SECTION III SUMATERA UTARA

SECTION III SUMATERA UTARA

1. Telephone Demand Forecast and Traffic Forecast

1-1 Telephone Demand Forecast

1-1-1 Telephone Demand in Sumatera Utara

Telephone demand may be forecast in three different methods: the method in which the relationship between economical indicators such as GDP (Gross Domestic Product) or NI (National Income) and telephone demand is utilized (economic method), the method in which demand is forecast by extrapolation from the time series data of the past demand (trend analysis), and the method in which telephone demand is obtained by calculating demands for individual land utilization plans of fractionated areas and summing up these demands (disaggregated method). The second method (trend analysis) is not suitable because of the unavailability of time series data, whereas the third method (disaggregated method) requires a considerable time for analysis. Under these circumstances, we have determined to utilize the relationship between GDP per capita and telephone demand for forecasting telephone demand in Sumatera Utara as the first step.

The GAS-5 document of CCITT has spedified that there is a close relationship between the GDP per capita and telephone demand density (the number of main telephone stations in operation

per 100 inhabitants). The following equation holds between GDP data and telephone demand density in many countries in 1973. (For details, refer to SECTION V, paragraph 1-1.)

$$\log Y = -7.1643 + 1.3968 \log X \quad \cdots\cdots (1)$$

where

Y is the telephone demand density (the number of line units per 100 inhabitants) and X the GDP per capita (Rp.)

Although the demand forecast method adopted here is usually employed for demand forecast on a national scale, it has been applied to the forecast of the total density of main telephone stations in Sumatera Utara which has as large a population as about 8,000,000 and may be determined to have the function of a nation in both economic scale and construction.

(1) Telephone demand density forecast

The GDP of Sumatera Utara per capita at 1971 constant prices was Rp. 72500 as of 1978 and we have estimated that the real annual economic growth rate is 6% in average. Details are described in SECTION V, paragraph 1-2.

Since the real economic growth tends to gradually slow down, we calculated the GDP

per capita at 1971 constant prices and telephone demand density in individual years for different real annual economic growth rates of 6%, 4.5% and 3%. The results are given in Table III.1.1-1.

Table III.1.1-1 GDP per capita at 1971 constant prices and telephone demand density in Sumatera Utara

Real Economic Growth Rate	Year			
	1978	1985	1995	2005
6%	0.42 73	0.74 109	1.68 195	3.79 349
4.5%	0.42 73	0.65 99	1.20 153	2.21 238
3%	0.42 73	0.56 89	0.85 120	1.28 161

Upper: Telephone demand density per 100 inhabitants
Lower: GDP per capita at 1971 constant prices (Rp.1000)

The team visited Vice Mayor of Medan

(2) Population forecast

Among Kotamadya having been surveyed, Medan and Binjai have high population increase rates whereas others have low population increase rates.

The population increase rates of Kabupaten range between the high and low population increase rates of Kotamadya. Since sufficiently reliable data has not been available regarding population forecast, we have set suitable population increase rates for Katamadya and Kabupaten and estimated populations in individual years. The results of population forecast of Sumatera Utara are shown in Table III.1.1-2.

From table III.1.1-2 the annual average population increase in Sumatera Utara is estimated to be 2.35% and the population of Sumatera Utara in 2005 is estimated to be 14,887,000.

Table III.1.1-2 Population Forecast of Sumatera Utara

		Population Increase(%)	Population (Thousand)					
			1978	1985	1990	1995	2000	2005
Kotamadya	Medan	2.8	1140	1383	1588	1823	2093	2403
	Binjai	2.7	74	89	102	116	133	151
	T. Tinggi	2.0	80	90	101	110	124	134
	Tg Balai	2.0	42	49	53	60	65	73
	P. Siantar	2.0	139	160	176	195	215	237
Kabupaten	Deli Serdang	2.3	1163	1363	1528	1712	1918	2149
	Langkat	2.3	634	734	833	934	1046	1172
	Asahan	2.3	696	799	914	1003	1148	1259
	Karo	2.3	204	240	268	301	336	378
	Simalungun	2.3	713	874	937	1097	1176	1316
Others*		2.3	3039	3563	3992	4473	5012	5615
Total		2.35	7924	9344	10492	11824	13266	14887

* Sibolga, Labuhan Batu, Tapanuli Tengah, Tapanuli Selatan, Tapanuli Utara, Nias and Dairi.

(3) First approximation of telephone demand

The total telephone demand of Sumatera Utara has been calculated for individual years for different economic growth rates from Tables III.1.1-1 and III.1.1-2. The results of the calculation are shown in Table III.1.1-3 which shows telephone increase rates also.

Table III.1.1-3 First Approximation of Telephone Demand

Economic Growth Rate	Telephone Demand Forecast (Thousand Line Units)				Telephone Increase Rate
	1978	1985	1995	2005	
6%	33	69	199	564	11.1%
4.5%	33	61	142	329	8.8%
3%	33	52	100	191	6.7%

The table shows that the estimated telephone demand obtained by the first approximation for the reference year (1978) is 33 thousand line units and the annual increase rates of the estimated telephone demand for the economic growth rates of 6%, 4.5%, and 3% are respectively 11.1%, 8.8%, and 6.7%.

The number of telephone stations used in Sumatera Utara in 1978 is 27956*. It may be determined, by adding the number of waiting applicants of Medan and others to the above-mentioned number of telephone stations in Sumatera Utara, that the estimated telephone demand of 33 thousand line units for the

reference year is a proper value and the annual telephone increase rate in Indonesia is 8% and is not greatly different from the increase rate obtained for the estimated telephone demand by the first approximation for the economic growth rate of 4.5%. Accordingly, we have determined that the value for the actual economic growth rate of 4.5% in Table III.1.1-3 may be used for the first approximation for the estimated telephone demand in Sumatera Utara.

* P48, Table III.1.9-2, S24. (see P.330)

1-1-2 Allotment of Estimated Telephone Demand Obtained by First Approximation to Areas

By first allotting the estimated telephone demand obtained by the first approximation for Sumatera Utara to Kotamadya and Kabupaten and then re-allotting the telephone demand of each Kabupaten to individual Kecamatan, we have proved the appropriateness of the estimated demand and determined the estimated demand values for individual Kotamadya, Kabupaten, and Kecamatan.

(1) Allotment of estimated telephone demand to Kotamadya and Kabupaten

We endeavored to collect necessary data for the allotment of estimated demand to areas, such as GDP and NI of different areas, at the offices of BAPPEDASU, Kotamadya, and Kabupaten. Unfortunately, however, we could not obtain necessary data.

Accordingly, we have allotted telephone demand to Kotamadya and Kabupaten for nonagricultural population ratios obtained from the data of the populations of laborers in different industries which are specified in the Census of 1971. In the case of Indonesia, high telephone demand is concentrated to the secondary and tertiary industries and, on the other hand, low telephone demand is concentrated to the primary industry, as detailed in SECTION V, paragraph 1-3.

The method and results of calculation for allotting the estimated telephone demand obtained by the first approximation to individual Kotamadya and Kabutapen are described in SECTION V, paragraph 1-4. We have determined, from the results of calculation, that the estimated telephone demand obtained by the first approximation is virtually appropriate but still requires examination for Kabupaten because of considerable discrepancies between estimated and actual values.

(2) Allotment of estimated telephone demand to Kecamatan

The equation giving the relationship between the telephone demand density and the GDP per capita, which has been employed for demand forecast, indicates the average service level of countries endeavoring to the spread of communication facilities. Indonesia provides an average service level corresponding to its GDP (as shown in Fig. V.1.1-1). Accordingly, if the method of allotting the estimated telephone demand to areas is proper, discrepancies between

the estimated and actual values will not be caused. However, considerable discrepancies appear between estimated demand values allotted to individual Kabupaten and actual values (the number of main telephone stations in operation in individual Kabupaten), as shown in Table V.1.4-2. We have then tried to still allot the estimated demand allotted to Kabupaten to individual Kecamatan to analyse discrepancies between the estimated and actual demand values. Allotment of the estimated demand to individual Kecamatan has been made by population ratio. Details of the method of calculation and the method of partial correction of the estimated demand are described in SECTION V, paragraph 1-5.

Through comparison of the current estimated demand values and the current number of main telephone stations in operation for individual Kecamatan where communication service is offered at present (SECTION V, paragraph 1-5), we have determined that no conspicuous discrepancies exist between the estimated and actual values, that the estimated demand obtained by the first approximation can be employed sufficiently for practical use by partial correction, and that the demand estimation method and allotment method described so far are sufficiently practical. Regarding discrepancies between the estimated demand and actual values for individual Kabupaten (estimated values are larger than actual values), we like to understand that PERUMTEL should make more efforts for the spread of rural telephone, rather than determining that the estimated values are too large.

1-1-3 Conclusion

The ultimate estimated telephone demand values obtained for individual Kotamadya and Kabupaten through the above-mentioned demand forecast calculation are given in Table III.1.1-4 and estimated demand values for individual Kecamatan are given in Table III.1.1-5 (1) ~ (3).

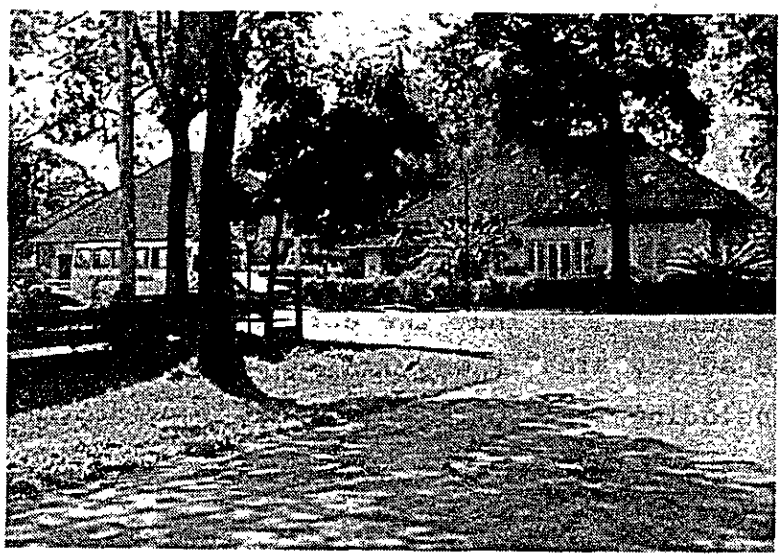
The "Reserve" in the estimated telephone demand given in Table III.1.1-4 is the telephone demand reserved (in the estimated telephone demand in the surveyed area) without being allotted to areas, due to partial correction. The table shows that the estimated telephone demand in the survey area is 53, 124, and 287 thousand line units (including reserve) respectively for 1985, 1995, and 2005.

Table III.1.1-4 Estimated Telephone Demand

		1985	1990	1995	2000	2005
Kotamadya	Medan	27542	42671	66110	102175	157915
	Binjai	1581	2461	3830	5833	8883
	T. Tinggi	1824	2692	3972	5940	8883
	Tg Balai	790	1160	1702	2592	3948
	P. Siantar	4130	5750	7950	11000	15134
Kabupaten	Deli Serdang	3545	5364	8113	12266	18540
	Langkat	1450	2195	3320	5005	7559
	Asahan	1551	2341	3535	5318	8006
	Karo	892	1299	1894	2882	4388
	Simalungun	1288	1909	2888	4206	6201
Total		44593	67842	103314	157217	239457
Reserve*		8407	13158	20686	30783	47543
Others**		8000	12000	18000	28000	42000
Sumatera Utara		61000	93000	142000	216000	329000

* Reserve in the total estimated demand over the whole survey area

** Sibolga, Labuhan Batu, Tapanuli Tengah, Tapanuli Selatan, Tapanuli Utara, Nias and Dairi.



Medan which is the biggest in Sumatera Island and has beautiful mall. Town inside is vivid.

Table III.1.1-5 (1) Estimated Telephone Demand

(Deli Serdang)

Item / Kecamatan	Estimated Telephone Demand				
	1985	1990	1995	2000	2005
1. Hamparan Perak	165	250	377	570	861
2. Labuhan Deli	63	95	143	216	327
3. Sunggal	225	340	514	777	1174
4. Delitua	126	191	287	434	656
5. Patumbak	151	228	345	522	788
6. Percut Sei Tuan	359	543	819	1238	1871
7. Biru-Biru	42	64	96	145	219
8. Kuta Limbaru	41	62	93	141	213
9. Namorambai	70	106	160	242	365
10. Pancur Batu	78	118	179	271	408
11. Sibolangit	34	51	77	116	175
12. Galang	130	197	296	447	677
13. Batang Kuwis	134	203	306	463	700
14. Pantai Cermin	112	169	255	385	583
15. Tanjung Merawa	151	228	345	522	788
16. Lubuk Pakam	273	413	624	943	1425
17. Perbaungan	165	250	377	570	863
18. Gunung Meriah	9	14	21	32	49
19. Kota Rih	73	110	166	251	379
20. Bangun Purba	45	68	104	157	236
21. Senembah Tanjung Mude Hilir	27	41	61	92	140
22. Senembah Tanjung Muda Hulu	11	17	25	38	58
23. Dolok Merawan	126	191	287	434	656
24. Bandar Khalifah	130	197	297	449	679
25. Sipispis	99	150	226	342	517
26. Tebing Tinggi	248	375	565	854	1292
27. Sei Rempah	186	281	424	641	969
28. Tanjung Beringin	150	227	364	550	831
29. Dolok Masihul	103	156	236	357	540
30. Teluk Mengkudu	19	29	44	67	101
Total	3545	5364	8113	12266	18540

Table III.1.1-5 (2) Estimated Telephone Demand

(Karo/Simalungun)

Item / Kecamatan	Estimated Telephone Demand				
	1985	1990	1995	2000	2005
(Karo)					
1. Kabanjahe	624	909	1324	2015	3068
2. Payung	49	71	104	158	240
3. Simpang Empat	36	52	76	116	176
4. Barus Jahe	37	54	80	122	187
5. Tiga Panah	25	36	52	79	120
6. Tiga Binanga	30	44	64	97	149
7. Mardinding	11	16	24	37	55
8. Munte	40	58	85	129	195
9. Juhar	23	34	48	73	111
10. Kota Buluh	17	25	37	56	87
Total	892	1299	1894	2882	4388
(Simalungun)					
1. Siantar	149	223	342	501	744
2. Jorlang Hataran	61	91	139	204	303
3. Sidamanik	134	201	307	450	669
4. Dolok Pardamean	19	28	43	63	93
5. Raya	33	49	75	110	163
6. Panei	106	159	242	355	527
7. Silima Kuta	35	52	79	116	171
8. Dolok Silau	16	24	37	54	82
9. Purba	40	60	93	136	201
10. Simpangan Bolon	123	166	223	300	400
11. Bosar Maligas	65	97	149	218	325
12. Dolok Panribuan	63	94	146	214	316
13. Tanah Jawa	160	240	366	536	796
14. Raya Kahean	25	37	57	84	125
15. Silau Kahean	24	36	54	79	118
16. Dolok Batu Nyanggar	111	166	253	371	551
17. Bandar	124	186	283	415	617
Total	1288	1909	2888	4206	6201

Table III.1.1-5 (3) Estimated Telephone Demand

(Langkat/Asahan)

Item / Kecamatan	Estimated Telephone Demand				
	1985	1990	1995	2000	2005
L-1. Gebang	87	132	199	300	453
2. Besitang	18	27	41	62	92
3. Pangkalan Susu	46	70	105	158	239
4. Babalan	174	264	400	600	920
5. Stabat	154	233	352	531	800
6. Padang Tualang	19	29	43	65	98
7. Hinai	135	204	310	468	705
8. Sicanggang	108	163	247	373	562
9. Tanjung Pura	138	209	316	477	719
10. Sei Bingei	48	73	111	167	252
11. Binjai	279	422	639	964	1454
12. Salapian	41	62	95	143	215
13. Kuala	82	124	186	281	423
14. Selesai	106	160	242	365	551
15. Bohorok	15	23	34	51	76
Total	1450	2195	3320	5005	7559
A-1. Sungai Kepayang	25	38	57	86	130
2. Air Joman	79	119	181	272	408
3. Simpang Empat	39	59	88	132	200
4. Kisaran	442	667	1007	1515	2280
5. Air Batu	101	152	230	346	522
6. Buntu Pane	38	57	87	131	198
7. Pulau Rakyat	41	62	94	141	212
8. Bandar Pulau	16	24	36	54	81
9. Bandar Pasir Mandoge	3	5	7	11	17
10. Talawi	125	189	286	430	647
11. Lima Puluh	95	143	217	327	492
12. Tanjung Tiram	86	130	195	293	442
13. Air Putih	207	313	471	709	1066
14. Medang Deras	102	154	232	349	526
15. Tanjung Balai	152	229	347	522	785
Total	1551	2341	3535	5318	8006

1-2 Traffic Foreast (Calling Rate: CR)

(1) For large cities:

For large cities (P. Siantar, Binjai and T. Tinggi) where more than 10 thousand demands are expected in the year 2005, Ibukota Kabupaten (Kisaran and Kabanjahe) of which the number of expected demands in the year 2005 is less than 10 thousand, and Kotamadya (Tg Balai), the subscriber's calling rate has been forecast by taking the current traffic in Medan as a model.

