A STUDY ON A REGIONAL DEVELOPMENT PLAN
FOR TELECOMMUNICATIONS NETWORKS
IN THE BANGKOK METROPOLITAN AREA
IN THE KINGDOM OF THAILAND

FINAL REPORT

FOR
A FEASIBILITY STUDY
ON
AN IMPLEMENTATION PLAN TO UPGRADE
THE TELECOMMUNICATIONS SERVICES QUALITY

SUMMARY

October 1992

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to a request from the Government of the Kingdom of Thailand, the Government of Japan decided to conduct a study on a Regional Development Plan for Telecommunications Networks in the Bangkok Metropolitan Area and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Thailand a study team headed by Mr. Satoshi Akaike, NTT International Corporation, twice between July 1991 and August 1992.

The team held discussions with the officials concerned of the Government of Thailand, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Kingdom of Thailand for their close cooperation extended to the team.

October 1992

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency

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List of Abbreviations for Local Exchange Areas in the BMA

NO.	LOCAL EXCHANGE AREA	ABBR	Telecom Area	NO.	LOCAL EXCHANGE AREA	ABBR	Telecom Area
1	Phloen Chit	PNC	1	30	Dao Khanong	DKN	3
2	Samran Rat	SRR	1	31	Bang Phlat	BGT	3
3	Krung Kasem	KKM	1	32	Phasi Charoen	PSN	3
4	Surawong	SRW	1	33	Charan Sanitwong	CSW	3
5	Samsen	SMS	1	34	Rat Burana	RBN	3
6	Asok Din Daeng	ASD	1	35	Lat Ya	LTY	3
7	Pathum Wan	PTW	1	36	Muban Setthakit	MSK	3
8	Sukhumwit	SKW	1	37	Ekkachai	EKC	3
9	Chaiyaphruk	CYP	2	38	Nong Khaem	NGK	3
10	Bang Na	BNA	2	39	Phra Pradaeng	PPG	3
11	Khlong Chan	KGC	2	40	Bang Bue Thong	BBT	3
12	Thung Mahamek	TMM	2	41	Phahonyothin	PYT	4
13	Sathupradit	STD	2	42	Inthamara	ITM	4
14	Thanon Tok	TNT	2	43	Bang Khen	BGN	4
15	Bang Chan	BGC	2	44	Bang Su	BGS	4
16	Phra Khanong	PKG	2	45	Don Muang	DNM	4
17	Hua Mak	HAM	2	46	Lak Si	LKS	4
18	Trok Chan	TKC	2	47	Ram Inthra	RIT	4
19	Lat Krabang	LKG	2	48	Lat Phrao 1	LTP1	4
20	Khlong Toei	KTI	2	49	Lat Phrao 2	LTP2	4
21	On Nut	ONT	2	50	Chaeng Watthana	CWT	4
22	Ramkamhaeng(	RKN	2	51	Nonthaburi	NTB	4
23	Samut Prakan	SPK	2	52	Ngam Wong Wan	NWW	4
24	Pu Chao Saming Phrai	PSP	2	53	Pak Kret	PKK	4
25	Bang Phli	BPL	2	54	Pathum Thani	PTT	4
26	Bang Pu	BGU	2	55	Rangsit	RST	4
27	Bang Phli Bang Bo	BBB	2	56	Thanyaburi	TYB	4
28	Thon Buri	TNB	3	57	Nawa Nakhon	NWN	4
29	Bang Khae	BKE	3	58	Bang Phun	BAN	4

CHAPTER 1 INTRODUCTION

1.1 Composition of the Study Report

The Final Report consists of the following two parts. Each part also consists of three volumes.

1) Part 1: The Long-term Plan Study
   a) Summary
   b) Main Report
   c) ANNEX

2) Part 2: The Feasibility Study on the Priority Project
   a) Summary
   b) Main Report
   c) ANNEX

This report presents the summary of the Feasibility Study.

1.2 Background of the Study

Japan International Cooperation Agency (hereinafter referred to as "JICA") has conducted "A Master Plan Study on Telecommunications Development in the Kingdom of Thailand" (hereinafter referred to as "the Master Plan Study") from September 1988 to December 1989 in response to the request of the Government of the Kingdom of Thailand. The Master Plan Study has revealed issues on telecommunications in the Bangkok Metropolitan area and urged the necessity for a further development study in the area.

In response to the request of the Government of the Kingdom of Thailand, the Government of Japan decided to implement A Study on A Regional Development Plan for Telecommunications Networks in the Bangkok Metropolitan Area in the Kingdom of Thailand (hereinafter referred to as "the Study"). JICA and Telephone Organization of Thailand (hereinafter referred to as "TOT") agreed upon the scope of work for the Study in October 1990.

The JICA study team on "A Regional Development Plan for Telecommunications Networks in the Bangkok Metropolitan Area in the Kingdom of Thailand" (hereinafter referred to as "the Study Team") headed by Mr. Satoshi Akaike, a senior manager of Planning Administration Department of Telecommunications Consulting Division in NTT International Corporation, begun the Study in July 1991.

The Study is conducted in two phases:

1) The first phase of the Study aims to formulate a long-term telecommunications development plan to fulfill telephone subscription demand, to upgrade the telecommunications services quality, to provide new telecommunications services in the Bangkok Metropolitan area and its Surrounding Area.

   The area to be covered by the Study is the Bangkok Metropolitan area (Bangkok, Pathum Thani, Samutprakarn, Nonthaburi: hereinafter referred to as "BMA") and its surrounding area (Nakhon Pathum, Samut Sakhon, and Ayutthaya). The planning period of the Study is fifteen (15) years from 1993 to 2007, and after selecting a top priority project, a feasibility study is carried out.

2) The second phase of the Study aims to conduct a feasibility study on the top priority project which should be selected from the high priority projects in the long-term plan.

   A study on "An Implementation Plan to Upgrade the Telecommunications Services Quality" has been selected as the second phase of the Study.

This final report presents the study results of the second phase of the Study and proposes the projects to upgrade the telecommunications services quality.

1.3 Objectives and Scope of the Study

1.3.1 Objectives

During the Work in Thailand-II, the JICA study team made a presentation of the Interim Report for the long-term plan. Through meetings and discussions between TOT and the JICA study team, the top priority project to be studied for the second phase of the Study was decided. The title of the feasibility study is "An Implementation Plan to Upgrade the Telecommunications Services Quality".

While there are many aspects in terms of telecommunications services quality, the following two items have been selected as the study objectives:

1) Improvement of Fault Ratio, and
2) Improvement of Call Completion Ratio.

Improvement of fault ratio and improvement of call completion ratio are essential because they directly affect the quality of customer services, performance of telecommunications networks, utilization of facilities, and operating revenues. Therefore, for the second phase of the Study, these two objectives have been selected to upgrade telecommunications services quality and concrete measures to achieve them would be established.

Toward the upgrading the services quality, the concrete measures which directly contribute to the two objectives are studied from the following viewpoints:

1) replacement of deteriorated facilities,
2) maintenance management standards, and
3) installation and construction method.

This study analyzes the present situation of the faults and the call completion ratio; and finds the major causes of the high faults ratio and the low call completion ratio. The Study Team proposes various measures and selects high priority projects among them as the action plan. The proposed projects are planned to be implemented during the period between 1993 and 1997 (Phase-1).

1.3.2 Scope

1) Target Figure

To improve the telecommunications services quality during the Phase-1, the following targets are set to be achieved by FY 1997.

a) Fault Ratio

Area	Present figure (1991)	Target figure (1997)	Definition
BMA	4.4	2.5	No. of Faults/100 subscribers/month
Provincial Area	4.9	3.0	ditto

To achieve the target figures of the Phase-1, the number of faults in a month for the existing facilities must be 2.5 per 100 main telephone lines connected in the BMA and 3.0 in the Surrounding Area. If the target figures are calculated on the basis of

both the existing telephone lines and the new ones to be installed by the future telephone expansion plan, i.e., the seventh ESDP of TOT, they will be easily achieved because the new installed facilities are expected to have very low fault ratios at the beginning.

However, even if the target figures are achieved because of the increased new telephone lines with a small number of faults and the existing telephone lines with the same number of faults, the high fault ratio for the existing subscribers will still prevail and the services quality will become worse. This study, therefore, excludes those new facilities from the fault ratio calculation as explained in 'Facilities Investigated in the Study' later.

The Study Team applies the above target figures on the existing facilities only because of the following reasons:

i) It is necessary to keep the fault ratios of the facilities maintained by TOT and by the new contractor close in order to provide customers with fair services,

ii) The Study Team expects that the target figures can be achieved through implementing the proposed projects. Among them, improvement of customer premises, the rehabilitation of timeworn subscriber cables, and the replacement of drop wires are quite effective and essential to reduce the number of faults; therefore they should be implemented at first.

b) Call Completion Ratio

Area	Present figure (%) (1992)	Target figure (%) (1997)	TOT Target Figure (%) (1996)
Study Area	23.5	55.0	50.0

The target figure for the call completion ratio by the end of the Phase-I (1997) was set at 60% in the Master Plan Study.

However, at present, TOT has set the target figure at 50% by the end of FY 1996. The Study Team has decided the target figure to be 55% by the end of the Phase-1 (1997). The reasons are as follows:

It is expected that the implementation of the first priority projects can improve the call completion ratio as follows because of their high effectiveness.

i) The call completion ratio of 23.5% in 1992 will be improved to become 30% in 1993,

ii) The ratio will increase to become 37.5% in 1994, 45% in 1995, 50% in 1996, and

iii) Finally, it will reach 55% by the end of the Phase-1 (1997).

2) Study Area

This Study covers the BMA and its Surrounding Area as well as the Study on the long-term plan.

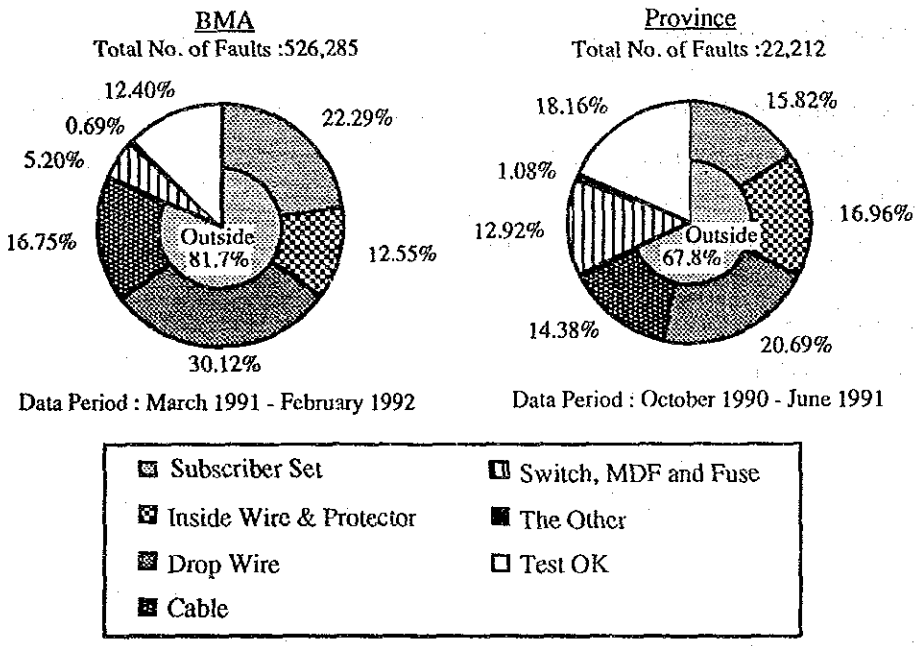
3) Facilities Investigated in the Study

It has been already decided that TOT would not expand the telecommunications networks in the BMA and its Surrounding Area by itself during the seventh Economic and Social Development Plan (ESDP) period. Therefore, the facilities to be covered by the Study are basically those existed by the end of the fiscal year of 1991.

CHAPTER 2 IMPROVEMENT OF FACILITY FAULT RATIO

2.1 Present State of Fault Ratio

Figure 2.1 shows the percentage distribution of the facility faults in both the BMA and provincial areas in TOT. Almost all of the facility faults in both areas occur in outside plant. In particular, in the BMA, 81.7% of the facility faults occur in outside plant, 5.2% in switching facility, and 0.7% in others (12.4% in Test OK). In this chapter the faults mean those found by customer claims; however, the fault of public telephones includes those discovered by TOT inspections.



Note: Sources are as follows:
- Monthly Maintenance Report by the Center of Maintenance and Operator Services
- Statistic of the Number of Faults at the Customer Premises by Complaint Center of Area 1
- Statistic of the Public Telephone Faults by the Public Telephone Division
- Summary of Monthly Report by the Department of Subscriber Service

Figure 2.1 Percentage Distribution of Faults by Types of Facility

Outside plant involves cables, drop wires, protectors, inside wires and subscriber sets including public telephones. Switching facilities involve switches, main distribution frame (MDF), fuses, etc. Others means the remainder of outside plant and switching facilities.

The Study Area in the provincial areas is the Surrounding Area which is a part of the provincial areas. But the facility faults represent those in the entire provincial areas because the Study Team could not isolate the faults of the Surrounding Area.

2.2 Outside Plant

1) Study Method

The Study was carried out by following procedure.

a) The Krungkasem Exchange Area was selected for the investigation because the fault ratios by all facilities are in the average levels in the BMA.

b) The recent repair records of the faults occurred in the Krungkasem Exchange Area are examined to understand the fault occurrence conditions by types of the facilities.

c) Some field investigations are carried out to understand the condition of the facilities in the Krungkasem Exchange Area.

