Chapter 4 ESTIMATION OF FUTURE TRANSPORT DEMANDS

Chapter 4. ESTIMATION OF FUTURE TRANSPORT DEMANDS

4.1 Estimation of Passenger Traffic Demands

4.1.1 Control Total of Person-Trip Ends in Medan City

(a) All-Purpose Trip Ends

The total of the all-purpose person trips are obtained through the process as shown in Fig. 4.1.1: Flow Chart of All-Person Trip Estimation, which is described individually in the following:

(i) Central Four Kechamatans (Zones #1 to #64)

It is known that unit-trip per person of the population usually does not change noticeably year by year. Consequently, the control total is obtained through the trip ends of the year 1978, being multiplied by the average annual growth rate of employed population of Sector II and Sector III plus student population by studying place and residential population.

(ii) Intermediate Study Area (Zones #47 to #57)

Utilizing the unit-trip per capita of residential population obtained in the proceeding paragraph the control total is obtained by multiplying the residential population of the surrounding areas in the year 2000 A.D. This is due to the fact that data on the person-trips among zones of the intermediate study area lack in the O-D survey conducted by Bina Marga in February 1978.

(iii) External Study Area (Zones #58 to #69)

The person trips of the external study area is calculated in this stage as commuting trips.

The person trips of all-purposes thus obtained are shown in Table 4.1.1 as their generation and their concentration by zone.

(b) Person Trip Ends by Purpose

Taking into account of reliability of the O-D Table obtained the contents of trip ends are classified into two groups such as the total of commuting trip ends and the total of rest two purposes. The calculating procedure of figures of those two groups is made as follow:

Based on the frame of 2000 A.D. commuting trip ends are calculated first and the rest group is calculated by deducting the commuting trips from the all purpose trip ends mentioned in the proceeding paragraph.

i) Commuting Trip Ends in Internal Study Area

Fig. 4.1.1 Flow Chart in Estimating All Person Trips of Medan City

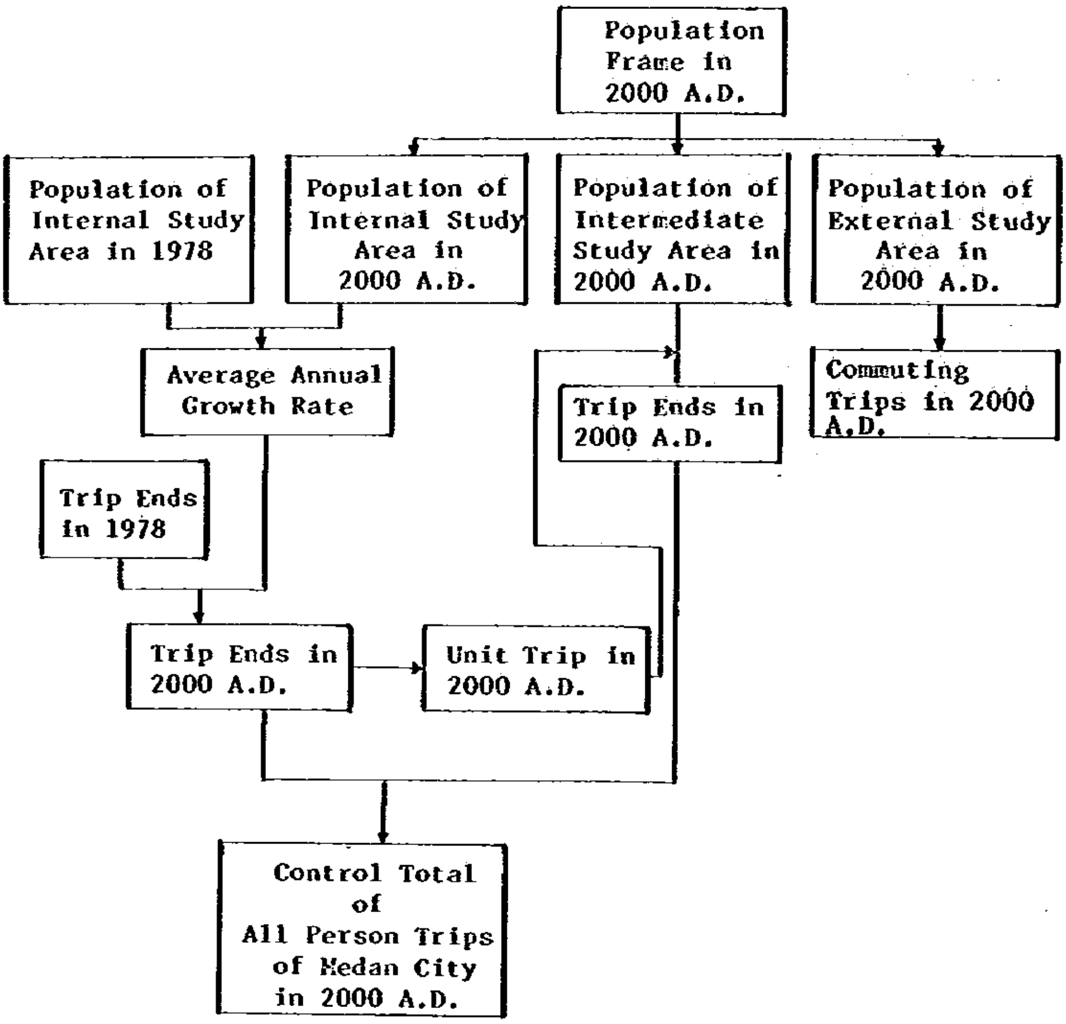


Table 4.1.1 Future Estimated Trip-Ends of All Purposes In Medan City

(Unit: 1000 Trip Ends)

Name of Zone	1978 A.D.		2000 A.D.			
			Trend Model		Redevelopment Model	
	Generated	Attracted	Generated	Attracted	Generated	Attracted
#1 to #46	1,175.7	1,175.7	2,125.2	2,179.7	2,007.0	2,007.9
#47 to #57	99.3	99.3	1,879.8	1,879.8	2,140.1	2,140.1
Total :	1,275.0	1,245.3	4,005.0	4,059.5	4,147.1	4,148.0

If they are calculated by purpose, it is necessary to calculate the volume of generated trips and also that of concentrated trips separately. The generated volume is calculated through the figures of the year 1978 by multiplying with the annual growth rate of residing employed population and the residing student population respectively, while the volume of concentration is calculated through those figures of the year 1978 by multiplying the annual growth rate of employed population by working place and the student population by studying place, and in the final stage of calculation a certain adjustment is made in order to keep a good consistency with the difference between the generated volume and the concentrated volume with figures of flowing-in and flowing-out of commuting trips.

ii) Commuting Trips of Intermediate Study Area

The commuting trips in 2000 A.D. are calculated through the unit trip of population in 2000 A.D. by multiplying the population of the intermediate study area in 2000 A.D., and in the final stage of calculation a certain adjustment is made in order to keep a good consistency of those figures thus obtained with those of flowing-in trips and flowing-out trips by trip purpose of commuting trips in the year 2000 A.D. The concept of this calculating procedure is shown in Fig. 4.1.2 and the results of calculation in Table 4.1.2.

Table 4.1.2 Control Totals of Estimated Commuting Trips in 2000 A.D. of Medan City (Excluding External Study Area)

(Unit: 1000 Persons & 1000 Trips)

Land Use Model	Zone	Frame			Trip		
		Generated	Attracted	In & Out Flow	Generated	Attracted	In & Out Flow
Current Trend Model	Core Zone	29.2	77.9	48.7	166.4	234.4	69.0
	Interal Study Area	406.5	583.1	176.6	327.1	484.4	157.3
	(Sub-Total)	(435.7)	(661.0)	(225.3)	(493.5)	(718.8)	(225.3)
	Intermediate Study Area	433.4	320.1	113.3*	369.2	255.9	113.3*
	Total	869.1	981.1	112.0	862.7	974.7	112.0
CBD Redevelopment Model	Core Zone	22.9	102.4	79.5	134.5	275.6	141.1
	Internal Study Area	350.7	538.5	187.8	291.0	417.2	126.2
	(Sub-Total)	(373.6)	(640.9)	(267.3)	(425.5)	(692.8)	(267.3)
	Intermediate Study Area	495.5	365.8	129.7*	417.5	287.8	129.7*
	Total	869.1	1,006.7	139.6	843.0	980.6	137.6

Notes:: 1) Core Zone means zones #1 to #8, plus zones #14 and #15.

2) Internal Study Area means zones #9 to #13 plus zones #16 to #46.

3) * marked means commuting trips flowing out of the study area.

4) Including internal trips within zones.

Fig. 4.1.2 Flow Chart in Estimating Commuting Trips of Medan City

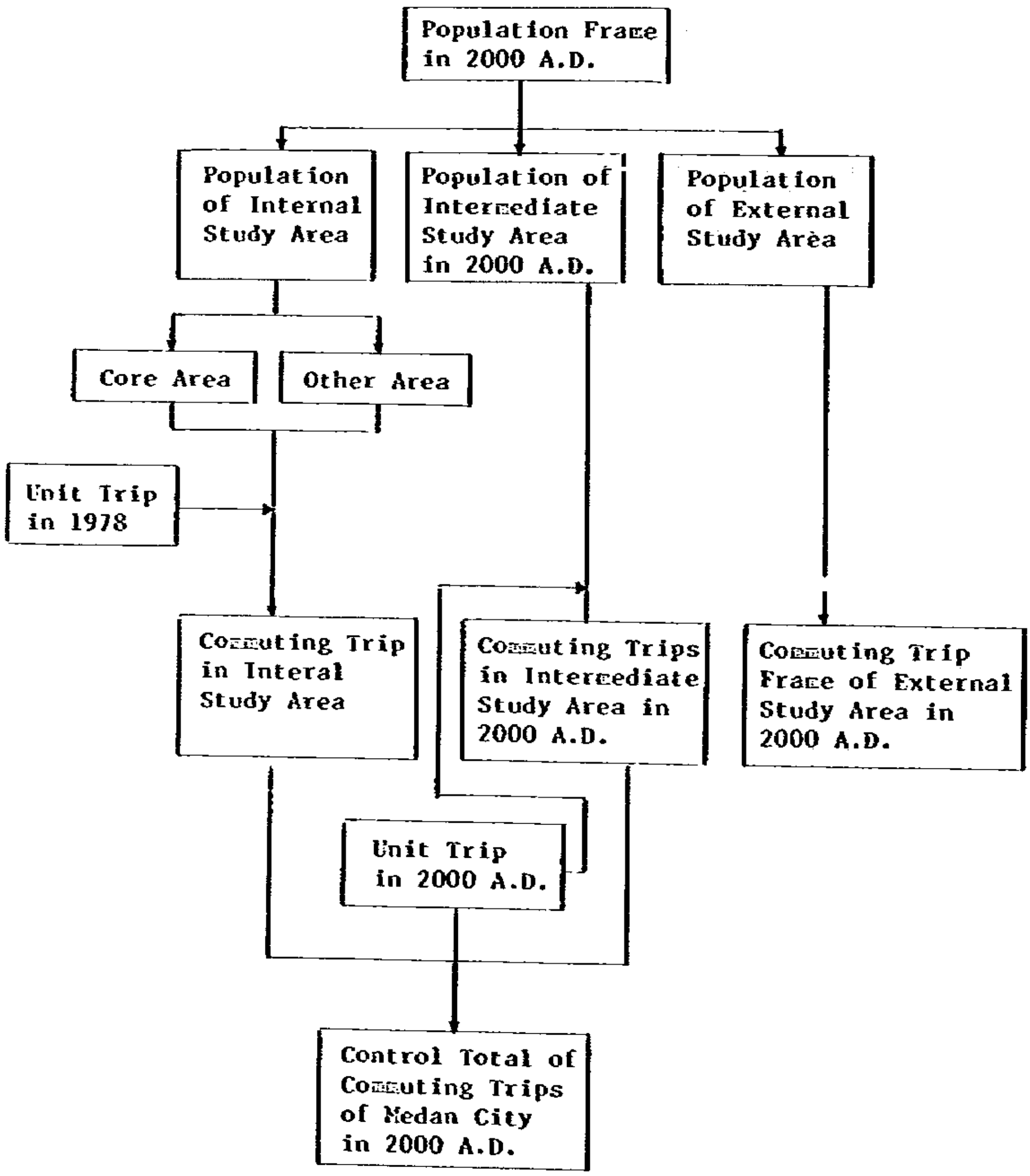


Table 4.1.3 Control Totals of Estimated Trip Ends by Purpose of Medan City (Excluding External Study Area)

(a) Generated Trips:

(Unit: 1000 Person-Trips)

Trip Purposes	Zone	1978 A.D.	2000 A.D.	
			Trend Model	Redevelopment Model
Commuting & Schooling	# 1 to #46	300.5	493.5	425.5
	#47 to #57	29.1	369.2	417.5
	(Sub-Total)	(329.6)	(862.7)	(843.0)
Other Purposes	# 1 to #46	875.2	1,631.7	1,581.5
	#47 to #57	70.2	1,510.6	1,722.6
	(Sub-Total)	(1,275.0)	(4,005.0)	(4,147.1)
Total	# 1 to #46	1,175.7	2,125.2	2,007.0
	#47 to #57	99.3	1,879.8	2,140.1
	(Total)	(1,275.0)	(4,005.0)	(4,147.1)

* Including internal trips within zones

(b) Attracted Trip:

(Unit: 1000 Person-Trips)

Trip Purposes	Zone	1978 A.D.	2000 A.D.	
			Trend Model	Redevelopment Model
Commuting & Schooling	# 1 to #46	298.6	718.6	693.2
	#47 to #57	31.4	255.9	287.8
	(Sub-Total)	(330.0)	(974.5)	(981.0)
Other Purposes	# 1 to #46	813.2	1,461.0	1,314.7
	#47 to #57	102.1	1,623.9	1,852.3
	(Sub-Total)	(915.3)	(3,084.9)	(3,167.0)
Total	# 1 to #46	1,175.7	2,179.6	2,007.9
	#47 to #57	99.3	1,879.8	2,140.1
	(Total)	(1,245.3)	(4,059.4)	(4,148.0)

* Including internal trips within zones

4.1.2 Zonal Trip-Ends

In this section how the allocation of trip-ends of control total is performed to each zone of the Study Area is explained.

(a) Commuting Trip-Ends

The method same as that applied to calculate the control total of Medan City is also applied in the allocation to find zonal trip-ends. In practice the generated trip is calculated through the trip-ends of the residential population and the student population by multiplying the average annual growth rate in the period between years 1978 and 2000 A.D., while the concentrated trips are calculated by multiplying the growth rate of employed population and the residing student population respectively.

(b) Trip-Ends by Other Purposes

In calculating zonal trip-ends the study area is divided into two types of zones such as the flowing-out zones and the flowing-in zones, then models are formulated based on their night-time population and the employment population of Sector II and Sector III, by which zonal trip-ends are calculated. The model formula used is as follow:

Basic Formula of Trip-End Model $Y = AX1 + BX2 + C$

where:

- Y : Volume of generated or attracted trip ends
- X1: Residential population
- X2: Employed population of Sector II and Sector III
- A : Parameter
- B : Parameter
- C : Parameter

Those parameters are shown in the following table::

Table 4.1.4 Parameters of Trip End Models

Case	Values of Parameters		
	A	B	C
Generation of flowing-out zones	305.7	- 810.5	7,777.0
Concentration of flowing-out zones	493.2	- 993.1	7,066.3
Generation of flowing-in zones *3)	- 0.3137	0.5714	4.0813
Concentration of flowing-in zones *3)	- 0.0389	0.5454	3.8509

Notes:
1) Flowing-out zones are such zones where flowing-out trip ends are in excess of the flowing-in trip-ends.
2) Flowing-in zones are such zones where flowing-in trip ends are in excess of flowing-out trip-ends.
3) The type of trip-end model is as follows:

$$\log Y = A.\log x1 + B.\log X2 + C$$

(c) Passenger's Volume at Polonia Airport

The past developments of the volume of arrival and departure passengers at Polonia Airport are shown in the table below:

Table 4.1.5 Yearly Volume of Arrival and Departure Passengers at Polonia Airport

(Unit: 1,000 Passengers/Yr.)

Year	Domestic	International	Total
'69	90.4	-	30.4
'70	120.0	-	120.0
'71	114.9	-	114.9
'72	115.5	16.6	132.1
'73	144.1	67.5	211.5
'74	200.3	83.5	283.8
'75	254.8	95.9	350.7
'76	330.3	113.2	443.5
'77	371.0	140.4	511.4
'78	487.7	165.2	652.9

Source: 1969 - 1976: 'North and West Sumatra Tourism Study', JICA, 1978

1977 : 'Buku Statistik Sumatra Utara', 1977

1978 : 'Statistik Telegahan Udara Polonia;

The average yearly growth rates of volume of domestic and international air passengers during the period 1973 - 1978 have been 27.6%/Yr. and 17.6%/Yr., respectively. As will be mentioned later in chapter 6: Proposed Long-Term Master Plan, in this report extension of the present runway and airport relocation are not considered.

In this section, the volume of air passengers in each future target year is estimated based on the past trend assuming the possible maximum utilization of capacity of a runway as follow.

According to the Japanese airport operating experiences the yearly total number of runway operations, the sum of yearly total number of landings and taking-offs, is not more than 150,000 including night operations at well-planned airports. If the average number of passengers per aircraft is assumed to be approximately 200, the maximum volume of air-passengers to be handled at an airport having a runway long enough for landing and taking-off of large in transports will be theoretically 30,000 x 10^3 passengers per year if the airport is equipped with landside facilities enough to handle such volume of air-passengers. If it is assumed that the possible maximum utilization of runway be 2/3 of the afore-mentioned yearly runway capacity and that the domestic and the international air-passengers be approximately 50% each of the yearly total due to the capacities of landside facilities of both types of traffic, then the maximum handling

Table 4.1.6 Trip-Ends in Current Trend Model (2,000 A.D.)

Unit: 1,000 Trip-Ends

Zone	Generated			Attracted		
	Commuting	Others	Total	Commuting	Others	Total
1. Gang Bauntu I	18.4	200.7	219.1	25.9	66.3	92.2
2. Pusat Pasar I	21.2	61.2	82.4	10.7	37.2	47.9
3. Pusat Pasar II	8.2	26.2	34.4	6.7	19.3	26.0
4. Pasar Baru	16.1	60.6	22.2	6.9	52.3	59.2
5. Aur I	23.8	37.0	60.8	18.3	31.5	49.8
6. Kasawan I	31.3	45.8	77.1	21.6	37.1	58.7
7. Gang Bauntu II	3.3	10.5	13.8	3.1	8.9	12.0
8. Pandam Hilir I	8.7	48.7	57.4	24.9	35.2	60.1
9. Sei Rengas I	13.3	54.1	67.4	5.3	43.5	48.8
10. Sei Rengas II	14.4	51.5	67.4	5.3	43.5	48.8
11. Aur II	10.4	49.8	60.2	26.9	50.7	77.6
12. Hamdan	6.3	25.7	32.0	13.5	19.8	33.3
13. Petisah Tengah I	7.6	27.1	34.7	13.1	15.1	28.2
14. Kasawan II	23.7	69.8	93.5	52.1	60.9	113.0
15. Sidodadi I	11.5	38.0	49.5	64.2	26.0	90.2
16. Didodadi II	12.0	46.3	58.3	30.0	51.8	81.8
17. Pandan Hilir	7.1	29.2	36.3	29.9	20.9	50.8
18. Pandan Hulu	9.0	30.4	39.4	8.5	27.8	36.3
19. Sei Rengas II	5.6	24.2	29.8	14.6	17.7	32.3
20. Kotamatsum	17.9	46.5	64.4	5.3	51.6	56.9
21. Sei Mati	4.8	16.7	21.5	15.5	14.0	29.5
22. Anggrung	9.3	28.7	38.0	23.2	28.5	51.7
23. Madnas Hulu	12.1	46.6	58.7	13.5	36.3	49.8
24. Petisah Tengah II	5.4	22.8	28.2	12.6	16.1	28.7
25. Silalas I	5.6	25.1	30.7	35.4	20.9	56.3
26. Silalas II	4.4	14.7	19.1	6.7	10.1	16.8
27. Kasawan III	4.9	17.1	22.0	7.1	16.1	23.2
28. Durian	6.3	15.6	21.9	6.3	27.2	33.5
29. Sidarame	3.7	11.3	15.0	12.4	38.4	50.8
30. Sei Kera Hulir	16.9	35.6	52.5	18.1	38.1	56.2
31. Tegal Sari	14.5	54.4	68.9	15.4	37.0	52.4
32. Teladan	9.3	40.4	49.7	15.4	46.4	61.8
33. Sitinejo	11.0	24.6	35.6	10.5	29.8	40.3
34. Baru	3.6	11.2	14.8	2.4	9.9	12.3
35. Polanig	4.1	13.8	17.9	2.4	15.2	17.6
36. Darat	7.9	18.7	26.6	22.5	17.7	40.2
37. Petisa Hulu	7.2	15.6	22.8	1.9	16.5	18.4
38. Petisah Tengah III	6.9	23.7	30.8	8.1	22.8	30.9
39. Sekip	17.1	59.8	76.9	23.7	79.7	103.4
40. Silalas	10.0	33.0	43.0	14.2	30.8	45.0
41. Braya n	14.1	34.4	48.5	10.8	49.3	60.1
42. Padang Bulan	8.6	25.8	34.4	8.9	18.1	27.0
43. Babura	8.2	17.5	25.7	5.2	15.3	20.5
44. Sei Sikambing D	5.1	31.0	36.1	7.7	27.3	35.0
45. Sei Putih	8.7	44.2	52.9	12.0	51.2	63.2
46. Sei Agul	14.0	20.6	34.7	10.9	23.8	34.7
Internal Study Area	493.5	1,631.7	2,125.2	718.6	1,461.0	2,179.6
47. Deli	29.4	144.7	174.1	20.3	151.4	171.7
48. Labuhan	37.4	127.5	164.9	25.9	142.9	168.8
49. Beluwan	30.7	299.3	330.0	21.3	306.5	327.8
50. Sidorejo	17.8	87.4	105.2	12.4	82.2	94.6
51. Denai	55.2	202.9	258.1	38.3	246.4	284.7
52. Kp. Binjei	24.1	102.9	127.0	16.7	103.4	120.6
53. Timbang Deli	11.1	109.5	120.6	7.7	90.0	97.7
54. Kedai Drian	11.8	78.6	90.4	8.2	66.6	74.8
55. Gedung Johor	22.7	93.5	116.2	15.8	93.4	109.2
56. Tuntungan	52.6	125.8	178.4	36.4	154.2	190.6
57. Surgal	76.4	138.5	214.9	52.9	186.4	239.3
Internal Study Area	369.2	1,510.6	1,879.8	255.9	1,623.9	1,879.8
58. P. Sei Tuan	2.1	0.5		0	1.0	1.0
59. Btg. Kuwis	15.9	3.7		0	7.9	7.9
60. Tg. Morawa	25.2	13.4		0	28.8	28.8
61. Potumbak	5.6	1.3		0	2.9	2.9
62. Deli Tua	8.1	1.9		0	4.1	4.1
63. P. Batu	5.6	6.4		0	13.8	13.8
64. Sunggal	6.1	2.6		0	5.7	5.7
65. Kp. Perak	15.9	6.8		0	14.7	14.7
66. Binjei	6.2	2.7		0	5.8	5.8
External Study Area	—	—		—	—	—
67. East	10.5	5.6		—	12.0	—
68. South	2.7	1.4		0	3.0	—
59. West	8.1	3.5		0	7.5	
69. West	8.1	3.5		0	7.5	
Outside Total	111.8	49.7	161.5	0	107.1	107.1
Grand Total	974.5	3,192.0	4,166.5	9,745	3,192.0	4,166.5

Table 4.1.7 Trip-Ends in Re-development Model (2,000 A.D.)

Unit: 1,000 Trip-Ends

Zone	Generated			Attracted		
	Commuting	Others	Total	Commuting	Others	Total
1. Gang Bauntu I	14.1	191.5	205.6	29.0	64.0	93.0
2. Pusat Pasar I	17.0	59.1	76.1	12.1	36.4	48.5
3. Pusat Pasar II	7.3	25.4	32.7	7.5	19.0	26.5
4. Pasar Baru	15.0	59.3	74.3	10.9	51.8	62.7
5. Aur I	18.2	35.0	53.2	21.9	30.2	52.1
6. Kasawan I	23.5	44.6	68.1	25.3	36.6	61.9
7. Gang Bauntu II	3.1	11.1	14.2	4.7	9.6	14.3
8. Pandam Hilir I	7.5	48.0	55.5	28.5	35.1	63.6
9. Sei Rengas I	10.9	44.7	55.6	5.6	36.3	41.9
10. Sei Rengas II	12.6	42.5	55.1	11.6	42.6	54.2
11. Aur II	8.8	40.2	49.0	22.8	41.4	64.2
12. Hamdan	4.8	19.3	24.1	10.6	15.2	25.8
13. Petisah Tengah I	6.0	21.4	27.4	10.7	12.1	22.8
14. Kasawan II	18.4	68.4	86.8	61.7	60.8	122.5
15. Sidodadi I	10.5	49.1	59.6	73.9	31.1	105.0
16. Sidodadi II	10.7	39.6	50.3	26.2	44.8	71.0
17. Pandan Hilir	6.5	32.1	38.6	25.8	21.5	47.3
18. Pandan Hulu	8.4	37.6	46.0	31.1	32.2	63.3
19. Sei Rengas II	5.0	26.0	31.0	12.2	19.1	31.3
20. Kotamatsum	15.9	49.9	65.8	19.0	45.0	64.0
21. Sei Mati	4.3	17.5	21.8	4.0	13.8	17.8
22. Anggrung	8.3	29.7	38.0	9.6	29.2	38.8
23. Madnas Hulu	8.7	36.9	45.6	19.9	29.1	49.0
24. Petisah Tengah II	4.2	17.8	22.0	10.6	12.6	23.2
25. Silalas I	4.4	20.3	24.7	10.6	16.7	27.3
26. Silalas II	3.7	15.3	19.0	28.3	10.4	38.7
27. Kasawan III	3.8	13.1	16.9	5.3	12.5	17.8
28. Durian	5.7	14.1	19.8	7.1	24.7	31.8
29. Sidarame	3.4	11.7	15.1	6.4	14.2	20.6
30. Sei Kera Hilir	15.3	44.8	60.1	13.2	44.7	57.9
31. Tegal Sari	13.4	56.5	69.9	14.3	36.7	51.0
32. Teladan	9.2	31.6	40.8	8.8	35.3	44.1
33. Sitinejo	11.6	25.7	37.3	9.0	30.8	39.8
34. Baru	3.1	10.6	13.7	1.4	8.6	10.0
35. Polanig	5.6	15.0	20.6	2.7	17.2	19.9
36. Darat	6.2	19.6	25.8	14.9	16.7	31.6
37. Petisa Hulu	5.8	12.0	17.8	1.0	12.8	13.8
38. Petisah Tengah III	5.6	18.2	23.8	6.2	17.7	23.9
39. Sekip	14.6	52.0	66.6	23.4	70.2	93.6
40. Silalas	8.1	24.3	32.4	10.2	22.8	33.0
41. Bnayan	14.0	36.1	50.1	9.1	49.7	58.8
42. Padang Bulan	7.2	17.1	24.3	4.8	12.1	16.9
43. Babura	7.5	16.5	24.0	3.1	9.2	12.3
44. Sei Sikambing D	4.9	28.5	33.4	5.1	24.1	29.2
45. Sei Putih	8.3	26.9	45.2	6.8	41.0	47.8
46. Sei Agul	14.7	14.9	29.6	6.3	17.1	23.4
Internal Study Area	425.5	1,581.5	2,007.0	693.2	1,214.7	2,007.9
47. Deli	32.6	168.5	201.0	22.5	175.9	198.4
48. Labuhan	41.0	142.0	183.0	28.3	158.7	187.0
49. Belawan	33.1	337.8	370.9	22.9	343.2	366.1
50. Sidorejo	18.4	97.2	115.6	12.7	89.7	102.4
51. Denai	57.7	224.8	282.5	39.7	268.8	308.5
52. Kp. Binjei	29.9	119.7	149.6	20.6	124.1	144.7
53. Timbang Deli	11.4	126.7	138.1	7.8	102.0	109.8
54. Kedai Drian	12.5	88.6	101.1	8.6	74.3	82.9
55. Gedung Johor	34.1	114.2	148.3	23.5	122.9	146.4
56. Tuntungan	62.2	144.9	207.1	42.8	180.4	223.2
57. Surgal	84.7	158.1	242.8	58.4	212.3	270.7
Internal Study Area	417.5	1,722.6	2,140.1	2,878	1,852.3	2,140.1
58. P. Sei Tuan	2.5	0.1	2.6	0	1.4	1.4
59. Btg. Kuwis	19.6	0.7	20.3	0	10.8	10.8
60. Tg. Morawa	31.1	2.7	33.8	0	39.5	39.5
61. Potumbak	6.9	0.3	7.2	0	4.0	4.0
62. Deli Tua	10.0	0.4	10.4	0	5.6	5.6
63. P. Batu	6.9	1.3	8.2	0	18.9	18.9
64. Sunggal	7.5	0.5	8.0	0	7.8	7.8
65. Kp. Perak	19.6	1.4	21.0	0	20.2	20.2
66. Binjei	7.7	0.5	8.2	0	8.0	8.0
External Study Area	–	–	–	–	–	–
67. East	12.9	1.1	14.0	0	16.5	16.5
68. South	3.3	0.3	3.6	0	4.1	4.1
69. West	10.0	0.7	10.7	0	10.3	10.3
Outside Total	138.9	9.9	147.9	0	147.0	147.0
Grand Total	981.0	3,314.0	4,295.0	981.0	3,314.0	4,295.0

capacity of air-passengers will be 10,000 x 10^3 passengers yearly in each the domestic and the international traffic, respectively. Based on such an assumption afore-mentioned the future air-passenger traffic demands are calculated as follows on the basis of the past trend. According to the measures described above, the zonnal trip ends by purpose is calculated as is shown in Table 4.1.6 and 4.1.7.