Automatic exchange:

(in erl)

Call Class	Calling Rate
Intraoffice call	0.025
Outgoing call	0.030
Incoming call	0.030
Total	0.085

(2) For ordinary Kecamatan:

The subscriber's calling rate for ordinary Kecamatan where the expected number of demands in the year 2005 is less than 2,000 but the office setup standard is satisfied has been forecast by taking the model of the existing offices in Sumatera Utara except Medan Kotamadya as follows.

Automatic exchange:

Call Class	Calling Rate
Intraoffice call	0.017
Outgoing call	0.020
Incoming call	0.020
Total	0.057

Manual exchange:

Call Class	Calling Rate
Intraoffice call	0.014
Outgoing call	0.016
Incoming call	0.016
Total	0.046

(3) For Kecamatan with limited supply:

The CR for those Kecamatan, which have not reached the required office setup standard, in which demands are fulfilled by means of line concentrators such as MAS and in which the supply volume is limited to important subscribers (such as Kantor Camat, police, army, plantations, toko, public telephones etc.), has been forecast to be slightly higher as follows.

Automatic exchange:

Call Class	Calling Rate
Intraoffice call	0.021
Outgoing call	0.025
Incoming call	0.025
Total	0.071

Manual exchange:

Call Class	Calling Rate
Intraoffice call	0.017
Outgoing call	0.020
Incoming call	0.020
Total	0.057

(4) Forecast method

Data obtained from outgoing calls from manual switchboards at existing offices in Sumatera Utara in the period of 1974 ~ 1978 was used as the traffic data for traffic forecast under the following three conditions.

a) Reference traffic equation

The reference traffic was obtained from average monthly traffic by the following equation.

Reference traffic = (Average monthly traffic for 12 months) x $(1 + K \cdot C_V)$

where C_V (Coefficient of variance) $= \frac{1}{\bar{a}} \sqrt{\frac{\sum_{i=1}^{12} (ai - \bar{a})^2}{12}}$

ai: monthly traffic

$\bar{a}$: average traffic for 12 months

and K is as follows.

Applicable condition		K
Average CR > 30 erl		1.80
Average CR $\leq$ 30 erl	$C_V > 0.15$	1.80
	$C_V \leq 0.15$	2.30

b) CR for individual office

The method of obtaining the calling rate from the total holding time of one month was as follows.

One month is supposed to actually consist of 25 days. The busy hour concentration ratio is supposed to be 1/6 (from the automatic exchange power consumption study report of Ujung Pandang Telephone Office).

$$\text{Calling Rate} = T \times \frac{1}{25} \times \frac{1}{6} \times \frac{60}{3600} \times \frac{1}{Sub}$$

where T is the total holding time of one month (in minutes) and Sub is the number of subscribers.

The calling rates of individual telephone offices (actual values) are shown in Fig. III-1-2-1.

c) Traffic correction coefficient

The traffic correction coefficient by adoption of automatic exchange (increase in the number of calls made by service improvement) is supposed to be 1.23. The income will increase 2.2 times as large by adoption of automatic exchange but the charge 1.78 times as large (the charge for every 3 minutes is supposed to be Rp.528 in the case of automatic exchange and Rp. 296 in the case of manual exchange). Hence, the corrected traffic coefficient for the adoption of automatic exchange is given by

$$2.2 \div 1.78 \fallingdotseq 1.23$$

(Data was obtained in Pematan Siantar.)

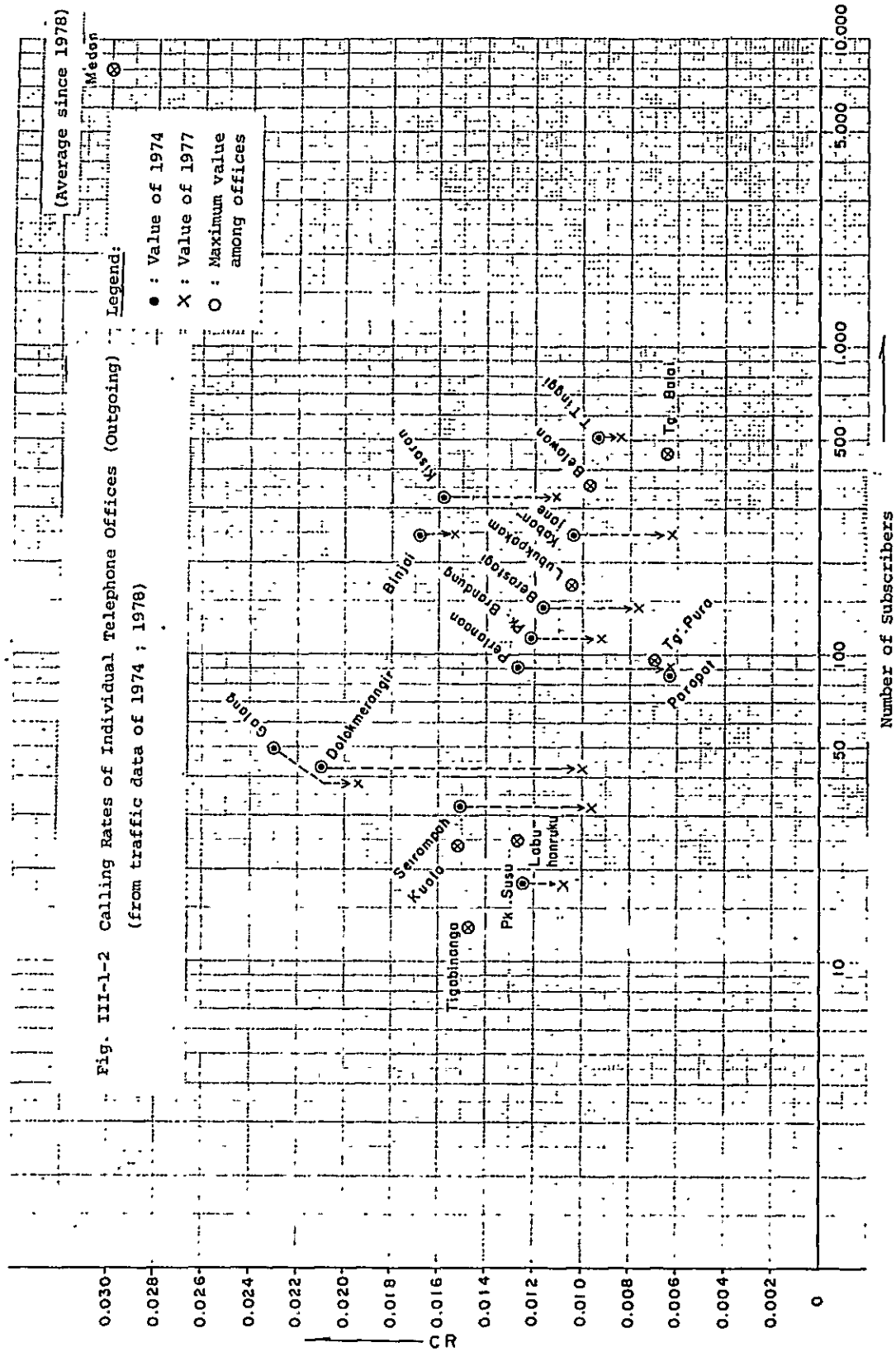


Fig. III-1-2 Calling Rates of Individual Telephone Offices (Outgoing)
(from traffic data of 1974 ; 1978)
Legend:
● : Value of 1974
X : Value of 1977
O : Maximum value among offices
(Average since 1978)
Medan
Belawan
T. Tinggi
Tg. Balai
Kisaran
Kabon-jahe
Lubukpakam
Bindjai
Berastagi
Pk. Brandan
Petrenoan
Tg. Pura
Porapat
Dolokmerangir
Gunung Golang
Seirompah
Kuala
Tigabinanga
Pk. Susu
Labu-hanruku
CR
0.030
0.028
0.026
0.024
0.022
0.020
0.018
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0
10
50
100
500
1,000
5,000
10,000
Number of Subscribers

2. Telephone Facility Plans

Such telephone facility plans that provides many labor opportunities and high productivity through introduction of latest technology are recommended.

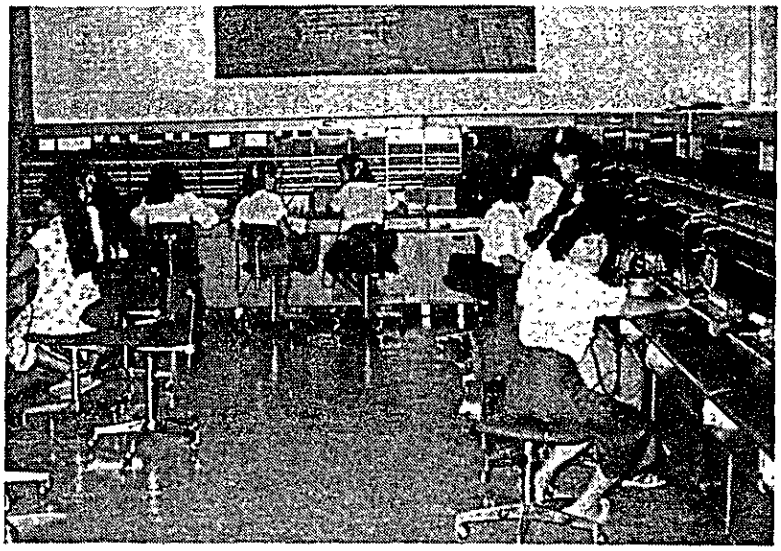
2-1 Demand Fulfilment and Office Setup Plans

The following office setup plan has been prepared to allow telephone demand fulfilment in all Kecamatan to be commenced in the first year (1985) for the elimination of no-telephone Kecamatan which is one of the major purposes of this project.

(1) Office setup
For such Kacamatan that has more than 200 demands for the first year of service, a telephone office is to be set up to afford telephone service for all demands.

(2) Temporary measure by line concentrator
For such Kecamatan that has demands of less than 200 in the first year of service, subscribers are to be collected at a suitable office by means of line concentrators through wired or radio links. In this case, 100% demand fulfilment will not necessarily be made and the demand fulfilment percentage is to be determined as per item (4) below.

(3) Parent Kecamatan (Key-point Kecamatan)
In taking measures for item (2), a telephone office is to be set up in "parent Kecamatan"(or "key-point Kecamatan") even though it has less than 200 demands in the first year of service.



Manual toll boards of Medan telephone exchange.

(4) Effective use of line concentrator

In the case of item (2) above, priority is given to the effective use of line concentrator (for instance, relocation of the line concentrator to another Kecamatan) and system design restrictions and the demand fulfilment percentage is to follow this situation.

(5) Office setup in case of item (2)

In such Kecamatan as in the case of item (2) above, a telephone office is to be set up in such a year when its demands exceed 200 so as to fulfil all demands. The line concentrator (subscriber's terminals) which are no more necessary in the Kecamatan are to be relocated to other Kecamatan for reuse at the new place.

The telephone demand fulfilment and office setup plan prepared for different future years under the above-mentioned conditions is shown in Table III.2.1-1.
The demand fulfilment and office setup plan for individual Kecamatan is shown in Attached Table III.2.1-1.

Table III.2.1-1 Telephone Demand Fulfilment and Office Setup Plan for Future Years

	Before 1985	1985	1990	1995	2000	2005	Total
Number of automatized excnanges	-	10	1	1	-	-	12
Number of newly set up automatic exchanges	-	8	8	5	8	7	36
Number of existing automatic exchanges	8	-	-	-	-	-	8
Total	8	18	9	6	8	7	56
Number of Kecamatan (1)*	8	35	44	49	57	65	65
Number of Kecamatan (2)*	-	50	42	38	30	22	22
Number of Kecamatan (3)*	13	2	1	-	-	-	87
Fulfiled demands		15226		35040		79650	

* The number of Kecamatan (1) means the number of Kecamatan to be covered in ordinary service area by automatic exchange.
The number of Kecamatan (2) means the number of Kecamatan to be covered by a line concentrator or concentrators.
The number of Kecamatan (3) means the number of Kecamatan to be covered by a manual switchboard.

2-2 Network Planning

The following items were considered in telephone network planning.

(1) Primary center area and numbering plan

With the automatization of telephone networks, network planning should be accomplished under definite office class designation and numbering plan. Although most offices in the existing telephone networks around urban areas employ manual switchboards and both network and numbering plans are not clear for the time being, it is desirable to achieve compliance to administrative districts as much as possible in preparing the future numbering plan of the primary center area. To be complete, the numbering plan recommended for the primary center area in consideration of the above-mentioned prerequisite is shown in Table III.2.2-1.

(2) Trunk circuit plan

Star network is to be introduced in principle. It is to be noted in particular that the adoption of traversal trunks between end offices is not considered and only the basic trunks of primary centers, are to be introduced for outgoing and incoming trunks. For connection between primary centers, traversal trunks are to be employed depending on the magnitude of the traffic.

The recommended trunk circuit plan for connection between primary centers is shown in Attached Table III.2.2-1.

Table III.2.2-1 Recommended Primary Center Areas

Primary Center	Primary Center Area		Number of Demands in 2005	Remarks
	Kabupaten	Number of Kotamadya and Kecamatan		
Medan	Medan	1 Kotamadya	158,000	Toll office code (61)
	Deli Serdang	22 Kecamatan	13,000	
T. Tinggi	Deli Serdang	1 Kotamadya 8 Kecamatan	14,500	Toll office code (621)
P. Siantar	Simalungun	1 Kotamadya 17 Kecamatan	21,300	Toll office code (622)
Kisaran	Asahan	1 Kotamadya 15 Kecamatan	12,000	Toll office code (623)
Kabanjahe	Karo	10 Kecamatan	4,400	Toll office code (628)
Binjai	Langkat	1 Kotamadya 15 Kecamatan	16,400	Toll office code (620)

2-3 Local Facilities (Switching System and Subscriber's Facilities)

(1) Switching system

A time division electronic switching system is to be employed. The ultimate capacity of the switching system is to be determined in consideration of the number of demands in 20 years hence. For the initial capacity and extension capacity, the number of demands to be fulfiled is generally small and the number of demands to be made 10 years hence is to be met. Accordingly, the next phase of expansion is to be started in consideration of the commencement of service 10 years hence. The ultimate capacity of most offices is to be 2000 terminals, the initial capacity is to be minimum 200 terminals, and the initial capacity may be increased in blocks of 200 terminals. Capacity expansion is also to be achievable in blocks of 200 terminals.
A switching system of less than 2000 terminals may be formed in a container type, assuring great labor reduction by centralized maintenance and others.
The first phase of construction plan (for commencing service in 1985) is shown in Table III.2.3-1.

