5.3.6 Rolling Stock and Its Maintenance

(1) Rolling Stock

1) Current conditions

a) General

① Organization chart of rolling stock concerned of VNR is shown in Fig. 5.3.6-1.

② Although the subject of our study is to make the master plan for the rehabilitation and improvement of Hanoi - Ho Chi Minh Railway of VNR, the rolling stock plan is to be nation-widely examined.

③ We have received the information such as number of rolling stock during past five years, particulars of rolling stock and others. Table 5.3.6-1 shows number of rolling stock during past five years in which 1,435mm rolling stock will disappear in near future due to track gauge unification to 1,000mm.

b) Locomotive

Table 5.3.6-2 shows that the depot-wise present situation of locomotives in 1993 is rearranged based on received information. Some figures are different from Table 5.3.6-1 due to possible data gathering time difference. SL will be condemned by 2010. The life of diesel locomotives is as follows.

D12E, D13E	:	20 years
D18E	:	25 years
D4H	:	15 years

c) Passenger coach and wagon (PC and FC)

Tables 5.3.6-3 and 5.3.6-4 respectively show that the Union-wise and the axle bearing-wise current situation of PC and FC in 1993 is rearranged based on received information. Tables 5.3.6-5, 5.3.6-6 and 5.3.6-7 respectively show the age-wise situation of PC (1,000mm gauge), FC (1,000mm gauge) and PC & FC (1,435mm gauge).

Passenger coaches equipped with plain bearing is being modified to roller bearing type, but wagons equipped with plain bearing will be used until their life without modification to roller bearing type. The life of PC and FC is 30 years.

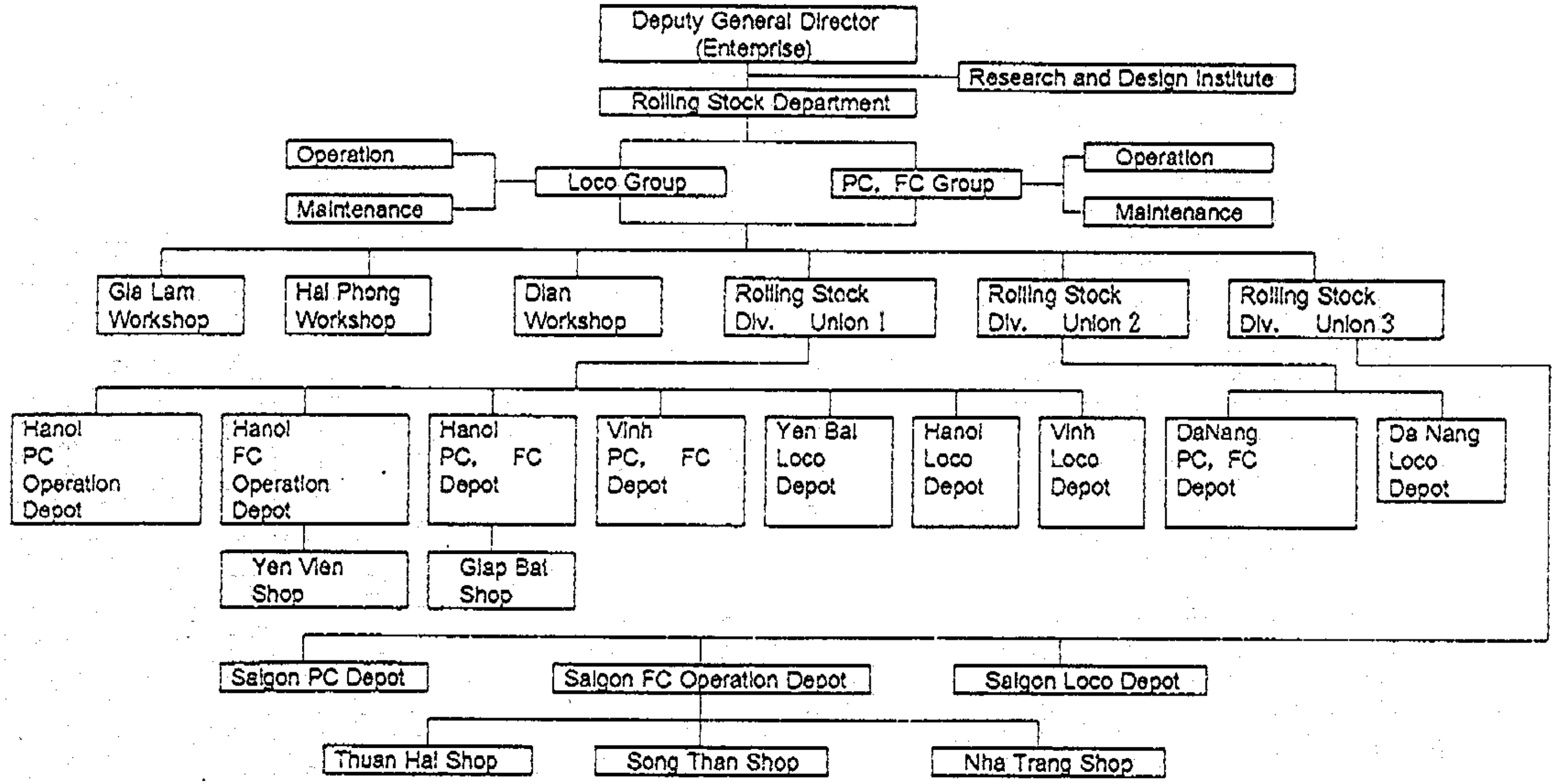


Fig. 5.3.6-1 Organization Chart of Rolling Stock Concerned (Revised: Aug. 1995)

Table 5.3.6-1 Number of Rolling Stock during Past 5 Years

1) 1000 mm Track Gauge

Kind	Type of Rolling Stock	Capacity	1989		1990		1991		1992		1993	
			on Book	Useable	on Book	Useable	on Book	Useable	on Book	Useable	on Book	Useable
DEL	D9E(GE)	910 CV	38	27	39	28	39	29	39	29	39	29
	D12E(Czecho)	1000 CV	20	20	30	26	40	40	40	40	40	40
	D13E(India)	1350 CV	15	11	15	12	15	12	15	12	15	12
	D18E(Belgium)	1800 CV	16	16	16	16	16	16	16	16	16	16
	Total		89	74	100	82	110	97	110	97	113	97
DHL	D4H(Russia)	400 CV	250	197	254	179	254	181	254	178	248	186
	D5H(Australia)	500 CV	-	-	-	-	-	-	-	-	3	3
	D11H(Rumania)	1100 CV	10	0	10	0	10	3	10	2	10	2
	Total		260	197	264	179	264	184	264	180	261	191
PC	1st Sleeper	24 persons	24	23	24	23	41	40	49	46	47	46
	2nd Sleeper	42 persons	73	65	76	63	71	65	66	64	74	70
	1st Class Car	64 persons	-	-	-	-	25	23	68	66	87	85
	2nd Class Car	72 persons	405	311	386	317	375	307	287	256	251	217
	3rd Class Car	63 persons	370	285	326	267	318	260	251	223	224	193
	Dinning Car	34 ton	42	35	39	34	37	33	25	22	23	25
	Baggage Car	20 ton	28	26	27	25	22	20	12	11	18	17
	Mail Car	25 ton	45	43	42	40	41	39	27	26	24	23
	Total		987	788	920	774	930	787	785	714	753	677
FC	Box Wagon	30 ton	1449	1371	1444	1366	1445	1370	1505	1423	1483	1411
	High Side Wagon	32 ton	1920	1810	1869	1763	1869	1765	1680	1587	1526	1441
	Low Side Wagon	27 ton	451	423	417	391	417	394	389	368	380	359
	Flat Wagon	26 ton	613	577	592	558	581	547	526	496	457	431
	Well Wagon	55 ton	29	19	28	19	28	19	27	18	26	13
	Tank Wagon	27 ton	213	196	217	200	217	201	213	197	206	191
	Brake Van	1.2ton	71	54	68	53	119	92	126	97	117	90
	Total		4746	4450	4635	4350	4676	4388	4466	4191	4200	3941

Table 5.3.6-1 Number of Rolling Stock during Past 5 Years (Continued)

SL	Prairie	750 CY	19	4	19	4	19	4	19	4	19	1
	Tu Luc	1100 CY	63	53	63	51	63	38	63	38	59	37
	Mikado	1100 CY	10	9	10	2	10	2	10	2	10	2
	Total		92	66	92	57	92	44	92	44	88	40
Special Wagon		5 ton	35	35	45	45	43	43	58	58	53	53

2) 1435 mm Track Gauge

Kind	Type of Rolling Stock	Capacity	1989		1990		1991		1992		1993	
			on Book	Usable	on Book	Usable	on Book	Usable	on Book	Usable	on Book	Usable
DHL	D8H (Russia)	800 CY	4	3	4	3	4	3	4	3	4	3
	Total		4	3	4	3	4	3	4	3	4	3
PC	1st Class Car	84 persons	1	1	1	1	1	1	1	1	1	0
	2nd Class Car	100 person	26	20	23	15	23	12	12	8	9	6
	3rd Class Car	84 persons	34	31	28	28	30	30	15	14	10	10
	Dinning Car		1	0	0	0	0	0	0	0	0	0
	Baggage Car	15 ton	2	1	2	1	2	1	1	1	1	1
	Total		64	53	54	45	56	44	29	24	21	17
FC	Box wagon	45 ton	54	51	53	50	53	50	53	50	51	46
	High Side Wagon	49 ton	394	374	388	343	388	343	383	339	377	336
	Low Side Wagon	40 ton	112	96	98	84	98	84	94	80	78	67
	Flat Wagon	57 ton	69	59	63	53	63	53	60	51	60	51
	Tank Wagon	30 ton	1	1	1	1	1	1	1	1	1	1
	Brake Van	8 ton	8	8	7	7	7	7	7	7	7	7
	Total		638	589	610	538	610	538	598	528	574	508
SL	GP6	1780 CY	17	12	17	10	17	7	17	7	16	7
Special Wagon		5 ton	7	7	5	5	5	5	6	6	4	4

Table 5.3.6-2 Locomotive (1993)

Loco	Wheel Arrangemen	Total Weight (t)	Axle Weight (t)	Output (CY)	Max. Speed (km/h)	Max. Tractive Effort(kg)	Yen Bai					Hanoi					Vinh					Union 1 Total				
							1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
SL (1000)	131, 141 231	50.05~63	10.5	750~1100	67~79	8000-14000	33	11	0	4	18	58	32	13	18	8						91	43	13	22	26
SL (1435)	141	79.3	13.2	1780	80	19,400						17	7	2	6	4						17	7	2	6	4
D4H	Bo-Bo	24	6	400	50/70	7,200	68	65	36	3	0	55	42	22	13	0	46	31	17	15	0	169	138	75	31	0
D5H	B-B	40.64	10.16	500	65	9,964	3	3	2	0	0											3	3	2	0	0
D11H	Bo-Bo	56	14	1100	100	16,200																				
D8H (1435)	Bo-Bo	78	19.5	800	90	21,000						5	3	3	2	0						5	3	3	2	0
D9E	Bo-Bo	52	13	900	114	15,600																				
D12E	Bo-Bo	56	14	1000	80	14,600						15	15	9	0	0						15	15	9	0	0
D13E	Co-Co	72	12	1350	96	21,600																				
D18E	Co-Co	84	14	1800	105	25,500											16	16	9	0	0	16	16	9	0	0

Loco	Usability 2 / 1	Operativity 3 / 1		Manufact. Country	Year of Manufacture	Age (Dec.1993)	Da Nang					Saigon					Enterprise					Grand Total				
							1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
SL (1000)	0.47	0.14		JPN.FRC. VIETNAM																		91	43	13	22	26
SL (1435)	0.41	0.12		CHINA																		17	7	2	6	4
D4H	0.73	0.36		RUSSIA	1985-1989 1981	4-8 (161) 12 (87)	57	32	14	23	2	4	4	1	0	0	18	7		11	0	248	181	90	65	2
D5H	1.00	0.67		AUSTRALIA	1966-1970	23~27																3	3	2	0	0
D11H	0.20	0.10		RUMANIA	1978	15	9	2	1	7	0	1	0	0	1	0						10	2	1	8	0
D8H (1435)	0.60	0.60		RUSSIA	1986	7																5	3	3	2	0
D9E	0.74	0.49		USA	1963	30						39	29	19	0	10						39	29	19	0	10
D12E	1.00	0.68		CZEKO	1985	8	25	25	18	0	0											40	40	27	0	0
D13E	0.80	0.33		INDIA	1985	8						15	12	5	2	1						15	12	5	2	1
D18E	1.00	0.56		BELGIE	1983	10																16	16	9	0	0