2) Present State of the Faults and Improvement Measures

a) Cable Faults

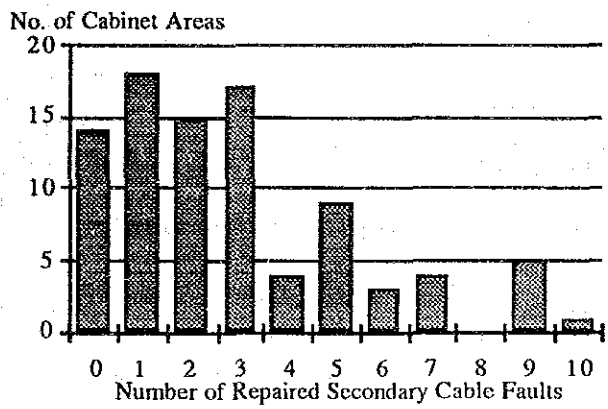


Figure 2.2-1 Distribution of the Repaired Secondary Cable Faults by Cabinet Area in the Krungkasem Exchange Area (1991.10 - 1992.3)

A few cabinet areas experienced high secondary cable fault ratios. About 50% of the secondary cable faults concentrate on about 20% of the cabinet areas in the Krungkasem Exchange Area. Figure 2.2-1 shows the number of cabinet areas classified by the number of repaired secondary cable faults in the Krungkasem Exchange Area during the recent 6 months. The present state of the cable faults and their improvement measures are as follows:

Present State of the Cable Faults	Improvement Measures for the Cable Faults
a) Many primary cable faults occur on the old cables b) Secondary cable faults concentrate on a few areas c) Water penetration is one of the reasons of the cable faults d) Cable damages by birds and insects in the ready access type closures are reported	i) Replacement of the faulty cables - Primary cables - Secondary cables ii) Introduction of a water penetration monitoring system for the jelly filled type primary cables iii) Improvement of reliability of the closures iv) Establishment of a preventive maintenance system by analyzing location and cause of the faults employing the quality control method

b) Drop Wire Fault

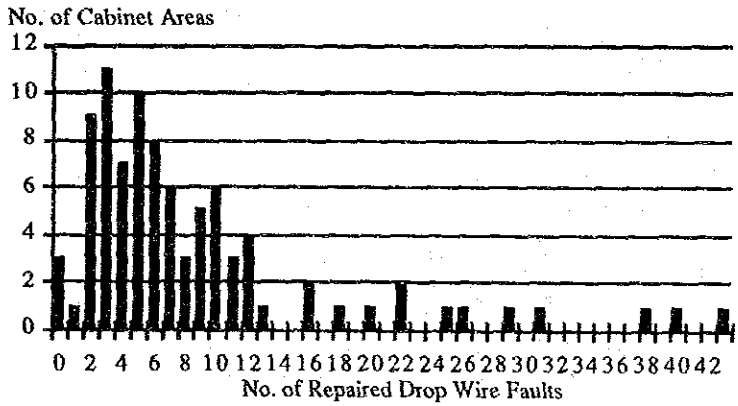


Figure 2.2-2 Distribution of the Repaired Drop Wire Faults by Cabinet Area in the Krungkasem Exchange Area during the Recent 6 Months (1991.10 - 1992.3)

The drop wire faults concentrate on a few cabinet areas. Usually, the drop wires are crowded and long in these areas. Figure 2.2-2 shows the number of cabinet areas classified by the number of repaired drop wires in the Krungkasem Exchange Area during the recent 6 months. The Present state of the drop wire faults and their improvement measures are as follows:

Present State of the Drop Wire Faults	Improvement Measures for the Drop Wire Faults
a) Drop wire faults concentrate on a few areas	i) Replacement of the drop wires with cables - Long drop wires - Crowded drop wires
b) Many drop wire faults occur between poles	
c) Many drop wire faults occur by touching with something and hanging down	ii) Renewal of the faulty drop wires
d) The drop wires which have experienced faults are easy to get another faults	iii) Improvement of the drop wire repair method
e) The reliability of the current type drop wires is not high against the sever climate in Thailand	iv) Improvement of the drop wire installation method
	v) Improvement of the material quality of the wires
	vi) Establishment of a preventive maintenance system by analyzing location and cause of the faults employing the quality control method

c) Public Telephone Fault

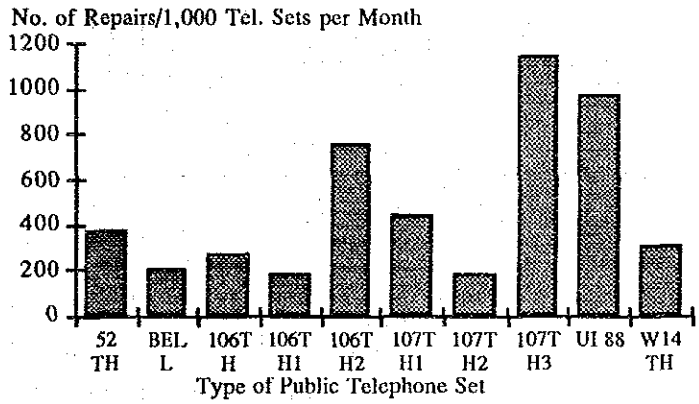


Figure 2.2-3 Fault Ratio by the Public Telephone Sets in the Krungkasem Exchange Area during the Recent 6 Months (1991.10 - 1992.3)

The fault ratios on certain types of the public telephone sets are very high compared with another types of telephone sets. Figure 2.2-3 shows the number of repairs per 1,000 telephone sets per month in the Krungkasem Exchange Area during the recent 6 months. The present state of the public telephone faults and their improvement measures as follows:

Present State of the Public Telephone Faults	Improvement Measures for the Public Telephone Faults
a) Certain types of public telephone set get faults repeatedly	i) Replacement of the faulty public telephone sets (including trial test)
b) Protectors for the public telephone sets have been cut off from local loops because of low quality	ii) Replacement of the protectors for the public telephone sets (including trial test)
	iii) Introduction of a repair method by changing the faulty parts with good ones or by repairing the faulty parts
	iv) Establishment of a preventive maintenance system by analyzing location and cause of the faults employing the quality control method

d) Faults at Customer Premises

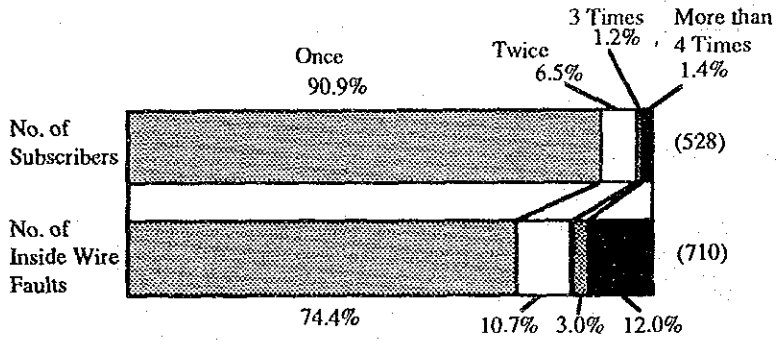


Figure 2.2-4 Present State of the Repeated Inside Wire Faults in the Krungkasem Exchange Area during Recent 6 Months (1991.10 - 1992.3)

Inside wire faults occur at certain subscribers frequently. Figure 2.2-4 shows only 1.4% of faulted inside wires share 12% of inside wire faults in the Krung Kasem Exchange Area during the recent 6 months. The present state of the faults in the customer premises and their improvement measures are as follows:

Present State of the Faults in the Customer Premises	Improvement Measures
a) Some customers have experienced frequent inside wire faults	i) Facility checks and consulting activities for customers
b) Inside wire faults originate from the low quality wiring works and lack of customer knowledge	ii) Introduction of onerous repair service
	iii) Campaign and advertisement to customers
c) TOT does not repair faults on customer premises	iv) Check customer premises before connection with TOT networks

3) Proposed Projects

To achieve the target of the facility fault ratio, more than 42% of the outside plant faults is required to be reduced. The Study Team proposes the following eight projects (Table 2.2). The work volume of these projects are estimated with their effects, efficiencies and investment costs are taken into consideration.

Table 2.2 Proposed Projects (Outside Plant Section)

Facility & Present Fault Ratio (% share of the facility faults)	Existing Volume (A)	Project and Work Volume (B)	% of Existing (B)/(A) %	Expected Fault Ratio after the Project
Cable **0.74** (16.8%)				**0.46**
Secondary Cable	1,156,126 pair-km (289,0314 pairs)	Rehabilitation 231,000 pair-km	20%	(- 27.6%)*1
Primary Cable	2,293,900 pairs	Rehabilitation 343,500 pairs	15%	(- 11.1%)*1
Drop Wire **1.33** (30.1%)	1,000,441 drop wires (113,420 km)			**0.55**
		Replacement of Drop Wires with Cables Cable 94,000 pair-km	58% of the total length of drop wires	(- 36.0%)*1
		Rearrangement of Distribution Points 8,250 DPs (99,000 drop wires)	10%	(- 4.0%)*1
		Renewal of Drop Wires 200,000 drop wires	20%	(- 19.1%)*1
Public Telephone **0.60** (13.7%)	17,495 sets BMA 17,174 Surrounding 317			**0.38**
		Replacement of Public Tel. Sets with Good Type 6,158 sets (BMA 5,841) (Surrounding 317)	35%	(- 31.4%)*1
		Replacement of Protectors with Good Type 17,500 sets	100%	(- 5.5%)*1
Customer Premises	1,250,551 sub.			
- Inside Wire **0.55** (12.6%)		Facility Check and Consulting Activity 187,000 sub.	15%	**0.41** (- 25.0%)*1
- Sub. Set **0.38** (8.6%)				**0.27** (- 30.0%)*1
Outside Total **3.59** (81.7%)				**2.07** (- 42.3%)*1

Note Unit of the fault ratio : Number of faults per 100 subscribers per month
*1 : Expected reduction rate of each facility fault ratio

2.3 Switching Facility

1) Present State of Faults

Figure 2.3-1 shows a comparison of the fault state between the XB switches and SPC switches in the BMA.

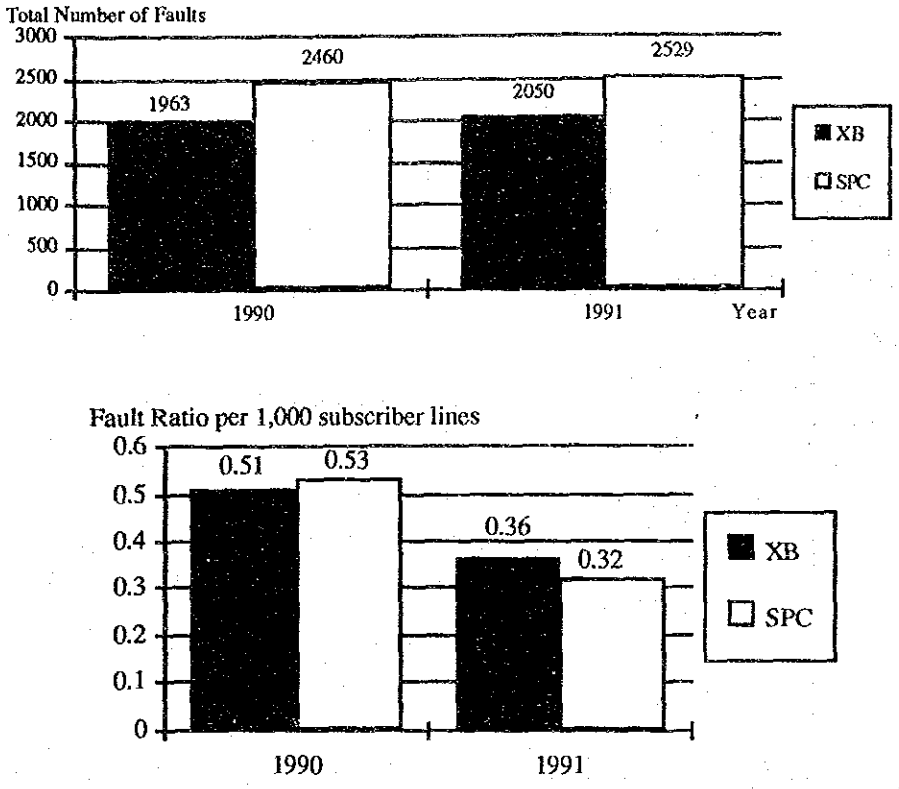


Figure 2.3-1 Comparison of Fault State between XB Switches and SPC Switches

There are only two year fault data. The fault ratio of the XB switches is higher than that of the SPC switches. Furthermore, the fault ratio of the XB switches in 1991 increased a bit compared with that in 1990. On the contrary, the fault ratio of the SPC switches in 1991 decreased compared with that in 1990 in spite that the number of lines connected increased year by year.

However, replacing the XB switches with the SPC switches is carried out from various viewpoints; not only out-of-service condition (fault ratio) but also telephone demand, demand for new services, efficiency of O&M, smooth and even replacement and purchase of spare parts as discussed in Chapter 13 of Main Report of the Long-term Plan Study.

The faults related to hardware of the SPC switches are classified into the LIB (Line Interface Board) fault and the OTH (Other Board). Figure 2.3-2 shows the fault ratio of

the LIB and the OTH. The fault ratio of the LIB is much higher than that of the OTH every year.

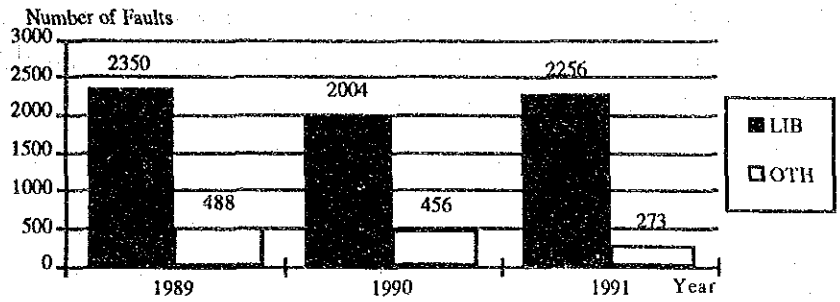


Figure 2.3-2 Total Number of LIB and OTH Faults in the BMA

2) Improvement Measures

a) Replacement of XB Switch

The Study Team proposes to start replacing the XB switches by the SPC switches in 1993 and to finish the replacement by 2000. Table 2.3 shows the replacement plan of the XB switches in the Study Area. The number of planned line units to be replaced is 234,824 in the BMA and 10,426 in the Surrounding Area between 1993 and 1997.

