5-3-4 Transmission Plan

In Indonesia also, telephone network is being re-oriented toward ISDN and network digitalization is in progress. To provide transmission criteria for the present transition period, "Fundamental Plan 1985 - Transmission Plan" is being formulated.

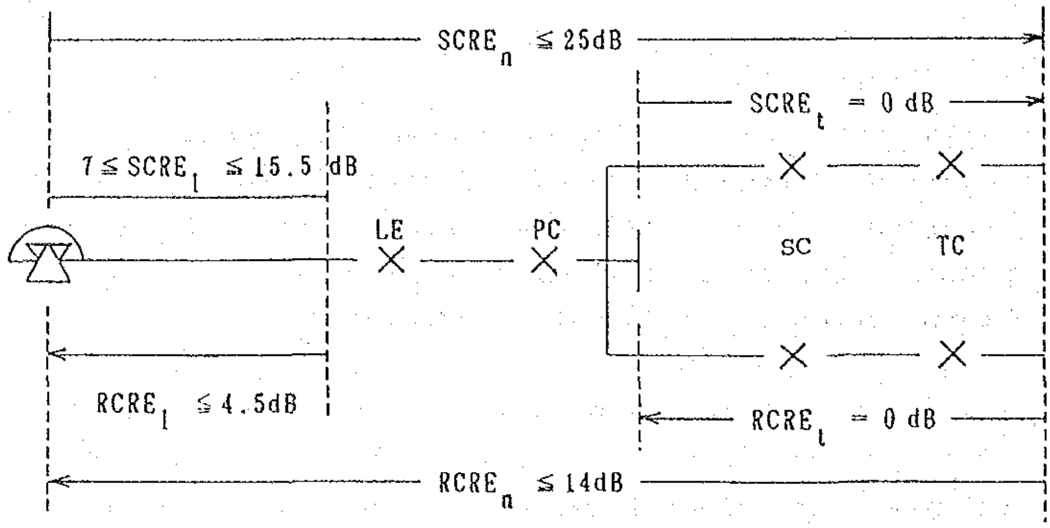
In the rural telecommunications network improvement plan, typical circuit connection is between analog terminals and digital switches. Thus, for transmission routes, analog and digital routes are co-used. Consequently, transmission system design for rural telecommunications network will be based on transmission plan in Fundamental Plan 1985 referred to above.

1) Reference Equivalent

Reference equivalent of international connection call in its national circuit section and of national call connection circuit is shown in corrected reference equivalent (CRE) in Figure 5-3-5. In this case, circuits are mostly analog circuits. As circuit digitalization progresses to the extent the digital switches are installed even in local exchange (LE), reference equivalent is to be modified as shown in Figure 5-3-6, wherein CCITT recommendations concerning singing, echo and stability are satisfied in the necessary minimum.

2) Local Circuit Characteristics

Local circuit connection formulas in rural telecommunications network are threefold as shown in Figure 5-3-7 to Figure 5-3-9. Reference equivalent in each case is shown in the corresponding illustration.



Hybrid Loss	:	3.5 db
2W Exchange Loss	:	0.5 db
Maximum Junction Loss	:	5.0 db

Figure 5-3-5 Reference Equivalents of National System (Connection of Analog Terminal Eq. and Analog Exchange)

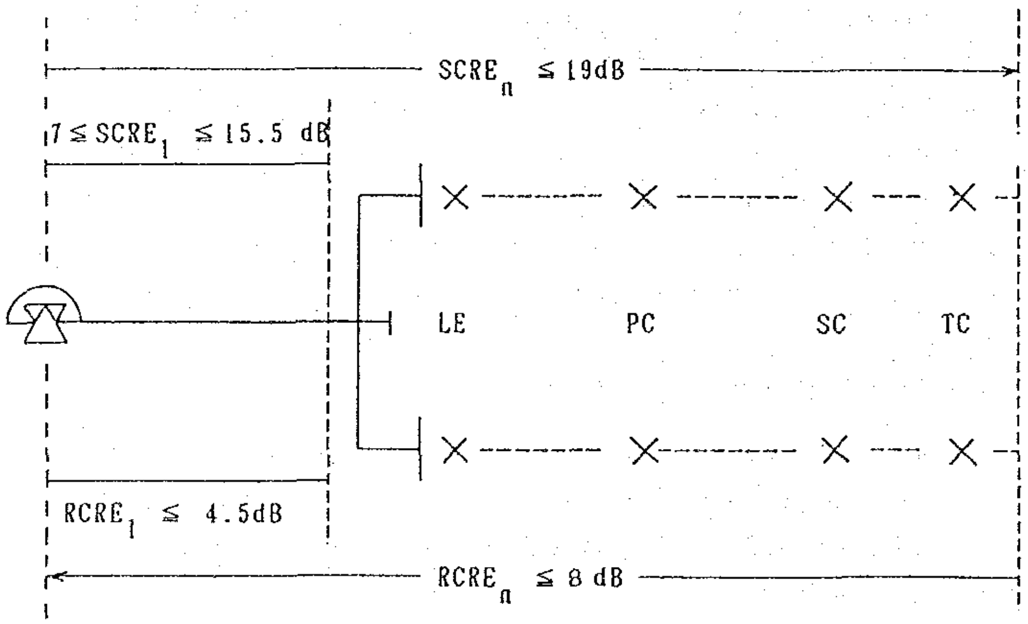


Figure 5-3-6 Reference Equivalents of National System (Connection of Analog Terminal Eq.and Digital Exchange)

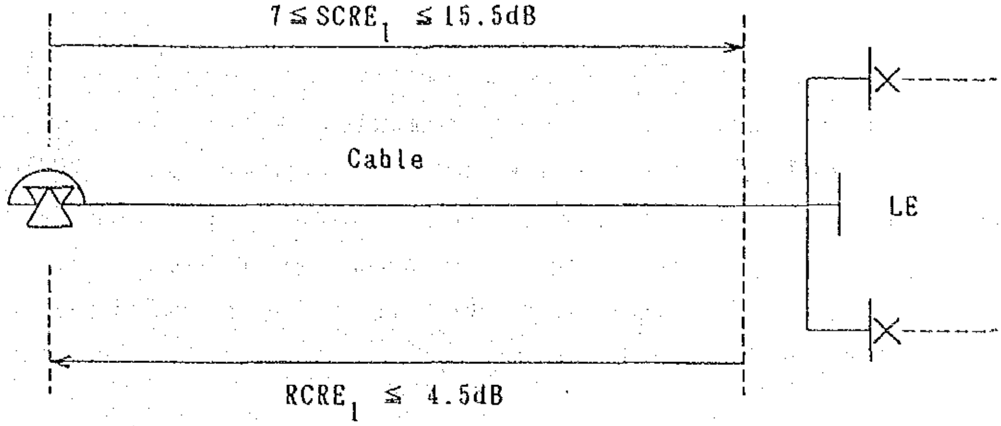


Figure 5-3-7 Reference Equivalent and Local Network Structure
(Cable only)

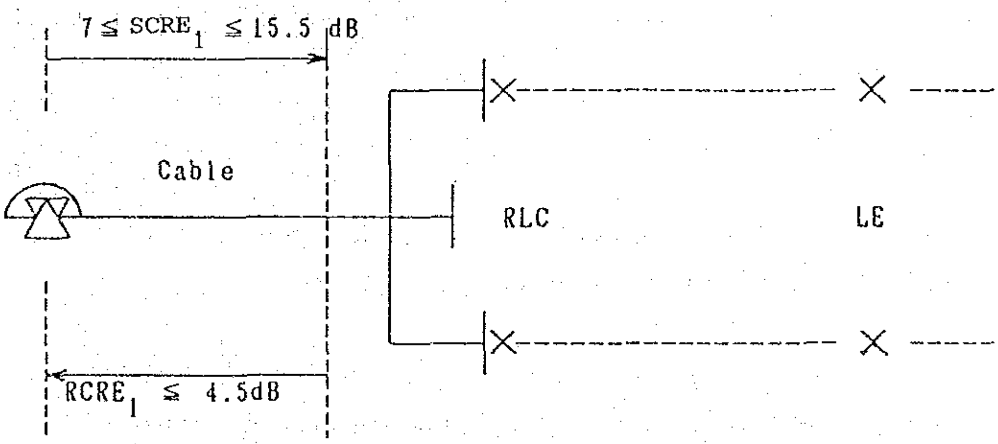


Figure 5-3-8 Reference Equivalent and Local Network Structure
(RLC + Cable)

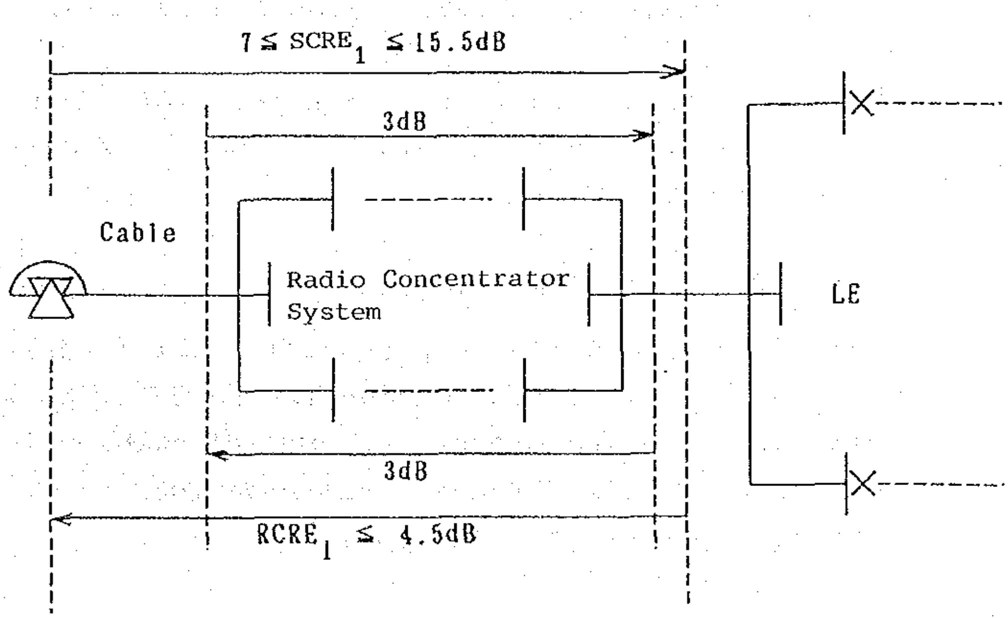


Figure 5-3-9 Reference Equivalent and Local Network Structure
(TDMA RCS + Cable)

By reasons of reference equivalent and limits to subscriber's line loop resistance by switching signal, in case where cables only are used (Figure 5-3-7), subscriber's line lengths vary according to cable conductor types as shown in Table 5-3-1. When cable of 0.9mmø conductor is used, subscriber's line length is about 10 km.

Table 5-3-1 Subscriber's Line Length

Cable Conductor Diameter (mm)	Loop Resistance (ohm/km)	*By Reference Equivalent (km)	** By Signal Control (km)
0.4	300	3.0	5.0
0.6	130	5.7	11.5
0.8	73	8.4	20.5

Note: * Sending corrected reference equivalent ($SCRE_O$) at terminal equipment = 4 dB

Receiving corrected reference equivalent ($RCRE_O$) at terminal equipment = -4 dB

Calculation is by method specified in "Fundamental Plan 1985 - Transmission Plan."

** Signal sensitive line resistance limit value without including terminal equipment is assumed to be 1,500 ohms.

3) Toll Circuit Characteristics

Speech quality deciding factors in toll circuit (4-wire system) include transmission loss, noise, singing, echo and crosstalk. For allowable limits of these factors, "Fandamental Plan 1985 - Transmission Plan" will apply.

5-3-5 Signalling Plan

Signalling systems now used in Indonesia are the following two:

- Supervisory Signalling

Analog transmission system (E&M)	:	OB (3,825 Hz)
Ordinary cable system	:	DC signalling

- Register Signalling

DC code system
Multifrequency code system

For signal transmission, end to end system and link by link system are used.

These signalling systems were adopted in accordance with the switching system introduced.

Signalling system compatibility with the existing switching system must be guaranteed by any subsequently introduced new switching system. This philosophy remains unchanged even in the basic technology transfer from analog to digital. Inter-network compatibility in due consideration of inter-area difference must also be guaranteed.

At present, in Indonesia, digital switching system is adopted as new switching system. Therefore, for signalling system, a system based on CCITT recommendation and compatible with international standard signalling system (e.g., digital R2 system or No. 7 system) is preferred.

5-4 Applicable System Menu and Construction Cost

5-4-1 Local Distribution Link

In rural telecommunications network, the undermentioned media are commonly used for local distribution link.

1) Overhead pair cable
2) Cable PCM link
3) Digital multi-channel radio link
4) Time division multiple access-radio concentrator system (TDMA - RCS)
5) SCPC satellite communication

For pair cable, direct buried type and conduit duct type are available besides overhead type. All these types cost too much for connecting a small number of remote subscribers to main link so that they are not fit for common use.

Cable PCM link and digital multi-channel radio link are appropriate media to relieve considerable subscriber demand consisting of several tens of waiting subscribers and located several tens of km distant from telephone exchange. However, this subscriber demand pattern does not hold true in telephone demand distribution in rural area of Indonesia.

TDMA - RCS, a recently developed system, is one of adequate systems for use in rural telecommunications network. In this case, coverage per base station is usually 30 km to 50 km. In Indonesia, a country where trees, 20 m tall in average, grow abundantly, coverage of 20 km at a standard and 30 km at a maximum is optimum economically.

SCPC satellite communication is applicable to isolated area and islands difficult of approach by terrestrial link. This system requires high construction cost so that, when the number of subscribers is considerable, e.g., several tens, it should be used as transfer link co-working with concentrator system.

Out of the foregoing systems, overhead pair cable link and TDMA - RCS are eligible for rural telecommunications network in Indonesia. Construction cost comparison of these two links is in Figure 5-4-1 and Figure 5-4-2.

The two illustrations indicate that when the distance exceeds 12 km or the numerical size of demand per community falls below 10, TDMA-RCS is economically more advantageous.

Optimum application range of each system which is used for local distribution link is in Figure 5-4-3. This application range is of general type resulting form study in technical and construction cost aspects. System selection in a strict sense requires cost comparison after combination with switching system, as described later.

5-4-2 Transfer Link

Transmission media fit for transfer link in rural telecommunications network are as under.

(1) Cable PCM link

(2) Digital multi-channel radio link

(3) SCPC satellite communication

Transfer link capacity in rural telecommunications network is considered to be between 10 and 400 circuits because telephone demand by Kabupaten is from 1,000 to 50,000. Thus, for each transmission media, the appropriate type is as under.

(1) Cable PCM link:

1) 1-12 system (30-360 CH) transmission capacity
2) Overhead or direct buried type

(2) Digital multi-channel radio link:

1) 4-34 Mbit/s (60-480 CH) transmission capacity
2) 800 MHz - 2 GHz radio frequency band

(3) SCPC satellite communication:

1) 3-60 circuit transmission capacity

Construction cost comparison of cable PCM link and digital multi-channel radio link is in Figure 5-4-4. Construction cost covers all related items except, access road. For building and power supply system cost, the corresponding cost at either one terminal exchange is estimated. This is because building and power supply system are for shared use with switching system.

Figure 5-4-4 indicates that when distance is less than 20 km, cable PCM link is economically more advantageous, and when distance is more than 30 km, digital multi-channel radio link commands greater advantage economically.

In this connection, Figure 5-4-5 indicated the application range of each system for transfer link in consideration of each system feature mentioned above.

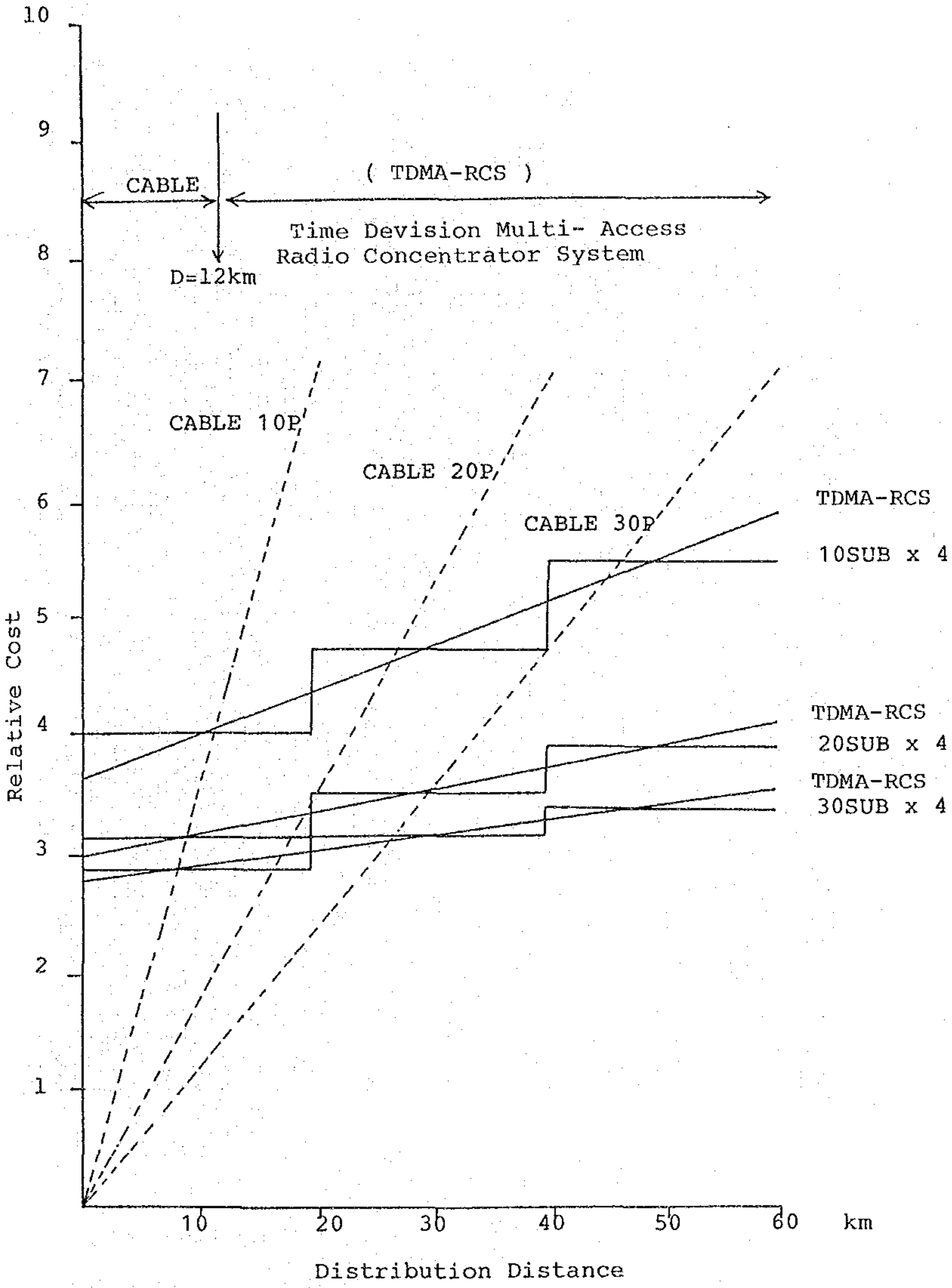


Figure 5-4-1 Construction Cost Comparison of Distribution Link (1)

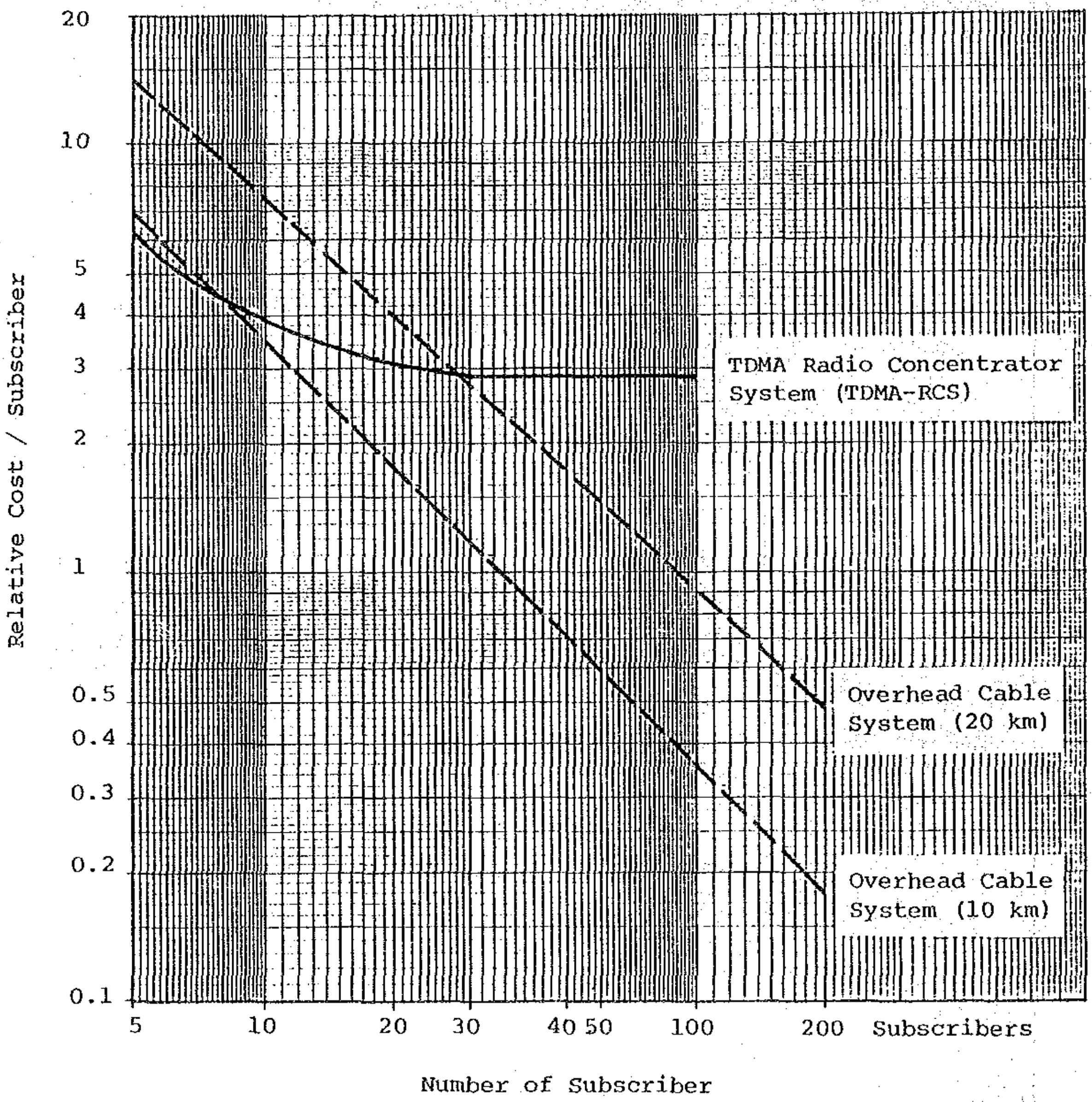


Figure 5-4-2 Construction Cost Comparison of Distribution Link (2)

