KB, SM-2, SLP are insufficient in case of Subscriber Stations with a high level of demand due to the following reasons.

i) Subscriber Stations with a high level of demand cannot use existing primary cable facilities, so that new cable duct will need to be installed.

ii) The demand level which was forecasted for the purpose of civil design in the past is different from that for 1994 within the area of Switching Centers mentioned above, because these Switching Centers show a large increase in number of demand as compared with those used for civil design.

Consequently, in the outside plant associated with the above Switching Centers, civil work will be required.

3) Relation between Primary Cable and MDF, vacant cable duct in major Switching Centers

The situation for each Switching Center, in the case where number of demand in 1994 can be totally met by a Cable System, is shown in Table 4-3-2.

The most Switching Centers are that the unused MDF capacity (including expansion capacity) and the number of vacant cable ducts (including expansion ducts) exceed the primary cable capacity.

Accordingly, building modification at the above Switching Centers is not necessary or can be carried out easily.

In the case of RMG and PLT, the number of vacant cable ducts is insufficient, and CPP, GB-2, KT-2, TBT and PLT are required the modification of a MDF and the swiching center.

Table 4-3-2 Situation regarding MDF and Vacant Cable Duct

NAME OF S.T.O	TERMINALS IN NOT USED MDF	NUMBER OF VACANT DUCTS	EXPANSION OF PRIMARY	CONDITIONS OF MDF	CONDITIONS OF DUCT	DATA COLLECTION
ANC	19,200	38,400	17,600	o	o	INVESTIGATED IN S.W.
CAW	23,200	36,000	13,400	o	o	INVESTIGATED IN S.W.
CPE	48,000	51,600	24,400	o	o	FROM PMC-O DATA
GB-1	48,800	76,800	46,500	o	o	INVESTIGATED IN S.W.
JT-2	64,000	86,400	30,000	o	o	INVESTIGATED IN S.W.
KAL	100,800	66,000	36,300	o	o	FROM PMC-O DATA
KB	35,200	24,000	24,200	o	o	INVESTIGATED IN S.W.
PLM	45,600	25,200	21,700	o	o	FROM PMC-O DATA
SM-1	72,000	62,400	9,100	o	o	INVESTIGATED IN S.W.
SM-2	98,400	45,600	40,300	o	o	FROM PMC-O DATA
SLP	22,400	82,800	21,800	o	o	INVESTIGATED IN S.W.
TPR	14,400	76,800	9,900	o	o	INVESTIGATED IN S.W.
RMG	41,600	4,800	21,300	o	x	INVESTIGATED IN S.W.
CPP	16,400	46,800	20,000	x	o	INVESTIGATED IN S.W.
GB-2	0	108,000	26,200	x	o	INVESTIGATED IN S.W.
KT-2	52,000	76,800	54,900	x	o	FROM PMC-O DATA
TBT	17,600	31,200	20,600	x	o	FROM PMC-O DATA
PLT	12,800	21,600	27,500	x	x	INVESTIGATED IN S.W.

Note:

o : not necessary to modify

x : necessary to modify

PMC-O DATA : "BASIC DESIGN REPORT" by PMC OPTION SERVICES

S.W. : Switching Center

4.4 Situation regarding Radio System

1) Radio Frequency

Frequency allocation in Indonesia is conforming to CCIR recommendations. The allocation for public communication, conditions for utilization, and applicability recommended by Directorate of Frequency Management of POSTEL in Jakarta are shown in Table 4-4-1 below.

Table 4-4-1 Frequency Allocation and Utilization

Frequency	Allocation & Utilization	Applicabil
890 ∿ 960 MHz	Land Mobile Service	x
1427 ∿ 2700	Radio Relay System (Remote Area & Spur Route)	x
3700 ∿ 4200	Fixed Satellite Service (Down-link)	x
5925 ∿ 6425	Fixed Satellite Service (UP-link)	x
6425 ∿ 7125	Radio Relay System (Into-sat & Back Bone)	x
7125 ∿ 7425	Radio Relay System (Spur for TV link)	x
7425 ∿ 7725	Radio Relay System (Spur Route)	x
8200 ∿ 8500	Radio Relay System (Back Bone for Satellite)	x
10.5 ∿ 10.68 GHz	Radio Relay System (TVRI)	o
10.7 ∿ 12.75	Radio Relay System (Back-up for Junction)	x
12.75 ∿ 13.25	Radio Relay System	Δ
14.5 ∿ 15.35	Radio Relay System	o
17.7 ∿ 19.7	Radio Relay System	o
19.7 ∿ 21.2	Fixed Satellite Service & Mobile Service	x
21.2 ∿ 22.5	Radio Relay System	o
22.5 ∿ 23.9	Broadcasting Service	x