REMARKS : 1 on Book, 2 Usable, 3 Normal Use, 4 Waiting Repair, 5 Waiting Condemnation

Table 5.3.6-3 No. on Book of PC and FC (1,000 mm) (Dec. 31, '93)

Revised : Aug. 1995

	TOTAL	UNION 1						UNION 2						UNION 3						Total	Assumption	
	Dec.31, 92	R	P	TOTAL	D	I	Dec.93	R	P	TOTAL	D	I	Dec.93	R	P	TOTAL	D	I	Dec.93	Dec.31, 93	R	P
PC (1000) TOTAL	748	242	205	447	58	17	406	52	64	116	3	12	125	179	42	221	22	23	222	753	504	249
Sleeping (1st)	48	23		23	2	1	22	4		4			4	21		21			21	47	47	0
Sleeping (2nd)	66	34		34		5	30	2	1	3			3	29		29		3	32	74	73	1
Coach (1st)	68	33		33		8	41	6		6			6	29		29		11	40	87	87	0
Coach (2nd)	287	109	64	173	24		149	29	2	31	1	5	35	69	14	83	16		67	251	210	41
Coach (3rd)	251	11	138	149	26		123	9	58	67	1	1	67	6	29	35	1		34	224	27	197
Dining	25	13		13	2	2	13	2		2	1	6	7	10		10	4	2	8	28	28	0
Baggage	12	3		3	2	1	2	2	1	3			3	3	3	6		7	13	18	14	4
Post	27	11	8	19	2		17							8		8	1		7	24	18	6
Wagon (1000) TOTAL	4,466	1546	1617	3163	238	2	2927	297	409	706	13	1	694	322	275	597	18		579	4,200	2168	2032
Covered	1,505	517	260	777	9		768	220	142	362	3		359	228	138	366	5		361	1,488	965	523
Open (High Side)	1,680	869	585	1475	147		1307	47	77	124	2		122	57	45	102	5		97	1,526	973	553
Open (Low Side)	389	47	249	296	6		290	13	57	70	3		67	2	21	23			23	380	62	318
Open (Flat)	526	67	275	342	64		278	14	117	131	1		130	7	46	53	4		49	457	88	369
Open (High Capacity)	27		25	25	1		24								2	2			2	26	0	26
Tank	213	30	144	174	5		169	3	7	10			10	17	12	29	2		27	206	50	156
Conductor	126	16	79	95	6	2	91		9	9	4	1	6	11	11	22	2		20	117	30	87

[Remarks]

R : Roller Bearing
P : Plane Bearing
D : Decrease (Condemnation or to Another Union)
I : Increase (from Another Union or New Manufacturing)
Assumption : Number of cars of R and P is assumed in decrease of P and increase of R.

Table 5.3.6-4 No. on Book of PC and FC (1,435 mm) (Dec. 31, '93)

Jan. 10. 94 VNR

	TOTAL	UNION 1						UNION 2						UNION 3						Total
	Dec. 31, 92	R	P	TOTAL	D	I	Dec. 93	R	P	TOTAL	D	I	Dec. 93	R	P	TOTAL	D	I	Dec. 93	Dec. 31, 93
PC (1435) TOTAL	29	7	22	29	8		21													21
Coach (1st)	1	1		1			1													1
Coach (2nd)	12	2	10	12	3		9													9
Coach (3rd)	15	4	11	15	5		10													10
Baggage	1	1		1			1													1
Wagon (1435) TOTAL	598	300	298	598	24		574													574
Covered	53	19	34	53	2		51													51
Open (High Side)	383	281	102	383	6		377													377
Open (Low Side)	94		94	94	16		78													78
Open (Flat)	60		60	60			60													60
Tank	1		1	1			1													1
Conductor	7		7	7			7													7
Special Car TOTAL	64	9	21	30	2		28		6	6			6	13	15	28	5		23	57
1000	58	9	15	24			24		6	6			6	13	15	28	5		23	53
1435	6		6	6	2		4													4

[Remarks]

R : Roller Bearing
P : Plane Bearing
D : Decrease (Condemnation or to Another Union)
I : Increase (from Another Union)

Table 5.3.6-5 PC by Manufacturing Year (1,000 mm)

(Dec.31, 1993)
(Revised : Aug.1995)

Kind / Mfg. Country \ Kind / Year	R	P	R	P	R										Total	
	Before1970		1971		1978	1979	1980	1984	1986	1987	1988	1991	1992	1993 1994		
AN (First class sleeping car)																
TQ (China)																
Ru (Russnia)					11										11	
AN (India)																
VN (VietNam)									10		2	7	4	4	27	
FAP(France)	9														9	
S. Total	9				11				10		2	7	4	4	47	47R+0P
BN (Second class sleeping car)																
TQ																
Ru					31		4								35	
AN																
VN					3	3	3	2		7	13	5			36	
FAP	2	1													3	
S. Total	2	1			34	3	7	2		7	13	5			74	73R+1P
A (First class coach)																
TQ																
Ru						54									54	
AN							21								21	
VN											12				12	
FAP																
S. Total						54	21				12				87	87R+0P
B (Second class coach)																
TQ			60	31											91	
Ru					52										52	
AN							25								25	
VN		3		7	18						30				58	
FAP	25														25	
S. Total	25	3	60	38	70		25				30				251	210R+41P
C (Third class Coach)																
TQ			6	90											96	
Ru																
AN															65	
VN	15	50														
FAP	6	57													63	
S. Total	21	107	6	90											224	27R+197P
HC (Dining car)																
TQ																
Ru						8									8	
AN							4								4	
VN										10				1	11	
FAP	2					3									5	
S. Total	2					11	4			10				1	28	28R+0P
HL (Baggage car)																
TQ			5												5	
VN				4					9						13	
S. Total			5	4					9						18	14R+4P
BV (Mail car)																
VN		6			18										24	
S. Total		6			18										24	18R+6P
Total	59	117	71	132	133	68	57	2	19	17	57	12	4	5	753	504R+249P

Table 5.3.6-6 FC by Manufacturing Year (1,000 mm)

(Dec.31,1993)
(Revised : Aug.1995)

Kind \ Year	R	P	P	P	P	R											
Kind	Before 1970		1971	1972 ~74	1975	1978	1979	1980	1984	1986	1987	1988	1991	1992	1993		
G Covered	190	100		300	123	175	210	300				15		75		1488	965R+523
H Open (High Sid)	107	100	103	250	100	235	100	380	151							1526	973R+553
V Open (Low Side)	62	318														380	62R+318P
M Open (Flat)	88	254			115											457	88R+369P
MVT Open (Hi-Capacity		26														26	0R+26P
P Tank	35	141		15					15							206	50R+156P
XT Conductor		20	10	42				3		21	6	15* (Plain Bearing)				117	30R+87P
TOTAL	482	959	113	607	338	410	310	683	166	21	6	30		75		4200	2168R +2032P

[Remarks] (1) Manufacturing countries
Most of all : China, Rumania, India
Few : Viet Nam, USA, France, Japan, Belgium, Russia

(2) R : Roller bearing
P : Plain bearing

Table 5.3.6-7 PC and FC by Manufacturing Year (1,435 mm)

(Dec.31.1993)
(Revised : Aug.1995)

Kind \ Year		R	P	R										Total	
		Before	1970	1978	1979	1980	1984	1986	1987	1988	1991	1992	1993 1994		
PC	A_R (First class coach)	1												1	France Mfg.
	B_R (Second class coach)		9											9	China Mfg.
	C_R (Third class coach)		10											10	China Mfg.
	H_R (Baggage car)		1											1	China Mfg.
TOTAL		1	20											21	1R + 20P
FC	G_R (Covered)		32		19									51	19R + 32P
	H (High Side)		96	100	100	81								377	281R + 96P
	N (Low Side)		78											78	0R + 78P
	M (Flat)		60											60	0R + 60P
	P (Tank)		1											1	0R + 1P
	XT (Conductor)		7											7	0R + 7P
TOTAL			274	100	119	81								574	300R + 274P

[Remarks] (1) R : Roller bearing car
P : Plain bearing car

(2) Roller bearing FCs are imported from Rumania
Plain bearing FCs are imported from China

Table 5.3.6-8 Cause-Wise Ineffectively of DELs

	1992					1993				
	D9E	D12E	D13E	D18E		D9E	D12E	D13E	D18E	
Regular maintenance										
Damaged by accident										
Waiting condemnation										
Rehabilitation										
Waiting space parts										
Engine-Generator set										
Engine										
Generator										
Traction motor										
Compressor set										
Radiator fan set										
Another important cause, if any										
Others										

(1) Example of ineffectivity (D12E)
Number on book : 40
Cause-wise ineffective days per year of each D12E : α
Cause-wise ineffectivity of D12E : $\sum_{1}^{40} \alpha / (40X365)$

2) Current Problems

a) General

① There are too many types of locomotives, passenger coaches and wagons. Therefore, great deal of uneconomical expenses are possible in many kinds of maintenance facilities, spare parts, etc. and also there may be difficulties in regular maintenance and in counter-measure against rolling stock failure. Fortunately, VNR could continue commercial service, because VNR has lot of reserved locomotives and passenger coaches. Anyway, we strongly recommend that the type of rolling stock should be decreased and standardized.

② In order to make rolling stock plan such as regular maintenance, condemnation, rehabilitation and new manufacturing, the following statistical figures should be compiled.

- Rolling stock age
- Availability or ineffectivity of rolling stock

It is the most important for making rolling stock plan to know the weak point of individual and type-wise rolling stock. Therefore, it is necessary to classify the ineffectivity of each locomotive, passenger coach and wagon in Union-wise and cause-wise, by which the most suitable rolling stock control such as countermeasures against rolling stock failure, spare parts control, shortening or prolongation of maintenance cycle and new manufacturing is possible.

Please refer our former questionnaire at the time of our primary study as shown in Table 5.3.6-8 (Example: Cause-wise ineffectivity of DELs). Availability is equal to (1-ineffectivity).

b) Locomotive

① D4H

There are many D4H locomotives, but D4H has small output power being hard to use, large fuel consumption and bad maintainability. Regular maintenance in depots is to be continued as in the present and D4H should be successively condemned in near future.

② D5H

Although we hear that the number of D5H will be increased for passenger transportation between Hanoi and Lao Cai and as shunting locomotive, we recommend that D5H should be successively condemned due to the same reason as the case of D4H.

③ D11H

According to the received information, rehabilitation of ten D11H is decided. Therefore, D11H will be usable in and after 2010. However, additional introduction of this type should not be planned, because the maintainability of diesel hydraulic locomotive is worse and standardization of locomotive is recommendable.

④ D9E

Age of D9E is more than 30. Therefore, this type should be condemned successively.

⑤ D13E

Fourteen D13E except one D13E waiting condemnation will be rehabilitated and used in and after 2010, but new procurement of this type should not be planned due to their small holding number and locomotive standardization. However, five D13Es are planned to be procured in 1996.

⑥ D12E and D18E

It is recommended that the future standard locomotive should be limited to D12E and D18E, because these locomotives have 100% usability in 1993 and also are suitable in our train operation plan.

c) Passenger coach and wagon

① Passenger coaches of limited express and express trains should be air-conditioned in near future.

② Daily cleaning system for passenger coach room and toilet should be established to offer comfortable travel for passengers.

(2) Rolling Stock Maintenance

1) Current Conditions

a) Rolling Stock Maintenance System

① The current rolling stock maintenance system of the VNR is shown in Fig. 5.3.6-1 and the Rolling Stock Department of the VNR's Head Office is responsible for the planning and implementation of rolling stock operation and maintenance. The actual maintenance work is conducted by workshops and depots under the instruction and supervision of the Rolling Stock Department.

② The maintenance of locomotives is conducted in accordance with the inspection cycle determined for each type of locomotive as shown in Table 5.3.6-9.