(2) Subscriber's line concentrator

Subscriber's line concentrator is device used to connect a subscriber in a no-telephone Kecamatan to an adjacent office located more than 10 km from the subscriber. At present two means of line concentration are available: Multi Access Radio telephone System (MAS) and Subscriber loop Multiplexer system-Analog (SMA). In consideration of the distribution of

telephone demands, the construction of outside plants, the condition of access roads for maintenance, and relocation of facilities, the radio telephone method (MAS) may be considered most advantageous for the present Sumatera Utara. Accordingly, the introduction of radio telephone for remote places is recommended for most no-telephone Kecamatan. For the relocation of the equipment for use at another office, consideration has been given to keep the base station as it is and only the subscriber's terminal is to be relocated.

A telephone number inquiry board of Medan telephone exchange

Table III.2.3-1 First Phase of Construction Plan (Switching System) (1/2)

Office (= desa name of Kantor camat)	Initial Facility Scale		Ultimate Capacity	Building	Remarks
	Type of Switch	Number of Terminals			
Medan	Digital switch	2250^{CCT}	(5000^{CCT})	Existing office is to be used.	Toll switching unit
Sunggal	Digital switch	600^{T}	(1200^{T})	Standard type	
Delitua	Digital switch	1000^{T}	(1800^{T})	Standard type	
Galang	Digital switch	400^{T}	(800^{T})	Standard type	
Batan Kuwis	Digital switch	400^{T}	(800^{T})	Container type	
Tembung	Digital switch	1000^{T}	(2000^{T})	Standard type	Kecamatan: Percut Seituan
Lubuk Pakam	Digital switch	800^{T}	(1600^{T})	Standard type	
Perbaungan	Digital switch	800^{T}	(1600^{T})	Standard type	
Tebing Tinggi	Existing switching system (Local)	3600^{T}	(11000^{T})	Existing office is to be used.	Toll and local switches to be used in combination.
	(Toll)	360^{CCT}	(920^{CCT})		
Sei Ranpah	Digital switch	800^{T}	(1800^{T})	Standard type	
Pematang Siantar	Existing switching system (Local)	5000^{T}	(16500^{T})	Existing office is to be used.	
	(Toll)	720^{CCT}	(1390^{CCT})		
Tanah Jawa Pematan	Digital switch	400^{T}	(800^{T})	Standard type	Kecamatan: Tanah Jawa
Serbalawan	Digital switch	400^{T}	(800^{T})	Standard type	Kecamatan: Dolok Batu Nyanggar
Perdagangan	Digital switch	400^{T}	(800^{T})	Standard type	Kecamatan: Bandar
Kisaran	Existing switching system (Local)	200^{T}	(2400^{T})	Existing office is to be used.	Toll and local switches to be used in combination.
	(Toll)	520^{CCT}	(1200^{CCT})		

Table III.2.3-1 First Phase of Consttuction Plan (Switching System) (2/2)

Office (= desa name of Kantor camat)	Initial Facility Scale		Ultimate Capacity	Building	Remarks
	Type of Switch	Number of Terminals			
Air Batu	Digital switch	400^{T}	(600^{T})	Standard type	
Labuhan Ruku	Digital switch	600^{T}	(1200^{T})	Standard type	Kecamatan: Talawi
New Town	Digital switch	800^{T}	(1600^{T})	Existing office is to be used.	Kecamatan: Air Putih
Tanjung Balai	Digital switch	2100^{T}	(4800^{T})	Standard type	
Pangkalan Brandan*	Digital switch	400^{T}	(600^{T})	Existing office is to be used.	Kecamatan: Babalan
Stabat	Digital switch	800^{T}	(1600^{T})	Standard type	
Tanjung Pura	Digital switch	400^{T}	(800^{T})	Standard type	
Binjai	Existing switching system (Local)	3600^{T}	(10600^{T})	Existing office is to be used.	
	(Toll)	480^{CCT}	(1160^{CCT})		
Kabanjahe**	Existing switching system (Toll)	140^{CCT}	(310^{CCT})	Existing office is to be used.	
	(Local)	(800^{T})	(2400^{T})		
Berastagi	Digital switch	400^{T}	1200^{T}	Standard type	Kecamatan: Kabanjahe
Tiga Binanga	Digital switch	200^{T}	(400^{T})	Standard type	
Total	26 offices	26500^{T} 4330^{CCT}		Standard building: 17 offices Container type: 1 office	

* Pk. Brandan has an automatization plan to be implemented by 1981. When this plan is implemented, the present plan will not be necessary.

** Kabanjahe has an automatization plan which aims at automatization by 1985. When this plan is implemented, local facilities will become unnecessary.

(3) Subscriber's line

Described hereunder are the subscriber's line network recommended, the types and applicable standards of cables, the limits of reference equivalent and DC resistance applied to a subscriber's line, and a construction plan for individual offices.

1) Subscriber's line network

Service areas for individual fixed distribution blocks are to be determined so that the number of demands to be made in 1995 should become 300 ~ 600. Service areas are to be determined in consideration of topographical conditions such as rivers, roads, and railways. Individual service areas incorporating exchanges are interconnected either directly or thorugh a cross connecting cabinet. The former method of interconnecting service areas is called direct connection and the latter method connection through cross connecting cabinet. These two connecting methods are to be adopted as follows.

a) Direct connection

Direct connection is to be adopted in service areas adjacent to an exchange and areas where connection through cross connecting cabinet will not be suitable.

b) Connection through cross connecting cabinet

This connecting method is to be employed where the line distance between the cross connecting cabinet and exchange exceeds several hundred meters. Cross connecting cabinet may be classified into two types by interconnecting capability —— one

capable of interconnecting 800 lines and the other capable of interconnecting 1600 lines.
The cross connecting cabinet capable of interconnecting 800 lines is to be employed in such areas that are expected to have nearly 300 demands in 1995, whereas the cross connecting cabinet capable of interconnecting 1600 lines is to be employed in such areas that are expected to have nearly 600 demands in 1995.

2) Types and applicable standard of subscriber's lines

Subscriber's lines can be classified into primary and secondary cables.
Primary cable is used for connection between a cross connecting cabinet and the exchange and between the first demand point and the exchange in a direct connection area.
Secondary cable is employed for connection between a cross connecting cabinet and a demand point and between the first demand point and a demand point in a direct connection area.

a) Primary cable

The number of primary cable pairs is to be 1.3 ~ 1.5 times as large as the expected number of demands in 1995.
Usually, conduit cable is to be used as the primary cable for interconnecting more than 300 pairs in urban areas and buried cable is to be used in suburbs.
Aerial cable is to be employed for interconnection less than 300 pairs. Aerial cable is to be employed for lead-in cable into a portable exchange even if the number of lines to be connected exceeds 300.

Conduit cable is to be a jelly filled polyethylene insulated and sheathed unit quad type cable.
Buried cable is a steel tape armoured, jelly filled polyethylene insulated and sheathed unit quad type cable.
Aerial cable is a selfsupporting, polyethylene insulated and sheathed unit quad type cable.
For aerial use, polyethylene insulated and sheathed unit quad type cable is to be employed.
The cable conductor diameters to be employed are 0.4 mm, 0.6 mm, and 0.8 mm.

b) Secondary cable

The number of lines to be interconnected by the secondary cable is to be equal to the number of demands to be made in 1995. In principle, aerial cable is to be employed for the secondary cable and underground distribution cable is to be employed only when the construction of aerial cable is extremely difficult as in shopping districts.
Aerial cable is to be a selfsupporting, polyethylene insulated and sheathed unit quad type cable.
Underground distribution cable is to be a jelly filled polyethylene insulated and sheathed unit quad type cable.
The cable conductor diameters of aerial cables to be employed are 0.4 mm and 0.6 mm and those of underground distribution cables 0.4 mm, 0.6 mm and 0.8 mm.

3) Permissible values of DC resistance and sending reference equivalent

The permissible values of DC resistance and sending

reference equivalent of subscriber lines for different types of switch is given in Table III-2-3-2. The conductor diameters, primary and secondary constants and permissible distance limits of different types of cables to be employed are given in Table III-2-3-3.

Table III 2-3-2 Permissible Values of DC Resistance and Sending Reference Equivalent

Type of Switch	DC Resistance (Ω)	Sending Reference Equivalent (dB)*
Electronic switching	2000	10.3
Cross bar switching	2000	10.3
Manual switchboard	1200	10.3

DC resistance includes the resistance of the telephone set.
For sending reference equivalent, 97% of subscribers shall not exceed the permissible value.

* The same as defined in the "FUNDAMENTAL PLAN, 1972, PERUMTEL".

Table III 2-3-3 Primary and Secondary Constants and Permissible Distance Limits for Different Types of Cable

Type of Cable		Loop Resistance (Ω/loop km)	Mutual Capacitance (nF/km)	S.R.E. (excluding Tel.) (dB/km)	Permissible Distance Limit (km)
0.4	PE	300	50	1.86	3.0
	JF	300	55	1.96	2.9
0.6	PE	130	50	1.11	5.6
	JF	130	55	1.16	5.5
0.8	JF	73	55	0.81	8.8

4) Construction plan

The number of lead-in cable pairs to be covered by the existing and new automatic switching offices (including automatic switching offices expected to be set up by REPERITA III) are given in Table III 2-3-4. In the table, the number of lead-in cable pairs of the new automatic switching offices (in the first phase) is equal to 1.4 times as large as the number of demands to be made in 1995, the number of lead-in cable pairs of such existing automatic switching offices that are expected to commence service by 1984 (in the first phase) is nearly equal to 1.4 times as large as the difference between the number of demands to be made in 1995 and the number of demand to be made in 1984, and the number of lead-in cable pairs of the existing automatic switching offices in service (in the first phase) is equal to a value 1.4 times as large as the number of demands to be made in 1995 minus the number of lead-in cable pairs existing at the time of our survey (end of 1984).
The number of lead-in cable pairs (ultimate) indicates the number of lead-in cable pairs corresponding to the number of demands to be made in 2005 irrespective of the presence/absence of the existing facilities.

Table III 2-3-4 Construction Plan

Name of Office (Name of Kecamatan)	Class of Construction*	No. of Lead-in Pairs		No. of Existing Lead-in Cable Pairs	Remarks
		First Phase	Ultimate		
Sunggal	A	700	1200		
Delitua	A	900	1500		
Percut Sei Tuan	A	1100	1900		
Galang	A	400	700		
Batang Kuwis	A	400	700		
Lubuk Pakam	A	900	1500		
Tebing Tinggi	B	5000	10200	1300	
Sei Rampah	A	1100	1800		
Perbaungan	A	500	900		
Kabanjahe	B	500	2000	400**	
Berastagi	A	100	200		
Tiga Binanga	A	500	1200		
Pematang Siantar	B	5800	16000	5800	
Simpang Bolon	B	0	0	400	
Tanah Jawa	A	500	800		
D. B. Nyanggar	A	350	600		
Bandar	A	400	650		
Babalan	B	350	1000		
Stabat	A	900	1600		
Tanjung Pura	A	450	800		
Binjai	B	4800	10400	1400	
Kisaran	B	800	2300		
Air Batu	A	300	550		
Talawi	A	650	1100		
Air Putih	B	200	1600		
Tanjung Balai	A	2900	4800		
Total		30500	66000		

* A: Automatization; B: Line unit expansion

** No. of lead-in cable pairs estimated through survey

2-4 Transmission Line

2-4-1 Multiplex Carrier Equipment

(1) General

The following three types of mulitplex carrier equipment are to be adopted in this project.

- Analog subscriber loop multiplexer equipment
- PCM-30 equipment
- Multiplex carrier equipment for PCM radio link

Each of these multiplex carrier equipment is outlined below.

1) Analog subscriber loop multiplexer equipment (SMA)

The major features of this multiplex carrier equipment are as follows.

Type of multiplexing:	Frequency division multiplexing
Applicable cable:	Local and toll cables
Maximum permissible distance:	approx. 24 km in the case of 0.6 mm polyethylen insulated, screened cable
Maximum capacity:	10 subscribers
Applicable types of equipment:	Central office terminal, repeater and subscriber terminal

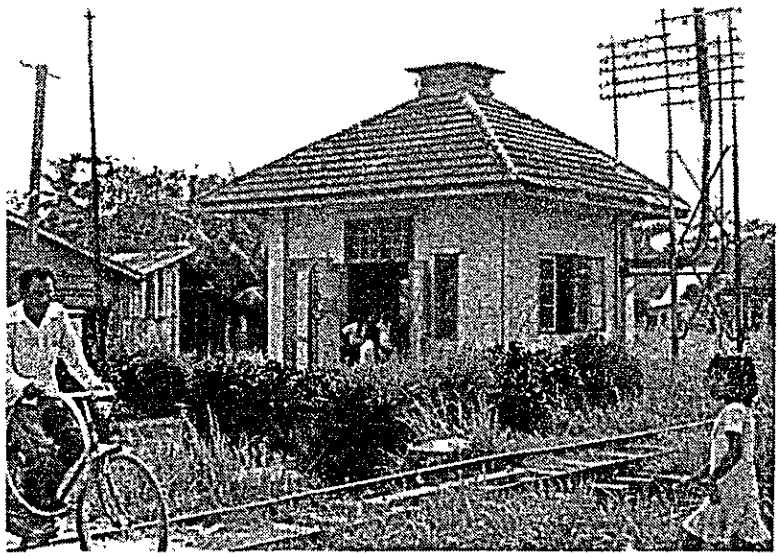
Power feeding:	Power is fed through cable core from the central office terminal via a repeater or repeaters to subscriber terminals at remote places.
Installation place:	The central office terminal is installed in the telephone office, the repeater on a pole, the subscriber terminals in subscriber's buildings.

2) PCM-30 equipment

The PCM-30 equipment is a PCM having a bit rate of 2048 K bits/S and specified in the CCITT recommendations. This equipment uses local (or toll) cable for transmission.

3) Multiplex carrier equipment for PCM radio link

The multiplex carrier equipment is a PCM capable of multiplexing and de-multiplexing between primary-order and higher-order digital groups.



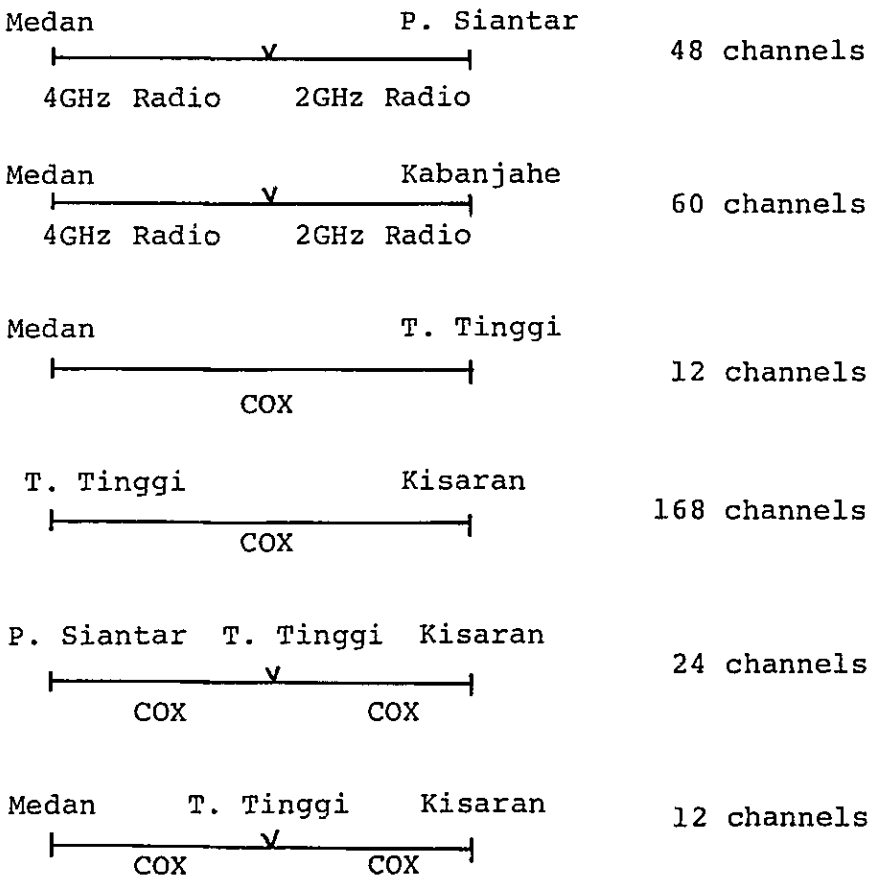
A building of Sei Rampah telephone exchange, most of old telephone exchanges like the Sei Rampah are standing beside railroad.