Note :

o : Possible to use for the Microwave Subscriber System

Δ : Possible to use with limitations

x : Impossible to use

Source : Information from Directorate of Frequency Management of POSTEL in November, 1988.

2) Rainfall

Based on the data obtained concerning rainfall intensity (Jakarta 1986, Attachment-4) and analysis flow indicated in Fig. 4-4-1, the analysis of rainfall intensity is carried out as shown below.

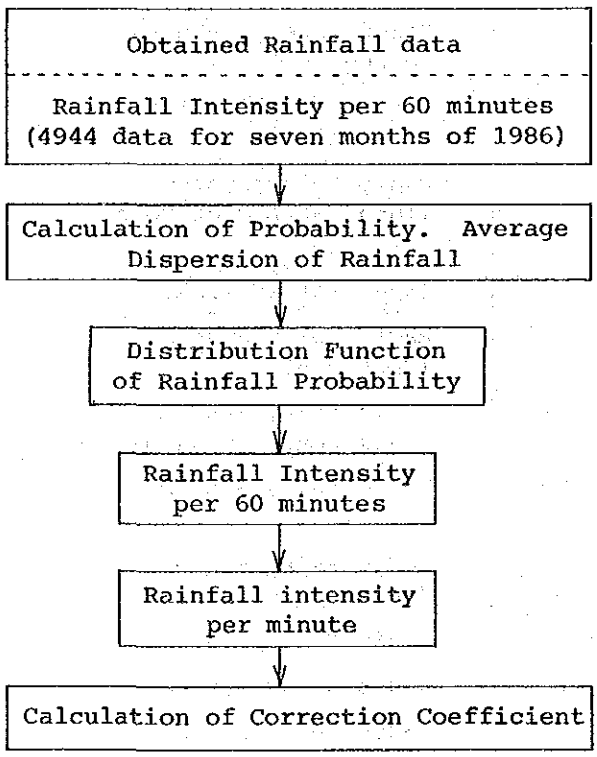


Fig. 4-4-1 Analysis Flow of Rainfall Intensity

a) Regression Curve

The distribution between rainfall probability and rainfall intensity per 60 minutes is shown in Fig. 4-4-2.