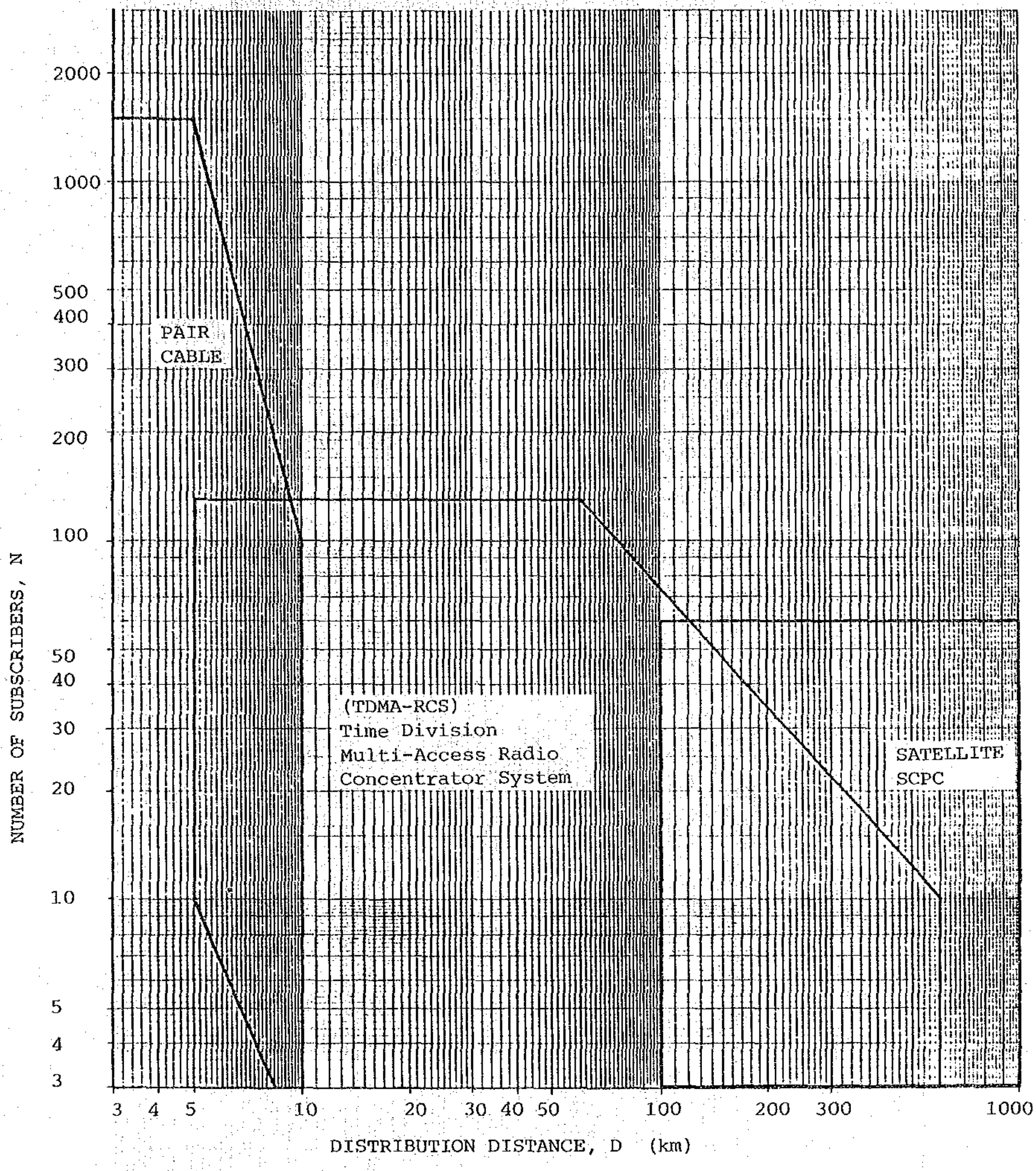


Figure 5-4-3 OPTIMUM SYSTEM FOR LOCAL DISTRIBUTION LINK

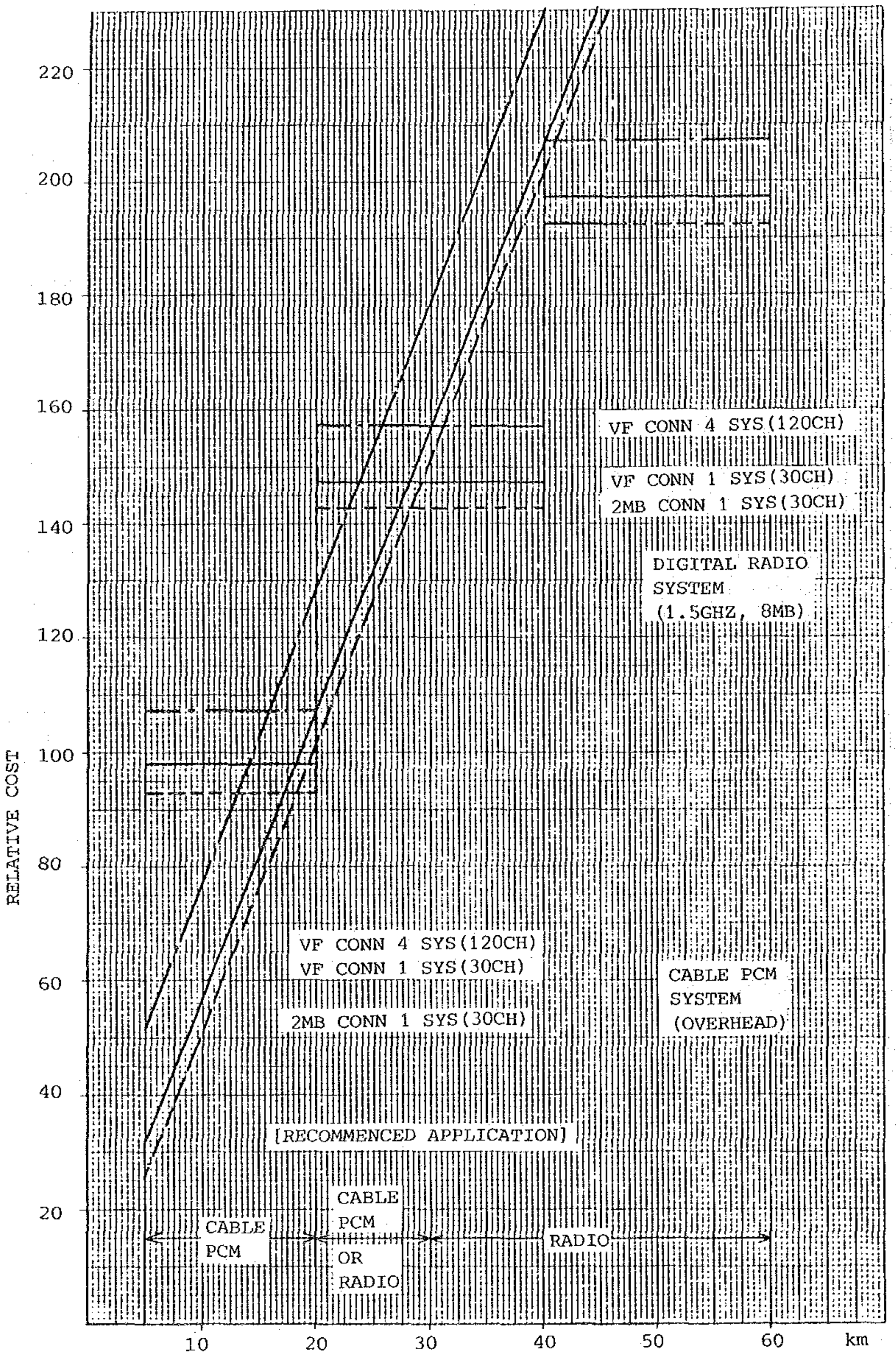


Figure 5-4-4 CONSTRUCTION COST OF TRANSFER LINK

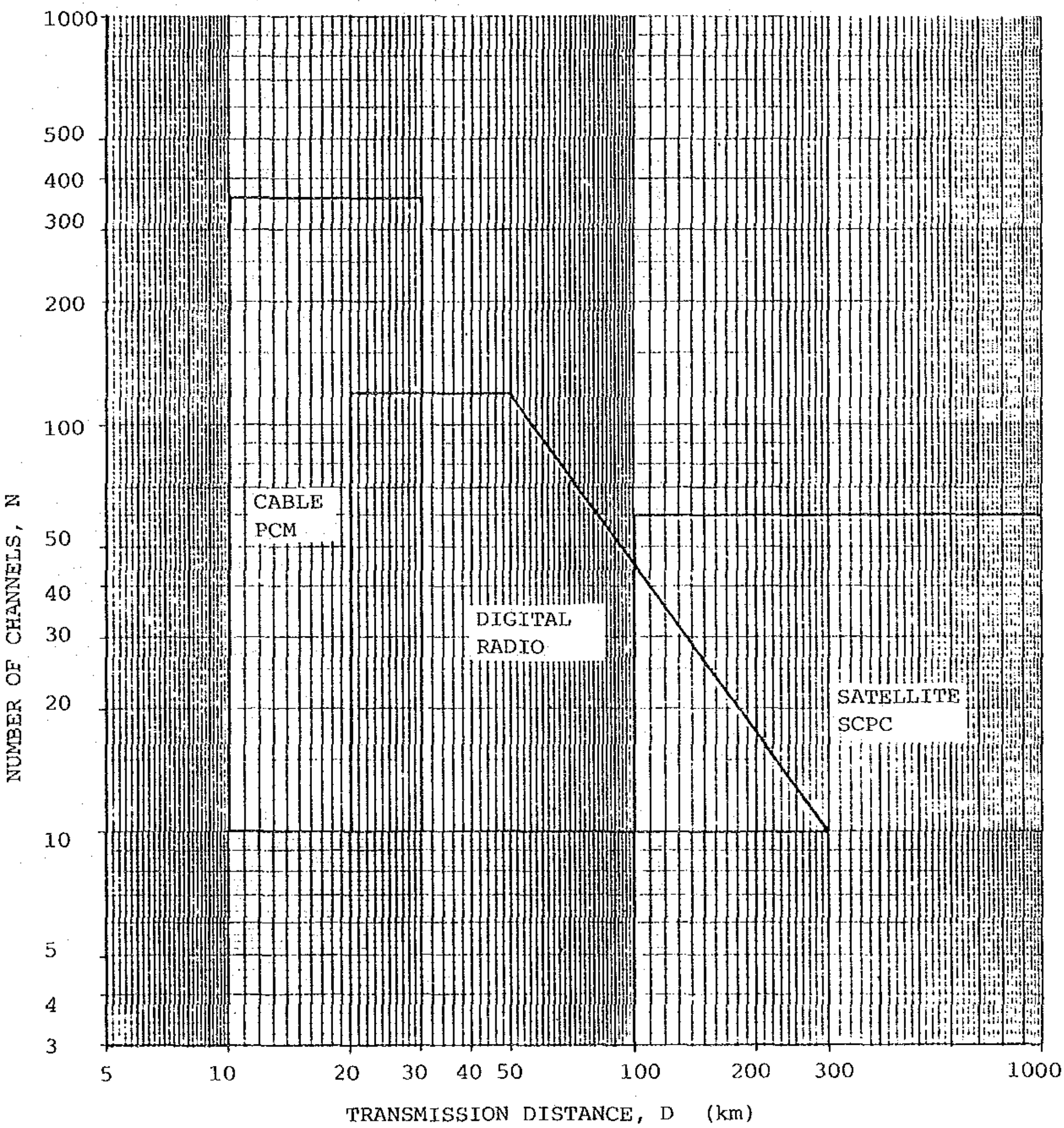


Figure 5-4-5 OPTIMUM SYSTEM FOR TRANSFER LINK

5-4-3 Satellite Communications System

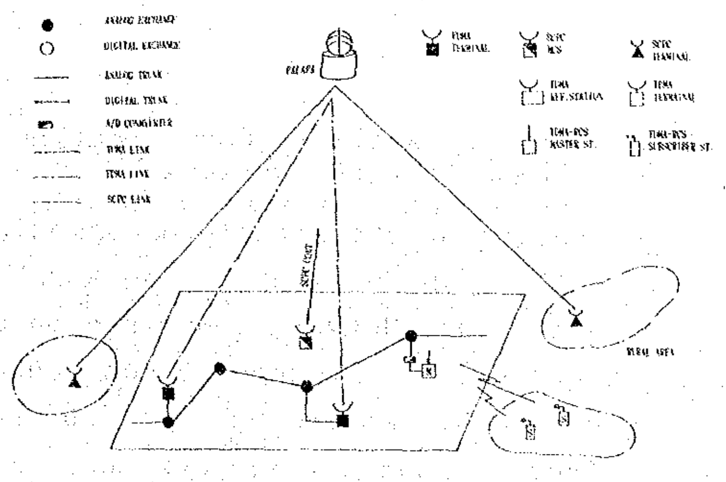
(1) Evolution of Domestic Satellite Communication System

The satellite communication system of Indonesia is expected to follow the course of development described in Figure 5-4-6.

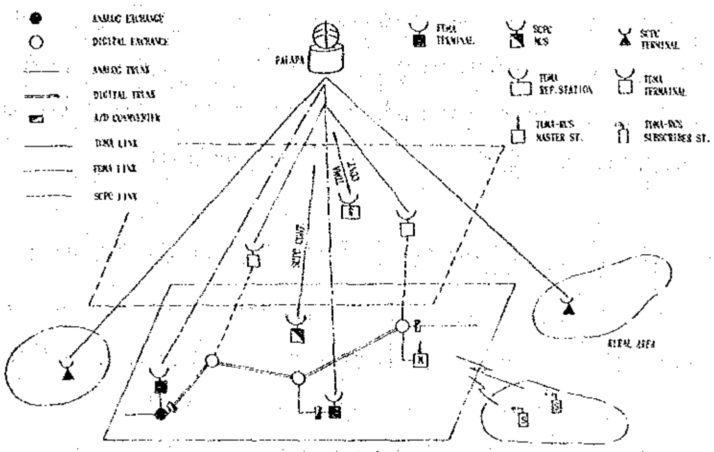
1) Around 1984
Terrestrial communications network is not yet digitalized to any visible extent. For satellite communications, FDMA and SCPC systems only are available. For relief of limited part of rural area, digital MAS begins to be used.

2) Around 1990 - 1995
Switching network becomes digitalized; however, transmission route digitalization is lagging behind. For satellite communications system, digitalization makes progress on account of positive introduction of TDMA system. In other words, digitalized satellite communications network is overlaid on national network.

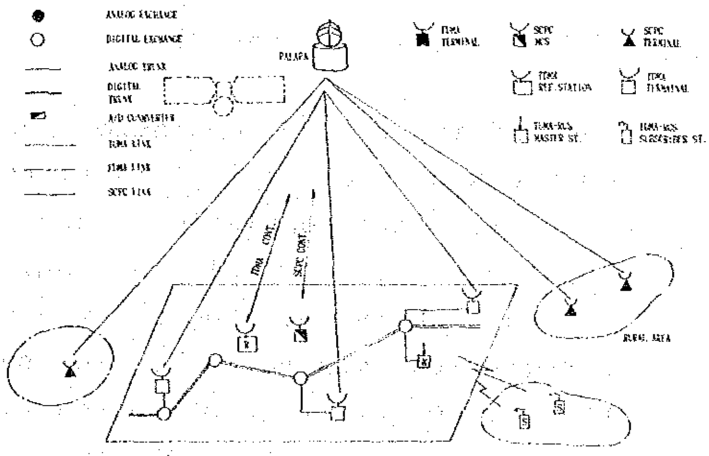
3) Around 2000
Terrestrial communications network inclusive of transmission system is digitalized. TDMA network for satellite communications is being incorporated in terrestrial communications network.



(1) Around 1984



(2) Around 1990 - 1995



(3) Around 2000

Figure 5-4-6 Evolution of Domestic Satellite Communication System in Indonesia

(2) Applicability of Satellite Communication System to Rural Telecommunications Network

The application of the satellite communication system as the transfer link in the Rural Telecommunications Network comprised on Kabupaten units is undesirable because it can cause "Double Hops Connection". Accordingly, in the Indonesian Rural Telecommunications Network there are many areas which cannot be covered by terrestrial transmission links due to long distance from the main exchange or separation by sea. For this reason, in these regions area codes should be affixed as independent primary areas, and the satellite communication systems should be applied as a trunk link with other areas.

(3) Application Study of Satellite Communication System

The following three indexes must be considered to apply the satellite communication system for rural areas:

1) Accessibility to the Population Center
2) Accessibility to the Existing Telecommunications Facilities
3) Topographical Accessibility

1) Accessibility to the Population Center
When the Kecamatan capital is so remotely located from the population center like Kabupaten capital or a large town, the long transfer link is required for the rural telecommunications network. For such transfer link, the construction of terrestrial transmission system is, sometimes, much more expensive than that of satellite communication system.

While a cost comparison between terrestrial transmission and satellite communication yields widely varying results depending on the conditions of selection and is therefore extremely difficult, the satellite communication system will be economical for the Kecamatan at distances exceeding 200-300 km from the Kabupaten capital or Primary Center.

2) Accessibility to the Existing Telecommunications Facilities

The exchange ranked as PTC (Primary Trunk Center) is usually located is the respective Kabupatne capital (IKK) or Kotamadya. If such exchange as above is not existing, the rural telecommunications network must be connected to the PTC in neighbor Kabupaten at the early stage of network development.

In this case, the length of terrestrial transfer link will be large and its construction cost becomes high. The satellite communication transfer link is generally applicable to such case.

3) Topographical Accessibility

In addition to the two kinds of accessibility, topographical conditions shall be taken into consideration when selecting an optimum system for rural areas.

There may be the case where topographical conditions constrain to choose satellite system as best for rural area communication means, even though Index I and II are favourable to the choice of terrestrial system.

Following are the clarified definitions of Index I through III. The symbols used to identify the grade of the respective accessibilities appear in ANNEX 2-6-4 and meanings of the symbols are explained hereinafter.

INDEX I: The distance separating the remotest Kecamatan in a Kabupaten from the population center (usually Kabupaten capital). Expressed in km.

INDEX II: The accessibility to PTC and/or higher exchange(s) in hierarchical order.

Symbol	Meaning
o	Accessible at present.
*	Accessible in the near future. (Under construction or planning)
x	May not be accessible by the year, 2000 A.D.

INDEX III: Here, it is assumed that the topographical accessibility could be represented by the road conditions of the respective Kabupatens, even though there are so many parameters indicating geographical conditions.

For instance, road conditions are not so good in the mountainous rural areas in general. That is why line-of-sight terrestrial radio system may not be applicable to such areas.

Symbol	Meaning
o	Every Kecamatan in a Kabupaten is connected to Kabupaten capital by road.
*	Most of Kecamatans are connected to Kabupaten capital.
x	Other than the above.

Figure 5-4-7 shows the flow chart for selecting the optimum satellite communication system. Approximately 130 Kabupatne were selected for application of the satellite communication system. The actual application plan for Kecamatan must be studied in detail.

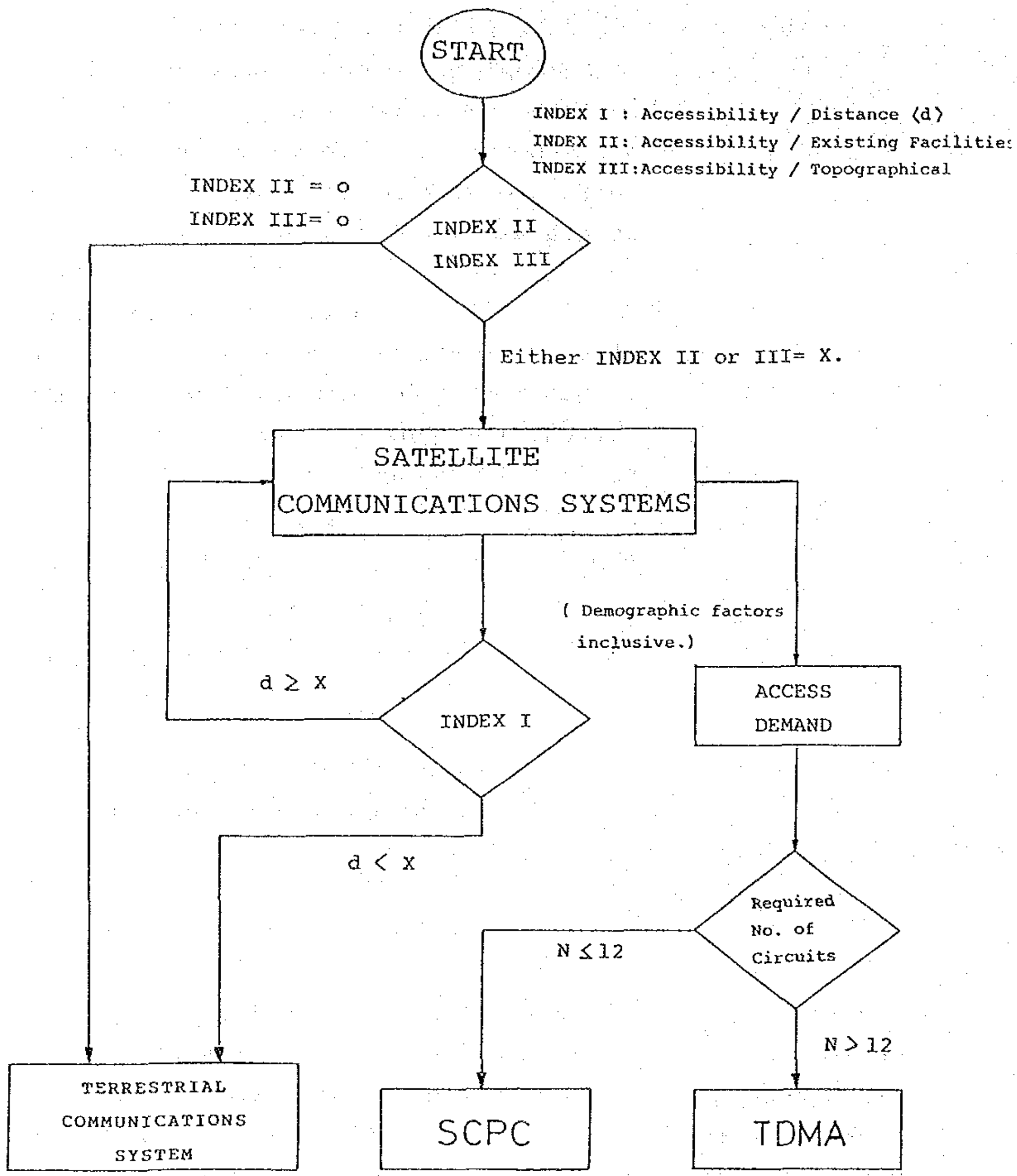


Figure 5-4-7 Flow Chart for Selecting Optimum Satellite Communications System

5-4-4 Switching System

Switching system components in rural telecommunications network are as under.

1) Main Exchange (ME)
2) Small Terminal Exchange (STE)
3) Remote Switching Unit (RSU)
4) Remote Line Concentrator (RLC)

Main Exchange is otherwise called Parent Exchange or Host Exchange. Besides switching for subscribers whom it accommodated, Main Exchange takes care of centralized control of remote units, i.e., RSU and RLC. Small Terminal Exchange fit for rural telecommunications network is of line capacity of 500 - 10,000 though generally, line capacity is between 5,000 and 50,000.

Remote Switching Unit, controlled by ME, is to carry out inter-switching for accommodated subscribers. RSU can be aptly used for more than 500 subscribers though this number depends substantially upon transfer link cost.

Remote Line Concentrator is subscriber unit controlled by ME. In spite of line concentration function which it owns, RLC depends wholly upon ME for switching. It is fit for small subscriber group where traffic is of low degree.

Switching system applicable to rural telecommunications network in Indonesia, justfied by the aforementioned Kabupaten level demand size, is small capacity system with line capacity of 1,000 - 8,000.

The construction cost of switching system is in Figure 5-4- 8 (1/2 - 2/2). When the number of subscribers falls below 1,000, construction cost per line draws sharp upcurve. Functional Requirements and Transmission Interfacing for Digital Exchange are shown in ANNEX 5-4-1 and 5-4-2 respectively.

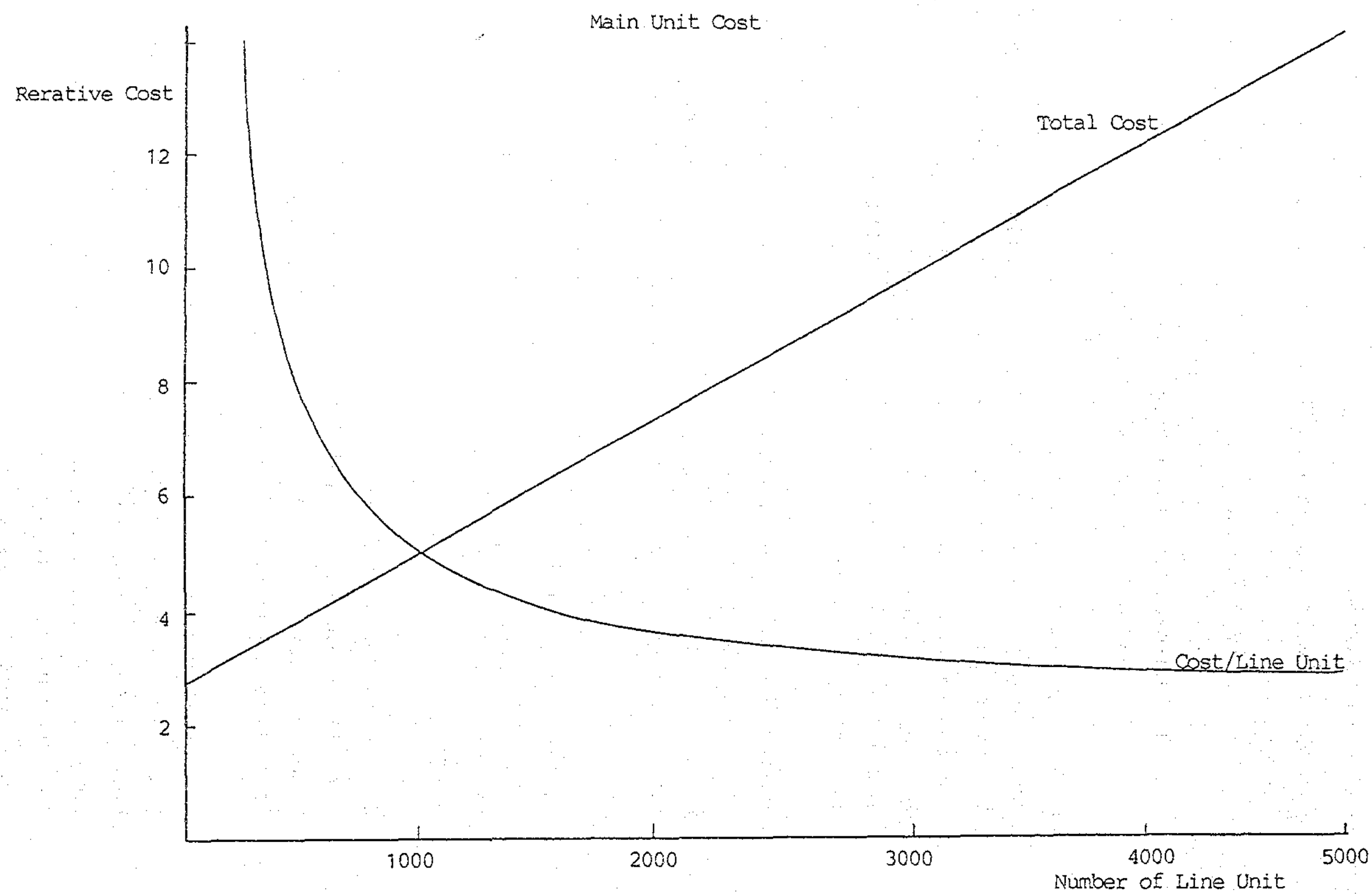


Figure 5 - 4 - 8 (1/2) Switching System Cost.

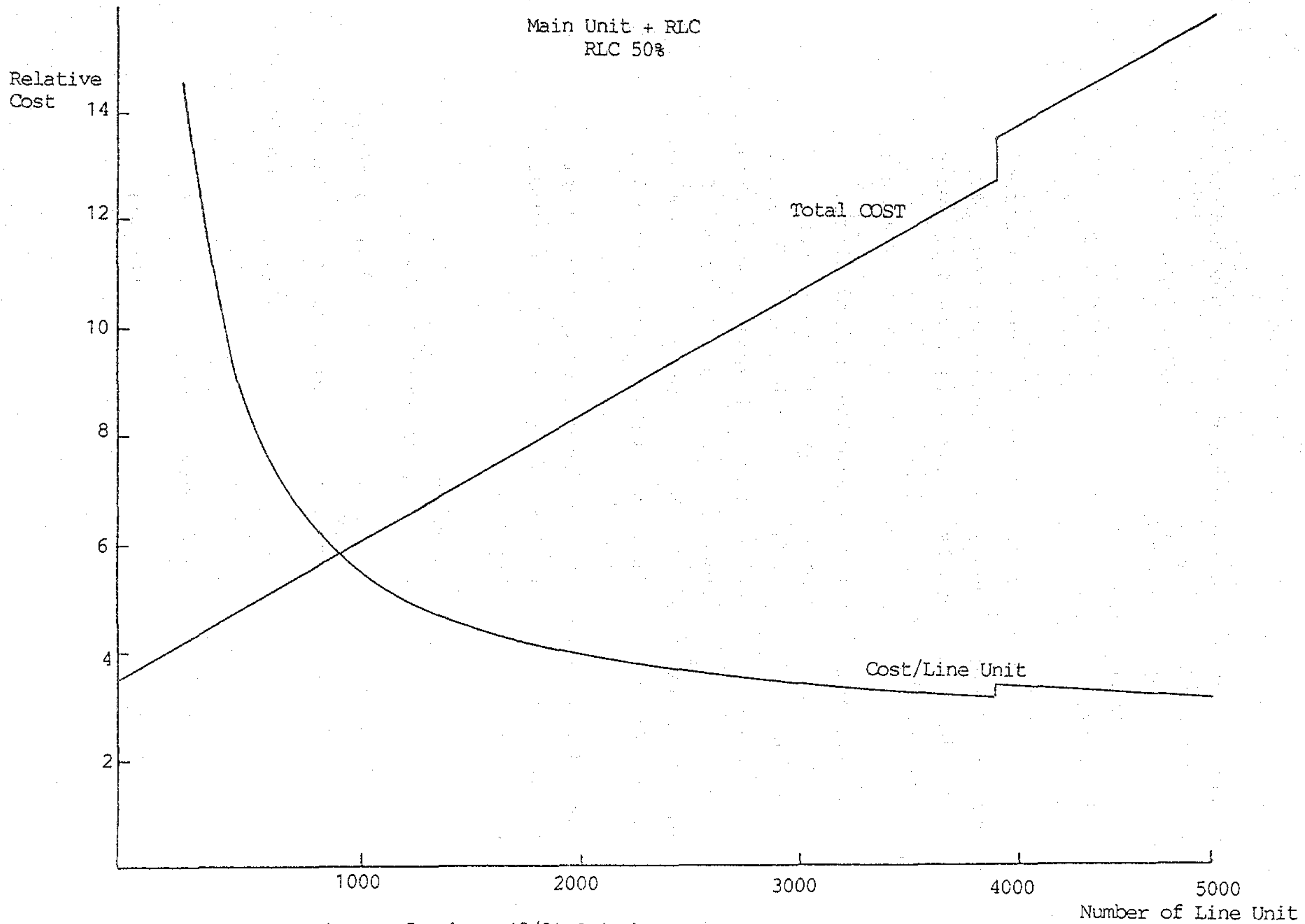


Figure 5 -4 - 8(2/2) Switching System Costs.

5-4-5 Power Supply System

Primary power source for telecommunications system are of three kinds. They are

1) Commercial power
2) Engine generator
3) Solar power

At present, in Indonesia, rural area sectors where commercial power supply is available are few. Even if commercial power supply is available, such is during night-time only in many cases.

In Indonesia, national development policy places emphasis on diffusion of commercial power supply. According to the schedule, all Desas will be supplied with commercial power by the year 2000. Nevertheless, around-the-clock commercial power supply to all Desa can seldom or never be expected. In many Desa, commercial power supply will likely be during night-time only.

From the foregoing, the undermentioned power supply systems are recommendable for application to rural telecommunications network.

Table 5-4-1 Power Supply Systems to Rural Telecommunications Network

Facilities	Primary Power	Standby Power
Main Exchange	Commercial power	Battery + fixed E-G
RSU/RLU	"	Battery + mobile E-G
RCS Base Station	"	"
RCS Repeater	Solar power	"
RCS Subscriber	"	Battery

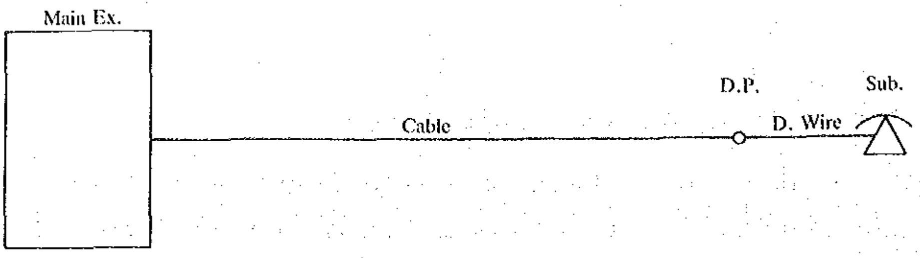
5-4-6 Network Patterns and Minimum Cost

Conceivable rural telecommunications network patterns, each consisting of transmission system and switching system combination, are in Figure 5-4-9 (1/2 - 2/2).