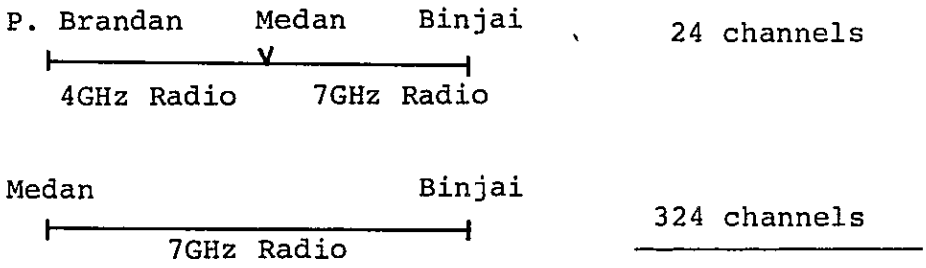
(2) Construction of Multiplex Carrier Equipment

The number of equipment to be installed newly for constructing multiplex carrier equipment in the first phase is to be as many as necessary for meeting demands in 10 years hence.

In case that existing transmission lines are expected to be overflowed by 10 years hence, the expansion of multiplex carrier equipment corresponding to the overflowed circuits is not planned in this project. The overflowed is expected to 270 channels between Medan and P. Siantar.

The multiplex carrier to be expanded and their numbers of channels are as follows.





Total: 672 channels

In this project the investment of expansion of equipment for the existing transmission lines is to be made for 672 channels in the first phase.
The multiplex equipment configurations planned in consideration of these conditions are shown in Attached Figs. III.2.4-1 (1) ~ (8).

To summarize, the following major multiplex carrier equipment is to be set up newly or expanded.

1) Multiplex carrier equipment to be set up newly in the first phase

Multiplex equipment for PCM radio link (60 channels):	20 systems
Multiplex equipment for PCM radio link (480 channels):	3 systems
PCM-30 equipment:	10 systems
Analog subscriber loop multiplexer equipment:	4 systems

2) Multiplex carrier equipment to be expanded in the first phase

Number of channels to be included by expansion on existing transmission lines:	672 channels

3) Multiplex carrier equipment expected to commence service in 1990

Multiplex equipment for PCM radio link (60 channels):	4 systems
PCM-30 equipment:	5 systems

2-4-2 Radio Transmission Line

This paragraph is intended to provide information for constructing radio transmission lines for use between offices higher in hierarchy than secondary center (including secondary center), as in the case of transmission lines by cable. This paragraph contains description of the following items.

1) An outline of radio transmission line
2) A radio transmission line between and an end office and a primary center
3) A radio transmission line between a primary center and a secondary center
4) Radio transmission line using MAS equipment
5) A radio tower
6) Items of radio equipment to be installed

(1) Outline of radio transmission line

A detailed configuration of the radio transmission line recommended in this project is shown in Attached DWG. III.2.4-2-1. The scales of the radio transmission line which have been obtained from the above-mentioned attached drawing are outlined in Table III.2.4-2-1. For the radio transmission line shown in Attached DWG. III.2.4-2-1, the line-of-sight condition in each radio section in the propagation course profile contained in SECTION V, paragraph 6 and a detail design with stable propagation characteristics is achievable by securing proper antenna heights (20m ~ 80m).

Table III.2.4-2-1 Radio Transmission Links in Sumatera Utara

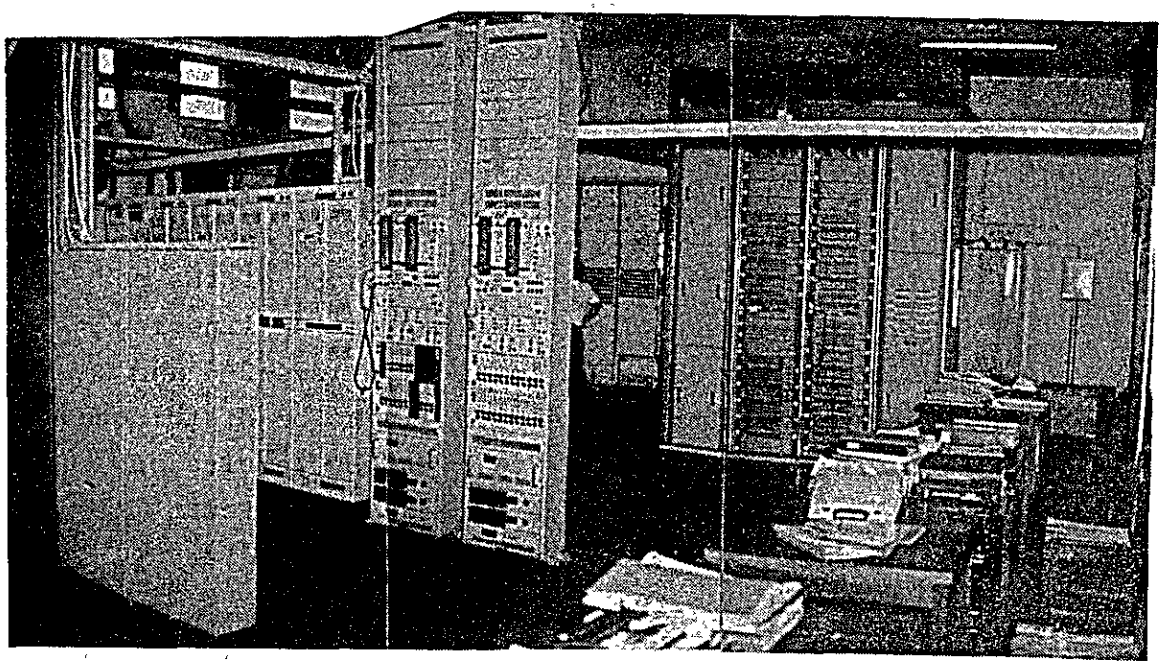
Kabupaten	Number of Radio Sections (Total Length)
Langkat	3 (39.3 km)
Karo	2 (38.8 km)
Deli Serdang	6 (112.8 km)
Simalungun	4 (105.9 km)
Asahan	4 (94.7 km)
Total	19 (391.6 km)

These transmission links are to be used for telephone transmission between an end office and a primary center and between a primary and secondary centers. Since the time division electronic exchange equipment is to be employed for telephone exchange in this project, the TDM-PCM system is recommended for the radio transmission lines. 800MHz and 2GHz frequency bands as stated in SECTION V, paragraph 5-3 are recommended. The radio transmission equipment are to be invested at a time in the first year (which is supposed to be 1985) and on this occasion radio station buildings, power plants, radio towers, etc., are to be constructed in the first year for meeting demands 20 years after that, although telephone channel multiplexer, radio transmitter-receiver, etc., are to be constructed for meeting demands 10 years later from the first year.

It is to be noted that this transmission line plan is intended for the transmission of telephone channels only and not for the transmission of television signals.

(2) Radio transmission line between end office and primary center

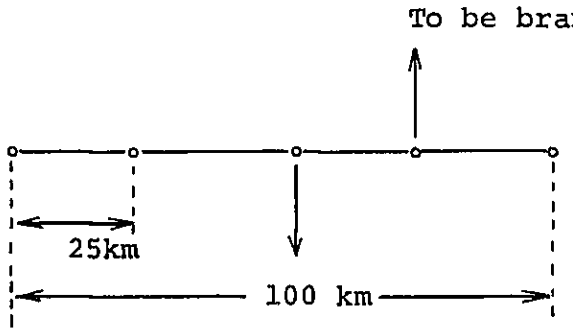
In designing a transmission line for use between an end office and another office ranking higher in telephone network hierarchy, it is generally necessary to determine whether transmission is to be made by radio or by cable. As already mentioned, the number of telephone offices to be set up in the first year of the project is 26 and the numbers of telephone offices to be set up 10 years and 20 years after that are respectively 41 and 56. If these telephone offices are to be connected by radio or cable, it has been determined as a result of the present survey that such a transmission line distance distribution as shown in Fig. V.5.3-2 is to be realized.



Transmission and radio equipment room of Medan control station

It can be roughly said by the economic comparison method that transmission by cable is more economical for distances of less than 20km and transmission by radio is more advantageous for distances of more than 20km. In this transmission line plan, consideration is given also to maintenability (by, for instance, avoiding designing such a transmission line between an end office and a primary center that contains a complicated mixture of cable and radio links and considering ease of cable maintenance, topographical districtions, etc.) as well as to the above-mentioned principle in the selection of cable/radio. For the 800MHz band PCM radio equipment, the recommendable maximum telephone channel capacity per a radio frequency channel is 60 telephone channels.

The numbers of required telephone channels for the individual radio sections are shown in Attached DWGS. III.2.4-2-2 ~ III.2.4-2-5). The distribution of the numbers of required channels obtained from these attached drawings is shown in Fig. V.5.3-1. Suppose transmission between an end office and a primary center is to be made by radio, it has been determined through survey that the length of the end office ~ primary center radio transmission line is to be distributed as shown in Fig. III.2.4-2-6 and that the number of radio sections is to be distributed as shown in Fig. III.2.4-2-7. By these results of survey, the following standard reference circuit is recommended for the end office ~ primary center radio transmission line.



Standard Reference Circuit for End Office ~
Primary Center Transmission Line

For the telephone channel quality of the transmission line, it is recommended to set up such a radio transmission line between the end office and primary center that provides a bit error rate of about 10^{-8}/100 km in ordinary condition and an unavailability of about 4×10^{-3}. The system configurations of the radio transmission lines including the MAS equipment (excluding transmission between a primary and secondary center) are shown in Attached DWGS. III.2.4-2-8 ~ III.2.4.2-12.

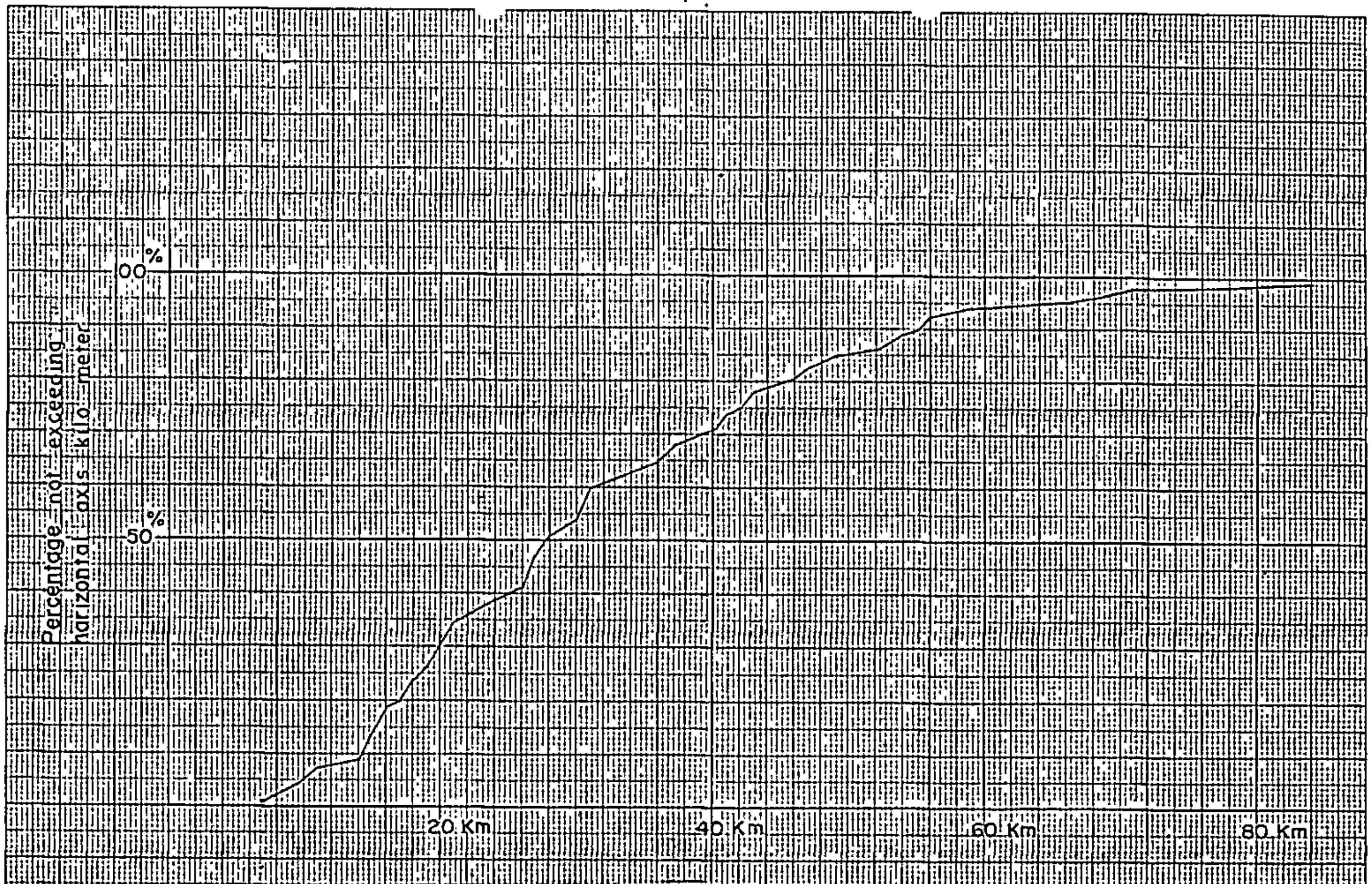


Fig. III-2-4-2-6 End office – primary centre radio transmission line length distribution