Table 4.1.8 Future Volume of Air Passengers at Polonia Airport

(Unit: 1,000 Passengers/Yr.)

Year	Domestic	International	Total
1985	710.9	250.9	961.8
1990	4,576.0	1,547.0	6,123.0
2000	9,029.1	4,850.0	13,879.1

4.1.3 Distribution to Zone Pairs

Trip ends calculated in the preceeding section are distributed into zone pairs in this section. The Gravity Model is applied in such distribution in finding initial values of each zone pair, which is adjusted with converging calculation by applying Mr. T. J. Fratar's procedure.

$$T_{ij} = K \frac{T_i^{\alpha} \cdot T_j^{\beta}}{(D_{ij})^n}$$

where:

- T_{ij} : Number of trips in zone i-j;
- D_{ij} : Travel time between i and j points;
- T_i : Trip end generation in zone i;
- T_j : Trip end generation in zone j.

Values of parameters such as α, β, K and n are as follow:

α = 0.04821
β = 0.06242
n = 0.39654
K = 56.6161

However, the internal trips within zones are calculated by using the present internal trip ratio of each zone because it is difficult to estimate the internal travel time of the respective zones.

4.1.4 Modal Split Curve and Trip Ends by Transport Mode

Concerning the trip ends generated and attracted, both Current Trend Model and CBD Re-development Model have been analized to compare the differencies of the trip-ends between two alternatives in land-use. However, as is described in Chapter 5, Re-development Model has high priority from the view point of land use. Therefore, the problems of modal split are calculated only on Re-development Model and the traffic volumes are estimated in both cases of High and Low Motorization which are explained in Chapter 3. Although these two types of alternative have basically the same traffic volume of generated and attracted trip-ends in Medan City, the difference of trip-ends can be seen between the private and the public transport modes in those alternative cases.

(a) Trip-Ends of Passenger-Cars

i) General

O-D Table by transport mode is formulated from the O-D Table by trip purpose in the year 2000 A.D. In this calculation Modal Split Curve is necessitated, which is obtained by following the concept mentioned below:

- Concerning sedans Trip-End Model is applied.

This is due to the fact that possessing sedans means a symbol to indicate his social status presently, and it is assumed that such tendency will still somewhat remain even in 2000 A.D. and which will result in difficulty to forecast of trip ends by means of Inter-Trip Model; consequently, Trip-End Model is applied in the case of Sedans.

- Modal Split

Modal split is performed by the binary choice procedure, and the flow-chart of which is shown in Fig. 4.1.3.

From the Fig. 4.1.3 it is clear that after excluding passenger-car person-trips two kinds of modal split curves are necessary in this procedure; namely, one is for separating public transport such as railway, bus and Bemo from private transport person-trips such as motor cycles, bicycles and other person-trips and the other is for the separation of railway person-trips from bus and Bemo person-trips.

In finding the total of passenger-car trip ends the growth rate of registered number of passenger-car is multiplied to the present persons trips utilizing passenger-cars. But it is not sufficient in the intermediate study area; and consequently, they are calculated by using the rate of person trips utilizing passenger-cars in the Internal Study Area, this is based on the assumption that the rate of possessed number of passenger-car will become homogenious approximately throughout the Medan Area by 2000 A.D.

The calculation results are as shown in Table 4.1.9 and Table 4.1.10 as by passenger-car and by other modes except passenger-cars, respectively.

Table 4.1.9 Distributed Trip-Ends by Passenger-Car in 2000 A.D. in Medan City (Excluding External Study Area)

(Unit: 1,000 Trip-Ends)

Study Area	Current Trend Model		CBD Redevelopment Model	
	Generated	Attracted	Generated	Attracted
Internal Study Area	795.2	817.5	804.1	808.6
Intermediate Study Area	702.3	748.0	862.3	861.1
Total of Medan City	1,497.5	1,565.5	1,666.4	1,669.7

Notes: The growth rate in the period between 1978 and 2000 A.D. indicates 3.769.

Table 4.1.10 Distribution of Trip-Ends by Those Modes Except Passenger-Car in 2000 A.D. in Medan City (Excluding External Study Area)

(Unit: 1,000 Trip-Ends)

Study Area	Current Trend Model		Redevelopment Model	
	Generated	Attracted	Generated	Attracted
Internal Study Area	1,333.0	1,362.1	1,202.9	1,199.3
Intermediate Study Area	1,177.5	1,131.8	1,277.8	1,279.0
Total of Medan City	2,507.5	2,494.0	2,480.7	2,478.3

ii) Motorization Grades

The contents of High and Low Motorizations are explained in Chapter 3, and Chapter 8 is assigned to describe on the administrative measures to be taken by the Municipal Government to attain the Low Motorization Grade. In this section, a description is made on how to estimate the trip-ends under the condition of Low Motorization.

As an example in Japan, considering the difference of modal split between the commuting purpose and the total purpose, the utilization ratio of sedans in commuting hours has been reduced down to 75∿80% comparing to its ratio in the daily movement. The strong reason of such reduction in the utilization of sedans in commuting hours seems to be due to the road traffic congestions, difficulty to find parking spaces in the CBD and others in commuting hours, which do not meet the commuters' demand. Such a fact can be said in another way that it is possible to control the utilization of sedans by appropriate administrative measures in the CBD by Municipal Government where traffic congestions and insufficient road facilities can be observed. In Indonesia, the public transport system is expected to be the back bone of the urban transport system in future; consequently, it seems to be necessary to take some strong administrative steps to attain such objectives, such steps have been successfully taken in Singapore, for instance, by applying in licensing and introducing the park and ride system etc. In this section, considering the extreme case for formulating the alternatives, such a case is presumed for Low Motorization case that the private-vehicle transport will be restricted down to 75% of that in case of High Motorization.

(b) Modal Split Curves for Public Transport

There exist usually several different methods of formulating Modal Split Curves, usually according to its national transport situation and local characteristics. In formulating that for Medan City it is preferable to take into account its local characteristics in the curves, particularly to reflect the improvement of transport facilities of Medan City in future. Consequently, Modal Split Curves are formulated in this study taking into account travel-time and fare structure which will reflect such future transport conditions abovementioned. Actually, the travel-time ratio between transport modes is used to indicate the Modal Split Curves out of the present O-D Table by mode.

The basic formula for this purpose is as follow:

$$P(g) = f(T_1/T_2)$$

where:

$P(g)$: Sharing rate of public transport service

T_1/T_2 : Travel-time ratio between two modes of transport in usual travel speeds

The result of such calculation is as shown in Fig. 4.1.4.

(c) Railway Modal Split Model

In formulating Modal Split Model for separating railway from other modes it is impossible to formulate it based on the present railway passenger O-D data because the railway has presently no substantial share of urban transport service in Medan area.

In this study a sharing model of the public transport service for bus could be formulated on the concept that both modes, railway and bus, have basically the same kind of responsibility to share the urban transport service of Medan Area and are different one another simply in their travel speeds and their fare structures. In such a model for bus the values of fare and speed of bus could be replaced with figures expressing the service level of railway; it is intended, by thus doing, to induce out the sharing rate of public transport service by railway.

The basic formula is given as follow:

$$P(g) = f(t_a/t_b)$$

where:

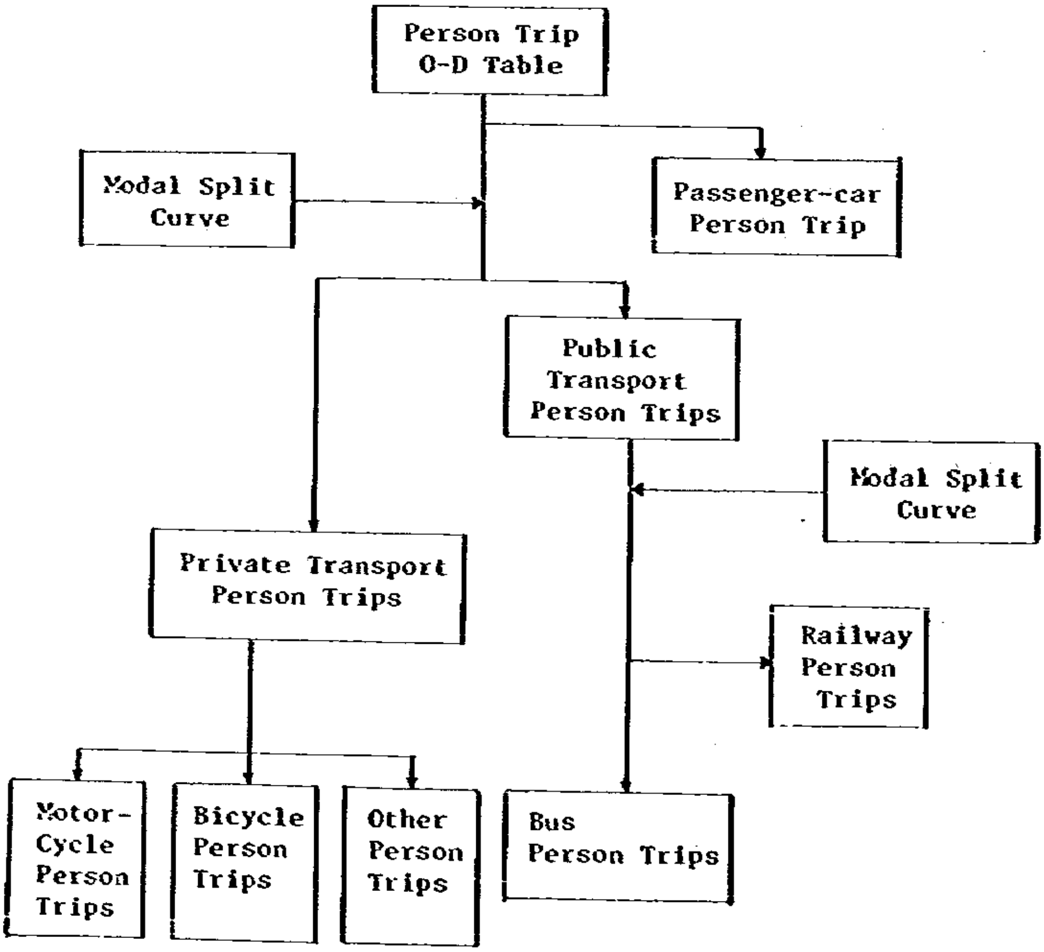
$P(g)$: Sharing rate of public service in Medan City by the mode which needs longer travel time for operation in the zone i-j;

t_a : The travel-time of the mode which is operated in slower speed;

t_b : The travel-time of the mode which is operated in higher speed.

In such a calculation procedure for Modal Split Model for Medan City taxicabs are excluded; and consequently, the sharing relations among railway, bus and Bemo are expressed. The results of such calculation could be graphically expressed as in Fig. 4.1.5.

Fig. 4.1.3 Flow Chart of Modal Split by Binary Choice Method



In Fig. 4.1.4 the modal split curve of bus system of Medan City is shown, in which the radius of circle means the number of data calculated whose values are indicated by the coordinate values of its circle center. The regression curve of those data is drawn so as to make the distance from the curve to those circle centers inversely proportionate to their radii. This curve can be also applicable to the railway system because both modes of transport belong to the public transport.

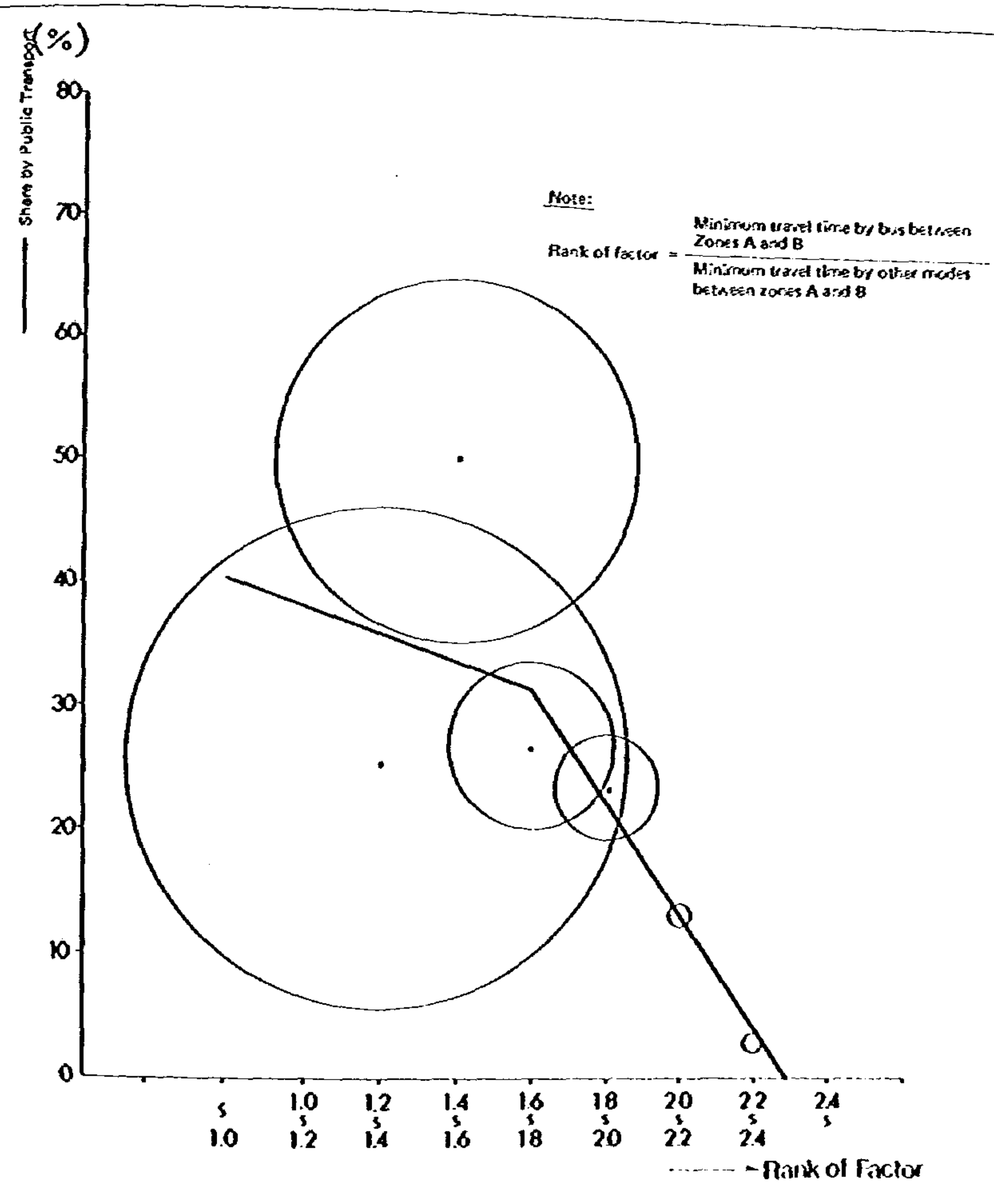


Fig. 4.1.4 Modal-Split Curve for Public Transport

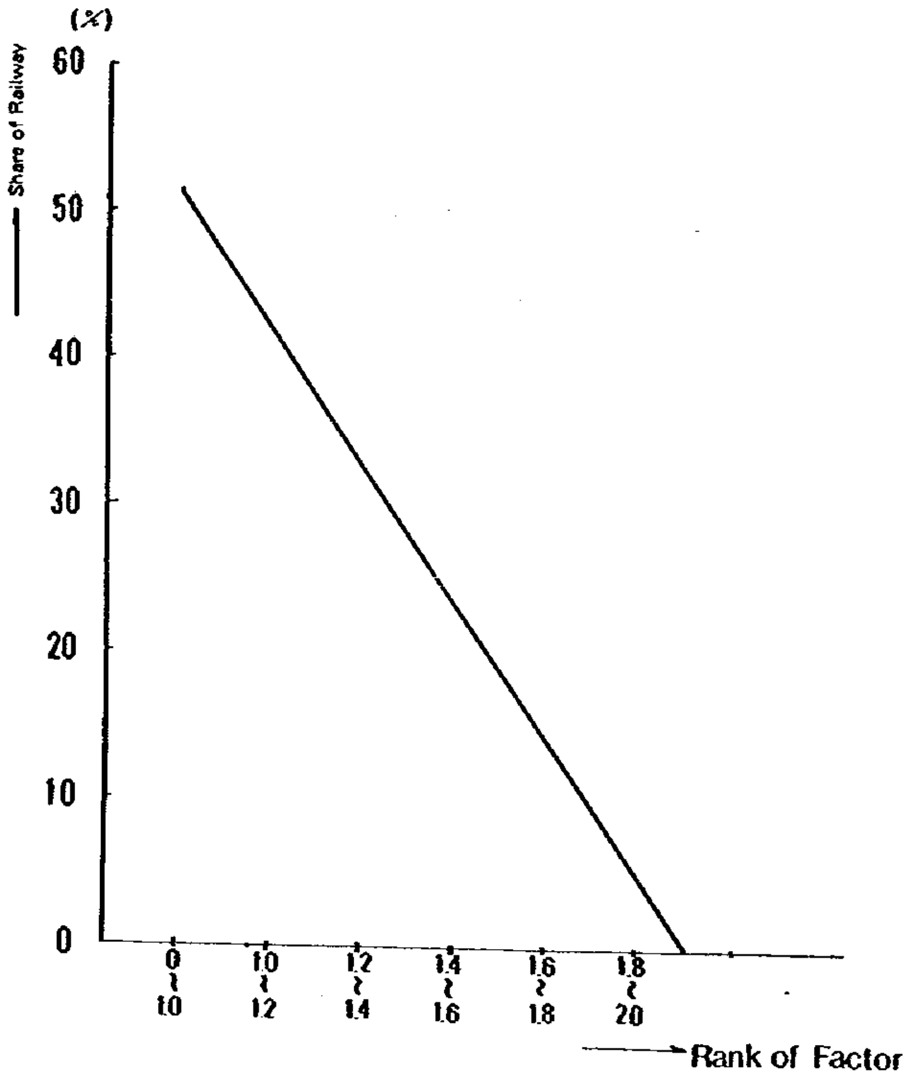


Fig. 4.1.5 Modal-Split Curve for Railway Transport

Moreover, the shares of taxis and Becak are considered as follows:

i) Taxi

As it is impossible to calculate the share of taxi by using the modal split curve, 5.8% and 4.1% for High and Low Motorization grades are adopted respectively in this study.

ii) Becak

Although it is desirable fundamentally to abolish Becak by 2000 A.D. being replaced by such other modes of transport as buses including mini-bus and/or taxis from the viewpoint of the preferable urban transport system. However, the utilization of Becak might remain possibliy in the peripherel areas of Medan City, and then it is difficult to estimate the exact rate of share by Becak; therefore, the numerical estimation of Becak is not substantially taken up in this study.

(d) Utilization

It can be said that the utilization of the modal split curves depends much on the extent of policy-wise judgement to be made in view of the results analized. However, it is preferable to cope with the facility planning in the case to apply such a policy-wise judgement, and it is better to refrain from judging based only on conceptual reason.

However, a methodology is considered in this section to reflect the concept, that the public transport system can be strengthened by increasing its service frequency and its operational speeding up, as mentioned in Chapter 3, to the modal split as a policy-wise judgement in order to receive the traffic of the case in low motorization.

Furthermore, although a tariff structure consists of one of important factors in formulating the modal split curve, it is actually rather difficult to correspond in modal splitting with tariff structure between respective modes of transport as is described later in Chapter 7. Therefore, the traffic demands are calculated by mode of transport based on the current tariff structure by mode in the calculation of modal split curve and the problem of appropriate tariff system is studied separately in Chapter 7 as the flexibility of current tariff structures.

(e) Traffic Demands by Transport Mode

The traffic demands which are estimated in this report are based on the CBD Re-development Model in land use pattern which induce two alternatives, Case 5-A and Case 5-B as mentioned in 3.3.4, the results of traffic estimation are summarized by mode in this section.

Based on the facility planning in each alternative case, the O-D Tables by mode are obtained by the traffic assignment of all purpose O-D Table to the transport network in which the operating conditions and capacities are tabulated in Table 4.1.11 and Table 4.1.12 and the O-D Tables and the desire lines of consolidated twelve zones are shown in Table 4.1.13 and Fig. 4.1.6 respectively.

According to the calculated results, the average trip lengths and distribution patterns by mode of transport are shown in Fig. 4.1.7

Table 4.1.11 Estimated Daily Traffic Demands by Mode of Transport in 2000 A.D. for Alternative Case

(Unit: Trip-Ends x 10^3/day)

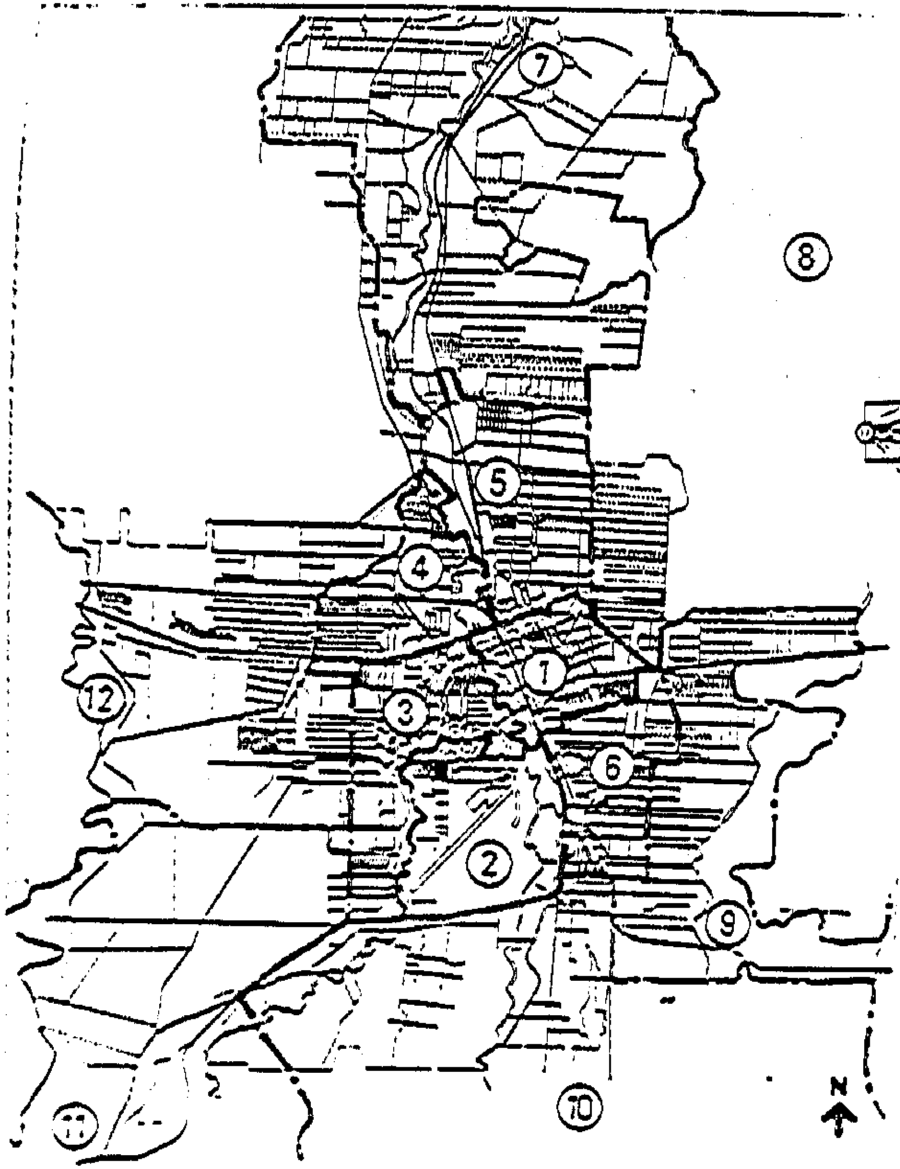
		Case 1-C	Case 5-A	Case 5-B
Public	Railway	- (0)	230.0 (4.1)	377.6 (6.9)
	Bus	2,166.9 (38.8)	936.0 (16.8)	1,789.3 (31.9)
	Taxi Cab	230.1 (4.1)	324.4 (5.8)	230.0 (4.1)
	Sub Total	2,396.9 (42.9)	1,490.4 (26.7)	2,496.9 (42.9)
	Sedan	1,676.5 (30.0)	2,198.0 (39.4)	1,676.5 (70.0)
	Motorcycle	1,110.0 (19.9)	1,392.5 (24.9)	1,110.0 (19.9)
	Bicycle	402.2 (7.2)	504.7 (9.0)	402.2 (7.2)
	Sub Total	3,188.7 (57.0)	4,095.2 (73.3)	3,188.7 (57.0)
Grand Total		5,585.6 (100.0)	5,585.6 (100.0)	5,585.6 (100.0)

Table 4.1.12 Estimated Traffic Demands in Peak Hour by Mode of Zone in 2000 A.D. for Alternative Case

(Unit: Trip-End x 10^3/peak hour)

		Case 1-C	Case 5-A	Case 5-B
Public	Railway	- (0)	64.1 (9.6)	95.8 (14.3)
	Bus	342.6 (51.1)	141.6 (21.1)	246.8 (36.8)
	Taxi Cab	22.1 (3.2)	34.1 (5.1)	22.1 (3.2)
	Sub Total	364.7 (54.3)	239.8 (35.8)	364.7 (54.3)
Private	Sedan	160.7 (24.0)	231.1 (34.5)	160.7 (24.0)
	Motorcycle	106.4 (15.9)	146.4 (21.8)	106.4 (15.9)
	Bicycle	38.5 (5.8)	53.0 (7.9)	38.5 (5.8)
	Sub Total	305. (45.7)	430.5 (64.2)	305.6 (45.7)
Grand Total		670.3 (100.0)	670.3 (100.0)	670.3 (100.0)

Note: Both tables exclude the internal trips within zones.