Table 2.3 Replacement plan of XB Switches in the Study Area

(Unit: Lines)

Year	1993	1994	1995	1996	1997	Total
BMA	52,000	48,310	48,050	46,300	40,164	234,824
Surrounding Area	3,426	3,000	2,000	1,000	1,000	10,426
Total	55,426	51,310	50,050	47,300	41,164	245,250

By the end of 1997, 68.2% and 100% of the XB switches will be replaced in the BMA and Surrounding Area respectively, according to the plan.

b) Introduction of Improved Versions of Line Protector

At present, TOT has been developing new improved line protectors and obtained good results. In order to effectively reduce SPC switch faults, the Study Team will adopt the new improved line protectors of TOT. As a result, it is expected to reduce about 70% of the LIB faults in five years starting from 1993 as a measure to reduce SPC switch faults.

3) Result

By replacing the XB switches and introducing the improved version of line protectors, it is expected to reduce the number of faults in a year from 19,614 in 1993 to 10,756 (reduced ratio 45%) by the end of 1997 as shown in Figure 2.3-2. The number of faults, 19,614, is calculated from the real number of faults in a year, 22,056 in 1991.

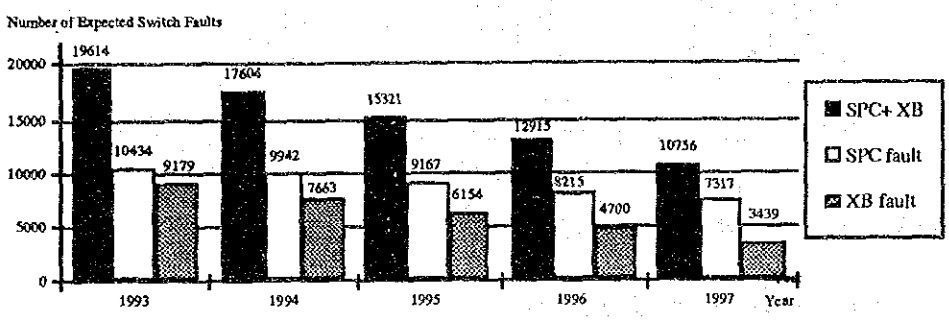


Figure 2.3-3 Total Number of Expected Switch Faults in Each Year in the BMA

2.4 Transmission Facility

The improvement of fault ratio in the transmission section does not directly promote the improvement of the fault ratio in this study, however, the improvement of fault ratio, a maintenance system is required to the transmission section from the viewpoint of upgrade of telecommunications service quality of TOT. The following issues to be improved are found in the section.

1) Issue of the Present Maintenance System

a) Fault Control

TOT has applied a facility availability control system as maintenance control. This method is an average fault control system. The Study Team recommends to apply an additional maintenance control target value to control irregular faults such as faults which take long repaired time.

b) Extraordinary Fault Control

TOT has already established an extraordinary fault information method; however, the definition of the extraordinary faults which should be informed to the headquarters of TOT.

c) Channel Assignment

The tool to automatically assign trunk circuits to doubled or looped transmission routes is required in the channel assignment section in TOT; however, they are not provided yet.

d) Leased Line Maintenance

TOT has established the leased line office in the last year (1991) and has been making an effort to upgrade the service quality of leased lines; however, the service quality is not still sufficient for users.

e) Deteriorated Facility Control

The deteriorated facility control system in the transmission section is basically operated smoothly; however, some parts should be improved in accordance with the maintenance control system proposed in the Study.

2) The Improvement Measures

To improve the issues mentioned above, the following improvement measures are proposed.

a) Definition of Maintenance Control Target value,
b) Definition of Maintenance Control Value for Extraordinary Faults,
c) Introduction of Tools for Channel Assignment,
d) Introduction of A Computerized Leased Line Control System,
e) Introduction of A Leased Line Remote Testing System,
f) Replacement of PCM Systems.

2.5 Operation and Maintenance

2.5.1 Present State

1) Outside Plant Section

The present issues in the outside plant section are as follows;

a) shortage of analysis and reliability in the official monthly maintenance report,
b) shortage of office automation system in the complaint center,
c) environment of maintenance activity.

i) Labor productivity

A suitable staff allocation for providing same level of services anywhere in the BMA and saving the useless operation cost is an important matter. Because the fault repair activities mostly depend on manpower. The establishment of a proper staffing system is indispensable for realizing successful maintenance operations. Figure 2.5.1-1 shows the number of faults per employee in the ordinary telephone as an example. The maintenance area 1 is the lowest the number of faults per employee. Especially, it is significantly different from the maintenance areas 1 and 4.

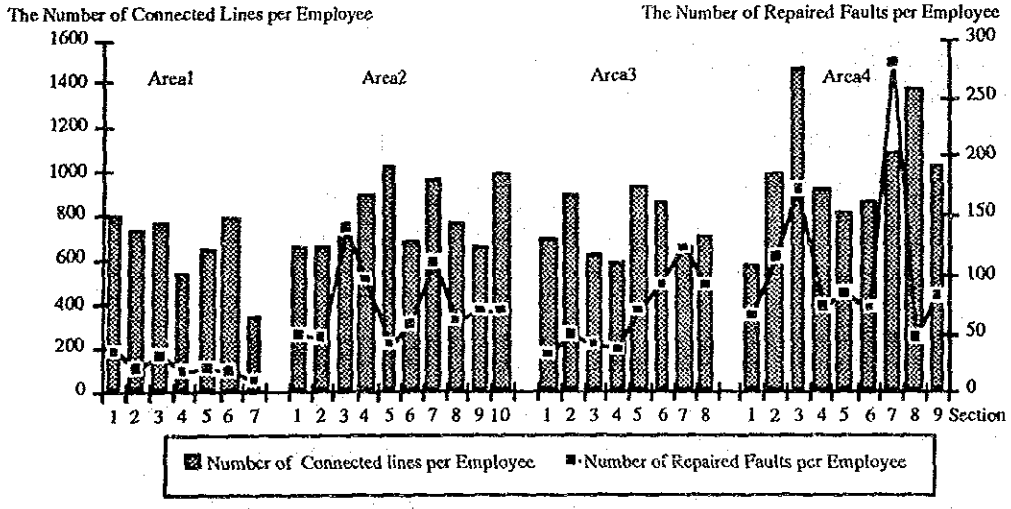


Figure 2.5.1-1 Number of Connected Lines per Employee and Number of Faults per Employee

ii) Customer Service Situation

A very important thing for TOT is to shorten the repair time in order to increase the customer service quality. Figure 2.5.1-2 shows the repair

completion ratio within one day. The maintenance areas 1 and 4 are lower than other areas in repair completion ratio within one day.

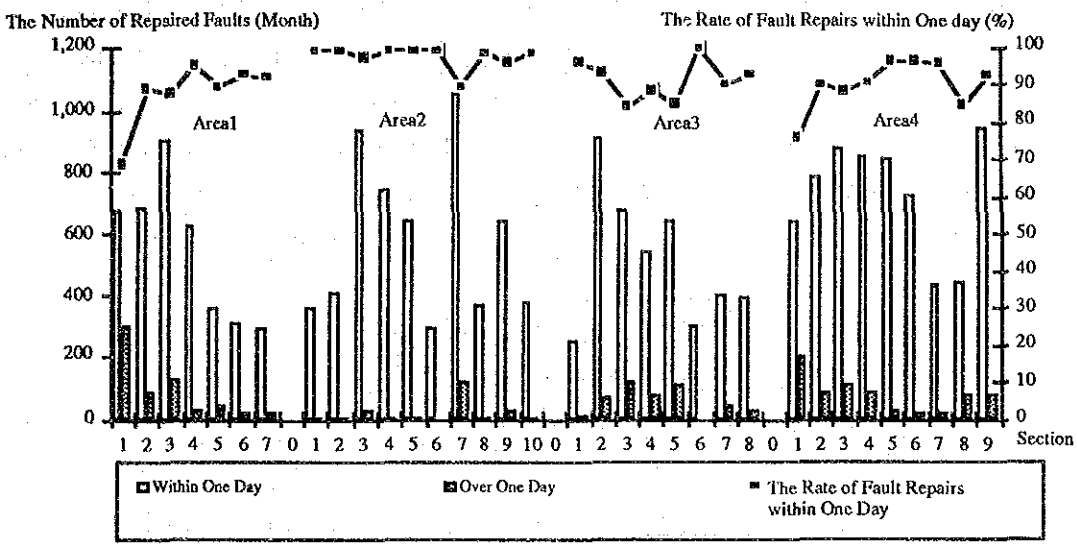


Figure 2.5.1-2 Required Days for Recovering Faults in Each Maintenance Sections (Ordinary Telephone)

d) Shortage of material management in the public telephone section
e) Shortage of manpower management

2) Switching Section

The present issues in the outside plant section are as follows;

a) non-existence of a centralized maintenance system for the SPC switches,
b) shortage of fault record management,
c) shortage of a follow-up system for human resource development,
d) shortage of spare parts for the SPC switches.

3) Transmission Section

The present issues in the transmission section is the shortage of a fault control system.

2.5.2 Improvement Measures

In order to improve the state of O&M activities, TOT needs to introduce a maintenance control system. Furthermore, it is also necessary to improve material and human resource management.

1) Establishment of Maintenance Control System

For establishing a reliable maintenance system and offering high quality services to the customers, TOT needs to adopt maintenance control system. The system consists of three control systems. One is Service Control System. Second is Extraordinary Failure Control System. The last is Plant Control System. An important thing in the system is to execute preventive maintenance activities based on the analysis of the present facility conditions. Figure 2.5.2 shows the concept of maintenance control system.

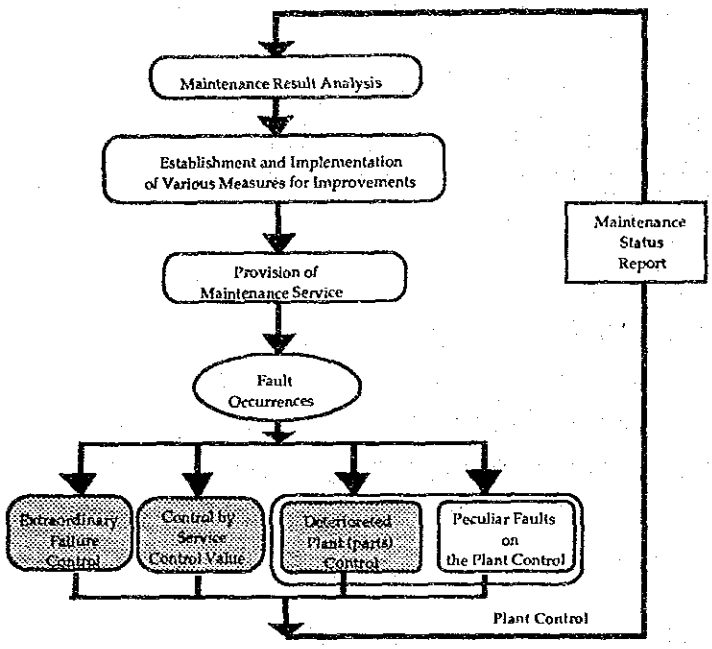


Figure 2.5.2 Maintenance Control System

2) Improvement of Maintenance Activities

The maintenance area 1 in the outside plant maintenance section needs to review the maintenance work activities such as despatch system, work method and staff morale. Because the labor productivity and customer service level is not in good condition, in spite of its importance for political and economic activities since big users and the government offices are concentrated on this area. Traffic jam sometimes happens. Fault repair activities can be difficult compared with other areas. However, this area needs to improve the situation. This area may need to adopt a different work system (such as setting up special repair teams and using more small-size motor vehicles etc.) from other areas.

The maintenance area 4 is in a serious situation. The number of fault repairs per employee and the number of fault repairs over one day in the area are high compared with other areas. If the cause depends on shortage of manpower, TOT needs to provide the

necessary manpower to the maintenance area 4. However, the measure is not to recruit new people but making an efficient use of the TOT staff by relocating and re-assigning people from other areas.

3) Saved Staff and Saved Manpower Costs

The project to decrease the faults can save maintenance and repairing load. Table 2.5.2 shows the number of saved staff and saved manpower costs by the project from FY1993 to FY1997.

Table 2.5.2 Number of Saved Staff and Saved Manpower Costs by the Project

	1993	1994	1995	1996	1997	Total
The Number of Saved Staff in the Outside Plant Section	46	39 (85)	50 (135)	48 (183)	81 (268)	264
The Number of Saved Staff in the Switching Section	36	36 (72)	31 (103)	34 (137)	31 (168)	168
Total	82	75 (157)	81 (238)	82 (320)	112 (432)	432
The Saved Manpower Costs in the Outside Plant Section	3.19	9.68	18.11	27.85	43.33	102.16
The Saved Manpower Costs in the Switching Section	2.49	8.20	13.81	20.85	27.56	72.91
Total	5.68	17.88	31.92	48.70	70.89	175.07

Note : ( ) shows the total number of saved staff from FY1993 to the year concerned.
The saved manpower costs unit is Million Baht.

CHAPTER 3 IMPROVEMENT OF CALL COMPLETION RATIO

3.1 Present State of Network Service Performance

The telephone call completion ratio measured at the NEAX-61 switches in the BMA in March 1992 is 23.5% and the categories of incomplete calls are P.S.Abandon (26.8%), B-sub busy (24.4%), P.D.Abandon (7.7%), ringing abandon (B-sub-no-answer) (5.8%), congestion (5.5%), technical fault (5.1%) and others (1.2%) as shown in Figure 3.1.