Table 5.3.6-9 Locomotive Inspection Cycle

Type of Inspection	RO (km)	RT (km)	R1 (km)	R2 (km)	R3 (km)	RK (km)	RG (km)
D4 H	1,000 ± 20%	5,000 ± 20%	10,000 ± 20%	30,000 ± 20%	–	60,000 ± 10%	240,000 ±10%
D5H	2,500	10,000	30,000	75,000	–	200,000	600,000
D11H	–	5,000	10,000	40,000	–	120,000	480,000
D8H	3,000 - 3,500	6,000 - 7,000	18,000 - 20,000	60,000 -	–	120,000 -	–
D9E	–	5,000	25,000	50,000	100,000	200,000	600,000
D12E	1,000 ±20%	10,000 ± 20%	30,000 ± 20%	100,000 ± 20%	–	200,000 ± 20%	800,000
D13E	–	5,000	25,000	50,000	100,000	200,000	600,000
D18E	4,000 ± 20%	12,500 ± 20%	25,000 ± 20%	75,000 ± 20%	125,000 ± 20%	250,000 ± 20%	800,000
Place of Inspection	Depot	Depot	Depot	Depot	Depot	Depot	Workshop

③ The maintenance of passenger cars is conducted in accordance with the inspection cycle determined for each type of passenger car as shown in Table 5.3.6-10.

Table 5.3.6-10 Passenger Car Inspection Cycle

Type of Inspection	Inspection Cycle	Place of Inspection
Yearly Inspection	one year (new car: 2 years)	Depot
Overhaul	5 years	Workshop

④ The maintenance system for freight cars is shown in Table 5.3.6-11.

Table 5.3.6-11 Freight Car Inspection Cycle

Type of Inspection	Inspection Cycle
Yearly Inspection (Depot)	1 year - plain bearing wagons, 2 years - roller bearing and new wagons
Overhaul (Workshop)	5 years - plain bearing wagons, 6 years - roller bearing wagons

⑤ The maintenance cycle for the DLs, PCs and FCs in ②, ③ and ④ above is not always followed due to the limited facilities and manpower at workshops and depots.

⑥ There are 3 workshops (as shown in Table 5.3.6-12) which conduct rolling stock maintenance and all are directly controlled by the VNR's Head Office.

Table 5.3.6-12 Workshops

Name of Workshop		Subject Rolling Stock	Parent Organization
1	Gia Lam Workshop	DL, PC, FC	VNR Head Office
2	Hai Phong Workshop	PC, FC	VNR Head Office
3	Dian Workshop	PC, FC	VNR Head Office

⑦ 10 depots which conduct rolling stock maintenance and which are controlled by the Union offices are shown in Table 5.3.6-13.

Table 5.3.6-13 Maintenance Depots and Enterprises

	Name of Depot and Enterprise	DL	PC	FC	Parent Organization
1	Hanoi Locomotive Depot	○			Union 1
2	Hanoi PC and FC Depot		○	○	Union 1
3	Yen Bai Locomotive Depot	○			Union 1
4	Vinh Locomotive Depot	○			Union 1
5	Vinh PC and FC Depot		○	○	Union 1
6	Da Nang Locomotive Depot	○			Union 2
7	Da Nang PC and FC Depot		○	○	Union 2
8	Saigon Locomotive Depot	○			Union 3
9	Saigon PC Depot		○		Union 3
10	Thuan Hai FC Shop and Song Than FC Shop			○	Union 3

b) Current Conditions of Workshops and Depots for Rolling Stock Maintenance

① Gia Lam Workshop

- The Gia Lam Workshop is located in northern Viet Nam. It is the largest workshop (some 1,000 workers) directly controlled by the VNR's Head Office and conducts the maintenance of DLs, PCs and FCs as well as the manufacture and remodelling of PCs and FCs. This large workshop was originally constructed to carry out the maintenance of SLs, PCs and FCs and has many machines and equipment. However, it has limited maintenance facilities for DLs and no facilities at all for DELs.
- As far as DLs are concerned, the Gia Lam Workshop can only provide a maintenance service for D4Hs.
- The completion testing of engines is entrusted outside the VNR organization and performance testing is not conducted.
- The Workshop is adequately equipped with rolling stock maintenance facilities and machinery except those for DLs. The substitution of maintenance role from SL to DL has reduced the workload of the Workshop and a large part of the Workshop's facilities is now left idle and becoming outdated due to their lack of use over a long period of time.

- The Workshop has a large-scale automated foundry plant which is left idle. The actual foundry work is carried out by an another small cupola.
- In regard to PCs and FCs, the Workshop has sufficient skill, knowledge and technologies to maintain, remodel and manufacture these cars, backed by the relevant equipment, jigs and tools, etc.

② Hai Phong Workshop

- The Hai Phong Workshop is also located in northern Viet Nam and is directly controlled by the VNR's Head Office. It was originally constructed by France prior to 1945 and was rebuilt in 1960. Its work consists of the maintenance, remodelling and manufacture of PCs and FCs with a workforce of 521.
- The main maintenance building does not have an electric overhead travelling crane (EOTC) and lifting jacks are used to lift the body and to remove the bogie.
- The premises of the Hai Phong Workshop have a total area of some 2,000m^2. While the working environment is not particularly good because of the small work space, the morale of the workforce, which has excellent maintenance skills, is very high. Consequently, the PCs and FCs maintained by this Workshop are of an excellent quality.

③ Dian Workshop

- The Dian Workshop is located in southern Viet Nam, is directly controlled by the VNR's Head Office and conducts the maintenance, remodelling and manufacture of PCs and FCs with a workforce of 485.
- The Workshop boasts huge premises and a large building with a good working environment.
- The good technical expertise and skills of the workforce are underlined by remodelling of the excellent new first class air-conditioned sleepers for limited express trains and the prototype DCs.

④ Hanoi Locomotive Depot (Union 1)

- The Hanoi Locomotive Depot is located in northern Viet Nam and its workforce of 1,645 conducts the operation and maintenance of DLs and SLs under the control of the Union 1.

- The main maintenance building for D4Hs lacks an EOTC and uses a mono-rail crane to remove/refit the engine. Lifting jacks are used to lift the body and to remove the bogie.

- The main maintenance building for D12Es lacks an EOTC and uses a gantry crane to remove/refit the engine. Lifting jacks are used to lift the body and to remove the bogie.

- The repair of engine crank shafts is entrusted outside the VNR organization.

- Engine revolution testing and performance testing after maintenance are not conducted.

- A large number of very old SLs which are held as scrap are left unattended on the premises.

⑤ Hanoi PC and FC Depot (Union 1)

- This depot is located in northern Viet Nam and conducts the maintenance of PCs and FCs under the control of the Union 1.

[PC Maintenance Place]

- Air jacks are used to lift the body and to remove the bogie at the main maintenance building.

- In this building, PCs equipped with plain bearing are remodelled to roller bearing type.

- The maintenance place is very narrow and long. The working environment is not particularly good as the congested space makes it difficult to change the cars, adversely affecting the car maintenance process efficiency. Nevertheless, the work morale is very high.

[FC Maintenance Place] (Yen Vien)

- This Yen Vien Shop provides a maintenance service for both 1,000 mm gauge and 1,435 mm gauge FCs. A 3 rail track is installed on the premises.

- As the main maintenance building has no EOTC, manual jacks are used to lift the body and to remove the bogie.

- The wheel maintenance shop is currently under construction. The shop will be equipped with a wheel lathe and axle lathe but not with an EOTC. Wheel washing and tyre overlay welding shops are included in the shop.

⑥ Yen Bai Locomotive Depot (Union 1)

- The Yen Bai Locomotive Depot is located in northern Viet Nam and has a workforce of 955. It conducts the operation and maintenance of DLs and SLs and is directly controlled by the Union 1.
- D4Hs are used for passenger or freight trains in double or triple traction.
- The repair of engine crank shafts is entrusted outside the VNR organization.
- The Depot is equipped with an engine revolution testing device.

⑦ Vinh Locomotive Depot (Union 1)

- The Vinh Locomotive Depot is located in northern Viet Nam and conducts the operation and maintenance of DLs under the control of the Union 1. It has a workforce of 762.
- The Depot receives from Belgium the supply of spare parts and equipment, and technical assistance to improve its maintenance skills.
- The main building for the maintenance of D18Es is currently under construction. When completed, the floor space will be doubled to 1,800 m^2 to improve the Depot's maintenance capacity and quality.
- The existing main building for the maintenance of D18Es lacks an EOTC and uses a gantry crane to remove/refit the engine. Lifting jacks are used to lift the body and to remove the bogie.
- The same building is equipped with a crank shaft grinding machine (vertical type) which has never been used. Reconditioning or overhauling will probably be required to make this machine serviceable, because of its long period of non-use.

⑧ Vinh PC and FC Depot (Union 1)

- The Vinh PC and FC Depot is located in northern Viet Nam and is under the control of the Union 1. It has a workforce of 190 and conducts the maintenance of FCs.

⑨ Da Nang Locomotive Depot (Union 2)

- The Da Nang Locomotive Depot is located in central Viet Nam and conducts the operation and maintenance of locomotives with a workforce of 715 under the control of the Union 2.
- Under the depot improvement plan, the construction of an additional maintenance building is currently in progress with expected completion in 1996.
- The depot improvement plan includes a detailed equipment and machinery procurement plan and, upon completion of the plan, the Da Nang Locomotive Depot will become an excellent maintenance centre for DLs.

⑩ Da Nang PC and FC Depot (Union 2)

- This depot is also located in central Viet Nam and has a workforce of 455. It is under the control of the Union 2 and conducts the operation and maintenance of PCs and FCs.

⑪ Saigon Locomotive Depot (Union 3)

- The Saigon Locomotive Depot is located in southern Viet Nam. It is under the control of the Union 3 and conducts the operation and maintenance of DLs with a workforce of 603.
- The wheel set shop does not have an EOTC and uses a jib crane.
- The out-going inspection place is equipped with integrated DEL performance testing facilities using water rheostat.
- The oil laboratory controls the oil and grease, etc. used for DLs by analysing their properties.

⑫ Saigon PC Depot (Union 3)

- This depot is located in southern Viet Nam and is under the control of the Union 3. It has a workforce of 1,080 and conducts the operation and maintenance of PCs.

⑪ Thuan Hai FC Shop (Union 3)

- This shop is also located in southern Viet Nam and is under the control of the Union 3. It has a workforce of 650 and conducts the operation and maintenance of FCs.
- This shop conducts the overhauling of FCs and has a workforce of approximately 250.
- The Song Than Shop conducts the yearly inspection of FCs and has a workforce of approximately 100.
- The Saigon FC Operation Depot is responsible for the operation of FCs and has a workforce of approximately 300.

2) Current Problems

a) Common Problems

① The items listed below are particularly important for the safe operation of rolling stock and must be inspected and maintained with the utmost care. Intensive cleaning must be conducted and any sign of damage or actual damage must not be ignored. It is, therefore, necessary to install the most suitable mechanised washing system for each type of car to improve both the work efficiency and the washing quality.

- wheels, axles
- bogies, under-frames
- bearings

② The rotating parts listed below have very delicate functions and a tiny amount of dust, scratch and rust can deteriorate these functions, possibly leading to a train accident or car breakdown. Consequently, they must be handled and stored with extreme care. In particular, the inspection, repair and storage of bearings must be conducted in a special clean room which is independent from other shops.

- rust prevention and protection of journal
- rust and dust prevention of bearings

③ A suitable flaw detector should be used for various parts. Flaw detection work must be carefully conducted to find any flaws at an early stage so that the appropriate remedial measures can be immediately implemented to ensure the reliability of rolling stock. The flaw detection results should be kept for reference purposes for the next inspection.

- ultrasonic flaw detector
- magnetic particle inspection unit
- colour check unit
- X-ray inspection unit

④ In general, the quantities of instruments, tools and meters, etc. required for maintenance are inadequate. The active introduction of pneumatic tools is particularly important to improve work safety and efficiency and to reduce the necessary manpower. The extensive use of instruments and meters, etc. will improve the reliability of rolling stock maintenance.

⑤ It is essential that passages in the shops must be kept clear at all times and every effort should be made to keep the shops clean and good arrangement to ensure work safety and to improve work efficiency. In general, all of the workshops and depots are found to have many places which are not properly clean and tidy. Items which do not appear necessary for maintenance work are currently scattered on the shopfloor and must be tidied up to create a pleasant and efficient work environment.

b) DL Maintenance Problems

① Improvement of the current DL maintenance system must be stressed in view of the fact that the maintenance of DLs fundamentally differ from the maintenance of SLs in the following regard.