Zoning Figure for Desire Line

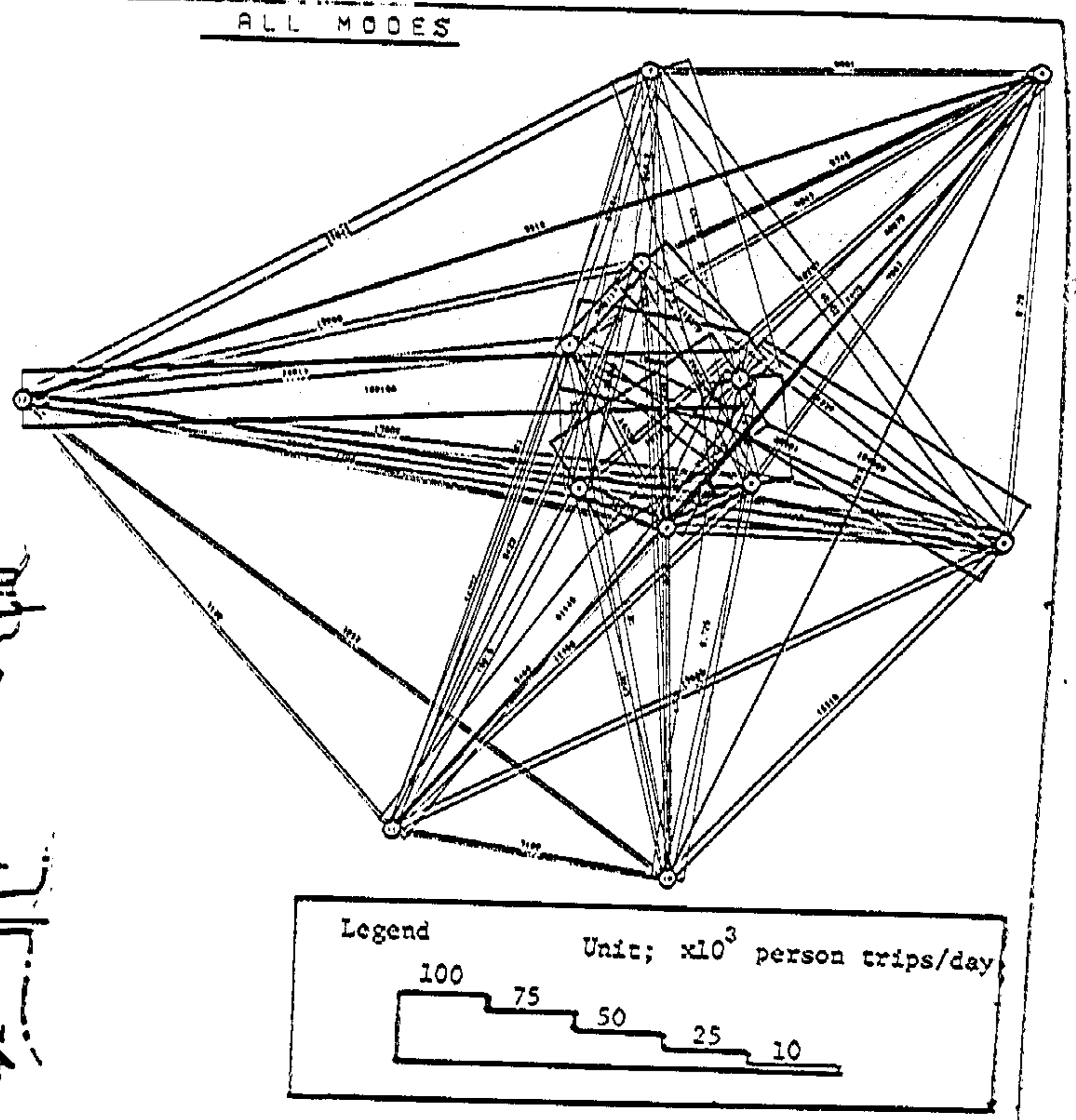


Fig. 4.1.6 Desire Line (2000 A.D.), Case 5-8

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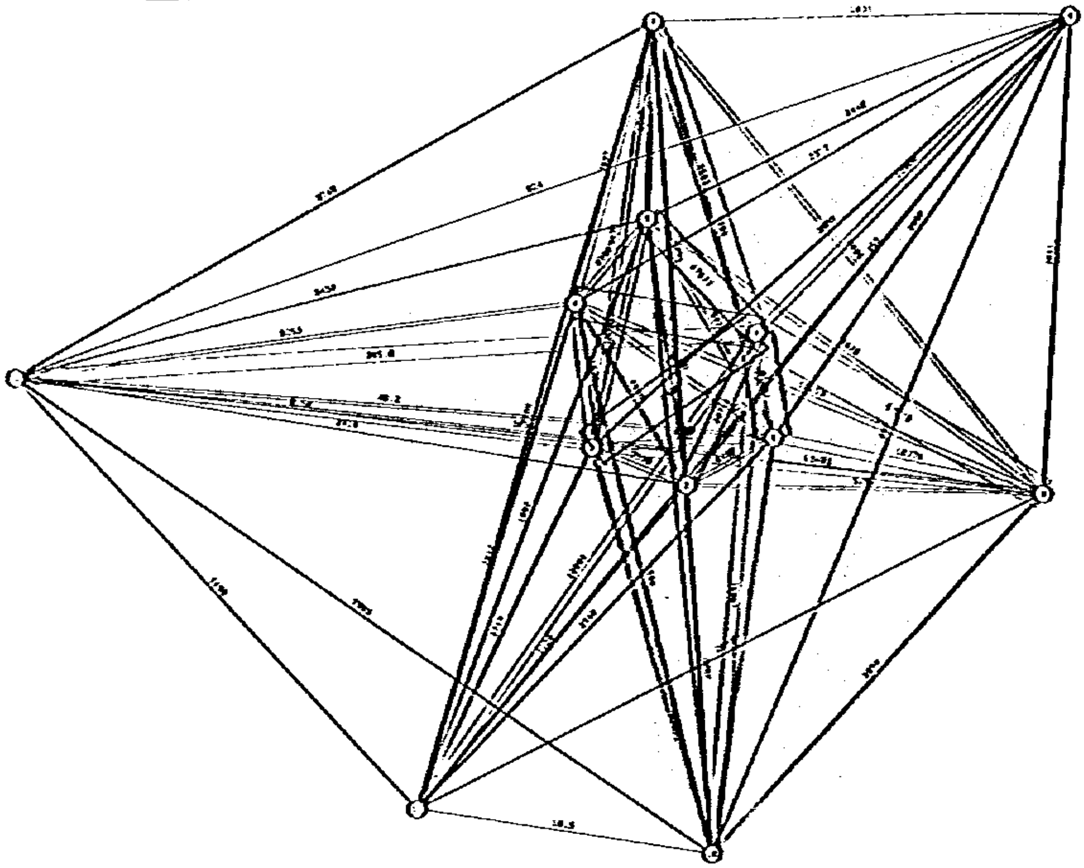
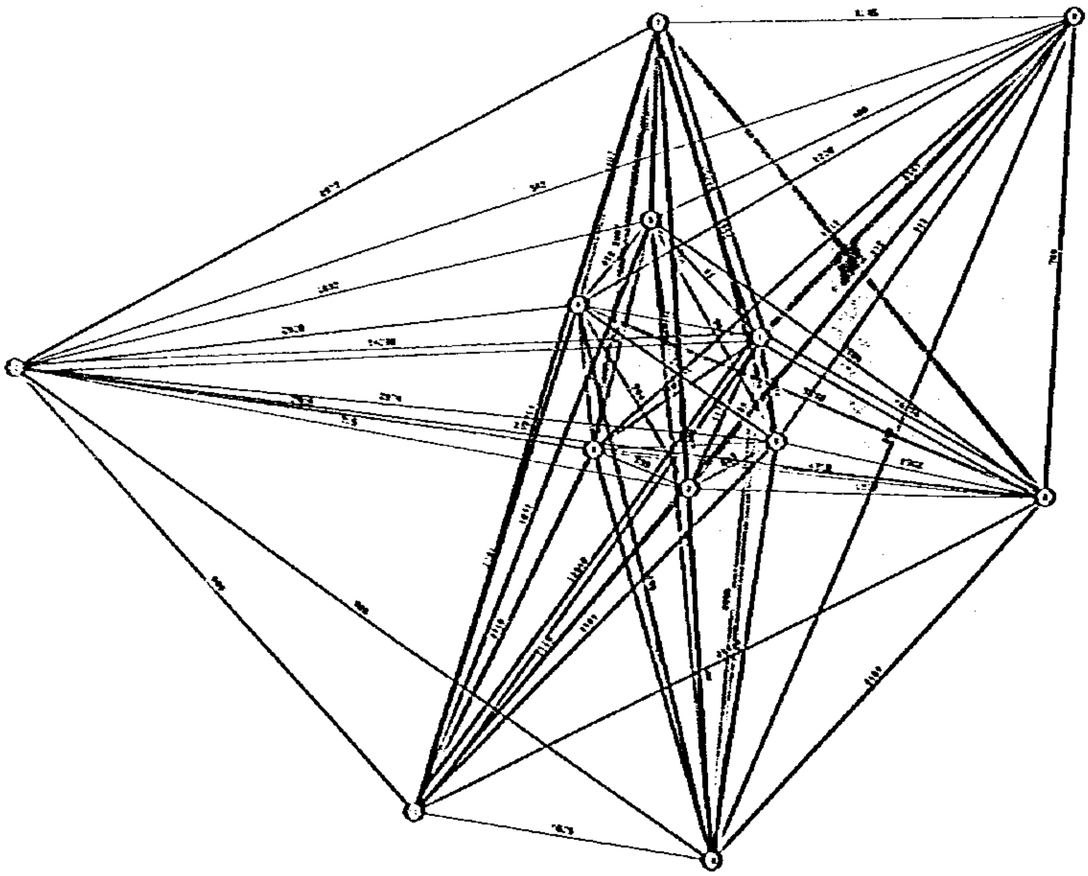
BUS



RAILWAY



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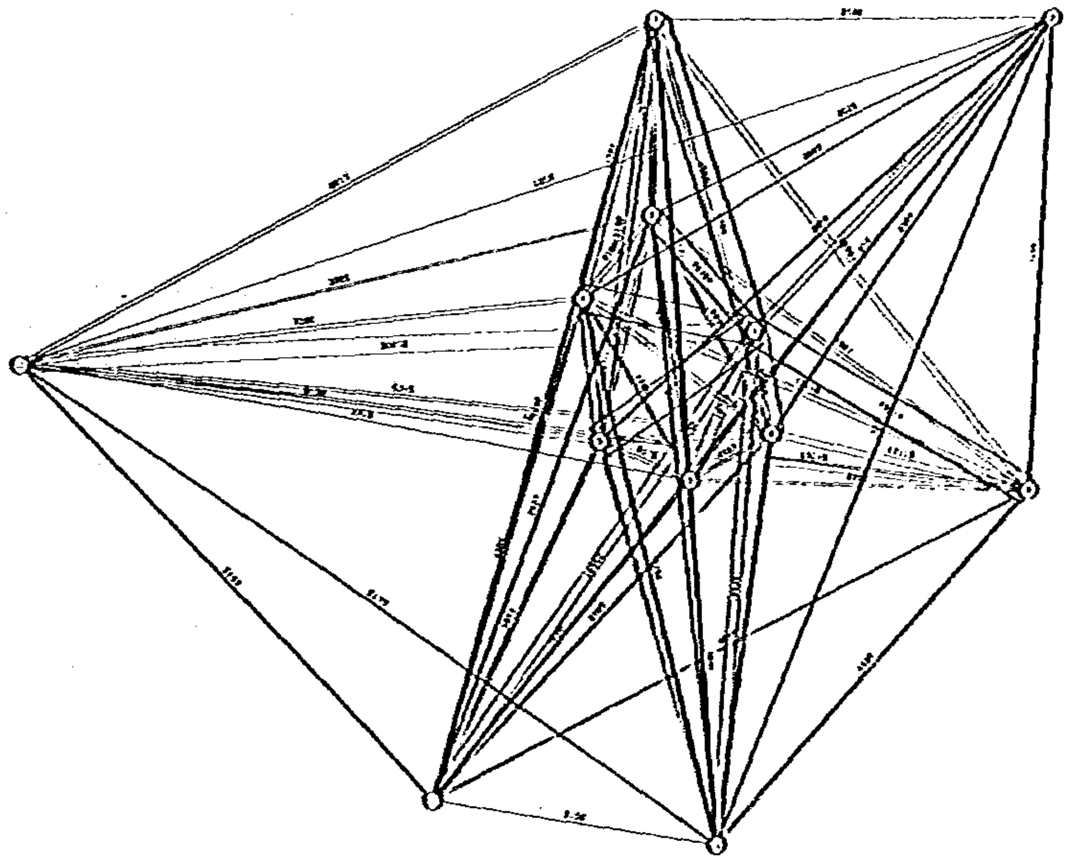
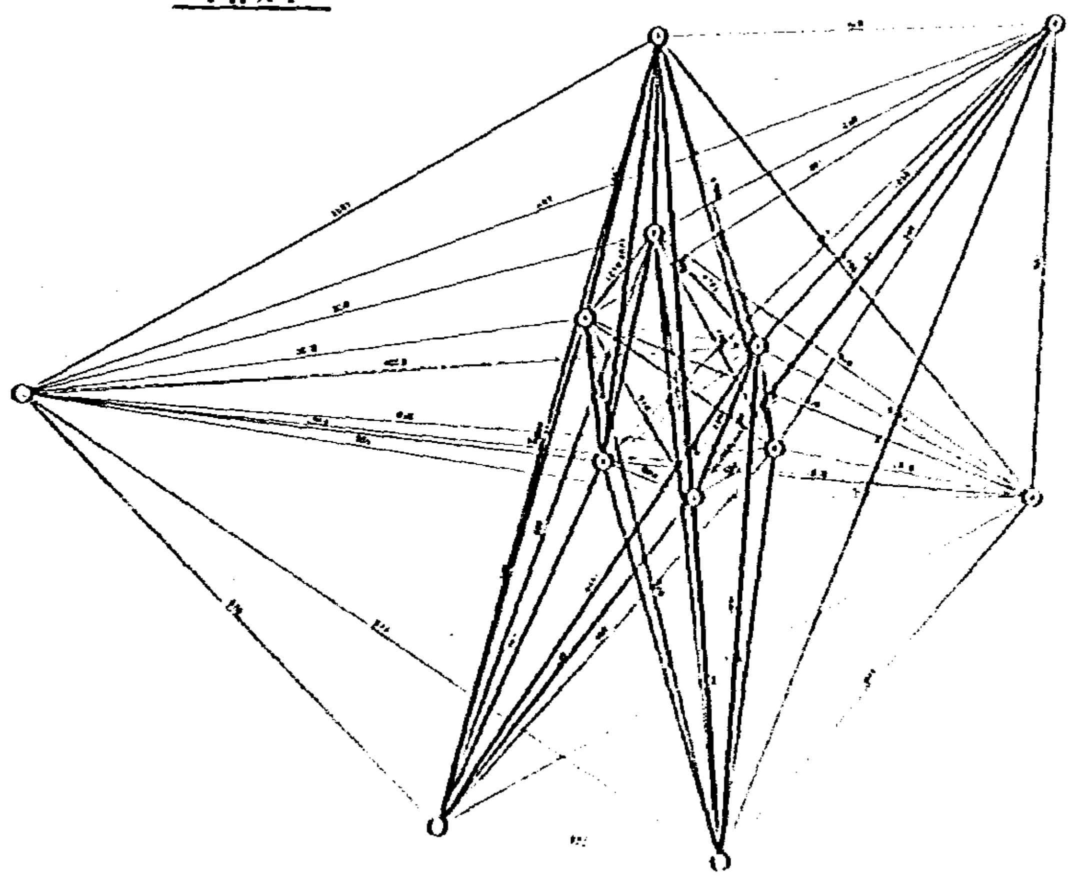
SEDAN



TAXI



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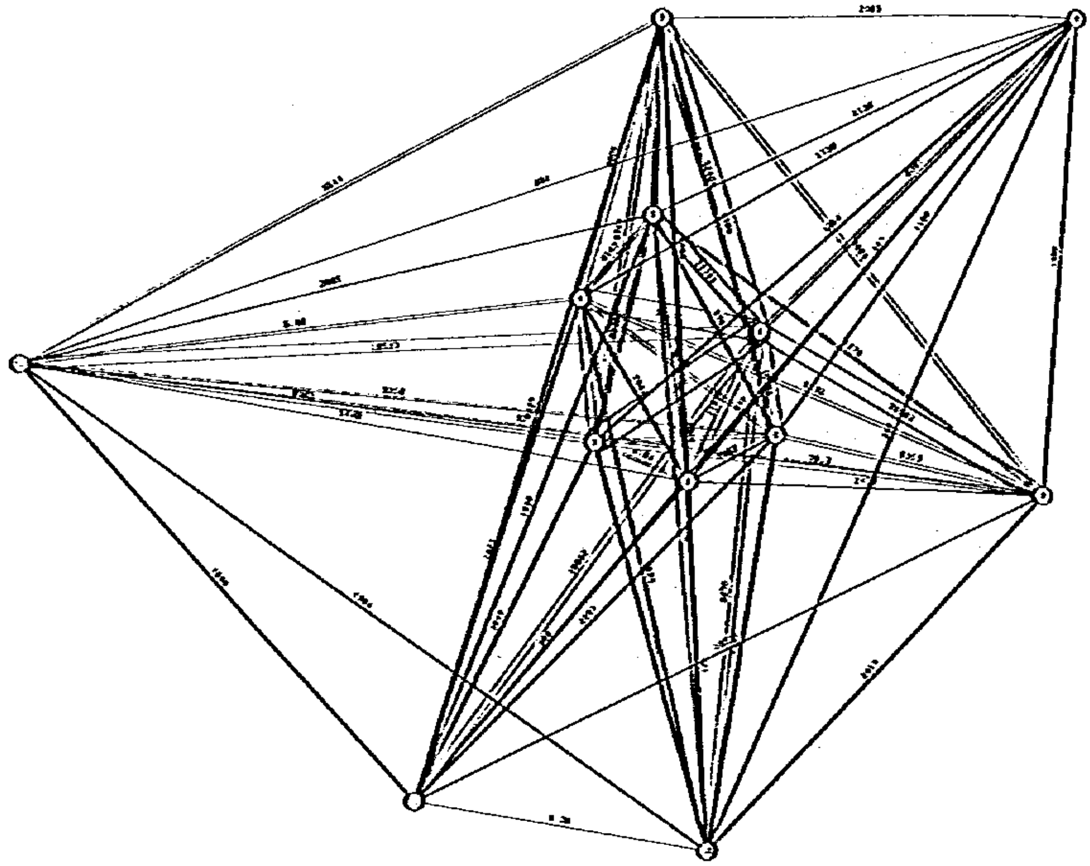
MOTOR CYCLE



BICYCLE

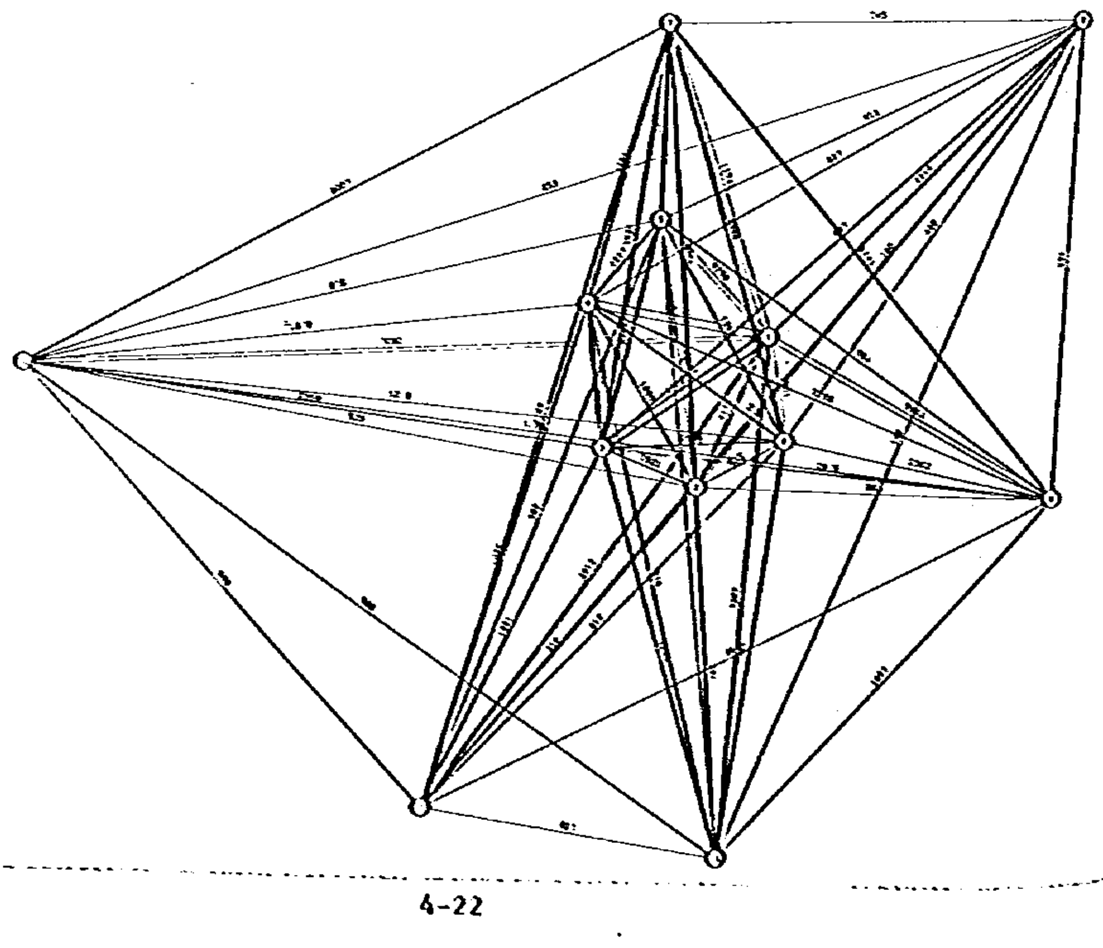


Table 4.1.13 Estimated O.D. Table by Mode in Case 5-B

Sedan

[illegible]

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	Total
(1)	196834	19726	59235	49216	35796	45533	45873	92835	43514	18555	18352	36458	618355
(2)		759	6326	4265	2652	4447	4120	876	4463	1826	1439	2313	54574
(3)			9078	35417	3755	11551	13155	3878	13265	5659	5655	5139	145527
(4)				5935	8133	9351	11326	2689	10260	4254	4355	2398	130310
(5)					2143	6498	2587	2825	2357	2555	2527	5185	92735
(6)						4427	9563	2346	12113	4565	5755	5345	173785
(7)							6505	2558	42844	4142	4494	4417	134767
(8)								181	2639	728	731	1958	35056
(9)									5135	4585	4535	4435	355218
(10)										616	2859	2177	51843
(11)											555	2155	55496
(12)												720	77173
TOTAL													1876524

Bus

[illegible]

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	Total
(1)	135590	26711	53955	57641	47677	61332	55937	12924	57619	11631	12836	24578	767351
(2)		1163	2593	4535	3759	4459	3227	953	5269	2244	1729	2474	47584
(3)			9555	15766	13726	16217	9176	2259	13481	4213	3718	8130	183782
(4)				4935	8759	5923	7837	2312	19253	4539	2012	4253	145762
(5)					2559	9423	5745	2469	8426	2767	1882	3434	115244
(6)						4547	7225	2558	14714	4556	2549	4872	135741
(7)							4929	1631	8455	3121	2755	3748	53784
(8)								55	2611	448	521	826	35715
(9)									5549	3976	2666	3576	122387
(10)										447	1435	2545	51548
(11)											248	1158	33615
(12)												422	44557
TOTAL													1783756

Railway

[illegible]

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	Total
(1)	0	1176	2969	888	41	2024	24749	5565	10246	8176	12848	64750	84711
(2)		0	235	284	153	223	1819	975	1326	438	1149	715	7875
(3)			21	92	265	1229	5767	7211	4854	1554	3718	2923	23835
(4)				137	655	1442	4427	1228	3769	1455	2785	2826	28252
(5)					9	366	3918	488	1554	410	1870	1452	15502
(6)						9	6355	218	1557	1559	2161	2374	15337
(7)							4476	1135	5925	2507	2216	2722	43793
(8)								69	769	565	592	542	17474
(9)									1578	2165	2614	2326	16787
(10)										575	1875	819	21102
(11)											269	555	35865
(12)												555	33176
TOTAL													545182

(Continued)

Motorcycle

***** PERSN OD (NEW12) *****

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	Total
(1)	84547	55527	61503	36212	22785	26785	32404	6591	26592	9220	15832	19532	493193
(2)		384	4186	2082	1478	2342	2883	447	2429	920	958	1449	32420
(3)			7459	13132	5975	7432	9769	1724	7317	3459	3513	6551	123322
(4)				5546	6163	6193	9095	1736	4292	2525	2823	5189	103312
(5)					1556	3731	4284	1136	4519	1456	1435	2495	69739
(6)						2237	4599	1189	4353	2132	2257	3359	72264
(7)							3999	2583	8589	2445	3227	5547	95737
(8)								55	1656	395	472	696	17557
(9)									3261	2017	2853	3514	79655
(10)										359	1124	1366	29097
(11)											178	1838	51776
(12)												559	52469
TOTAL													1103359

Bicycle

***** PERSN OD (NEW12) *****

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	Total
(1)	33745	4979	15578	13128	8256	9738	11742	2214	1482	5353	3313	7892	149763
(2)		139	1521	1039	565	855	1566	169	481	354	358	520	11753
(3)			2714	4754	2155	2655	3535	437	2875	1253	1321	2359	43576
(4)				2510	2227	2236	3264	827	2230	916	1925	1876	37424
(5)					555	1345	2277	431	1584	513	592	975	22813
(6)						799	2355	428	2392	735	815	1219	26537
(7)							1456	745	3141	959	1189	2537	35951
(8)								20	534	143	174	255	6369
(9)									1179	1857	956	1198	23776
(10)										142	497	559	19522
(11)											42	665	16539
(12)												245	19593
TOTAL													492276

Taxi

***** PERSN OD (NEW12) *****

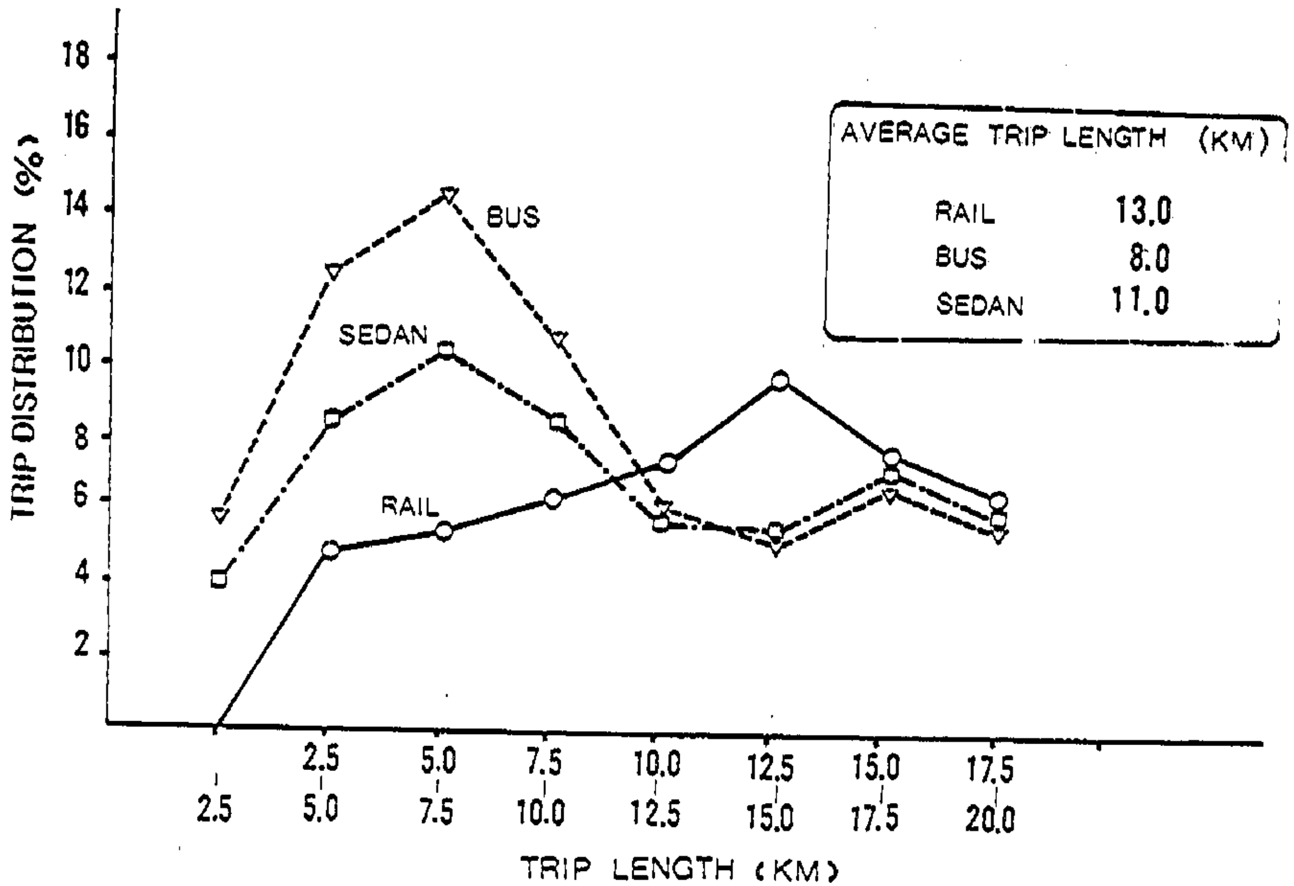
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	Total
(1)	17571	2392	8658	7505	4729	5561	4735	1259	3695	1933	2241	4553	85595
(2)		81	969	618	339	492	596	96	594	192	206	351	6735
(3)			1548	2210	1234	1545	2323	347	1659	719	757	1353	26929
(4)				1147	1272	1296	1547	361	1358	523	596	1379	21416
(5)					322	778	1355	235	938	292	338	558	12582
(6)						457	1348	245	1319	456	455	496	15976
(7)							856	428	1718	559	679	1151	28543
(8)								11	392	77	95	147	3936
(9)									615	693	552	887	16165
(10)										93	237	277	4316
(11)											35	378	4595
(12)												923	18926
TOTAL													233316

All modes

***** PERSN OD (NEW12) *****

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	Total
(1)	389597	95711	197361	153983	119276	151215	152033	42878	166118	61725	55549	102156	2262448
(2)		2497	28575	14269	5925	14939	13731	2935	14963	4537	5459	7783	170102
(3)			33235	52139	29256	35535	43551	18257	44115	11147	18516	35418	561536
(4)				15810	26977	32258	37684	8147	34169	14191	14352	24513	442517
(5)					7145	22332	24592	8743	24338	8533	8428	13269	338318
(6)						14759	31221	7887	49369	15373	12959	17835	412427
(7)							21833	8551	49222	53837	14938	22842	449242
(8)								351	8128	2392	2565	3518	102232
(9)									17116	55318	13656	18234	459335
(10)										2242	7169	7252	172653
(11)											1855	7178	169176
(12)												2431	257849
TOTAL													5585336

Fig. 4.1.7 Estimated Trip Distribution in 2000 A.D. Medan Area



4.2 Freight Flow

4.2.1 General

In this section, the freight flows in Medan City and the surrounding areas are analized based mainly on the results of freight O.D. survey carried out by Bina Marga in 1978, and then, the future freight flows are forecasted.

For this purpose, the freight flows due to exports and imports via Port Belawan are separated from the other freight flows. As for the freight flows via Port Belawan, their future flows are estimated by referring to "PADANG-MEDAN Highway", Sauti-Renardet-Ice, Sept. 1978, and "Indonesian Ports Study", Sir William Halcrow & Partners, Oct. 1975. As for the freight flows generated by other factors, since their increases are mainly attributable to general economic activities of Medan City, and are estimated by assuming an increase rate of regional income in Medan City and conducting a zone distribution according to the ratio of the number of jobs in industry of sectors II and III in each zone obtained in Sec. 2.4.3 Employment Structure by Zone.

Finally, a commodity distribution terminal is planned referring to "the potential demand for commodity distribution terminal in 1978" shown in the Report "PADANG-MEDAN Highway".

4.2.2 Freight Flows via Port of Belawan

In the "PADANG-MEDAN Highway", the generated truck traffic due to the port activities at Belawan, is calculated, thereby its future volume is estimated. The calculation was made as of 1976, and then the values are revised to those of 1978 based on the estimated freight handling volume shown in "Indonesian Ports Study", Sir Silliam Halcrow & Partners, Oct. 1978.

Table 4.2.1 Truck Traffic via Belawan

(Unit: Truck/Day)

	1976	1978*)	1985	2000
Exports	1,303	1,359	2,819	9,440
Imports	2,870	3,036	6,602	16,102
Total	4,173	4,395	9,421	25,542

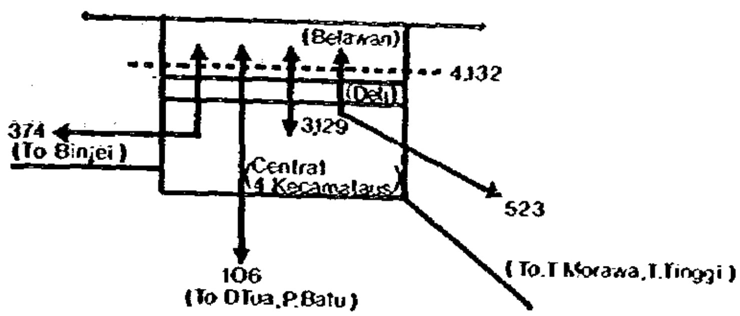
Source: "PADANG-MEDAN Highway", Sauti-Renardet-Ice, 1978.

Notes: *) Refer to Chapter 8: Future Traffic through the Port, Part 3, Vol. 5, "Indonesian Port Study", Sir William Halcrow and Parners, Oct. 1975, by which the growth rate of truck-shared generated tonnage of freight is used in calculation.