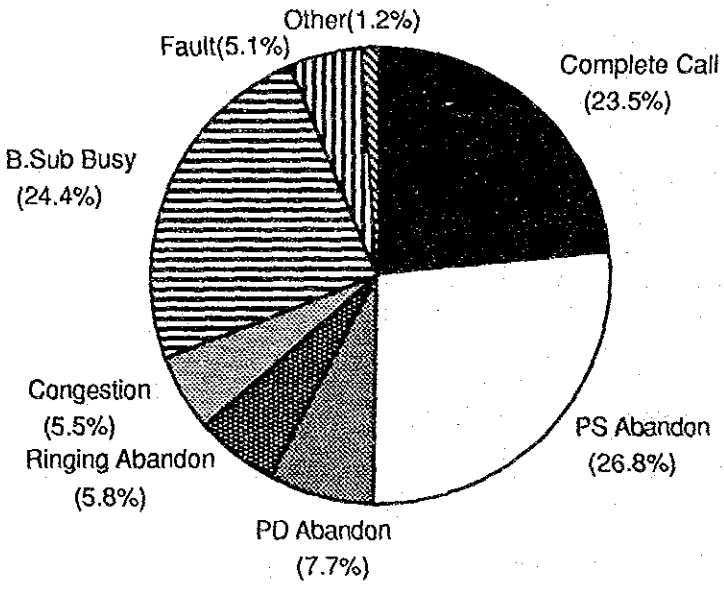


Figure 3.1 Service Performance in the BMA (March, 1992)
(Observed during Busy Hour)

3.2 Causes and Measures

The study was focused on the NEAX-61 SPC switches in the BMA because of the following reasons.

1) At present all of the SPC local switches in the BMA are NEAX-61.
2) The XB switches have been planned to be replaced by the SPC switches in the near future.

The followings are the results of the study on causes and measures of each category of incomplete calls.

1) P.S.Abandon

P.S.Abandon calls are the biggest problem that severely affects the completion ratio of the TOT networks. After a field trial at Phra Khanong-T6, it was found that a part of the P.S.Abandon calls originated in proportion to traffic volume and the rest originated independently of traffic volume. It was found that the former category of the P.S.Abandon calls originated from faulty subscriber lines including faulty public telephones.

Measures to reduce P.S.Abandon calls are as follows:

a) To clear all faulty subscriber lines including public telephones,
b) To rehabilitate deteriorated subscriber lines,
c) To undertake a user campaign urging users to use telephone correctly.

2) B-sub Busy

B-sub busy calls are the second biggest factor of aggravating the completion ratio. But the Study Team considers that reducing B-sub busy calls is the most important work in this project because a B-sub busy situation occurs at the final stage of a calling process after occupying most of the network facility. Improvement of B-sub busy situations will directly influence the revenue of TOT. Introducing hunting systems to the subscribers who have more than one telephone line is considered as the most effective method to improve terminating call completion ratio. But according to the data from the CDAS (Computerized Directory Assistance Service), about 80% of the subscribers who use PABX have not introduced the hunting system yet.

Measures to reduce B-sub busy calls are as follows:

a) To promote the introduction of hunting systems,
b) To install additional main telephone lines to high B-sub busy subscribers,
c) To promote call waiting service to the subscribers who have single telephone line,
d) Installing automatic howling tone sender to send a howling tone to subscriber line which has been left off-hook.

3) Traffic Congestion

a) System Over-load

From the past two (2) year data, system over-load problems were seen only in three switching offices of Surawong, Samran Rat and Khlong Toei. Even in these

switch units, there were still some CP units which load were rather low comparing with the capacity.

The measures to improve system over-load problems is to even out the loading rate of CP units by changing accommodations of high traffic subscribers with low traffic subscribers.

b) Traffic Congestion on Circuits

A total of 3,200 circuits were calculated as the number of circuits being in short on direct routes and final routes between local switches and tandem switches in the BMA including junction routes between PSTN (Public Switched Telephone Network) and MTXs (Mobile Telephone Exchanges) in the BMA. Many routes which have excess circuits were also detected. It seems that this unbalance between the traffic volume and the number of circuits is due to the reason that the TOT networks are now on the process of network restructuring from the network structure of the 4th TOT ESDP to that of the 5th.

Measures to improve traffic congestion on circuits are as follows:

a) To reinforce facility management based on measured traffic,
b) To hasten the construction of the transmission network which has been planned in the 5th and 6th expansion projects.

4) P.D.Time-out

P.D.Time-out occurs when the time interval between dialing each number becomes longer than the limit time being set on a register in a telephone exchange. At present, the timing of P.D.Time-out in TOT network is set at 4 seconds. It seems the time is too short. For example, the time in Japan is 20 seconds and in Malaysia 8 seconds. The Study Team estimates the time can be extended from 4 seconds to 8 seconds.

5) Overlook of Causes and Measures

Table 3.2 shows an overlook of causes of each incomplete call category, their measures, estimated effects and improvement targets at the end of the projects.

Table 3.2 Causes, Measures and Improvement Target

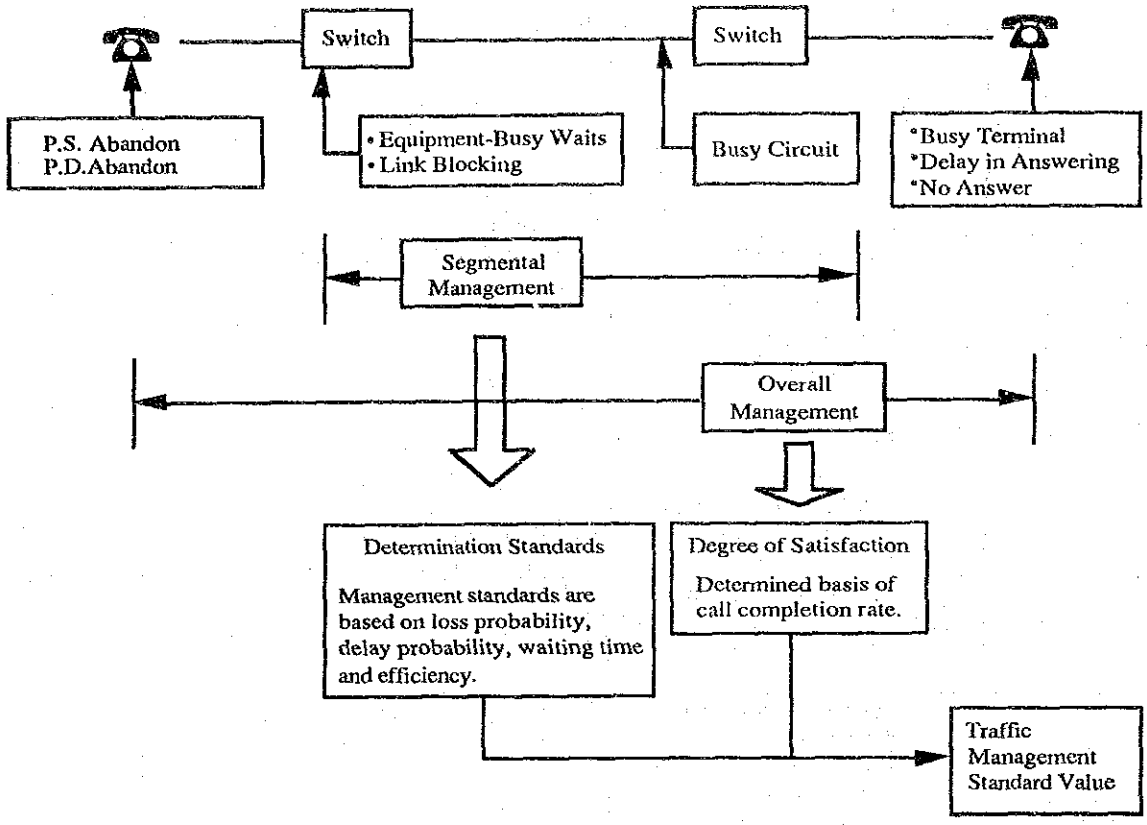
(Cost Unit: Million Baht)

Categories	Present (%)	Causes	Measures	Effect (%)	Target (%)	Cost
P.S.Abandon	26.8	Subscriber line faults User behavior	Repair of faulty subscriber lines	-6.8	16.0	(*)
			Replacement of public telephone & protector	-1.0		(*)
			Subscriber line rehabilitation work	-2.0		(*)
			User campaign (correct use of telephone)	-1.0		(-)
B-sub Busy	24.4	Not enough introduction of hunting system	Promotion of multi-hunting-system	-4.4	13.6	(-)
		Shortage of main telephone lines	Expansion of subscriber lines	-5.2		(-)
		Not enough introduction of call-waiting service	Promotion of call-waiting service	-1.0		(-)
		Faulty subscriber line	Subscriber line rehabilitation work	-0.1		(*)
			Installation of Automatic Howling Tone Sender	-0.1		(6)
P.D.Abandon	7.7	Subscriber line faults	Subscriber line rehabilitation work	-1.0	5.0	(*)
		User behavior	Dial consulting activity	-1.7		(-)
B-sub No Answer	5.8	No information of changed telephone numbers except telephone directory service	Introduction of information service for changed number	-1.0	3.5	(70)
			Promotion of automatic answer telephone	-0.6		(-)
		No person to answer	Promotion of call transfer service	-0.2		(-)
		Subscriber line faults (line disconnection)	Subscriber line rehabilitation	-0.3		(*)
		Operator's answer delay	Management on operator's answer delay time	-0.2		(-)
Congestion	5.4	Shortage of trunk circuits	Increasing number of circuits	-2.4	2.4	(56)
		CC over-load	Subscriber line accommodation adjustment	-0.1		(-)
		Repeat call attempts	Introduction of recorded announcement	-0.5		(1)
Fault	5.2	Shortage of P.D.Timing	Changing P.D.Timing	-1.7	2.5	(-)
		Multi-frequency code error	Improvement of periodic maintenance	-1.0		(-)
Others	1.2	---	---		2.0	

Note: (*) indicates that the cost of the item is counted in improvement work of fault ratio.

3.3 Creating Management Standards for CCR Management

In order to improve the call completion ratio, it is required to create management standards on which CCR management is carried out. The method is described in Figure 3.3.



Overall Management

From the standpoint of guaranteeing service quality, overall management comprehensively manages the entire connection system from dialing by a user to being connected to the destination party, and cover all traffic-related elements -- even including user phone habits. (Comprehensive evaluation is carried out by using the call completion ratio.)

Segmental Management

Segmental management deals with the service quality of switches and circuits. Management is effected through management standards based on loss probability, delay probability, waiting time and efficiency.

Figure 3.3 Creating Management Standards for CCR Management

CHAPTER 4 IMPLEMENTATION PLAN

The causes of the high fault ratio and the low call completion ratio of the present telecommunications services in the Study Area are analyzed in Chapter 2 and Chapter 3. Both chapters propose various measures to reduce fault occurrences and increase complete calls.

This chapter selects 26 projects as measures to be implemented in Phase-1, i.e., the next 5 years; and groups those projects into the following three fields at first:

1) the outside plant field,
2) the switching and transmission field, and
3) the other field.

Secondly this chapter arranges those selected projects in priority order and classifies them into the three priority classes taking the improvement effects and the cost of each project into consideration. Then, an implementation schedule is formulated for every project.

4.1 Formulation of Implementation Plan

4.1.1 Selection of Implementation Project

The measures to improve the services quality of the telecommunications in the Study Area are proposed in Chapter 2 and Chapter 3. The Study focuses two service categories: one is to decrease faults and the other is to increase complete calls.

The Study Team selects 26 projects to formulate an implementation plan, i.e., the action plan in other words, taking the following viewpoints into consideration:

1) Projects which are expected to contribute to the improvement of the fault ratio and the CCR directly,
2) Projects which are able to be carried out smoothly within the Phase-1 period.

All the projects are indispensable for TOT to achieve the services targets of the fault ratio and the CCR within the Phase-1 period.

Other improvement measures that are not listed in the 26 projects are also expected to promote and support upgrading the telecommunications services quality. They are proposed as the other measures in section 4.5 of this chapter.

4.1.2 Priority Order

The selected projects can be divided into two groups. One group is for improving the fault ratio, and the other group is for improving the CCR. The rehabilitation projects of subscriber lines are for both purposes.

The projects are classified into three priority classes taking the following procedures:

1) Evaluate the effects to improve the fault ratio,
2) Evaluate the effects to improve the CCR, and
3) Evaluate the improvement performance per investment cost,

for each project.

To classify the 26 projects into the three classes: Class A "The First Priority", Class B "The Second Priority" and Class C "The Third Priority", the Study Team evaluates the projects and gives a priority point to each project by taking the effect and the cost of each project into consideration. Then the Study Team classifies them into the three priority classes according to the following table.

Table 4.1.2 Classification Table for Priority Order Arrangement of the Projects

Class	Weight of Effect (Improvement Ratio)	
	Fault ratio	CCR
Class A "The First Priority"	Priority Point E: E >130	Priority Point E: E >130
Class B "The Second Priority"	Priority Point E: 130≥E >100	Priority Point E: 130≥E >105
Class A "The Third Priority"	Priority Point E: 100 ≥ E	Priority Point E: 105≥ E

The priority points are calculated according to the following manner. The detailed procedure is described in APPENDIX of the Main Report.

1) Priority Points for the Effects to Improve the Fault Ratio

a) The maximum point of 100 is given to a project to yield maximum improvement on the fault ratio and the minimum point of zero (0) is given to a project to yield zero improvement (PCM cable system replacement).

b) Each project is given a priority point ranging from zero to 1,000 in proportion to the improvement.

2) Priority Points for the effects to Improve the CCR

The same procedure is applied to evaluate each project on the effect to improve the CCR.

3) Improvement Performance of Service Quality per Investment Cost

The priority point of 100 is given to the highest efficiency improvement projects, i.e., the lowest cost to improve one percent of the fault ratio or the CCR. The projects which can be implemented without any additional cost are also given 100.

4) Special Projects

Several projects can improve both the fault ratio and the CCR. In this case, evaluation points on the fault ratio and the CCR are calculated for these projects in proportion to the improvement.