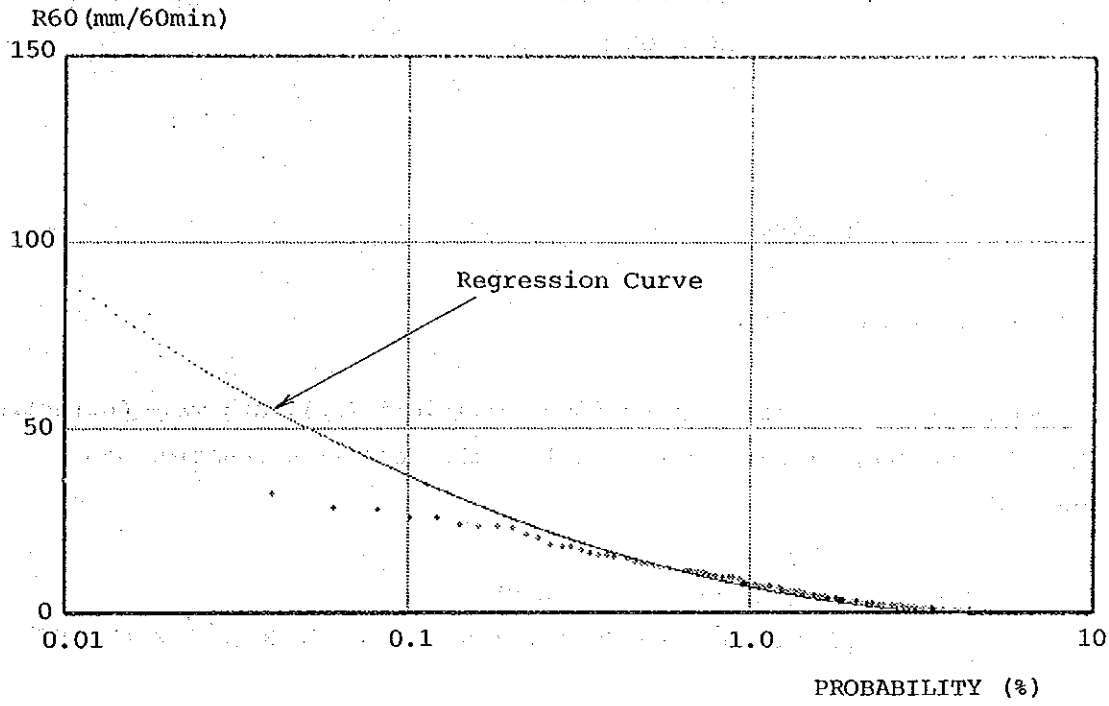


Fig. 4-4-2 Relation between Rainfall Probability and Rainfall Intensity per 60 minutes

Based on this distribution, the regression curve between rainfall probability and rainfall intensity per 60 minutes is also shown in Fig. 4-4-2.

The rainfall intensity per 60 minutes (R_{60} at 0.0025% in rainfall intensity) is 132.3 mm/60 minutes.

This value is converted to the value per minute by using the conversion constant derived from the incomplete Gamma Function as follows:

$$(R_{60}/R_1) = 40.26$$

where R_{60} : Rainfall Intensity per 60 minutes at 0.0025%

R_1 : Rainfall Intensity per 1 minute at 0.0025%

Then :

$$R_1 = R_{60}/40.26$$
$$= 3.29 \text{ mm/min}$$

b) Correction Coefficient

To calculate the Space Correction Coefficient (fp), and Time Correction Coefficient (Γp) of rainfall intensity, the following equation was applied:

$$\Gamma p = a_0 + a_1.(\log P) + a_2.(\log P)^2$$
$$= -4.860 \times 10^{-2} - 0.2919 \times (\log P) + 4.300 \times 10^{-2} \times (\log P)^2$$

$$fp = b_0 + b_1.(\log P) + b_2.(\log P)^2 + b_3.(\log P)^3$$
$$= -3.467 \times 10^{-2} - 1.563 \times 10^{-1} \times (\log P) - 5.712 \times 10^{-2} \times (\log P)^2 - 7.722 \times 10^{-3} \times (\log P)^3$$

where:

$a_0 \sim a_2, b_0 \sim b_3$: Constant

P : Performance Objectives (%) by Rainfall Attenuation

3) Performance Objectives

Performance objectives for subscriber lines are not stipulated by CCIR', therefore those for trunk lines stipulated in CCIR Rec.594 were modified and used for the subsequent Study as shown below.

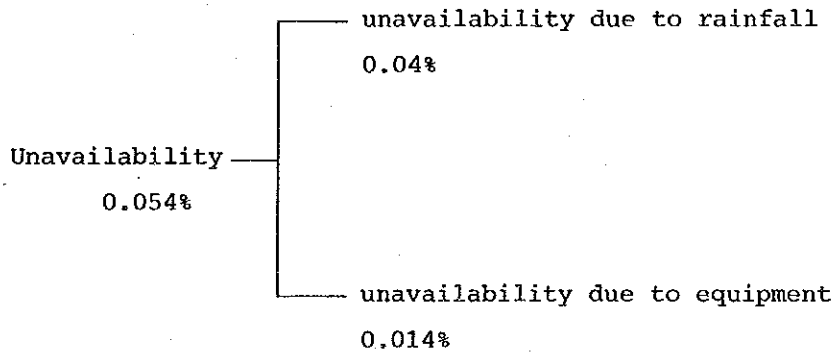
- CCIR Rec.594

"The bit error ratio should not exceed the value of 1×10^{-3} during more than 0.054% of any month : integration time one second."