According to the results of truck O.D. survey conducted by Bina Marga in 1978, the average number of trucks generated in connection with Port of Belawan is 4,132/day and its volume by direction is as shown in Fig. 4.2.1: Truck Traffic via Belawan (1978).

Fig. 4.2.1 Truck Traffic via Belawan (1978)

(Unit: Truck/day)



Notes: The figures do not include those related to Kec. Medan Deli; but actually the truck flow between Kec. Medan Deli and Port of Belawan is quite limited.

4.2.3 Freight Flows other than those related to Port of Belawan

The number of truck traffic in those flows other than those via Port Belawan are obtained from the results of O.D. survey by Bina Marga, as shown in Table 4.2.2: Truck Traffic except via Belawan.

Table 4.2.2 Truck Traffic except via Belawan

(Unit: Truck/Day)

	1978	1985 *)	2000 *)
Truck Traffic	61,288	97,132	218,893

Source: Truck O.D. survey by Bina Marga (1978)

Notes: *) Future figures are estimated by using the growth rate of regional income of Medan City in future. (See Sec. 2.2.5: Car Ownership)

In this project, for the purpose to respect the results of O.D. survey conducted by Bina Marga, the figures in Table 4.2.1: Truck Traffic via Belawan are corrected using the current figures obtained from the O.D. survey results.

Table 4.2.3 Adjusted Truck Traffic via Belawan

(Unit: Truck/Day)

	1978	1985	2000
Exports	1,278*)	2,657	8,897
Imports	2,854*)	6,222	15,175
Total	4,132*)	8,879	24,072

Notes: The results of O.D. survey by Bina Marga, 1978.

Consequently, from Table 4.2.2: Truck Traffic except via Belawan and Table 4.2.3: Adjusted Truck Traffic via Belawan, the total number of truck traffic are figured out as follows:

Table 4.2.4 Truck Traffic in Total

(Unit: Truck/Day)

	1978	1985	2000
Via Belawan	4,142	8,879	24,072
Except via Belawan	61,288	97,132	128,893
Total	65,430	106,011	242,965

4.2.4 Number of Truck Traffic Generated/Attracted by Zone

First, the truck O.D. data covered in Bina Marga survey are recompiled according to the zoning in this study. Out of such recompiled O.D. data of generated/concentrated truck trip-ends only those of zone #48 and zone #49 are assumed to be related to Port of Belawan, figures of those two zones are taken from Adjusted Track Traffic via Belawan shown in Table 4.2.3. As for the rest of zones, the total number of trucks generated/concentrated except for those related to Port of Belawan is proportionally distributed by means of the average growth rate of the employed population of working places (jobs) in sectors II + III, in 1985, and two alternative plans for 2000, versus 1978, and the number of truck trip ends in 1978. (Refer to Table 4.2.5: Truck Traffic by Zone).

However, the results of O.D. survey by Bina Marga are based on Bina Marga's own zoning, posing various problems due to its many assumptions made in re-compiling process, for the use of this study. Further improvements in this regard have to be continued towards preparing the Draft Final Report after submitting this Interim Report.

Table 4.2.5 Truck Traffic by Zone

(unit: 1,000 Trucks/Day)

		1978	1985	2000 (1)	2000 (2)
1.	Gang Bauntu I	2.0	2.0	2.7	3.3
2.	Pusat Pasar I	2.4	2.5	3.3	3.9
3.	Pusat Pasar II	1.3	1.6	3.0	3.4
4.	Pasar Baru	3.2	3.0	2.2	3.6
5.	Aur I	1.7	1.5	2.1	2.5
6.	Kasawan I	2.2	2.0	3.0	3.6
7.	Gang Bauntu II	0.6	0.7	0.7	1.1
8.	Pandam Hilir I	1.5	3.7	9.3	0.9
9.	Sei Rengas I	1.7	1.5	1.4	1.8
10.	Sei Rengas II	1.5	2.0	3.3	3.0
11.	ASur II	1.1	2.3	5.1	4.6
12.	Hamdan	0.4	0.7	1.1	0.9
13.	Petisah Tengah I	0.5	0.9	2.1	1.8
14.	Kasawan II	1.4	2.3	4.8	6.0
15.	Sidodadi I	0.9	2.8	21.9	26.3
16.	Sidodadi II	1.1	2.5	5.6	5.1
17.	Pandan Hilir	0.9	2.8	12.7	11.7
18.	Pandan Hulu	1.5	4.6	15.9	17.9
19.	Sei Kengas II	1.3	4.0	4.7	8.0
20.	Kotamatsum	1.8	4.8	4.9	7.7
21.	Sei Mati	0.5	0.7	1.8	1.5
22.	Anggrung	0.7	1.1	2.1	1.4
23.	Madras Hulu	0.6	1.0	1.5	1.4
24.	Petisah Tengah II	0.3	0.6	1.5	1.3
25.	Silalas I	0.7	1.9	4.7	4.3
26.	Silalas II	0.5	1.5	14.4	12.2
27.	Kasawan III	0.6	0.8	1.8	1.4
28.	Durian	0.4	0.7	1.1	1.3
29.	Sidarame	0.2	0.6	1.5	1.6
30.	Sei Kara Hilir	1.0	3.1	6.3	7.3
31.	Tegal Sari	1.5	2.5	5.2	4.4
32.	Teladan	0.5	1.0	3.4	1.9
33.	Sitirejo	0.6	0.6	1.2	1.1
34.	Baru	0.4	4.9	0.6	0.4
35.	Polanig	0.5	0.6	0.7	0.8
36.	Darat	0.6	0.7	1.8	1.4
37.	Petisa Hulu	0.7	0.6	0.6	0.3
38.	Petisah Tengah III	0.4	1.0	2.6	2.1
39.	Sekip	1.1	2.4	4.1	4.4
40.	Silalas	1.2	1.9	4.2	3.1
41.	Brayan	1.8	3.3	5.2	4.5
42.	Padang Bulan	0.5	0.6	1.8	0.5
43.	Babura	0.5	0.8	2.5	0.9
44.	Sei Sikambing D	0.3	0.5	1.5	1.1
45.	Sei Putih	0.4	0.9	3.3	1.9
46.	Sei Agul	0.3	0.5	1.6	0.8
	Internal Study Area	46.2	83.2	186.3	190.0
47.	Deli	1.8	1.9	3.5	0.9
48.	Labuhan	1.9	3.8	5.2	5.2
49.	Belawan	2.2	5.1	18.8	18.8
50.	Sidorejo	0.1	0.1	0.1	–
51.	Denai	–	–	–	–
52.	Kp. Binjei	0.4	0.4	0.8	0.3
53.	Timbang Deli	0.4	0.4	0.8	0.3
54.	Kedai Drian	0.3	0.3	0.4	0.2
55.	Gedung Johor	0.2	0.2	0.6	0.3
56.	Tuntungan	0.2	0.3	1.5	0.6
57.	Sungal	1.6	1.6	3.3	1.1
	Internal Study Area	8.9	13.9	34.0	7.7
58.	P. Sei Tuan	0.1	0.1	0.1	0.3
59.	Btg. Kuwis	0.1	0.3	0.6	0.6
60.	Tg. Morawa	3.3	0.3	3.2	0.9
61.	Potumbak	0.4	0.1	0.3	0.3
62.	Deli Tua	0.6	0.2	0.7	0.8
63.	P. Batu	0.6	3.1	1.6	12.0
64.	Sunggal	0.6	0.4	0.6	0.5
65.	Kp. Perak	1.6	1.0	3.7	4.3
66.	Binjei	0.6	0.7	1.4	1.3
	External Study Area	7.9	6.2	7.0	20.8
67.	East	1.4	1.5	2.7	2.1
68.	South	0.2	0.2	0.8	0.6
69.	West	0.8	1.0	2.2	1.8
	Outside Total	2.4	2.7	5.7	4.5
	Grand Total	65.4	106.0	243.0	243.0

Note (1) : Current Trend Model
(2) : Redevelopment Model

4.2.5 Commodity Distribution Terminal

In "Padang-Medan Highway", study a questionnaire survey was conducted on warehouse operators in Medan City.

According to the survey, there are 35 ha of land in total occupied by warehouses existing in Medan City, about 58% of which are concentrated in the Internal Study Area. They are roughly classified into the following 4 types:

(a) Relatively large warehouses for export freight;
(b) Relatively large warehouses for import freight;
(c) Relatively small warehouses for wholesale business;
(d) Relatively small warehouses for retail business

Of these, since types (c) and (d) are closely related to commercial activities in each area; consequently it is not appropriate to relocate them as a large warehouse group. As for the type (a), those warehouses in Port of Belawan are most suitable for the freight to be exported. In the case of warehouse operators in the type (b), they are already interested in improved efficiency by way of facility modernization. Since they know that the relocation is inevitable, they are looking for any suitable site for their new warehouses.

In "Padan-Medan Highway Study", the required site area of new warehouses at the relocated location was calculated by the quantity of imported commodities which are not handled at such warehouses existing in the CBD selected out of total commodities dealt in existing warehouses located in the CBD.

According to this report, the warehouse area around the railway stations which should preferably be relocated, is 3 ha in area, and the total quantity of imported freight to be handled at those relocated warehouses, is estimated at 990,000 tons/yr.

$$990{,}000 \text{ (tons/yr)} = V \text{ (m}^3\text{)} \times 0.6 \times 365 \text{ (days/yr)}/40 \text{ (days)} \times 1 \text{ (ton/m}^3\text{)}$$

- Total capacity of warehouse: V (m^3)
- Operation rate : 60%
- Average days of storage : 40 days
- Average weight of freight : 1 ton/m^3

Accordingly, the required warehouse capacity is figured out to be 180,000 m^3 for which about 45,000 m^2 of total floor space is required. Supposing the floor area ratio to the land area to be 0.25, then the total land area of about 180,000 m^2 is necessary.

Supposing that about 2/3 of the entire freight volume handled at the warehouses in the vicinity of railway stations which are planned to be relocated is occupied by such freight, further addition of 10,000 m^2, or 1/3 of 3 ha should be necessary. Consequently, the total site area for the relocated warehouses will be some 220,800 m^2.

The quantity of freight to be reloaded will correspond to 1,085 trucks/day assuming the average load per truck to be 2.5 tons, and about

405 trucks/day out of which (about 29%) must drop in Medan City to carry the said freight quantity.

The required warehouse area in the year 2000 A.D. is estimated, based on the study "Padan-Medan Highway Study", with the following premises:

- The total quantity of imported freight in 2000 A.D. via Belawan is assumed to be 15,175 trucks/day as shown in Table 4.2.3: Adjusted Truck Traffic via Belawan and Fig. 6.5.1.

- The distribution ratio of truck traffic by direction in 2000 A.D. is assumed to follow Fig. 4.2.1: Truck Traffic via Belawan.

- The number of trucks by direction above mentioned is integrated into 3 major directions, Belawan→Medan, Belawan→T. Morawa and Belawan→Binjei plus Belawan Pancur Batu.

- Warehouse groups shall be relocated to two locations; one group to the vicinity of interchanges of Belawan-Medan-T. Morawa Tollway in the east side of the city and the other group to the interchange zone of the Outer Ring Road in the west of the city. The trucks bound for the directions of Belawan→Medan and Belawan→T. Morawa are assumed to use the eastern group, while the trucks in directions of Belawan→Binje and Belawan→Pancur Batu are assumed to use the western group.

- Out of trucks in the direction of Belawan→Medan, those destinating to warehouses account for 29% as at present, while the rest turcks account for 66% as at present.

Under such assumptions and referring to the study "Padan-Medan Highway", the eastern and western warehousing areas required are estimated at about 80 ha and 20 ha, respectively. However, according to a survey of truck traffic by direction conducted by the survey team at the existing six weight-bridges, there is a salient difference in the average load per truck between T. Mawara direction and Binjei directions.

Table 4.2.6 Ratio between Large and Small Trucks by Direction

Direction	Truck Type	Ratio
To Binjei	Small	62.4
	Large	37.6
	Total	100.0
To T. Morawa	Small	38.1
	Large	61.9
	Total	100.0

Source: The survey results obtained by the survey team, 1978.

Assuming that the average loading volume for a large truck is 3 tons and that for a small truck, 1 ton, the average loading volume in the Binjei direction is about 1.8 tons/truck, and that in the T. Morawa direction is about 2.2 tons/truck. The latter's average load in the T. Morawa direction is very close to 2.5 tons/truck assumed when the removed freight volume was converted into the number of trucks. Consequently, it is considered valid to adjust with the ratio of average loading volume in the Binjei and T. Morava directions, the 20 ha, or the required site area obtained concerning the warehouse group in the west of Medan City. Thus, the site area in the west of Medan is corrected to some 16 ha.

Chapter 5 EVALUATION

Chapter 5. EVALUATION

5.1 General Description

As is mentioned in Chapter 3.3.1, the alternatives of urban transport planning formulated for the year 2000 A.D consist of the following three steps of evaluation:

i) Original classification;
ii) Evaluation by grade of road motorization; and
iii) Evaluation by railway operating conditions.

Each classification has different categories and items to be evaluated and the followings are the general descriptions on those alternatives:

(1) Original Classification

In this classification, the evaluations are summarized as follows:

i) Railway participation in urban transport
ii) Land use planning
iii) The way of railway transport for commuters

Due to the facts summarized above those evaluations depend mainly on the governmental policies and the key point is how to evaluate the continuous railway elevation in the CBD.

(2) Evaluation on Road Motorization

The evaluation in this step occupies a most important place in this study and the key point is whether it is possible or not to evaluate the active participation of public transportation in urban transport from the objective view point. Although many ways and items to evaluate on these alternatives can be considered, it is examined mainly by economic analysis as well as social cost analysis which include such items as volume of fuel consumption, volume of exhaust gas and others.

(3) Evaluation on Railway Operating Conditions

The evaluations on railway operating conditions are summarized as in terms of the volume of passengers transferring at Medan Railway Station and mutual through train operation among four main lines originating from Medan Station. Namely those alternatives are different in the number of Platforms at Medan Railway Station due to the operating conditions. Under those premises the number of rolling stock and the operating head way of urban trains are studied in each alternative case, and an optimum case is selected out of them judging from the viewpoint of railway operation system. However those alternatives are evaluated mainly from qualititative viewpoints in this step.

5.2 Evaluation on Original Classification

5.2.1 Comparison of Construction Cost

The purpose of estimation of construction costs of alternative improvement plans presented in this section is only for the rough comparison of plans financially. The costs related to the road network improvement result in approximately similar amounts except for the cost of flyovers in Alternative 3. Therefore, the comparison of plans approximately results substantically in the comparison of costs related to railway improvements.

Standing on the viewpoint of grade separation of railway crossings existing in the CBD, the main feature of railway elevation and road flyovers in the CBD are shown in Table 5.2.1.

Table 5.2.1 Main Features of Railway Elevation and Road Flyovers in the CBD

Railway Elevation		Road Flyovers	
General view : See Fig. 5.2.1		General view : See Fig. 5.2.2	
Total Length of main tracks to be elevated	2.9 Km	Number of locations of proposed flyovers	6
Platform length	170m	Total length of a typical flyover including both approaches	450m
Number of platforms	2		
Maximum profile gradient	25/1000	Design speed	60 Km/h
Minimum radius of curvature	R=300m	Number of lanes on flyover	4 lanes
		Maximum profile gradient	5%

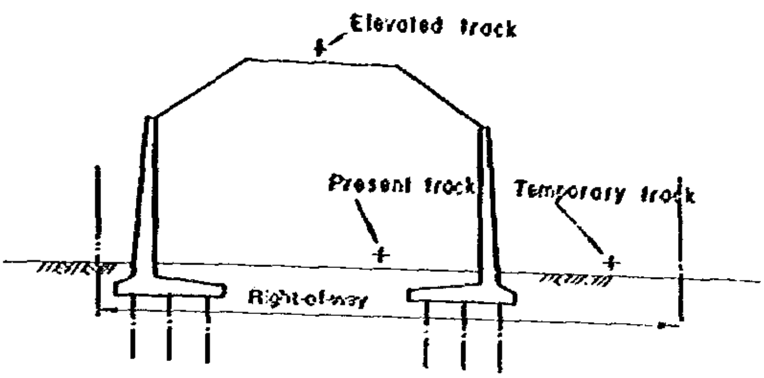
Estimated construction costs of railway elevation and road flyovers are tabulated in Table 5.2.2.

It can be considered that the total cost of railway elevation is approximately similar to that of road flyovers, but there are such vital points to be taken into account on construction as follow :

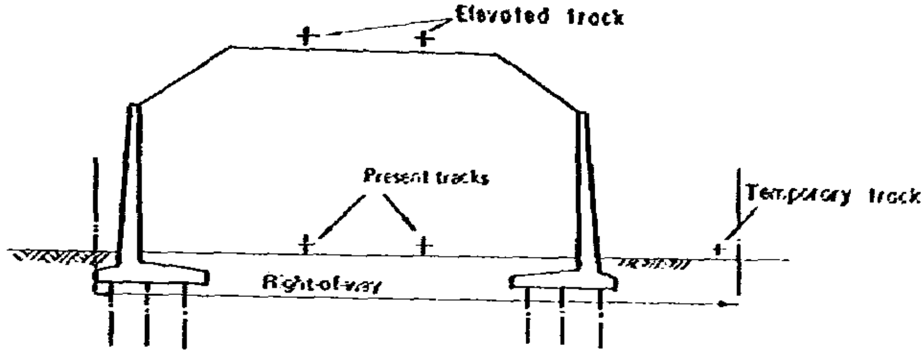
(a) Difficult and dangerous problems will take place during the construction of flyovers because the road traffic volume of each of those locations proposed is estimated much larger than the present volume of 30,000, perhaps may be in the range of 30,000 to 60,000 vehicles per day.

(b) On the contrary, the right-of-way of railway is wide enough along the route proposed for the purpose of elevating construction and of operating trains on a temporary track aside. Therefore, the construction of railway elevation has few causes to affect on the road traffic during the construction.

Single track section



Double track section



MEDAN Station

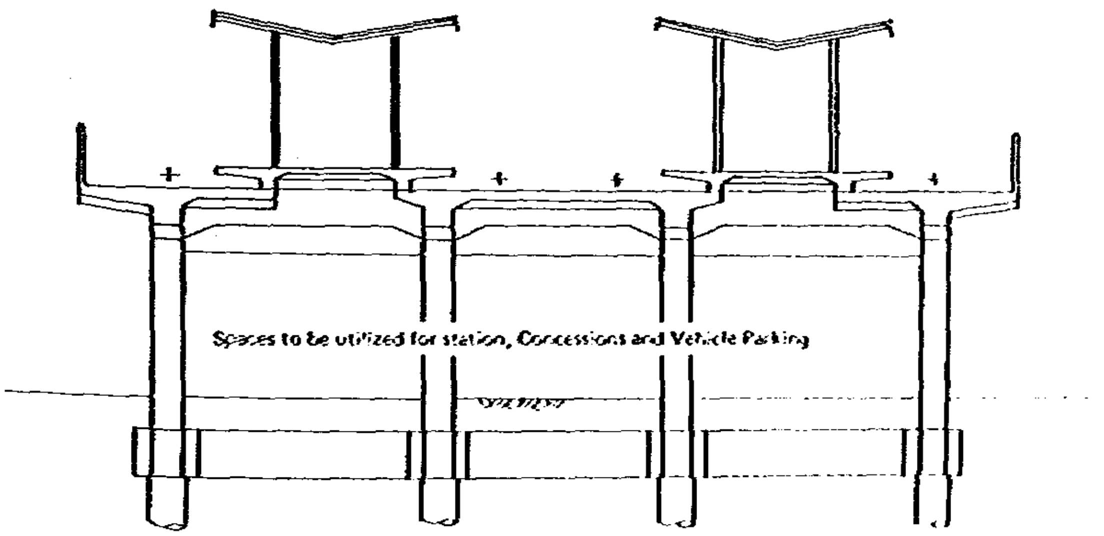


Fig.5.2.1 Standard sections of the elevated portion of railway	Legend	Scale 1:250 0 1 2 3 4 5m
Medan Area Transortation Study		

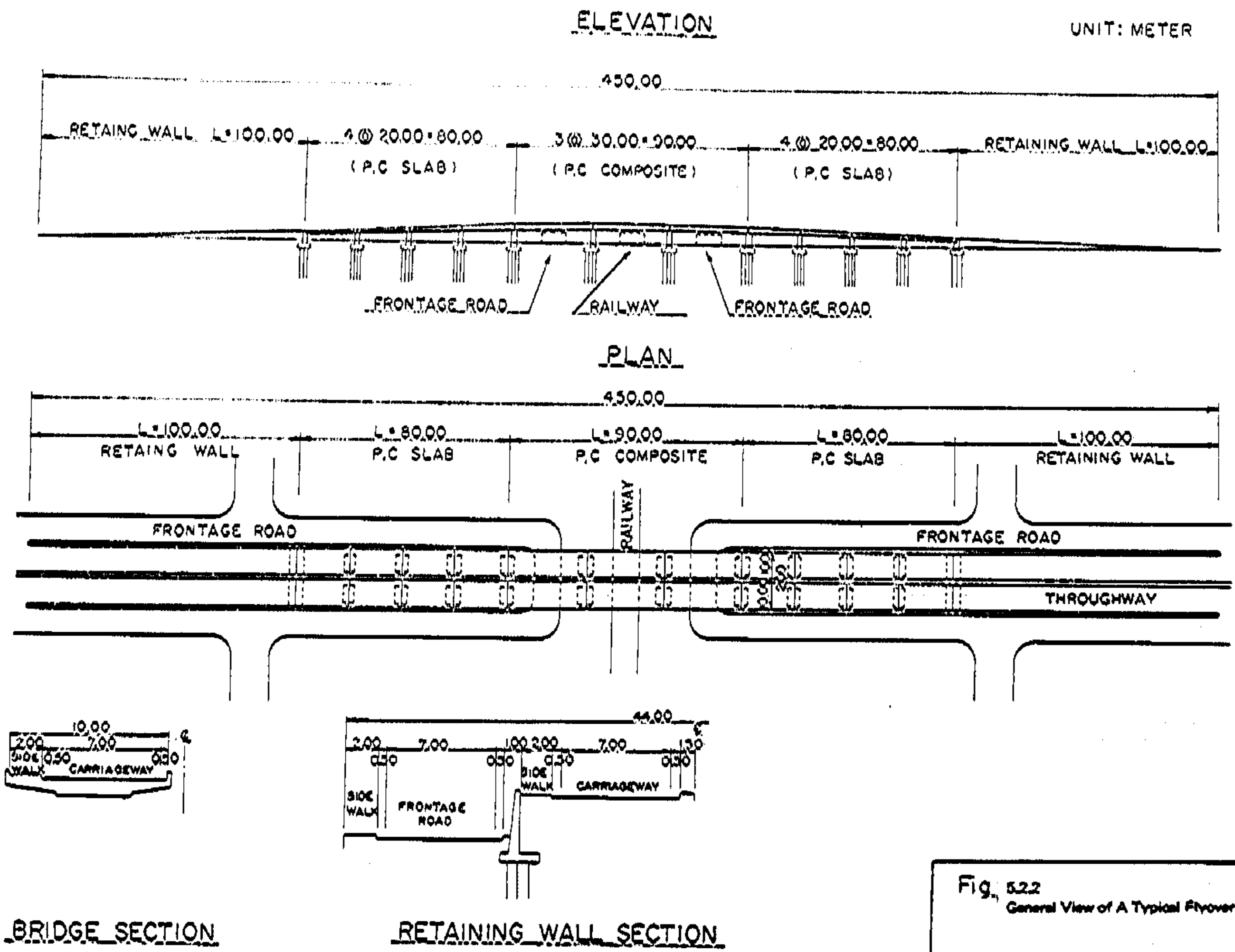


Fig. 5.2.2 General View of A Typical Flyover

Medan Area Transportation Study

Table 5.2.2 Costs of Construction of Railway Elevation and Road Flyovers in the CBD

(Unit: Rp x 10^6)

Elevated Railway Trucks		Road Flyover	
Item	Cost	Item	Cost
Embankment, retaining walls and bridge structures	9,610	(Costs per Flyover) - Earth work	22
Elevated Medan station	9,240	- Pavement	108
Tracks	1,700	- Structures	2,269
Sheds, signal & telecommunication and others	2,320	- Drainage	62
		- Miscellaneous	109
		- Mobilization and others	386
Land acquisition and compensation	320	- Land acquisition and compensation	288
		Sub. Total	3,244
Total	23,190	Total costs of 6 flyovers	19,464

Table 5.2.3 shows the summary of total cost by alternative case respectively. Moreover, although the alternative Case-5 shows the highest total cost in the construction cost, those costs indicates one of the factors only for the comparison purpose and an attention should be paid on the fact that much differences cannot be seen between the continuous railway elevation and the road flyovers from the viewpoint of construction costs.

5.2.2 Comparison of Overall Items (Refer to Table 5.2.4)

(1) Effects on Urban Development:

Redevelopment potential of the present central district centered by the present Medan Station depends upon:

- Commencement of railway commuter service; and
- Railway track elevation

The commencement of railway commuter service will rather drastically increase accessibility to the central district from suburban areas. In the Alternative Case-1 no railway commuter service is proposed and urban transportation service is burdened solely on the road transport. In this case accessibility is more homogeneous throughout the urbanized area without outstanding centers. In the Alternative Case-4 and 6 the present Medan Station will be split into the north and south stations, and it is anticipated that those two stations will become two independent growth poles promoting development between them. The railway track elevation will certainly contribute to the redevelopment of central district diminishing the barrier

Table 5.2.3 Summary of Railway Improvement Costs of Seven Improvement Alternatives

Unit: Rp x 10^6

	Quantity	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7
		Railway Crossings at Grade	Railway Crossings at Grade	Railway Crossings in CBD Opened During Day-Times	Railway Track Elevated Detouring Line for Freight Trains Constructed	Railway Track removed from CBD Detouring Line for Freight Trains Constructed	Railway Track Elevated
Relocation of Freight Yard, Freight Terminals, Locomotive Depot, Diesel Car Depot, and Coach Yard	-	20,150	20,150	20,150	20,150	20,150	20,150
Rehabilitation of Southern Lines for Reopening the Passenger Services	29.2 km	10,400	10,400	10,400	10,400	10,400	10,400
Construction of Medan South Sta.	-	-	-	3,710	-	3,710	3,710
Construction of Medan North Sta.	-	-	-	3,710	-	3,710	3,710
Railway Elevation in the CBD.	2.9 km	-	19,460 *	-	23,190	-	23,190
Construction of Additional Small Stations for Passenger Services	4 stations	1,330	1,330	1,330	1,330	1,330	1,330
Improvement of Medan Sta.	-	1,690	1,690	-	-	-	-
Construction of Detouring Line for Freight Trains	17.3 km	-	-	-	18,200	18,200	-
Short-Cut Track Construction between Binejei and Belawan Lines	2.4 km	2,200	2,200	2,200	2,200	2,200	2,200
Short-Cut Track Construction between Pancur Batu Line and T. Tinggi Line	0.8 km	-	-	1,870	-	1,870	-
Total		35,770	55,230	43,370	75,470	61,570	64,690

Note: * The Cost of Road Flyovers

In the original cost comparison table following costs are excluded :
(a) Rolling Stocks; (b) Improvement of Pulu Berayan; (c) Railway Employee Housing; (d) Double Tracking; (e) Railway Electrification; (f) Construction of Station Plaza

on the ground level between the east and west sides of the railway, and from only this aspect the complete removal of track proposed in the Alternative Case-6 will be the best. Contrarily, road flyovers in the Alternative Case-3 are not very effective for the unification of the both sides of track in terms of pedestrians circulation.

(2) Effects on Road Facilities

Case 1, in which the railway does not participate in the urban transport and no railway improvement is made, is formulated in order to show the extreme case of the highest traffic burden on the road system in the CBD where railway crossings remain at their present locations with heavier crossing traffic on roads than they have now. Therefore Case 1 is evaluated as D. Case 4 and 6 are formulated in order to show cases in which Medan Station is relocated together with complete removal of railway tracks from the CBD as shown in Case 6 or Medan Station is relocated but the main lines still remain in the CBD permitting freight trains to be operated only at night and no passenger train is operated in the CBD as shown in Case 4. In Case 6 the complete removal of railway tracks results in elimination of crossings and the former railway right-of-way may be subject to urban redevelopment but this case compels commuters some inconvenience to reach the central part of the CBD which results in causing some duplication of trips. Therefore, Cases 4 and 6 are evaluated as C. In the rest alternatives effects on the road facilities are all in the equal conditions. Therefore Cases 2, 3, 5 and 7 are evaluated as A.

(3) Effects on Closing Time of Railway Crossings

i) In Case 1 all crossings remain at the present locations in the CBD, the road traffic on crossings becomes heavier but train frequency does not increase noticeably because urban trains are not operated. The effect on closing time is neglegible. Therefore Case 1 is evaluated as C.

ii) In Case 2 train frequency is increased because of commencement of operation of urban trains. The effect on closing time of crossings becomes worse compared to Case 1. Therefore, Case 2 is evaluated as D.

iii) In Cases 4 and 7 train frequency is much less on the main line on the ground is much less than Case 2 because of the abolishment of passenger train operation on the ground is eliminated but freight train are still operated at night on the ground. The effect on closing time of crossings is much less than Case 2. Therefore Case 4 and 7 are evaluated as B.

iv) In Cases 3, 5 and 6 the closing time of crossings become nil because of either by railway elevation, or roads flying over the railway or the complete removal of railway in the CBD. The effect on closing time of crossings are equally most favorable. Therefore Cases 3, 5 and 6 are evaluated as A.

(4) Accessibility to the CBD by Railway Passengers

i) In Cases 1, 2, 3, 5 and 7 Medan Station remains at the present location and the access to the CBD area on the part of railway passengers are equally satisfactory. Therefore Cases 1, 2, 3, 5 and 7 are evaluated as A.

ii) In Cases 4 and 6 Medan Station is relocated from the present location, and the access to the CBD on the part of railway passengers become worse. Therefore, Cases 4 and 6 are evaluated as D.