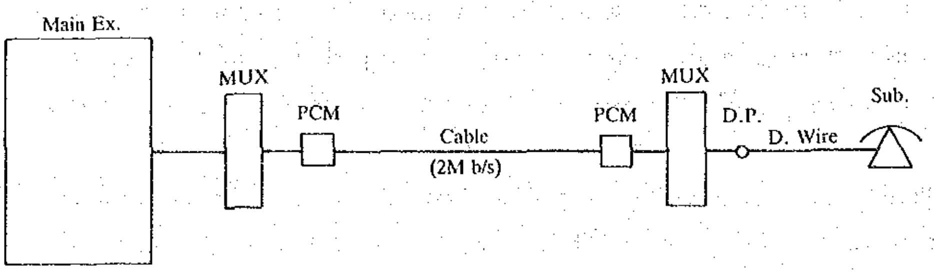
For 10 network patterns in the illustration, construction cost comparison was made, using distance from main exchange and number of subscribers as parameters.

Then, selection was made for network of minimum construction cost at different values of parameters. Selection diagram for such optimum network is in Figure 5-4-10.

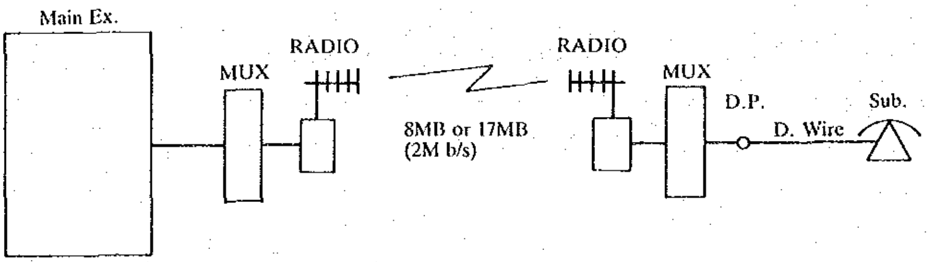
This selection diagram presents standard scope of selection. In some parts, it is subject to change according to terms of location. Nevertheless, it can be used as guideline when basic plan is established.



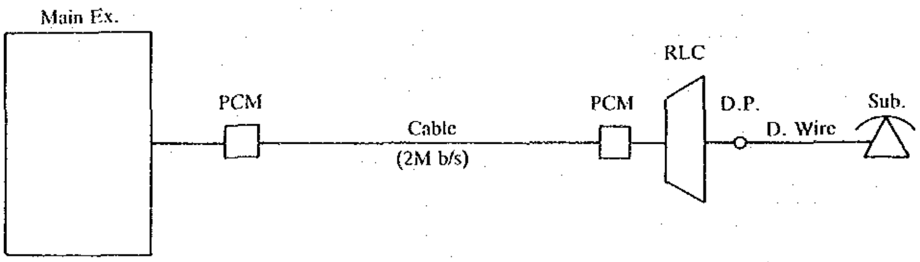
No. 1. Cable Concentration System



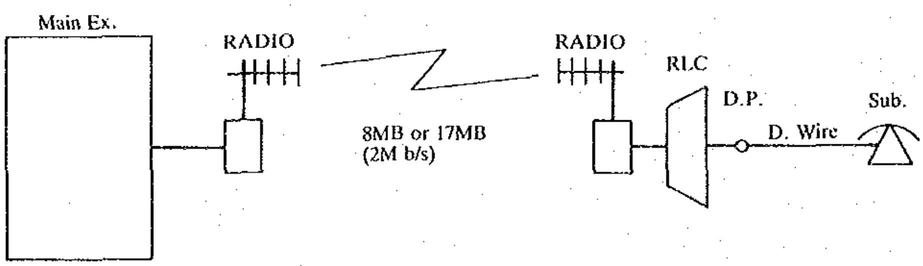
No. 2. Sub.-MUX System



No. 3. Sub.-MUX Radio System

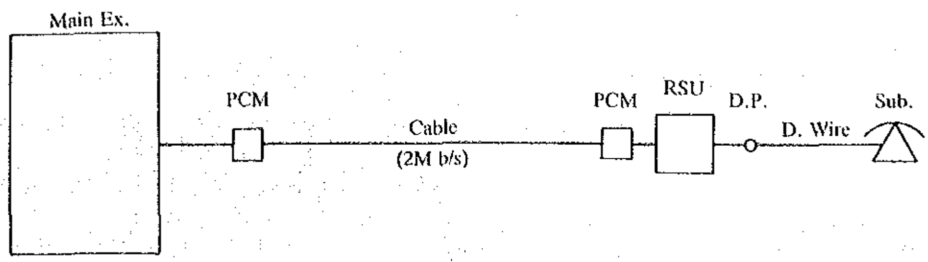


No. 4. RLC-Cable PCM System

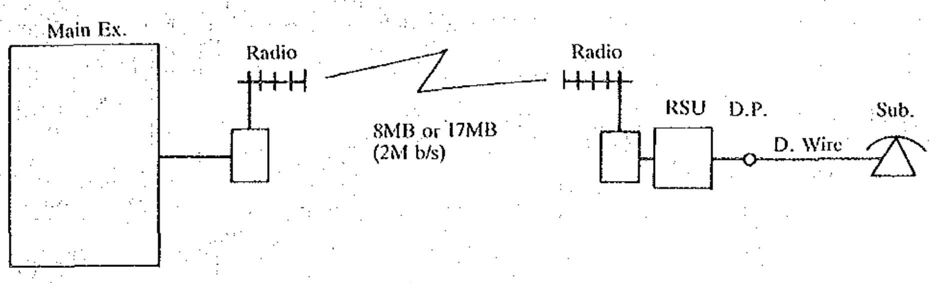


No. 5. RLC-Radio PCM System

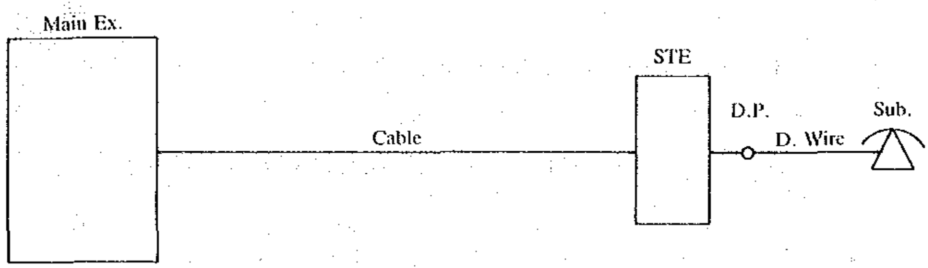
Figure 5-4-9 (1/2) Various Network Configuration (1)



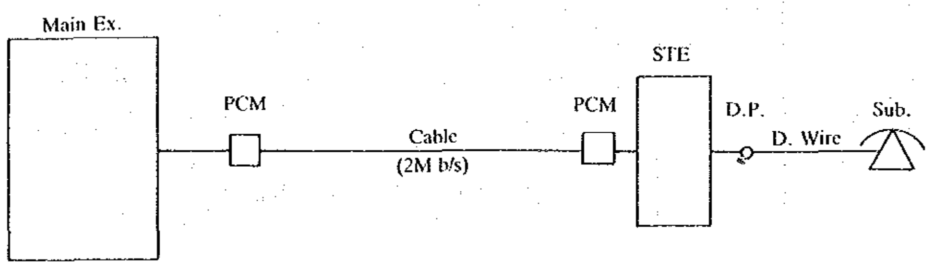
No. 6. RSU-Cable PCM System



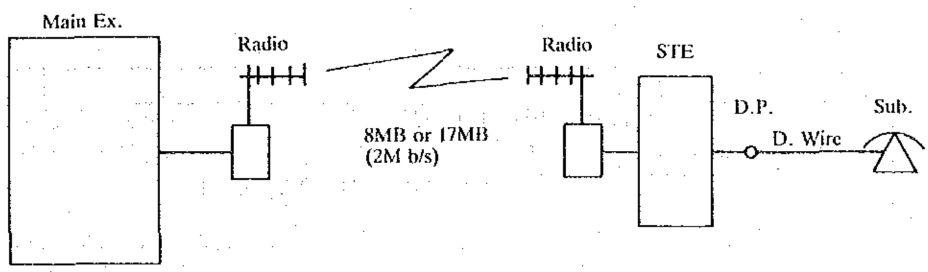
No. 7. RSU-Radio PCM System



No. 8. STE System

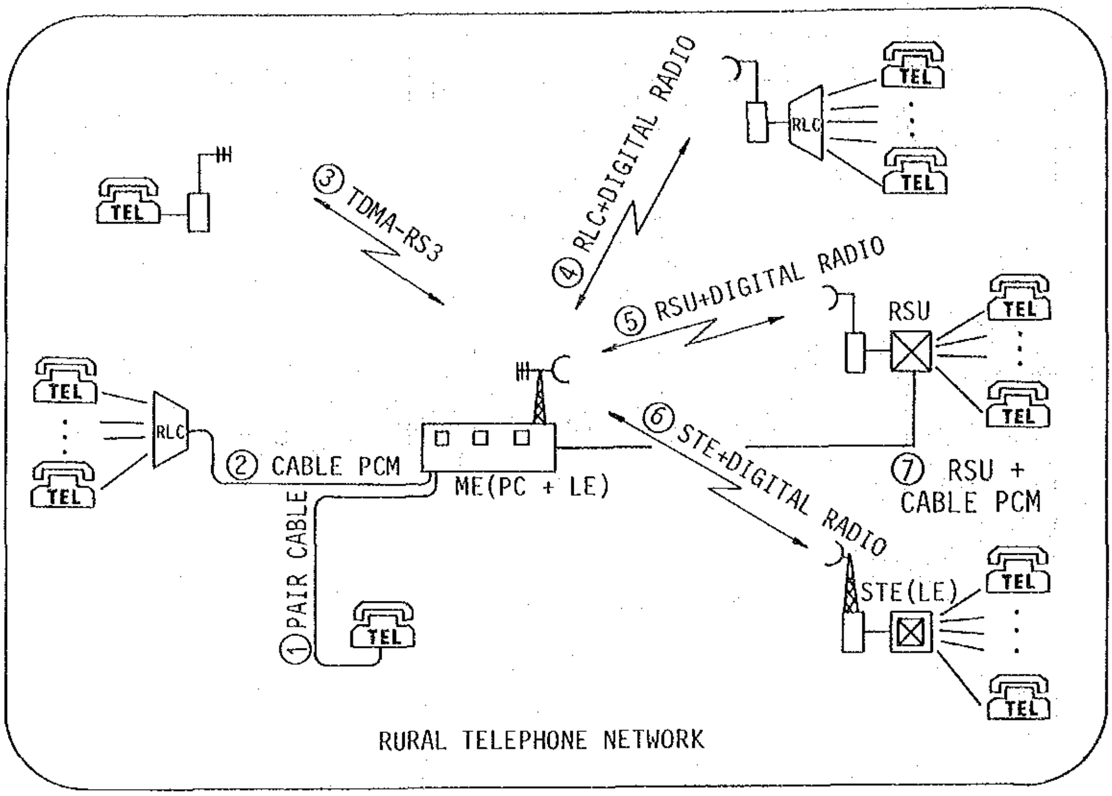


No. 9. STE-Cable PCM System



No. 10. STE-Radio PCM System

Figure 5-4-9 (2/2) Various Network Configuration (2)



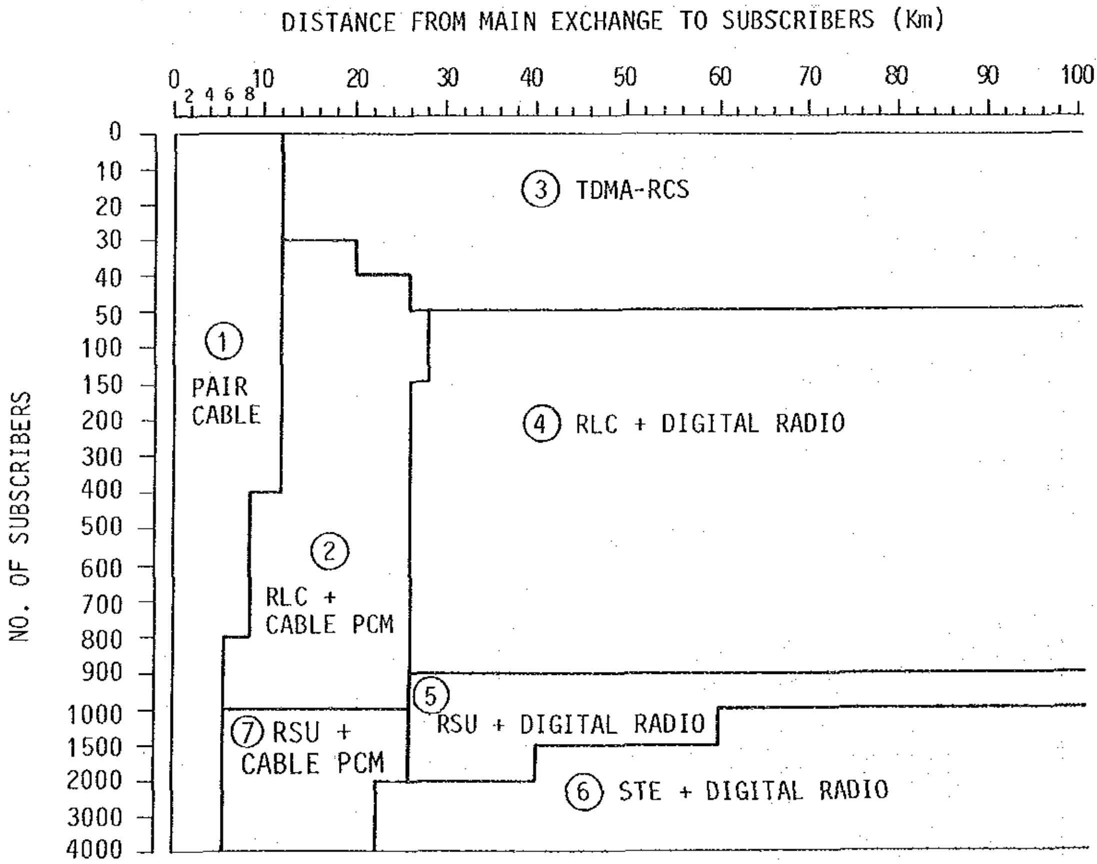


Figure 5-4-10 System Selection Diagram for Rural Telecommunication Network

5-5 Study of Initial Investment

5-5-1 Model System in Sample Area

The model system was designed for 10 Kabupaten including five sample areas and five reference areas for the study. This design is to be refered for the total investment of rural telecommunications network is whole Indonesia.

Table 5-5-1 presents the subscriber demand and the geographic features in each Kabupaten. Figure 5-5-1 through Figure 5-5-10 introduce model systems for five Kabupaten. The model system for all 10 Kabupaten is shown in ANNEX 5-5-1 - 5-5-21.

Table 5-5-1 Demand and Geographic Features in 10 Kabupaten

Kabupaten	Existing Subscribers	Demand in 2000	Area (sq. km)	Demand Density (/sq. km)	Are. Distance to Kecamatan (km)
Prop. Riau					
Indragiri Hulu	214	1,986	15,855	0.13	82.9
Kampar	116	3,867	28,291	0.14	90.1
Prop. Jawa Tengah					
Cilacap	1,001	11,959	2,338	5.12	33.4
Banyumas	1,635	9,485	1,310	7.24	15.0
Purbalingga	283	4,048	765	5.29	10.6
Prop. Kalimantan Selatan					
Hulu Sei Selatan	203	1,293	1,703	0.76	12.4
Hulu Sei Tengah	186	1,702	1,373	1.24	8.3
Prop. Sulawesi Selatan					
Sinjai	124	1,288	1,067	1.21	19.0
Pang. Kep	128	1,529	1,215	1.26	24.3
Prop. Maluku					
Maluku Tengah	177	5,070	25,091	0.20	151.5