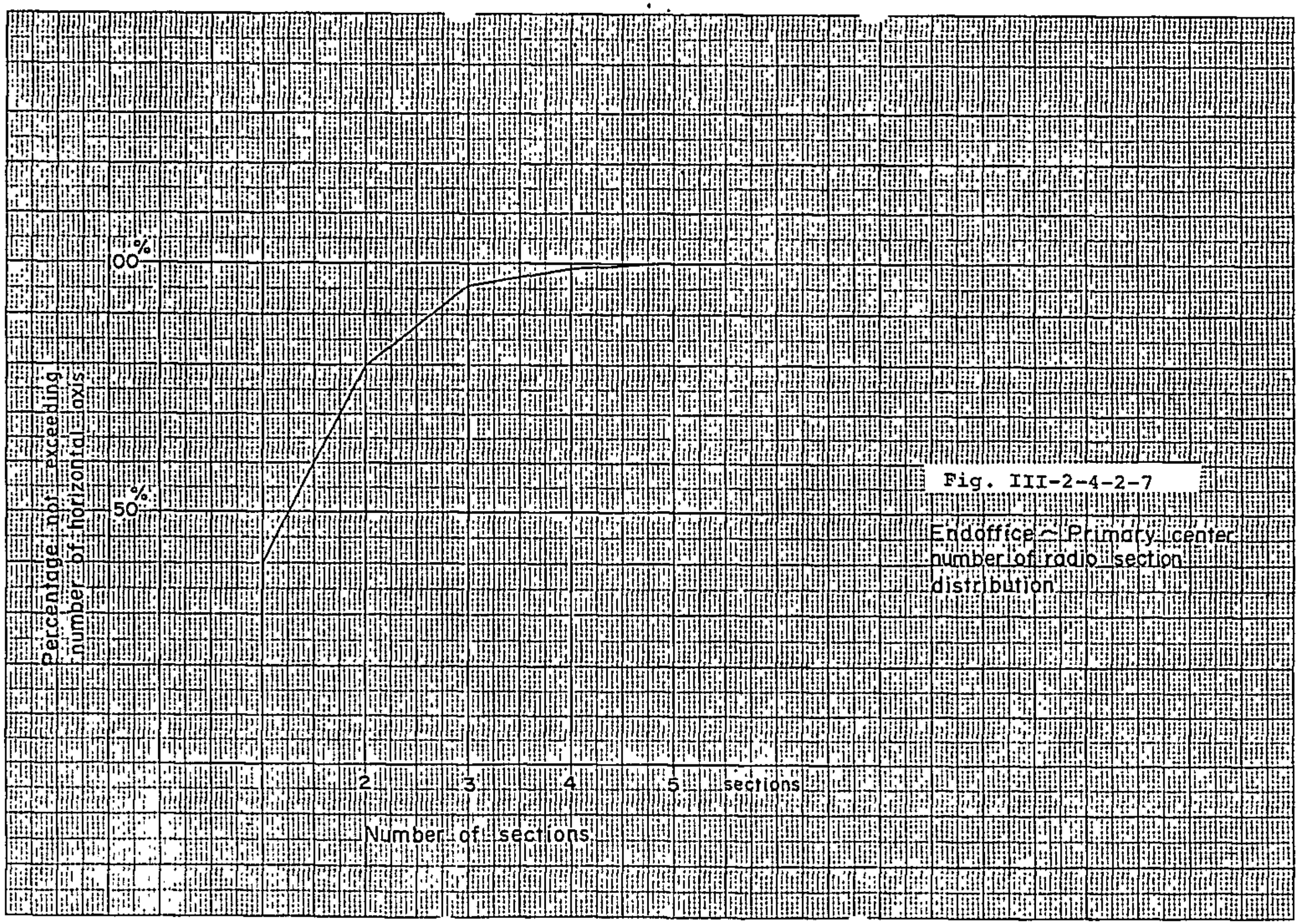


Fig. III-2-4-2-7

Endoffice ~ Primary center number of radio section distribution

(3) Radio transmission line between primary and secondary centers

On the other hand, the 2GHz band to be used for a transmission line between a primary center and secondary center are recommended. Such 2GHz band PCM radio equipment is recommended that provides a maximum channel capacity of 480 telephone channels per radio channel in consideration of the telephone demand forecast. For the channel quality, such a transmission system that provides a bit error rate of 2.5×10^{-7} per 2500 km is recommended.
For the radio frequency channel allocation of these systems, see SECTION V, paragraph 5-3. In consideration of the achievability of a high circuit reliability and ease of equipment maintenance, it is recommended to employ the so-called radio frequency channel protection system having a protection channel so as to assure continued operation through switchover of the working channel to the protection channel in case the working channel fails. The radio transmission line to be employed between a primary and secondary centers is shown in Attached DWG. III.2.4-2-13. For this transmission line, it is recommended

- to newly set up a transmission link using 2GHz radio PCM between Medan and Tebing Tinggi,
- to use the existing Banda-Ache Microwave Link (presently under construction) for transmission between Binjai and Medan,
- to employ the existing Trans-Sumatera Microwave Link for transmission between Medan and Kabanjahe, and
- to use the existing coaxial cable for transmission between Tebing Tinggi and Tanjung Balai and between Tebing Tinggi and Kisaran.

(4) Radio transmission using MAS equipment

For those Kecamatan where no telephone office is to be set up, the adoption of radio equipment using the MAS is recommended. The MAS radio equipment recommended

here is of analog type. In consideration of the future trend of telecommunications technology, the adoption of digital MAS radio equipment may be considered to be more desirable for constructing the telecommunications network. However, such digital MAS radio equipment that may be applicable to this project have not been field proven sufficiently and no satisfactory data were obtained at the time of preparing this report. That is, the digital MAS equipment seems to be in their transient period for the time being. For further detail, see SECTION V, paragraph 5-4.
This report recommends the adoption of an electronic exchange for the local switch, and the PCM-PM system for transmission between an end office and higher ranking offices in the telephone network hierarchy.

Under these circumstances, the adoption of MAS equipment based on the digital technique, although not recommended because of being not field proven sufficiency, will be desirable in future. In this MAS equipment, telephone subscribers scattering within a maximum distance of 25 km can be connected by radio transmission lines (which are recommended to use 400MHz bands) with a certain telephone office being the radio base station so far as the line-of-sight condition is available.
However, in this system the traffic per telephone subscriber is assumed to be 0.071 erl. and about 40 telephone demands are to be covered by using a maximum of 8 radio channels per a radio base station. That is, the so-called radio sbuscriber lines with line concentrators are to be formed. When there are 50 ~ 100 telephone demands in a certain area (which are supposed to correspond to as many subscribers as covered in the service area of a telephone office) and local line distances between

these subscribers are to exceed 6 ~ 8 km (in the case of cable), the adoption of subscriber lines using the MAS equipment will be advantageous economically. The adoption of such MAS equipment that cause noise of less than 10,000 pW (in weighted value) is recommended between the radio base station and subscriber terminal equipment. (If these radio sections are to be formed by using digital MAS equipment, a bit error rate of 10^{-7} ~ 10^{-8} will be necessary.

A total of 28 such MAS systems (each consisting of base station equipment for maximum 8 radio channels) are recommended for 18 base stations, that is, a total of 898 sets of subscriber's equipment are recommended. The scales of MAS equipment to be set up in individual Kabupaten are given in Table III.2.4-2-2. The distribution of the MAS radio section length to be set up in the first year is shown in Fig. III.2.4-2-14.

Table III.2.4-2-2 Scales of MAS Equipment to Be Introduced in Individual Kabupaten

Kabupaten	No. of Base Stations	No. of Systems	No. of Subscriber Set
Langkat	3	6	200
Karo	2	3	86
Deli Serdang	6	10	323
Simalungun	4	5	163
Asahan	3	4	126
Total	18	28	898

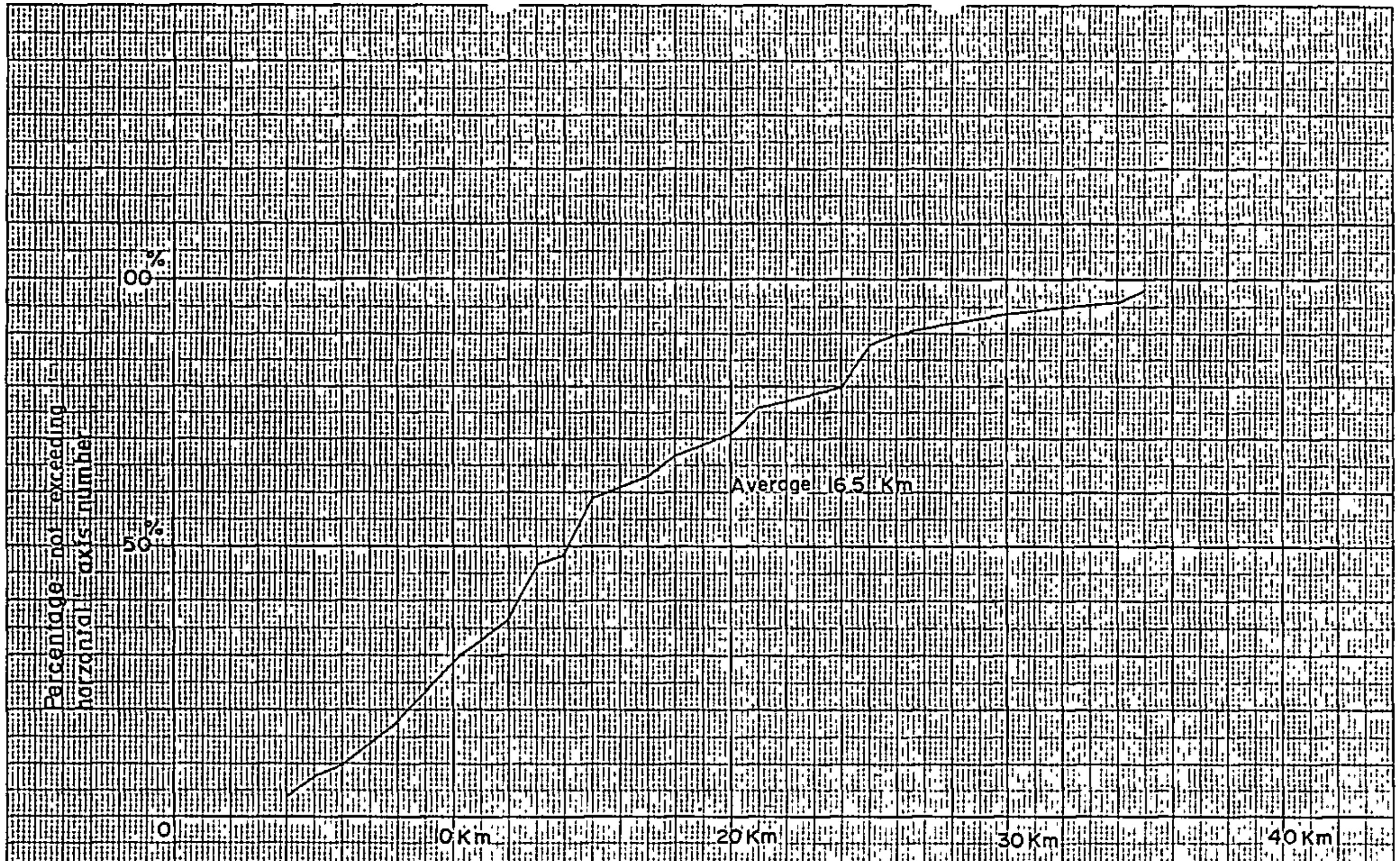


Fig. III-2-4-2-14 Distance distribution of MAS radio section

If MAS equipment are to be introduced according to this table, 20 telephone sets are to be set up in each of 50 Kecamatan having no telephone office in the first year of this project. Twenty six (26) telephone offices are to be set up in the first year and 41 and 56 offices are to be set up respectively in 10 and 20 years later. Accordingly, the number of base stations of the MAS equipment will decrease in places where the number of telephone offices increases and the number of Kecamatan where telephone service is to be given by the MAS equipment in 20 years later will consequently become 24. (See Table III.2.4-2-4.)

For those areas (Kecamatan) to which radio transmission from the radio base station is not achievable in the MAS equipment, the setup of repeater stations is recommended in this project.
By selecting a repeating point at a location on line of sight from both the radio base station and the Kecamatan expected to be furnished with telephone, MAS subscriber's equipment and VHF single channel radio equipment are to be installed there to form a repeater station. Then, transmission between the radio base station and repeater station is to be achieved by the MAS equipment and transmission between the repeater station and each telephone subscriber's house is to be achieved by VHF radio equipment. The method requires a pairs of VHF radio equipment in addition to the MAS subscriber's equipment and requires an installation cost about 2 times as large as the cost for the ordinary MAS subscriber's equipment.

This method is to be employed in 2 Kacamatan in Kabupaten Karo, one Kecamatan in Kabupaten Deli Serdang, 2 ~ 3 Kecamatan in Kabupaten Simalungun, 2 Kecamatan in Kabupaten Asahan and no Kacamatan in Kabupaten Langkat, that is, in a total of 7 ~ 8 Kecamatan in this project. If a great number of subscribers are to be relieved by this method, it is necessary to increase the number of frequencies to be assigned for VHF radio transmission and, accordingly, restrictions in frequency assignment may be caused. In the 7 ~ 8 Kecamatan where this method is to be employed in this project, the number of telephone demands is supposed to be rather small and three subscribers are to be assigned in each Kecamatan. In such a case as this, the power consumption is estimated to be about 200W at the peak and about 10 ~ 20W stand-by and the peak power consumption period is estimated to be about one hour (at the maximum) a day, as mentioned in detail in the paragraph on the power supply equipment. Accordingly, solar battery type power supply equipment for these repeater stations is recommended.

(5) Radio tower

A total of 24 radio towers are to be constructed in this project. Of these towers, 17 towers are of selfsupporting type and the remaining seven towers are of guyed-wire type. The selfsupporting type of radio tower is to be used for transmission between an end office and a primary center or between a primary center and a secondary center and the guyed-wire type of radio tower is to be used for other types of transmission (at radio base stations or repeater stations in the MAS equipment).

(6) Items of radio equipment to be installed

Table III.2.4-2-3 gives a list of items of equipment and facilities to be installed in the radio installation work. These items given in the table are to be installed in the first year to meet demands to be made for the first 10 years as mentioned earlier in this report and in ten years after commencing this project reinvestment is to be made for meeting demands to be made for another 10 years later. An outline of these processes of installation work to be accomplished in the first year and ten years later is shown in Table III.2.4-2-4.

Table III.2.4-2-3 List of Items to Be Set up in Radio Installation Work

Kecamatan	Radio Tower (sets)		PCM Radio Equipment (number of radio sections*A)		MAS Radio Equipment			Fixed VHF radio Equipment (sets)
	Self-support Type	Guyed-Wire Type	800MHz Equipment	2GHz Equipment	Base Station (Stations)	A System (SYS)	Subs Equipment (sets)	
Langkat	3		3 *B		3	6	200	
Karo	2	2	2		2	3	86	16
Deli Serdang	6	1	4	2 *C	6	10	323	8
Simalungun	2	2	4		4	5	163	8
Asahan	4	2	4 *D		3	4	126	16
Total	17	7	17	2	18	28	898	48

Remarks

*A Most of the PCM radio sections comprise one radio working channel with a protection channel.

*B One radio section out of the three sections in Langkat exceptionally comprises two radio working channels with a protection channel.

*C One radio section out of the two 2GHz sections exceptionally comprises two radio working channels with a protection channel.

*D Two radio sections out of the four radio sections in Asahan exceptionally comprise two radio working channel with a protection channel.

Table III.2.4-2-4 Processes to Be Implemented in the First Year and 10 Years Later

Kabupaten	Process	First Year	10 Years Later
Langkat	PCM radio equipment	3 sections	5 sections
	MAS equipment	3 base stations	3 base stations
	Kecamatan to introduce MAS telephone	9 Kecamatans	4 Kecamatans
Karo	PCM radio equipment	2 sections	3 sections
	MAS equipment	2 base stations	3 base stations
	Kecamatan to introduce MAS telephone	6 Kecamatans	5 Kecamatans
Deli Serdang	PCM radio equipment	6 sections	13 sections
	MAS equipment	6 base stations	3 base stations
	Kecamatan to introduce MAS telephone	17 Kecamatans	6 Kecamatans
Simalungun	PCM radio equipment	4 sections	5 sections
	MAS equipment	4 base stations	3 base stations
	Kecamatan to introduce MAS telephone	10 Kecamatans	6 Kecamatans
Asahan	PCM radio equipment	4 sections	10 sections
	MAS equipment	3 base stations	2 base stations
	Kecamatan to introduce MAS telephone	8 Kecamatans	3 Kecamatans
Total	PCM radio equipment	19 sections	36 sections
	MAS equipment	18 base stations	14 base stations
	Kecamatan to introduce MAS telephone	50 Kecamatans	24 Kecamatans

It is now understood from the table that the service by PCM radio is to be commenced in 19 sections in the first year and is to be ultimately given in a total of 36 sections by equipment expansion to be made for 17 sections in 10 years later. For MAS equipment, however, the number of telephone offices is to reach 56 in 20 years after commencing service in this project and accordingly the number of telephone subscribers using the MAS equipment is to decrease. That is, the 18 base stations of the MAS equipment are to be changed to 14 base stations and as a result the number of Kecamatan in which telephone service is to be given by the MAS equipment is to decrease from 50 to 24.