(5) Safety Grade of Railway Crossings

Evaluations are same as those in (3) 'Effects on Closing Time of Railway Crossings'.

(6) Effects on Train Operation

i) In Cases 3 and 5 the railway remains in the present location but is flied over by roads or is continuously elevated, both of which results in elimination of crossings. Consequently, there exists no hindrance to the train operation. Therefore, Cases 3 and 5 are evaluated as A.

ii) In Case 7 railway crossings still remain in the CBD but it is expected that the existence of those crossings will give no hindrance to the train operation because freight trains are operated only at night. Therefore, Case 7 is also evaluated as A.

iii) In Case 6 the present function of Medan Station is divided into Medan North Station and Medan South Station; some restrains are sure to be expected as compared to Cases 3, 5 and 7. Therefore, Case 6 is evaluated as B.

iv) In Cases 1 and 2 all crossings remain at the present locations in the CBD and passenger as well as freight trains are operated on the mainlines in the CBD and the latter's operation is limited only at night. Therefore, it is sure that such existence of crossings will give the worst hindrance to the train operation. Therefore Cases 1 and 2 are evaluated as C.

(7) Improvement Costs of Railway Facilities

(The total cost of railway improvement)	(Evaluation)
Case 1 $<$ Rp 30×10^9	A
Rp 30×10^9 $<$ Case 2 & Case 4 $<$ Rp 45×10^9	B
Rp 45×10^9 $<$ Case 3 $<$ Rp 60×10^9	C
Rp 60×10^9 $<$ Cases 5, 6 and 7	D

(8) Effects of Freight Train Operation to Urban Areas

i) In Cases 5 and 6 Air polutions and noises to be and vibration problems in the urban area to be caused by the freight train operation are completely eliminated by the construction of a detouring line for freight trains. Therefore, Cases 5 and 6 are evaluated as A.

ii) In Cases 1, 2, 3, 4 and 7 such problems afore-mentioned still remains. Therefore, they are all evaluated as D.

(9) Saving Energy

With respect to the evaluation based on saving energy point of view all alternatives are evaluated in two points of view, namely, land-use pattern and railway crossings. The evaluation on railway crossings will results in the same evaluation made in the category No. (3) 'Effects on Closing Time of Railway Crossings'. The evaluation on from the land-use pattern point of view the CBD Redevelopment Model are superior to those alternative of 'The Current Trend Model'. In the integrated evaluation on them Cases 1 and 2 are leveled up one grade from those evaluation in the category No. (1) 'Redevelopment of the CBD, namely Case 1 as C and Case 2 as B because in the Current Trend Model the urbanized area is comparatively concentrated and consequently, their average trip distances are shorter than others. While in the Cases 3, 4, 5, 6 and 7 are leveled down one grade from those evaluations in the evaluating category No. (3) 'Effects on Railway Crossings', namely Case 3 as B, Case 4 as C, Case 5 as B, Case 6 as B and Case 7 as C because in the CBD Redevelopment Model the urbanized area expands than the Current Trend Model and consequently, their average trip distance becomes longer.

(10) Utilization of Railway Property from Municipal Points of View

i) Case 6 is evaluated as A because all railway property around Medan Station can be freed from railway for urban redevelopment.

ii) Case 5 is evaluated as B because the spaces under the elevated portion of railway with structures can be utilied for station's own purposes as well as concessions and parking space, etc.

iii) Case 7 is evaluated as C because the utilization is a little less than in Case 5 due to the remaining main track on the ground for the freight train operation irrespective of the railway elevation.

iv) Cases 1, 2, 3 and 4 are all evaluated equally as D because the railway property is still occupied by the existing railway facilities.

(11) Operation and Maintenance Costs of Crossings

i) Cases 3, 5 and 6 all crossings are eliminated; consequently, the operation and maintenance costs of crossings are completely saved. Therefore, Cases 3, 5 and 6 are evaluated as A.

ii) In Cases 4 and 7 only freight trains are operated through the CBD on the ground surface only at night; consequently the operation and maintenance costs of crossings in necessary but not large amount. Therefore, Cases 4 and 7 are evaluated as B.

iii) In Case 1 the number of trains to be operated through the CBD on the ground surface is less train frequency but the heaviest road crossing traffic. Consequently, the operation and maintenance costs of crossings are somewhat larger than in Cases 4 and 7. Therefore, those both cases are evaluated as C.

Table 5.2.4 Evaluation Matrix of Improvement Alternatives of Urban Transport Plan for Medan Area in 2000 A.D.

	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7
1. Redevelopment of the CBD	D	C	C	C	B	A	B
2. Effects on Road Facilities	D	A	A	C	A	C	A
3. Effects on Road Traffic Closing Time at Railway Crossings	C	D	A	B	A	A	B
4. Accessibility to the CBD by Railway Passengers	A	A	A	D	A	D	A
5. Safety Grade of Railway Crossings	C	D	A	B	A	A	B
6. Effects on Train Operation	C	C	A	D	A	B	A
7. Improvement Cost of Railway Facilities	A	B	C	B	D	D	D
8. Effects of Freight Train Operation to Urbanized Areas	D	D	D	D	A	A	D
9. Saving Energy	C	B	B	C	B	B	C
10. Utilization of railway property from the muni-cipal points of view	D	D	D	D	B	A	C
11. Maintenance Cost of Railway Crossings	C	D	A	B	A	A	B
12. Utilization of Space Under Elevated Railway	D	D	D	D	A	-	A

Note: Characters used in indicating the grades of evaluating means from the viewpoint of urban transport planning are as follows :
A : Excellent
B : Fair
C : Poor
D : Bad

iv) In Case 2 the operation and maintenance costs of crossings is the largest because of handling the heavy road and railway traffic compared to Case 1. Therefore, Case 2 is evaluated as D.

Furthermore, the followings are the detailed evaluations on major items.

i) Land Use Pattern:

The CBD Re-development Model is considered favorable.

ii) Public Transport

It is more indispensable to strengthen and expand the public transport system as the urban size becomes bigger. It is proposed that bus and Bemo or mini-bus services is proposed to be strengthened under the positive participation by railway in the public transport; namely, the introduction of circulating bus routes in addition to radial bus route network, the improvement and the new construction of bus terminals, and establishment of a bus-lane in each direction on arterial roads in peak hours, etc. are necessary.

iii) Railway Urban Transport and Medan Station

The participation by railway in the urban passenger transport is indispensable to formulate a mass transport system of the city. When the railway's share is estimated as 6.9% replacing the railway's role in 2000 A.D. with bus and Bemo is considered impossible from the viewpoints of the progress rate of strengthening road facilities and the growth trend of motor transportation.

Therefore, the role of railway in the urban passenger transport service of the city in future is eminent and an integrated urban transport system under the coordination by both road and railway.

If the railway intends to commence the urban transport consisting mainly of the commuter service for workers as well as students, the relocation of Medan Station will surely give citizens inconvenience in their accessibility to reach the CBD; therefore, it is rather favorable that Medan Station remain at the present location, and it is proposed to fulfill its function as a symbolic transport node of Medan City.

iv) Improvement of Railway Crossings

As the number of trains increases noticeably in future when the railway commences its urban passenger service it is anticipated inevitablly the increase of the closing time of railway crossings existing in the CBD, which will more aggravate the traffic jams in the CBD. The grade separation of railway and roads in the CBD is necessarily closed up with indispensability.

v) Railway Detouring Line

The steady increase in the freight transportation in future is estimated in North Sumatra Transport Study and it is necessary to consider at an appropriate time the construction of a line detouring the CBD reaching to the freight yard to be constructed on Belawan-Medan Line from the viewpoint of urban environment as well as of the track capacity of the East Line.

vi) Strengthening of Road Network

It is necessary to progress the strengthening of road network and to form new city blocks for urban development under the policy to assume radial arterial roads and Outer Ring Road as its basic road network.

vii) Legislative Measure

In this stage of study, a mention is made only on Becak. It is proposed that an appropriate legislative measure is to be taken to abolish Becak step by step in Medan City by 2000 A.D.

viii) Financial Problem

The detailed amounts of public investments to complete the urban transport system of Medan City for 2000 A.D. are not calculated in the present stage, but it is evident that a considerably large amount of funds is necessary to implement the Master Plan. In such a financial problem how to make its costs most reasonable, and how to share reasonablly such a big amount of fund among the government agencies concerned are of imminent importance, and also the cost of grade separation between railway and roads in the CBD is the main issue in Master Plan implementation.

In view of improving the urban environment of Medan City, the CBD Redevelopment Model in land use pattern is considered favorable; on the other hand, it is necessary to increase the dependence on the public transport system by its strengthening and also by discouraging the use of private vehicles particularly in the CBD in order to handle the urban traffic demands in 2000 A.D. efficiently. For realizing such an objective it is necessary to unify the road transport by bus and Bemo with the railway transport into an integrated urban transport system of the city. In such an estimated future situation the relocation of Medan Station will result in losing Medan Station's present strategic position in the CBD and in reducing the convenience of railway users, which is contrary to the strengthening of public transport system. Due to such reasons it is proposed to improve Medan Station at its present location into an urban symbol at the central transport node of Medan City.

In respect of improvement of railway crossings, it is anticipated that the possible increase in the number of passenger trains will result in aggravating the road traffic situation in the CBD by the noticeable increase in closing time of crossings, which will become a grave hindrance in the performance of the urban transport function of the city. Viewing the railway crossing problem from such a background several improvement alternatives were formulated; it is inevitable to choose either road flyovers or railway elevation in grade separating procedure in the CBD.

Next is the problem of a detouring line for freight trains. Presently the weight of freight transportation is heavier compared to that of passenger transport, but the operation of freight trains through the urbanized area, particularly through the CBD, is considered not favorable from the viewpoint of urban environment, therefore, the construction of a line detouring the CBD is proposed to consider at an appropriate time also from the viewpoint of track capacity of the East line in the Medan Area.

In progressing such improvements, which also concerns on land use, the re-development of the CBD is made possible by relocating freight yard, loco-motive depot, warehouses and railway-related residences presently existing in and around Medan Station, and by so doing it will result in to dig out the potential demand of railway passengers in the CBD area around Medan Station.

Based on the evaluating results mentioned above and the governmental policies of Indonesia, the alternative-5 is selected as an optimum plan in this original classification step and the following studies are further continued on Alternative-5.

5.3 Evaluation on Road Motorization Grade

In this step, the alternative cases consist of Case 1-C, Case 5-A and Case 5-B, the contents of which are described as below:

i) Case 1-C

This is the case being set up only for the comparison purpose in which the railway does not participate in the urban transport service and the road system has to bear all burden of the urban traffic demands.

ii) Case 5-A

This case is developed from the Alternative 5 in the original classification and shows that the private-vehicle transport will grow without any administrave restrictions.

iii) Case 5-B

This case is also developed from the Alternative 5, however some administrative restrictions are enforced to private-vehicle transport.

5.3.1 Traffic Demands

The evaluation on traffic demands will be made by the rate of dependence on the public transport and the traffic control on private-vehicle transport. The estimated traffic demands by mode of transport for these cases in 2000 A.D are shown in Table 5.3.1 and 5.3.2.

Table 5.3.1 Estimated Daily Traffic Demands by Mode of Transport in 2000 A.D. for Alternative Case

(Unit: Trip Ends x 10^3/day)

		Case 1-C		Case 5-A		Case 5-B	
Public	Railway		(0)	230.0	(4.1)	377.6	(6.9)
	Bus	2,166.9	(38.8)	936.0	(16.8)	1,789.3	(31.9)
	Taxi Cab	230.1	(4.1)	324.4	(5.8)	230.0	(4.1)
	Sub total	2,396.9	(42.9)	1,490.4	(26.7)	2,396.9	(42.9)
Private	Sedan	1,676.5	(30.0)	2,198.0	(39.4)	1,676.5	(30.0)
	Motorcycle	1,110.0	(19.9)	1,392.5	(24.9)	1,110.0	(19.9)
	Bicycle	402.2	(7.2)	504.7	(9.0)	402.2	(7.2)
	Sub Total	3,188.7	(57.0)	4,095.2	(73.3)	3,188.7	(57.0)
Grand Total		5,585.6	(100.0)	5,585.6	(100.0)	5,585.6	(100.0)

Table 5.3.2 Estimated Traffic Demands per Peak hour by Mode of Transport in 2000 A.D for Alternative Case.

(Unit Trip End x 10^3/peak hour)

		Case 1-C	Case 5-A	Case 5-B
Public	Railway	- (0)	64.1 (9.6)	95.8 (14.3)
	Bus	342.6 (51.1)	141.6 (21.1)	246.8 (36.8)
	Taxi Cab	22.1 (3.2)	34.1 (5.1)	22.1 (3.2)
	Sub Total	364.7 (54.3)	239.8 (35.8)	364.7 (54.3)
Private	Sedan	160.7 (24.0)	231.1 (34.5)	160.7 (24.0)
	Motorcycle	106.4 (15.9)	146.4 (21.8)	106.4 (15.9)
	Bicycle	38.5 (5.8)	53.0 (7.9)	38.5 (5.8)
	Sub Total	305.6 (45.7)	430.5 (64.2)	305.6 (45.7)
Grand Total		670.3 (100.0)	670.3 (100.0)	670.3 (100.0)

Note: (1) In both tables the internal trips within zones are excluded.
(2) Figures in bracket are expressed in percentage.

In the above-mentioned tables, particularly in the comparison between Case 5-A and Case 5-B the reason of the difference of the sharing rate in the public transport is due to the fact that the numbers by trips of sedan are different and that a bus-lane is provided in each direction on the said roads according to the active policy to enhance the dependence on the public transport in the case of low motorization.

According to the above tables the sharing ratio of daily trips by the public transport is as low as 26.7% in the case of high motorization, while it is expected to rise up to 42.9% in the case of low motorization due to the active policy to enhance this rate of share.

On the other hand, in peak hours, those sharing rates are indicated as 35.8% in the case of high motorization and as high as 54.3 % in the case of low motorization. Such shares of public transport in peak hours seems to be high enough to recognize the public transport as the backbone of urban transport system in Medan Area in case of low motorization.

As it is apparent from other similar large cities that it will necessitate a particular endeavor physically as well as administratively in order to attain such a high dependence on the public transport, and it is also considered that such a high dependence as much as around 54.3 % in peak hour is to be the possible maximum of such dependence on the public transport in general.

As for the relation between the numbers of sedan ownership and the numbers of trips by sedan, both cases of high and low motorizations are same in the numbers of sedan ownership but are different in the numbers of trips per day. This is the results from the evaluation based on the premise that an administrative step shall be strongly taken to control the utilization of sedans for the commuting purpose particularly in the CBD in specified peak hours and that a bus-lane shall be provided physically in each direction on arterial roads during the specified peak hours except on Sundays.

5.3.2 Economic Cost Benefit Analysis

The cost benefit analysis in this chapter is performed to consider what alternative case is preferable among Cases 1-C, 5-A and 5-B. Therefore, the costs are estimated under the premise that each alternative plan is completed 100 % by 2000 A.D., disregarding how they are invested year by year. On the other hand, the benefits are calculated by the differences between the case that the future traffic demands utilize the present transport facilities in 1980 and each three alternatives mentioned above, namely, Cases 1-C, 5-A and 5-B in which the facility plans meet the future traffic demands. Concretely, the benefits are calculated by two factors, namely, running cost and time-saving cost.

(1) Costs

The construction costs, maintenance and operating costs of each alternative are shown in Table 5.3.3 and 5.3.4.

All tax quotas in the costs must be deducted when an economic evaluation is made for selecting the optimum alternative.

In Indonesia, import tax rates of 5 % to 20 % are applied to materials and equipment to be imported for any projects. While, those materials and equipment to be produced domestically are imposed approximately tax quota of 7.8 % on an average.

Standing on the viewpoint to select the optimum alternative by economic evaluation, the following conversion factors are assumed:

i) Costs of railway cars and buses to be procured by foreign loans are not imposed any tax;

ii) Total tax quota for costs of materials and/or equipment imported except for the case (i) is assumed to be 22.8 % : and

iii) Tax for domestically produced materials and equipment is assumed to be 7.8 %.

(2) Benefits

The benefits are estimated under the conditions described below :

i) The facility plannings are completed;

ii) The benefits are calculated from differences between the case of the future traffic demands utilized the present transport facilities and the case of each alternative mentioned here; and

iii) The running and the time-saving costs are taken into consideration and the time-saving cost for the continuous railway elevation is also included;

Table 5.3.3 Summary of Financial Costs of Alternatives (Priced in price level in January 1980)

(Unit: Rp x 10^6)

Categories	Items	Case-1-C	Case-5-B	Case-5-A
Construction Cost	Railway	0	169,300	135,700
	Road	468,300	264,100	360,500
	Road related facilities	62,800	59,000	71,000
	Sub total	531,100	492,400	431,500
Rolling Stock and Bus	Railway rolling stock	0	61,400	33,000
	Buses	171,400	130,700	70,500
	Sub total	702,500	192,100	103,500
Total		1,233,600	684,500	535,000
Annual Maintenace and Operating Costs in 2000 A.D.	Railway	0	4,368	3,202
	Bus	14,825	11,354	6,113
	Road	3,451	2,529	2,733
	Road related facilities	1,839	1,810	1,896
	Total	20,115	20,061	13,944

Table 5.3.4 Summary of Economic Costs of Alternatives (Priced in price level in January 1980)

(Unit: Rp x 10^6)

Categories	Items	Case-1-C	Case-5-B	Case-5-A
Construction Cost	Railway	0	150,700	120,300
	Road	397,200	224,600	305,900
	Road related facilities	54,100	50,700	61,500
	Sub total	451,300	426,000	487,700
Rolling Stock and Bus	Railway rolling stock	0	61,400	33,000
	Buses	171,400	130,700	70,500
	Sub total	171,400	192,100	103,500
Total		622,700	618,100	591,200
Annual Maintenance and Operating Costs in 2000 A.D.	Railway	0	3,988	2,924
	Bus	12,668	9,702	5,223
	Road	3,181	2,330	2,519
	Road related facilities	1,696	1,669	1,748
	Total	17,545	17,689	12,414

Based on the conditions above-mentioned, the benefits of each alternative are calculated as shown in the following table.

Table 5.3.5 Estimated Annual Benefits of Alternatives

(Unit: Rp x 10^9)

Case	Time Saving Benefits	Running Cost Benefits	Total
1-C	219.5	225.4	444.9
5-B	284.5	247.1	531.6
5-A	280.0	245.4	525.4

(3) Cost Benefit Analyses

It does not seems to be much effective to utilize cost-benefit analysis to compare the alternatives of urban transport master plan. This is because cost-benefit analysis is much available to discuss about its appropriateness of a single project. Generally, it is an evidence to provide a master plan in a certain city for the purpose of public facility development plan and its appropriateness is recognized without studies. Namely the important point in this study is not to decide whether or not to have a master plan but which master plan of alternatives is optimum among them. Considering these facts, the approximate cost-benefit analysis is examined simplifying the conditions as below:

i) The maintenance and operating costs do not change after 2000 A.D.

ii) The project life-span is assumed as 15 years and only the procurement of new bus units is taken into account, because the necessary electric railcars are scheduled to be procured in 1998 A.D and the new railcars are not procured in this life-span after 2000 A.D. due to the depreciation period of around 15 years of these railcars.

iii) Such three kinds of discount rate as 10 %, 12 % and 15 % are applied for this analysis.

The results of such cost-benefit analysis are shown in Table 5.3.6.

Table 5.3.6 Results of Cost-Benefit Analysis of alternatives for 15 years after 2000 A.D.

Discount Rate & IRR / Case	B/C ratio			Internal Rate of Return (%)
	10%	12%	15%	
Case 1-C	5.68	5.13	4.46	75.4
Case 5-B	6.02	5.48	4.80	84.4
Case 5-C	5.80	5.29	4.65	83.1

5.3.3 Social Cost Analysis

Social Cost Analysis is examined to evaluate each alternative by such comprehensive items as not to be considered in economic analysis.

i) Energy consumption
ii) Quantity of exhaust gases by automobiles
iii) Traffic accidents
iv) Land use and transport

(1) Energy Consumption

Although a matter of energy consumption is studied in economic analysis as a part of running cost, the total volume of fuel consumption seems to be one of the evaluation items in view of the preservation of the natural resources. The daily consumption of gasoline and diesel oil in each alternative case is calculated as is shown in Table 5.3.7.

Table 5.3.7 Estimated Energy Consumption in 2000 A.D.

(Unit: Kilo-litres/day)

Case	Gasoline	Diesel Oil	Total
Case 1-C	915	496	1411
Case 5-B	915	458	1373
Case 5-A	1273	400	1673

Table 5.3.8 Estimated Vehicle-Kilometers

(Unit: Vehicle Kilometers x 10^3)

Type	Case 1-C	Case 5-B	Case 5-A
Sedans	6,078	6,078	9,095
Motorcycles	829	829	1,732
Trucks	3,255	3,255	3,255
Buses	498	382	205
Railway	-	48	29
Total	10,660	10,592	14,316

(2) Quantity of Exhaust Gases by Automobiles

Exhaust gas is analized only on automobiles and it is estimated under the following premises.

i) Although the volume of exhaust gases by automobiles are variable by the product age of vehicles, vehicles of 1975 production is applied as the basis in this estimation.

ii) The condition of automobile engines is assumed to be same with that of made in Japan.

iii) The mode of running speed is assumed as 30 k.p.h. to simplify the calculation.

iv) Only CO and NO x gases are calculated.

The vehicle-kilometers by type of vehicle and exhaust coefficiency are shown in Table 5.3.9, 5.3.10.

Table 5.3.9 Estimated Vehicle Kilometers by Type

(Unit: Vehicle-Kms x 10^3)

Type	Case 1-C	Case 5-B	Case 5-A
Sedans	6,078	6,078	9,095
Motorcycles	829	829	1,732
Light Trucks	2,278	2,278	2,278
Heavy Trucks	1,475	1,359	1,182
Total	10,660	10,544	14,287

Note: Light Truck = Truck x 70%
Heavy Truck = Truck x 30% + Bus

Table 5.3.10 Exhaust Coefficiency

(Unit: g/Vehicle-Kilometer)

Type	CO	NO x
Sedans	0.30	0.29
Motorcycles	1.10	1.08
Light Trucks	10.58	2.60
Heavy Trucks	2.57	4.61

According to the results tabulated above, the volume of exhaust gases in each alternative case are shown in Table 5.3.11.

Table 5.3.11 Volume of Exhaust Gases

(Unit: ton/day)

Case	CO	NOx
1-C	30.6	15.4
5-B	30.3	14.8
5-A	31.8	15.9

(3) Traffic Accident

Due to insufficient statistical data on traffic accidents in Indonesia, it seems to be difficult to analize from the viewpoint of accidents. Therefore, the alternatives are evaluated by the death ratio per 1,000,000 vehicle-kilometers which has been the average value in Japan. The vehicle-kilometers in each case is shown in Table 5.3.8 and the results multiplied by 0.0841 death per one million vehicle-kilometers are tabulated in Table 5.3.12.

Table 5.3.12 Estimated Annual Death Rate by Traffic Accident in Medan Area

Case	Numbers of Death Per Year
1-C	322
5-B	322
5-A	439

(4) Land Use and Transport

Alternative Case 5-A and 5-B seem to have the same priority from the viewpoint of "land use and transport system". However much differences can be observed between these two cases and Case 1-C. Namely, the land development will be restricted only alongside of roads in case of non-participation of railway in the urban transport which cannot be able to respond to large-scaled development projects. On the contrary, the railway participation in urban transport is considered to be able to promote the various development plans in peripheral areas of Medan City more rapidly.

5.3.4 Selected Alternative

In this section, the overall evaluated items are summarized and an optimum alternative is selected in the stage of Road Motorization Grade. The items of evaluation are as follows:

i) Items relevant to cost

- Construction costs;
- Costs of rolling stock and bus units;
- Maintenance and operating costs;
- Number of railway cars to be assigned; and
- Number of bus units to be assigned.

ii) Items relevant to benefits

- Benefits due to time-saving;
- Saving in running cost; and
- Cost-benefit ratio

iii) Items relevant to social costs

- Quantity of energy consumption;
- Quantity of exhaust gases; and
- Traffic accidents

The evaluation items described above is summarized in Table 5.3.13 and Table 5.3.14 is the evaluation in which the evaluation is replaced by indice based on the value in Case 1-C. In the expression in indice in the table it means that the favorable cases are those of indice lower than 100 in the categories of Cost and Social Cost and also those of indice larger than 100 in the category of benefits.

According to the results tabulated in these tables, some differences can be seen based on the balance between the construction costs and the cost of rolling stock in items relevant to cost and in the economy of cost of rolling stock Case 5-A indicates the lowest index which is followed by Case 5-B. As for the actual necessary numbers of rolling stock and bus which are proportional to their cost, but the number of rolling stock is largest in Case 5-B and the number of bus units is largest in Case 1-C.

As for benefits, the index of Case 5-B shows the highest value but the differience between Case 5-B and Case 5-A is considered rather small. As cost-benefit ratio shows the relationship between cost and benefit, Case 5-B shows the supremacy among three alternatives. Regarding social costs although Case 5-B receives the same evaluation with that of Case 1-C in the item of traffic accidents, Case 5-B is considered superior to other alternatives.

The key point is how to evaluate these results and the followings are the comparison from this point of view.

- Comparison between Case 1-C and Case 5-B

  The point of this comparison is to analyze which alternative case is desirable the railway participation in urban transport or the full bearing of urban transport only by buses. According to the results shown in Table 5.3.14, appropriateness of railway participation in urban transport is clearly revealed by the total costs of construction and rolling stocks including buses as well as the total benefits though the costs of rolling stocks and buses in Case 5-B slows high value, and it is clearly justified by the cost-benefit ratio. This dominance is also supported by the social cost which seems to express the condition of whole living circumstances of Medan City.

- Comparison between Case 5-A and Case 5-B

  The point of comparison is what the differences of transport system are between the encouragement to use the public transport and the natural growth of private-vehicle transport which mean Low and High Motorization. According to the results in Table 5.3.4 a large merit can be observed in Case 5-A from the viewpoint of the costs of rolling stocks and buses which shows a low value. However, Case 5-B occupies a dominant place from the viewpoint of the benefit as well as the cost-benefit ratio.

Especially, Case 5-B seems to be clearly favorable in the items of social cost and as a whole Case 5-B is recognized as the most appropriate facility plan promoting the encouragement of the public transport.

Due to the facts mentioned above, Case 5-B is revealed as the most favorable plan for Long-Term Master Plan of urban transport in Medan Area in the stage of Road Motorization Grade, in which the public transport is encouraged restricting the private-vehicle transport.

Table 5.3.13 Evaluation on Motorization Grade

			Unit	Case-1-C	Case-5-B	Case-5-A
Costs	Construction Cost		Rp x 10^9	531.1	492.4	567.2
	Rolling Stock and Bases		Rp x 10^9	171.4	192.1	103.5
	Sub Total		Rp x 10^9	702.5	684.5	670.7
	Annual Maintenance & Operating Cost in 2000 A.D.		Rp x 10^9	20.1	20.0	13.9
	Additional Number of Railway Coaches in 2000 A.D.		Unit	0	158	100
	Number of Buses in 2000 A.D.		Veh.	3,558	2,725	1,467
Benefits	Annual Time Saving Benefit in 2000 A.D.		Rp x 10^9	219.5	284.5	280.0
	Annual Running Cost Benefit in 2000 A.D.		Rp x 10^9	225.4	247.1	245.4
	Sub Total/Year		Rp x 10^9	444.9	531.6	525.4
	B/C ratio			4.66	4.80	4.46
Social Costs	Energy Consumption		Kl/Day	1,411	1,373	1,673
	Exhaust Gas	CO	Ton/Day	35.2	34.9	38.2
		Nox	Ton/Day	18.0	17.5	20.4
	Traffic Accidents		Person / Year	322	322	439

Notes: (1) In the category of annual maintenance and operating cost in 2000 A.D. Costs of Sedans are not included.

(2) Energy consumption and traffic accidents are calculated based on the estimated vehicle -kms, and figures due to the existence of crossings are not included.

Table 5.3.14 Evaluation on Motorization Grade by Indice

				Case-1-C	Case-5-B	Case-5-A
Costs	Construction Cost			100	93	107
	Rolling Stock and buses			100	112	60
	Sub total			100	97	95
	Annual Maintenance & Operating Cost in 2000 A.D.			100	100	69
	Number of Railway Cars in 2000 A.D.			-	-	-
	Number of Buses in 2000 A.D.			100	77	41
Benefits	Annual Time Saving Benefit in 2000 A.D.			100	130	128
	Annual Running Cost Benefit in 2000 A.D.			100	110	109
	Sub total			100	119	118
	B/C ratio			100	103	96
Social Costs	Energy Consumption			100	97	119
	Exhaust Gases	CO		100	99	109
		NOx		100	97	113
	Traffic Accidents			100	100	136

5.4 Evaluation on Railway Operating Conditions

5.4.1 Arrangement of Alternatives for Comparison

As the train operation system for the railway passenger traffic forecasted towards 2000 A.D four alternative plans have been proposed in Table 3.3.8. The merits and demerits of each plan are given in Table 5.4.1. As is seen therein, Case 5-B-3 and Case 5-B-2-2 are advantageous from the comprehensive standpoint. When these two are compared, Case 5-B-3 has transportation capacity enough to spare over East Line and West Line. However, when various costs relative to track elevation, construction work and rolling stock are compared, these are less expensive to a great extent than Case 5-B-2-2. Consequently Case 5-B-2 would be taken up from the standpoint of duly emphasizing the importance of earnings and expenses.

On the other hand, Case 5-B-2-2 has superior elasticity as to the transportation capacity over East Line and West Line. This plan is, therefore, worthwhile to be considered from the standpoint of advantageous train operation.

5.4.2 Optimum Alternative

The alternatives in each step consisting of Original Classification, Road Motorization Grade and Railway Operating Conditions and analized and the process to select these alternatives are summarized as follows:

i) Original Classification

The seven alternatives are analized and the Alternative 5 is selected as the optimum one.

ii) Road Motorization Grade

The three alternatives are studied including the Case 1-C which is formulated only for the comparison purpose and the Case 5-B which is developed from the Alternative 5 mentioned above is selected.

iii) Railway Operating Conditions

The four alternatives are analized in this step being developed from the Case 5-B which is selected in Motorization Grade and the Case 5-B-3 is placed as the best one.