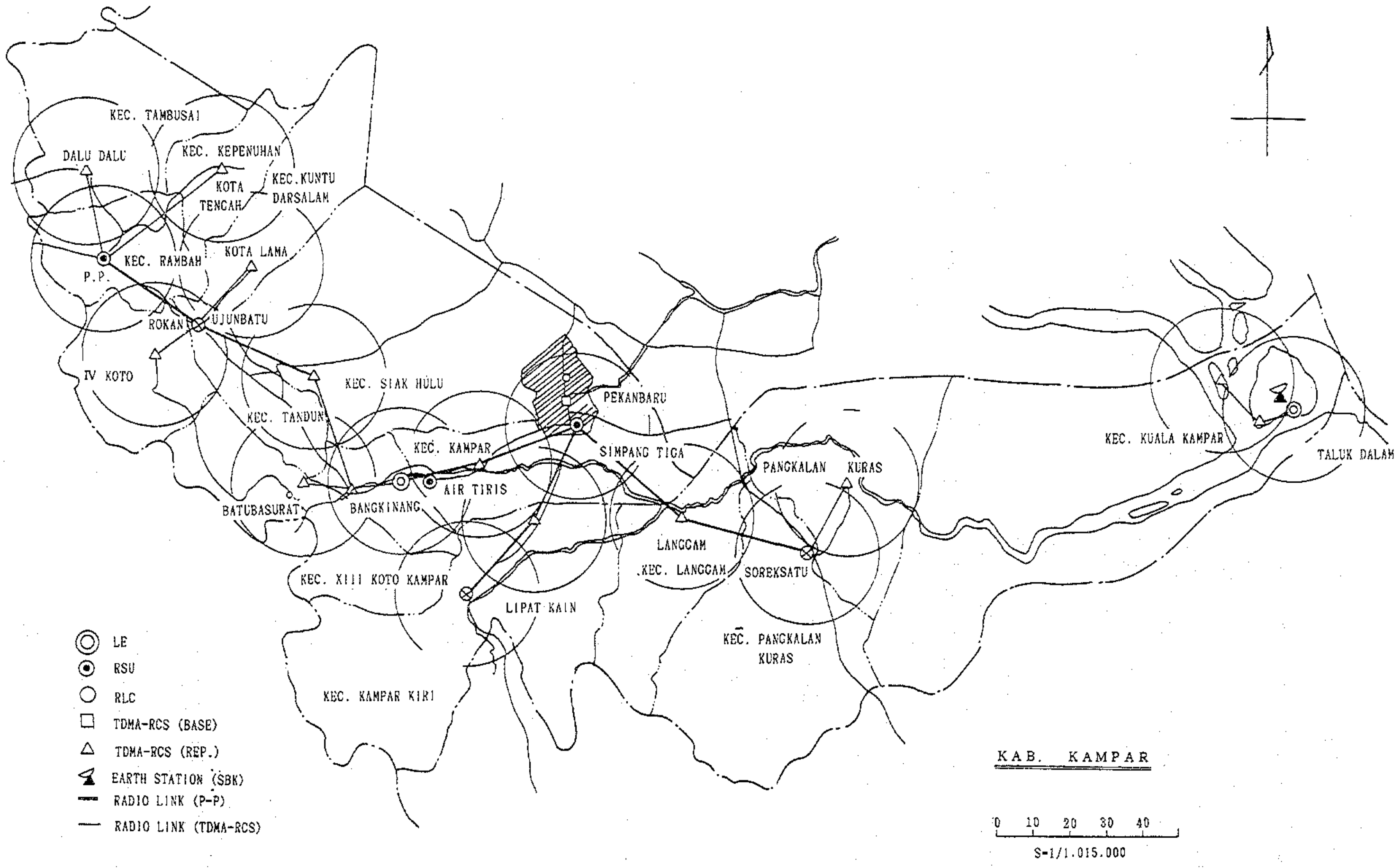


Figure 5-5-1 T.D.M.A. - R.C.S. in Sample Area

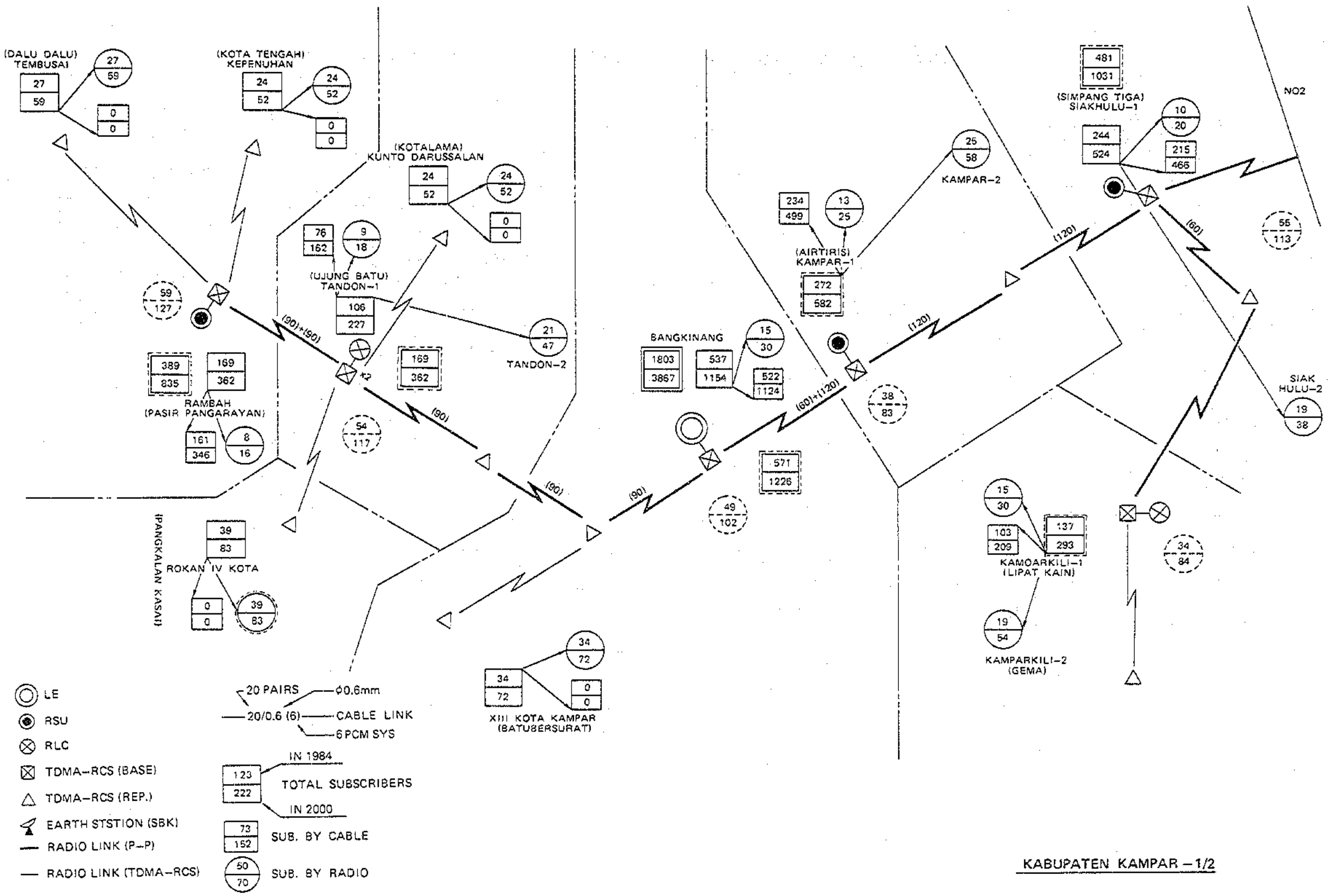


Figure 5-5-2 (1/2) Optimum System for Sample Area

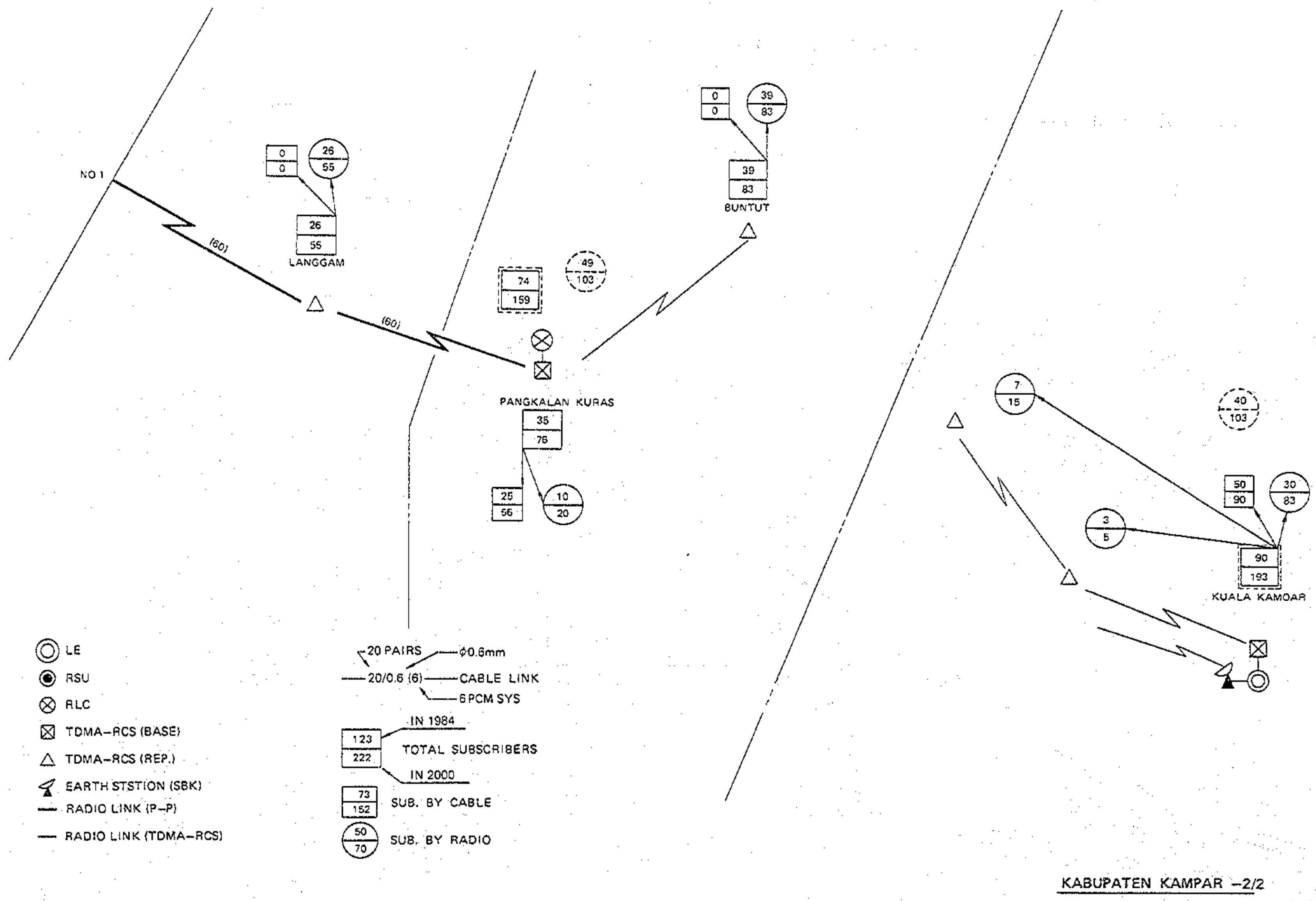


Figure 5-5-2 (2/2) Optimum System for Sample Area

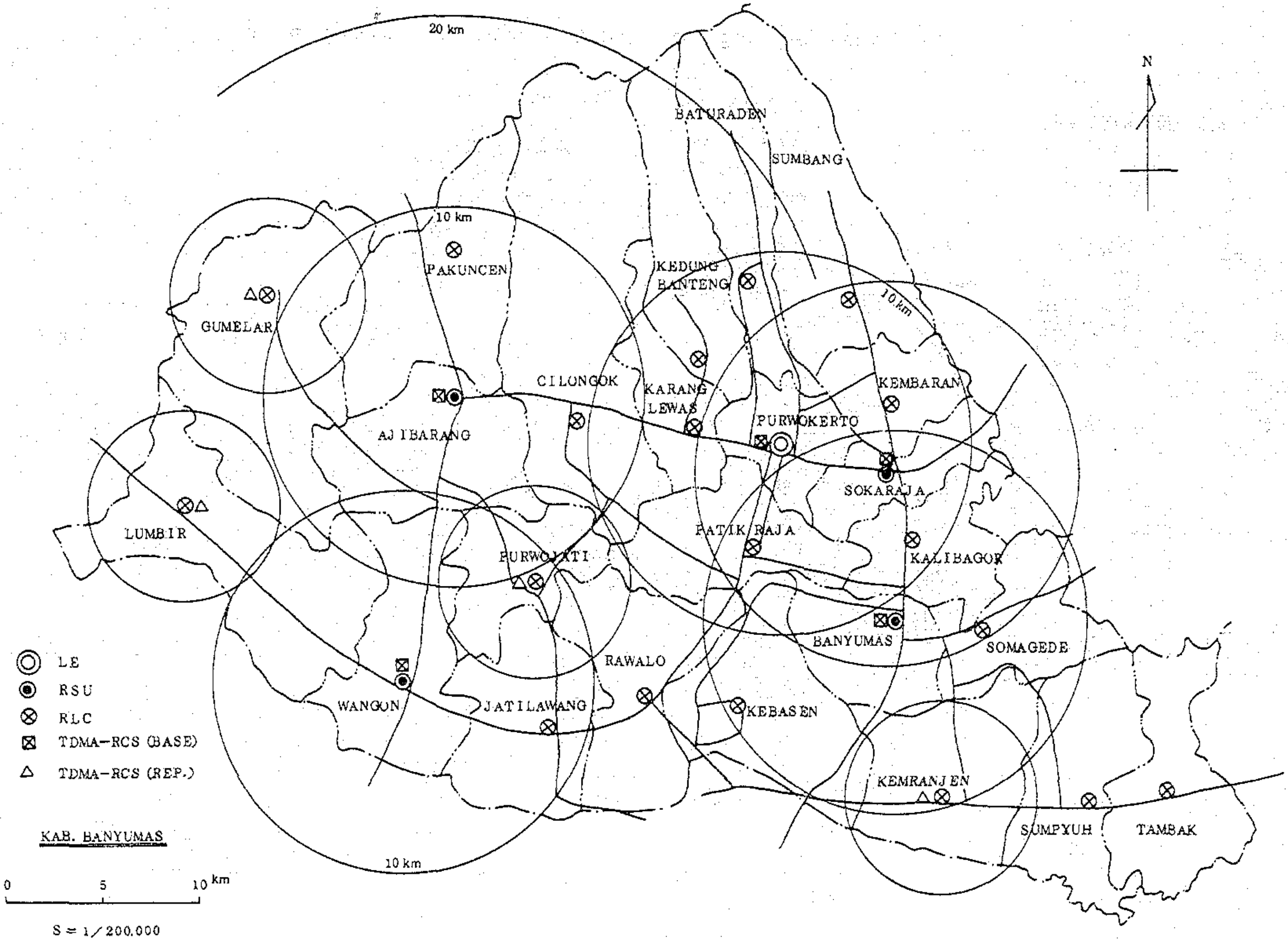


Figure 5-5-3 T.D.M.A. - R.C.S. in Sample Area

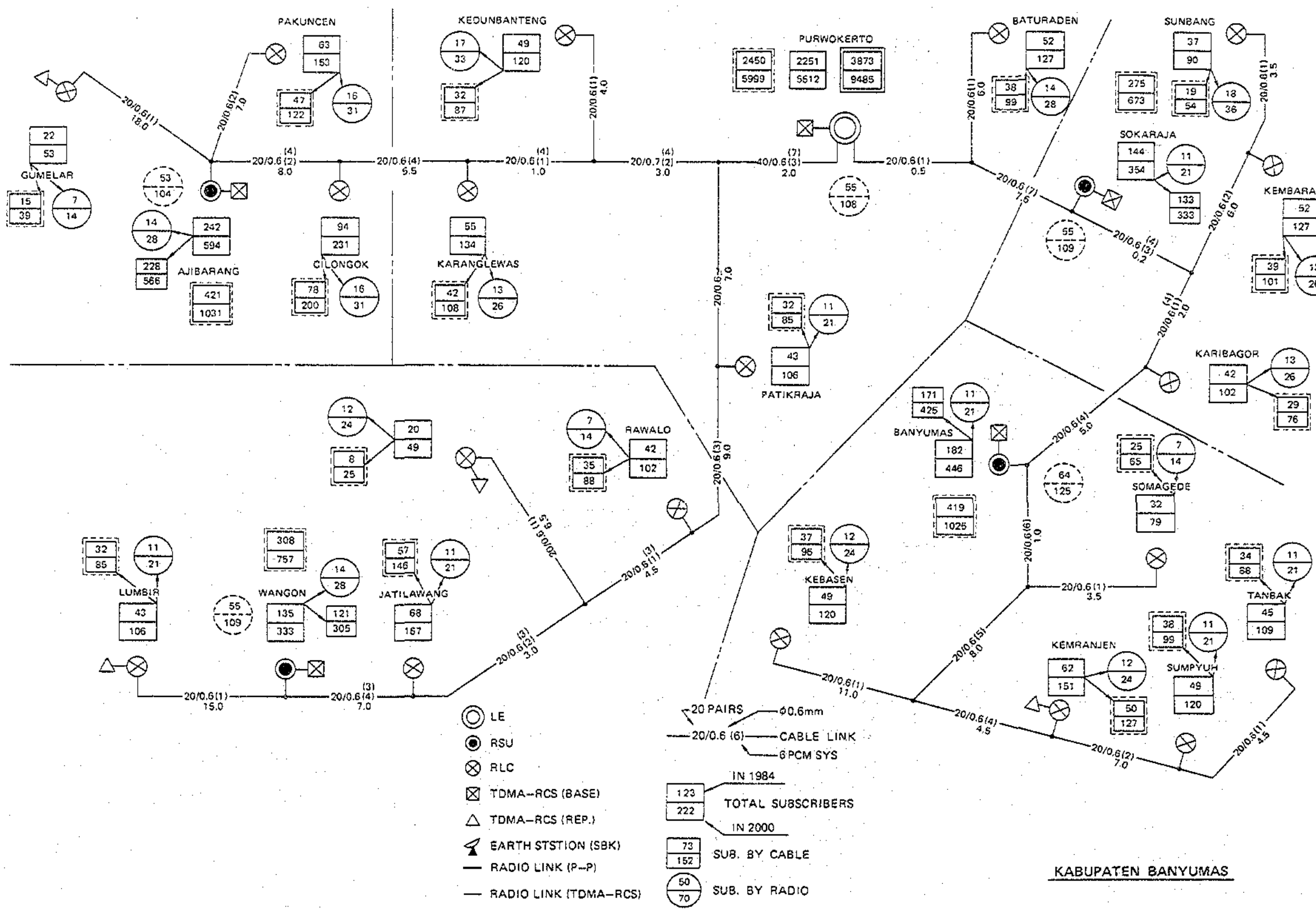


Figure 5-5-4 Optimum System for Sample Area

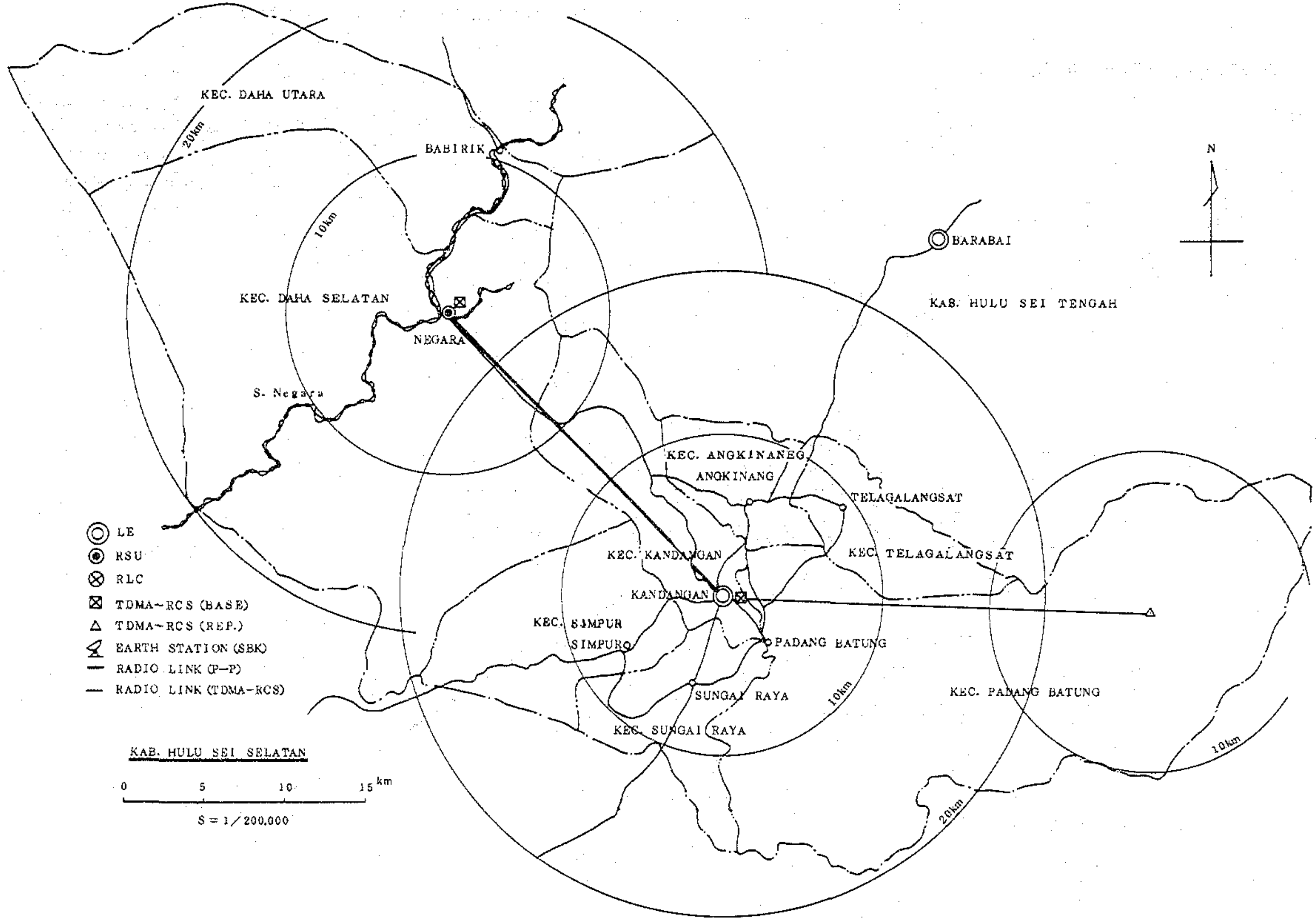


Figure 5-5-5 T.D.M.A. - R.C.S. in Sample Area

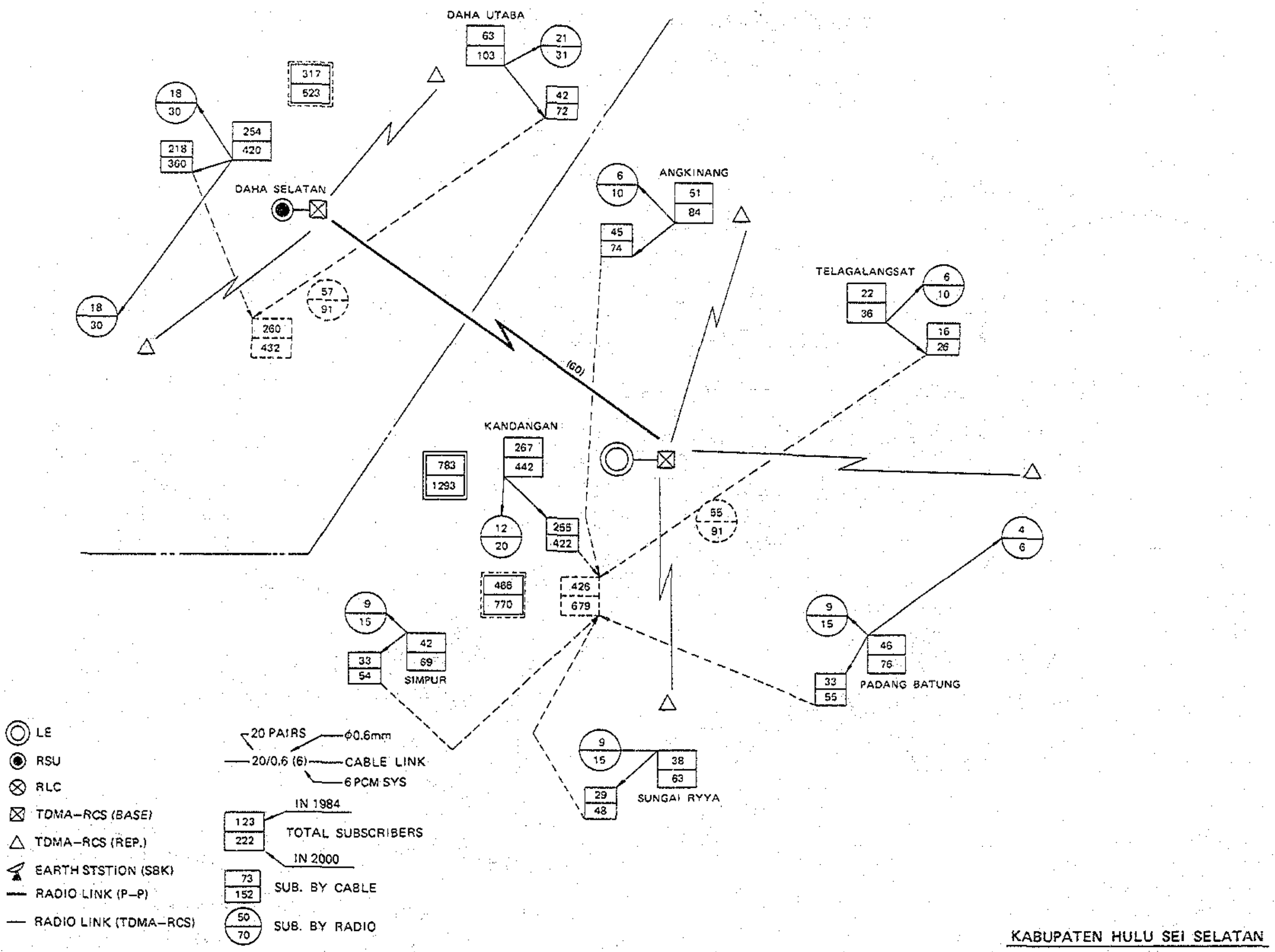


Figure 5-5-6 Optimum System for Sample Area

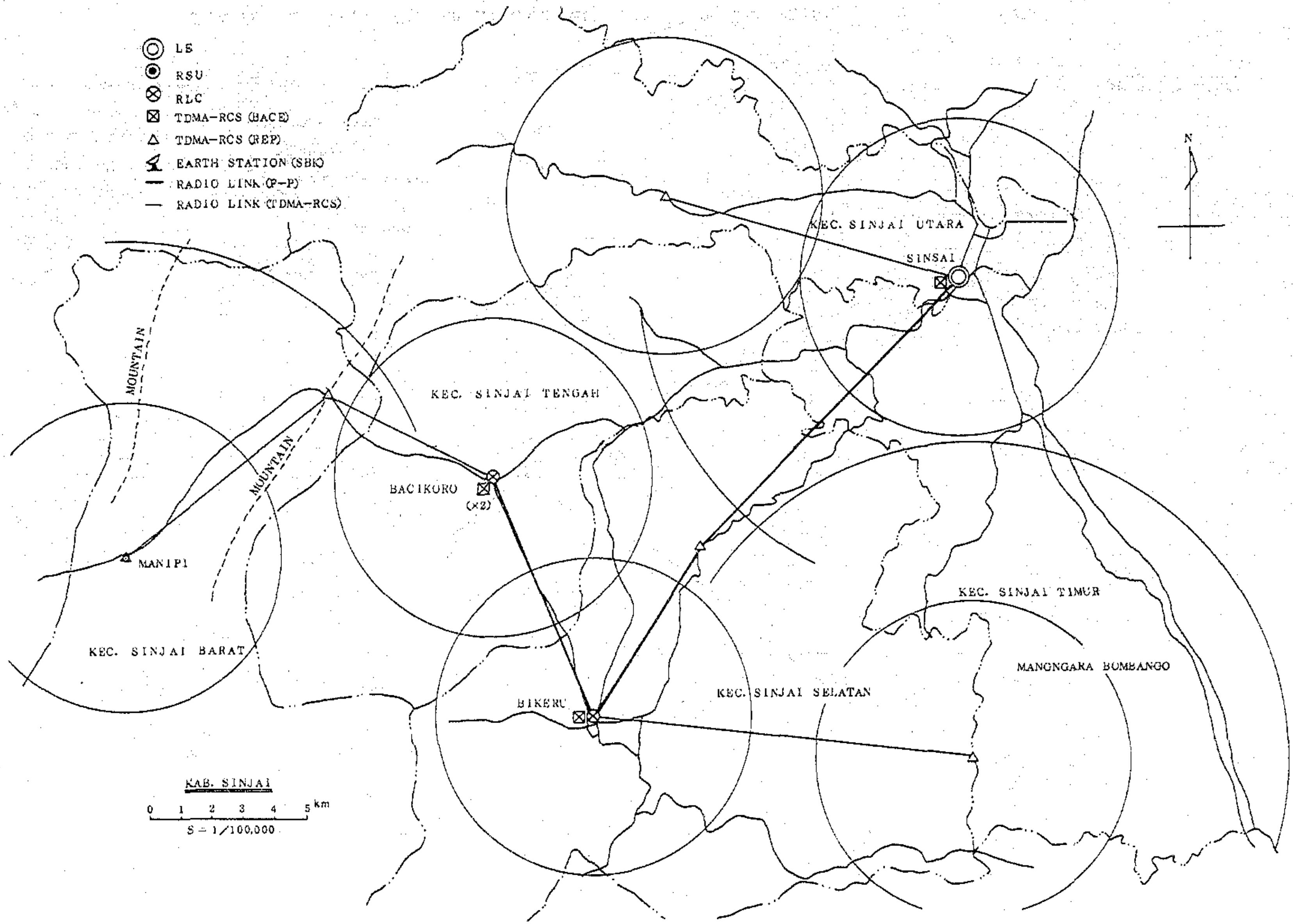


Figure 5-5-7 T.D.M.A. - R.C.S. in Sample Area

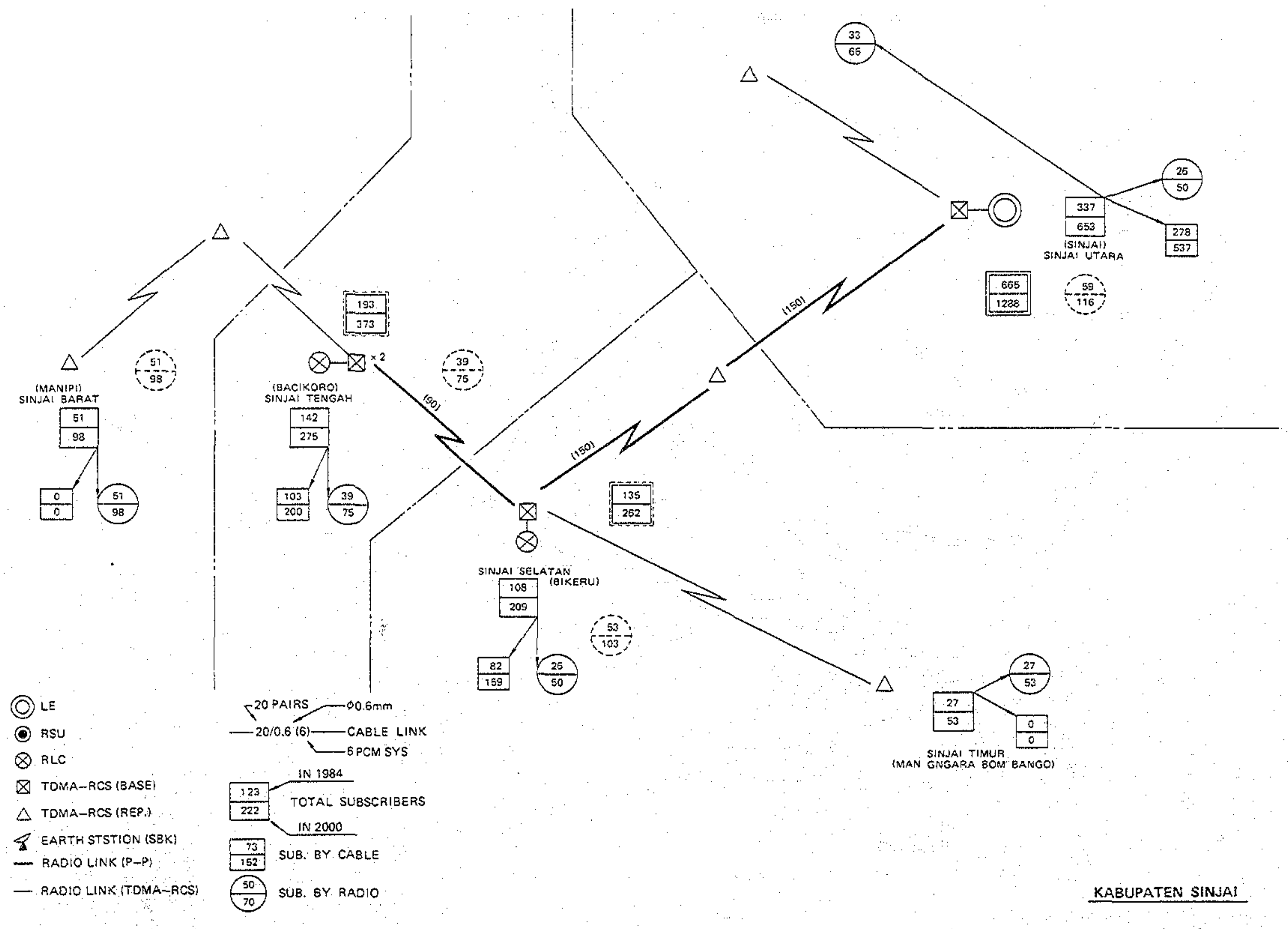


Figure 5-5-8 Optimum System for Sample Area

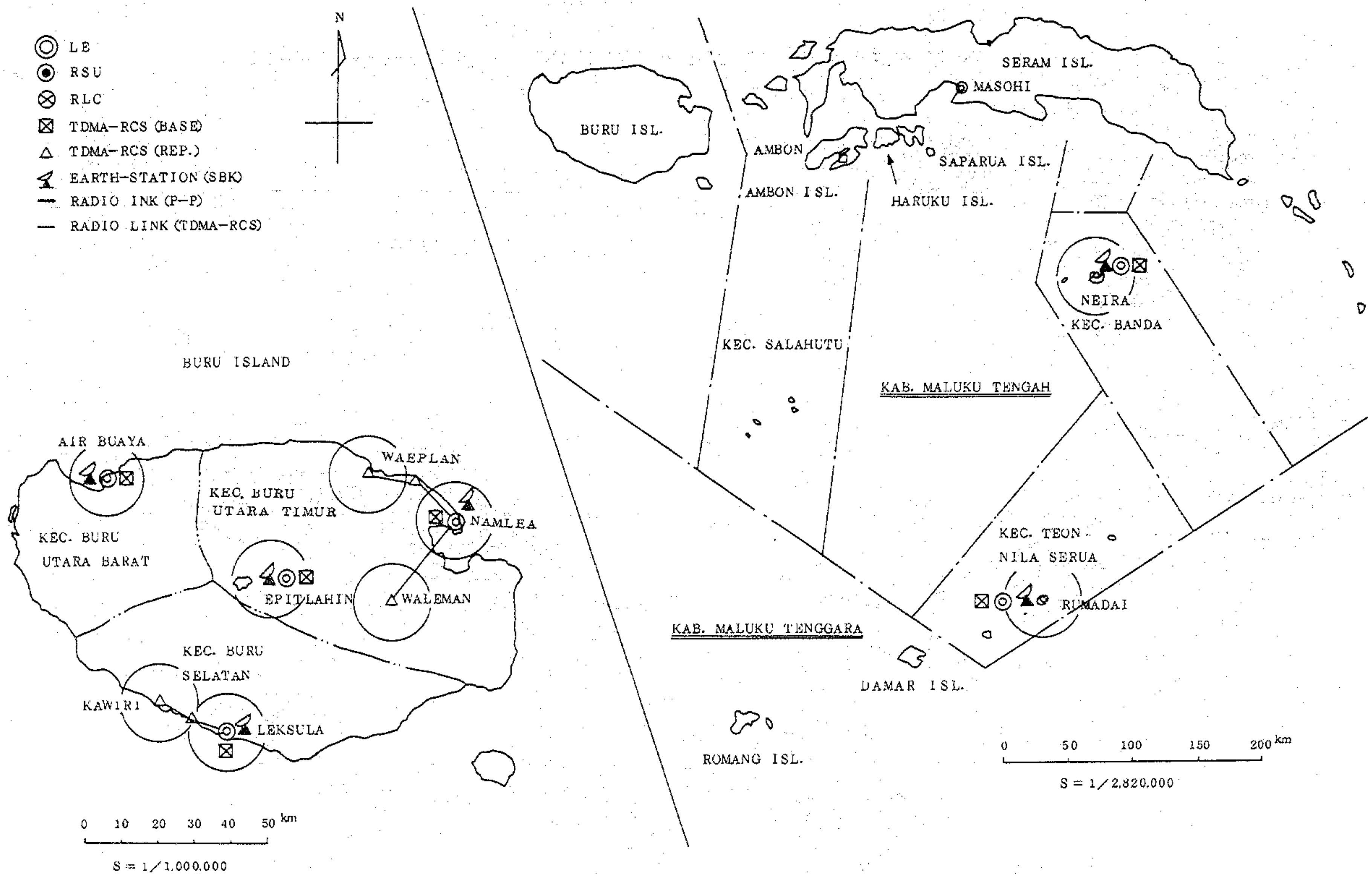


Figure 5-5-9 (1/2) T.D.M.A. - R.C.S. in Sample Area

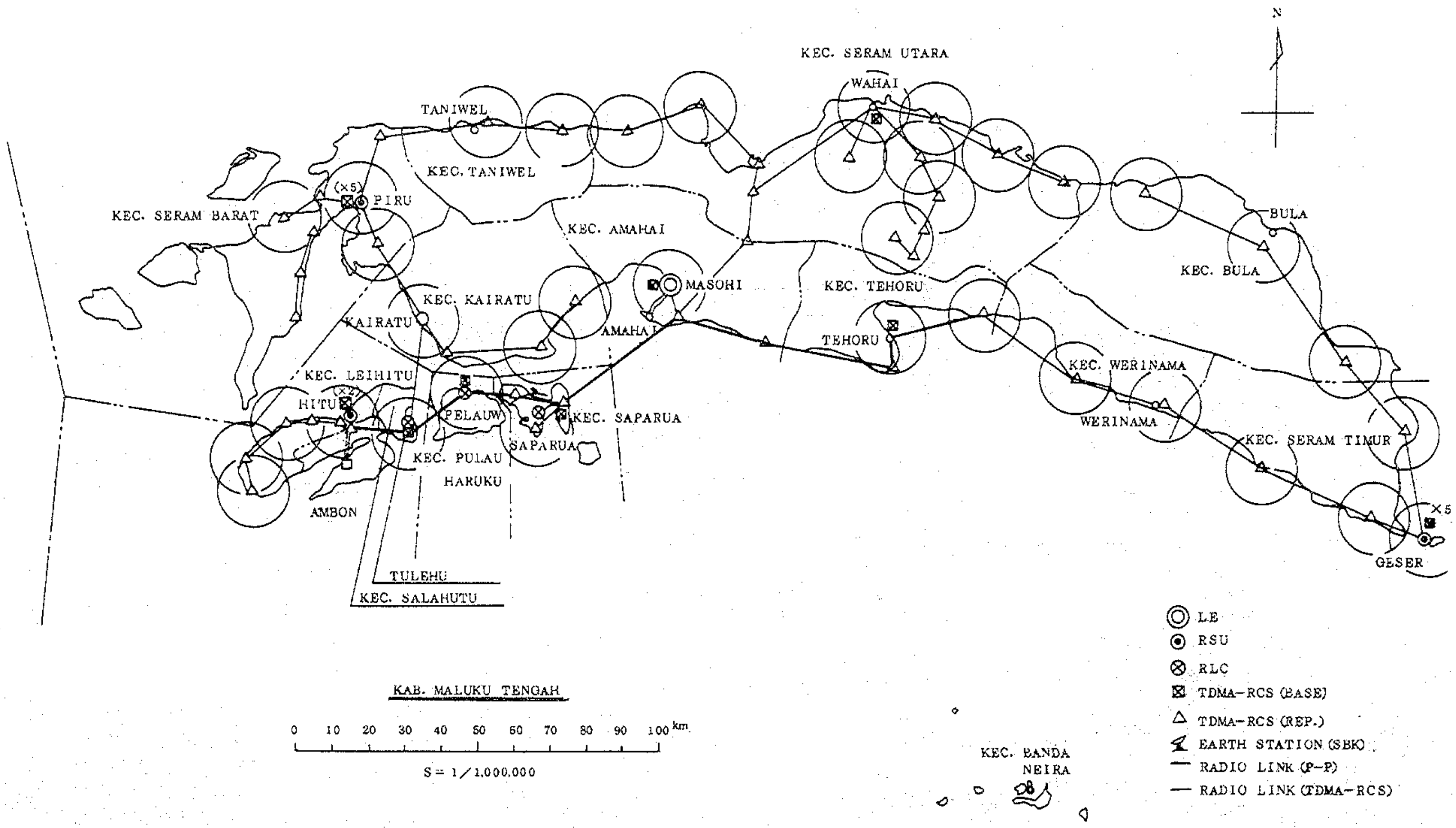


Figure 5-5-9 (2/2) T.D.M.A. - R.C.S. in Sample Area

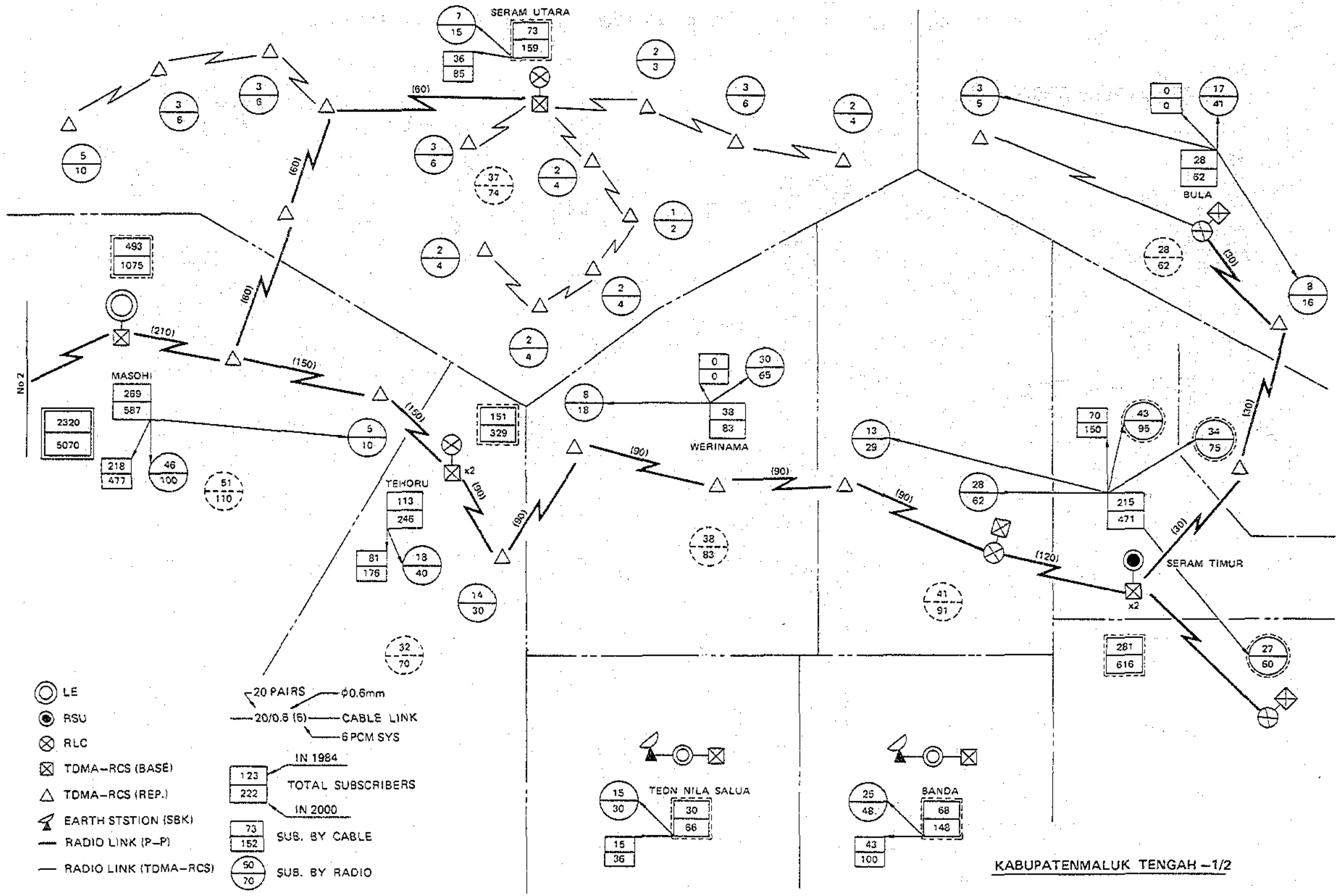


Figure 5-5-10 (1/2) Optimum System for Sample Area

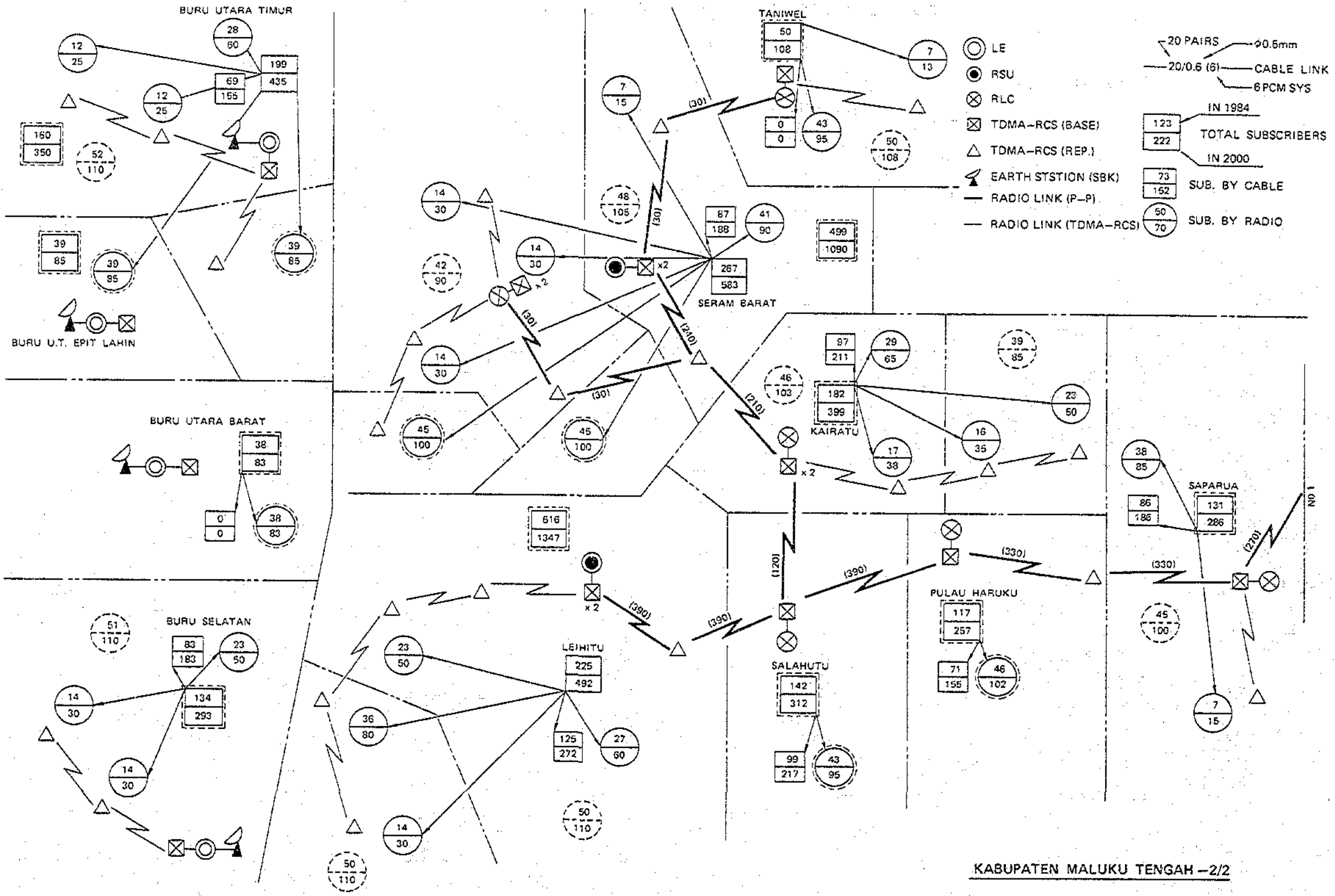


Figure 5-5-10 (2/2) Optimum System for Sample Area

5-5-2 Initial Investment in Sample Area

(1) Initial Investment by Sub-system

The construction volume and initial investment for model systems in 10 sample Kabupaten is shown in Table 5-5-2.

The initial cost was estimated for following for sub-systems:

1) Transfer Link Cost
2) Switching System Cost
3) Local Distribution Link Cost
4) Engineering Cost for Project Implementation (5% of item 1 through item 3)

To find the best regression model for cost estimation of various areas, the regression analysis have been carried out using many variable concerning geographic features. Figure 5-5-11 through Figure 5-5-13 show the relation between cost for sub-system and geographic feature as the result of analysis.

(2) Demand Share in IKK/Kecamatan/Desa

Concerning the demand share in IKK (Kabupaten capital), Kecamatan capital and Desa the regression analysis also have been carried out. The result and regression model is shown in Figure 5-5-14 and Figure 5-5-15.

Table 5-5-2 (1/2) Construction Cost of Sample Area

Unit: Million Rp

KABPATEN Item / Work Item or Classification	INDRAGIRI HULU		KAMPAR		CILACAP		BANYUMAS		PURBALINGGA		S. Total	
	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost
SW (LU/EX)	1000/1	616	1500/1	889	6600/1	2,094	6000/1	1,936	2900/1	1,118	18000/G	6,653
RSU (Lu/EX)	1000/1	616	2600/3	1,610	5200/4	2,886	3700/4	2,253	1300/1	774	13800/13	8,139
RLC (LU/LC)	1100/4	823	1000/3	730	4000/12	2,922	3500/19	2,781	2900/11	2,165	12500/49	9,421
Sub Total		2,055		3,229		7,902		6,970		4,057		24,213
T. cable (km)	0	0	0	0	227	5,368	171	3,788	53	1,857	451	11,013
PCM (Case)	0	0	0	0	108	119	71	79	33	40	212	238
PCM (Rep)	0	0	0	0	488	216	208	92	119	53	814	361
PCM (Max)	0	0	0	0	37	1,025	37	1,025	27	748	101	2,798
Radio Link	7	2,156	11	3,159	2	774	0	0	0	0	20	6,089
Tower	8	554	12	827	3	207	0	0	0	0	23	1,588
SKB	0	0	1	440	0	0	0	0	0	0	1	440
Sub Total		2,710		4,426		7,709		4,984		2,698		22,527
D1 Cable (km)	1	44	3	114	10	418	8	343	2	62	24	981
Civil (km)	1	88	3	229	10	836	8	686	2	123	24	1,962
D2 Cable (km)	48	849	83	1,456	329	5,786	222	3,903	137	2,411	819	14,405
S.D. Tower (km)	116	1,527	180	2,372	259	3,419	159	2,099	126	1,663	840	11,080
TDMA-RCS (Base)	6	1,320	9	1,980	7	1,540	5	1,100	6	1,320	33	7,260
TDMA-RCS (Rep)	7	717	14	1,434	4	409	4	409	3	308	32	3,277
TDMA-RCS (Sub)	552	2,284	916	3,788	663	2,741	554	2,292	564	2,332	3,249	13,437