- Modification of CCIR Rec.594

"Bit Error Rate $>1 \times 10^{-4}$ for no more than unavailability 0.054% should be allocated to radio section is the range of two (2) hops as the worst case"

The above unavailability is allocated as follows:



Then, unavailability due to rainfall per hop is P = 0.02%

CHAPTER 5

DEMAND FORECAST

CHAPTER 5 DEMAND FORECAST

In this chapter, macroscopic demand in DKI Jakarta and microscopic demand for subject Subscribers are forecast based on the data established in Chapter 4.

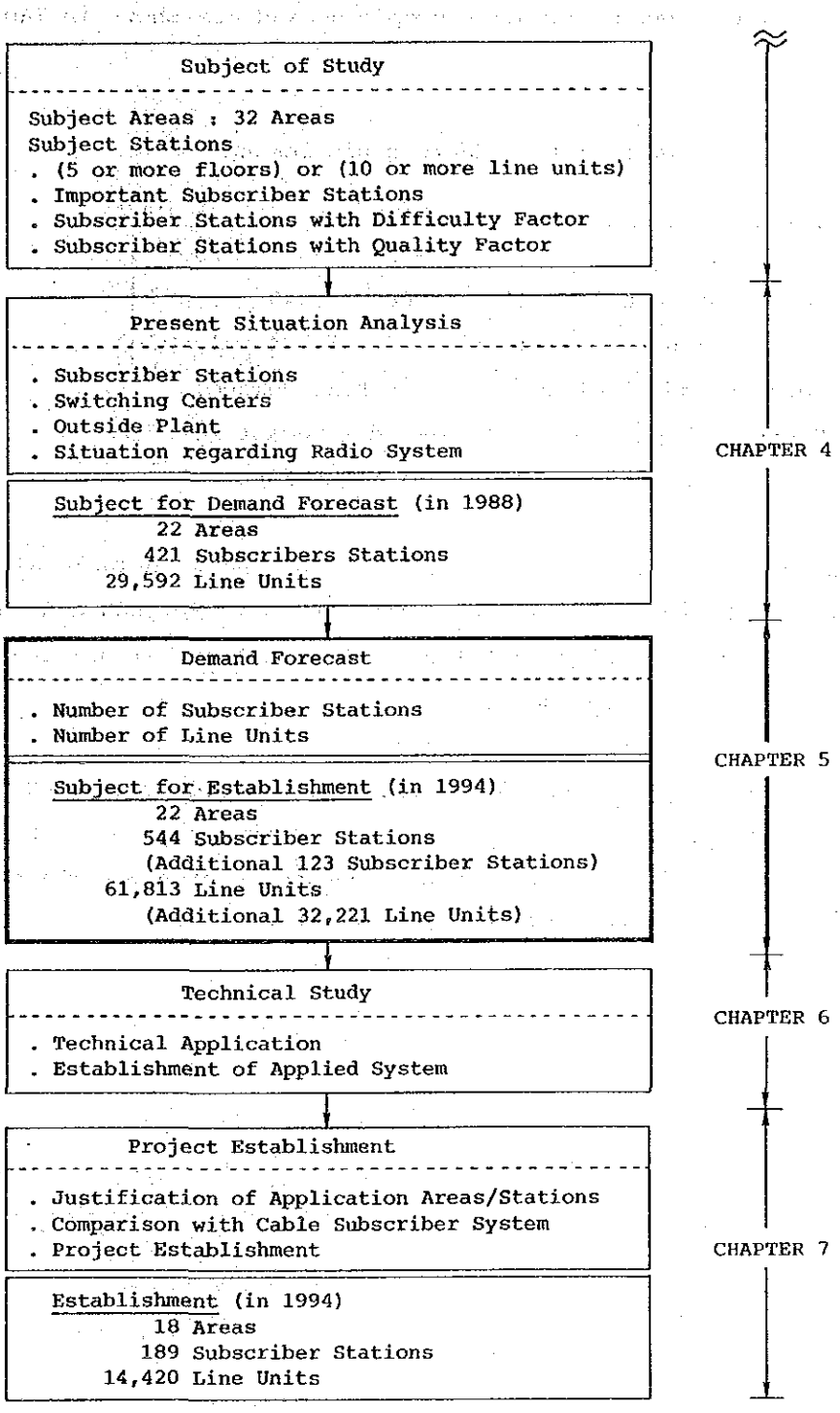


Fig. 5-1 Project Establishment Flow

5.1 Analysis

1) Macroscopic Demand

A macroscopic demand forecast for the Jakarta area has already been made by PMC Option. Changes in the macroscopic demand are shown in Table 5-1-1.