- Extreme importance of thorough washing: washing of the engine (both inside and outside) and the hydraulic transmission (both inside and outside) is particularly important.
- Necessity to conduct output adjustment and performance testing following completion of maintenance work: performance testing of the engine and hydraulic transmission, revolution testing of the traction motor

and integrated performance testing of the engine and generator are particularly important.

② The necessary equipment and machinery for engine maintenance lack.

- The absence of engine maintenance equipment means inadequate engine maintenance work.

- The absence of an engine performance testing unit means that it is impossible to check the engine output after the completion of maintenance work.

③ The necessary equipment and machinery for the maintenance of such electrical equipment as the main generator and traction motor is short.

- The absence of an armature and other repair equipment means inadequate electrical equipment maintenance.

- The absence of a performance testing unit for such electrical equipment as the main generator and traction motor means that it is impossible to check the output of this electrical equipment.

④ Dust prevention measures at engine shop are inadequate. The intrusion of a small amount of dust in an engine can cause a functional troubles. Thorough dust prevention measures should, therefore, be implemented in the engine shop.

⑤ A large number of DLs queue up for maintenance work, resulting in inefficient DL operation. The poor DL operation efficiency is caused by a combination of the following items which require individual remedies.

- The long maintenance work duration (cycle time) forces the withdrawal of DLs from active service for a long period of time.

  D4H cycle time : RK = 35 days, RG = 60 days
  D12E cycle time : RK = 60 days
  D18E cycle time : RK = 90 days

- DL maintenance work generally requires a large number of man-hours.

  D4H maintenance man-hours : RK = 4,727 man-hours,
  RG = 10,283 man-hours

D12E maintenance man-hours :	RK = 13,368 man-hours,
	RG = 20,566 man-hours
D18E maintenance man-hours :	RK = 15,141 man-hours,
	RG = 30,849 man-hours

- The lack of spare parts in store prolongs the cycle time, because some time is required to obtain the necessary spare parts.

c) Other Areas for Improvement

① VNR-wide statistical data should be prepared annually on the number of train accidents and rolling stock failures by cause and by type of rolling stock. (This data will be extremely useful for rolling stock control and maintenance.)

② VNR-wide statistical data should be prepared annually on the rolling stock maintenance results by type of rolling stock, type of inspection and maintenance place. (This data will be extremely useful for rolling stock control and maintenance).

③ Repair criteria, repair limits, use limits, etc. should be established for each maintenance items and should be strictly enforced in order to standardise rolling stock maintenance skills at all workshops, depots and enterprises.

④ The Head Office of the VNR should actively sponsor regular technical meetings to facilitate exchanges of technical information and techniques, etc. between workshops, depots and enterprises in order to improve rolling stock maintenance skills.

⑤ The Gia Lam Workshop should be provided with DEL maintenance facilities as soon as possible and training of DEL maintenance personnel is important.

⑥ Effluent from workshop and depot premises is currently discharged without prior treatment. In the near future, it will be necessary to introduce an effluent treatment plant to separate oil from effluent and to adjust the pH value, etc. in response to the growing concern in regard to environmental problems.

5.3.7 Summary of Current Problems

Current Problems of Hanoi-Ho Chi Minh Railway are summarized in Table 5.3.7-1.

Table 5.3.7-1 Summary of Current Problems

Item		Current Problems
Safety	Dangerous Sections	The most bridges and tunnels are posing a high risk for train operation under normal circumstances due to ageing and war damage, etc.
	Disaster Prevention Features	- Slope protection works necessitate to be constructed at sections vulnerable to collapse due to torrential rain. - Drainage channels necessitate to be constructed at places vulnerable to roadbed collapse due to poor drainage. - Protective facilities vis-a-vis falling rocks necessitate to be introduced at vulnerable places and falling rock warning devices are necessitated to stop trains to prevent major disasters.
	Track	Rails and turnouts are worn or deteriorated due to ageing and light rails.
	Signalling System	- At present, most signals are semaphore signals using a kerosine lamp and are difficult to confirm at night or during bad weather. These necessitate to be replaced by electric colour-light signals. - At present, the interlocking system between the points and signals at the station premises is inadequate. The relay interlocking system necessitates to be introduced to prevent accidents caused by mishandling. - The ATS system necessitates to be installed to prevent such serious accidents as train collisions.
	Level Crossings	A train approach warning system necessitates to be installed at those level crossings with heavy traffic to prevent accidents.
Reliability	Flood Prevention	New track necessitates to be constructed at those sections which are frequently rendered impassable for a long time due to flooding in the rainy season.
	Track	Both corrosion and abrasion of the iron sleepers are observed. In many sections, the ballast thickness is less than 20cm.
	Track Maintenance	In order to ensure reliable transportation, a high speed track inspection car, multiple tie tampers and other maintenance equipment necessitate to be introduced.
	Rolling Stock	Rolling stocks are deteriorated due to aging.
	Inspection Facilities at Workshops, etc.	The inspection facilities at workshops, etc. necessitate to be improved or replaced by new facilities. Environmental improvements should be made in regard to waste water treatment and others.
Transport-ation Capacity	Stations	New interchange stations necessitate to be constructed at those sections of insufficient track capacity due to the long distance between stations and/or bad alignment. Following the strengthening of the medium and long-distance through freight service, new storage track will be necessitated at key freight stations.
	Rolling Stock	New rolling stock will be necessitated to meet the increased transportation demand.
Service Level	Station Square	The existing station squares do not take such feeder services as buses and taxis, etc. into consideration. The stations squares necessitate to be improved to ensure a smooth inter-modal traffic flow and environmental improvements.
	Long welded Rails	The number of rail joints necessitate to be reduced to reduce noise and vibration and in view of improved comfort, maintenance and service speed.
	Low Journey speed	Train journey speed is low and should be raised to be competetive against road transport.

Item		Current Problems
Transport Efficiency	Train Operation Control, Passenger Information and Freight Information Systems	The aged communication network necessitates to be renovated to strengthen the train operation control and disaster control functions. A passenger information system necessitates to be introduced for reservation control and better passenger services. Ticket selling system should be improved and time table should be distributed among customers. The introduction of a freight information system will improve the marketing control, transportation efficiency of freight cars and services for consignors.
Manage-ment	Financial Structure	The financial statements prepared by the VNR are rather old-fashioned and require a radical revision in view of their acceptance by the international community.
	Organization	The VNR is something like a conglomerate, the activities of which will cover a group of industries, supporting railway operation, such as manufacturing, construction, services etc. Along the instruction given by the Prime Minister, on March 26, 1994, the VNR is to be reorganized as a profit-making enterprise specialized in its proper business, transportation, being relieved of the heavy capital investments on infrastructure. In this connection, it is quite natural that the VNR should have the rationalization plan of management, and seriously consider of early independence of indirect parts of business that often arrest the growth of its proper income, in parallel with a personnel reduction on the whole.
	Manpower	The present productivity of VNR based on the current manpower level is very low in comparison with other countries. It is quite necessary to improve the productivity steadily.
	Commercial and Marketing	Fare and charge system are complicated and should be simplified. Marketing system is very poor, and not convenient for customers.
	Education and Training	Current educational and training facilities and equipment are not matching with present requirement and not sufficiently equipped.

5.4 Urban Transport

5.4.1 Current Problems of Urban Transport

The main means of urban transport in Hanoi and Ho Chi Minh City today are bicycles and motorbikes. In particular, the number of motorbikes has been rapidly increasing in recent years. In contrast, public transport, including buses and the railway, plays only a minor role. The transport infrastructure in Hanoi with a population of approximately 3.15 million is far from satisfactory. The roads are narrow and the road density is inadequate. The road network is particularly poor in newly developed residential areas. Apart from the VNR railway network, there is no other mode of transportation using track. In the field of urban transport, the VNR has failed to use the advantages of the railway to their best advantage because of the many level crossings, infrequent train services and small number of stations with long distances between them.

Ho Chi Minh City has a population of approximately 4 million and the transport demand of local residents and tourists has been rapidly increasing. Like Hanoi, motorbikes and bicycles are the main means of urban transport, accounting for 95 - 97% of the transportation volume and leaving public transport a share of 3 - 5%.

The transport demand in both cities is expected to grow in the future following the economic growth of Viet Nam and there is concern in regard to a worsening of the following urban transport problems.

(1) Chronic congestion during the morning and evening rush hours

(2) Increase of the number of traffic accidents

(3) Environmental problems, such as traffic noise and air pollution

(4) Inefficient socioeconomic activities resulting from the above problems and adverse impacts on civic life

5.4.2 Remedial Measures

It is essential to solve the problems of urban transport for the economic development of cities safe and healthy civic life. From the long-term perspective, a transport plan based on the land use plan of a given city should be prepared with a view to implementing the plan components in accordance with their priority order.

It is necessary to make public transport more attractive in terms of the service frequency, speed, punctuality, distance to nearest stop/station and fares, etc. The resulting increase of the share of public transport will help to solve the above problems.

In general, the maximum transportation capacity in one direction is said to be 20,000 passengers/hr for buses and 30,000 - 80,000 passengers for a rail-based transportation system (trains). The latter is superior to the former in terms of punctuality, energy consumption and air pollution.

When preparing the long-term plan mentioned earlier, it is necessary to clearly identify the relationship (or advantages and disadvantages) of different modes of transport and the roles of each mode of transport as each mode has a different transportation capacity, land requirements, construction cost and maintenance cost, etc. An efficient transport network can be created by combining various modes of transport.

The construction cost of a rail-based transportation system is generally higher for an underground system than for an elevated railway system. The latter also allows flexible future planning to improve stations and/or expand the network.

The present railway system can be vitalised by means of signal modernisation, construction of new stations, introduction of shuttle service facilities and improvement of station squares, etc. The construction of a second track and electrification of the route should be put on the agenda in the case of a substantial increase of the transportation demand in the future.

When planning the construction of a new railway line, it is necessary to carefully select the route taking not only the demand forecast figures but also the planned strategic layout of cities and urban facilities in the future into proper consideration.

The railway improvement plans, including the possible construction of a new railway line, for Hanoi and Ho Chi Minh respectively as part of the efforts to improve the overall urban transport facilities in these cities, which were provided by the Vietnamese counterpart is attached as Appendix 5.4-1, 5.4-2.

Note: The JARTS organized the Seminar on Rail-Based Urban Transport in Viet Nam in July, 1994 in Hanoi. Refer to the papers submitted for the Seminar for further urban transport details.

5.5 International Transport

The following 4 corridors (see Fig. 5.5-1) should be considered when discussing the prospect of an international link for the Viet Namese railway network.

(1) Kunming (China) - Lao Cai - Hai Phong/Cai Lan (existing line)

(2) Nanning (China) - Dong Dang - Hanoi (existing line)

(3) Bua Yai (Thailand) - Savannakhet (Lao PDR) - Cua La (new line)

(4) Bangkok (Thailand) - Poipet (border) - Phnom Penh (Cambodia) - Ho Chi Minh City (existing and new lines)

The recent drastic changes of the international political and economic environment in East and Southeast Asia, such as the normalisation of the diplomatic relationship between China and Viet Nam, the establishment of a basic framework for long-lasting peace in Cambodia and the progress towards a market economy in Lao PDR, Viet Nam and China, etc. have created bright prospects for international transport in the Asian sub-region which includes China, Viet Nam, Thailand, Cambodia, Lao PDR, Myanmar, Malaysia, Indonesia and other ASEAN countries. One advantage is that all railway track in these areas is 1,000 mm gauge except the Nanning - Dong Dang Line and that in Indonesia, allowing smooth cross-border passenger and freight traffic without changing the bogies or freight transfer at borders. The prospective development of the international transport systems will stimulate trade and personnel exchanges and will without doubt contribute to integrated social, economic and cultural development in this sub-region. The current conditions of the above 4 corridors are further described below.

(1) Kunming - Lao Cai - Hai Phong/Cai Lan

Yunnan Province has rich mineral resources and a population of 56 million. The nearest international ports for Yunnan Province are Ports Hai Phong/Cai Lan and the said railway linking these ports with Kumming, the capital of Yunnan Province, plays a crucial role in the Province's trade route. This route is also important for the development of industrial and mining activities in the area along the route in Viet Nam. As the railway line in Yunnan Province is already in good conditions, the rehabilitation/modernization of the remaining section, i.e. between Lao Cai and Hai Phong/Cai Lan is strongly hoped for.