Tower (Base)	0	0	1	70	4	277	5	348	4	277	14	972
Tower (Rep)	5	145	9	260	4	114	4	114	3	88	25	721
Tower (Sub)	552	972	916	1,610	663	1,166	554	977	564	994	3,249	5,719
Sub Total		7,946		13,313		16,706		12,271		9,578		59,814
Eng. Cost		634		1,047		1,615		1,210		836		5,342
	Sub		Sub		Sub		Sub		Sub		Sub	
G. TOTAL	1,986	13,345	3,867	22,015	11,959	33,932	9,485	25,435	4,049	17,169	31,346	111,896
Cost/Sub		6.73		5.68		2.82		2.68		4.22		3.57

Table 5-5-2 (2/2) Construction Cost of Sample Area

Unit: Million Rp

KABPATEN Item / Work Item or Classification	HULU SEI SELATAN Q'ty	HULU SEI SELATAN Cost	HULU SEI TENGAH Q'ty	HULU SEI TENGAH Cost	SINJAI Q'ty	SINJAI Cost	PANGKAJENE KEPULAUAN Q'ty	PANGKAJENE KEPULAUAN Cost	MALUKU TENGAH Q'ty	MALUKU TENGAH Cost	S. Total Q'ty	S. Total Cost
SW (LU/EX)	800/1	510	1800/1	827	1300/1	695	1600/1	774	2200/7	1,556	7700/11	4,362
RSU (Lu/EX)	600/1	405	0	0	0	0	0	0	3200/3	1,822	3800/4	2,227
RI.C (LU/LC)	0	0	0	0	700/2	509	300/1	882	1900/6	1,396	2900/9	2,127
Sub Total		915		827		1,204		996		4,774		8,716
T. cable (km)	0	0	0	0	0	0	0	0	0	0	0	0
PCM (Case)	0	0	0	0	0	0	0	0	0	0	0	0
PCM (Rep)	0	0	0	0	0	0	0	0	0	0	0	0
PCM (Max)	0	0	0	0	0	0	0	0	0	0	0	0
Radio Link	1	272	0	0	3	983	1	272	21	7,005	26	8,532
Tower	2	138	0	0	4	207	2	138	22	1,520	30	2,003
SKB	0	0	0	0	0	0	0	0	6	2,640	6	2,640
Sub Total		410		0		1,190		410		11,165		13,175
D1 Cable (km)	1.5	66	1.5	66	0.8	35	1.2	53	0.7	31	5.7	751
Civil (km)	1.5	132	1.5	132	0.8	70	1.2	106	0.7	62	5.7	502
D2 Cable (km)	64.0	1,078	68.0	1,201	25.5	440	28.0	486	88.0	1,439	267.5	4,644
S.D. (wire)	62.5	825	92.5	1,221	78.0	1,030	97.0	1,280	429.0	5,663	759.0	10,019
TDMA-RCS (Base)	2	440	4	880	4	880	5	1,100	27	5,940	42	9,240
TDMA-RCS (Rep)	5	513	3	308	4	410	6	615	50	5,126	68	6,972
TDMA-RCS (Sub)	182	753	357	1,477	392	1,621	550	2,275	2,479	10,253	3,960	16,379
Tower (Base)	0	0	1	69	0	0	0	0	6	414	7	483
Tower (Rep)	5	143	3	86	5	143	6	172	37	1,058	56	1,602
Tower (Sub)	182	320	357	628	392	690	550	968	2,479	4,363	3,960	6,969
Sub Total		4,270		6,068		5,319		7,055		34,349		57,061
Eng. Cost		280		345		386		423		2,514		3,943
	Sub		Sub		Sub		Sub		Sub		Sub	
G. TOTAL	1,293	5,875	1,702	7,240	1,288	8,099	1,529	8,884	5,070	52,802	10,882	82,895
Cost/Sub		4.54		4.25		6.29		5.81		10.41		7.62

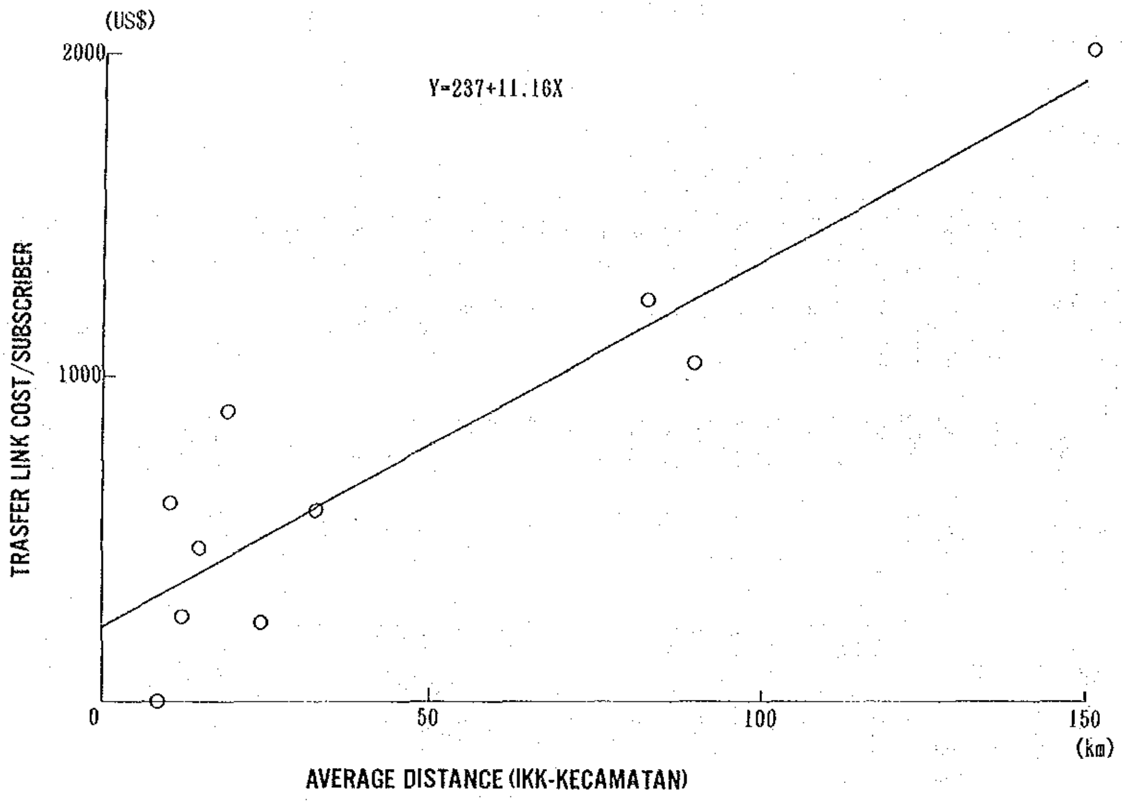


Figure 5-5-11 Initial Cost of Transfer Link

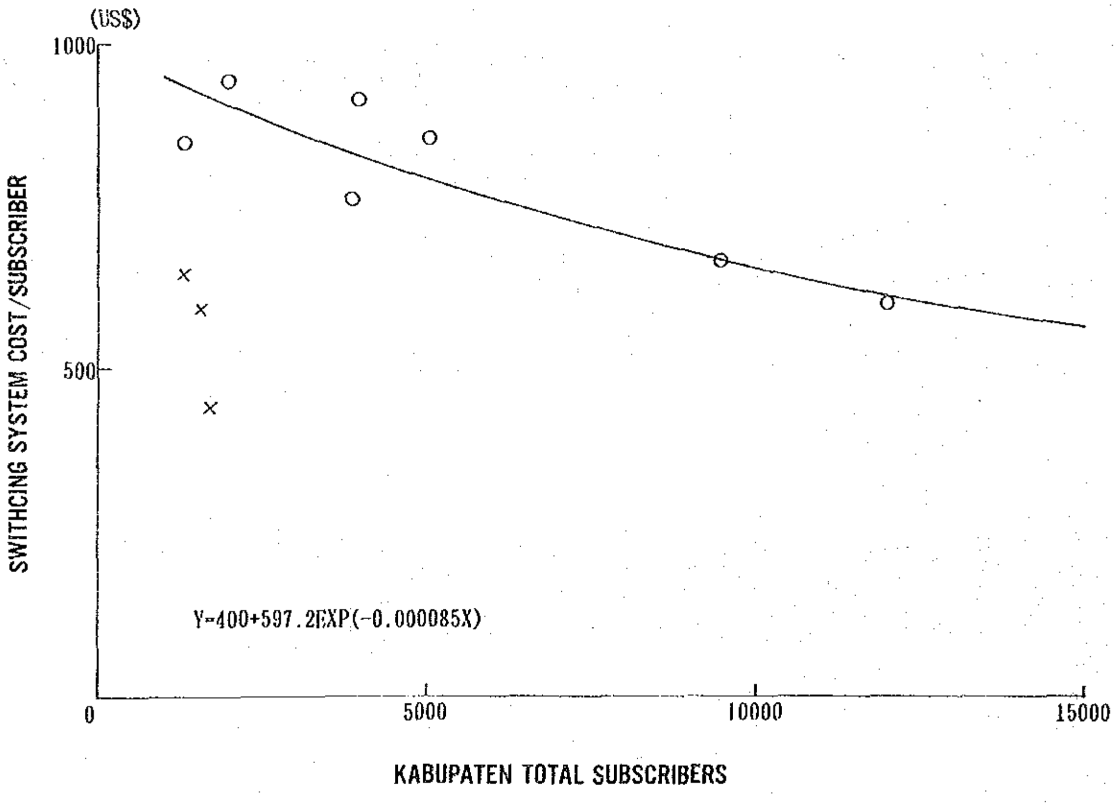


Figure 5-5-12 Initial Cost of Switching System

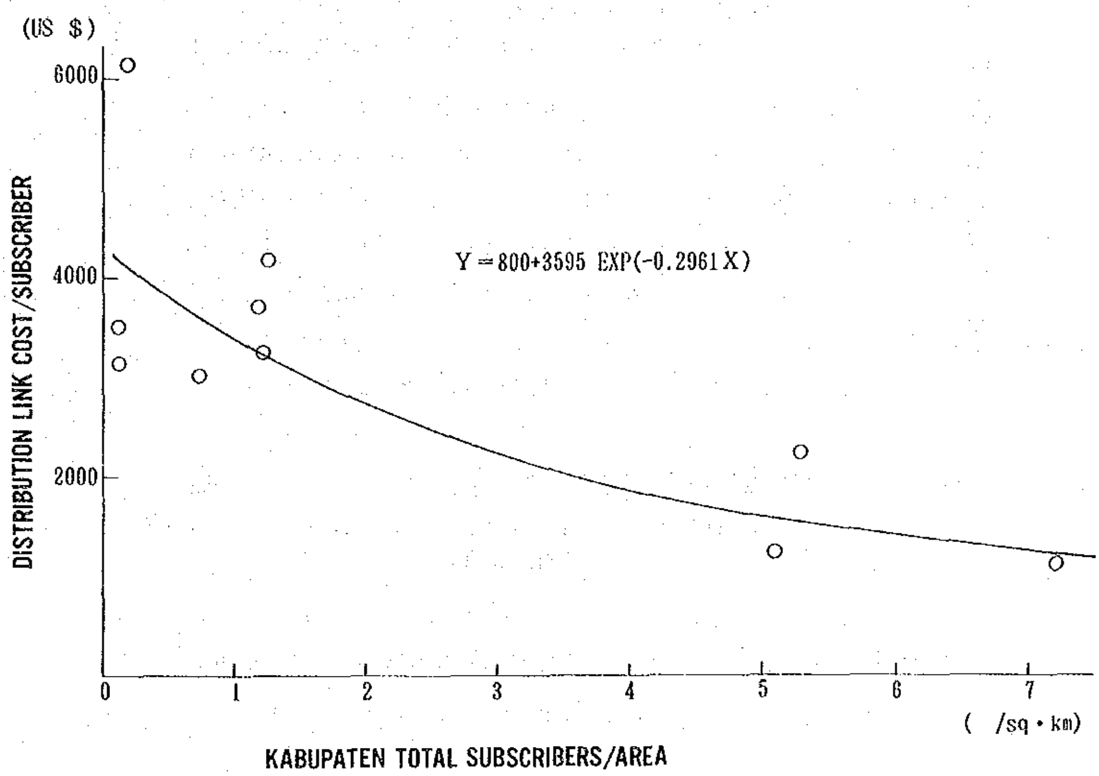


Figure 5-5-13 Initial Cost of Local Distribution Link

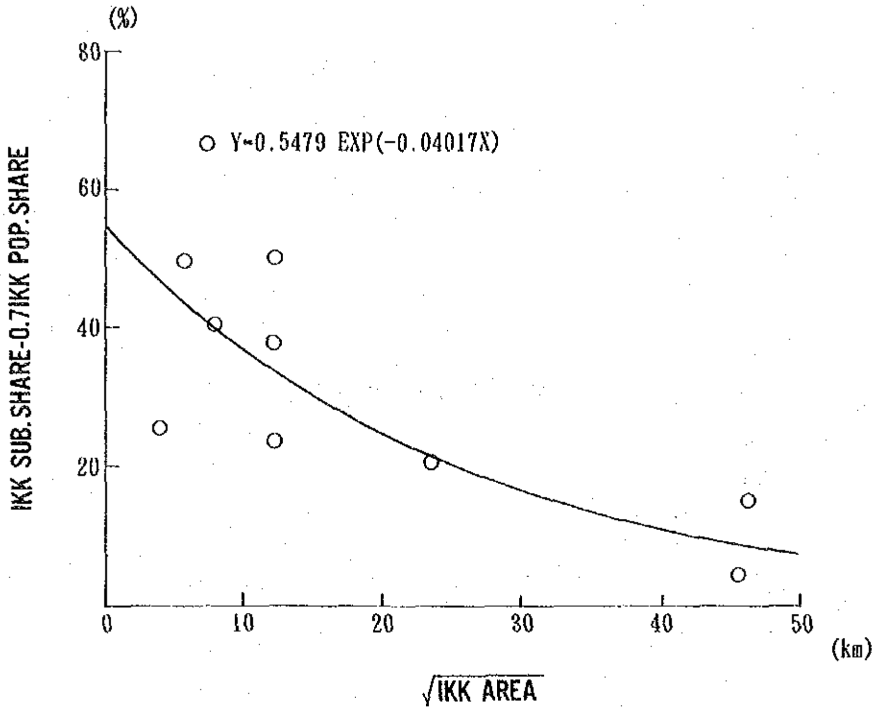


Figure 5-5-14 Subscriber Share in I.K.K.

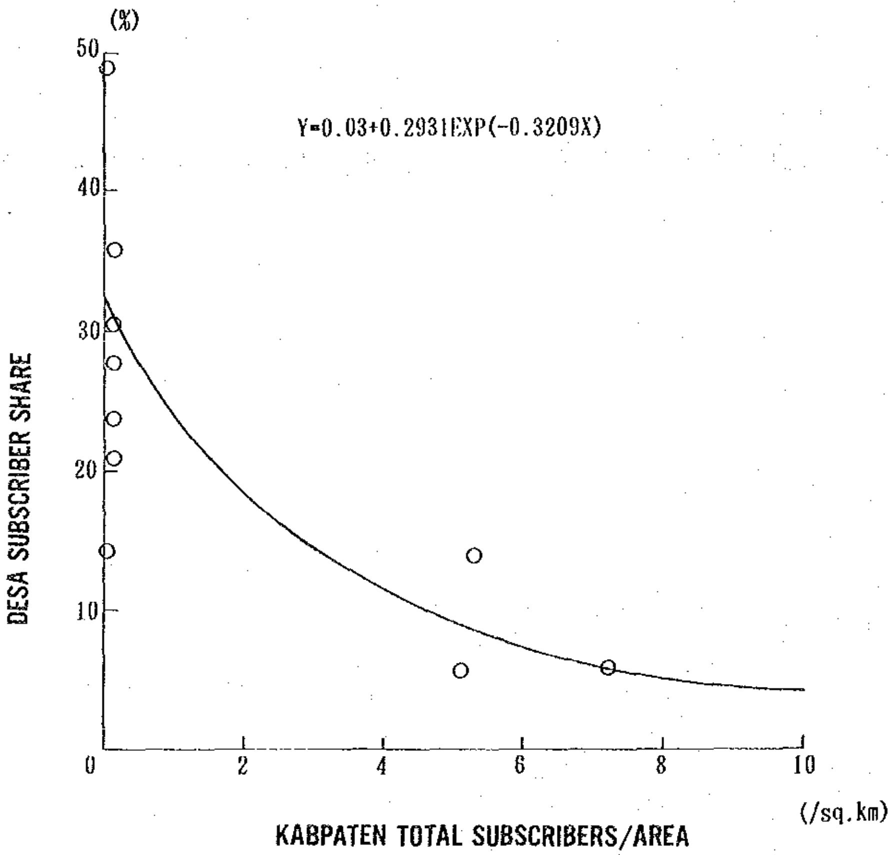


Figure 5-5-15 Subscriber Share in Desa

5-5-3 Initial Investment in Each Kabupaten

(1) Demand Share in IKK/Kecamatan/Desa

For all 246 Kabupaten, the demand share in IKK/Kecamatan/Desa was estimated using the regression model. Figure 5-5-16 shows the island total of demand share. The demand share in IKK (Kabupaten capital) is high in Jawa and is low in Kalimantan. The demand share in Desa is low in Jawa and high in Maluku, Irian Jaya.

The total demand in whole Indonesia is shared in IKK, Kecamatan and Desa as follows:

IKK Demand Share 42%
Kecamatan Demand Share 44%
Desa Demand Share 14%

(2) Initial Investment in Each Kabupaten

For all 246 Kabupaten, the initial investment in each Kabupaten was estimated using the regression model described before. Figure 5-5-17 shows the island total of initial investment for IKK, Kecamatan capital and Desa. The cost for IKK is low and the cost for Desa is high in all islands.