Table 5-1-1 Macroscopic Demand

X 1000

Year	1987	1992	1997	2002
Telephone Demand	447	708	1,049	1,463
Total Demand	458	726	1,074	1,497

Total demand includes non-telephone demand.

Source: Report on Macro Demand forecast for Jakarta and Surabaya, PMC Option March 1988

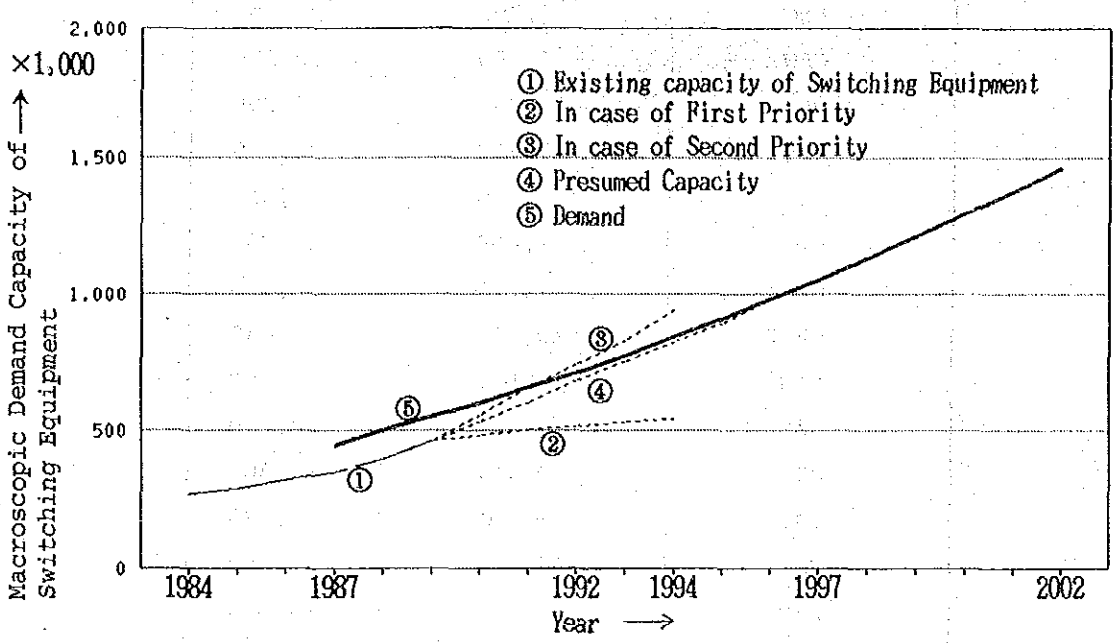
The actual demand data in 1988 was obtained as shown in Table AT3-1 of Attachment 3. The number of existing line units is 301,000 and the number of waiting line units is 191,000 then total number of line units is 492,000 according to the data.

Meanwhile, the telephone demand in 1994 is estimated as 844,000 and total demand is estimated 865,000 assuming the same rate of increase from 1992 to 1997. Distribution of telephone demand in each Switching Center's area in 1988 and 1994 is shown as Table 5-1-2.

Table 5-1-2 Distribution of Telephone Demand in Each Area

Switching Center / Year	No. of Existing Line Units in 1988	Forecasted Demand in 1994
ANC	6,300	21,780
CAW	4,290	12,250
CPP	13,030	33,090
CKG	5,770	26,820
CIL	0	7,310
CPE	11,030	28,220
GB-1	41,220	80,530
GB-2	19,710	42,030
GAN	950	6,290
JAG	110	2,580
JT	14,190	37,300
KAL	9,740	34,130
KB	23,230	55,890
KED	0	14,500
KGD	2,340	22,170
KLD	2,830	17,040
KT-1	11,250	20,530
KT-2	39,340	74,490
MER	0	8,530
PEN	0	10,360
PLM	9,870	33,420
PLT	11,500	37,020
PSM	3,610	12,270
PSR	1,850	10,880
RMG	14,500	38,230
SM-1	9,570	30,960
SM-2	9,960	45,480
SLP	13,150	33,840
TPR	7,960	18,360
TBT	10,910	27,700
Total	298,210	844,000

As shown in Fig. 5-1-1, if the construction volume of recent years continues in the future, the volume of switching equipment will balance demand after 1997.