(2) Nanning - Dong Dang - Hanoi

The Nanning - Dong Dang section uses standard gauge while the Dong Dang - Hanoi section uses dual gauge (standard gauge and meter gauge). According to the JICA report "Master Plan Study on Transport Development in Northern Part of Socialist Republic of Viet Nam", this line's annual freight transportation volume is merely in the order of several hundred thousand tons and passenger traffic is largely determined by the policies of the Chinese and Viet Namese governments on the use of the route for passenger traffic. As the Government of Viet Nam has decided to unify the gauge to meter gauge, it will be necessary to construct both passenger and freight transfer facilities at Dong Dang.

(3) Bua Yai - Savannakhet - Cua La

This is a new line which is mainly planned to assist the development of iron ore resources in Lao PDR. The line will mainly run along Route 7, reaching Port Cua La in Viet Nam from where iron ore is exported.

(4) Bangkok - Poipet - Phnom Penh - Ho Chi Minh

The 48 km section between Poipet and Sisophon was destroyed during the war and requires reconstruction while the 337 km section between Sisophon and Phnom Penh requires rehabilitation. In addition, a new line extending for 195 km between Phnom Penh and Ho Chi Minh City must be constructed.

The prospective rehabilitation and construction of the above railway lines will obviously require huge funding. In view of their significant contribution to integrated social, economic and cultural development in the sub-region, however, continued effort should be made to realize them step by step while carefully assessing the likely traffic demand of each line.

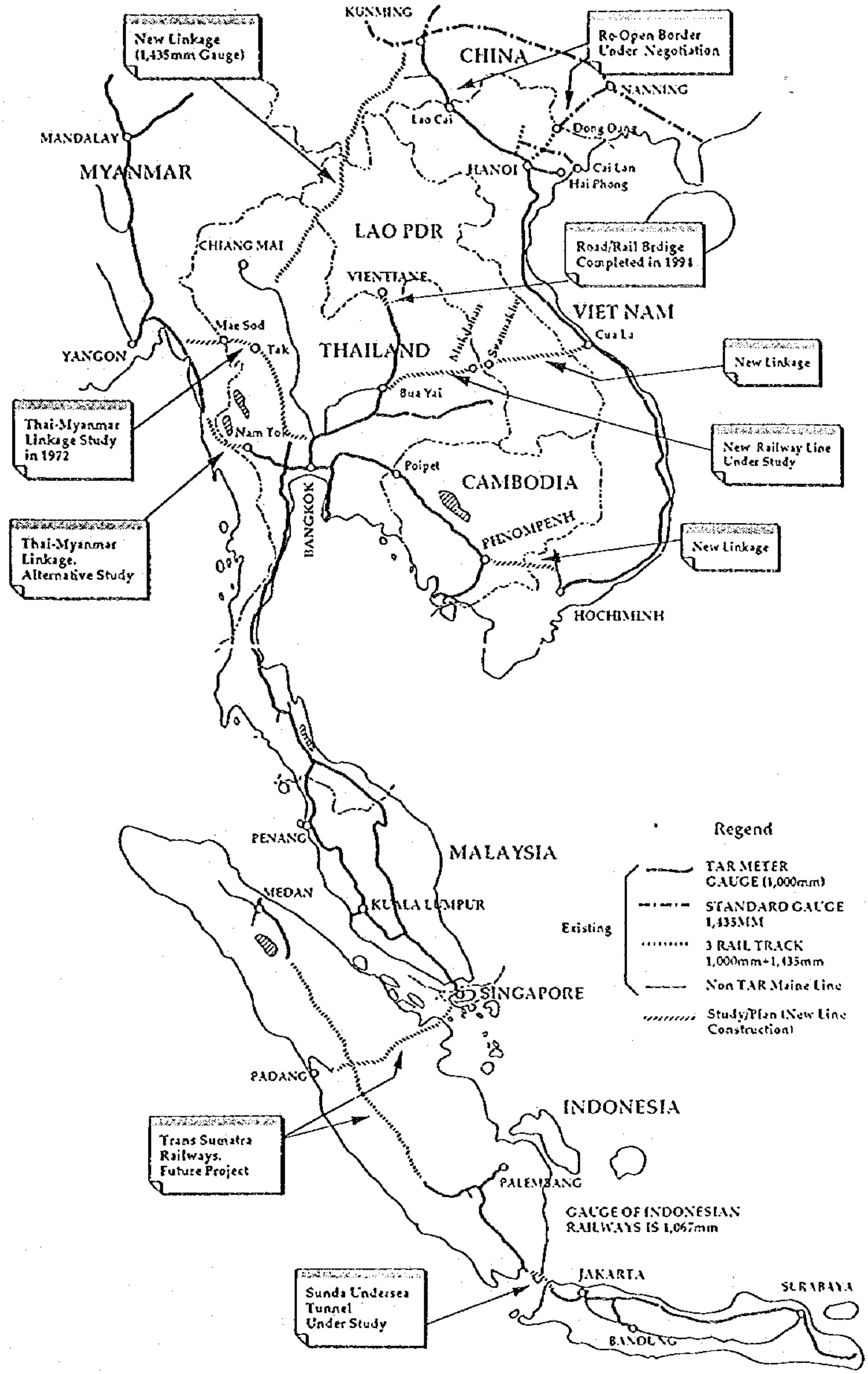


Fig. 5.5-1 Trans-Asia Railway (TAR) Map

CHAPTER 6 FORMULATION OF HANOI-HO CHI MINH RAILWAY MASTER PLAN

Taking the Doi Moi Policy, the Socio-Economic Stabilization and Development Strategy toward the Year 2000 and the Guidance to Consolidate and Develop the Communication and Transportation Sectors from Today to the Year 2000 which were described in 3.1 into consideration, the Master Plan for Hanoi-Ho Chi Minh Railway are formulated. (Refer to Fig. 6-1)

6.1 Railway Sector's Role Towards the Year 2010

In view of the basic policies and measures envisaged for the development of Vietnam's national economy in general and the transport sector in particular described above, the roles of the Hanoi – Ho Chi Minh Railway, the subject of the present study, can be defined as follows, taking the geographical and topographical conditions, current transport network, conditions of economic zones and regional development requirements, etc. into consideration.

<u>Roles of Hanoi – Ho Chi Minh Railway</u>

(1) Backbone of the Nation and Contribution to Socioeconomic Development in Areas Along Route

The Hanoi – Ho Chi Minh Railway stretches 1,726km and links Hanoi, the capital of Vietnam which is located at the centre of the Red River delta with some 3.15 million inhabitants, and Ho Chi Minh City, Vietnam's largest commercial city which is located at the centre of the Mekong delta with some 4 million inhabitants. Given the national land's shape and topographical characteristics, this trunk railway line forms of the backbone of the national land, traversing it from north to south. Along its route lie such major cities and industrial zones in Vietnam as Nam Dinh, Thanh Hoa, Vinh, Da Nang, Quy Nhon, Nha Trang and Bien Hoa. In fact, some 78% of the GNP and 72% of the total population are expected to be concentrated in areas along the route by the year 2010. Despite its crucial importance, the realities of the Hanoi – Ho Chi Minh Railway today are epitomised by highly deteriorated infrastructure due to war damage, natural ageing and lack of investment. There exist 731 compulsory slow speed sections due to safety hazards, and neither the equipment for safe train operation nor the rolling stock are exceptions to the general deterioration. Many of the disaster-hit areas have not been rehabilitated, causing train operation stoppages during bad weather. The train operation safety and reliability levels appear to be lower than the desirable levels. As a result of these adverse conditions, the average train speed is slow and the passenger service level, including passenger comfort during travel, is unsatisfactory. Appropriate investment is urgently required to improve the safety, reliability, service and management efficiency so that the restored proper functions of the railway service can positively contribute to socioeconomic development in areas along the route.

(2) Unification of North and South

Given the fact that Vietnam was politically and socially divided into the North and South for some 30 years in its recent past, the Hanoi – Ho Chi Minh Railway can be expected to play a significant role in facilitating the political, social, economic and cultural integration of the North and South.

As Vietnam today still has divided economic zones in the North and South, it is essential to promote efforts to rectify the economic gap between the North and South while also stimulating the economic development of each economic zone. The following three areas have been identified as key areas for the medium-term development strategy.

① the northern triangle (a triangular area formed by Hanoi, Hai Phong and Quang Ninh)

② the central area around Da Nang

③ the southern triangle (a triangular area formed by Ho Chi Minh City, Vung Tau and Bien Hoa)

Integrated economic development in these three areas will necessitate improvement of the transport infrastructure linking the North and South. The available infrastructure linking the North and South consists of the Hanoi – Ho Chi Minh Railway and State Route No.1 which runs along Hanoi – Ho Chi Minh Railway line. Such major international sea ports of Vietnam as Hai Phong, Da Nang and Ho Chi Minh City are also located along the same railway route. In view of the strategical position of the Hanoi – Ho Chi Minh Railway, it appears imperative that the Railway play an appropriate role in the socioeconomic integration of the North and South and the socioeconomic development of areas along its route through the creation of an integrated transport system with other modes of transportation.

(3) Inter-Regional Transportation

Examination of the present and future traffic conditions of Hanoi – Ho Chi Minh Railway among the various modes of land transportation has found that, even though the volume of through traffic between the North and South is not particularly large in terms of either passenger transportation or freight transportation, the sectional passenger transportation volume is almost level for the entire route with the volume of freight transportation in Union 1 being larger than those in Union 2 or Union 3 (the freight transportation volumes in Union 2 and Union 3 are similar; see Fig. 6.1-1 and 6.1-2). The above finding suggests that improvement of the passenger service is strongly required for inter-regional operation to share the transportation burden with the regional road networks. In the case of freight transportation, while coastal shipping may eventually become the dominant force in long-distance, bulk transportation through improvement of the port facilities and modernisation of vessels, the railway will still maintain an important share of inter-regional transportation and the transportation of such specific commodities as cement, coal, iron ore and chemical fertilizers, etc.

Roles of Northern Railway Lines

The expected roles of the northern railway lines are described in the Master Plan Study on Transport Development in the Northern Part of Vietnam (JICA), an outline of which is presented below. The major railway lines in the northern part of Vietnam and their respective roles are ① the Hanoi – Haiphong Line which links the two large cities of Hanoi and Haiphong and which provides passenger and freight services for relatively developed areas along its route, ② the Hanoi – Lao Cai Line which serves to promote the economy in a remote region, which is an international transportation link with China and which is used for the transportation of mineral resources, predominantly apatite, ③ the Hanoi – Cai Lan Line which mainly serves for the transportation of coal and for the future cargo transport generated from industrial development together with the planned development of Port Cai Lan, and the transportation of tourists visiting Halong and ④ the Hanoi – Dong Dang Line, the current importance of which is relatively low and the role of which will depend on the development of international transportation links with China in the future.

6.2 Basic Principles to Formulate Master Plan

Clear identification of the current conditions of Hanoi – Ho Chi Minh Railway and the railway's characteristics as a means of transportation is essential in order to establish the basic principles to formulate the Master Plan designed to fully exploit the potential of the said railway to contribute to the future socioeconomic development of Vietnam.

6.2.1 Current Conditions of Hanoi – Ho Chi Minh Railway

The Hanoi – Ho Chi Minh Railway was originally constructed some 60-90 years ago and now shows signs of much deterioration due to war damage, natural ageing and the lack of investment as described below.

Decline of Operational Safety

There are 724 sites along the route where trains are forced to go slow due to dangerous bridges and tunnels, etc. The facilities to ensure train operation safety are both outdated and deteriorated. Moreover, there are many hazardous areas involving fallen rocks and slope erosion, etc.

Decline of Service Reliability

Many old, light (27-30kg/m) rails are still in use, particularly in the South, causing a problem of unstable train movement. The deterioration of rolling stock, i.e. locomotives, passenger cars and freight cars, means the possibility of rolling stock failures. The rolling stock maintenance workshop/depots are poorly equipped while track maintenance work, etc. is inadequate. The track bed is submerged in some places during the rainy season, frequently causing the suspension of train operation.

Transportation Capacity Problems

The average distance between the neighbouring stations of Hanoi – Ho Chi Minh Railway is as long as 10.7km and the longest distance is 26.3km. In addition, many sections of continuous sharp curves (R97-100m) and of steep inclination (upto 16‰) (such as Hai Van Pass) constitute bottlenecks for efficient transportation. Neither the track capacity nor the rolling stock fleet size appear sufficient for future demand volume.