The estimation result of initial investment in each Kabupaten is shown in ANNEX 5-5-22.

For whole Indonesia, the demand share in IKK, Kecamatan capital and Desa, and the initial investment is shown in Figure 5-5-18.

1) Using only 13% of the total cost, it is possible to meet demand in Kabupaten capital representing 42% of the total number of telephone installations.

2) Although 57% of the total cost would be required in order to extend the network coverage are to the Kecamatan level, this would raise the percentage of telephone installations to 86% of demand.

3) The investment efficiency rate resulting, if the network coverage area were extended to the Desa level, is extremely low compared with that for the Kecamatan level.

(3) Initial Cost Scale by Kabupaten

The distribution of the scale of initial cost for each Kabupaten is described in Figure 5-5-19. The majority of Kabupaten (54%) have initial costs lying in the 4-20 billion Rp. range. 41 Kabupaten, or 17% of the total, have initial costs exceeding 40 billion Rp. If construction is implemented collectively in the Kabupaten which have high initial costs, the major portion of the construction investment sum for the given fiscal year will be used for a small number of Kabupaten, and this would be undesirable from the standpoint of achieving a nationwide balance. For this reason, it would be best to distribute construction in Kabupaten with large-scale initial costs over a longer time span.

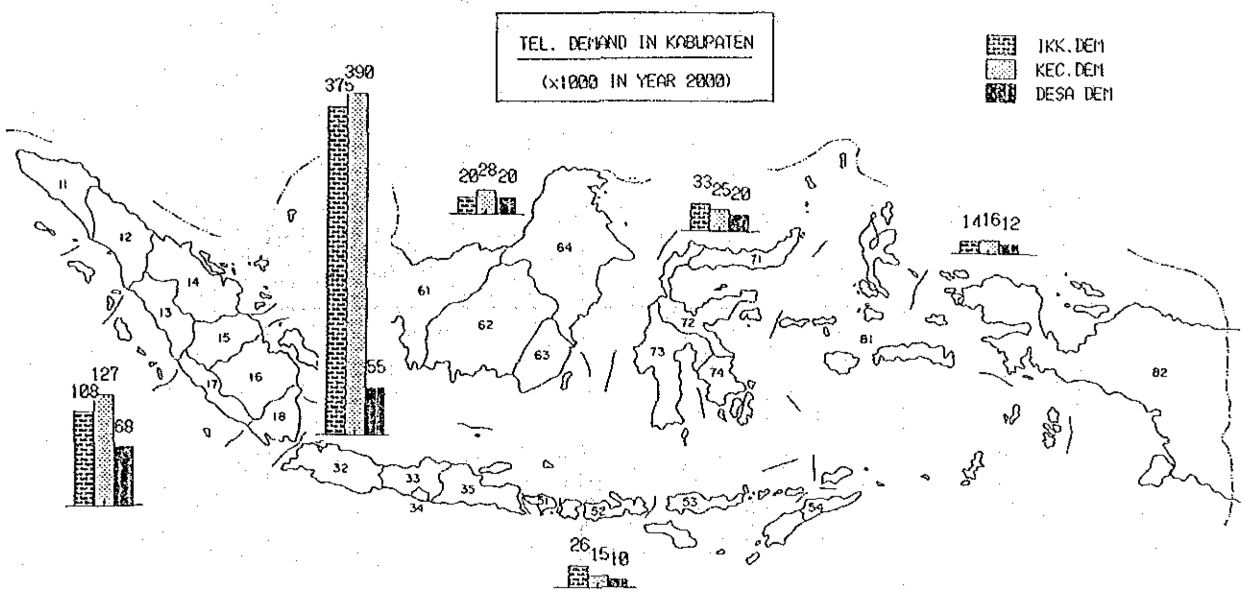


Figure 5-5-16 Telephone Demand Share by Island

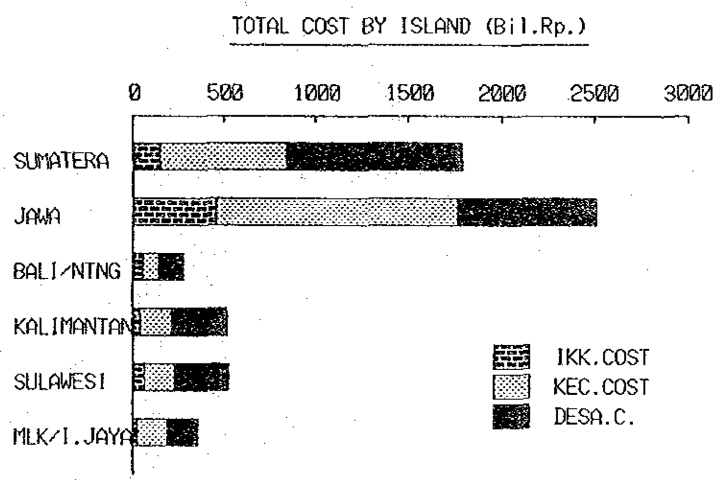


Figure 5-5-17 Total Cost by Island

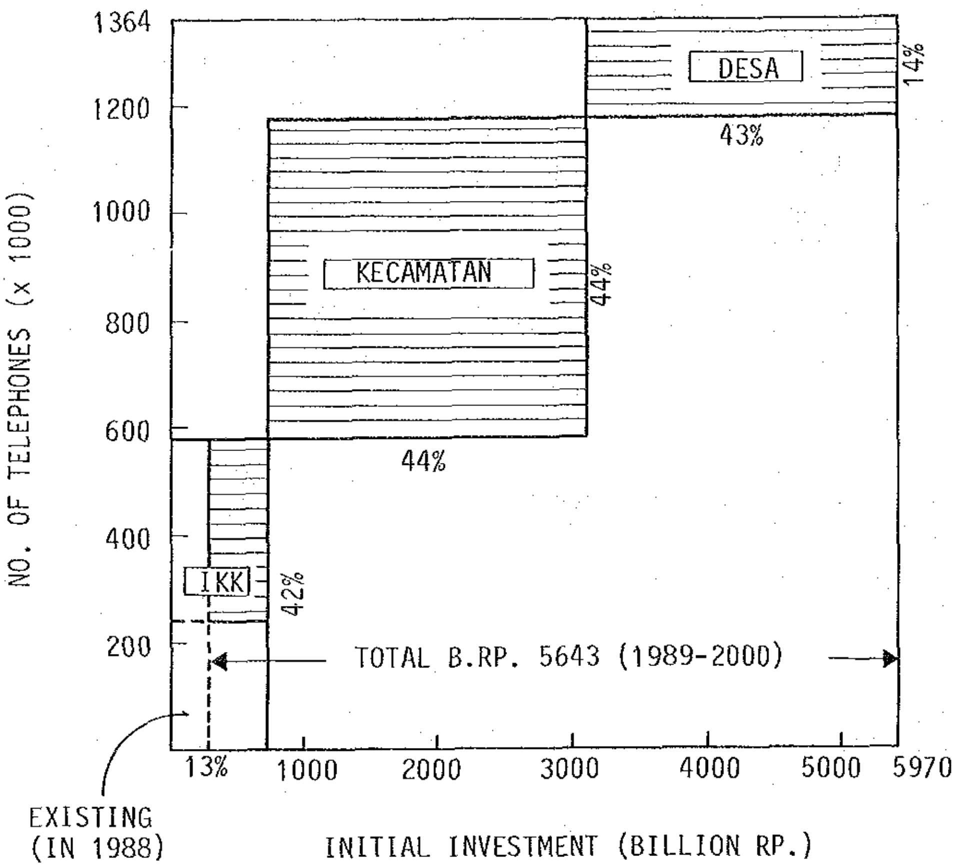


Figure 5-5-18 Demand Share and Initial Investment for Whole Indonesia

(4) Initial Investment in Each Province

Table 5-5-3 (1/3) through Table 5-5-3 (3/3) show the total investment by province.

As refered to in Paragraph 5-1, close propinquity is noticed between area scale of Kabupaten and that of Kecamatan. On the other hand, local distribution link and transfer link cost occupies 81% of total investment required for rural telecommunications network. This cost increases in proportion to distance from main exchange to subscribers.

From these facts, investment in rural telecommunications system can be safely assumed to hold relationships to average subscriber density in a network.

Note:

$$\text{Average Subscriber Density} = \frac{\text{Total No. of Subscribers}}{\text{Coverage Area of Network}}$$

Based on cost estimation result, the above relationships can be illustrated as in Figure 5-5-20.

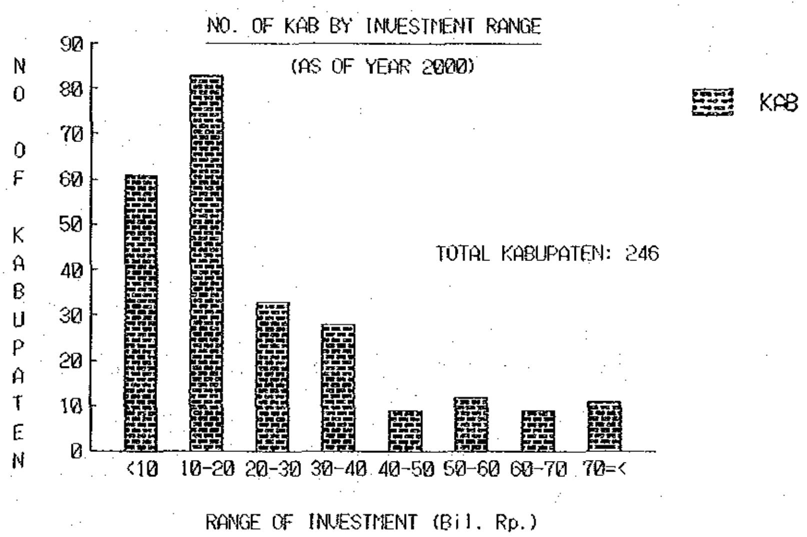
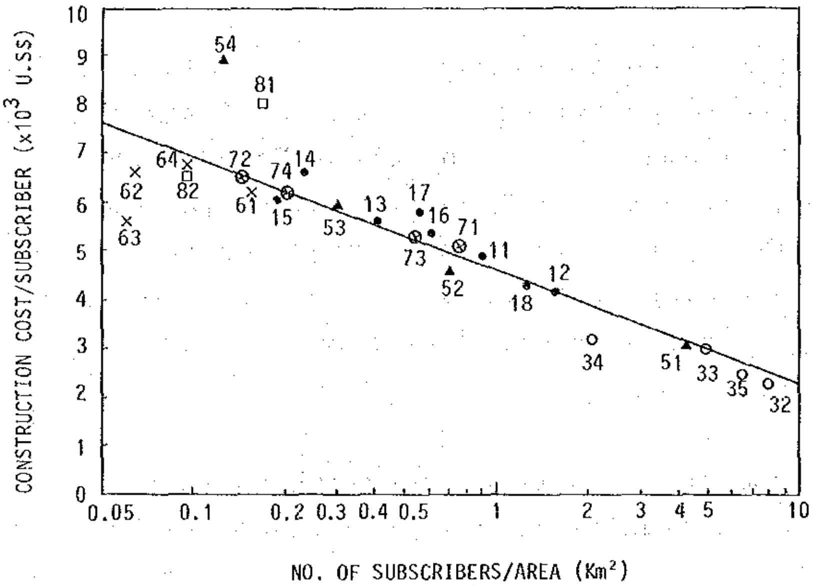


Figure 5-5-19 Initial Cost Scale Distribution



NOTE

SUMATERA

11 D.I. ACHE
12 SUMATERA UTARA
13 SUMATERA BARAT
14 RIAU
15 JAMBI
16 SUMATERA SELATAN
17 BENGKULU
18 LAMPUNG

JAWA

32 JAWA BARAT
33 JAWA TENGAH
34 D.I. YOGYAKARTA
35 JAWA TIMUR

NUSA TENGGARA

51 BALI
52 NUSA TENGGARA BARAT
53 NUSA TENGGARA TIMUR
54 TIMOR TIMUR

KALIMANTAN

61 KALIMANTAN BARAT
62 KALIMANTAN TENGAH
63 KALIMANTAN SELATAN
64 KALIMANTAN TIMUR

SULAWESI

71 SULAWESI UTARA
72 SULAWESI TENGAH
73 SULAWESI SELATAN
74 SULAWESI TENGGARA

MALUKU & IRIAN JAYA

81 MALUKU
82 IRIAN JAYA

Figure 5-5-20 Telephone Density and Cost per Sub. by Province

Table 5-5-3 (1/3) Initial Investment in Each Province

FILE:COSTPROR (IR 46) R1:48 (R9:34)
DEMAND & COST ESTIMATE (85/10/15)

(¥ = Rp.4.4, U.S.$ = Rp.1.100)

1	2	3	4	5	6	7	8	9	10	11	12	13
CODE	NAME (PROP.ISLAND)	IKK.AREA km2 1980	TTL.AREA km2 1980	TTL.POP (2000)	TTL.DEM (2000)	DEM/AREA (/sq.km)	DIST.TO KEC.(km)	TR.C/SUB (Mil.Rp)	SW.C/SUB (Mil.Rp)	DB.C/SUB (Mil.Rp)	ENG.C/SUB (Mil.Rp)	TTL.C/SUB (Mil.Rp)
1100	D.I. ACEH	1800	46236	4192270	41646	0.901	44.0	0.779	0.800	3.538	0.256	5.372
1200	SUMATERA UTARA	3520	64663	10040623	98923	1.530	33.9	0.705	0.690	3.020	0.221	4.635
1300	SUMATERA BARAT	2618	42077	3434250	17517	0.416	33.1	0.682	0.982	4.224	0.294	6.182
1400	RIAU	4626	94499	3474654	22404	0.237	104.0	1.506	0.868	4.495	0.343	7.213
1500	JAMBI	10166	53300	2446007	10376	0.195	46.2	0.857	0.988	4.589	0.322	6.755
1600	SUMATERA SELATAN	7289	101317	6853201	62118	0.613	50.1	0.873	0.742	4.014	0.281	5.910
1700	BENGKULU	1670	10035	1481662	5620	0.560	53.7	0.881	0.997	4.163	0.302	6.343
1800	LAMPUNG	582	34805	11806464	44362	1.275	44.5	0.775	0.615	3.130	0.226	4.747
3200	JAWA BARAT	1662	45489	37957684	361764	7.953	21.5	0.529	0.567	1.280	0.119	2.496
3300	JAWA TENGAH	1624	34652	29115575	164906	4.759	16.5	0.479	0.824	1.791	0.155	3.248
3400	D.I. YOGYAKARTA	158	7987	3230738	16165	2.024	11.7	0.401	0.895	2.108	0.170	3.575
3500	JAWA TIMUR	1550	42932	32374832	278450	6.486	19.5	0.518	0.691	1.447	0.133	2.789
5100	BALI	711	4829	3303300	20701	4.287	14.6	0.453	0.934	1.908	0.165	3.460
5200	NUSA TENGGARA BARAT	1634	20160	4074100	14480	0.718	22.1	0.513	0.953	3.395	0.243	5.103
5300	NUSA TENGGARA TIMUR	1496	47142	4145701	14150	0.300	33.6	0.710	1.023	4.463	0.310	6.505
5400	TIMOR TIMUR	4218	15708	866300	1938	0.123	20.1	0.762	1.632	6.972	0.468	9.834
6100	KALIMANTAN BARAT	5554	149057	3465981	22592	0.152	75.0	1.030	0.874	4.556	0.323	6.784
6200	KALIMANTAN TENGAH	16817	157450	1695180	10251	0.065	62.1	1.120	1.007	4.739	0.343	7.209
6300	KELIMANTAN SELATAN	7826	265100	2828789	16020	0.060	28.6	0.639	0.984	4.232	0.293	6.148
6400	KALIMANTAN TIMUR	9788	197767	1479730	18828	0.095	86.2	1.601	0.768	4.697	0.353	7.420
7100	SULAWESI UTARA	591	27439	2850385	20791	0.758	59.3	0.844	0.811	3.640	0.265	5.559
7200	SULAWESI TENGAH	2245	67766	2533200	9838	0.145	75.6	1.214	0.944	4.644	0.340	7.142
7300	SULAWESI SELATAN	6883	73762	7257155	40152	0.544	28.8	0.632	0.964	3.945	0.277	5.818
7400	SULAWESI TENGGARA	3571	38139	1660100	7758	0.203	51.7	0.928	0.989	4.574	0.325	6.816
8100	MALUKU	3586	76490	2028263	13132	0.172	205.2	2.832	0.900	4.615	0.417	8.765
8200	IRIAN JAYA	25416	303116	2090900	28660	0.095	148.1	1.898	0.874	4.191	0.348	7.311

CODE	NAME (PROP.ISLAND)	IKK.AREA km2 1980	TTL.AREA km2 1980	TTL.POP (2000)	TTL.DEM (2000)	DEM/AREA (/sq.km)	DIST.TO KEC.(km)	TR.C/SUB (Mil.Rp)	SW.C/SUB (Mil.Rp)	DB.C/SUB (Mil.Rp)	ENG.C/SUB (Mil.Rp)	TTL.C/SUB (Mil.Rp)
1000	SUMATERA	32271	446932	43729131	302966	0.678	47.8	0.826	0.751	3.565	0.257	5.399
3000	JAWA	4994	131060	102678829	821285	6.266	18.6	0.513	0.667	1.456	0.132	2.768
5000	BALI.NUSA TENGGARA	8059	87839	12389401	51269	0.584	23.4	0.553	0.990	3.224	0.238	5.006
6000	KALIMANTAN	39985	769374	9469680	67691	0.088	57.6	1.110	0.891	4.546	0.327	6.875
7000	SULAWESI	13290	207106	14300840	78539	0.379	40.9	0.790	0.923	4.014	0.286	6.014
8000	MALUKU.IRIAN JAYA	29002	379606	4119163	41792	0.110	165.7	2.191	0.882	4.324	0.370	7.768
	TOTAL (INDONESIA)	127601	2021917	186687044	1363542	0.674	40.6	0.681	0.730	2.379	0.190	3.980

Table 5-5-3 (2/3) Initial Investment in Each Province

FILE:COSTPROR (IR 46) R1:48 (R9:34)
DEMAND & COST ESTIMATE (85/10/15)

(¥ = Rp.4.4. U.S.$ = Rp.1,100)

CODE	NAME (PROP.ISLAND)	TR.C.TTL (Mil.Rp)	SW.C.TTL (Mil.Rp)	DB.C.TTL (Mil.Rp)	ENG.C.TTL (Mil.Rp)	TTL.COST (Mil.Rp)	IKK.COST (Mil.Rp)	KEC.COST (Mil.Rp)	DESA.COST (Mil.Rp)	IKK.C/SUB (Mil.Rp)	DESA.C/S (Mil.Rp)
1100	D.I. ACEH	32445	33311	147325	10654	223735	24897	82477	116360	1.330	12.633
1200	SUMATERA UTARA	69725	68277	298704	21835	458542	44255	190389	223898	1.156	12.467
1300	SUMATERA BARAT	11953	17194	73994	5157	108297	13271	32980	62047	1.963	12.902
1400	RIAU	33748	19448	100712	7695	161604	11263	63817	86524	1.719	13.049
1500	JAMBI	8891	10249	47615	3338	70092	5671	23127	41295	2.150	13.117
1600	SUMATERA SELATAN	54199	46069	249364	17482	367113	25088	137426	204600	1.460	12.768
1700	BENGKULU	4949	5604	23395	1697	35645	4708	11509	19428	1.994	12.824
1800	LAMPUNG	34391	27305	138843	10027	210565	16358	89341	104867	1.033	12.473
3200	JAWA BARAT	191511	205293	463115	42996	902916	153105	504435	245375	0.954	12.193
3300	JAWA TENGAH	79015	135809	295349	25509	535682	105210	248316	182156	1.333	12.216
3400	D.I. YOGYAKARTA	6478	14474	34080	2752	57784	11854	22270	23660	1.538	12.567
3500	JAWA TIMUR	144240	192505	402889	36982	776615	142083	408123	226410	1.108	12.215
5100	BALI	9388	19332	39500	3411	71632	19057	27431	25143	1.569	12.226
5200	NUSA TENGGARA BARAT	7426	13794	49153	3519	73892	12282	23268	38342	1.723	12.607
5300	NUSA TENGGARA TIMUR	10041	14474	63148	4383	92046	13099	24909	54038	2.102	13.018
5400	TIMOR TIMUR	1476	3163	13511	908	19058	2432	8763	7864	2.448	13.169
6100	KALIMANTAN BARAT	23278	19747	102934	7298	153257	10796	53445	89016	1.738	13.098
6200	KALIMANTAN TENGAH	11484	10321	48578	3519	73903	6299	24781	42822	2.124	13.244
6300	KELIMANTAN SELATAN	10235	15761	67805	4690	98491	12231	29334	56926	1.990	12.912
6400	KALIMANTAN TIMUR	30146	14466	88439	6653	139704	7123	54979	77601	1.628	13.207
7100	SULAWESI UTARA	17556	16854	75673	5504	115587	11932	43277	60378	1.448	12.680
7200	SULAWESI TENGAH	11941	9289	45692	3346	70267	6257	24150	39860	1.897	13.161
7300	SULAWESI SELATAN	25383	38694	158418	11125	233620	34374	69929	129317	1.854	12.750
7400	SULAWESI TENGGARA	7201	7676	35483	2518	52878	5940	16214	30724	1.998	13.105
8100	MALUKU	37187	11824	60610	5481	115102	7315	55079	52709	1.667	13.137
8200	IRIAN JAYA	54390	25044	120113	9977	209524	16339	92364	100821	1.690	12.932

CODE	NAME (PROP.ISLAND)	TR.C.TTL (Mil.Rp)	SW.C.TTL (Mil.Rp)	DB.C.TTL (Mil.Rp)	ENG.C.TTL (Mil.Rp)	TTL.COST (Mil.Rp)	IKK.COST (Mil.Rp)	KEC.COST (Mil.Rp)	DESA.COST (Mil.Rp)	IKK.C/SUB (Mil.Rp)	DESA.C/S (Mil.Rp)
1000	SUMATERA	250300	227456	1079951	77885	1635593	145510	631064	859018	1.343	12.687
3000	JAWA	421245	548081	1195433	108238	2272997	412251	1183143	677602	1.098	12.219
5000	BALI.NUSA TENGGARA	28332	50763	165313	12220	256628	46870	84371	125387	1.769	12.735
6000	KALIMANTAN	75144	60295	307756	22160	465354	36449	162539	266366	1.850	13.113
7000	SULAWESI	62080	72513	315267	22493	472353	58502	153571	260280	1.770	12.836
8000	MALUKU.IRIAN JAYA	91577	36868	180723	15458	324626	23653	147442	153530	1.683	13.002
	TOTAL (INDONESIA)	928677	995977	3244442	258455	5427551	723237	2362132	2342183	1.253	12.633

Table 5-5-3 (3/3) Initial Investment in Each Province

FILE:COSTPROR (IR 46) R1:48 (R9:34)
DEMAND & COST ESTIMATE (85/10/15)

(¥ = Rp.4.4, U.S.$ = Rp.1.100)

CODE	NAME (PROP.ISLAND)	IKK.SHARE	KEC.SHARE	DESA.SHARE	IKK.DEM	KEC.DEM	DESA.DEM	IKK.POP (1980)	TTL.POP (1980)	IKK.POP SHARE	IKK.POP (2000)	IKKD.DENS /100.2000	TTLD.DENS /100.2000
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1100	D.I. ACEH	0.449	0.329	0.221	18720	13715	9211	268344	2477514	0.108	455234	4.11	0.99
1200	SUMATERA UTARA	0.387	0.431	0.182	38282	42681	17960	805770	6509317	0.124	1255849	3.05	0.99
1300	SUMATERA BARAT	0.386	0.340	0.275	6759	5948	4809	319221	2696344	0.118	405901	1.67	0.51
1400	RIAU	0.292	0.412	0.296	6551	9222	6631	294831	1976697	0.149	512382	1.28	0.64
1500	JAMBI	0.254	0.442	0.303	2638	4590	3148	273916	1214430	0.226	545054	0.48	0.42
1600	SUMATERA SELATAN	0.277	0.465	0.258	17181	28913	16024	551850	3742882	0.147	1013484	1.70	0.91
1700	BENGKULU	0.420	0.310	0.270	2362	1743	1515	195673	693255	0.282	420083	0.56	0.38
1800	LAMPUNG	0.357	0.453	0.190	15838	20117	8408	213187	4048679	0.053	618059	2.56	0.38
3200	JAWA BARAT	0.443	0.501	0.056	160440	181200	20124	2400027	25974799	0.092	3515619	4.56	0.95
3300	JAWA TENGAH	0.479	0.431	0.090	78936	71059	14911	2339243	23393901	0.100	2925446	2.70	0.57
3400	D.I. YOGYAKARTA	0.477	0.407	0.116	7706	6576	1883	196184	2851936	0.069	230042	3.35	0.50
3500	JAWA TIMUR	0.461	0.473	0.067	128261	131653	18536	2031104	26018905	0.078	2514928	5.10	0.86
5100	BALI	0.587	0.314	0.099	12143	6502	2057	689650	2469724	0.279	946285	1.28	0.63
5200	NUSA TENGGARA BARAT	0.492	0.298	0.210	7130	4309	3041	590283	2723678	0.217	889033	0.80	0.36
5300	NUSA TENGGARA TIMUR	0.440	0.266	0.293	6232	3767	4151	318832	2733580	0.117	479690	1.30	0.34
5400	TIMOR TIMUR	0.513	0.179	0.308	993	348	597	193936	555350	0.349	304807	0.33	0.22
6100	KALIMANTAN BARAT	0.275	0.424	0.301	6213	9583	6796	271135	2114876	0.128	438042	1.42	0.65
6200	KALIMANTAN TENGAH	0.289	0.395	0.315	2965	4053	3233	170291	893819	0.191	330047	0.90	0.60
6300	KELIMANTAN SELATAN	0.384	0.341	0.275	6146	5466	4409	316614	1695194	0.187	534128	1.15	0.57
6400	KALIMANTAN TIMUR	0.232	0.456	0.312	4376	8576	5876	101865	672570	0.151	225042	1.94	1.27
7100	SULAWESI UTARA	0.396	0.375	0.229	8241	7788	4762	192161	1800597	0.107	305604	2.70	0.73
7200	SULAWESI TENGAH	0.335	0.357	0.308	3299	3511	3029	198666	1242943	0.160	409965	0.80	0.39
7300	SULAWESI SELATAN	0.462	0.286	0.253	18537	11473	10143	936070	5614684	0.167	1277069	1.45	0.55
7400	SULAWESI TENGGARA	0.383	0.315	0.302	2973	2441	2345	171794	903519	0.190	329928	0.90	0.47
8100	MALUKU	0.334	0.360	0.306	4389	4731	4012	167033	1314823	0.127	246611	1.78	0.65
8200	IRIAN JAYA	0.337	0.391	0.272	9667	11197	7796	281089	1097839	0.256	528962	1.83	1.37

CODE	NAME (PROP.ISLAND)	IKK.SHARE	KEC.SHARE	DESA.SHARE	IKK.DEM	KEC.DEM	DESA.DEM	IKK.POP (1980)	TTL.POP (1980)	IKK.POP SHARE	IKK.POP (2000)	IKKD.DENS /100.2000	TTLD.DENS /100.2000
1000	SUMATERA	#REF!	#REF!	#REF!	108330	126930	67706	2922792	23359118	0.125	5226047	2.07	#REF!
3000	JAWA	#REF!	#REF!	#REF!	375342	390488	55454	6966558	78239541	0.089	9186036	4.09	#REF!
5000	BALI,NUSA TENGGARA	#REF!	#REF!	#REF!	26498	14925	9846	1792701	8482332	0.211	2619815	1.01	#REF!
6000	KALIMANTAN	#REF!	#REF!	#REF!	19700	27678	20314	859905	5376459	0.160	1527260	1.29	#REF!
7000	SULAWESI	#REF!	#REF!	#REF!	33050	25212	20277	1498691	9561743	0.157	2322565	1.42	#REF!
8000	MALUKU,IRIAN JAYA	#REF!	#REF!	#REF!	14056	15927	11809	448122	2412662	0.186	775573	1.81	#REF!
	TOTAL (INDONESIA)	#REF!	#REF!	#REF!	576976	601160	185406	14488769	127431855	0.114	21657295	2.66	#REF!