Source: ① The data of WITEL-IV

② ③ REPELITA-V Investment Program (First Draft), February 1988 PMC

④ Presumption based on past data

⑤ Report on Macro Demand Forecast for Jakarta and Surabaya, March 1988 PMC

Fig. 5-1-1 Demand and Capacity of Switching Equipment

2) Distribution of Subject Subscriber Stations

To determine the future development tendency of DKI Jakarta, a future area classification map was drawn up as shown in Fig. 5-1-2 based on the DKI Jakarta city plan as of 2005.

Generally speaking, existing subject Subscriber Stations are concentrated in the areas designated as office and commercial areas on the future classification map. Meanwhile, some vacant spaces can still be found in center, and these spaces are planned as land for building construction.

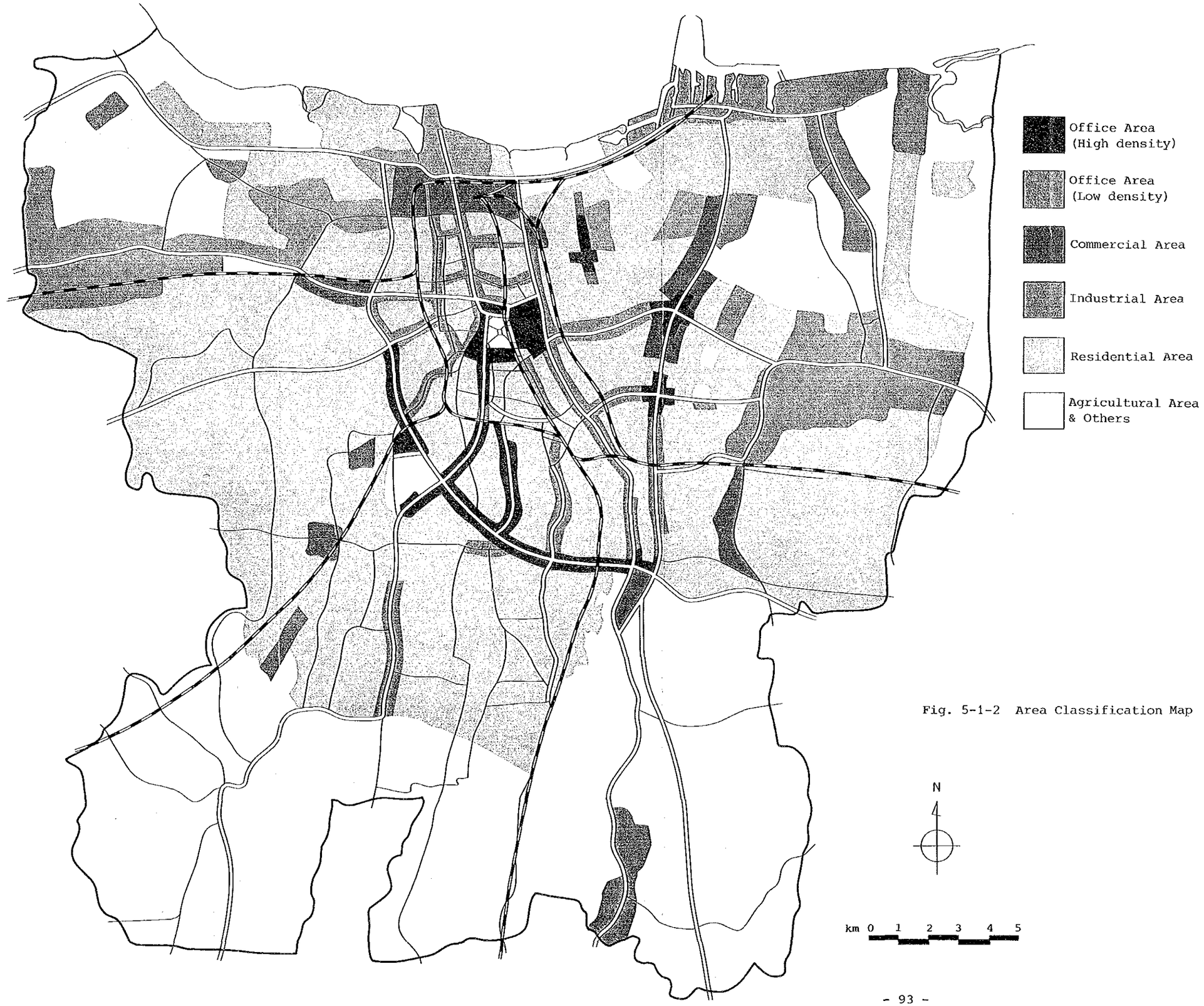


Fig. 5-1-2 Area Classification Map

The forecast of the increase in the number of subject Subscriber Stations was carried out in following manner.

Step 1

The area of future buildings was determined based on the master plan of city area as (as of 2005).

Step 2

The area of future buildings classified into 4 groups (1-4F, 5-8F, 9-16F and 17F or more) was measured excluding the area of existing buildings.

Step 3

The average base area of existing buildings classified into the 4 groups mentioned in step-2 was calculated from the data obtained.

Table 5-1-3 Average Base Area of Buildings

Classification	Base Area (m^2)
1 ∿ 4 F	1,100
5 ∿ 8 F	1,300
9 ∿ 16 F	1,400
17 F ∿	1,400

Step 4

The increase in the number of buildings up to 1994 was calculated from the following formula:

$$f = \frac{a \times 0.6}{b} \times \frac{6}{17}$$

where:

f : Increase in number of buildings up to 1994

a : Effective site area measured in Step 2

b : Average base area calculated in Step 3

0.6: Ratio of ground area occupied by buildings

$\frac{6}{17}$: (1989 ∿ 1994) ÷ (1989 ∿ 2005)

Step 5

The number of additional buildings was distributed in each group by categories of Government, Office, Bank, Hotel and Others by ratio obtained from the Field Survey.

$$N = f \times r$$

where:

N : Number of additional buildings in each occupation

f : Number of additional buildings calculated in Step 4

r : Ratio of buildings in each occupation

Step 6