4.1.3 Ranking of the Projects

Table 4.1.3 lists up the selected projects with the priority classes. Each project is explained in the section of the previous chapters as indicated in the reference. The 26 projects are classified into the three classes as follows:

- Class A: "the first priority" 10 projects,
- Class B: "the second priority" 9 projects,
- Class C: " the third priority" 7 projects.

All these proposed projects should be completely carried out within the Phase-1 period (FY 1993-FY 1997) to achieve the targets of the fault ratio and the CCR by the end of 1997. However, if TOT cannot carry out all the projects during the Phase-1 period, TOT is recommended to implement the projects according to their priority order, i. e. to carry out from those projects with high priority.

Table 4.1.3 Ranking of the Projects

Field	Project Code	Project Name	Work Volume		Total Evaluation	Reference (Section)
Outside Plant		1) Rehabilitation of Subscriber Lines				
	OSP-1	Rearrangement of Distribution Points	(Unit: DPs)	8,250	A	2.2.3 3)
	OSP-2	Replacement of Drop Wires with Cables	(Unit: Pair-Km)	94,000	A	2.2.3 3)
	OSP-3	Renewal Drop Wires	(Unit: Drop wire)	200,000	A	2.2.3 3)
	OSP-4	Replacement of Secondary Cables	(Unit: Pair-Km)	187,000	B	2.2.3 2)
	OSP-5	Replacement of Primary Cables	(Unit: Pairs)	343,500	C	2.2.3 2)
		2) Customer Premises				
	OSP-6	Check and Consulting for Customer Premises	(Unit: Subscriber)	187,000	A	2.2.3 5)
		3) Replacement of Public Telephones				
	OSP-7	Replacement of Public Telephone Sets	(Unit: Set)	6,158	A	2.2.3 4)
	OSP-8	Replacement of Protectors	(Unit: Protector)	17,500	B	2.2.3 4)
Switching & Transmission	S&T-1	Replacement of Line Protectors	(Unit: Main Tel. Line)	855,066	B	2.3.2 2)
	S&T-2	Replacement of XB Switches with SPC Switches	(Unit: Line Capacity)	245,250	C	2.3.2 1)
	S&T-3	Replacement of Circuits	(Unit: Circuit)	3,154	C	2.3.2 1)
	S&T-4	Installation of Automatic Howling Tone Service	(Unit: Device)	239	C	3.7.3
	S&T-5	Subscriber Line Accommodation Adjustment			B	3.6.1
	S&T-6	Introduction of Record Announcement	(Unit: Device)	61	B	3.9
	S&T-7	Changing P.D. Timing			A	3.7.3
	S&T-8	Improvement of Periodic Maintenance			B	3.7.3
	S&T-9	Replacement of PCM System with FOTS	(Unit: DTI)	1,144	C	2.4.2
	S&T-10	Increasing Number of Circuits	(Unit: Circuits)	3,295	A	3.6.2
Others	OT-1	Expansion of Subscriber Lines	(Unit: Main Tel. Line)	500,000	A	3.5.1
	OT-2	Promotion of Multi-hunting-system			A	3.5.2
	OT-3	Promotion of Call-waiting Service			B	3.5.4
	OT-4	Dial Consulting Activities (User Campaign)			A	3.7.1
	OT-5	Promotion of Automatic Answer Telephones			B	3.7.2
	OT-6	Promotion of Call Transfer Service			C	3.5.4
	OT-7	Management on Operator's Answer Delay Time			C	3.7.2
	OT-8	Introduction of Information Service for Changed Numbers	(Unit: Switch unit)	1	B	3.7.5

4.2 Implementation Schedule

Table 4.2-1, Table 4.2-2, and Table 4.2-3 illustrate the implementation schedules for the first priority projects, the second priority projects, and the third priority projects during the next five years from FY 1993 to FY 1997, respectively.

Table 4.2-1 Implementation Schedule for the First Priority Project Group

	Project Name and Code		Total Fiscal Year / Work Volume (Unit) / Cost (1,000 B)	1 1993	2 1994	3 1995	4 1996	5 1997
OSP-2	Replacement of Drop Wires with Cables	Total	94,000 Pair-km	1,840	1,840	30,040	30,140	30,140
			524,040 (1,000 B)	6,440	6,440	170,000	170,580	170,580
		TOT Work		Detail Investigation & Design				
			9,200 Pair-km	1,840	1,840	1,840	1,840	1,840
			32,200 (1,000 B)	6,440	6,440	6,440	6,440	6,440
		Contract Work		Basic Design and Approval	Detail Design and Contract			
			84,800 Pair-km			28,200	28,300	28,300
			491,840 (1,000 B)			163,560	164,140	164,140
OSP-1	Rearrangement of Distribution Points			Detail Investigation & Design				
				Construction				
			8,250 DPs	1,650	1,650	1,650	1,650	1,650
			12,375 (1,000 B)	2,475	2,475	2,475	2,475	2,475
OSP-6	Check and Consulting for Customer Premises			Strategy, Public Subscription (Private Company) Making Manuals and Training Implementation				
		Facility Check and Consulting	187,000 Subscribers	17,000	85,000	85,000		
		Vehicle, Equipment and Other Expenses	24,360 (1,000 B)	20,360	2,000	2,000		
OSP-3	Renewal of Drop Wires		200,000 Drop Wires	4,300	4,300	63,800	63,800	63,800
		Total	121,400 (1,000 B)	1,075	1,075	39,750	39,750	39,750
				Detail Investigation & Design				
		TOT Work	21,500 Drop Wires	4,300	4,300	4,300	4,300	4,300
			5,375 (1,000 B)	1,075	1,075	1,075	1,075	1,075
		Contract Work		Basic Design and Approval	Detail Design and Contract			
			178,500 Drop Wires			59,500	59,500	59,500
			116,025 (1,000 B)			38,675	38,675	38,675
OSP-7	Replacement of Public Telephone Sets with Good Type		Total 6,158 Sets					
	Trial Test and Telephone Set Selection		100 Sets	100				
			3,500 (1,000 B)	3,500				
	Replacement		6,058 Sets		2,000	2,050	2,008	
			201,240 (1,000 B)		70,000	71,000	60,240	
OT-1	Expansion of Subscriber Lines			Basic Design and Approval	Detail Design and Contract			
			500,000 Lines			200,000	200,000	100,000
			19,126,630 (1,000 B)			7,650,652	7,650,652	3,825,326
OT-2	Promotion of Multi-hunting-system			Make manual Traffic Measurement, Selection of High B-Sub Busy Lines Study on Measures Subscriber Consulting Action Installation			Repeat every 6 Months	
OT-4	Dial Consulting Activities (User Campaign)			Strategy, Target and Method of Campaign Implementation				
S&T-10	Increasing Number of Circuits			Traffic Measurement	Repeat every 6 Months			
		Line Control	3,295 Circuits	Installation				
		Total	55,761 (1,000B)					
				Design				
		Switching		Contract				
			32,418 (1,000B)	Installation	1,648	1,647		
					16,214	16,204		
		Transmission		Plan				
			23,343 (1,000B)		Installation			
					11,675	Acceptance Test 11,668		
S&T-7	Changing B.. Timing			Technical Check Implementation				
	Sub Total (Investment Cost) * 2		20,069,306 (1,000B)	33,850	109,879	7,963,749	7,923,697	4,038,131

Note: 1. Project names are arranged in higher effect order in each field.

2. Summation of each project cost is not equal to the sub total because of the rounding off the figures.

Table 4.2-2 Implementation Schedule for the Second Priority Project Group

	*1 Project Name and Code	Total	1	2	3	4	5
		Fiscal Year	1993	1994	1995	1996	1997
		Work Volume (Unit)					
		Cost (1,000 B)					
OSP-4	Replacement of Secondary Cables	231,000 Pair-km	8,700	8,700	70,500	71,500	71,600
	Total	2,006,100 (1,000 B)	48,720	48,720	629,640	639,040	639,980
			Detail Investigation & Design				
	TOT Work	43,500 Pair-km	8,700	8,700	8,700	8,700	8,700
		243,600 (1,000 B)	48,720	48,720	48,720	48,720	48,720
	Contract Work		Basic Design and Approval				
				Detail Design and Contract			
		187,500 Pair-km			61,800	62,800	62,900
		1,762,500 (1,000 B)			580,920	590,320	591,260
OSP-8	Replacement of Protectors with Good Type (Public Phon	Total 17,500 Sets					
	Trial Test and Telephone Set Selection	200 Sets	200				
		50 (1,000 B)	50				
	Replacement	17,300 Sets		8,500	8,800		
		7,650 (1,000 B)		3,750	3,900		
S&T-1	Replacement of Line Protectors		Contract				
		855,066 Lines	139,484	146,954	179,591	201,749	187,288
		312,643 (1,000 B)	51,000	53,732	65,665	73,767	68,479
S&T-8	Improvement of Periodic Maintenance		Review of Maintenance Manuals				
				Improve Periodic Maintenance			
OT-3	Promotion of Call-waiting Service		Strategy and Method of Promotion				
				Promotion Activity			
OT-8	Introduction of Information Service for Changed Numbers		Basic Design				
				Specifications			
		1 SW Unit		Contract			
		69,546 (1,000 B)			Installation 69,546		
OT-5	Promotion of Automatic Answer Telephones		Strategy and Method of Promotion				
				Promotion Activity			
S&T-6	Introduction of Record Announcement	61 Devices	Technical Check, Specifications				
		1 Device/Sw unit		Contract			
		765 (1,000 B)			Installation 765		
S&T-5	Subscriber Line Accommodation Adjustment		Selection of Object Switches, Traffic Measurement and Study on Improvement Measures				
				Implementation			
	Sub Total (Investment Cost) * 2	2,396,755 (1,000B)	99,770	106,967	768,751	712,807	708,459

Note: 1. Project names are arranged in higher effect order in each field.

2. Summation of each project cost is not equal to the sub total because of the rounding off the figures.

Table 4.2-3 Implementation Schedule for the Third Priority Project Group

	*1 Project Name and Code	Total	1	2	3	4	5
		Fiscal Year					
		Work Volume (Unit)	1993	1994	1995	1996	1997
		Cost (1,000 B)					
OSP-5	Replacement of Primary Cables		Basic Design and Approval				
				Detail Design and Contract			
	Contract Work	343,500 Pairs			114,500	114,500	114,500
		2,404,500 (1,000 B)			801,500	801,500	801,500
S&T-2	Replacement of XB Switches with SPC Switches		Design				
	Replacement of XB Local Switch	245,250 Lines	Contract				
		29 Unit	4	5	7	7	6
		2,248,341 (1,000 B)	508,120	470,387	458,836	433,625	377,373
S&T-3	Replacement of Circuits Total	3,154 Circuits	Plan				
		53,510 (1,000 B)	820	Installation 713	803	267	551
			13,877	12,066	13,589	4,519	9,459
				Acceptance Test			
	Replacement of XB Tandem Switch in KKM	1,505 Circuits	610	100	233	100	462
	Sub Total	25,603 (1,000 B)	10,323	1,692	3,943	1,693	7,952
	Removal of XB Tandem Switch (1 unit)	134 (1,000 B)					134
	Installation of New SPC Tandem Switch (Switching)	14,807 (1,000 B)	6,002	984	2,292	984	4,545
	(Transmission)	10,662 (1,000 B)	4,321	708	1,651	709	3,273
	Increaseing number of circuits related on replacement of XB local switch in another area	1,649 Circuits	210	613	570	167	89
	Sub Total	27,907 (1,000 B)	3,554	10,374	9,646	2,826	1,507
	Installation of New SPC Tandem Switch (Switching)	16,224 (1,000 B)	2,066	6,031	5,608	1,643	876
	(Transmission)	11,683 (1,000 B)	1,488	4,343	4,038	1,183	631
S&T-9	Replacement of PCM System with FOT	1,144 DTI	Plan				
		(34,320 Channels)		Construction			
				Acceptance Test			
		910,999 (1,000 B)	182,200	182,200	182,200	182,200	182,200
OT-6	Promotion of Call Transfer Service		Strategy and Method of Promotion				
				Promotion Activity			
OT-7	Management on Operator's Answer Delay Time		Measurement Standards				
				Implementation			
S&T-4	Installation of Automatic Howling Tone Service		Technical Check and Specifications				
	Howler Osaillator	239 unit	Contract				
	Howler Trunk	717 Trunk		Installation			
		6,117 (1,000 B)		6,117			
	Sub Total (Investment Cost) * 2	5,623,465 (1,000B)	704,197	670,770	1,456,125	1,421,844	1,370,532

Project Cost	1. First Priority Project Group	20,069,306	33,850	109,879	7,963,749	7,923,697	4,038,131
	2. Second Priority Project Group	2,396,755	99,770	106,967	768,751	712,807	708,459
	3. Third Priority Project Group	5,623,465	704,197	670,770	1,456,125	1,421,844	1,370,532
	4. Direct Cost Total	28,089,526	837,817	887,616	10,188,625	10,058,348	6,117,122
	4.1 Rehabilitation Projects	8,962,896	837,817	887,616	2,537,973	2,407,696	2,291,796
	4.2 500,000 New Telephone Line Installation * 3	19,126,630	0	0	7,650,652	7,650,652	3,825,326
	5. Contingency on Rehabilitation Project (5%) * 3	448,145	41,891	44,381	126,899	120,385	114,590
	6. Implementation Cost on Rehabili. Project (5%) * 3	448,145	41,891	44,381	126,899	120,385	114,590
	7. Sub Total Rehabilitation (4.1 + 5 + 6)	9,859,186	921,599	976,378	2,791,771	2,648,466	2,520,976
	Grand Total (4 + 5 + 6)	28,985,816 (1,000B)	921,599	976,378	10,442,423	10,299,118	6,346,302

Note: 1. Project names are arranged in higher effect order in each field.