5-5-4 Reduction of Initial Cost

The project's initial cost based on subsystem are in the following breakdown:

Local distribution link (cable)	18%	
Local distribution link (radio, TDMA-RCS)	45%	81%
Transfer link (cable and radio)	18%	
Switching system	19%	

Accordingly, a reduction in the cost of transmission links would contribute greatly to a reduction in overall project cost. Following three examples are recommended to be achieved for the initial cost reduction ways:

1) Common use of power distribution poles for telephone cables
2) Use of commercial power
3) Larg-volume simultaneous orders of one model of equipment

(1) Common Use of Power Distribution Poles for Telephone Cables

In a rural telecommunications network, aerial cables are used with great frequency. In this Project, construction of such cables represents 30% of the initial cost. It is estimated that half of the supporting poles for these aerial cables could be derived through common use with power line poles. By sharing these poles, it is expected that initial costs for the aerial cable system could be reduced by about 10%, considering payment of rental charge for common poles thereby realizing a reduction of 3% in overall Project cost. The breakdown of cost reduction is shown in Table 5-5-4.

Table 5-5-4 Cost Comparison for Common Poles

Item	Relative Cost Independend Poles	Common Poles
Installation of aerial cable	50	50
Construction of independent poles	50	-50
Reinforcement of common poles	0	10
Rental charge of common poles	0	20
Total	100	80

Overall cost reduction = (100 - 80) x 1/2 = 10 %

(Note: 1/2 means that 50% of poles can be commonly used.)

Table 5-5-5 shows the recommendable separation between electric power lines and telephone line based on the technical standard in Japan.

Table 5-5-5 Minimum Separation between Power Lines and Telephone Lines

(Unit: cm)

Electric Power Line / Telephone Line	Voltage						
	AC600V or less		AC600 - 7000V		More than AC7000V		
	Insulated Wire	Cable	Insulated Wire	Cable	Insulated Wire (A)	Insulated Wire (C)	Cable
Outside Wire SD Wire Cable	75	30	150	50	500	250	50

(2) Use of Commercial Power

For the purposes of this Study, initial costs were estimated based on the use of solar batteries as the power source for TDMA-RCS subscriber units. If, however, commercial power can be obtained for all subscribers, then it is expected that initial costs of the TDMA-RCS could be reduced by about 10%. PLN is now preceeding with development aimed at supplying commercial power to all Desa by the year 2000. Therefore, if construction of the TDMA-RCS is carried out first in those Desa receiving commercial power supply, the Project costs can be reduced by 4% overall.

(3) Large-Volume Simultaneous Orders of One Model Equipment

When ordering manufacture of telecommunications equipment, by ordering the same model in large quantities at one time it is possible to reduce the (unit) cost of equipment manufacture. Figure 5-5-21 shows the estimated rate of cost reduction which would be possible if this procedure were applied for the TDMA-RCS.

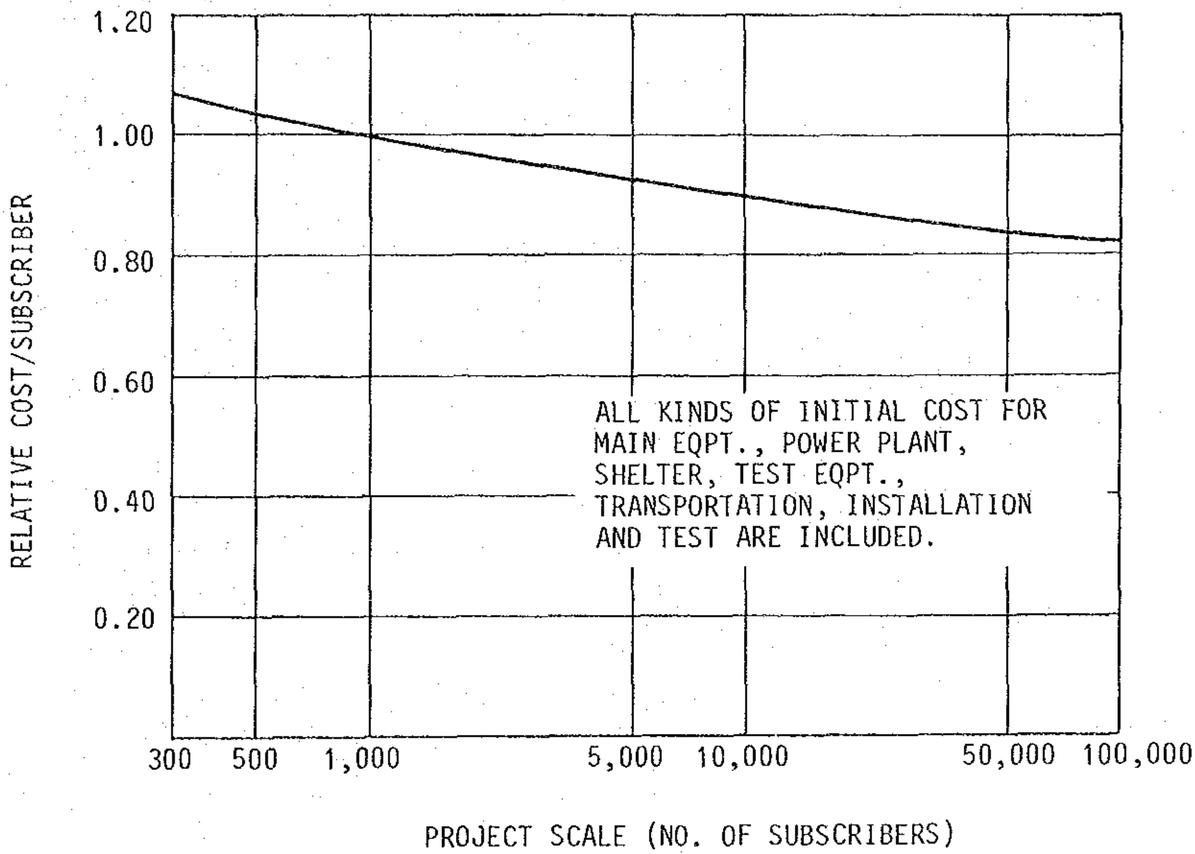


Figure 5-5- 21   Cost Reduction by Mass Production

CHAPTER 6 IMPLEMENTATION PROGRAM FOR RURAL TELECOMMUNICATIONS NETWORK IMPROVEMENT PLAN

CHAPTER 6. IMPLEMENTATION PROGRAM FOR RURAL TELECOMMUNICATIONS NETWORK IMPROVEMENT PLAN

6-1 Network Improvement Objectives

6-1-1 Planning Guidelines

Following are the guidelines whereby to fomulate the rural telecommunications network improvement plan:

(1) To what extent to improve demand fulfillment
(2) To what extent to expand network coverage
(3) To which area to extend service priority
(4) To which subscriber category to extend service priority

Further description of each guideline follows:

(1) Demand Fulfillment Rate
When demand is forecasted, the degree to which to fulfill forecasted demand must be determined. Decision depends upon PERUMTEL budget and Government policy toward telecommunication services. Decision must also be made in consideration of the foregoing guidelines (2) and (4).

Telephone supply and waiting applicants in the whole of Indonesia during 1975 through 1982 are as follows:

Table 6-1-1 Telephone Supply and Waiting Applicants

Year	No. of Telephones Supplied	No. of Waiting Applicants	Demand Fulfilled Rate (%)
1975	12,526	74,700	17
1976	12,372	85,700	14
1977	20,931	131,500	16
1978	35,949	119,500	30
1979	46,909	131,400	36
1980	47,728	143,200	33
1981	57,342	333,800	17
1982	48,774	524,400	9
Average	35,316	193,025	18

Average demand fulfillment rate of 18% as shown above indicates that as the number of supply increases, so does the demand also. Therefore, even if the forecasted demand up to 2000 is fulfilled 100%, further demand is expected on the waiting list as of 2000.

(2) Network coverage Range

Telecommunication network configuration based on administrative units is shown below.

Administrative Unit	Number	Telephone System	Number
National capital	1	Tertiary Center	7
Province capital	27	Secondary Center	33
Kabupaten capital	246	Primary Center	259
Kecamatan capital	3,420	Terminal exchange	
Desa About	65,000		

At present, in Indonesia, Primary Center is in general established in each Kabupaten capital. However, among Kabupaten capitals are those where manual service only is available. Master Plan herein prepared intends to make SLDD service available in all Desas also whereby to increase accessibility to telephone service. For telecommunication network expansion to lower level administration organization components than Kabupaten capitals, three methods are conceivable. They are:

i) To complete Kabupaten Capital - Kecamatan Capital - Desa network construction in one work phase.

ii) To complete network expansion in two work phases, i.e., Kabupaten capital - Kecamatan Capital network construction and further extension to Desa.

iii) To complete network expansion in three work phases, i.e., at Kabupaten Capital level, at Kecamatan Capital level and at Desa level.

Comparative study of these three methods arrives at the following conclusion:

Basic difference among the three network expansion methods consists in time gap in respect of work execution. In the case of i), on the assumption of ten year's project life, time gap of nine years arises between Kabupaten to have the work executed earliest and Kabupaten to have the work executed latest. In the case of iii), compared with i), Kabupaten by Kabupaten time gap in work execution can be reduced, and this is because the three phases of work are executed on equal basis. However, work cost ratio between i) and iii) is about 1 : 1.2 and this fact signifies that in iii), work cost increases by 20%. Reason is that work execution in three phases requires more time and labor than work execution in one phase. In the number of demand per Kabupaten, Jawa Island takes top place with 10,016 and Bali, Nusa tenggara takes bottom place with 1,315. Thus, for the latter where work volume is limited, work execution efficiency by iii) leaves room for doubt. Especially for the area where demand is small and which is remotely located, higher efficiency can be expected from wrok execution by i).

In terms of financial internal rate of return (FIRR), work execution in two phases commands advantage. In this case, FIRR stands at 7.1%. In Jawa, the number of Kabupatens, where work execution in three phases careates high FIRR, is large; in Kalimantan, a large number of Kabupatens follows suit with work execution in one phases; in Maluk and Irian Jaya, the same holds true when work execution is by one phase.

The reasons why the F.I.R.R differenciated among those three phase works, results in both the demand share and the cost share of each Kapupaten Capital, Kecamatan Capital and Desa.

One phase work produce the hightest F.I.R.R in Kabupaten which has the features that there are low cost share of Kabupaten capital and Desa, comparing with their covering demand shares. On the other hand, three phase work produce the hightest F.I.R.R in case of Kabupaten, covering lower demand share of Desa with higher cost share of Desa. (Refer to Table 6-1-3).

Table 6-1-2 Network Coverage Comparison (National Plan)

	Cost Ratio	Work Execution Feasibility	Impartiality (Equality) among Kabupaten	FIRR
i) Kabupaten-Kecamatan-Desa work in 1 phase	1.0	Simple	Inequal	6.1%
ii) Kabupaten-Kecamatan and Desa work in 2 phases	1.1	Complicated	Equal	7.1%
iii) Kabupaten, Kecamatan and Desa work in 3 phases	1.2	Most Complicated	Most Equal	6.0%

Table 6-1-3 Demand and Cost Share Comparison by Island

	Average Demand per Kabupaten	Demand Share %			Cost Share %		
		Kabupaten Capital	Kecamatan Capital	Desa	Kabupaten Capital	Kecamatan Capital	Desa
Sumatera	5,941	35.8	41.9	22.3	8.9	38.6	52.5
Jawa	10,016	45.7	47.5	6.8	18.1	52.1	29.8
Bali-Nusa	1,315	51.7	29.1	19.2	18.2	32.9	48.9
Kalimantan	2,418	29.1	40.9	30.0	7.9	34.9	57.2
Sulawesi	2,380	42.1	32.1	25.8	12.4	32.5	55.1
Maluk, Irian Jaya	3,215	33.6	38.1	28.3	7.3	45.4	47.3
All Indonesia	5,543	42.3	44.1	13.6	13.3	43.5	43.2

(3) Area Priority Ordering
For execution of telecommunication network improvement, area by area priority must be determined. For this purpose, evaluation criteria whereby to assess socio-economic contributions of each area are to be established. Procedural details are described in the following section.

(4) Subscriber Priority Ordering
Telephone subscribers are classified into the following categories:

i) Public Demand A
This category consists of demand from such sources as military, police and adminstrative organizations (including P.C.O.)

Public Demand B

This category consists of demand from social service facilities, such as post offices, medical institutions and schools.

ii) Industry Demand
This category consists of demand from such industrial sources as banks, hotels, mining and manufacturing industries, agriculture and commerce.

iii) Residence Demand
This category consists of demand from individuals with financial capability to bear necessary expenses.

Telephone diffusion rate and demand category shares by islands obtained from demand forecast by Kabupatens are illustrated below. When diffusion rate is replaced with time span, the result is as shown in Figure 6-1-1.

From the viewpoints of telephone role in each subscriber categories, public subsriber can provide their services to regional society by using telephone. Industrial subscriber can contribute regional economy by making profits with telephone use. Terefore, the subscriber priority ordering must be determined as follows.
Public subscriber-Industrial subscriber-Residential subscriber.

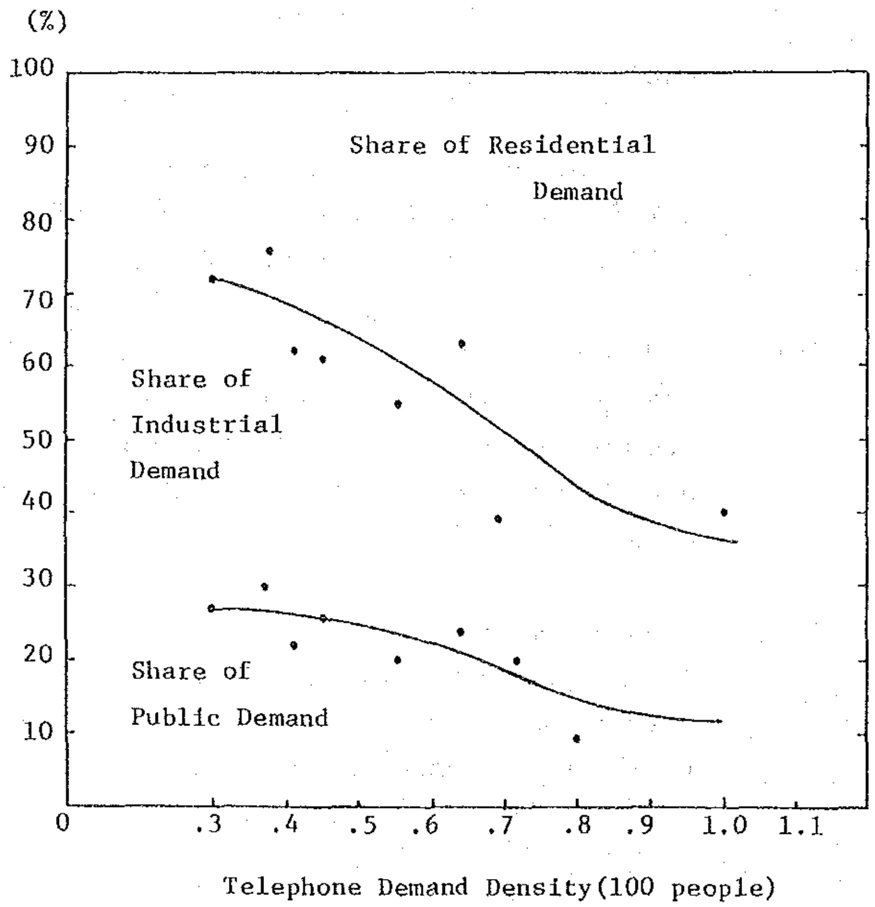


FIGURE 6-1-1 TELEPHONE DEMAND DENSITY AND SHARE OF SUBSCRIBER CATEGORIES

6-1-2 Establishing of Network Improvement Plan Objectives

(1) Planning Elements

In conformity with the spirit of "Equality" as the basic political guideline of the Republic of Indonesia, demand fulfillment priority is not to be established on Province basis. Instead, the network improvement work is to be commenced simultaneously for all Provinces, using Kabupaten as work unit. Network coverage and Kabupaten basis area priority for each Province are considered as deciding factors.

Work flow for network improvement plan is given in Figure 6-1-2. As the result of study by this work flow, decision is made to adopt the aforementioned method ii), i.e., work execution in two phases, wherein highest FIRR can be expected from the viewpoint of network coverage.

(2) Project Period

Project period is from April 1989 to March 2001, totaling 12 years. The year 1989 is the initial year of the forthcoming fifth five-year telecommunication network improvement.

(3) Contents of Service

Service to be supplied is only telephone which is completely automatized (SLDD).

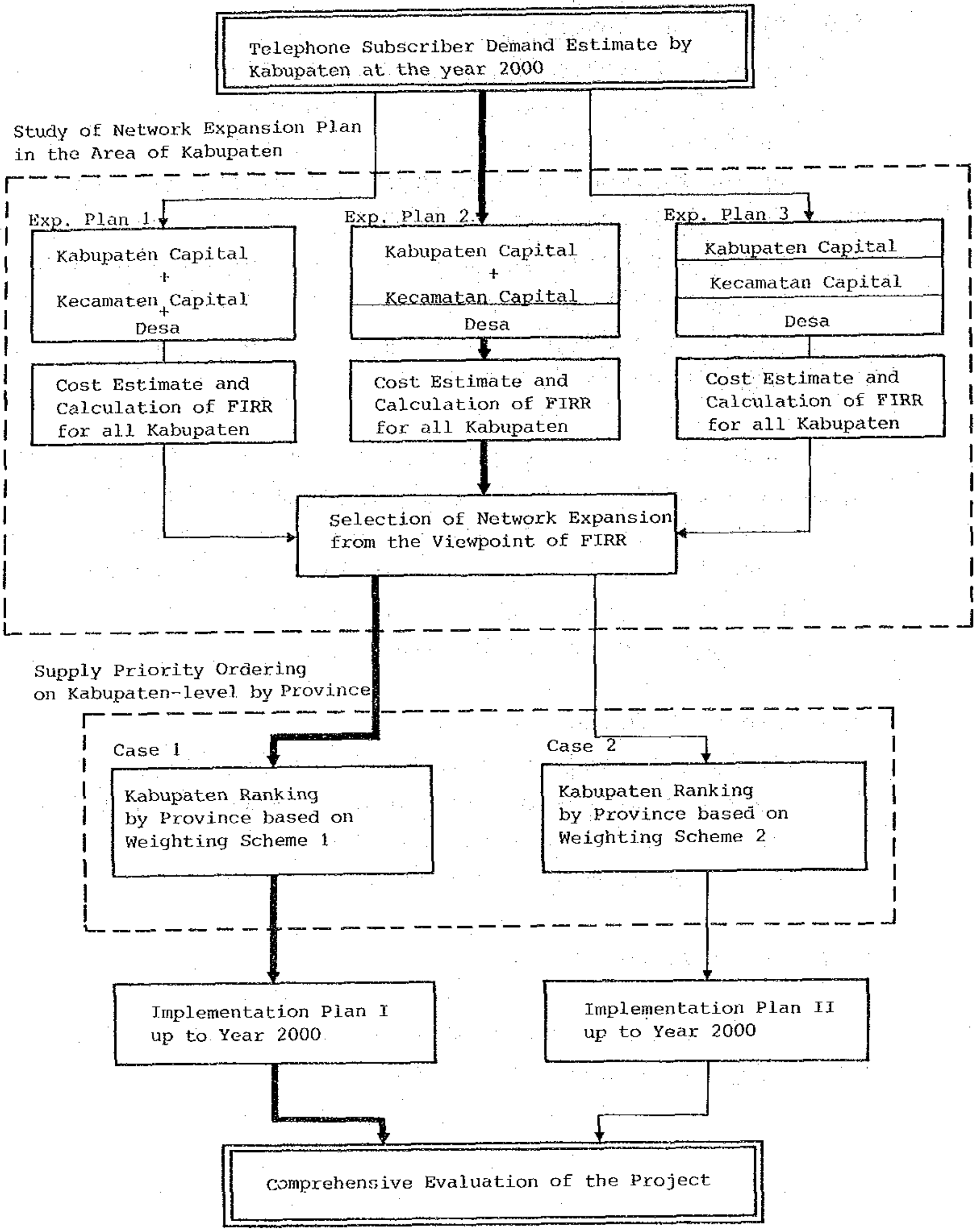


Figure 6-1-2 Flow Chart of Establishing of Improvement Plan

6-2 Area Priority Ordering

6-2-1 Preconditions

From the viewpoint of equality realization of development achievement, this project places emphasis on social impact and long term financial and economic benefits. In this respect, the project differs from the investment in such areas where short term financial internal rate of return is high, i.e., the kind of investment so far carried out.

For telephone network improvement, Kabupaten is to be the minimum priority unit. This is to confirm to the existing telephone network configuration where primary trunk center (PTC) is established in each Kabupaten and charging area coincides with Kabupaten.

6-2-2 Evaluation Criteria

In view of the significance of the project, social impact and long term financial internal rate of return are conceivable as priority area ordering criteria.

Social impact signifies that installation of telephones creates social and economic effects in the area concerned. Social impact as priority ordering criteria consists of the following two factors:

- Improtant area in regional development policy.

- Substitution effect and expansion effect resulting from introduction of telephones.

- Area where long term financial internal rate of return is high, signifies such area where construction cost is low and service revenue is at high level. Development work for rural area where service revenue is at lower level than in urban area, should begin with area where service revenue prospect looms relatively large so that revenue raised in such area can be used for development work in areas with poor service revenue prospect.

Priority area ordering criteria established, together with their contents, are introduced in table 6-2-1.

(1) Regional Development Policy

In PELITA IV now in progress, road development constitutes the main item of regional development. This is to eliminate isolated areas and to reduce time requirement for inter-area contact. Border area development assumes special importance. Areas where population density is expected to increase will be taken up as priority areas for development. Propinsi by Propinsi development plan in PELITA IV establishes several development areas, each composed of a plural number of Kabupatens and Kotamadyas, in each Propinsi and, for each such development area, growth pole and main industry sector to be developed are designated.
Furthermore, from the way the telepohones are used in industries, judgment is made that telephone needs are high in the order of tertiary, secondary and primary industries.

Table 6-2-1 Ordering Criteria for Area Priority Establishment

Orderging Criteria	Contents
A. Regional Development	
1) Geographical accessibility	Depending upon whether roads are through to all Kecamatans or not, areas are classified into Groups 2, 1 and 0.
2) Border area	Depending upon whether border area exists or not, areas are classified into Groups 1 and 0.
3) Industry to be developed	Depending upon whether industry to be developed is primary, secondary or tertiary sector, areas are classified into Groups 0, 1 and 2.
4) Regional potentiality	Area classification is by population density growth ratio during the period from 1984 to 2000. Ares with 80% or more growth ratio, Group 3; area with 40% or more growth ratio, Group 2; area with 20% or more growth ratio, Group 1; area with less than 20% growth ratio, Group 0.
B. Socio-Economic Effect	
1) Consumer's surplus	With Propinsi base subscriber demand estimation formula, estimation is made for consumer's surplus of telephone installation fee per subscriber. Total consumer surplus by Kabupaten is calculated by applying their respective subscriber demands.
2) Coverage population size to demand (supply)	On the assumption that Kabupaten base demand is fulfilled 100%, population size to be covered by one telephone is considered to be the effect.
C. Financial Internal Rate of Return (FIRR)	By FIRR in the case of work execution in two phases, rankings are made for all Kabupatens.

(2) Socio-Economic Effect

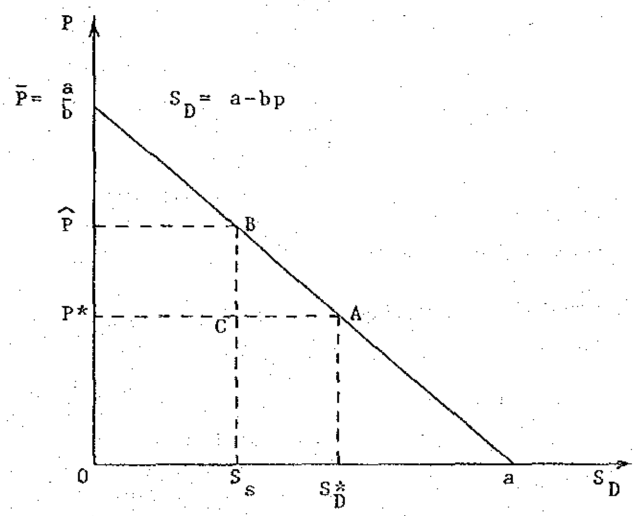
1) Consumer's Surplus

a) Theoretical Consideration

Assume that subscriber demand function in a certain area can be formularized as under.

$$S_D = a - bP \text{ .... } (1)$$

where S_D is the number of subscriber demand pursuant to P as subscription fee. The above formula (1) can be graphically presented as under.



Now, assume that subscription fee is P*. Then, S_D number of subscriber demand can be expected. In this case, the trapezoid,

$$0 - \frac{a}{b} - A - S_D^*,$$

stands for willingness to pay. This indicates the gross amount which S_D^* number of subscribers are willing to pay, at heart, for property called telephone subscription. On the other hand, B - S_s spacing (i.e., height of demand curve at the time the number of subscriber is S_s) represents reservation price, otherwise called marginal willingness to pay. This indicates the maximum amount which additional one subscriber to S_s (i.e., S_s + 1-st subscriber) is willing to pay when subscribing for telephone. In other words, when reservation price is higher (lower) than subscription fee to be actually paid, such additional one subscriber intends (does not intend) to subscribe for telephone service. That under subscription fee P*, S_D* number of subscriber demand can be expected signified that reservation price of S_D*-th subscriber is equal to subscription fee to be actually paid so that those having higher reservation price than his can be considered to be potential subscribers but those having lower reservation price than he cannot be considered as potential subscribers.

Suppose that at subscription fee P*, demand S_D* can be wholly fulfilled. Then, consumer's surplus forms the triangle,

$$P^* - \frac{a}{b} - A.$$

In other words, consumer's surplus = total willingness to pay (trapezoid:

$0 - \frac{a}{b}$ $A - S_D^*$) - amount to be actually paid by consumer (square: $0 - P^* - A - S_D^*$).

b) Estimation Result

Records show that in Indonesia, telephone service supply stands at a lower level than demand. This supply-demand relationship is indicated by S_S (supply volume) and S_D* (demand volume) in the previously introduced graphical illustration. Therefore, the realized consumer's surplus cannot be found elsewhere than the trapezoid,

$$P^* - \frac{a}{b} - B - C.$$

The remaining triangle CBA represents the unrealized consumer's surplus (i.e., opportunity loss of social benefit). To demonstrate this relationship, estimation was made for subscriber demand function, using Propinsi base data. The result obtained is:

$$DEM_t = A_t \ (N_t - S_{t-1}) \ \ldots \ (2)$$

where

DEM_t: Number of subscriber demand in the term t

$N_t - S_{t-1}$: Number of potential demand sources in the term t, i.e., population N_t in the term t minus the actual number of subscribers in the preceding term. This number is equal to the total number of persons who do not own telephones.

A_t: Adjustment coefficient. A_t% of the number of potential demand sources is the number of realized demand in the term t. A_t is an assumption to be established, based on subscription fee, GRDP per capita and telephone diffusion rate.

$$S_{Dt} = [0.000875 - \underset{(-3.170)}{0.000015\, P_t} + \underset{(2.000)}{0.000007\, \left(\frac{Y}{N}\right)_{t-1}}$$

$$+ \underset{(22.838)}{0.0013\, \left(\frac{S}{N}\right)_{t-1}}] \times [N_t - S_{t-1}] \quad \ldots\ldots\ldots (3)$$

R = 0.96

Figure in ( ) is t value.

where

Y: Real GRDP at 1975 constant price

N: Population

S: No. of Telephone Subscriber

P_t Real subscription fee at 1975 constant price in the period t

$\left(\frac{Y}{N}\right)_{t-1}$: Real GRDP per capita at 1975 constant price in the t-1 period

$\left(\frac{S}{N}\right)_{t-1}$: Telephone diffusion rate in the period t. This variable presents external effect of telephone service. That is to say, as the number of telephone owners increases, so does telephone demand.

S_{Dt} : Formula to obtain the number of subscribers in the period t is:

Annual increment in the number of automatic and manual exchange subscribers provided in PERUMTEL Annual Report + (New telephone applicants in Indonesia + Number of waiting subscribers) X Subscriber share of the Province concerned in Indonesia.

Data of new telephone applicants and Number of waiting subscribers is based on international model data.

By means of modification of the foregoing formula (3), the following reservation price formula can be obtained:

$$\hat{Pt} = \frac{0.000875}{0.000015} + \frac{0.000007}{0.000015} \left(\frac{Y}{N}\right)_{t-1} + \frac{0.0013}{0.000015} \left(\frac{S}{N}\right)_{t-1} - \frac{1}{0.000015} \times \frac{S_{D_t}}{N_t - S_{t-1}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

When S_{D_t} is substituted by actual supply volume in the period t, reservation price in the period t is produced. When simulation is made by extending GRDP per capita and subscription fee in Formula (3) by annual real growth rate per capita of 3%, the result as in Table 6-2-2 can be obtained.