2-5 Buildings and Power Supply Equipment

2-5-1 Buildings

Buildings necessary for the implementation of this project can be classified roughly into the following types.

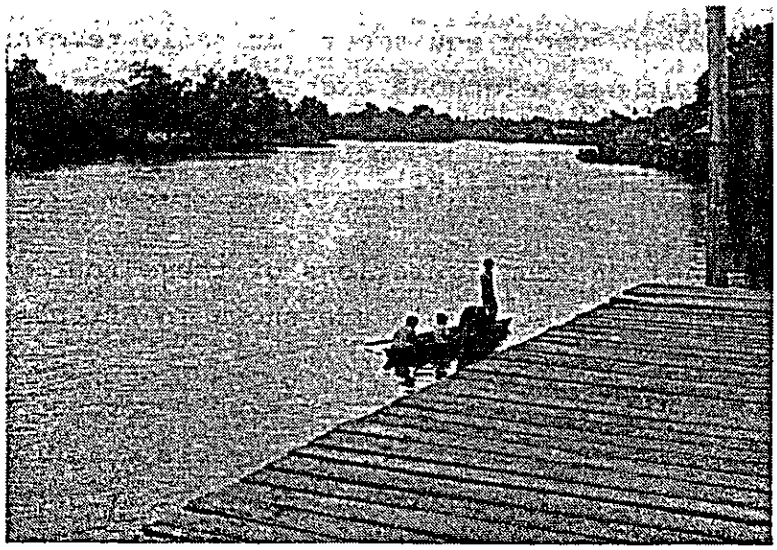
- Building to accommodate both telephone exchange equipment and carrier/radio equipment
- Building to accommodate radio equipment only

The former type of building is to be constructed at telephone offices to be set up at major Kacamatan (or Kotamadya) and the latter type at base stations expected to accommoate the MAS equipment.
The former type of building requires a floor area of 350 m^2 and a site which allows a steel tower of 50 m ~ 80 m height to be erected.
The latter type of buildng requires a floor area of 180 m^2 and a site which allows a guy-wire steel tower of about 50 m height to be erected. For such a building that is to be employed when the radio wave does not directly reach the MAS terminal equipment from the base station or for a satellite exchange, it is recommended to employ a repeater box (made of steel) of 20 ~ 30 m^2.
The required number of office buildings and the total floor area of each Kabupaten are shown in Table III.2.5-1.

Table III.2.5-1

Kabupaten	Number of Buildings of 350 m^2	Number of Buildings of 180 m^2	Number of Repeater Boxes of 20 ~ 30m^2	Total Floor Area (m^2)
Langkat	2	1		880
Karo	2		2	760
Dali Serdang	7	1	2	2690
Simalungun	3	1	2	1290
Asahan	3	0	2	1110
Total	17	3	8	6730

All buildings are to be single-storied reinforced concrete buildings.



The River Asahan near Tanjung Balai

2-5-2 Power Supply Equipment

In this project power supply equipment corresponding to the average telecommunication capacity of the telephone offices of Kecamatan class and that of Kotamadya class in 20 years after the reference year are estimated and the estimated average sized power supply equipment are to be applied to all telephone offices in the individual classes. The power supply equipment of the existing automatic switching offices are supposed to have sufficient capacities and their expansion is not planned in this project. For the average sized power supply equipment, the following four different models are provided.

1) Power supply equipment for telephone office of Kotamadya class
2) Power supply equipment for telephone office of Kecamatan class.
3) Power supply equipment for radio terminal (without telephone exchange equipment)
4) Solar battery type power supply equipment (for MAS repeater)

The equipment configurations of these four power supply equipment models are shown in Attached Table III.2.5-2.
In the case of solar battery type power supply equipment of which the dischargeable duration depends on the sunshine duration, it is necessary to provide the maintenance center with a portable rectifier (for charging batteries) and a portable engine generator for use in the event of emergency.

2-6 Maintenance and Operation

The telecommunication network proposed in this project is designed on the assumption that it is to be modified into an integrated services by digital network in future. In general, digital exchanges and radio transmission equipment are designed and manufactured to operate with sufficiently high reliability for use at unattended offices. On the basis of this high reliability of the digital exchange and radio equipment, the following maintenance and operation system are recommended.

(1) Maintenance

For the maintenance of telephone exchanges and radio transmission equipment, a maintenance center is to be set up at primary centers (such as Medan, T. Tinggi, P. Siantar, Binjai, Kabanjahe and Kisaran) where maintenance personnel are to reside for the maintenance of telephone exchanges and radio equipment in the primary center service area. Individual telephone offices such as radio terminals and radio repeater stations (excluding toll centers) are to be unattended the maintenance of which is to be performed by maintenance personnel residing at individual maintenance centers.

For the maintenance of subscriber's lines, about three maintenance personnel are to reside at each telephone office to be engaged in simple trouble shooting and repair and inspection by patrol. Each maintenance center mentioned above is also to have resident maintenance personnel

to be engaged in construction work, removal of equipment due to other construction work or by request, recovery in the event of disasters, etc.

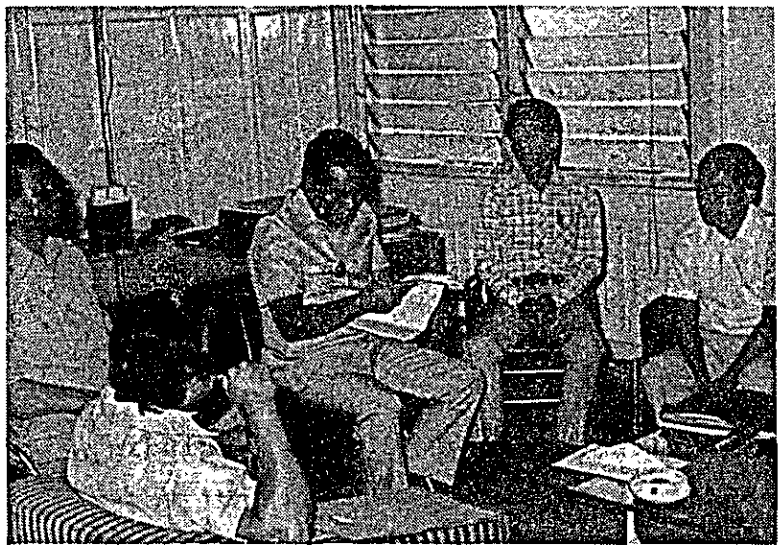
In order to manage the above-mentioned six maintenance centers, a central maintenance control center is to be set up to provide necessary control personnel in Medan.

The number of personnel necessary for the above-mentioned maintenance system is about 200 in total. The breakdown of these maintenance personnel is to be as follows.

Central Maintenance Control Center:	12 persons
Medan Maintenance Center:	41 persons
T. Tinggi Maintenance Center:	13 persons
P. Siantar Maintenance Center:	26 persons
Binjai Maintenance Center:	23 persons
Kabanjahe Maintenance Center:	19 persons
Kisaran Maintenance Center:	24 persons
Telephone offices (14 offices x 3 persons):	42 persons

Maintenance equipment or measuring instruments that are expected to be used frequently are to be provided at each maintenance center and site and maintenance equipment that are not to be used frequently will be provided at the Central maintenance control center. Spare panels and parts should be concentrated at each maintenance center as much as practicable and

minimum quantities of consumable parts and others are to be provided at site. Such spare panels that are very expensive and that are to be provided in small quantities are to be provided at the Central Maintenance Control Center.



The team visited Mayor of Pematang Siantar

(2) Operation

The communication network composed in this project is to employ subscriber dialling and requires no telephone operator in principle.

(3) Training

The telecommunication network proposed in this project is a digital network of which maintenance may not be achievable by technical personnel having the background of only analog technique. Proper training should be provided by equipment suppliers for achieving digital techniques. Accordingly, it is recommendable to provide the article of training in the contract for this project.

2-7 Project Implementation Schedule

The construction work to be implemented in this project can be divided roughly into the following two types of work depending on the method of equipment procurement.

- System construction to be implemented by using Indonesian products
- System construction to be implemented by using foreign products

The former type of construction work comprises:

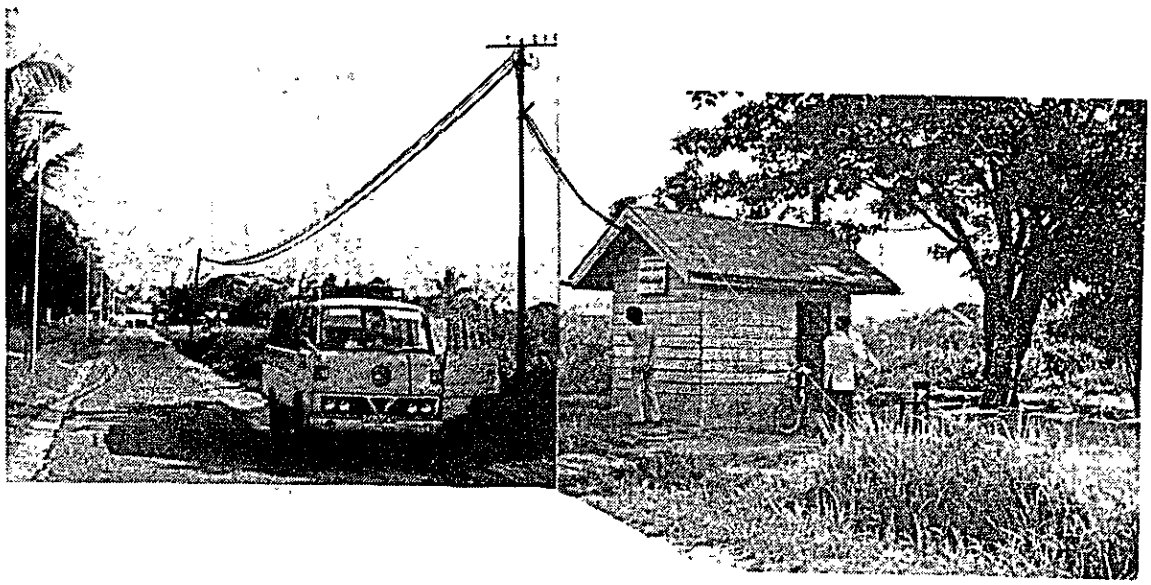
- Construction of buildings (including appurtenant facilities)
- Civil work (such as foundation)
- Tower erection
- Exchange expansion (expansion of existing exchanges)
- Installation of local cables (including poles) and appurtenant work
- Installation of telephone sets

The latter type of construction work comprises:

- Installation of analog subscriber loop multiplexer system equipment
- Installation of MAS system equipment
- Installation of VHF (FDM) radio equipment

- Installation of UHF/SHF (PCM) radio equipment
- Installation of digital telephone exchange
- Installation of PCM-30 system equipment
- Installation of power supply equipment for communication

This project is to be implemented by introducing both domestic and foreign products. In order to achieve smooth implementation of the project, it is more recommendable for the Government of Indonesia to let the domestic and foreign contractors work on a joint basis or on a subcontract basis through representation by a distinguished foreign contractor rather than making orders separately to domestic and foreign contractors. This is suitable also from the standpoint of clarifying the responsibility for the implementation of the project.



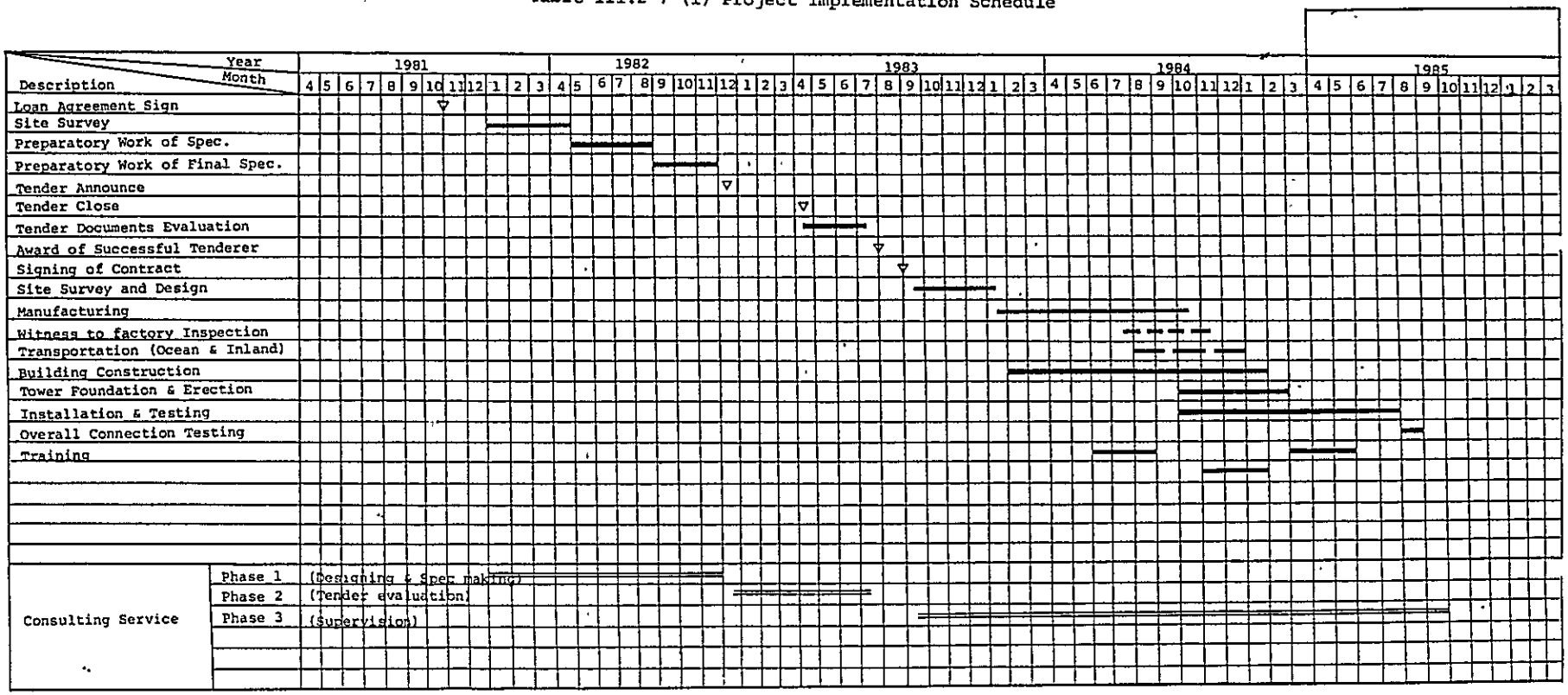
A building of Perdagangang telephone exchange, which is located in crop fields.

The term of work of this project will be determined by the periods of time required for the following works.

- Period ranging from tender announcement to signing of contract
- The design of equipment and the system
- Manufacture and transportation of equipment
- Installation, adjustment and testing
- Construction of station buildings

These periods depend on the scale of the project. A project implementation schedule planned for this project is shown in Table III.2.7 (1).

Table III.2-7 (1) Project Implementation Schedule



2-8 Cost Estimation

2-8-1 Construction Costs

(1) Telephone exchange switches

The construction costs of telephone exchange switches are estimated as follows.

1) The cost of digital telephone switching systems is divided into two types of cost: the fixed cost of central control units, main and file memory units, etc., and the cost proportional to the traffic (number of trunks) such as speech path.

2) For the terminal extension of the existing telephone offices, the same type as that of the existing exchange switches is to be installed.

3) The result of cost estimation is summarized in Table III.2.8-1-1.

Table III.2.8-1-1 Estimated Costs of Telephone Exchange Switches (Unit:million Rp.)

	Foreign Currency	Local Currency	Total
Foreign Products	5,127 (1,709)*	312	5,439
Domestic Products		1,050	1.050
Total	5,127 (1,709)	1,362	6,489
* Million yen			

(2) Subscriber's lines

The construction costs for the procurement of subscriber's lines to be served by 18 new automatic exchange offices, and eight existing automatic exchange offices are as follows.