2. Summation of each project cost is not equal to the sub total because of the rounding off the figures.

3. Cost of 500,000 New Telephone Line Installation already includes contingency and implementation cost.

4.3 Implementation Procedure

4.3.1 Effects of Projects

The Study Team proposes all the selected projects are to be carried out completely within the Phase-1 period. If TOT can not carry out all the project during the period, which project should be selected as the top priority is important.

Table 4.3.1-1, Table 4.3.1-2, and Table 4.3.1-3 show the effects of the projects classified by the priority group. Table 4.3.1-4 shows the total costs and the total effect of each priority project group. The tables indicate the followings:

1) The improvement rates by the first priority projects will be 72.7% for the fault ratio and 82.2% for the CCR.

2) When the first and the second priority projects are carried out, the improvement rates of the fault ratio and the CCR are estimated to become 91.9% and 97.7%, respectively.

3) The projects classified in the third priority group require larger costs and longer implementation periods compared to other rehabilitation, replacement, and renewal projects. The Study Team, however, proposes that these projects of the third priority should be carried out completely by taking not only the short-term effects but also the long-term ones into consideration.

   The rehabilitation of the primary cables, the replacement of the XB switches with the SPC switches, and the replacement of the PCM systems with the optical transmission systems are indispensable for TOT not only to improve the present service quality and to introduce the new services but also to maintain the networks and facilities in operational condition and to save the limited space of the existing exchange offices and the cable conduits for the future expansion.

   These three projects require large amount of investment funds and long implementation periods; therefore, it is essential for TOT to map the project implementation schedules carefully from the initial stage to save costs, work load, and time and initiate the projects implementation from the beginning of the Phase-1.

Table 4.3.1-1 Effects of the First Priority Projects

Project Code	Project Name	Unit	Volume	Project *2 Cost (M B)	Improvement Effect (%)	
					Fault Ratio	CCR
OSP-2	Replacement of Drop Wires with Cables	pair-km	94,000	524	26.0	4.7
OSP-1	Rearrangement of Distribution Points	Dp	8,250	12	2.9	0.5
OSP-6	Checked and Consulting for Customer Premises	Subs-criber	187,000	24	10.8	21.1
OSP-3	Renewal Drop Wires	Drop Wire	200,000	121	13.7	2.5
OSP-7	Replacement of Public Telephone Sets	set	6,158	205	10.3	2.6
OT-1	Expansion of Subscriber Lines	Main Tel. Line	500,000	19,127	-	16.1
OT-2	Promotion of Multi-hunting-system	-	-	0	-	13.6
OT-4	Dial Consulting Activities	-	-	0	-	8.4
S&T-10	Increasing Number of Circuits	Circuit	3,295	56	-	7.4
S&T-7	Changing P. D. Timing	-	-	0	-	5.3
	Reduction Ratio of Test OK *1	-	-	-	9.0	-
Total *3				20,069	72.7	82.2

Note: *1. Reduction of Test OK has 12.4% share in the total improvement effect. This 12.4% effect is divided into the three priority groups in proportion to the sub total effect percentage of each group to the grand total effect except Test OK (= 100.0-12.4).

*2. Project Cost here excludes the expenses for the internal resources of TOT such as staff remuneration.

*3. The summation of each project cost is not equal to the total cost because of the rounding off the figures.

Table 4.3.1-2 Effects of the Second Priority Projects

Project Code	Project Name	Unit	Volume	Project *2 Cost (M B)	Improvement Effect (%)	
					Fault Ratio	CCR
OSP-4	Replacement of Secondary Cables	pair-km	231,000	2,006	11.2	2.0
OSP-8	Replacement of Protectors	Main Tel. Line	17,500	8	1.8	0.5
S&T-1	Replacement of Line Protectors	Protectors	855,066	313	3.8	-
S&T-8	Improvement of Periodic Maintenance	-	-	0	-	3.1
OT-3	Promotion of Call-waiting Services	-	-	0	-	3.1
OT-8	Introduction of Information Service for Changed Numbers	Center	1	70	-	3.1
OT-5	Promotion of Automatic Answer Telephones	-	-	0	-	1.9
S&T-5	Subscriber line Accommodation Adjustment	-	-	0	-	0.3
S&T-6	Introduction of Record Announcement	Device	61	1	-	1.5
	Reduction Ratio of Test OK *1				2.4	
Total *3				2,397	19.2	15.5

Note: *1. Reduction of Test OK has 12.4% share in the total improvement effect. This 12.4% effect is divided into the three priority groups in proportion to the sub total effect percentage of each group to the grand total effect except Test OK (≈ 100.0-12.4).

*2. Project Cost here excludes the expenses for the internal resources of TOT such as staff remuneration.

*3. The summation of each project cost is not equal to the total cost because of the rounding off the figures.

Table 4.3.1-3 Effects of the Third Priority Projects

Project Code	Project Name	Unit	Volume	Project *2 Cost (M B)	Improvement Effect (%)	
					Fault Ratio	CCR
OSP-5	Replacement of Primary Cable	pair-km	343,500	2,405	4.4	0.8
S&T-2	Replacement of XB Switches with SPC Switches	Line Capacity	245,250	2,248	2.7	
S&T-3	Replacement of Circuits	No. of Circuits	3,153	53		
S&T-9	Replacement of PCM System with Optical Fiber System	No. of DTI	1,144	847	0	-
OT-6	Promotion of Transfer Service	-	-	0	-	0.6
OT-7	Management on Operator's Answer Delay Time	-	-	0	-	0.6
S&T-4	Installation of Automatic Howling Tone Services	Device	-	6	-	0.3
	Reduction Ratio of Test OK *1	-	-		1.0	
Total *3				5,560	8.1	2.3

Note: *1. Reduction of Test OK has 12.4% share in the total improvement effect. This 12.4% effect is divided into the three priority groups in proportion to the sub total effect percentage of each group to the grand total effect except Test OK (= 100.0-12.4).

*2. Project Cost here excludes the expenses for the internal resources of TOT such as staff remuneration.

*3. The summation of each project cost is not equal to the total cost because of the rounding off the figures.

Table 4.3.1-4 Comparison of Effects from Each Priority Group

Priority Order Group	No. of Projects	Cost (MB)	Improvement Effect (%)	
			Fault Ratio	CCR
1. First Group	10	20,069	72.7	82.2
2. Second Group	9	2,397	19.2	15.5
3. Sub Total (1+2)	19	22,466	91.9	97.7
4. Third Group	7	5,560	8.1	2.3
5. Total (3+4)	26	28,026	100.0	100.0
6. Contingency and Implementation		890		
7. Grand Total (5+6)		28,916		

4.3.2 Implementation Method

In preparing the implementation of the projects, the following items are necessary to be taken into consideration.

1) Implementation Method of the Projects in the Outside Plant Section

a) Area Ranking

A characteristic of outside plant is that the coverage area and facilities are spread widely while switching covers points. Construction, rehabilitation, and renewal of outside plant facilities, therefore, take a lot of time, work load, and costs. Hence, the decision of area ranking is important for the replacement of drop wires, the rehabilitation of secondary cables, etc. to implement the projects in the outside plant field effectively. The area ranking is given as follows:

i) Narrow Down the Area

Firstly, the areas with high fault ratios are selected by a repair record analysis and by detail field investigation to narrow down the facilities to be rehabilitated.

ii) Decision of Area Ranking

Secondly, setting up the area ranking for the rehabilitation projects is achieved in taking customer situations into consideration. The Study Team proposes the following priority order according to the development strategy set in the Long-term Plan of the Study:

- Central Business Area,
- Rapidly Growing Suburban Area,
- Industrial Area, and
- Other Area.

Because of social needs for the public telephones, the replacement project of public telephone sets should be, however, carried out according to fault ratio conditions not by the area ranking.

b) Combination and Synchronization of the Projects

i) Rearrangement of Drop Point

Usually the secondary cables have some spare pairs; therefore, rearrangement of distribution points for some drop wires is possible by the installation of new distribution points. To carry out this measure, field investigations such as confirmation of customer locations will be required. Hence, the replacement of drop wires with cables and the drop wire renewal projects should be combined in order to avoid the duplicated works and construction.

ii) Public Telephone Projects

The two projects of the public telephones, i.e., the replacement of the public telephone sets and the replacement of the protectors, are to be combined to save time and cost.

2) Implementation Method of the Projects in the Other Sections

To implement the proposed projects in the switching & transmission field and other fields, the following procedures are proposed.

a) Office Ranking for the XB Switch Replacement

To replace the XB switches with the SPC switches, the necessary floor space for the replacement should be secured. It can be estimated that most of the exchange offices will be crowded with many switches and have no additional capacity for the expansion by the end of 2007 without any measure. Hence, it is necessary to promote a planned replacement of the XB switches to secure the space for the future expansion. All XB switches in the Study Area should be replaced with the SPC switches by FY 2000 according to the following five criteria.

i) Telephone Demand

Give high priorities for the replacement to the switching offices which will face large demand increase and shortage of floor space.

ii) Demand for New Services

Give high priorities for the replacement to the switching offices which will have large demands for new services.

iii) Maintenance Condition

Give high priorities for the replacement to the switching offices which have many old and frequently malfunctioning switches.

iv) Efficient O & M

It becomes possible to monitor and control all SPC switches from the 12 concentration centers. Hence, O & M can be improved after all the XB switches are replaced with the SPC switches.

v) Even Replacement Work

Which switch will be replaced in which phase is to be planned according to the above four criteria. Switches which do not fall into any of the above four criteria should be utilized as long as possible.

Since the area 1 in the BMA has high telephone demand and new service demands, the XB switches in the area should be replaced at first. All the XB switches in the area 1 and in the Surrounding Area should be replaced in the Phase-1 and those in other areas should be replaced in the Phase-1 and the Phase-2.

Table 4.3.2 illustrates the priority order and the annual schedule of the replacement in the Phase-1.

Table 4.3.2 Priority of XB Switch Replacement

Area	Unit Name	Type	Insta-llation	Line Capacity	Replaced Year and Line Capacity					Total
					1993	1994	1995	1996	1997	
BMA (Local Switch-es)	PNC-1	C-400	1971	12,000	22,000					22,000
	PNC-2	C-400	1971	10,000						
	SRR-1	C-400	1970	10,000						
	SRR-2	C-400	1970	10,000		30,000				30,000
	SRR-3	C-400	1978	10,000						
	KKM-2	C-400	1970	10,000		10,000				10,000
	SRW-1	C-400	1976	10,000						
	SRW-2	C-400	1976	10,000	30,000					30,000
	SRW-3	C-400	1978	10,000						
	SMS-1	C-400	1980	5,800				5,800		5,800
	ASD-1	C-400	1979	10,000			10,000			10,000
	PTW-1	C-400	1980	5,384					5,384	5,384
	KGC-1	C-400	1971	13,000				13,000		13,000
	STD-1	C-400	1971	3,250			3,250			3,250
	PSP-1	C-400	1977	7,000				7,000		7,000
	HAM-1	C-400	1979	8,000					8,000	8,000
	SPK-1	ARF-102	1964	5,000		5,000				5,000
	TNB-1	C-400	1970	20,000					20,000	20,000
	PPG-1	C-400	1969	3,310		3,310				3,310
	BGT-1	C-400	1976	11,000			11,000			11,000
	BGS-1	C-400	1970	10,000				10,000		10,000
	NWW-1	C-400	1969	5,300				5,300		5,300
	DNW-1	C-400	1970	3,480					3,480	3,480
	PYT-1	C-400	1967	12,000			17,800			17,800
	PYT-2	C-400	1976	5,800						
	LKS-1	C-400	1976	6,000			6,000			6,000
	NTB-1	C-400	1979	3,300					3,300	3,300
	LTP-1	C-400	1979	5,200				5,200		5,200
	Sub Total			234,824	52,000	48,310	48,050	46,300	40,164	234,824
Provin-cial Area (Local Switch-es)	SPR-1	ARF-102	1975	1,000			1,000			1,000
	SKN-1	ARF-102	1960	2,000	2,000					2,000
	NPT-1	PC1000	1970	3,000		3,000				3,000
	BPN-1	ARF-102	1979	1,000			1,000			1,000
	WNI-1	ARF-102	1979	1,000				1,000		1,000
	PCI-1	ARF-102	1979	1,000					1,000	1,000
	AYT-1	PC1000	1960	1,426	1,426					1,426
	Sub Total			10,426	3,426	3,000	2,000	1,000	1,000	10,426
Grand Total				245,250	55,426	51,310	50,050	47,300	41,164	245,250
BMA (TDMs)	KKM T1	Remove of XB (cct)		1,505					1,505	1,505
		Installation of SPC		(1,505)	(610)	(100)	(233)	(100)	(462)	(1,505)
	Installation of SPC in another area			(1,649)	(210)	(613)	(570)	(167)	(89)	(1,649)
Total No of cct to be installed				(3,154)	(820)	(713)	(803)	(267)	(551)	(3,154)

Note : cct = circuits TDM = Tandem

According to the above mentioned criteria, the XB switches at PNC and SRW should be replaced at first.

b) Other Priority Order

The replacement of the line protectors is given the priority order according to the fault ratios.

4.3.3 Setting up Advisory Committee and Working Groups

TOT has been making considerable efforts to provide better telecommunications services to the customers since its establishment in 1954. The present services offered by TOT in the Study Area, however, are sufficient neither in quantity nor quality.

The proposed 26 projects should be initiated as early as possible to upgrade the service quality. The implementation of the 26 projects requires the total efforts and coordination among the many departments and divisions concerned in TOT, not only the Project Office in the Engineering Bureau, but also the Maintenance and Operation Sections of the switching, the transmission, and the outside plant, and the Commercial Division in Operation Bureau, from each local office to the Headquarters.

It is highly proposed and recommended for TOT to set up an advisory committee that one of top executives chairs. The role of the committee is:

1) to coordinate and organize all the divisions and departments concerned,
2) to set up the targets in detail and guide all the staff for one goal,
3) to allocate their management resources,
4) to monitor the progress,
5) to find and solve problems, obstacles, and bottlenecks for the scheduled projects implementation,
6) to avoid wasting valuable work efforts, money, and time,
7) to achieve the targets as planned, and
8) to improve the services quality and provide the better quality of telecommunications services.