Decline of Service Level

The train service level is poor in terms of the train frequency, average train speed, feeder services to the railway line and passenger comfort, etc., which will present a problem in securing an appropriate share of the railway service in the transport sector under a market economy.

Decline of Transport Efficiency

The present weakness of the information/communication network causes problems in regard to the control of train operation, the passenger ticket sales system, the freight service booking system and the operation efficiency of freight cars, etc.

6.2.2 Characteristics of Railway Transport

Since its introduction in 1825, the railway transport system has been playing an important role throughout the world as the leading land transportation system. In recent years, however, many of the world's railway services are facing severe competition from road and other transportation systems and their financial strength is not necessarily strong enough to allow them independent management status. However, in most countries, the government provides appropriate support to maintain the railway service due to its importance in the national economy.

The railway service is positively appraised due to such special characteristics or advantages vis-a-vis other modes of land transportation as (i) good reliability and safety, (ii) excellent energy efficiency, (iii) large transportation capacity, (iv) low unit transportation cost on those lines with a certain transportation volume level, (v) lower vulnerability to weather conditions than any other modes of transportation, including air and maritime transport systems, (vi) higher speed than other modes of transportation, except air transportation, and strong potential for speeding up, (vii) high passenger comfort level for passengers allowing than more relax during transportation, thus making it ideal for tourists and (viii) fewer adverse impacts on the environment and ecosystem.

Making the best use of these characteristics, the railway service should find a future role in commuter transport in large cities and in inter-city passenger transportation and medium-to-long distance large volume cargo transportation.

6.2.3 Basic Principles to Formulate Master Plan

Taking the current conditions of Hanoi – Ho Chi Minh Railway and the general characteristics of the railway service described in 5.3 and 6.2.2 respectively into consideration, the following basic principles are established here to formulate the Master Plan for Hanoi – Ho Chi Minh Railway in 2010 to facilitate the contribution of the said Railway to Vietnam's socioeconomic development.

(1) Coordination with national and regional development plans and urban development plans as well as projects in progress or for which the planning has been finalised should be consciously sought.

(2) Integration between the railway and other modes of transportation (roads, inland water (river) transportation, coastal maritime transportation and aviation) should be sought to create an integrated transport network.

(3) In regions where the railway competes with other modes of transportation, active investment should be conducted in those fields where the advantages of the railway can be fully exploited in view of the railway playing an important role as part of the infrastructure to support socioeconomic development.

(4) Instead of aiming at the uniform improvement and modernisation of all parts of the railway network, any improvement and modernisation project should try to enhance the specific functions and characteristics of each railway section.

(5) Every effort should be made to achieve safe and reliable transportation. Improvement of the management efficiency should also be considered. The existing facilities should be utilised as far as practical.

(6) In estimating the required railway investment, due consideration should be given to the national economic strength and investment of the transport sector in Vietnam so that the Master Plan is of a practical investment size.

(7) Domestic products, materials and technologies should be used where possible. At the same time, advanced foreign technologies should be made use of with the aim of accelerating modernisation.

(8) Proper attention should be paid in the planning of the Master Plan to social impacts, including environmental impacts, and indirect benefits (local development, etc.) in addition to the financial improvement of railway management.

(9) Coordination with JICA's Master Plan Study on Transport Development in the Northern Part of Vietnam (hereinafter referred to as Northern Transport M/P (JICA)) should be sought.

(10) Special attention should be paid to balanced planning for the marketing, transportation, civil engineering facility (track, stations, tunnels, bridges), electrical (signalling and telecommunications) and rolling stock (rolling stock and workshops) sectors, taking the current conditions of these sectors in Vietnam into proper consideration. The training and education of staff should be duly considered, too.

(11) Unification of the railway track gauge into meter gauge should be taken into consideration.

(12) International transport should be considered as far as necessary.

6.3 Development Objectives of Master Plan

It is necessary to focus on the following development objectives with a view to implementing measures to improve the current conditions of Hanoi – Ho Chi Minh Railway so that the said Railway can significantly contribute to the socioeconomic development of Vietnam.

(1) Consolidation of Transport Safety

- Eradication of dangerous slow speed sections
- Improvement of train operation safety facilities/equipments
- Improvement of disaster prevention systems

(2) Consolidation of Reliable Service

- Introduction of measures to prevent submergence of the track bed
- Improvement of track
- Rehabilitation of rolling stock
- Improvement of maintenance facilities

(3) Expansion of Transportation Capacity

- Introduction of interchange stations
- Increase of rolling stock

(4) Improved Service in Response to Market Economy

- Improvement of train frequency, average train speed and feeder services
- Improvement of passenger comfort
- Improved convenience for inhabitants along the route

(5) Improvement of Transport Efficiency

- Strengthened control of train operation
- Improvement of passenger ticket sales system, freight service booking system and efficiency of freight car management

(6) Adoption of Practical Investment Size

The Master Plan Study on Transport Development in the Northern Part of Vietnam (JICA) lists the following principles for railway service improvement in Northern Vietnam.

- Optimum utilisation of the existing facilities
- Rehabilitation and upgrading of the existing facilities
- Improvement of the capabilities of human resources
- Improvement of the management and organization
- etc.

There are differences in the functions and current conditions of the northern railway lines and the Hanoi – Ho Chi Minh Railway. For example, the former, consisting of 5 lines, accounts for 38% of the freight transportation and 19% of the passenger transportation in Vietnam on a ton-km and person-km basis respectively compared to 62% and 81% respectively on the single Hanoi – Ho Chi Minh Railway, indicating the overwhelming importance of the latter in passenger transportation. While the railway infrastructure of some of the former is relatively sound, that of the latter suffers from severe deterioration along the entire route. Despite these differences, the basic principles for the improvement and development objectives of the Hanoi – Ho Chi Minh Railway described in 6.2.3 and above are basically the same as those for the northern railway lines described above.

6.4 Formulation of Master Plan Alternatives and Evaluation

6.4.1 Formulation of Master Plan Alternatives

(1) Basic Ideas to Formulate Alternatives

In formulating the Master Plan for the year 2010, there may be conceived many alternatives in regard to the level of envisaged improvement. One alternative is the higher improvement of the railway functions, aiming at achieving higher safety, higher reliability and higher service levels. Another is minimum improvement to establish the minimum railway functions with minimum improvement of the operation safety, reliability and service levels. Another alternative lies somewhere between the above two alternatives. The optimum Master Plan should be selected from among various alternatives of different improvement levels in terms of the safety, reliability and service levels, based on a comprehensive evaluation of each alternative involving a cost benefit analysis and both social and political evaluation of the alternatives. For the present purposes, three alternatives involving different improvement levels have been established with the agreement of the Government of Vietnam based on the development objectives referred to in 1.3 for the selection of the optimum Master Plan alternative. In addition to the above-mentioned development objectives, the following points have also been taken into consideration in the establishment of the three alternatives.

① The subject issues for improvement of each alternative are safety, reliability, transportation capacity meeting the demand, service level and transport efficiency.

② In order to make the investment size practical, alignment improvement and other work requiring huge investment should be kept to a minimum. At those sections where the current alignment poses a considerable problem, an improvement plan should be prepared for each section for examination of the appropriateness of its inclusion in the Master Plan by means of cost benefit analysis.

③ As the Master Plan envisages the state of the subject Railway in the 21st century (the target year is 2010), technical features relating to the meter gauge in foreign countries (advanced countries as well as neighbouring countries) should be taken into considered where deemed necessary.

④ Regarding the increase of the train speed to improve the service level, an increase of the journey speed is particularly important, which in turn will necessitate comprehensive examination of the desirable track, rolling stock and alignment, etc. Effective measures with the minimum investment cost should be sought to increase the journey speed. While the maximum speed of the current rolling stock is 80km/hr, a maximum speed of 110km/hr can be achieved with the introduction of high speed, light axle weight cars with slight modification of the current track structure. In neighbouring Thailand, a maximum speed of 105km/hr is permitted for light axle weight trains (120km/hr for the trains recovering delayed times). Taking the above facts into consideration, a maximum speed of 110km/hr should be permitted for some light axle weight trains.

(2) Basic Characteristics of Three Alternatives

① Alternative I

There are many slow speed sections at track, bridges and tunnels due to dangerous conditions. Alternative I envisages the realisation of a higher level of train safety and reliability by the total eradication of the current dangerous slow speed sections between Hanoi and Ho Chi Minh City and also by improving the natural disaster prevention system, track, signals, communications and rolling stock maintenance. In addition, new high speed rolling stock will be introduced with modest additional investment to achieve a maximum speed of 110km/hr for limited express passenger trains as well as for inter-regional express passenger trains. As a result of these improvement measures, the journey speed between Hanoi and Ho Chi Minh City of a limited express passenger train will be significantly increased from the present 48km/hr to 72km/hr. The improvement level is the highest among the three alternatives for the Hanoi – Ho Chi Minh Railway for 2010 within the confines of a practical investment figure.

② Alternative II

Alternative II envisages the realisation of the minimum required level of train safety and reliability by the eradication of dangerous slow speed sections of less than 40km/hr and also by improving the natural disaster prevention system, track, signals, communications and rolling stock maintenance and the rehabilitation and replacement of the current rolling stock which is capable of running at a maximum speed of 80km/hr. As a result of these improvements, the journey speed between Hanoi and Ho Chi Minh City of a limited express passenger train will be increased to 58km/hr. Alternative II represents the minimum improvement level required for the Hanoi – Ho Chi Minh Railway for 2010.

③ Alternative III

The envisaged level of improvement of the railway facilities and services is midway between that of Alternative I and Alternative II. Alternative III envisages the realisation of safe and reliable train operation by the eradication of all dangerous slow speed sections at tunnels and slow speed sections of less than 40km/hr at bridges in addition to the eradication of all slow speed sections of which the alignment could tolerate a travelling speed of 110km/hr (excepting some 18 of them) and further by the improvement of the natural disaster prevention system, track, signals, communications and rolling stock maintenance. In addition, new high speed rolling stock will be introduced for limited express passenger trains with a maximum travelling speed of 110km/hr. The expected journey speed between Hanoi and Ho Chi Minh City under Alternative III is 69km/hr for limited express passenger trains.

(3) Detailed Components of Three Alternatives

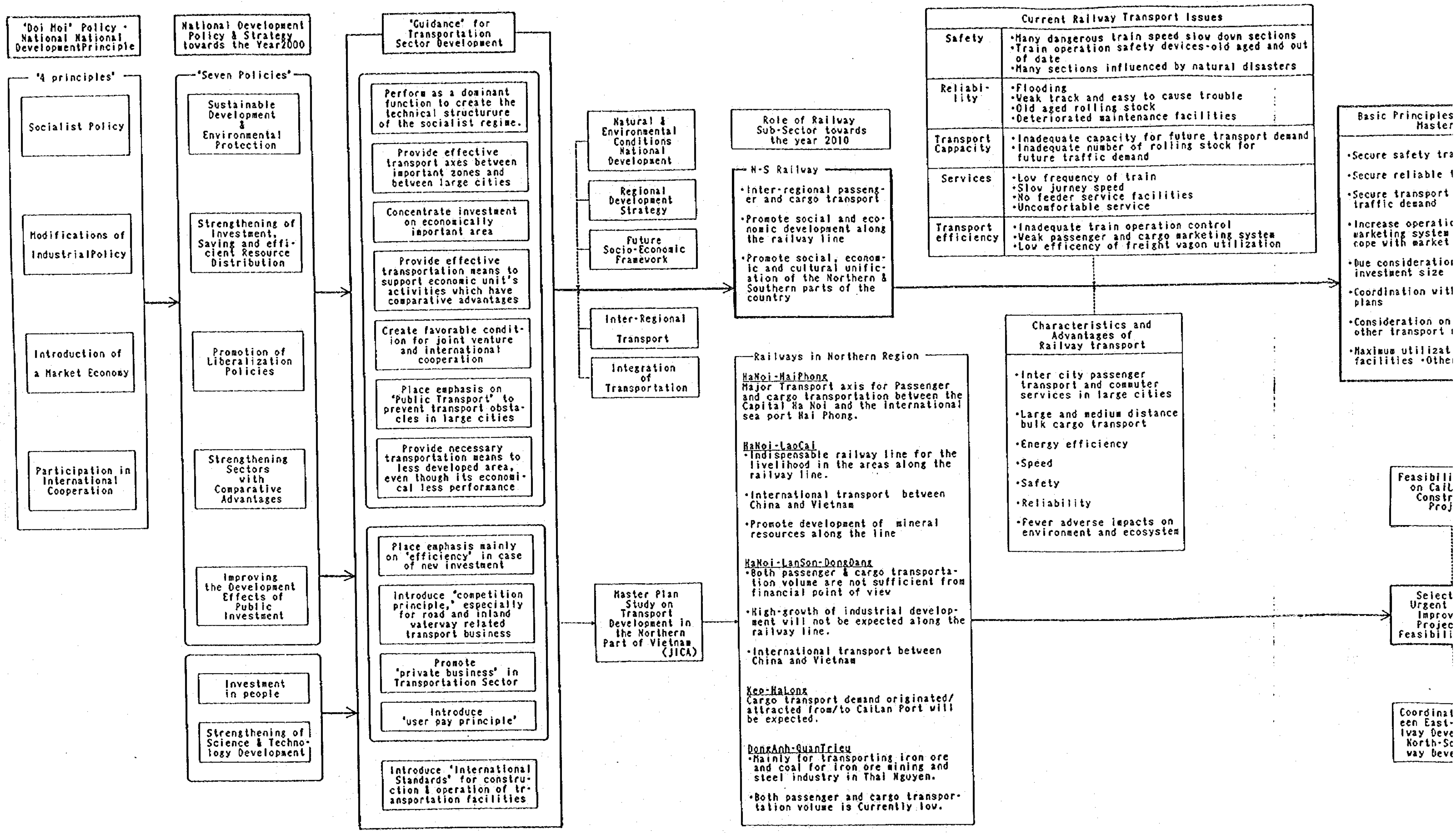
The detailed components of the three alternatives are given in Table 6.4-1 and Appendix 6.4-2.