Total construction costs: Rp. 11346 x 10^6
(¥3782 x 10^6)

(3) Multiplex carrier equipment

The construction costs have been calculated for the system configuration and conditions specified in SECTION III, paragraph 2-4-1, item (2). The costs are as follows.

1) Construction cost for setting up multiplex carrier equipment newly

a) Multiplexer for UHF radio equipment
Foreign currency: Rp. 520 million (=¥173 million)
Local currency: Rp. 61 million (=¥20 million)

b) PCM-30 equipment
Foreign currency: Rp. 329 million (=¥110 million)
Local currency: Rp. 39 million (=¥13 million)

c) SMA equipment
Foreign currency: Rp. 134 million (=¥45 million)
Local currency: Rp. 16 million (=¥5 million)

d) Measuring instruments
Foreign currency: Rp. 155 million (=¥52 million)
Local currency: Rp. 5 million (=¥2 million)

2) Cost for circuit expansion of existing transmission line

Foreign currency: Rp. 568 million (=¥189 million)

Local currency: Rp. 67 million (=¥22 million)

(4) Radio equipment

Three types of radio equipment are to be installed in this project: 800MHz radio equipment and 2GHz radio equipment for transmission between an end office and a higher ranking office in telephone network hierarchy and radio equipment using the MAS system.

First, 800MHz band and 2GHz PCM radio equipment are to be provided for 19 radio sections (each radio section consisting of 4 sets of radio transmitter-receiver for use in one radio section forming one working circuit and one stand-by circuit). The construction costs include, in addition to the cost of the radio equipment proper, the costs of supervisory and control equipment, antennas and their feeders, basic measuring instruments, and selfsupporting radio towers and also includes the cost of installation materials, various transportation fees, insurance fee, and the cost associated with the installation cost.
The cost of radio towers includes their assembly and foundation construction cost.

MAS equipment comprises, in addition to basic station radio equipment, line concentrators, omnidirectional antennas and feeders. For the

construction costs, such additional costs as mentioned in the paragraphs on the PCM-800MHz and PCM-2GHz radio equipment are also quoted in addition to the cost of the radio equipment proper.
For the MAS subscriber's equipment, carrier terminal radio equipment, telephone sets, antennas (Yagi antennas), 6m antenna poles, and feeders are quoted.
For VHF radio equipment, Yagi antennas and associated feeders are quoted in addition to the radio equipment.
For MAS subscriber's equipment and VHF radio equipment, such additional costs as mentioned above are also quoted.

For the sectioning of the local and foreign currencies, it is recommended to purchase PCM radio equipment and MAS equipment by the foreign currency, and also recommended to purchase radio towers and VHF radio equipment by the local currency. For those equipment to be purchased by foreign currency, inland transportation and domestic insurance are to be paid by the local currency, so that these costs for inland transportaion and domestic insurance are to be included in the local currency.

(5) Office/station building and power supply equipment

As already stated in paragraph 2-5, each office/station building is to be one-storied reinforced concrete building of 350 m^2 or 180 m^2. The costs of lighting, water supply and drainage facilities and airconditioning equipment are also included in the estimate of office/station buildings. 30 m^2 repeater boxes are

quoted on condition that only one office/station building (Deli Serdang) out of eight office/station buildings is to be furnished with airconditioning equipment. All these have been estimated in terms of the local currency.

Power supply equipment can be classified into the following six categories, as mentioned in the paragraph on facility planning.

- Power supply equipment to be installed at telephone offices in Kotamadya (Tanjung Balai only in this project) ..... Type 1

- Power supply equipment to be installed at telephone offices in Kecamatan
  When commercial power is available ..... Type 2-1
  When commercial power is not available ... Type 2-2

- Power supply to be installed at repeater stations expected to be furnished with transmission radio equipment only
  When commercial power is available ..... Type 3-1
  When commercial power is not available ... Type 3-2
  When commercial power is not available
  but solar battery is to be adopted..... Type 3-3

The number of offices of the individual categories classified as above are given in Table III.2.8-1-3. It is recommended that all these power supplies are to be purchased by foreign currency. The costs of installation materials, shipment (marine transportation), overseas insurance, and installation are to be added as additional expenses to be paid

by foreign currency. The costs of inland transportation and domestic insurance are to be added as additional expenses to be paid by the local currency.

Table III.2.8-1-3

Kabupaten	Type 1 (sets)	Type 2-1 (sets)	Type 2-2 (sets)	Type 3-1 (sets)	Type 3-2 (sets)	Type 3-3 (sets)	Total (sets)
Langkat		2		1			3
Karo		1	1			2	4
D. Serdang		8			1	1	10
Simalungun		1	2		1	2	6
Asahan	1		2			2	5
Total (sets)	1	12	5	1	2	7	28

. (6) Totalization of cosntruction costs

Table III.2.8-1-4 gives the total costs of the individual items discussed so far. The sum of the consultant's fee and contingency given in the table is 5% of all construction costs. The consultant's fee is to be spent mainly for the detailed design of this project and the evaluation of tender specifications. The costs supervisory process, installation test, etc., necessary for the implementation of construction are quoted within the construction costs of the individual items.

The cost of training is included in the equipment costs.

Table III.2.8.1-4 Construction Costs

(Unit: million Rp.)

Item	Process	Cost			Remarks
		Foreign Currency	Local Currency	Total	
(1) Telephone exchange					
1) Automatic exchange	26 offices	5127	1362	6489	
2) Manual switchboard	offices				
Subtotal:		5127	1362	6489	
(2) Subscriber's facilities					
3) Subscriber's line unit	26 offices		11346*1	11346	*1 Including telephone sets.
4) MAS	28 SYS	3039	66	3105	
5) Subscriber's line carrier transmission equipment	4 SYS	134	16	150	
Subtotal:		3173	11428	14601	
(3) Transmission facilities					
6) Transmission by radio	38 SYS	1840 520	1149*2 61	2989*4 581	*2 Radio towers and VHF radio equipment are to be purchased by local currency.
7) Carrier transmission by cable	10 SYS*3	485	45	530	*3 Including four SMA systems.
8) Expansion of existing transmission line	672 lines	568	67	635	*4 Including measuring instruments.
9) Access road	km				
Subtotal:		3413	1322	4735	
(4) Office/station building					
10) Office/station building	28 offices		1797	1797	
11) Power supply facilities	28 offices	2424	52	2476	
Subtotal:		2424	1849	4273	
Total		14137	15961	30098	
(5) Consultant's fee and contingency		707	798	1505	
Grand total		14844 (4948)	16759 (5586)	31603 (10534)	

Figures in parentheses ( ): in Japanese yen

Exchange rate: Rp. 3 =¥1

2-8-2 Maintenance and Operating Costs

In general, maintenance and operating costs can be expressed by the following equations.

$$\text{Maintenance cost} = \text{Amount of investment} \times \text{Maintenance cost ratio} \times \text{Personnel expense correction coefficient}$$

$$\text{Operating cost} = \text{Sales} \times \text{Operating cost ratio} \times \text{Personnel expense correction coefficient}$$

These ratios and coefficients used in the above-mentioned equations are supposed to be as follows.

Maintenance cost ratio = 3% of amount of initial investment

Personnel expense correction coefficient = 0.475
(The ratio of non-personnel expense to personnel expense is made 0.3:0.7 and the personnel expense in Indonesia is supposed to be 1/4 of that in Japan in consideration of wage level and working efficiency in Indonesia.)

To summarize, the respective costs in this project have been obtained by the following equations.

$$\text{Maintenance cost} = \text{Amount of intial investment} \times 0.03 \times 0.475$$

$$\text{Operating cost} = \text{Gross annual sales} \times 0.3 \times 0.475$$

2-8-3 Working Capital Cost

The working capital cost is a cost necessary for smooth operation of a project and is given by multiplying the difference between the gross earnings of the year and the gross earnings of the preceding year by a certain coefficient which is determined by the operating scale of the project (0.3 in the case of this project).

2-8-4 All Estimated Costs

Table III.2.8-4-1 gives all estimated costs of this project for Sumatera Utara.

Table III.2.8-4-1 All Estimated Costs (Sumatera Utara)

Item	Foreign Currency	Local Currency	Total	Remarks
1. Construction Costs	14,844 (4,948)	16,759 (5,586)	31,603 (10,534)	
2. Maintenance and Operating Costs	-	1,747	1,747	in the first year of service
3. Working Capital Cost	-	1,815	1,815	

* For detail see Table III.3-2 (P.122, 123)

Unit: Rp. million
Figures in parentheses are in Japanese million yen.
Exchange rate: Rp.3 = ¥1

2-9 Revenue (Sumatera Utara)

Revenue discussed in the financial analysis of this project are to come from 1) telephone installation charge, 2) (monthly) rental charge, 3) call charge, 4) incoming call earning.

The telephone installation charge consists of all charges to be collected from new subscribers upon installing telephone facilities and comprises charges for facilities and installation work. The (monthly) rental charge is a charge to be collected from each subscriber periodically irrespective of the number of telephone calls made and comprises the flat-rate portion in the calling charge as in the case of manual exchange service.

The call charge is a charge to be collected from each subscriber depending on the number of calls he has made during a given period of time. Estimated call charge is obtained by multiplying the average annual traffic per subscriber by the weighted average interlocal call charge.

The average annual traffic per subscriber is obtained from the predetermined traffic per subscriber and average line occupancy rate by the following equation.

Average annual traffic per subscriber (every 3 minutes) (480 calls)

= Predetermined traffic (in earlang in the busiest hour)(0.02)

x Average line occupancy rate (0.66)

÷ Busiest hour concentration ratio (1/6)

x Average monthly usage (in days)(25)

x 12 (months) x 60 (minutes)÷ Duration per call(minutes)(3).

The average call charge is the weighted average call charge to be obtained by multiplying the traffic for each toll zone in subscriber trunk dialling service by the individual charges and then dividing the result by the total traffic, as follows.

Weighted average interlocal call charge per subscriber (Rp./3 minutes)(768 Rp.)
= (40Rp. x 26.9 + 240Rp. x 37.55 + 1200Rp. x 14.21 + 1440Rp. x 5.96 + 2400Rp. x 11.87 + 3600Rp. x 3.51) ÷ 100

A building of Parapat telephone exchange, which is modern and accomodates the cross-bar type automatic exchange.

The average annual call charge earning per subscriber is calculated on the assumption that the percentage of effective calls, which yield earnings, out of average annual traffic is 72.25%, as follows.

Average annual call charge earning per subscriber (in 10^3Rp.)(267)

= Average annual traffic per subscriber (480)

x Average call charge (0.768) x Telephone call completion ratio (0.7225)

Incoming call earning is a type of earning from increase in the number of telephone calls from areas outside of this project by the implementation of this project and is estimated to be 35% of the call charge earning in this project. In estimating the earning from telephone installation charge, Rp.25,000 applicable to a Class 7 office has been applied to all subscribers since this project is intended mainly for medium- and small-scale telephone offices. The telephone installation charge earning is acquired only upon installing telephone facilities and later earnings from transfer or removal of telephone facilities by subscriber's request are neglected.
The basic rate earning is estimated to be annually 12,000Rp. per subscriber in consideration of automatic exchange service in this project.

The estimation of earnings is made assuming that no revenue will arise during the construction period, that all telephone facilities for waiting applicants and the palnned number of facilities for the year will operate to commence telephone service in the beginning of the first year of service and that in the second and following years the planned number of telephone facilities will commence operation to start service in the beginning of the year in the same manner.

Since revenue are estimated for the capacity achievable by the initial investment for 10 year's demands, increase of revenue by facility expansion after ten years since the commencement is not estimated.

The number of demands to be made in 1985 which is the reference year for the estimation of revenue in this project is estimated to be 15,226 and the average number of telephone sets to be installed after that is estimated to be 1,696 per year.

The annual fund statement of the project for Sumatera Utara is shown in Table III.2-1.

3. Financial and Economic Analyses (Sumatera Utara)

3-1 Financial Analysis

(1) Premises for financial analysis

Revenue and expenditure used in the financial analysis are based on the estimated figures mentioned in paragraphs 2-8 and 2-9 of this section.

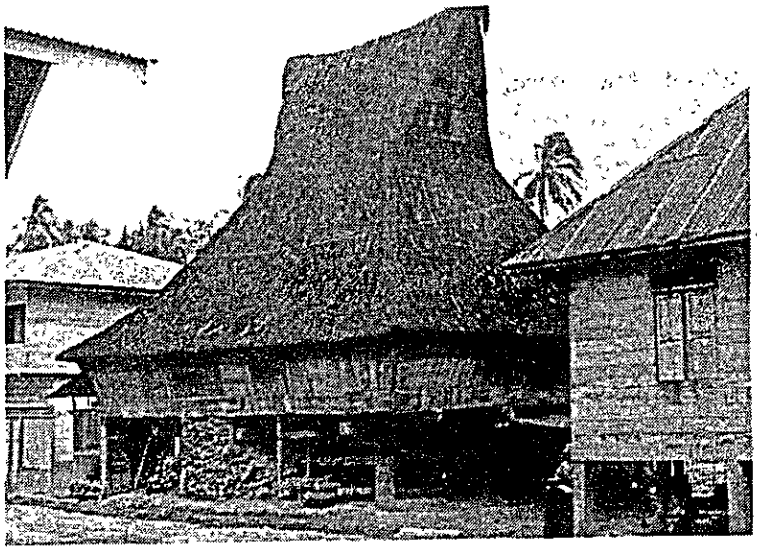
These costs comprise 1) construction investment cost, 2) maintenance and operating costs, and 3) working capital costs.

The construction investment cost consists of the construction cost of exchange switches, subscriber's lines, interlocal transmission lines, and office buildings. The construction cost includes the sum of investment for meeting demands to be made for ten years after commencement.

The maintenance and operating costs can be divided into the maintenance cost estimated from the sum of investment for the construction and the operating cost estimated from annual revenues.

A total of 1.425% of the construction investment is to be appropriated annually for the maintenance cost which includes the maintenance parts cost of 0.9% of the construction investment and personnel cost of 0.525% of the construction investment. For the operating cost, 9% and 5.25% of the gross annual revenue are appropriated respectively for the non-personnel and personnel costs.

The working capital of each year is to be 30% of the annual increment of the gross annual revenue and the total sum of these gross annual revenue increments is to be refunded at the end of the system life.



A folk housing of Karo Batac tribes in North Sumatera

The construction investment is supposed to be distributed uniformly to the individual years throughout the period of the construction in this project.
For funds necessary for the construction investment, the ratio of profits to local finance is calculated on the assumption that loan in Japanese yen credit is to be offered for the foreign currency portion and the rest is to be covered by the local finance. In this case, the ratio of the loan in Japanese yen credit to the total amount of investment and the loan conditions are supposed to be as follows.

Ratio of loan in Japanese yen to total investment:	45.7%
Interest rate:	3.5%
Grace period:	10 years
Repayment period:	20 years

The payment of the interest is supposed to be started in the year of commencement.
There may actually be considerable differences in service life and residual value among individual facilities but in this project the service life is supposed to be 20 years after commencement and the residual value after the expiration of the service life is supposed as small as negligible.

(2) Analysis of the ratio of profit to gross investment

Under the above-mentioned premises the internal rate of return (IRR) for this project is estimated on the basis of the cost and revenue estimated in paragraphs 2-8 and 2-9 of this section.
The estimated cost and revenue of individual items in individual years throughout the system life are given in Table III. 2-1.
As the result, the estimated IRR of this project is 16.8%. This estimated IRR exceeds the interest rate from the Indonesian Government to PERUMTEL (12%), so that it can be determined that this project is profitable for PERUMTEL. In other words, this project can be determined to be feasible at least from financial standpoint.