In order to implement the various proposed projects, several working groups are necessary to be set up. Each group is responsible for the project implementation under the authority of the advisory committee.

4.4 Investment Cost

The costs of the projects are estimated as shown in Table 4.4-1 and Table 4.4-2.

Table 4.4-1 Estimated Costs of the Proposed Projects

(Cost Unit: Million Baht)

Main Target	Project Code	Project Name	Work Volume		Cost
1. Improvement of fault ratio					
	OSP-1	Rearrangement of Distribution Points	Unit: DPs	8,250	12
	OSP-2	Replacement of Drop Wires with Cables	Unit: Pair-Km	94,000	524
	OSP-3	Renewal Drop Wires	Unit: Drop Wire	200,000	121
	OSP-4	Replacement of Secondary Cables	Unit: Pair-Km	231,000	2,006
	OSP-5	Replacement of Primary Cables	Unit: Pairs	343,500	2,405
	OSP-6	Check and Consulting for Customer Premises	Unit: Subscriber	231,000	24
	OSP-7	Replacement of Public Telephone Sets	Unit: Set	6,158	205
	OSP-8	Replacement of Protectors	Unit: Protector	17,500	8
	S&T-1	Replacement of Line Protectors	Unit: Main Tel. Line	855,066	313
	S&T-2	Replacement of XB Switches with SPC Switches	Unit: Line Capacity	245,250	2,248
	S&T-3	Replacement of Circuits	Unit: No. of Circuit	3,154	54
	S&T-9	Replacement of PCM System with FOTS	Unit: No. of DTI	1,144	847
2. Improvement of CCR					
	S&T-4	Installation of Automatic Howling Tone Service	Unit: Device	239	6
	S&T-5	Subscriber Line Accommodation Adjustment			
	S&T-6	Introduction of Record Announcement	Unit: Device	61	1
	S&T-7	Changing P.D. Timing			
	S&T-8	Improvement of Periodic Maintenance			
	S&T-10	Increasing Number of Circuits	Unit: No. of Circuits	3,295	56
	OT-1	Expansion of Subscriber Lines	Unit: Main Tel. Line	500,000	19,127
	OT-2	Promotion of Multi-hunting-system			
	OT-3	Promotion of Call-waiting Service			
	OT-4	Dial Consulting Activities (User Campaign)			
	OT-5	Promotion of Automatic Answer Telephones			
	OT-6	Promotion of Call Transfer Service			
	OT-7	Management on Operator's Answer Delay Time			
	OT-8	Introduction of Information Service for Changed Numbers	Unit: Switch unit	1	70
Total		26 Projects			28,026

Table 4.4-2 Comparison between Effects of Each Priority Group

Priority Order Group	No. of Projects	Investment Cost (MB)	Improvement Effect (%)	
			Fault Ratio	CCR
1. First Group	10	20,069	72.7	82.2
2. Second Group	9	2,397	19.2	15.5
3. Sub Total (1+2)	19	22,466	91.9	97.7
4. Third Group	7	5,560	8.1	2.3
5. Total (3+4)	26	28,026	100.0	100.0
6. Contingency and Implementation		890		
7. Grand Total (5+6)		28,916		

4.5 Other Measures to Upgrade the Telecommunications Service Quality

The Study Team proposes the projects to upgrade the telecommunications service quality in the previous section. There exist not only those proposed projects but also other measures which are important to maintain and improve the networks and facilities to provide better quality of the telecommunications services. This section summarizes the other measures introduced and explained in Chapter 2 and Chapter 3. Table 4.5 shows the framework of the additional improvement measures.

1) Telecommunications networks and facilities are the basis the services. Only well maintained networks and facilities can provide the better quality of the services. Therefore, maintenance control systems are essential for telecommunications operating entities to maintain their networks and facilities in a good operational condition.

2) Traffic management is the basis of the business operation for telecommunications operating entities. Traffic or calls is the service to be provided to the customers by operating entities. The smooth traffic flow in networks without any congestion is the ultimate goal to be achieved.

3) Installation and construction method is one of the fundamental factors to build networks and facilities with good quality. Two items are recommended here in this part.

4) Five measures in the outside plant field, three measures in the transmission field, and four measures in the operation and maintenance field are selected as other measures here.

Table 4.5 Recommended Main Improvement Measures

Classification	Improvement Measure Titles	Reference
1. Maintenance Management Standard	Establishment of Maintenance Control System (Improvement of the fault ratio)	2.5.3
	1) Service Control	
	Definition of Maintenance Control Value	2.4.2 2)
	2) Extraordinary Control System	2.4.2 1)
	Definition of Maintenance Control Value	
	3) Plant Control	
	a) Deteriorated Facility Control System	
	b) Peculiar Faults on the plant Control	
	Traffic Management (Improvement of the CCR)	3.8.3 1)
	1) Overall Management	
	2) Segmental Management	
2. Installation & Construction Method (includes maintenance repair system)	(Outside Plant)	
	1) Improvement of the Drop Wire Repair Method	2.2.3 3)
	2) Improvement of the Drop Wire Installation Method	2.2.3 3)
3. Others	(Outside Plant)	
	1) Introduction of Water Penetration Monitoring System	2.2.3 2)
	2) Improvement of Closures	2.2.3 2)
	3) Improvement of the Quality of Drop Wires	2.2.3 3)
	4) Advertisement and Campaigns to Customers	2.2.3 5)
	5) Check Customer Premises before Connection with TOT Network	2.2.3 5)
	(Transmission)	
	6) Introduction of Tools for Channel Assignment	2.4.2 3)
	7) Introduction of Computerized Leased Line Control System	2.4.2 5)
	8) Introduction of Leased Line Remote Testing System (LLTS)	2.4.2 5)
	(O & M)	
	9) Improvement of Centralized Maintenance System	2.5.2
	10) Introduction of Computerized Customer Record System	2.5.2
	11) Establishment of Stock Management System	2.5.2
	12) Technical Skill Advancement	2.5.2

CHAPTER 5 PROJECT EVALUATION

This chapter evaluates the Project from financial, social and economical, and technical viewpoints and describes recommendations on the Project implementation.

5.1 Financial Evaluation

This section estimates the effects of the Project on the call revenue and analyzes the feasibility of the Project from the financial viewpoint. The increase of the call completion ratio (CCR) means the increase of the complete calls that brings the telephone company the increased telephone call revenue. The telephone call revenue is expected to increase also when faults decrease and repairing periods become shorter.

5.1.1 Methodology

The Project is classified into two groups of main activities. One is to reduce the occurrences of faults and to make repair periods shorter. The other is to increase the number of complete calls, i.e., to improve the CCR.

At first, these effects on the call revenues by fault decrease and increased completed calls are estimated separately. After revenue estimation, the cost and the benefit of the Project are analyzed from the viewpoint of the financial internal rate of return (FIRR).

5.1.2 Assumptions

The financial evaluation of the Project in this section is based on the following assumptions at first.

1) The structure of the telephone network in the Study Area, i.e., the number of main telephone lines and line capacity, and the network configuration is unchanged for the Project period because the Project focuses on the measures to improve the present TOT telecommunications networks in the BMA and the Surrounding Area.

2) Two million telephone lines will be installed in the next five years by the private company as another local network in the BMA. The new local network will generate additional traffic in the existing TOT network. However, the Study does not take the matters into consideration. The surveys, observations, and analyses are based on the present service quality of the existing TOT networks and the network rehabilitation projects focus on the measures to improve the present service quality.

3) The proposed rehabilitation Project excluding the new telephone line installation plan costs 9,789 million Baht in total during the five year Project period. The proposed rehabilitation Project with the new telephone line installation plan costs 28,916 million Baht during the five year Project period (An exchange rate of five point five (5.5) Japanese Yen to one (1) Thai Baht is employed).

4) The implementation of the Project will decrease the number of faults, which recovers the lost call revenue of 24.08 million Baht and saves the repairing work load of 175.07 million Baht in total during the five year period.

The implementation of the Project will increase the number of complete calls. To estimate the number of complete call increase, a Calling Behavior Model is applied based on the total number of originating calls in the BMA in FY 1991. The Project implementation will increase the number of complete calls and bring the call revenue increase of 8,152.615 million Baht in total during the five year period. Table 5.1 shows the estimated call increase and the call revenues.

Table 5.1 The Estimation of the Increased Call Revenues by Improving the CCR

FY	1993	1994	1995	1996	1997	Sub Total (93-97)	98-
Net Increase of CCs (Million Calls)	113.139	312.959	465.815	582.389	671.123	2,145.425	709.456
Increased Call Revenue Estimates (Million Baht)	429.927	1,189.244	1,770.097	2,213.080	2,550.267	8,152.615	2,695.934

5) Assumptions employed in the financial analysis are as follows:

a) Project period is set for 10 year between FY 1993 and FY 2002. The rehabilitation project cost is estimated annually during initial 5 years according to the implementation plan. From the 6th year, the annual average amount of the total cost in the initial 5 year is applied. As for the project benefits, the same amounts are applied from the 6th year.

b) The facilities to be constructed for the 500,000 telephone lines have unused values at the end of the project period. These unused values are recovered at the end of the project period. Durable years differ for each facility type; however, only 10 year is applied as a durable year to simplify the estimation procedure.

c) Direct cost are estimated. In order to operate the additional 500,000 line to be installed by the Project, additional operation and maintenance costs will be required; however, the financial analysis does not take these cost increase into account. Additional working capital and the remittance to the Treasury are not taken into account in the analysis.

d) As for the revenues from the 500,000 lines, installation fee, monthly charge, and call revenues are estimated based on the revenue per line estimated in the long-term plan Study. The deposits from subscribers are also taken into cash inflow but are to be returned at the end of the project period.

After the estimation and analysis of the benefits and the costs of the network rehabilitation projects, the financial analysis takes into account the effects of the 500,000 lines expansion plan, i.e., the new installation of the subscriber telephone lines for high B-sub busy subscribers.

5.1.3 Results

Table 5.1.3-1 shows the costs and the benefits of the Project only for the renewal and the rehabilitation projects, i.e., excluding the installation of new main telephone line, in terms of annual cash-flows. The internal rate of return on the Project is estimated as 22.61%.

Table 5.1.3-1 Cost and Benefit of the Project excluding the New Main Telephone Line Installation

(Unit: Million Baht)

Term	FY	Project Cost	Project Benefit			Net Balance
		Total	CCR	Fault	Total	
1	1993	907.56	429.93	7.00	436.93	-470.63
2	1994	962.34	1,189.24	20.01	1,209.25	246.91
3	1995	2,777.73	1,770.10	36.75	1,806.85	-970.88
4	1996	2,634.42	2,213.08	55.80	2,268.88	-365.54
5	1997	2,506.93	2,550.27	79.59	2,629.86	122.92
6	1998	1,928.71	2,695.93	79.59	2,775.52	846.81
7	1999	1,928.71	2,695.93	79.59	2,775.52	846.81
8	2000	1,928.71	2,695.93	79.59	2,775.52	846.81
9	2001	1,928.71	2,695.93	79.59	2,775.52	846.81
10	2002	1,928.71	2,695.93	79.59	2,775.52	846.81
FIRR						22.61%

Table 5.1.3-2 shows the costs and benefits of the Project with the installation of the 500,000 new main telephone lines. The internal rate of return on the Project is estimated as 11.28%.

Table 5.1.3-2 Cost and Benefit of the Project including the Installation of the Main Telephone Line

(Unit: Million Baht)

	FY	Project Costs			Project Benefits			Net Balance	
		Rehabili.	New Install	Total	Rehabili.	New Install	Total	Annual	Accumu.
1	1993	908		908	437		437	-471	-471
2	1994	962	0	962	1,209	0	1,209	247	-224
3	1995	2,778	7,651	10,428	1,807	1,803	3,609	-6,819	-7,043
4	1996	2,634	7,651	10,285	2,269	2,874	5,142	-5,143	-12,185
5	1997	2,507	3,825	6,332	2,630	3,047	5,677	-655	-12,841
6	1998	1,929	0	1,929	2,776	2,680	5,456	3,527	-9,314
7	1999	1,929	0	1,929	2,776	2,680	5,456	3,527	-5,787
8	2000	1,929	0	1,929	2,776	2,680	5,456	3,527	-2,260
9	2001	1,929	0	1,929	2,776	2,680	5,456	3,527	1,267
10	2002	1,929	-5,355	-3,427	2,776	1,180	3,956	7,382	8,649
Total (5 years)		9,789	19,127	28,916	8,352	7,723	16,075	-12,841	
Total (10 years)		19,433	13,771	33,204	22,229	19,623	41,852	8,649	
FIRR									11.28%

5.1.4 Financing Availability

The cost and benefit analysis of the Project indicates that the Project generates the revenue increase and the FIRR is positive in the both cases of the rehabilitation Project only and the rehabilitation Project with the 500,000 lines installation plan. The issues to be investigated in the next is how to finance the Project to implement.

Table 5.1.4 shows the financing simulation to implement the Project. TOT own funds are provided to make the annual cash balances positive. The total required amount of the own fund is 12,900 million Baht for the initial five year period. The cash balance from FY 1998 becomes positive with the cash generation by the Project itself. The required amount of the funds for the first year is 500 million Baht. That of the third year is 6,700 million Baht, and the forth year is 5,000 million Baht.