According to the results described above, the Case 5-B-3 which is shown in Fig 3.3.1 is eventually realized the optimum urban transport master plan in 2000 A.D in Medan City.

Table 5.4.1 Superiority Comparison of Alternatives

Item \ Alternatives		Case-5-B-1	Case-5-B-2		Case-5-B-3
			Case-5B2-1	Case-5-B-2-2	
Main Line Track Length to be Operated (Kms)		153.7 ○	135.3 ◎	153.7 ○	135.3 ◎
Required No. of Diesel Railcars(Cars)		198 ○	200 △	192 ○	166 ◎
Diesel Railcar Running Kms (Car-Kms)		52.100 △	48.500 ○	48.700 ○	48.200 ○
Medan Stn.	No.of Transfer Passengers (x 1000Person)	55.5 ○	60.3 △	60.3 △	26.1 ◎
	No. of Platforms	2 ○	2 ○	3 △	2 ○
Train Headway on Eastern & Western Lines (Minute)		8~11 ◎	18-22 △	15 ◎	18~22 △
Invesiment Cost		○	○	△	○
Effect on the other Lines in case of Traffic Accidents		Effect on Other Lines ○	No Problem ◎	No Problem ◎	Effect on Other Lines ○
Transporting Capacity		◎	△	◎	△
Integrated Evaluation		○	△	◎	◎

◎ Suprior

○ Medium

△ Inferior

Chapter 6 PROPOSED LONG-TERM MASTER PLAN

Chapter 6 PROPOSED LONG-TERM MASTER PLAN

6.1 Railway Facilities

6.1.1 Number of Passengers and Rolling Stock

Concerning future railway passenger demand in the Medan Area no trend could be estimated based on the regional characteristics of the Medan Area since present railway transport is not sufficient in Sumatra. However, based on experience in developed nations, the general trend of railway passenger demand in urban transportation will progress along the following steps listed below.

(1) At the beginning when railway services are opened, the number of railway passengers tends to be low because of the number of railway passengers is limited to only the residencial areas along the railway.

(2) Thereafter, the trend in the number of railway passenger will increase rapidly in line with housing developments and other developments on the areas alone a railway.

(3) Over the long terms, the development of landuse along a railway will be reach a peak and the growth of railway passenger demand will slow down.

These patterns mentioned above are shown in Fig. 6.1.1 in detail for the case of Japan. Those curves in the diagram are one of typical demand curves known as the "Gonpheltsu curves". Therefore, in this studv the Gonpheltsu curves in Fig. 6.1.2 was adopted to determine the number of railway passengers for each year and to forecast the necessary development of facilities to cope with this demand.

The number of railway passengers forecast in the year 2000 in the case of low motorization (Case 5-B) is assumed to be 377,600 persons. It is estimated that the growth in passenger numbers for the period of 1980 - 2000 will be as shown in Fig. 6.1.2. This is ascribable to the fact that no tremendous increase is expected at the initial stage. The actual achievements of railway passenger transport will be accumulative, and in addition, the effect of the housing complex constructions, etc. must take place before an outstanding increase in passenger numbers actually comes to the fore.

It would be opportune for the electrification program to start the electric car operation almost simultaneously over the entire system, so that the ground facilities for electrification be made good use of. Under the current situation, the line would be opened to the public in 1998, when sufficient traffic volume over the line is expected. Consequently, before such time as mentioned above, diesel cars would be brought into use and gradual investment would be made during 1996 - 2000. The number of required rolling stock in each fiscal year is mentioned in the same Fig. 6.1.2.

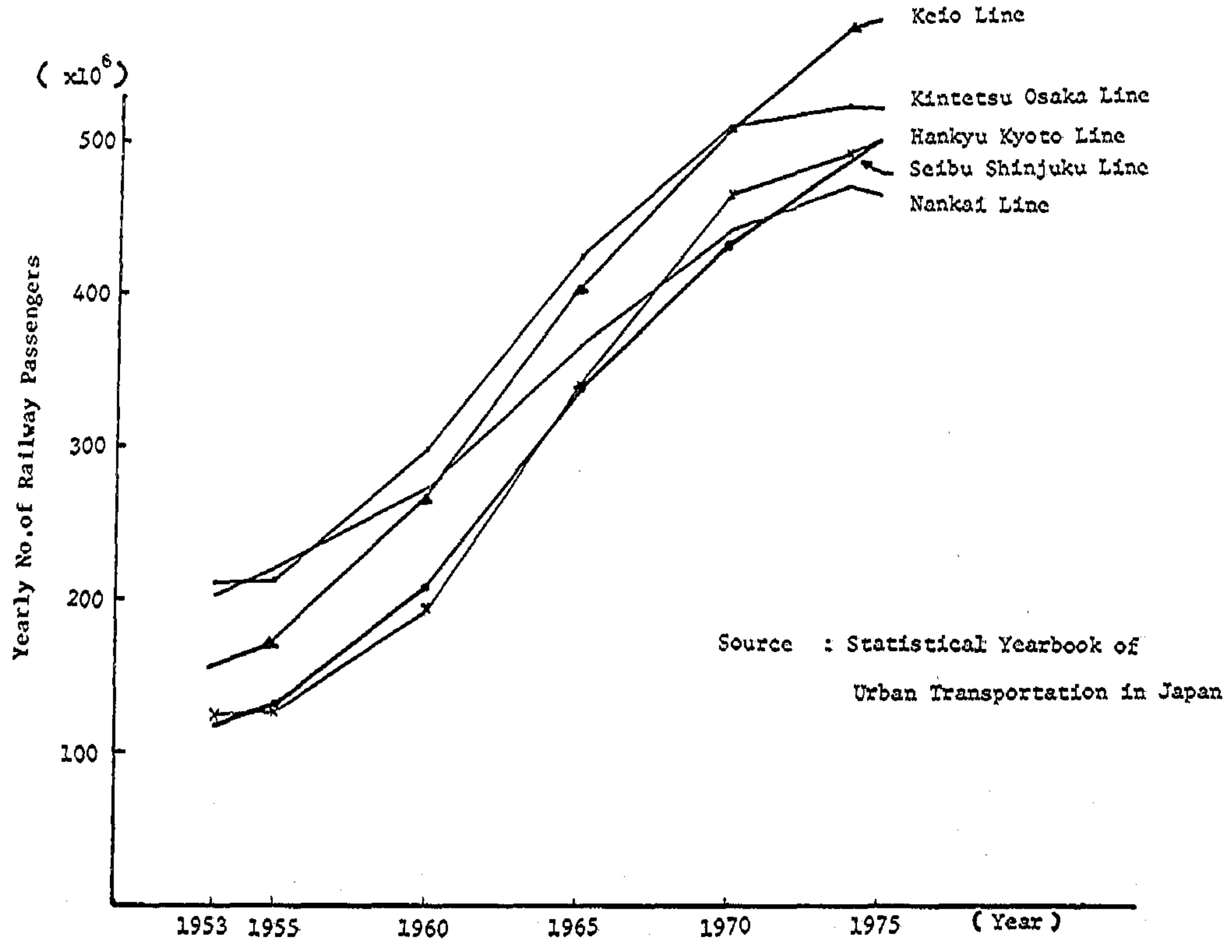
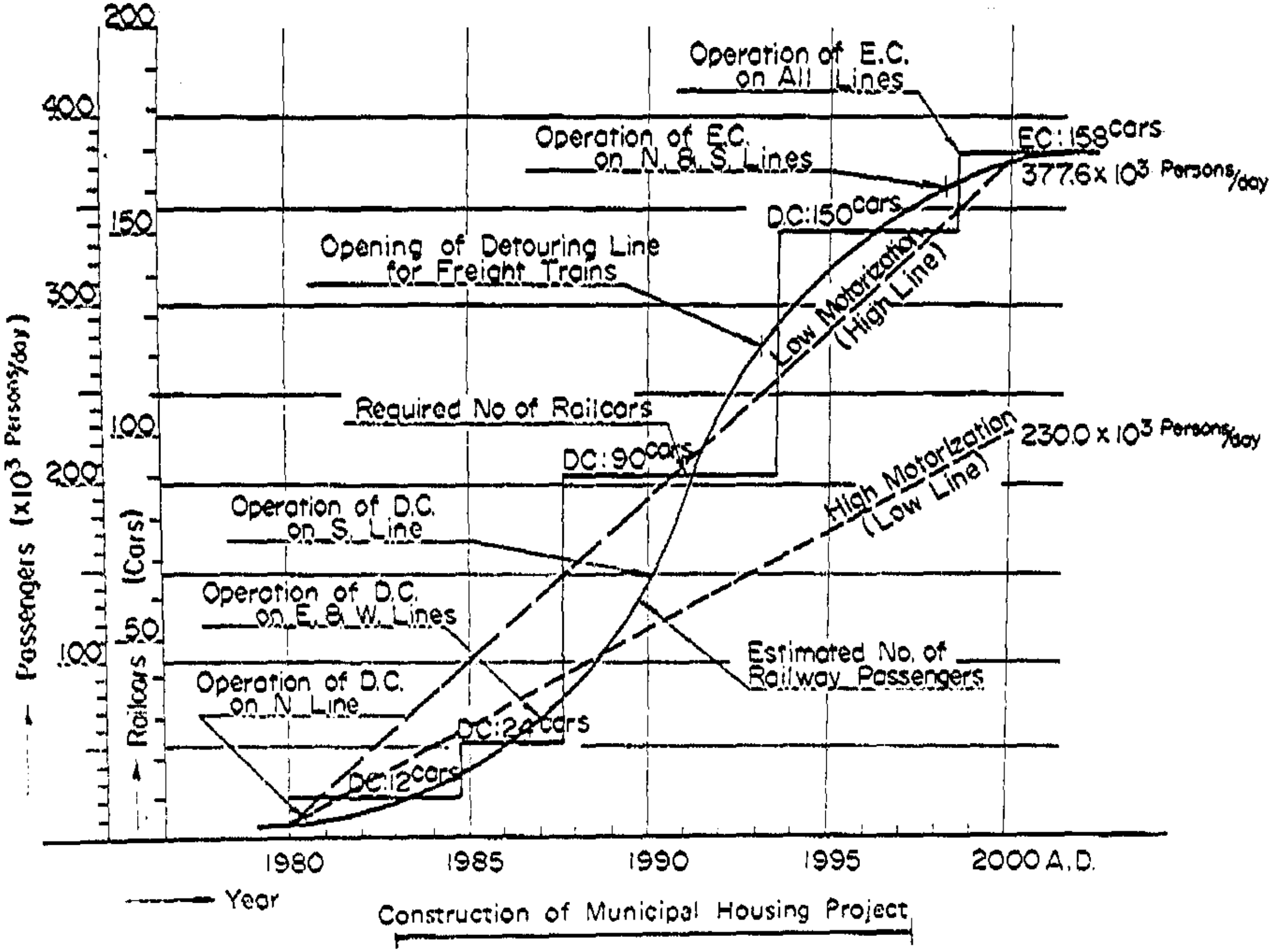


Fig. 6.1.1 Trend in Yearly No. of Railway Passengers

Fig. 6.1.2 Estimated Number of Railway Passengers and Required Number of Railcars in Medan Area



Remarks:

(1) Estimated Number of Boarding Passengers
Considerable increase in the upward tendency thereof is expected, starting from the initial stage of low pace towards high tempo in the Intermediate period, when the Housing Complex Construction Program is to be in full pace of progress. The relevant curve, therefore, is steep in gradient in the intermediate term.

(2) Required Number of Diesel Railcars
The intersection points of the curve with the required diesel railcar number and that of the estimated number of passengers show the case when the car occupancy reaches 130 percent during the peak hours. Accordingly the plan has been worked out to increase the number of diesel railcars when the car occupancy exceeds 180%.

Notes: D.C.: Diesel Railcars
E.C.: Electric Railcars

6.1.2 Railway Network Forecasts in 2000 A.D.

The railway map in 2000 A.D. of the train operation system presented in Case 5-B-3 of Table 3.3.8, is as shown in Fig. 6.1.3.
The main items are as follows:

(1) Two platforms are envisaged in Medan Station.

(2) The passenger yard, the freight yard and the rolling stock base would be newly installed at Titipapan.

(3) Two lines (Medan-Batu and Medan-Pancur Batu) would be revitalized.

(4) The lines, Medan-Ujung Baru and Medan-Pancur Batu, would be double-tracked.

(5) The freight train detour line linking the Eastern Line with Titipapan and the freight train shortcut line linking the Western Line with the Northern Line would be newly constructed.

(6) One station in the Eastern Line, two stations in the Western Line, and another in the Northern Line would also be newly constructed.

Of these tracks, the section including Medan Station, covering the distance of 2.9 km long would require elevation. Fig. 6.1.4 shows the relevant elevated section.

6.1.3 Track

The annual passing tonnage during the years which are taken into consideration of this project is as shown in Fig. 6.1.5. The current grades of these tracks are shown in Fig. 3.4.4, in the Short Term Report.
The present structures are too frigible for the passing tonnage described above. Therefore, it is necessary to improve the track structure of each section to the levels shown in Table 6.1.1.

6.1.4 Rolling Stock

According to the forecasts in 2000 A.D., all the railway cars which would be in service for the urban traffic will be electrified as described in Section 3.3.5. At the initial and intermediate stage, however, diesel cars would be used instead. The transitional stages for these cars, are classified by each fiscal year, as shown in Fig. 6.1.2.
The features of the electric and diesel cars are summarized as follows:

(1) Diesel Cars

All diesel cars will be motorized. The diesel cars will be of 2 types: one equipped with a driver's cab on one side, the other without a cab; The main features and capacities will be as follows:

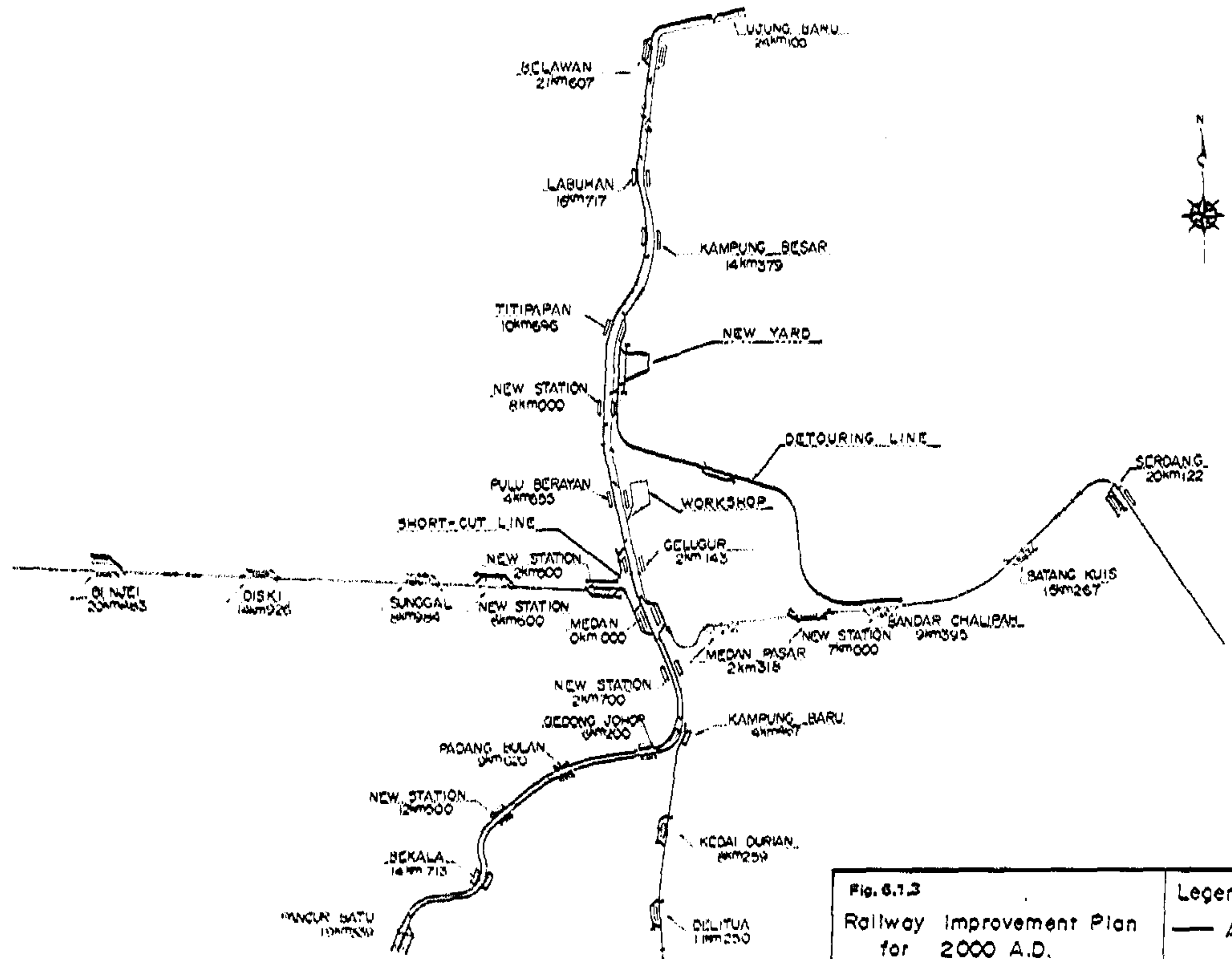


Fig. 6.1.3

Railway Improvement Plan for 2000 A.D. (Case-5-B-3)

Medan Area Transportation Study

Legend

— Additional Facilities

— Existing Facilities

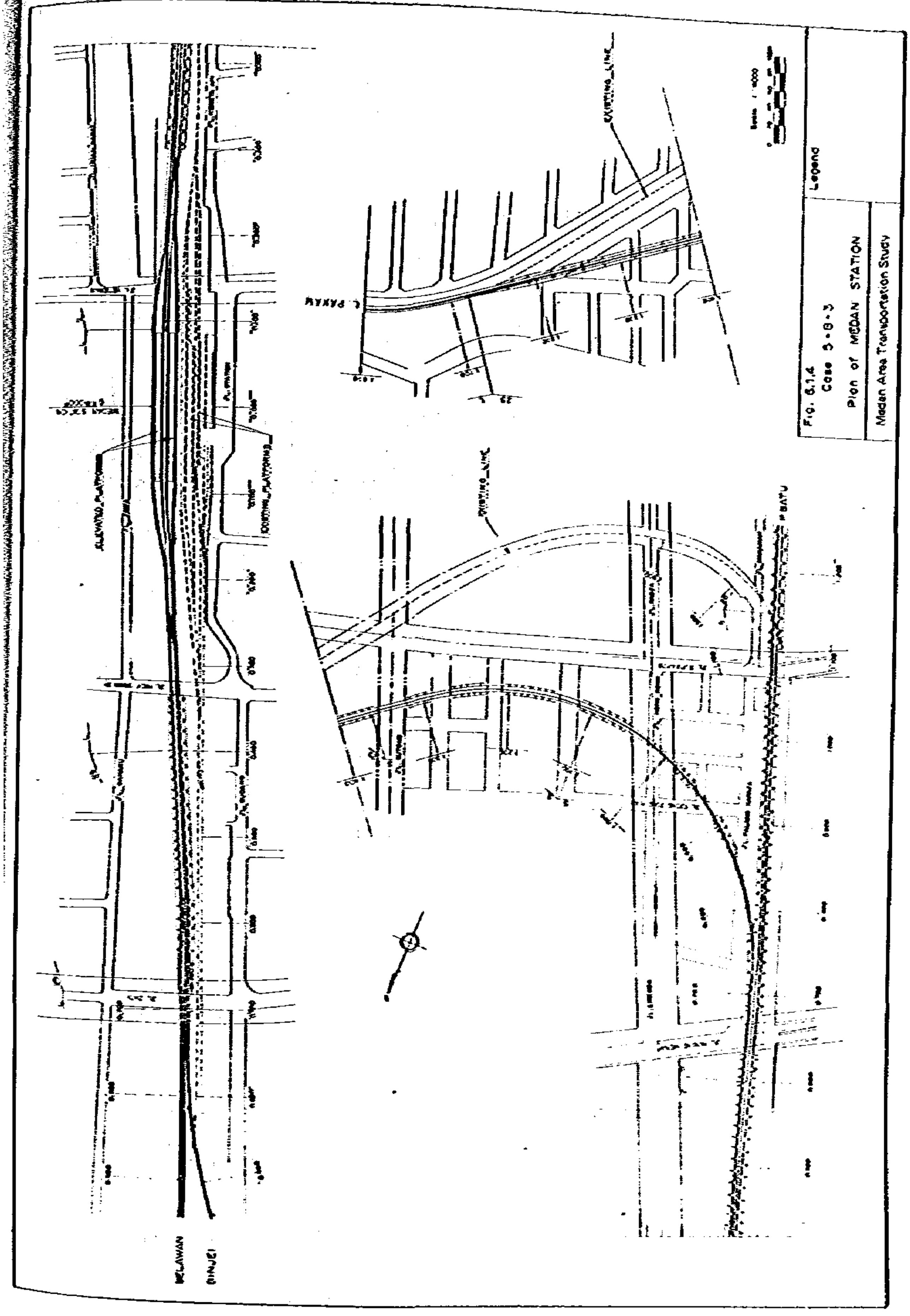


Fig. 6.1.4
Case 5-B-3
Plan of MEDAN STATION

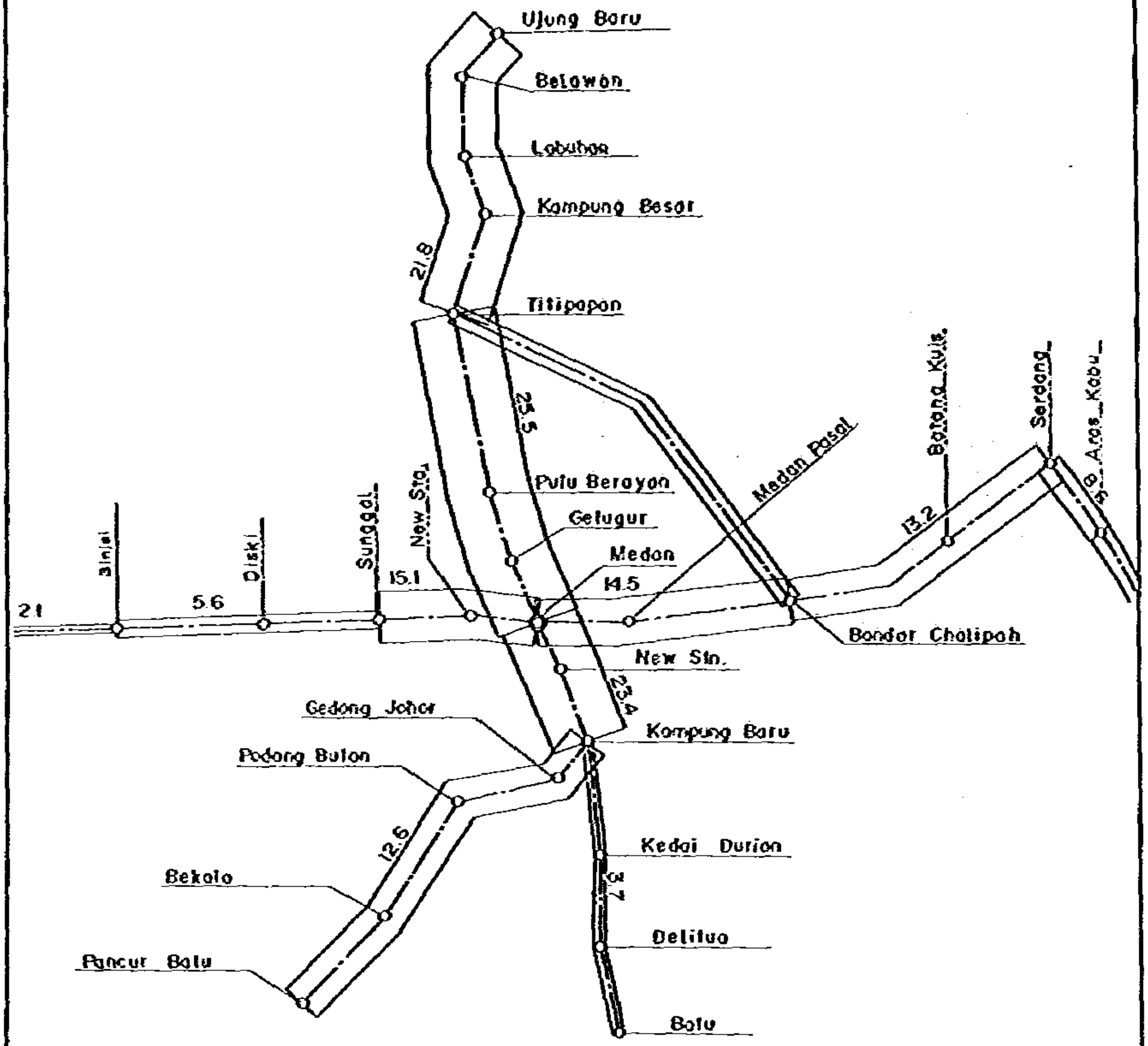


Fig. 6.1.5
Total Estimated Railway Passing Tonnage in Study Area
(2000 A.D. - Case-5-B-3)

Medan Area Transportation Study

Legend

(Unit : x 10^6 Tons / yr)

Table 6.1.1 Estimated Annual Passing Tonnage in 2000 A.D. and Proposed Track Structures

Section		Estimated Annual Passing Tunnage		Weight of Rail (kg/m)		
		(x10^3 Ton)	(x10^3 Ton Single Track)	U.I.C. Recommendation	J.N.R. Recommendation	Recommendation
Northern Line	Belawan-Titipapan	21,800	10,900	46-50		
	Titipapan-Medan	25,500	12,750	50-60	50	50-
Southern Line	Medan-Kampung Baru	23,400	11,700			
	Kampung Baru-Pancur Batu	12,600	6,300			
	Kampung Baru-Batu	3,700	3,700	46-50	40	40-
Eastern Line	Medan-Bandar Chalipah	14,500	7,250			
	Bandar Chalipah-Serdang	13,200	13,200	50-60	50	
	Serdang-	8,600	8,600			50-
Western Line	Medan-Sunggal	15,100	7,550			
	Sunggal-Binjei	5,600	5,600	46-50	40	
	Binjei-	2,100	2,100			40-
Detouring Line	Titipapan-Bandar Chalipah	6,700	6,700			50-

Note: U.I.C.: Union International Chemin de Fer
J.N.R.: Japanese National Railways

Diesel car features and Capacities

Gauge	1,067 mm
Car body length	20,000 mm
Maximum body width	2,999 mm
Capacity (including standing passengers)	100 (type with the cab) 110 (cabless type)
Maximum axle weight	14 t
Highest speed	100 km/h
Acceleration	1.1 km/h/sec (0 - 50 km/h)
Motive power transmission system	Liquid pressure system

(2) Electric Cars

The constituents of electric trains would be as follows:

6-coach train: Tc.M.M'.M.M'Tc
8-coach train: Tc.M.M'.T.T.M.M'.Tc

Note: Tc: Ancillary diesel car with cab
T : Diesel car without cab
M : Motor car with air compressor
M': Motor car with electromotive generator

The main features and capacities would be as follows:

Gauge	1,067 mm
Car body length	20,000 mm
Maximum body width	2,990 mm
Maximum body height	3,620 mm
Capacity (including standing passengers)	100 (type with the cab) 110 (cabless type)
Highest speed	100 km/h
Acceleration	1.8 km/h/sec (0 - 50 km/h)
Motive power transmission system	1,500 V DC

6.1.5 Signal Facilities

Since all the object sections of this project are subject to the future growth in traffic density, it would be appropriate to introduce an automatic block system in each case. Thus, the double track automatic block system over the double track sections and the single track automatic block system over the single track sections will be applied.

In accordance with the intensity of the traffic density, the operating frequency within the station compounds will be increased. In order to improve on the traffic safety, a relay interlocking device will be introduced.

In line with the improvement of these safety facilities, a communications system, such as operation despatcher device, communication telephone system, etc. will be improved.

6.1.6 Rolling Stock Base and Rolling Stock Workshop

All the rolling stock bases in Medan Area relative to locomotives, passenger cars, freight cars, diesel cars and electric cars will be consolidated in one site at Titipapan. The layout is as shown in Fig. 3.3.11.

In these rolling bases, rolling stock operations together with the light inspection and repair work on a minor scale will be conducted. However, heavy inspection and repair work for diesel cars and electric cars which are newly introduced will be conducted in the Pulu Berawan Workshop as heretofore mentioned. All the necessary expenses for the newly installed inspection and maintenance equipment together with the expanded buildings have been considered.

6.1.7 Organization

In order to manage the electrified urban traffic, the administrative organization will have to be improved. A model organization for this purpose is shown in Table 6.1.2.