In addition, the components of the Alternatives, classified under the respective railway facilities, are shown in Appendix 6.4-1. (This is the same as Table 3-1-1 of the "Selection of Optimum Alternative of Master Plan at 2010 for Hanoi – Ho Chi Minh Railway" submitted to and approved by the Government of Viet Nam in October, 1994).

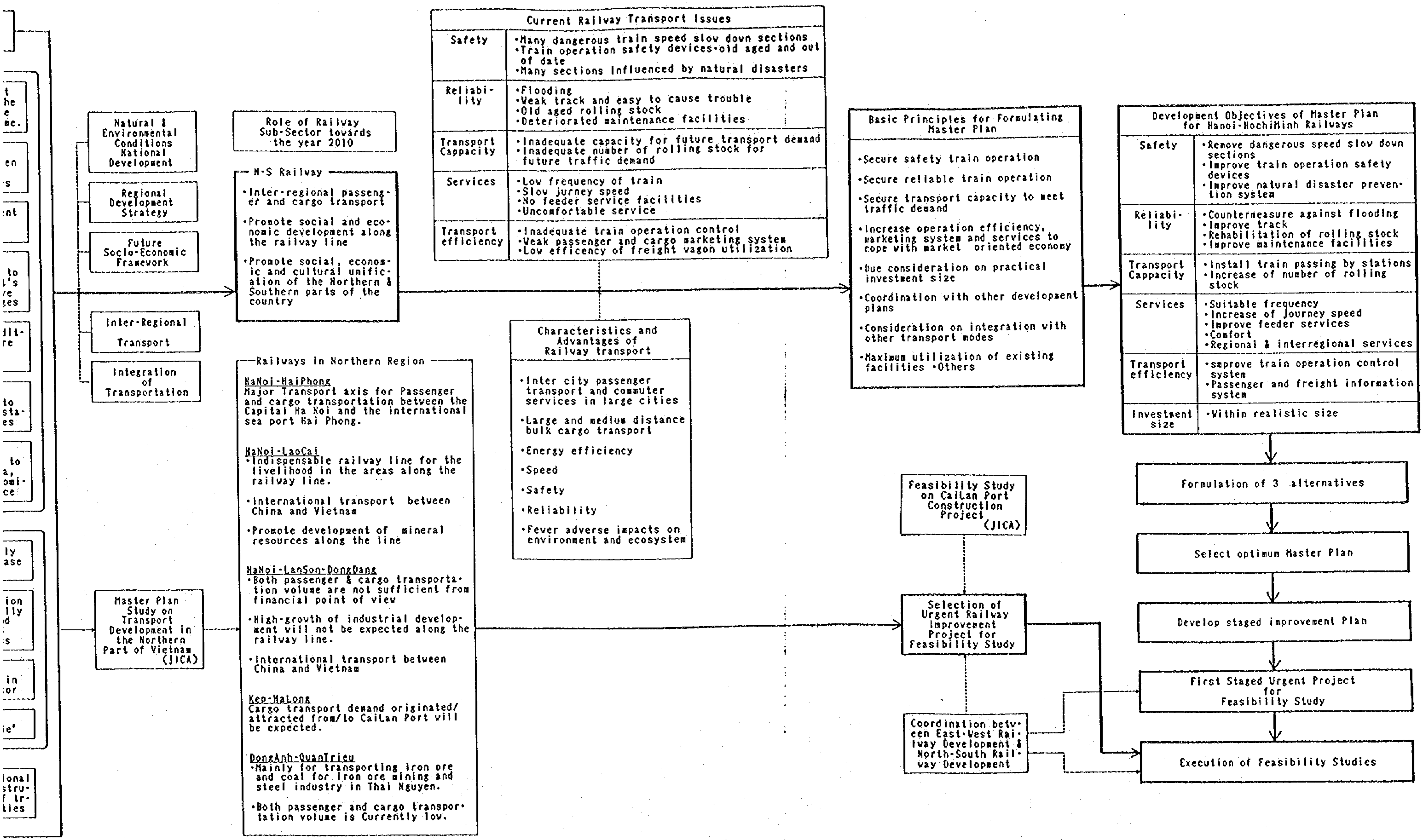
(4) Investment Size of Each Alternative

The investment size of each alternative is given in Table 6.4-2, Fig. 6.4-1 and Appendix 6.4-2.

Fig. 6-1 Approach for Formulating Master Plan for Rehabilitation and Improvement of Hanoi-Ho Chi Minh Railways



1. Approach for Formulating Master Plan for Rehabilitation and Improvement of Hanoi-Ho Chi Minh Railways



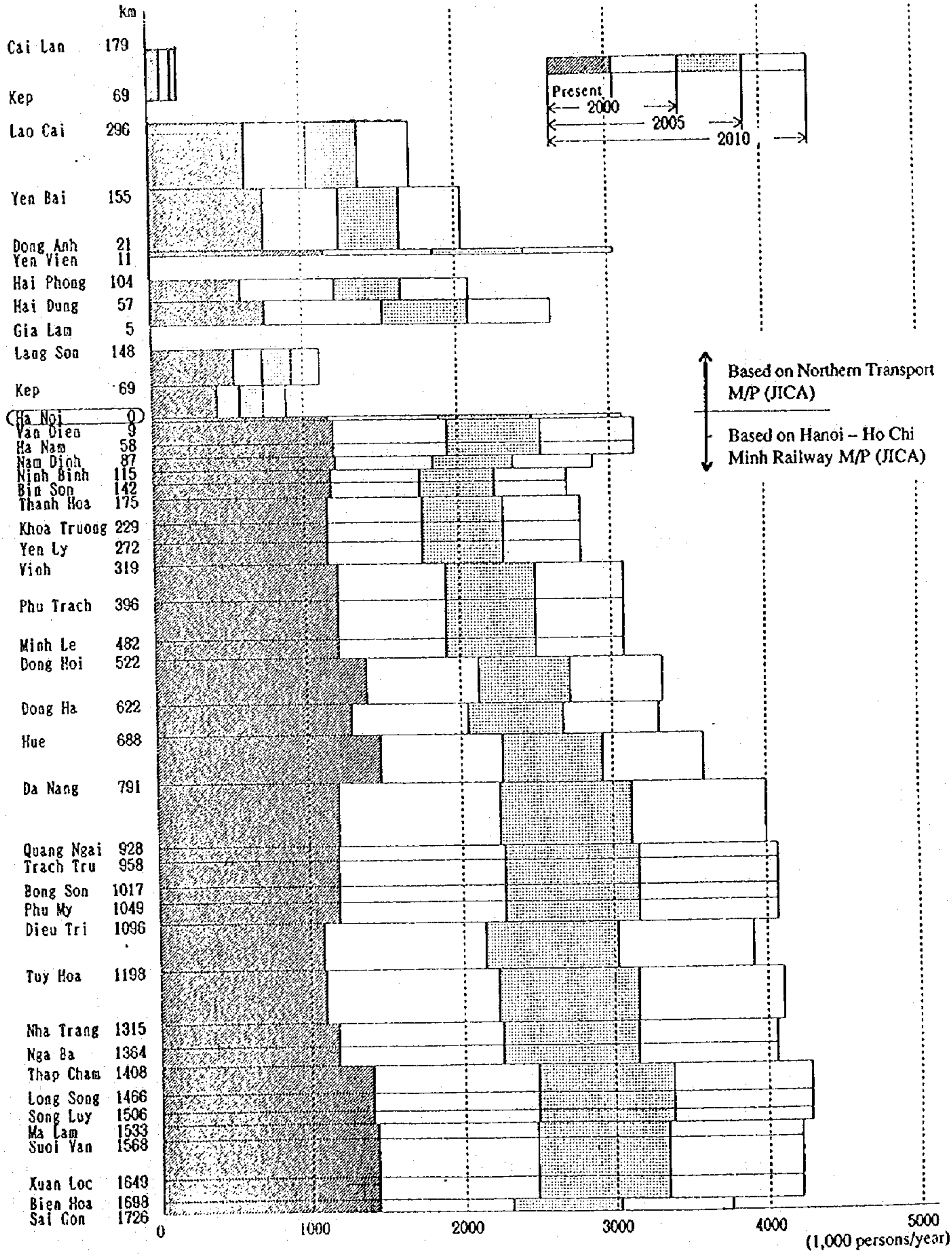


Fig. 6.1-1 Sectional Passenger Transportation Volume of Major Railway Lines in Vietnam

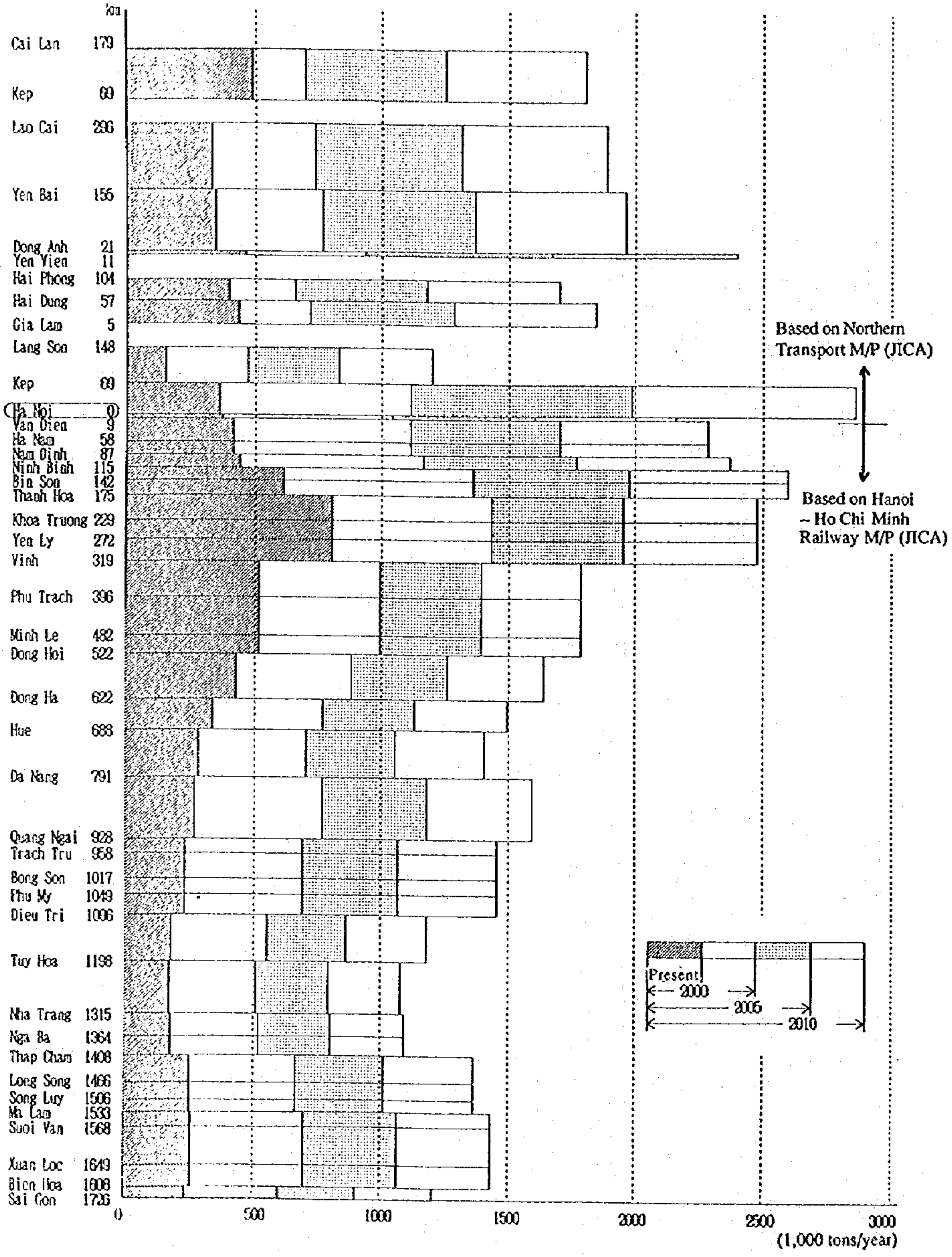


Fig. 6.1-2 Sectional Freight Transportation Volume for Major Railway Lines in Vietnam