In estimating the call charge earning which is to occupy a great portion of all earnings, a considerable discrepancy may be involved from actual call charge earning since there is no data of past call charge earning in the currently non-telephone areas where telephone service is to be introduced newly by this project.
Suppose the call charge earning per subscriber is about 10% less than the estimated value, the IRR of this project will become 14.9%.
This value is still more than 12%, which shows that this project can be determined feasible from the financial standpoint even if a considerable safety factor is included.

(3) Analysis of the ratio of profit to local portion

Although this project can be determined feasible from the internal rate of return through the financial analysis of gross investment it is necessary, for determining the feasibility of the project in more detail, to determine whether sufficient funds can be raised for this investment or not and whether funds necessary for reinvestment can be reserved during the period of the system life of this project or not.

Table III.2-1 Cash Flow Statement (Sumatera Utara)

(Unit: Thousand Rp.)

Item		Loan from Foreign Government	Total Revenue	Invest-ment	Working Capital	Mainte-nance and Operation Costs	Repayment of Loan and Interest	Total Expenditure	Balance between Revenue and Expenditure	Accumula-tion of Balance
Year No.	Income									
1	0	7426679	7426679	15801450	0	0	0	15801450	-8374771	-8374771
2	0	7426679	7426679	15801450	0	0	259934	16061384	-8634705	-17009472
3	6049586	0	6049586	0	1814875	1745632	519867	4081374	1968212	-15041260
4	6344328	0	6344328	0	88423	1785538	519867	2393828	3950500	-11090760
5	6977121	0	6977121	0	189838	1869066	519867	2578771	4398350	-6692410
6	7609913	0	7609913	0	189838	1952595	519867	2662300	4947613	-1744797
7	8242706	0	8242706	0	189838	2036123	519867	2745828	5496878	3752081
8	8875498	0	8875498	0	189838	2119651	519867	2829356	6046142	9798233
9	9508291	0	9508291	0	189838	2203180	519867	2912885	6595406	16393627
10	10141083	0	10148291	0	189838	2286709	519867	2996414	7144669	23538288
11	10773876	0	10773876	0	189838	2370238	519867	3079943	7693933	31232208
12	11406668	0	11406668	0	189838	2453766	519867	3163471	8243197	39478392
13	11364193	0	11364193	0	-12742	2448159	1262535	3697952	7666241	47141632
14	11364193	0	11364193	0	0	2448159	1236580	3684739	7679454	54821072
15	11364193	0	11364193	0	0	2448159	1210561	3658720	7705473	62526544
16	11364193	0	11364193	0	0	2448159	1184605	3632764	7731429	70257968
17	11364193	0	11364193	0	0	2448159	1158587	3606746	7757447	78015408
18	11364193	0	11364193	0	0	2448159	1132568	3580727	7783466	85798864
19	11364193	0	11364193	0	0	2448159	1106613	3554772	7809421	93608272
20	11364193	0	11364193	0	0	2448159	1080594	3528753	7835440	101443696
21	11364193	0	11364193	0	0	2448159	1054639	5302798	7861395	109305088
22	11364193	0	11364193	0	-3409257	2448159	1028620	67522	11296671	120601744

In consideration of the current PERUMTEL's capability of raising funds on hand, it may be presumed difficult to raise as much funds as the estimated amount of investment for the elimination of non-telephone areas only by funds on hand. Accordingly it is necessary to raise funds from foreign country for implementing this project and suppose a long range and low rate loan is offered by an amount of 45.7% of the total amount of investment for this project, the fund position of this project will become as shown in Table III.2-1. The earning rate of PERUMTEL's funds on hand and funds to be raised locally in Indonesia which is estimated on the assumption of introducing the loan in Japanese yen mentioned in the preceding paragraph, is to be 25.16%. It is clear, from the fund statement table also, that if the soft loan is introduced, funds necessary for the renewal of this project can be sufficiently secured by the end of the system life of this project.

The present worth of this project is to be Rp.20,008 million and the cost-to-earning ratio is to be 0.70 on the assumption of a social discount rate of 12%.

3-2 Economic Analysis

(1) Premises

The estimation of costs and benefits used in economic analysis is based on cost and revenue used in financial analysis.
Basic factors used in economic analysis are obtained through various types of conversion of financial data depending on individual characteristics.
Factors employed in these types of conversion are: 1) Standard conversion factor (SCF), 2) Consumer conversion factor (CCF), and 3) Shadow wage rate (SWR).

The SCF is an average value for the two years obtained from the export/inport satistics and government customs revenues of 1977 and 1978 and is 0.980.
The CCF is obtained from the national income statistics of 1977 and is 1.00.
These values are national average values and will become much smaller if only modern sectors alone are considered. However, since this project is intended for traditional sectors, it may be more suitable to employ national average values.
The SWR is obtained from the average wage of Grade I personnel of PERUMTEL and the minimum wage of agricultural laborers and the premium of saving (1.5 is adopted herein) in Sulawesi Selatan and is 0.59.

In economic analysis it is necessary to estimate costs and benefits in other than financial analysis

and here the consumer's surplus belonging to subscribers is estimated as one of the benefits. The consumer's surplus is estimated by introducing a utility function from inter-city traffic data obtained in Sulawesi Selatan, the populations of individual cities and distances between cities and then obtaining theoretical inter-city traffic obtained from the utility function and actual inter-city charges.

The demand function and utility function are respectively obtained as follows and the average consumer's surplus per subscriber which is obtained from these functions is 1.05 times as large as the earning per subscriber obtained in the financial analysis.

Demand function:

$$\ln T_{ij} = -15.7869 + 1{,}01663 \ln Ni + 1{,}05789 \ln Nj - 0.726461 \ln D_{ij} \qquad (R^2 = 0.6646)$$

Utility function:

$$P_{ij} = 673.792 - 1.43459 \hat{T}_{ij} \qquad (R^2 = 0.7444)$$

where T_{ij}: traffic between cities i and j

N_i: population of city i

N_j: population of city j

D_{ij}: road distance between cities i and j

P_{ij}: call charge per 3 minutes between cities i and j

$\hat{T}_{ij}$: traffic obtained from the demand function

In economic analysis, costs are divided into the cost to be paid by the foreign currency and that to be paid by the local currency, the cost to be paid by the local currency is still divided into non-personnel cost and personnel cost, and the personnel cost is still divided into the cost of skilled laborers and that of unskilled laborers. For those costs that are estimative, values are applied and for those that are not estimative, those values obtained in the case of Sri Lanka (mentioned in the Feasibility Study of Sri Lanka Telecommunication Expansion Plan, 1977 July, JICA) are applied.
For the ratio of the non-personnel cost to personnel cost in the maintenance and operating costs, the value obtained in the financial analysis is employed.

(2) Economic analysis

In the economic analysis present value analysis has been made for the social discount rate of 12%. Costs and benefits in different economic sectors in individual years are given in Table III.3-2. and the present value of this project is Rp.82,507 million. This means that this project is extremely effective from the economical standpoint and should be implemented from the standpoint of national economy.

Costs and benefits in different economic sectors are given in Table III.3-2. The employment enhancing effect of this project can be estimated from the costs and benefits in different sectors.
The employment enhancing effect of engineers and technicians is about 11,600 man-years and that

of unskilled laborers about 1,600 man-years. It can be understood that this project is supposed to bring about the employment opportunities of 600 persons per year in average.

The estimated direct effect to local industries amounts to Rp.79,196 million and is presumed to still increase if employment opportunities to be provided through the local industries (about 1,800 persons per year) are included.

Table III.3-2 Cost and Benefit Table (Sumatera Utara)

PV = 82507733

	1	2	3	4	5	6	7	8	9	10
PB1	0	0	6049586	6344328	6977121	7609913	8242706	8875498	9508291	10141083
PB2	0	0	0	0	0	0	0	0	0	0
MB	0	0	0	0	0	0	0	0	0	0
SB1	6699813	6699813	0	0	0	0	0	0	0	0
SB2	0	0	527136	527136	527136	527136	527136	527136	527136	527136
SB3	0	0	544463	570989	627941	684892	741843	798795	855746	912697
LSB1	837476	837476	0	0	0	0	0	0	0	0
LSB2	0	0	420951	420951	420951	420951	420951	420951	420951	420951
LSB3	0	0	254083	266462	293039	319616	346194	372771	399348	425925
LUB	837476	837476	0	0	0	0	0	0	0	0
EB	0	0	0	0	0	0	0	0	0	0
GB	0	0	0	0	0	0	0	0	0	0
CB1	0	0	12401646	13005867	14303092	15600315	16897536	18194752	19491984	20789200
CB2	0	0	0	0	0	0	0	0	0	0
TOTAL	8374766	8374766	20197864	21135733	23149280	25162823	27176366	29189902	31203456	33216993
PC1	8374771	8374771	0	0	0	0	0	0	0	0
PC2	0	0	0	0	0	0	0	0	0	0
PC3	0	259934	519867	519867	519867	519867	519867	519867	519867	519867
PC4	0	0	1814875	88423	189838	189838	189838	189838	189838	189838
PC5	0	0	1746632	1785538	1869066	1952595	2036123	2119651	2203180	2286709
PC6	0	0	0	0	0	0	0	0	0	0
MC	0	0	0	0	0	0	0	0	0	0
SC1	5777918	5777918	0	0	0	0	0	0	0	0
SC2	0	0	454602	454602	454602	454602	454602	454602	454602	454602
SC3	0	0	469545	492421	541536	590651	639766	688880	737995	787110
LSC1	753729	753729	0	0	0	0	0	0	0	0
LSC2	0	0	378855	378855	378855	378855	378855	378855	378855	378855
LSC3	0	0	228674	239816	263735	287655	311574	335494	359413	383333
LUC	494111	494111	0	0	0	0	0	0	0	0
EC	0	0	0	0	0	0	0	0	0	0
GC	0	0	0	0	0	0	0	0	0	0
CC1	0	0	5928594	6217441	6837578	7457714	8077851	8697987	9318124	9938260
TOTAL	15400529	15660463	11541645	10176964	11055078	11831777	12608477	13385175	14161875	14938575

(Continued)

	11	12	13	14	15	16	17	18	19	20
PB1	10773876	11406668	11364193	11364193	11364193	11364193	11364193	11364193	11364193	11364193
PB2	0	0	0	0	0	0	0	0	0	0
MB	0	0	0	0	0	0	0	0	0	0
SB1	0	0	0	0	0	0	0	0	0	0
SB2	527136	527136	527136	527136	527136	527136	527136	527136	527136	527136
SB3	969649	1026600	1022777	1022777	1022777	1022777	1022777	1022777	1022777	1022777
LSB1	0	0	0	0	0	0	0	0	0	0
LSB2	420951	420951	420951	420951	420951	420951	420951	420951	420951	420951
LSB3	452503	479080	477296	477296	477296	477296	477296	477296	477296	477296
LUB	0	0	0	0	0	0	0	0	0	0
EB	0	0	0	0	0	0	0	0	0	0
GB	0	0	0	0	0	0	0	0	0	0
CB1	22086432	23383648	23296576	23296576	23296576	23296576	23296576	23296576	23296576	23296576
CB2	0	0	0	0	2274572	2274572	2274572	2274572	2274572	2274572
TOTAL	35230546	37244083	37108929	37108929	39383501	39383501	39383501	39383501	39383501	39383501
PC1	0	0	0	0	0	0	0	0	0	0
PC2	0	0	0	0	0	0	0	0	0	0
PC3	519867	519867	1262535	1236580	1210561	1184605	1158587	1132568	1106613	1080594
PC4	189838	189838	-12742	0	0	0	0	0	0	0
PC5	2370238	2453766	2448159	2448159	2448159	2448159	2448159	2448159	2448159	2448159
PC6	0	0	0	0	0	0	0	0	0	0
MC	0	0	0	0	0	0	0	0	0	0
SC1	0	0	0	0	0	0	0	0	0	0
SC2	454602	454602	454602	454602	454602	454602	454602	454602	454602	454602
SC3	836225	885340	882043	882043	882043	882043	882043	882043	882043	882043
LSC1	0	0	0	0	0	0	0	0	0	0
LSC2	378855	378855	378855	378855	378855	378855	378855	378855	378855	378855
LSC3	407252	431172	429566	429566	429566	429566	429566	429566	429566	429566
LUC	0	0	0	0	0	0	0	0	0	0
EC	0	0	0	0	0	0	0	0	0	0
GC	0	0	0	0	0	0	0	0	0	0
CC1	10558398	11178534	11136908	11136908	11136908	11136908	11136908	11136908	11136908	11136908
TOTAL	15715276	16491974	16979927	16966714	16940695	16914739	16888721	16862702	16836747	16810728

(Continued)

	21	22
PB1	11364193	11364193
PB2	0	3409257
MB	0	0
SB1	0	0
SB2	527136	527136
SB3	1022777	1022777
LSB1	0	0
LSB2	420951	4420951
LSB3	477296	477296
LUB	0	0
EB	0	0
GB	0	0
CB1	23296576	23296576
CB2	2274572	2274572
TOTAL	39383501	42792758
PC1	0	0
PC2	0	0
PC3	1054639	1028620
PC4	0	0
PC5	2448159	2448159
PC6	0 0	0 0
MC	0	0
SC1	0	0
SC2	454602	454602
SC3	882043	882043
LSC1	0	0
LSC2	378855	378855
LSC3	429566	429566
LUC	0	0
EC	0	0
GC	0	0
CC1	11136908	11136908
TOTAL	16784773	16758754

Legend:

PB1	:	PERUMTEL 1
PB2	:	PERUMTEL 2
SB1	:	Local supplyers 1
SB2	:	Local supplyers 2
SB3	:	Local supplyers 3
LSB1	:	Skilled laborer 1
LSB2	:	Skilled laborer 2
LSB3	:	Skilled laborer 3
LUB	:	Unskilled laborer
CB1	:	Subscribers 1
CB2	:	Subscribers 2
PC1	:	PERUMTEL 1
PC2	:	PERUMTEL 2
PC3	:	PERUMTEL 3
PC4	:	PERUMTEL 4
PC5	:	PERUMTEL 5
PC6	:	PERUMTEL 6
SC1	:	Local supplyers 1
SC2	:	Local supplyers 2
SC3	:	Local supplyers 3
LSC1	:	Skilled laborers 1
LSC2	:	Skilled laborers 2
LSC3	:	Skilled laborers 3
LUC	:	Unskilled laborers
CC1	:	Subscribers

4. Evaluation

The Sumatera Utara area plays an extremely important role for the economic and social development of Indonesia. Today the economic activity level of the area exceeds the national one. Having a large potential, the area is expected to have a possibility for leading the future Indonesian economy.

However, telecommunication service, especially telephone service, which is considered to be enevitable for modern economic and social activities is given only in large cities, Ibukota Kabupaten and some medium and small cities for the time being and its improvement and deveopment are strongly desired. In other words, it is feared that the underdevelopment will make a great obstacle to the future economic and social development of the country.

In the Sumatera Utara area the development of the Trans-Smatra Telephone Network connecting large cities has been considerably progressed and what are presently required urgently are to eliminate non-telephone Kacamatan and substitute automatic switching service for unpopular manual switchboard service. Regardless to say, these problems should be solved within the framework of financial and economic possibilities.

Today's telecommunication technology allows the latest, highest-level telephone service in all areas if there is no limitation in costs. However, under economic

restrictions and the necessesity of effective use of existing facilitites and considerations to be given to future telecommunication system formation, the improvement and development in telephone service can not help but being limited.
The project discussed herein has been selected to be most suitable from among various possible projects from both technical and economic standpoints.

To summarize, we have had a conclusion that in the Sumatera Utara area it is most desirable to commence automatic switching telephone service in all Kecamatan as soon as possible.
One of the most serious problems to be solved is whether sufficient funds can be raised in the present Indonesia or not.
In consideration of the economic effects and the political and social importance of the Sumatera Utara project, we have reached a conclusion that the introduction of economic cooperation is desirable.

The project for the Sumatera Utara area will contribute effectively to the economic and social development of Indonesia through long-range, low-rate loan from outside.