6.1.8 Implementation Program

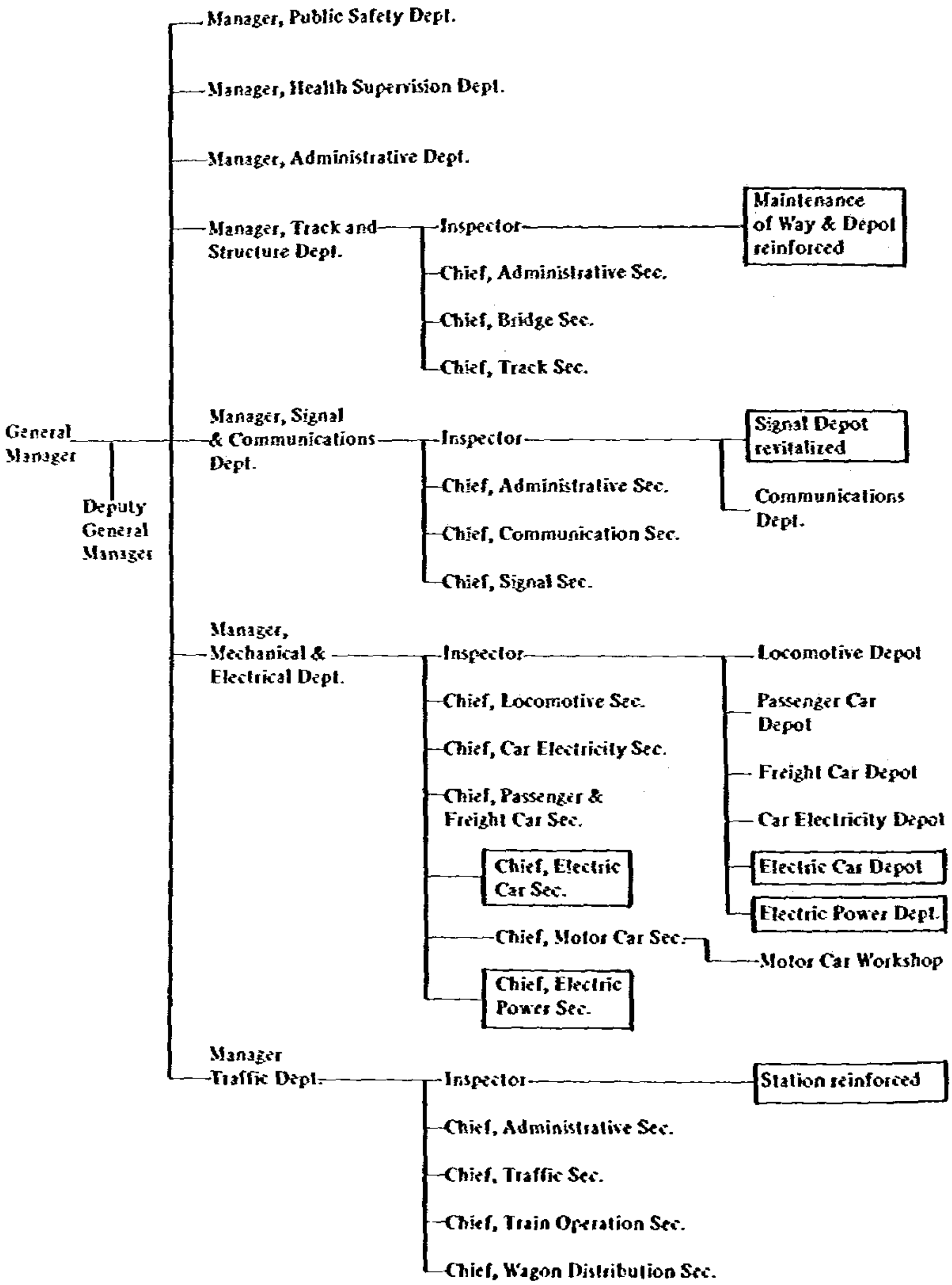
(1) Summary Table of Construction Cost

The years from 1986 to 2000 have been grouped into five years periods. The construction cost relative to railway in each period is divided into Foreign and Local Currency parts. Table 6.1.6 shows the project items thus classified by objective in each period.

(2) Construction Work Contents in Each Five Years Period

Concerning the Summary Table mentioned above, construction contents in each five-year period are shown in Tables 6.1.3 thru 6.1.5 and Figs. 6.1.6 thru 6.1.8. Figs. 6.1.6 thru 6.1.8 shows, in bold-faced type, the newly installed or repaired sections or stations in each period.

Table 6.1.2 Proposed Medan Railway Regional Office Organization for Railway Electrification



Remarks: Operating organizations encased in [box] denote those which are to be newly installed or reinforced.

Table 6.1.3 Summary of Railway Improvement Costs in Medan Area
Cast 5-B-3 (1986 - 1990 A.D.)

Item	Contents of Improvement Construction & Procurement	Construction Cost (x10 Rp)			
		Foreign Currency	Local Currency		Total
			Const. Cost	Right. of Way	
1) Medan Sta.	1 temporary platform; D.C. Base of 90 cars in capacity	1.5	0.6	-	2.1
2) East. Line	1 new station	0.2	0.08	0.02	0.3
3) West. Line	2 new stations; Track reinforcement of 17.4 km	0.3 2.6	0.17 1.1	0.03 -	0.5 3.7
4) South. Line	Medan-Pancur Batu(19.3 km) and Kampung Baru-Batu (9.8 km); 10 new stations	7.2	3.16	0.04	10.4
5) North. Line	Partial double tracking of Medan-Titipapan (10.7 km); Partial track reinforcement of 21.6 km	3.8	1.79	0.01	5.6
6) New Rolling Stock Base	Freight station; Freight yard of daily handling capacity of 300 cars; D.L. Base of 23 locos; Part of D.C. Base of 100 cars in capacity	5.5 1.0	1.7 0.4	0.8 0	8.0 1.4
7) Detour Line	Right-of-way (51.9 ha)	-	1.3	0.7	2.0
8) Short-Cut Line	-	-	-	-	-
9) Pulu Berayan Workshop	Workshop (900 m2); Equipment for diesel railcars	0.4	0.3	-	0.7
10) PJKA Housing	-	-	-	-	-
Sub Total		22.5	10.6	1.6	34.7
11) D.C.	34 units	8.5	0	-	8.5
12) E.C.	-	-	-	-	-
Sub Total		8.5	-	-	8.5
Total		31.0	10.6	1.6	43.2

Note: D.C.: Diesel railcars; D.L.: Diesel locomotives
E.C.: Electric Railcars

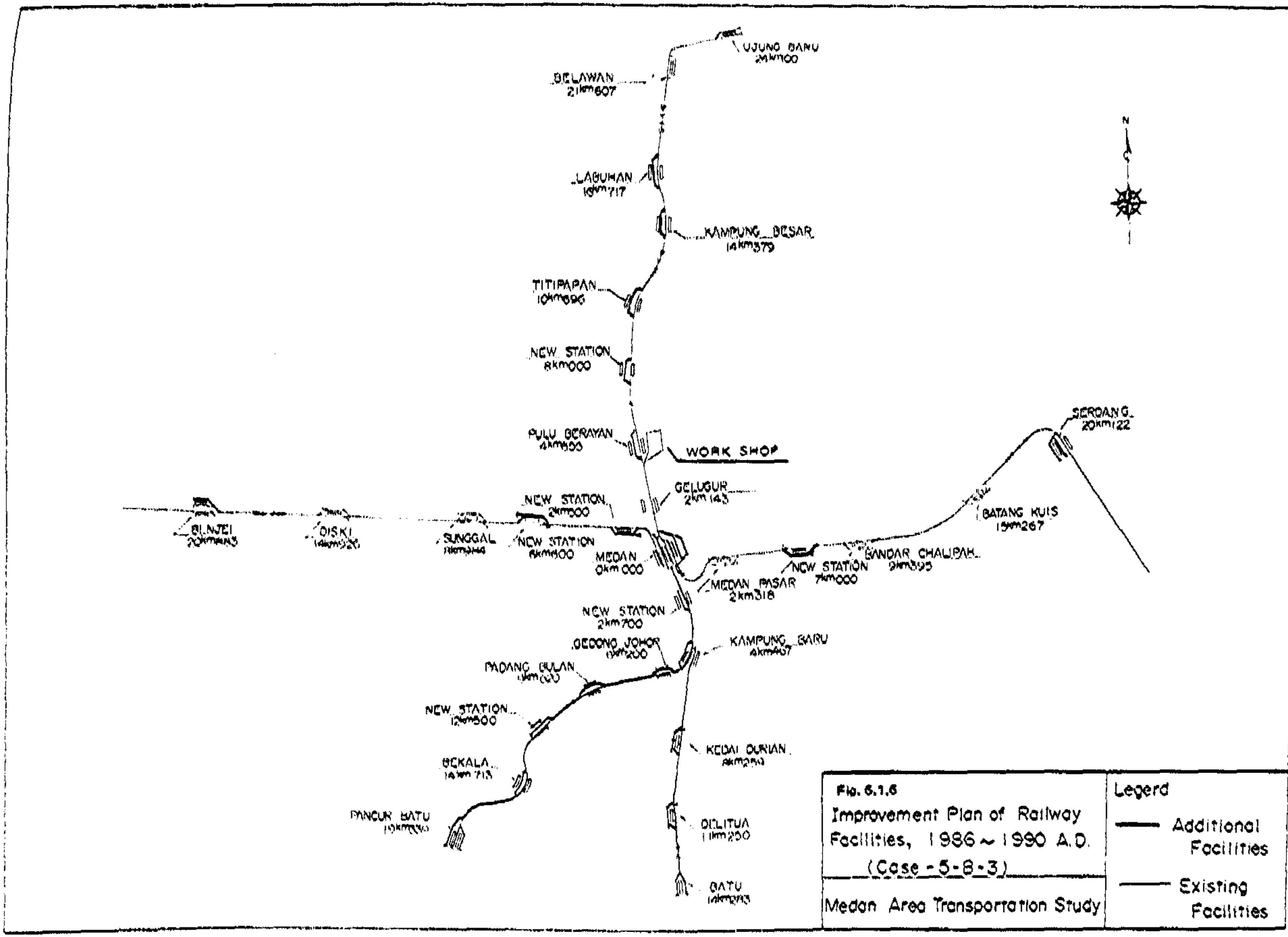


Fig. 6.1.6
Improvement Plan of Railway Facilities, 1986 ~ 1990 A.D.
(Case -5-8-3)

Table 6.1.4 Summary of Railway Improvement Cost in Medan Area
Cast-5-B-3 (1991 - 1995 A.D.)

Item	Contents of Improvements, Construction & Procurement	Construction Cost (x10 Rp)			
		Foreign Currency	Local Currency		Total
			Const. Cost	Right of Way	
1) Medan Sta.	Partial track elevation of 4 tracks and 2 platforms	6.8	2.8	0.3	9.9
2) East. Line	Track reinforcement of 20.1 km	2.8	1.3	-	4.1
3) West. Line	Partial track reinforcement of 20.9 km	0.5	0.2	-	0.7
4) South. Line	-	-	-	-	-
5) North. Line	Rest of double tracking of Medan-Titipapan (10.7 km); Rest of track reinforcement of 21.6 km; Partial double tracking of Titipapan-Ujung Baru (14.8 km)	5.4 3.9	2.4 1.7	- -	7.8 5.6
6) New Rolling	Rest of D.C. Base of 100 cars; Expansion of D.L. Base for 8 locos; Expansion of D.C. Base for additional 56 cars; Expansions of freight yard for additional 100 cars and 200 cars in handling capacity	3.7 1.7	1.7 0.7	- -	5.4 2.4
7) Detour Line	-	12.6	3.6	-	16.2
8) Short-Cut Line	-	1.5	0.5	0.2	2.2
9) Pulu Berayan Workshop	Additional equipment for diesel locomotives	0.3	0.1	-	0.4
10) PJKA Housing	Procurement of land(ha)	-	0.5	0.3	0.8
Sub Total		39.2	15.5	0.8	55.5
11) D.C.	59 units	14.8	-	-	14.8
12) E.C.	-	-	-	-	-
Sub Total		14.8	-	-	14.8
Total		54.0	15.5	0.8	70.3

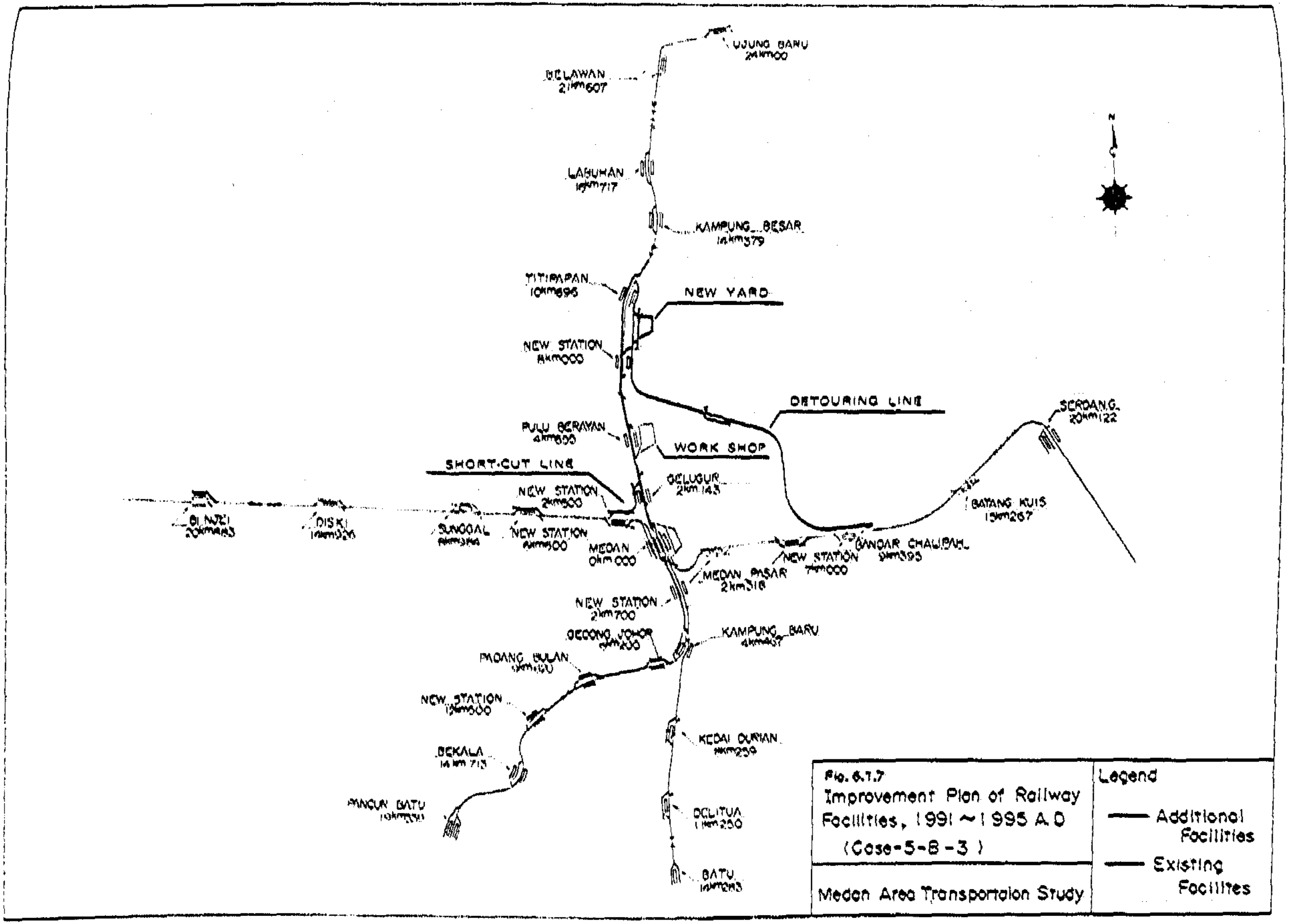


Fig. 6.7.7
Improvement Plan of Railway Facilities, 1991 ~ 1995 A.D
(Case-5-B-3)
Medan Area Transportaion Study

Table 6.1.5 Summary of Railway Improvement Cost in Medan Area Case 5-B-3 (1996 - 2000 A.D.)

Item	Contents of Improvements Construction & Procurements	Construction Cost ($\times 10^9$ Rp)			
		Foreign Currency	Local Currency		Total
			Const. Cost	Right of Way	
1) Medan Sta.	Rest of elevation of 4 tracks & 2 platforms	9.1	4.2	-	13.3
2) East. Line	Electrification of line (20.1 km)	3.2	1.4	-	4.6
3) West. Line	Electrification of line (20.9 km)	3.4	1.5	-	4.9
4) South. Line	Rest of double tracking between Kampung Baru-Pancur Batu;	8.0	3.6	-	11.6
	Electrification of line (29.2 km)	7.6	3.4	-	11.0
5) North Line	Rest of double tracking of Titipapan-Ujung Baru (14.8 km);	3.8	1.8	-	5.6
	Electrification of line (21.6 km)	6.8	3.0	-	9.8
6) New Rolling Stock Base	Expansion of D.C. Base for additional 58 cars; Rest of expansion of freight yard for additional capacity of 200 cars;	3.3	1.4	-	4.7
	D.C. Base of 158 cars is remodelled into E.C. Base of same capacity	1.0	0.5	-	1.5
7) Detour Line	-	-	-	-	-
8) Short-Cut Line	-	-	-	-	-
9) Pulu Berayan Workshop	Replacement of D.C. repair equipment with E.C. repair equipment	0.1	-	-	0.1
10) PJKA Housing	Accommodations for 600 families	1.2	10.8	-	12.0
Sub Total		47.5	31.6	-	79.1
11) D.C.	45 units	11.2	-	-	11.2
12) E.C.	158 units	26.9	-	-	26.9
Sub Total		38.1	-	-	38.1
Total		85.6	31.6	-	117.2

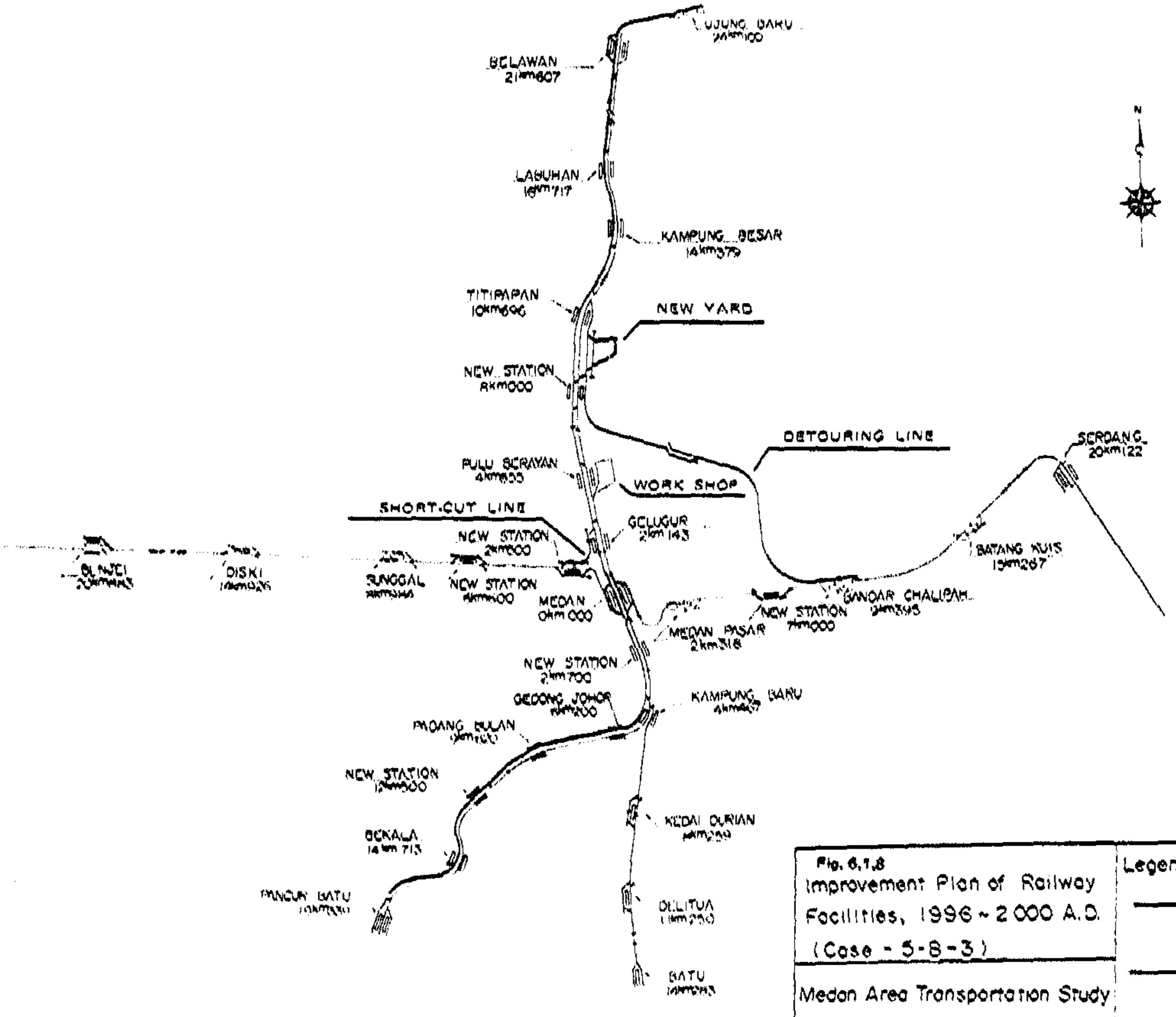


Fig. 6.1.8
Improvement Plan of Railway Facilities, 1996 ~ 2000 A.D. (Case - 5-8-3)

Medan Area Transportation Study

Legend
— Additional Facilities
— Existing Facilities

Table 6.1.6 Summary of Railway Improvement Costs in Medan Area (Case-5-B-3)

Unit: 10^9 Rp.

Item	1986 - 1990			1991 - 1995			1996 - 2000			Total		
	Frgn. Curcy.	Local Curcy.	Total	Frgn. Curcy.	Local Curcy.	Total	Frgn. Curcy.	Local Curcy.	Total	Frgn. Curcy.	Local Curcy.	All Total
1) Medan Sta	1.5	0.6	2.1	6.8	3.1	9.9	9.1	4.2	13.3	17.4	7.9	25.3
2) East. Line	0.2	0.1	0.3	2.8	1.3	4.1	3.2	1.4	4.6	6.2	2.8	9.0
3) West. Line	2.9	1.3	4.2	0.5	0.2	0.7	3.4	1.5	4.9	6.8	3.0	9.8
4) South. Line	7.2	3.2	10.4	-	-	-	15.6	7.0	22.6	22.8	10.2	33.0
5) North. Line	3.8	1.8	5.6	9.3	4.1	13.4	10.6	4.8	15.4	23.7	10.7	34.4
6) New Rolling Stock Base	6.5	2.9	9.4	5.4	2.4	7.8	4.3	1.9	6.2	16.2	7.2	23.4
7) Detour. Line	-	2.0	2.0	12.6	3.6	16.2	-	-	-	12.6	5.6	18.2
8) Short-cut Line	-	-	-	1.5	0.7	2.2	-	-	-	1.5	0.7	2.2
9) Pulu Brayan Workshop	0.4	0.3	0.7	0.3	0.1	0.4	0.1	-	0.1	0.8	0.4	1.2
10) Housing for PJKA Staff	-	-	-	-	0.8	0.8	1.2	10.8	12.0	1.2	11.6	12.8
Sub-total	22.5	12.2	34.7	39.2	16.3	55.5	47.5	31.6	79.1	109.2	60.1	169.3
11) D.C. (Diesel Railcar)	8.5	-	8.5	14.8	-	14.8	11.2	-	11.2	34.5	-	34.5
12) E.C. (Electric Railcar)	-	-	-	-	-	-	26.9	-	26.9	26.9	-	26.9
Sub-total	8.5	-	8.5	14.8	-	14.8	38.1	-	38.1	61.4	-	61.4
Total	31.0	12.2	43.2	54.0	16.3	70.3	85.6	31.6	117.2	170.6	60.1	230.7
Main Construction	1 platform N.L. and W.L.: Track reinforced Rehabilitation of of S.L. New rolling stock base Detour Line D.C. Repair faciliteis			Elevation of Medan Stn. W.L.: Track reinforced New rolling stock base Detour Line Short-cut Line			Elevation of Medan Stn. S.L. and N.L.: Track doubling All Line: Electrification New rolling stock base Housing E.C. Repairing facilities			-		

6.2 Road Facilities

6.2.1 Arterial Road Network in 2000 A.D.

There exist two concepts to be taken into consideration in formulating the future road network of Medan City as follows:

i) Master Plan of Medan City (Refer to Fig. 6.2.1)

The Master Plan of Medan City was planned and was authorized in 1974. The road network consists of 6 radial arterial roads, 3 in the east-west direction and 3 in the north-south direction, and Inner, Intermediate and Outer Ring Roads. The concept includes the construction priorities in four phases.

ii) Medan Urban Development Study (Refer to Fig. 6.2.2)

The road network in the adjusted Master Plan proposed by Engineering Science's group in 1979 is the adjusted one from the original road network in the Master Plan, taking into account the Belawan-Medan-Tg. Morawa Tollway which was additionally planned by the Government after the authorization of Master Plan of Medan City.

In the Medan Area Transportation Study the arterial road network within Intermediate Ring Road was partially adjusted and the construction priorities were re-examined.

After reviewing those two road network plans by Medan Urban Transport Study Team the following two new conditions became necessary to be taken into account in the urban transport planning:

i) Active participation by the State Railway in the urban passenger transport service of Medan City in future;

ii) In addition to Belawan-Medan-Tg. Morawa Tollway, Outer Ring Road and Binjei Bypass are to be newly added to the Tollway network.

The Study Team conducted the arterial road planning for 2000 A.D. taking into account those two additional conditions to the previous plannings. The basic concept of arterial road planning can be summarized as follow:

i) Systematic improvements of the road network from regional roads down to municipal roads that provide convenience, comfortableness and safety necessary for citizens' daily lives;

ii) Improvements that are well-balanced and keep consistency with the land use plan, the tollway network plan and the public transport plan by bus and railway;

iii) Improvements for securing urban spaces necessary for the healthy urban development and for formulating the basic frame of urbanized areas;

iv) To secure refuge roads in case of disasters and fire-stopping

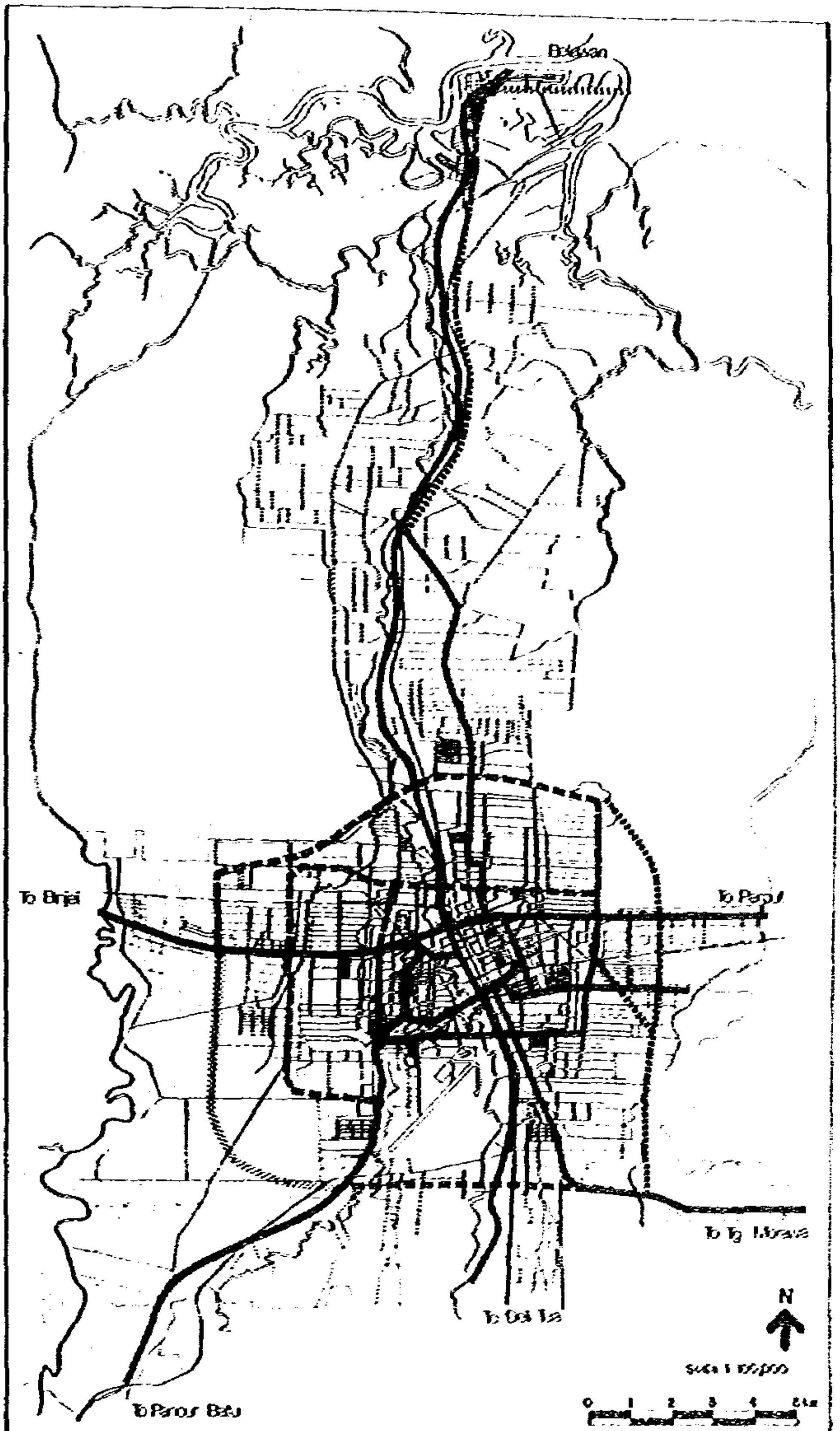


Fig. 6.21

Road Network proposed by Master Plan Kotamadya Medan

Medan Area Transportation Study

Legend

- Construction Stage I
- Construction Stage II
- Construction Stage III
- Construction Stage IV

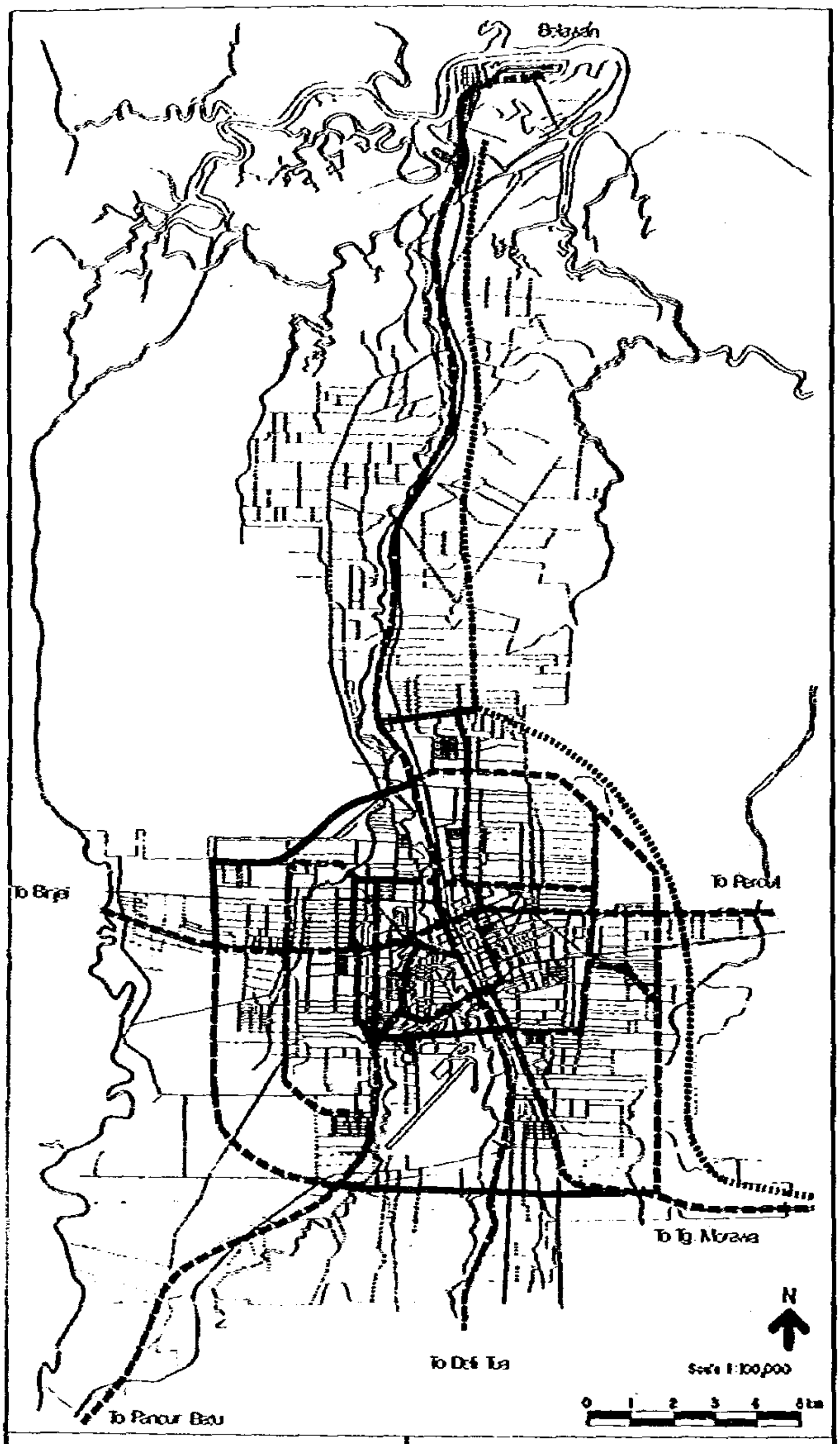


Fig. 6.2.2

Road Network proposed by Medan Urban Development Study (MUDS)

Medan Area Transportation Study

Legend

- MUDS Proposal for Road Development in Pelita III
- Road Network Proposed in Master Plan Kotamadya Medan
- Belawan – Medan – Tg. Morawa Tollway

belts necessary for the prevention of urban disasters.