Table 5.1.4 Financing Assumption for the Project with 500,000 Lines Installation

(Unit: Million Baht)

FY	Cash Balance at Beginning	Own Fund	Project Operation	Cash Balance at Ending
1993	0	500	-471	29
1994	29	0	247	276
1995	276	6,700	-6,819	157
1996	157	5,000	-5,143	15
1997	15	700	-655	59
1998	59		3,527	3,586
1999	3,586		3,527	7,113
2000	7,113		3,527	10,640
2001	10,640		3,527	14,167
2002	14,167		7,382	21,549
Total		12,900	8,649	

Annual budget of TOT for the project investments was 8,042 million Baht and 9,802 million Baht in FY 1989 and FY 1990, respectively. These budgets were allocated to expand the telecommunications network to install main telephone lines. The private company named "Telecom ASIA" will invest to construct the local network and to install 2 million telephone lines in the BMA. TOT, on the other hand, will not need to invest for the expansion and installation projects except for the rural telephone project, the network rehabilitation projects, and so forth.

Therefore, TOT can allocate the sufficient budget for the rehabilitation Projects on its existing networks. If the TOT's total budgets for the project investments during the next five year can be estimated as 50,000 million Baht (10,000 Million Baht X 5 years), the estimated 12,900 million Baht of its own fund in total accounts for only 25.8% of the total budgets estimation. Hence, the rehabilitation Project is feasible from the financial viewpoint.

5.2 Social and Economical Evaluation

The Present Issues

The implementation of the proposed Project can solve the present issues on the telecommunications services quality in the BMA. The problems at present are described as follows:

1) From the Users Viewpoint

a) Telephone subscribers find sometimes that their telephones are out of order and try to call the TOT service claim center ("17" Center). However, their lines are always busy. Even after they succeed to claim their faults and ask TOT to repair, they sometimes have to wait more than one week for TOT to dispatch repairing teams. Some subscribers can not wait for so long that they try to repair their fault lines by themselves, which may cause another faults later.

b) Even if the users succeed to have repairing teams from TOT, the users are told that the causes of the faults are in their terminal systems or in-house wiring so that TOT staff can not do anything. TOT repairing teams go back without doing anything and the faulty telephones remain. The users still can not make any call before somebody fixes their telephone sets and/or in-house wiring.

c) Some telephone users use their telephones so often that they find it is difficult not only for their customers but also for themselves to make out-going calls from their offices and to make in-coming calls from outside. Therefore, they want to install additional telephone lines but they have to wait the approximately 4 or 5 years for a new telephone line in the BMA at present.

d) Some telephone users may continue to call changed telephone numbers because they are not informed new telephone numbers. Before they become aware that the lines are not used or the telephone numbers are changed, they may try to call many times to hear only the ringing-tone but they never hear any voice or reply signal.

e) In order to know the new telephone numbers or confirm the correct telephone numbers, the customers try to call the TOT CDAS Center for telephone directory services ("13" service) but they find again that the lines are always busy and it is difficult to get the correct telephone numbers.

f) In the area of heavy telephone traffic congestion, particularly in the Surawong Exchange area, the users often can not hear the dial-tone or they can hear the busy-tone in the morning busy hours. Secretaries and clerks ordinary continue to re-dial for about 15 minutes or even an hour to make one telephone call in the morning. This also makes the traffic congestion worse. The users have to wait until the afternoon or they have to send some messengers riding motorbikes that may cause traffic congestion in the streets and air pollution in the BMA.

g) The PABX users have more than one main telephone line but hunting systems are not widely used among them. Because there are misunderstandings among TOT staff that only the PABX subscribers can use the hunting system and only 5% of the switching capacity could use the system, many subscribers are using their multi-lines without the hunting system.

2) From the Economic and Social Viewpoints

a) Because the telecommunications service quality in the BMA is in a poor level, the telephone network is not reliable to send a vast amount of information such as transferring data files among computer systems. It is better to use fast delivery services instead of telecommunications. However, delivery services require the longer time to send information, increases traffic congestion on the road network, and wastes the valuable natural resources and time.

b) The domestic telecommunications as well as the international telecommunications are one of the most essential business tools for the companies whose activities and markets are spread worldwide. Without reliable, speedy, easy-to-use, many, and economical telecommunications services, present business activities can not function in this information oriented world.

c) The telecommunications service quality differs so wide among the developing countries and cities. The cities and states that can provide sufficient, many, reliable, speedy, and economical telecommunications services can become telecommunications hubs or information centers in this region. If Bangkok can not provide these services, multinational business firms will not shift their operations to Bangkok and domestic large corporations may shift some parts of their Headquarters functions from Bangkok to other cities.

3) From the TOT's Viewpoints

a) Subscribers terminal sets, systems, and the in-house wiring are not TOT's possessions. TOT is not in charge of maintenance on subscribers' facilities; therefore, when the repairing staff find some faults in customers' telephone sets and in-house wiring, the staff can not do any repair work for customers and must go back to repair other faults. Subscribers' terminals and in-house wiring cause a large portion of faults claimed by subscribers. Their faults waste a large amount of the work load of the repairing teams.

b) Old and small buildings are being demolished and many new high rise buildings are now under construction in the BMA. Roads are also under construction in many places. Drop-wires and subscriber cables which hang on electric poles are often gotten detached from them and left alone without any temporary measure.

c) Heavy storms often blow out cables and wires. Trees along sidewalks sometimes damage cables. Small insects cause damages in cables. All the influences of social and natural environments are severe for the outside plant of the telecommunications networks in the BMA.

d) Most of telephone users do not wait for even three minutes before they re-dial when they get busy signals. If they can wait for three minutes to re-dial after encountering B-sub busy conditions, the possibility of call completion becomes much higher. Because users often and quickly make re-dials, the network congestion becomes worse.

e) Because of frequent faults and the low CCR, the lost telephone call revenue is so large and the investment and maintenance costs to maintain the networks in the operational condition become higher.

Conclusions

It is possible and expected for TOT to solve all the above mentioned issues by implementing the proposed rehabilitation, replacement, renewal Projects. As the results of the Project implementation, the following effects will be expected to the users, the society, and the telecommunications sector. Figure 5.2 shows how they will be benefited by the Project.

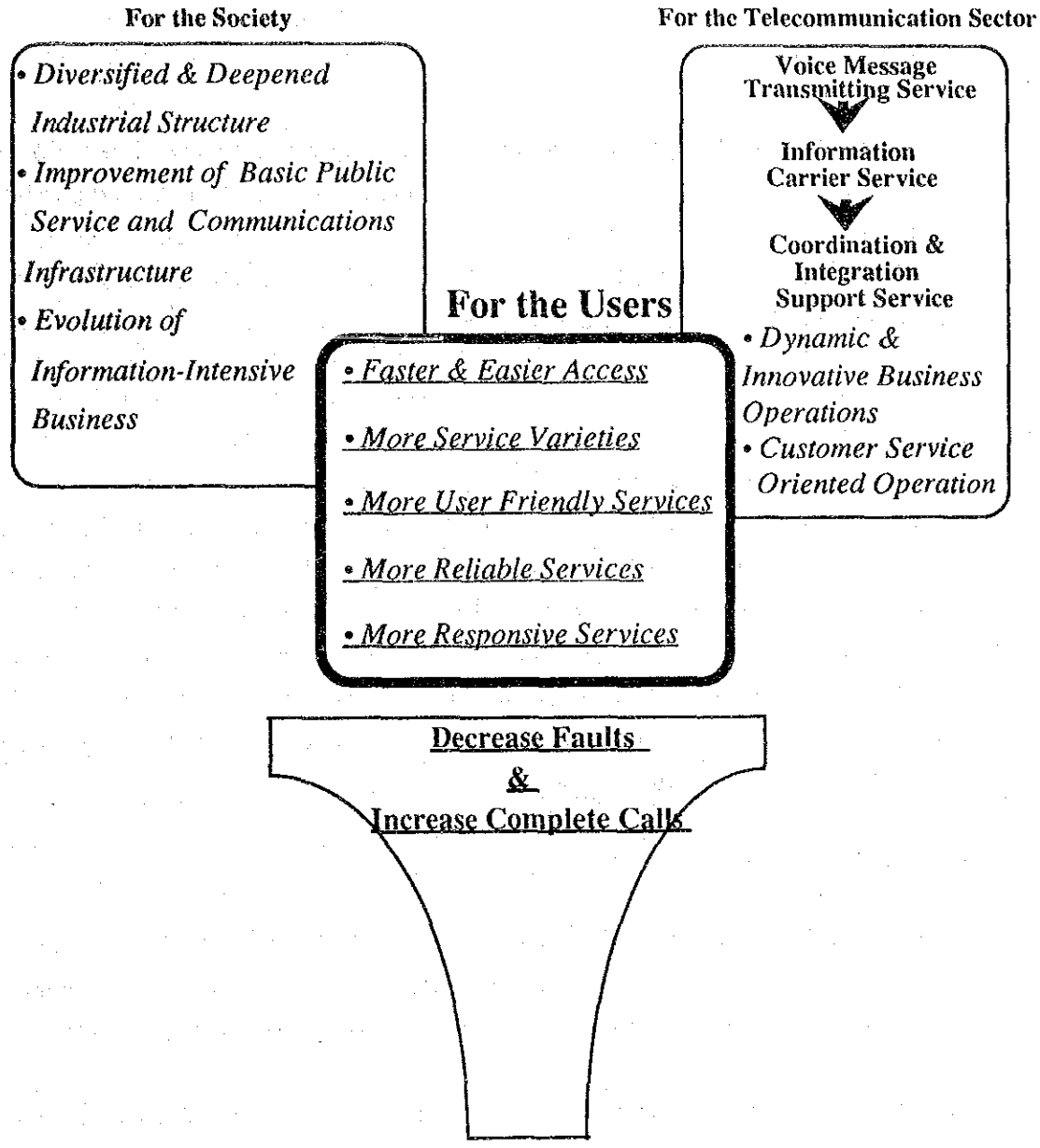


Figure 5.2.4 Effects of the Project

1) To the Users

As the results of the Project, users can expect:

- faster and easier access,
- more reliable services,
- more responsive services,

- more service varieties,
- more user friendly services.

Together with the network expansion and modernization, improvement and innovation in the operation and maintenance system can provide the customers with the fullest possible benefits of the services that TOT can offer. Business and residential users can enjoy not only better basic telecommunications services but also will be benefited from new intelligent services in operating business more strategically and captivating more intellectual life style.

2) To the Society

The economic growth in Thailand has been remarkable in recent years. People in Thailand expect to continue this economic growth well into the next decade. As a major infrastructure to support socioeconomic activities of people in Thailand, upgrading the telecommunications service quality is indispensable together with the expansion of the telecommunications network. The society will develop not only a sound platform of the basic infrastructure for national development and integration but also strategic infrastructure around which a new information intensive society can evolve.

3) To the Telecommunications Sector

It can be expected that modernization and expansion of the network (hardware improvement) coupled with operation and maintenance system changes (software improvement) will create an environment for dynamic and innovative business operations for TOT.

TOT can demonstrate not only how responsive and reliable it can be as the national basic telecommunications service carrier but also how innovative it can be in providing services to support strategic operations of business users and enrich the quality of life of the residential users. By meeting the needs of the customers and better serving the society, TOT can enhance its external business opportunities and enrich its internal corporate culture and strength.

Not only TOT but also the telecommunications industry as a whole may be forced into the situation in which the characteristics of the telecommunications business must be reviewed and redefined. The telecommunications business is no longer confined to the traditional voice messages transmitting service business but extends well beyond to information carrier service business. Many people expect further the telecommunications

business in the information society is expected to play a role of communications system integrators and coordination supporters on strategic alliances.

5.3 Technical Evaluation

There is no technical problem in implementing the Project to improve the call completion ratio and facility fault ratio. Since there are, however, relatively many exchange offices that do not have enough floor space for installing the SPC switches in replacing the XB switches, technical know-hows and careful planning are necessary for disconnecting and reconnecting lines and making an efficient use of the limited floor space. In rehabilitating the outside plant, technical know-hows are also needed particularly for cable replacement.

5.4 Recommendations

5.4.1 Adjustment of the Project

The proposed projects were formulated by examining several sample offices and maintenance areas because of the limited study period. When the projects are executed in the Study Area, therefore, some parts may be modified in accordance with the environment of the areas and a further study may be required by TOT itself by the reasons mentioned above. The Study Team, however, believes that these projects can be effectively carried out to upgrade the telecommunications service quality of TOT.

5.4.2 Coordination with the Seventh ESDP Expansion Project of TOT

The proposed projects are basically formulated for the existing telecommunications network facilities of TOT; however, another two million telephone lines constructed and operated by the private firm will be connected to the TOT networks by the end of 1996. Therefore, change of the TOT network condition must be taken into consideration for implementing some projects.

For example, the traffic condition in the TOT networks will be affected by the connection of the new telecommunications network. More subscriber lines and trunk circuits will be required to improve the call completion ratio at that time.

5.4.3 Manpower and Procurement

To carry out the proposed projects, a huge size of manpower for design and construction will be required during the projects implementation period. In outside plant section particularly, TOT is required to provide necessary manpower for the designing and construction work. The Study Team recommends that several projects should be carried out by the TOT employees themselves from planning and designing to implementation of the projects. To experience implementation of the projects is a good chance for the TOT employees to improve their skills and techniques.

Implementation of the proposed projects requires vast volume of equipment and materials such as cables and switches. Since the seventh ESDP expansion project of TOT has been carried by the private firm and its expansion volume amounts 3 million telephone lines, shortage of construction work is foreseeable. It is, therefore, urgent for TOT to secure the necessary procurement and start the projects implementation.

5.5 Conclusion

The proposed projects are effective and essential to upgrade the telecommunications service quality. They therefore should be implemented immediately by TOT. The effects of the proposed projects are summarized as follows:

1) Financial Viewpoints

a) Considerable project benefit
- Project Cost (5-year period): 28,916 million Baht
- Project Benefit (5-year period): 16,075 million Baht
- IRR (10-year period): 11.28%

b) Manpower saving in the maintenance work (5-year period):
- 432 persons (175 million Baht)

2) Social and Economic Viewpoints

a) To the users

- Enjoying every telecommunications service when necessary.

b) To the society

- Supporting socioeconomic activities.

c) To the telecommunications sector

- Creating an environment for dynamic and innovative business operation.