Table 6-2-2 Consumer Surplus of Area Priority (Installation Fee)

Code	Province	- 1992 P 1000Rp	^ 1992 P 1000Rp	* 1992 P 1000Rp	(- * P- P)/2	CONSUMER SURPLUS 92 (1000 Rp)	CONSUMER SURPLUS 92 REALIZED	CONSUMER SURPLUS 92 NON-REALIZ	CONSUMER SURPLUS 92 REALIZ(%)	CONSUMER SURPLUS 92 NO-REA(%)
11	D.I. Aceh	783	501	87	348	2528122	1570547	957575	62.12	37.88
12	Sumatra Utara	1233	725	87	573	20709193	13755624	6953569	66.42	33.58
13	Sumatra Barat	647	407	83	282	1897409	1222685	674724	64.44	35.56
14	Riau	787	490	84	351	2210632	1418285	792348	64.16	35.84
15	Jambi	737	455	85	326	1355690	885322	470369	65.3	34.7
16	Sumatra Selatan	759	482	95	332	4302731	2732325	1570405	63.5	36.5
17	Bengkulu	449	208	108	170	206680	184473	22207	89.26	10.74
18	Lampung	637	488	92	272	3747832	1692185	2055647	45.15	54.85
31	Dki Jakarta	6081	2317	88	2996	361396044	302691640	58704404	83.76	16.24
32	Jawa Barat	619	396	92	263	14370596	9227427	5143169	64.21	35.79
33	Jawa Tengah	460	302	96	182	5724917	3747972	1976945	65.47	34.53
34	D.I. Yogyakarta	842	507	86	378	2756774	1830958	925816	66.42	33.58
35	Jawa Timur	777	477	94	342	23006682	15202092	7804590	66.08	33.92
51	Bali	1241	721	113	564	5276296	3610940	1665356	68.44	31.56
52	Nusa Tenggara Barat	308	212	95	106	236644	159070	77575	67.22	32.78
53	Nusa Tenggara Timur	384	253	100	142	421575	289245	132330	68.61	31.39
54	Timor Timur									
61	Kalimantan Barat	482	322	99	192	723728	459314	264414	63.47	36.53
62	Kalimantan Tengah	669	432	84	293	722854	449165	273690	62.14	37.86
63	Kalimantan Selatan	1047	623	84	482	3536390	2338157	1198233	66.12	33.88
64	Kalimantan Timur	1670	984	64	803	7444186	4814281	2629906	64.67	35.33
71	Sulawesi Utra	825	513	105	360	2135919	1396898	739021	65.4	34.6
72	Sulawesi Tengah	493	323	89	202	480182	307425	172757	64.02	35.98
73	Sulawesi Selatan	723	451	98	312	4271078	2799379	1471699	65.54	34.46
74	Sulawesi Tenggara	611	394	88	262	540433	342097	198335	63.3	36.7
81	Maluku	754	474	90	332	1281963	821910	460053	64.11	35.89
82	Irian Jaya	924	604	114	405	1584335	964716	619619	60.89	39.11
	INDONESIA					472868886	374914133	97954753	79.29	20.71

c) Analysis of Results

Estimated reservation price P, when applied to Jakarta, amounts to about 2,300,000 Rp., at the price level of 1975. Province where estimated reservation price is lowest, i.e., 210,000 Rp., is Bengkulu. Average consumer's surplus per subscriber in Jakarta and Bengkulu amounts to 300,000 Rp. and 170,000 Rp., respectively.

In Jakarta, the portion of realized surplus is the largest and the opportunity loss of social benefits is the smallest.

d) Application to Area Priority Ordering

In order to calculate Kabupaten's consumer surplus, the following formula is applied.

(P-P*)/2 in 1992 x No. of Demand by Kabupaten up to Year 2000

In other words, the average consumer surplus per subscriber in 1992 is multiplied by the number of demand. Then, total amount of consumer surplus by each Kabupaten is obtained, used for ranking their priority ordering.

(3) Coverage Population Size to Demand (Supply)

Coverage population size signifies population that can be covered by one telephone in the event of 100% supply to total demand as of the year 2000.

Logical perception is that the larger the coverage population size per telephone, the higher the needs for telephones and the greater the socio-economic impact that develops.

(4) Financial Internal Rate of Return (FIRR)

Based on work execution in two phases as selected in the study of network coverage, calculation is made for financial internal rate of return (FIRR) of each Kabupaten.

Preconditions are

1) Service revenue item be restricted to telephone service. Service life be 20 years.

2) Inflation not be considered. That is to say, calculation be made by price level of 1985.

3) Exchange rate be 1,100 Rp. = 250 yen = 1 U.S. dollar.

4) Equipment life be 20 years. Salvage value be zero.

5) Long distance network be excluded from work items. That is to say, 85% of gross revenue be revenue from this plan.

6) Initial investment payment schedule be as follows:

Construction in Two Work Phase	Construction Period	Cost Expenditure
i) Kapupaten and Kecamatan capital	Three years (1989 to 1991)	One third of total per year
ii) Desa	Two years (1977 to 1998)	One second of total per year

7) For working capital, 30% of revenue difference between the year concerned and the preceding year be appropriated. For final year, gross operating capital be in the time.

8) For maintenance expense, 3% of investment amount be appropriated.

9) For operating cost, 25% of revenue be appropriated. Personnel expense be appropriated, based on the number of PERUMTEL staff forecast (refer to "Chapter 7, Maintenance") and by estimated wage per capita.

10) Charges in effect as of 1985 are as under.

Installation fee	125,000 Rp.
Rental fee	2,000 Rp./month
Call charge	75 Rp./pulse

Traffic per subscriber as of 2000 is applied to each project year.

6-2-3 Priority Ordering Plan

Based on field survey findings, priority evaluation criteria A, B and C are weighted as under.

	Weighting (1)	Weighting (2)
A. Regional development policy	25 %	30 %
B. Socio-economic impact	15 %	40 %
C. FIRR	60 %	30 %

Priority plan formulated by weighting category (1) is to be classified as Scenario (1). Priority plan formulated by weighting category (2) follows suit as Scenario (2).

Scenario (1) places major weight on FIRR so that work execution begins with area where service revenue prospect looms large, whereby to supply fund for work execution in area where service revenue prospect is poor. Scenario (2) takes up socio-economic impact as major motivation of development investment in rural areas. In this case, fund supply for work execution is mainly from external sources.

Scoring diagram for the three priority evaluation criteria appears in Figure 6-2-1.

The results of priority ordering plan for each area are shown in ANNEX 6-2-1.

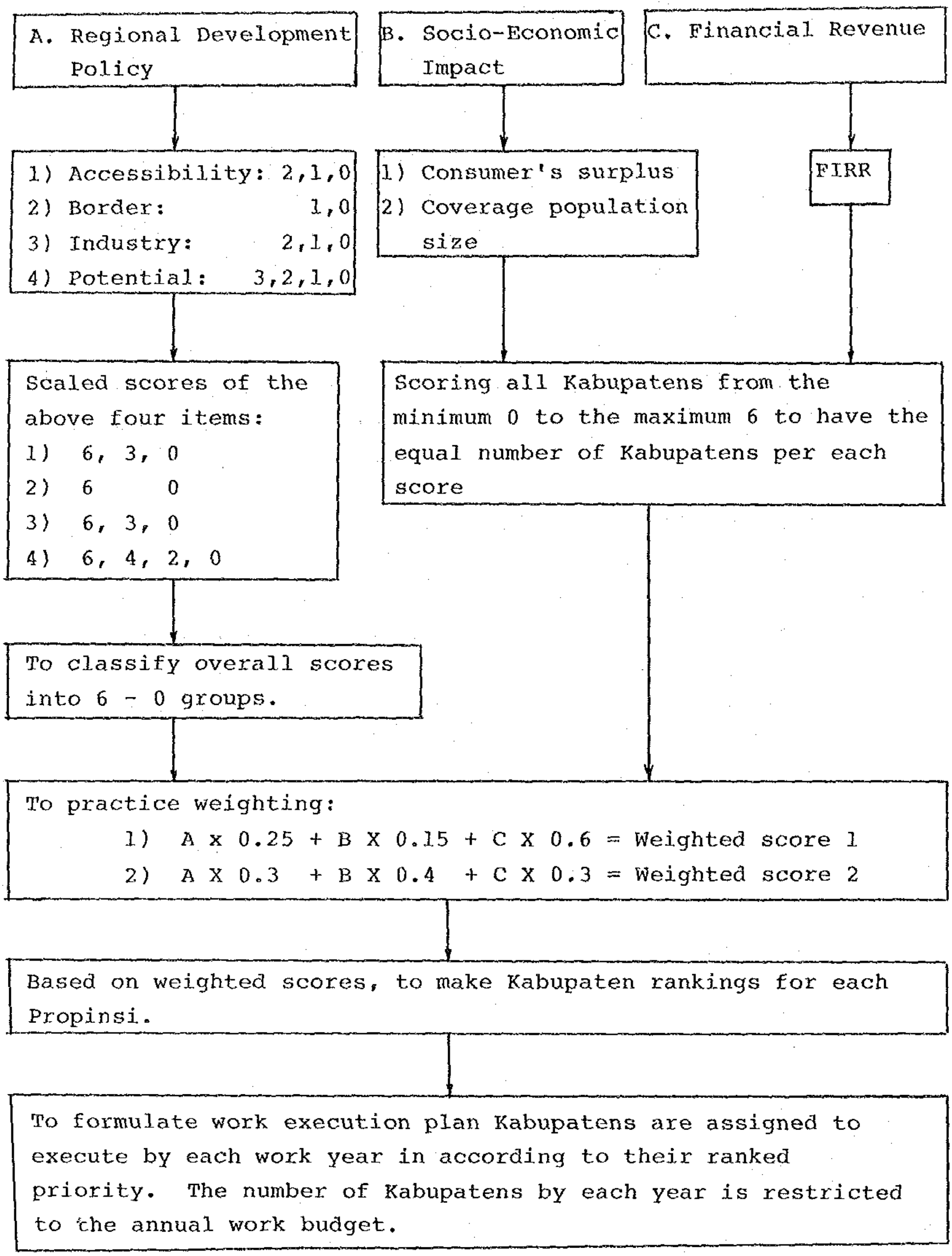


Figure 6-2-1 Scoring Diagram

6-3 Implementation Plan

The ability to supply all of our subscribers (predicated amount) in the year 2000 is the keynote of our policy. regional development policies, socioeconomic benefits, financial revenues, and budget scales were all considered in this plan. Refer to Figure 6-3-1.

1) Network Coverage

2) Scale of Construction
To accommodate 1,127,000 additional line units, 5,643 billion rupiah will be invested in new construction.

3) Construction Period
The construction period will be three years for Kabupaten and Kecamatan and two years for Desa. The total construction period will be 12 years.

4) Other
No priority is given to any specific provinces. construction for all provinces will start at the same time, Kabupaten being the basic unit for each construction project.

The results of construction program per Kabupaten is shown in ANNEX 6-3-1.

UNIT: BILLION Rp

Year / Project	1 1.989	2 1.990	3 1.991	4 1.992	5 1.993	6 1.994	7 1.995	8 1.996	9 1.997	1 0 1.998	1 1 1.999	1 2 2.000	TOTAL	NO of KAB	NO of SUB $\times 10^3$
IKK & KEC 1	158	158	158										474	25	127
IKK & KEC 2		130	130	130									390	25	125
IKK & KEC 3			143	143	143								429	25	153
IKK & KEC 4				115	115	115							345	32	113
IKK & KEC 5					159	159	159						477	35	149
IKK & KEC 6						129	129	129					387	38	108
IKK & KEC 7							128	128	128				384	32	113
IKK & KEC 8								108	108	108			324	34	54
DESA 1									372	372			744	(63)	79
DESA 2										197	393		590	(58)	37
DESA 3											367	734	1.101	(125)	69
TOTAL	158	288	431	388	417	403	416	365	608	677	760	734	5.645	246 (246)	1.127

Figure 6-3-1 Implementation Plan and Construction Cost

CHAPTER 7 MAINTENANCE

CHAPTER 7. MAINTENANCE

7-1 Overview

Telecommunications service performs the role of nerve center for all kinds of social and economic activities. Thus, for telecommunications, maintenance is, in final analysis, to supply good service to users at all times, and, for this purpose, competent authorities that take over the system after the completion of its construction must exercise utmost care for normal operation and proper maintenance of the system.

Correct knowledge about working condition of facilities and service performance through careful routine inspections is essential for optimum maintenance planning and service quality improvement.

Good service to users consists of failure rate minimization and, through it, service interruption elimination.

Methods to supply good service to users are to manufacture equipment of high reliability and to carry out thorough system design and construction, and, on the other hand, to prepare effective maintenance plan with emphasis on failure rate diminution.

7-2 Maintenance System

For desirable operation of existing telecommunications systems in various parts of Indonesia and of new systems to be constructed by PELITA-IV and other telecommunications projects, the most important requirement is to establish the well planned modus operandi for all those systems, supported by the effective maintenance scheme.

In Indonesia, about 13,700 islands, large and small, exist. Out of them, about 3,500 islands are inhabited. Telecommunications systems to be constructed in those islands have to defy in not a few cases such geographical difficulty that prevents access. Therefore, whether those telecommunications systems will operate normally or not depends a great deal upon the effectiveness of maintenance system.

A typical example is found in maintenance of radio repeater station. In this case, maintenance of power supply system usually assumes major importance. For selection of optimum power supply system, facilitation of maintenance must be considered first of all.

From the viewpoint of easy maintenance, solar cell system deserves to be adopted positively as it is a system of small power consumption. For solar cell system, further price reduction can be expected from now forward. Besides, there is no need for routine engine maintenance and overhaul. Nor does necessity for fuel supply exist. These facts reduce maintenance cost broadly.

In Indonesia, for telecommunications system maintenance, georgraphical features of each area, as well as operating scale of each system, must also be duly considered. At major telephone exchanges and radio stations, ad hoc operation system must be established, while for other system components, non-attended operation must be introduced positively.

The existing PERUMTEL organization consists of headquarters in Bandung and 12 WITELs covering the whole country. As seen in Table 7-2-1, secondary center and primary center are established in each WITEL. Tertiary centers are located in seven main cities.

Table 7-2-1 Number of Trunk Centers in Indonesia

WITEL	Tertiary	Secondary	Primary
I	1	4	35
II	0	3	27
III	1	4	32
IV	1	1	1
V	0	2	16
VI	0	3	21
VII	1	4	22
VIII	0	4	25
IX	1	5	38
X	1	5	37
XI	1	2	19
XII	0	3	26
Total	7	40	299

Thus, in principle, the nationwide maintenance system is to be as under.

(1) Maintenance centers and maintenance sub-centers are to be established at key places in the country.

(2) Maintenance center is to be established in each secondary center.

(3) Maintenance sub-center is to be established in each primary center.

(4) Maintenance center and maintenance sub-center are to carry out operational supervision, periodical inspection and test, trouble-shooting for telephone exchanges and radio stations in their respective areas of control.

(5) Distribution of maintenance parts and spares, as well as vehicles, to each maintenance center and maintenance sub-center is to be as under.

1) To distribute maintenance necessaries which are frequently used to each maintenance center and maintenance sub-center or to each telephone exchange and radio station, and to distribute maintenance necessaries which are less frequently used to each maintenance center collectively.

2) To distribute maintenance tools and spare parts to each maintenance center and maintenance sub-center, and package boards (PCB) and allied goods to each maintenance center collectively.

3) To distribute two or more maintenance vehicles to each maintenance center and two to each maintenance sub-center.

(6) Draft plan for maintenance personnel lineup is as under.

1) Maintenance Center

Chief	1
Sub-chief	1
Radio and multiplex engineer	6 in 3 shifts (2 in each shift)
Switching and power engineer	6 in 3 shifts (2 in each shift)
Cable engineer	6 in 3 shifts (2 in each shift)
Assistant engineer	3
Total	23

2) Maintenance Sub-center

Chief	1
Radio and multiplex engineer	3 in 3 shifts (1 in each shift)
Switching and power engineer	3 in 3 shifts (1 in each shift)
Cable engineer	3 in 3 shifts (1 in each shift)
Assistant engineer	3
Total	13

The number of maintenance personnel for this project is estimated at approx. 4,300 as follow:

1) Maintenance Center : 23 x 40 = 920
2) Maintenance Sub-center: 13 x 259 = 3,367

Movements in total number of PERUMTEL personnel and number of personnel per 1,000 line units appear in Figure 7-2-1.

As of 1975, personnel on PERUMTEL payroll numbered about 23,000 and number of line units per person was about 11. At end of 1988, the final year of PELITA-IV, number of line units per person will be about 36. Considerable productivity improvement can thus be expected.

Total number of PERUMTEL personnel as of 1988 is scheduled to be about 46,500. As of 2000, number of personnel per 1,000 line units is assumed to be about 20, as estimated in Figure 7-2-1. Number of line units per person as productivity indicator can be expected to increase to 50 or thereabouts.

7-3 Training

For transmission system, as well as switching and terminal equipments, digital system will be introduced henceforward, in principle. Thus, for engineers, whose expertise is based on conventional analog technology, system maintenance will become difficult. Those engineers will have to undergo training on ways to handle digital system equipment wherein they are least experienced.

Training on new digital technology generally comprises four categories. They are:

(1) To administer in-factory training and basic classroom education by equipment supplier to about half the number of maintenance center and maintenance sub-center staffs for a period of about three months.
(2) To allow trainees to take part in construction works of different kinds so that they can receive on-the-job training for tests and trouble-shooting.
(3) To practice service base training (for tests and trouble-shooting) by equipment supplier's engineers for at least one year after the system service-in.

(4) To invite several PERUMTEL staffers to participate in routine training courses of equipment supplier for the purpose of education of personnel to be PERUMTEL Training Center instructors.

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1988	1989	1994	2000
No. of Personnels (10^3)	23.0	24.6	25.3	26.2	26.6	26.7	27.1	27.4	29.0	46.3	-	-	-
Capasity L.U. (10^3)	244	265	326	475	548	599	629	645	670	1647	-	-	-
Manpower per 1000 L.U.	94	93	78	55	49	45	43	43	43	28	* 27	* 24	* 20
Productivity	11	11	13	18	21	22	23	23	23	36	* 37	* 42	* 50

$$\text{Productivity} = \frac{1000\ \text{L.U.}}{\text{Manpower per 1000 L.U.}}$$

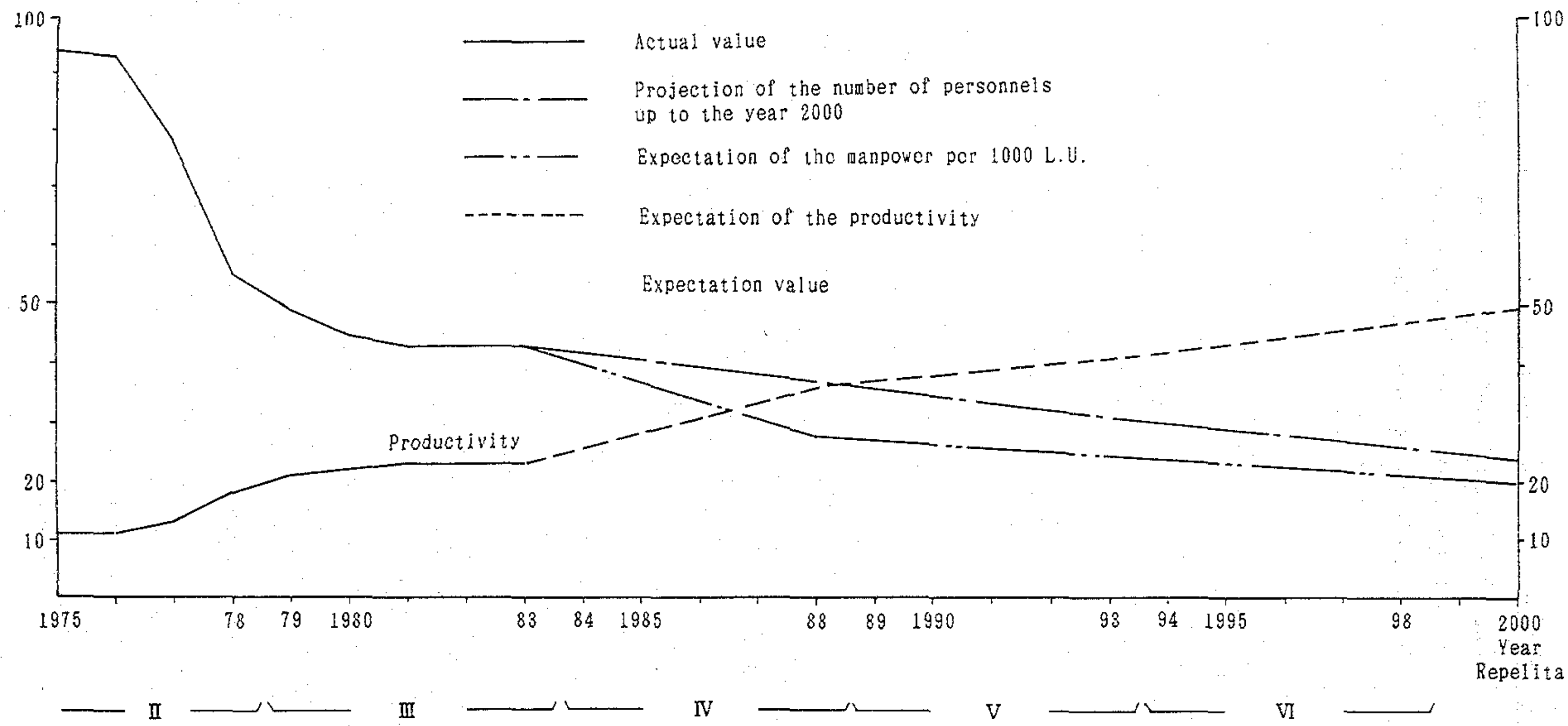


Figure 7-2-1 No. of Personnels Manpower per 1,000 L, U, and Productivity

CHAPTER 8 FINANCIAL ANALYSIS AND ECONOMIC EVALUATION

CHAPTER 8. FINANCIAL ANALYSIS AND ECONOMIC EVALUATION

8-1 Financial Analysis

8-1-1 Premises

(1) Only telephone service should be covered in the financial analysis.

(2) The long-distance network should be excluded from the construction work of the master plan. This means that 85% of the total revenue is the revenue generating for the plan. CCITT's General Network Planning indicates the following average percentage investments in public telephone equipment.

Table 8-1-1 Average percentage investments in public telephone equipment

Item	Average for 16 countries
Subscriber's plant	13%
Outside plant for local networks . . .	27%
Exchanges	27%
Long-distance trunks	23%
Buildings and land	10%

Typically, the long-distance network accounts for 23% of the total public telephone equipment investment. However, this project has an high percentage of local network cost because it includes transfer links and covers rural areas. Accordingly, the share of the long-distance trunk is estimated at 15% in this analysis.

(3) The period of service should be 20 years, on the basis of the service life of the equipment. No salvage value should be allowed for.

(4) No inflation should be taken into account. This means that the price at 1985 constant should be used as basic price. Consequently, the tariff as of 1985 should be used throughout the analysis.

(5) An foreign exchange rate of Rp. 1,100 = Yen 250 = US$ 1 should be used in the analysis.

8-1-2 Expenditures

(1) Initial Investment
The initial investment should cover a period of 12 years, extending from April of 1989 to March of 2001. The spending plan should be based upon supply scenarious 1 and 2. Table 8-1-2 shows the expenditure plan for the initial investment.

(2) Working Capital
A telecommunications entity, like any other business enterprise, requires funds to be on hand. In this analysis, the amount of the required funds is estimated at 30% of the difference in revenue between the relevant year and the preceding year.

(3) Maintenance Costs
According to the items of construction work covered by the analysis, the maintenance costs are broken down as follows:

Items of construction work	Share of total construction cost	Ratio of maintemance cost to total construction cost
Outside Plant	60%	6%
Switching Plant	18%	7%
Transmission Plant	17%	5%
Other	5%	-

Table 8-1-2 Scenario 1 and 2

SCENARIO-1 (IN THE YEAR)	PELITA III			PELITA IV					REPELITA V					REPELITA VI			REPELITA VII	
YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
NO.OF LINE UNIT																		
KAB.MANUAL							0	0	-27	-27	-33	0	0	0	0	0	0	0
KAB.AUTOMATIC							0	0	127	125	153	113	149	108	113	133	37	69
KOTA.MANUAL						-2	0	0	0	0	0	0	0	0	0	0	0	0
KOTA.AUTOMATIC							141	148	156	163	172	180	189	199	208	219	230	241
TOTAL (KAB/KOTA)		39	156	287	229	235	141	148	256	261	292	293	338	307	321	352	267	310
INVESTIMENT COST																		
KAB.LOCAL							158	288	431	388	417	403	415	364	608	677	760	734
KAB.TRUNK							43	87	130	130	130	130	130	130	87	43	0	0
KOTA.LOCAL							258	271	285	298	315	329	346	364	381	401	421	441
KOTA.TRUNK							65	68	71	75	79	82	87	91	95	100	105	110
TOTAL (KAB/KOTA)		354	691	629	804	614	524	714	917	891	941	944	978	949	1171	1221	1286	1285
SCENARIO 2	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
NO. OF LINE UNIT																		
KAB.MANUAL	87					87	87	87	60	33	0	0	0	0	0	0	0	0
KAB.AUTOMATIC	91					237	237	237	364	489	642	755	904	1012	1125	1258	1295	1364
KOTA.MANUAL	2					0	0	0	0	0	0	0	0	0	0	0	0	0
KOTA.AUTOMATIC	486					1288	1429	1577	1733	1896	2068	2248	2437	2636	2844	3063	3293	3534
TOTAL (KAB/KOTA)	666	705	861	1148	1377	1612	1753	1901	2157	2418	2710	3003	3341	3648	3969	4321	4588	4898
INVESTIMENT COST																		
KAB.LOCAL							158	446	877	1265	1682	2085	2500	2864	3472	4149	4909	5643
KAB.TRUNK							43	130	260	390	520	650	780	910	997	1040	1040	1040
KOTA.LOCAL							258	529	814	1112	1427	1756	2102	2466	2847	3248	3669	4110
KOTA.TRUNK							65	133	204	279	358	440	527	618	713	813	918	1028
TOTAL (KAB/KOTA)							524	1238	2155	3046	3987	4931	5909	6858	8029	9250	10536	11821

The above maintenance cost ratios are based upon actual data obtained in Japan. considering the difference in labor cost between Japan and Indonesia, the ratio of maintenance cost is assumed to be 3% in this plan.

(4) Operating and General Administrative Costs

1) Materials cost
Based upon the profit and loss statements of PERUMTEL (covering 1976 to 1982), the share of the materials cost ranges from 13% to 31%. therefore, the materials cost is estimated at 25% for this analysis.

2) The number of staff members for PERUMTEL is estimated in the "Outline of Maintenance" chapter. The salary per staff is estimated by applying the growth rate of the real GDP per capita to the actual salaries for 1976 through 1982.

(5) Depreciation
Assuming a service life of 20 years, the straight line depreciation method should be applied at a yearly rate of 5%.

8-1-3 Revenues

(1) Tariff for the Plan
Revenues from telephone service include the three categories such as installation fee, annual rental fee, and call charges. The new rate structure (revised in February of 1985) is shown in Table 2-5-13. The installation fee varies according to local circumstances. Area I covers Jakarta, Area II covers other major cities (such as Medan), and

Area VII covers minor telephone offices (such as manually operated ones). The installation fee decreased as the Area number increases (Area I has the highest fee; Area VII the lowest).

In this project, the installation fee is assumed at Rp. 125,000 (the prevailing rate in Area V). This is because the project covers those cities that are the same size as, or smaller than, the Kabupaten capital.

What determines the annual rental fee is whether the relevant telephone office is manually operated or automatically operated. Moreover, if it is manually operated, another factor is whether or not it has 500 line units or more. In this project, the annual rental fee is assumed at Rp. 2,000/month (which is standard for automatically operated telephone offices).

(2) Calculation of Revenue

Revenue is calculated for each of the categories by using the following equations:

Revenue per annum installation fee = (Number of services newly generated in the year) x Rp. 125,000

Revenue per annum annual rental = (Newly accumulated number of generated x Rp. 2,000 x 12 months

Revenue per annum call charges = (Newly accumulated number of generated in services) x Pulses per subscriber x Rp. 75