In order to improve the road network systematically as well as efficiently urban roads can be classified as follows according to their functions:

i) Freeways/Tollways:

Full access-controlled roads in high design standard for the sole passage of motorized vehicles.

ii) Major Arterial Roads:

Regional and urban trunk roads which link major transport nodes.

iii) Arterial Roads

Municipal trunk roads.

iv) Supplementary Arterial Roads:

Community service roads.

In the land use plan of 2000 A.D. Medan City area is devided into five types of area according to their natures, namely, built-up areas, infill areas, new development areas, environmental protection areas and employment areas, while in the road network planning is conducted for the following four types of area for which their configuration of road cross sections are proposed: (Refer to Fig. 6.2.3)

i) Major Built-up-Areas (A-Areas);
ii) Infill Areas (B-Areas);
iii) New Development Areas (C-Areas); and
iv) Others (D-Areas).

Their configuration of road cross sections shall be determined according to their functional classification as well as their environmental conditions. The typical cross sections shown in Fig 6.2.3 are proposed for Master Plan 2000 A.D. taking these points into account.

The recommended Road Network for the year 2000 A.D. are shown in Fig 6.2.4 and the concept of this road network is outlined as follows:

i) The road network is planned to consolidate the arterial road network consisting of six radial roads, Intermediate Ring Road and the tollway network consisting of three tollways such as Belawan-Medan-Tg. Morawa Highway, Binjei Bypass and Outer Ring Road. The road network within Intermediate Ring Road is planned densely to improve its mobility, accessbility and reliability.

ii) Intermediate Ring Road is located so as to involve all built-up areas in the land use plan of 2000 A.D. aiming at dispersing the traffic in the CBD by avoiding its excessive concentration and reducing the traffic burden of arterial roads located inside of Intermediate Ring Road and distributing such traffic by means of installing grade separations, at main road intersections.

iii) Outer Ring Road is located so as to involve all infill-areas in the land use plan of 2000 A.D. and is expected to function as a bypass route enabling to avoid inflows of the through traffic into the urbanized area. In the vicinity of its interchanges truck terminals including warehouses are planned to be installed.

iv) In the inside of Intermediate Ring Road the road network is formed by two arterial roads with environmental spaces in the north-south direction, one on each side of the railway, and two arterial roads in the east-west direction across the railway. Thus the urban area inside of this Ring Road can be divided into six large blocks, each being surrounded by the arterial roads of 50 m in width accompanied with environmental spaces, which are expected to be refuge roads and also to function as fire-stopping belts and spaces for fire-fighting in disasters and also for urban spaces to hold all types of utilities underneath the roads. (refer to Fig 6.2.5)

v) As the continuous elevation of railway progresses in the CBD the grade separation between railway and roads is realized in the inside of Outer Ring Road, thus eliminating railway crossings to cope with the increase of number of trains for the purpose of strengthening transport capacity of the railway.

vi) Improvements of arterial roads for main bus routes and also of those linking railway stations with urbanized areas are to be carried out in order to improve the bus service on major bus routes as well as the bus service to feed railway and to improve the accessibility to railway.

In formulating the typical cross-sections of those arterial roads, the following alternative conditions are taken into account:

i) Case-5-A ..... High motorization, in which the transport share on private vehicles becomes high;

ii) Case-5-B ..... Low motorization, in which the transport share on the public transport system becomes high;

iii) Case-1-C ..... Without railway passenger service and consequently with a high transport share on the bus system in Case-5-B.

Fig 6.2.6 shows the traffic assignment on the proposed road network in 2000 A.D. in Case-5-B, and Fig 6.2.7 shows the future arterial road network of Case-5-B in the Internal Study Area, indicating locations of grade separation structures and number of lane planned, taking into account their traffic volume in peak hour, the bus operating system, and other planning criteria.

Table 6.2.1 is the summarized results of accumulated road length by type of road by each cases and Table 6.2.2 is the proposed number of locations

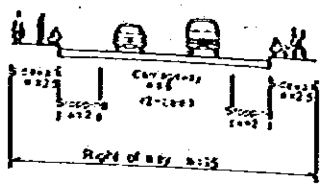
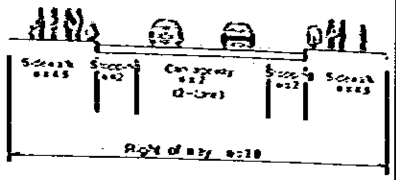
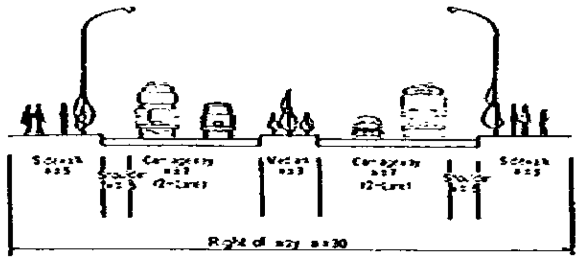
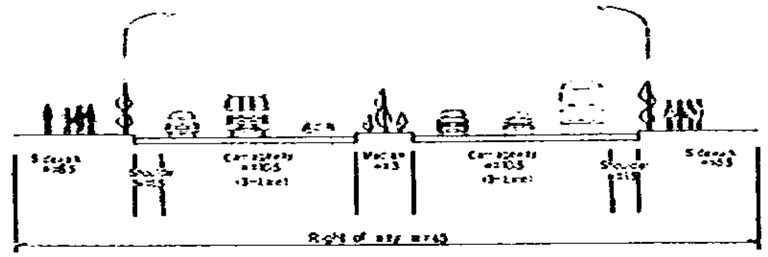
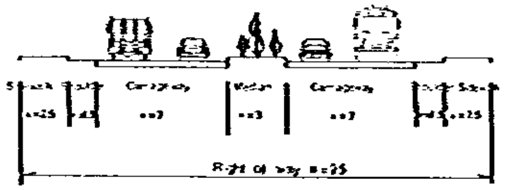
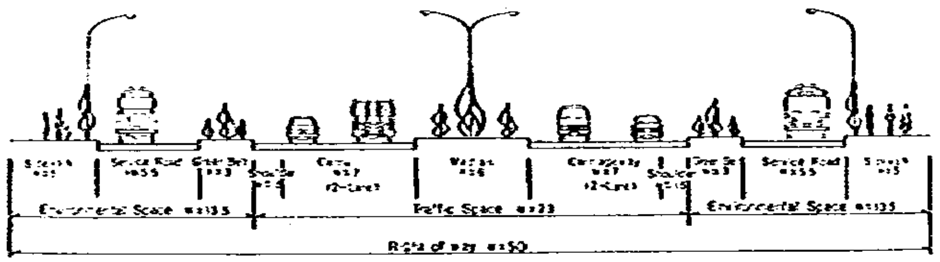
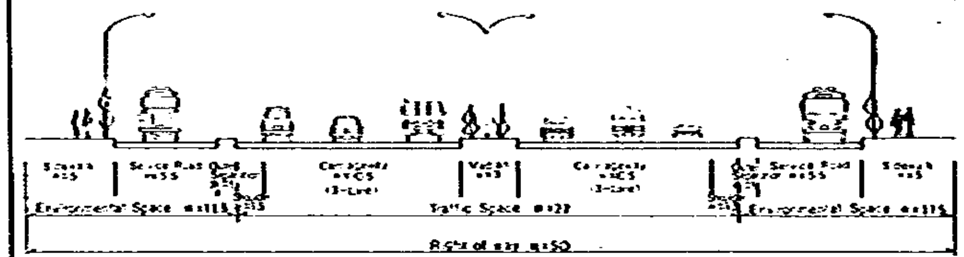
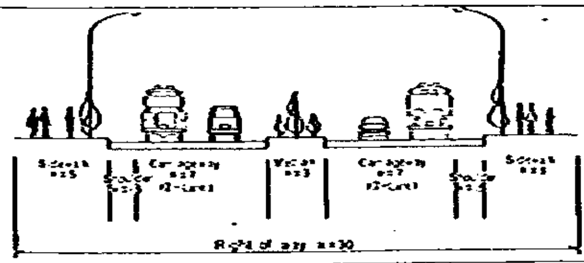
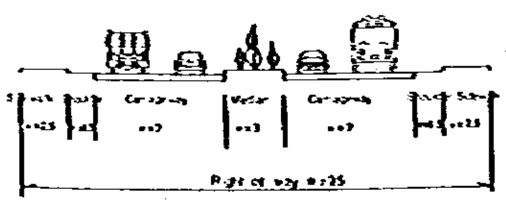
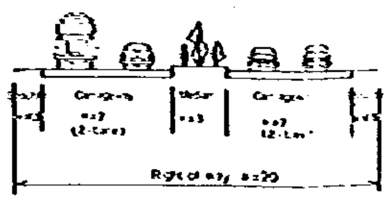
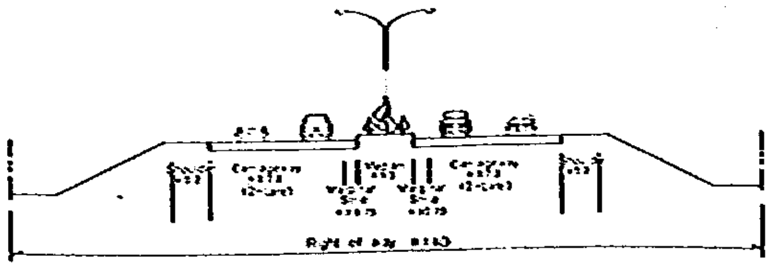
		2 Lanes	4 Lanes	6 Lanes
Supplementary Arterial Roads				
Arterial Roads	A & B-AREA			
	C-AREA			
Major Arterial Roads	A-AREA			
	B-AREA			
	C/D-AREA		 	
Tollway				

Fig. 6.2.3
Proposed Standard Cross Sections of Arterial Roads for the Recommended Road Network in 1000 A.D.

Medan Area Transportation Study

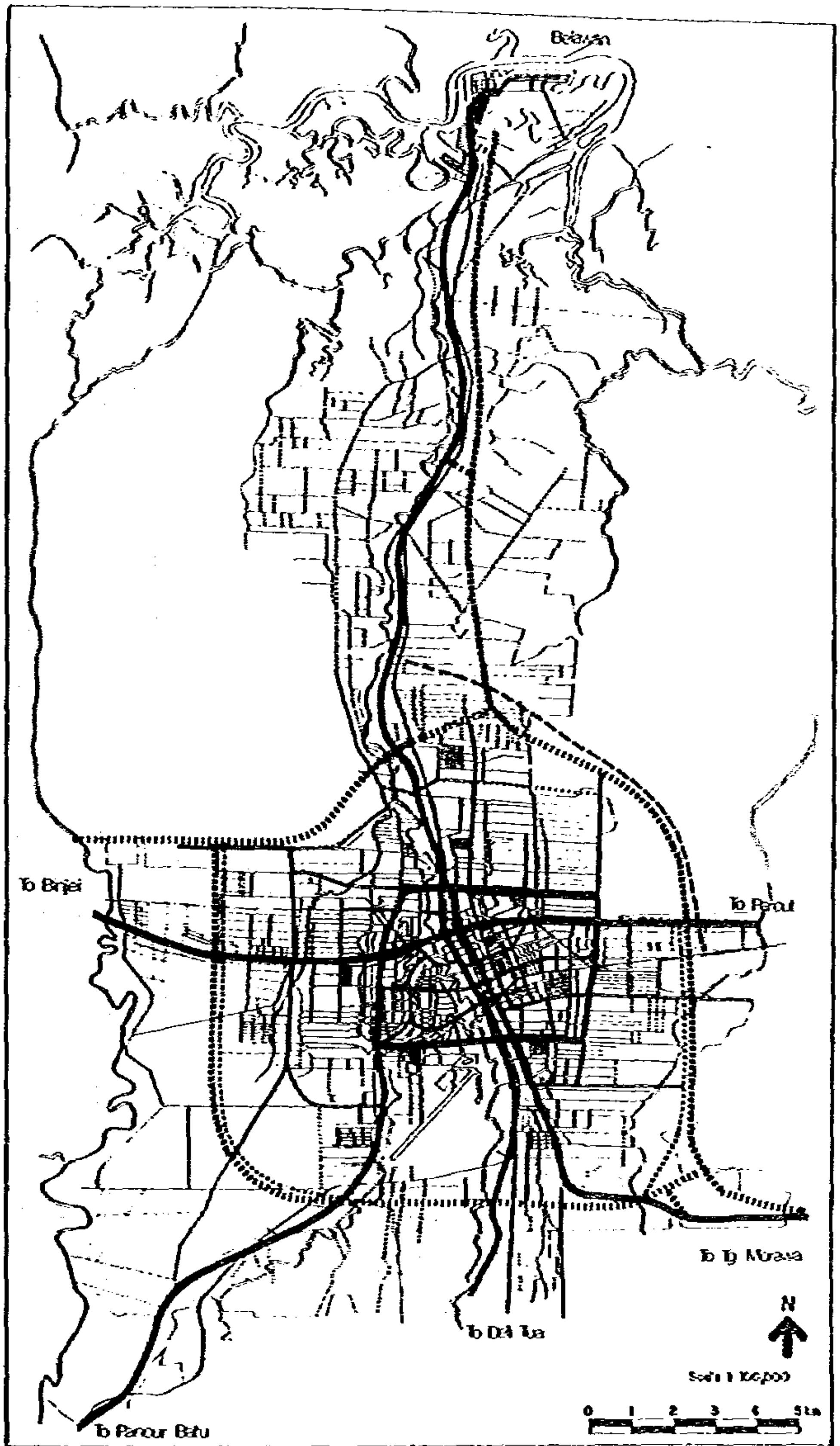


Fig. 6.2.4

Proposed Road Network in 2000 A.D.

Medan Area Transportation Study

Legend

- Tollway
- Major Arterial Road
- Arterial Road
- Frontage Road
- Railway, detouring line

of arterial road intersections classified by intersecting type in each cases.

Table 6.2.1 Proposed Accumulated Road Length by Type of Road

(Unit: km)

Alternatives	8 lanes	6 lanes	4 lanes		2 lanes	Less than 2 lanes	Total Length
			Tollway	Toll Free			
Present Situation (1979)		-	-	42.8	460.7	42.0	545.5
Case-5-A	12.6	27.7	87.0	191.3	342.4	0	661.0
Case-5-B (2000 A.D.)	0	11.8	87.0	183.5	378.7	0	661.0
Case-5-C	0	80.2	87.0	238.5	255.3	0	661.0

Table 6.2.2 Proposed Number of Locations of Road Grade Separation by Type

Alternatives	Fully Grade Separation	Partly Grade Separation	Major At-Grade Intersection	
			Widened	Normal
Present Situation (1979)	-	-	-	47
Case-5-A	10	17	37	4
Case-5-B	10	17	37	4
Case-1-C	10	18	32	4

Note: (1) Fully grade separations are those on tollways, in which any traffic signal does not remain at such locations.

(2) Partly grade separations are those on other arterial roads, in which traffic signals still remain at such locations.

(3) Partly grade separations include roads flying over railway.

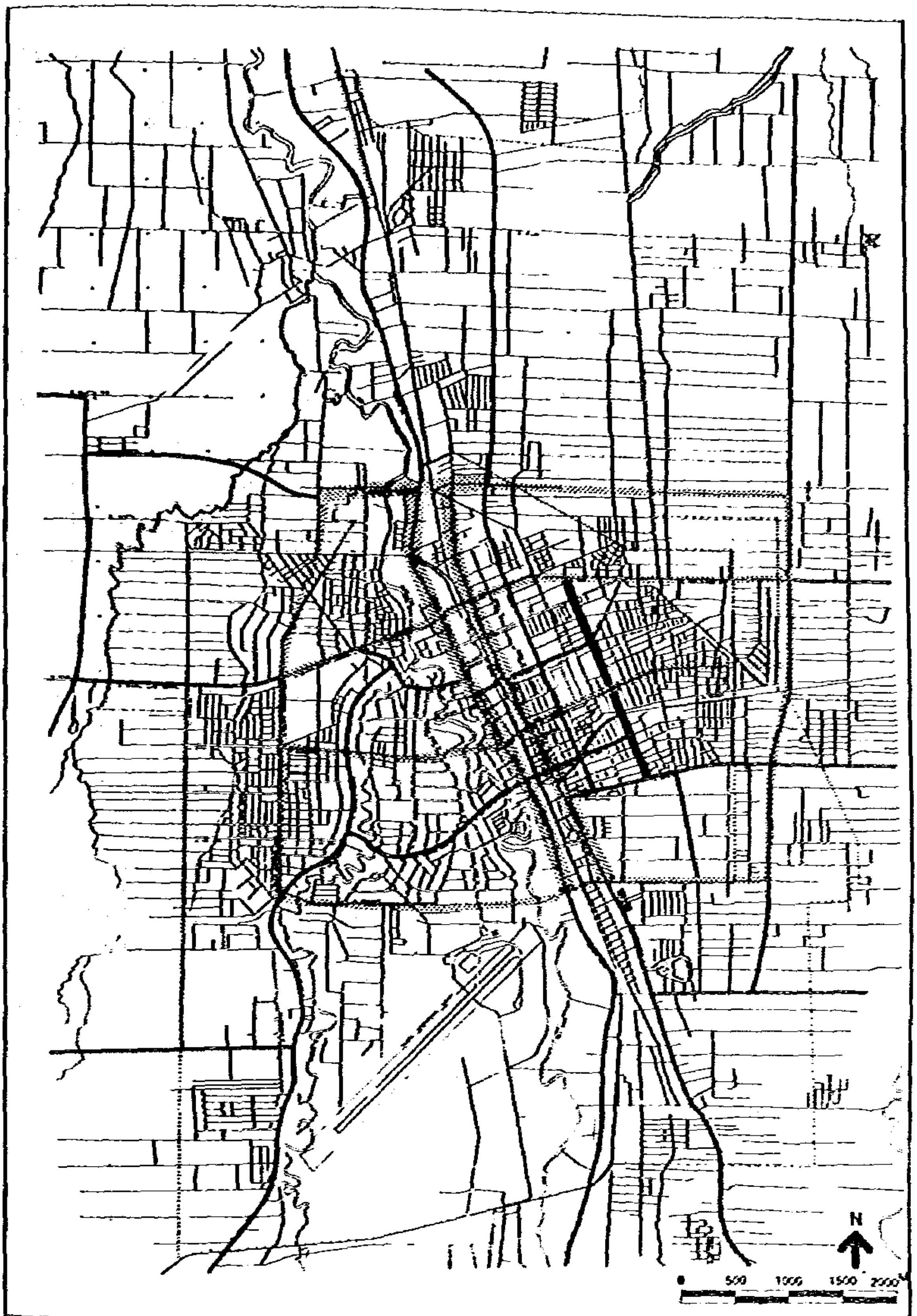


Fig. 6.2.5

Future Arterial Road Network by Lane Number

Medan Area Transportation Study

Legend

- 6 - Lane with Environmental space
- 6 - Lane
- 4 - Lane with Environmental space
- 4 - Lane

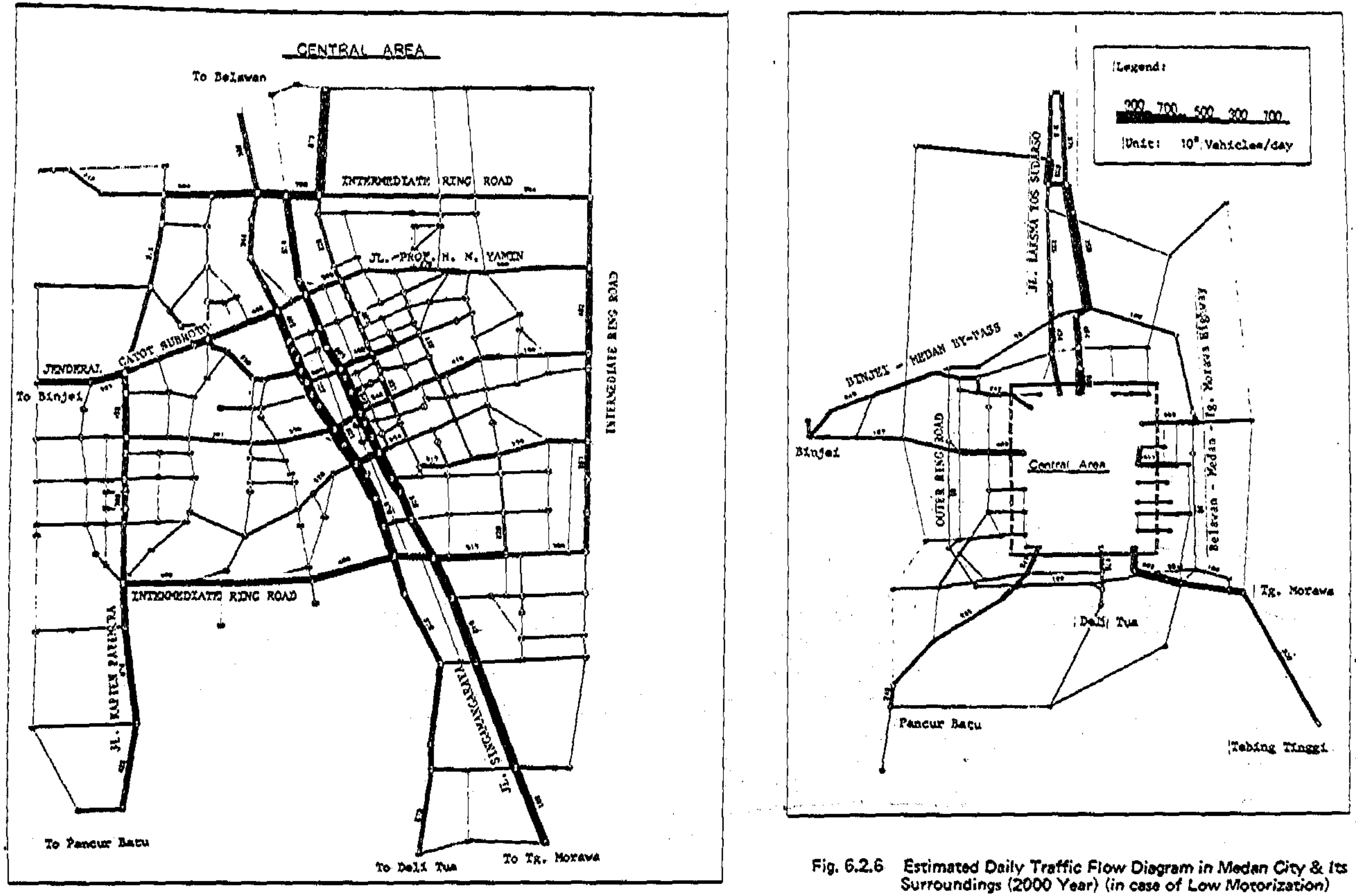


Fig. 6.2.6 Estimated Daily Traffic Flow Diagram in Medan City & Its Surroundings (2000 Year) (in case of Low Motorization)

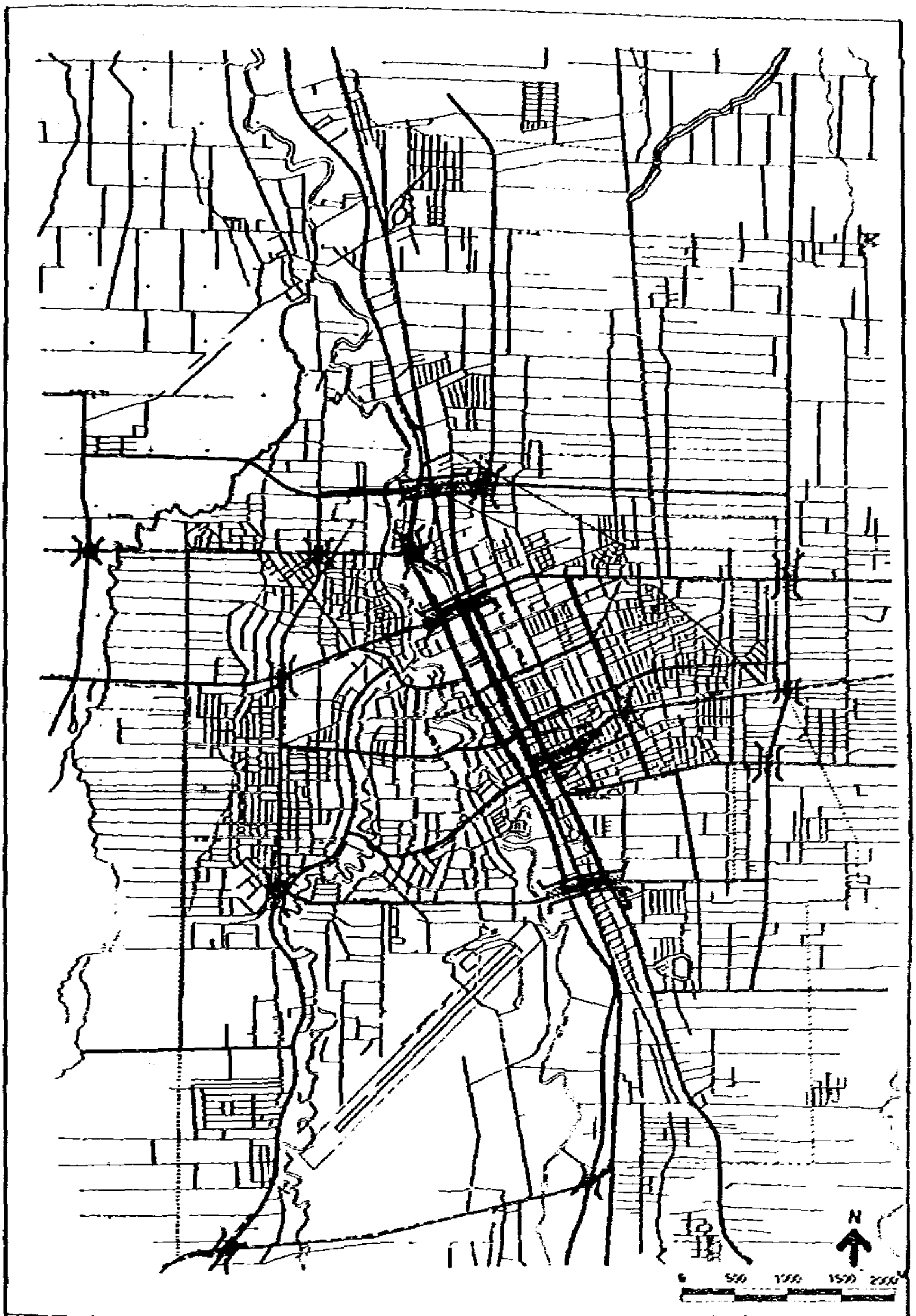


Fig. 6.27

Future Arterial Road Network in the Internal Study Area (Long Term)
Case - 5 - B

Medan Area Transportation Study