The number of additional buildings and their location were revised a little after investigation, taking into account the actual situation including the surrounding area.

Finally, the number of additional buildings forecast by the above procedure is converted into the number of additional subject Subscriber Stations.

3) Future Number of Line Units

To estimate the number of line units up to 1994, the growth rate of GRDP (Gross Regional Domestic Products) in Jakarta was applied to the rate of increase in subject Subscriber Stations' line units.

The annual growth rate of GDP in real terms during the REPELITA-V program period is assumed to be the same five (5) percent as for the REPELITA-IV program period, and GRDP in Jakarta during the past 5 years (1981 - 1985) grew by an annual average of 5.0% as shown in Table 5-1-4.

The GRDP growth rate in Jakarta had been forecast as five (5) percent per year by the other associated project (PMC) on the assumption that GRDP will grow in future at the same rate as in the past.

Table 5-1-4 GRDP Growth Rate in Jakarta

Year	1981	1982	1983	1984	1985	Average
Growth Rate (%)	10.4	2.2	5.8	7.3	-0.5	5.0

Source: Biro Pusat Statistik, STATISTIK INDONESIA 1986

According to the above, the future number of subject Subscriber Stations' line units was calculated from the following equation:

$$FNC = ENC \times (1.05)^{6.5}$$

where:

FNC : Estimated number of line units as of end of 1994

ENC : Existing number of line units investigated at 1988

1.05: Average annual rate of increase in line units

6.5 : Number of years from June 1988 to December 1994

Regarding the existing number of subject Subscriber Stations, line units requested by each subscriber during interview/investigation were also considered in calculating the increasing number.

Regarding future subject Subscriber Stations, the ENC used was the number of line units calculated for each Subscriber Station group classified by occupation and number of floors as shown in Table 5-1-5. ENC of Government and Office categories were calculated from the equations shown in Fig. 4-1-5. ENC of the other categories were obtained from average number of existing line units of subject Subscriber Stations.

Table 5-1-5 ENC for Future Subject Subscriber Stations

Occupation	1 ∿ 4F	5 ∿ 8F	9 ∿ 16F	17F ∿
Government	12	52	132	172
Office	28	96	232	285
Bank	-	35	92	172
Hotel	-	32	52	80
Others	12	35	60	-