Table 6.4-1 Outline of Master Plan Alternatives

Subject	Envisaged Measures	Alternative I	Alternative II	Alternative III
Improved Safety	Elimination of Dangerous Sections	Trains are currently forced to go at a slow speed at aged or deteriorated bridges and tunnels, etc. All these dangerous slow speed sections will be eliminated to ensure operational safety.	Those aged or deteriorated bridges and tunnels, etc. where the maximum speed is set at less than 40km/hr will be improved.	In addition to those bridge sections referred to in Alternative II, all other dangerous slow speed sections where high speed operation is feasible will be improved except for some 20 sections. Slow speed tunnel sections will be eliminated
	Improved Disaster-Prevention Features	Slope protection works and/or drainage works will be introduced at major slopes and track bed which are considered disaster-prone. Together with facilities to protect the track from falling rocks, falling rock warning devices will be installed to stop trains in order to prevent major disasters.	Same as Alternative I except that the number of places for slope protection and drainage works is roughly halved as only those posing a serious threat will be dealt with.	Same as Alternative I
	Track Reinforcement	Worn or deteriorated turnouts due to aging and light rails will be replaced.	Same as Alternative I	Same as Alternative I
	Introduction of Colour-Light Signals	At present, most signals are semaphore signals using kerosine, etc. and are difficult to confirm at night or during bad weather. All signals at all stations will be changed to electric colour-light signals.	Same as Alternative I	Same as Alternative I
	Upgrading to Relay Interlocking System	At present, the points and signals on the station premises are interlocked by the Class 2 mechanical interlocking system. This will be upgraded to either the Class 1 or Class 2 relay interlocking system to eradicate human error to improve the safety of train operation.	Same as Alternative I but only three major stations will be equipped with the Class 1 relay interlocking system.	Same as Alternative II
	Installation of ATS System	In view of the single track operation, the ATS system will be installed at all stations to prevent such serious accidents as train collisions.	Same as Alternative I	Same as Alternative I
	Installation of Warning System at Level Crossings	A train approach warning system will be installed at major level crossing to prevent collisions between trains and cars.	Only major level crossings in urban areas, etc. will be equipped with the new system.	Same as Alternative II
Improved Reliability	Flood Prevention	New track will be constructed at those major sections which are frequently rendered impassable for a long time due to flooding in the rainy season to improve the transportation reliability.	Same as Alternative I	Same as Alternative I
	Track Reinforcement	Improved RC sleepers will be used with a ballast thickness of 250mm. High speed turnouts will be used for 110km/hr sections while improved and ordinary turnouts will be used for 80km/hr sections and upto 70km/hr sections respectively.	The existing concrete block sleepers will not be replaced. A ballast thickness of 200-250mm will only be adopted for 80km/hr sections. Ordinary turnouts for use upto 70km/hr will be used.	Same as Alternative I except that a ballast thickness of 200-250mm will only be adopted for 80-110km/hr sections.
	Improved Track Maintenance	In order to maintain appropriate track conditions for reliable transportation, a high speed track inspection car and miscellaneous track inspection and maintenance tools and equipment, including a multiple tie tamper, will be introduced.	Same as Alternative I	Same as Alternative I
	Rehabilitation of Rolling Stock	The rehabilitation of deteriorated rolling stock due to ageing will be conducted to ensure reliable train operation and new rolling stock will be procured to provide a faster service.	Same as Alternative I except that no new high speed rolling stock will be procured and that the existing rolling stock will be rehabilitated.	Same as Alternative I except that the volume of new rolling stock to provide a faster service will be smaller than Alternative I and that the existing rolling stock will be rehabilitated.
	Improved Inspection Facilities at Workshop, etc.	The deteriorated or outdated rolling stock inspection facilities will be improved or replaced by new facilities.	Same as Alternative I except that washing facilities for high speed new rolling stock will not be introduced due to the absence of such rolling stock.	Same as Alternative I

Subject	Envisaged Measures	Alternative I	Alternative II	Alternative III
Expansion of Trans-portation Capacity	New interchange stations and Expansion of Yard Facilities	New interchange stations will be constructed at sections of insufficient track capacity due to the long distance between stations and/or bad alignment (4 sections). Following the strengthening of the medium and long-distance through freight service, new storage track will be introduced at key freight stations. It must be noted that Alternative I will generate the highest transportation demand as its service level is the highest among the three alternatives.	Same as Alternative I except that only one interchnage station will be constructed. It must be noted that Alternative II will generate the least transportation demand as its service level is the lowest among the three alternatives.	Same as Alternative I except that only two interchange stations will be constructed. It must be noted that Alternative III will generate a medium level transportation demand as its service level is halfway between that of Alternative I and that of Alternative II.
	Increased Rolling Stock	New high speed trains will be procured to meet the increased transportation demand.	Instead of introducing new high speed trains, the new rolling stock will be the same models as the existing rolling stock.	The volume of new high speed trains to be procured will be smaller than that of Alternative I in response to the smaller transportation demand planned.
Improved Service Level	Station Square Improvement	The existing station squares do not take such feeder services as buses, taxis and motorcycles, etc. into consideration. The station squares of major stations will be improved to ensure a smooth inter-modal traffic flow and environmental improvements will also be conducted.	Same as Alternative I	Same as Alternative I
	Use of Long Welded Rails and Speeding-Up	The number of rail joints will be reduced through the use of long welded rails to reduce noise and vibration in view of improved comfort and maintenance. Long welded rails will be used at those sections where the radius curve is more than 600m.	Same as Alternative I except that long welded rails will be used for 80km/hr sections only.	Same as Alternative I except that long welded rails will be used for 80-110km/hr sections only.
	High Speed Trains for Speeding-Up and Improved Comfort	New high speed trains (Vmax = 110km/hr) will be introduced to serve as limited express trains and inter-regional express trains for a faster service and improved comfort.	No new high speed trains will be procured. The train speed will be increased through improving of the existing rolling stock and track. The existing rolling stock will be rehabilitated to provide improved comfort on limited express trains and inter-regional express trains.	New high speed trains (Vmax = 110km/hr) will be introduced to serve as limited express trains for a faster service and improved comfort. The comfort level of inter-regional express trains will be improved through the rehabilitation of the existing rolling stock.
Improved Transport Efficiency	Improvement of Train Operation Control, Passenger Information and Freight Information Systems	The aged communication network will be renovated to strengthen the train operation control and disaster control functions. A passenger information system will be introduced for reservation control and better passenger services. The introduction of a freight information system will improve the marketing control, transportation efficiency of freight cars and services for consignors.	Same as Alternative I except that the capacity of the underground cable and fibre optics cable will be reduced and that a telephone switchboard will only be installed at key stations.	Same as Alternative II
Travelling Time (Hanoi – Ho Chi Minh City)		The travelling time between Hanoi and Ho Chi Minh City will be 24 hours (journey speed: 72km/h) for a limited express passenger train and 40 hours for a through freight train. Due to the commitment to a practical investment size, the technological level of Alternative I is not necessarily on a par with the meter gauge technology of advanced countries. Nevertheless, from the viewpoint of a practical investment size in Vietnam, Alternative I proposes the highest improvement level for the Hanoi – Ho Chi Minh Railway in the year 2010 among the three alternatives.	The travelling time between Hanoi and Ho Chi Minh City will be 30 hours (journey speed : 58km/h) for a limited express passenger train and 43 hours for a through freight train. Alternative II proposes the minimum improvements necessary for the Hanoi – Ho Chi Minh Railway.	The travelling time between Hanoi and Ho Chi Minh City will be 25 hours (journey speed: 69km/h) for a limited express passenger train and 41 hours for a through freight train. Alternative III proposes intermediate improvement prospects between Alternative I and Alternative II.

Table 6.4-2 Investment Size of Master Plan Alternatives

(Unit: million US$)

	Measure	Description		Alternative I		Alternative II		Alternative III	
				Quantity	Cost	Quantity	Cost	Quantity	Cost
Improved Safety	Elimination of Dangerous Sections	Those bridges and tunnels posing a high risk for train operation under normal circumstances due to ageing and war damage, etc. will be improved.	Bridges	627 sites	430.4	436 sites	306.8	554 sites	374.0
			Tunnels	27 sites	55.4	27 sites	50.3	27 sites	55.4
	Improved Disaster Prevention Features	- Slope protection works will be constructed at sections vulnerable to collapse due to torrential rain.	Slope Protection	165 km	34.7	83 km	20.5	165 km	34.7
		- Drainage channels will be constructed at places vulnerable to roadbed collapse due to poor drainage.	Drainage	136 km	9.0	66 km	4.4	136 km	9.0
		- Protective facilities vis-a-vis falling rocks will be introduced at vulnerable places and falling rock warning devices will be installed to stop trains to prevent major disasters.	Protective Facilities Vis-a-Vis Falling Rocks	20 km	0.4	20 km	0.4	20 km	0.4
	Track Reinforcement	Worn or deteriorated turnouts due to ageing and light rails will be replaced.	Turnouts Heavier Rails	599 370 km	51.2	599 370 km	51.2	599 370 km	51.2
	Introduction of Colour-Light Signals	At present, most signals are semaphore signals using a kerosine lamp and are difficult to confirm at night or during bad weather. These will be replaced by electric colour-light signals.		143 stations	4.2	143 stations	4.2	143 stations	4.2
	Upgrading to Relay Interlocking System	At present, the interlocking system between the points and signals at the station premises is inadequate. The relay interlocking system will be introduced to prevent accidents caused by mishandling.	Class 1 Relay	10 stations	15.2	3 stations	5.7	3 stations	5.7
			Class 2 Relay	143 stations	20.2	143 stations	20.2	143 stations	20.2
	Installation of ATS System	The ATS system will be installed to prevent such serious accidents as train collisions.		166 stations	12.5	163 stations	12.5	164 stations	12.5
	Installation of Warning System at Level Crossings	A train approach warning system will be installed at those level crossings with heavy traffic to prevent accidents.		200 sites	9.8	57 sites	2.8	57 sites	2.8
	Investment Sub-Total				(643.0)		(479.0)		(570.1)
Improved Reliability	Flood Prevention	New track will be constructed at those sections which are frequently rendered impassable for a long time due to flooding in the rainy season.		3 sections 57 km	59.5	3 sections 57 km	59.5	3 sections 57 km	59.5
	Track Reinforcement	Wooden and steel sleepers etc. will be replaced by improved type concrete block sleepers. The minimum ballast thickness will be increased.			165.5		134.1		165.0
	Improved Track Maintenance	In order to ensure reliable transportation, a high speed track inspection car, multiple tie tampers and other maintenance equipment will be introduced.	High Speed Track Inspection Car Multiple Tie Tampers	1 cars 6 cars	21.3	1 cars 6 cars	21.3	1 cars 6 cars	21.3
	Rehabilitation of Rolling Stock	The deteriorated rolling stock due to ageing will be rehabilitated.		80 cars	65.2	287 cars	96.2	269 cars	93.6

	Measure	Description		Alternative I		Alternative II		Alternative III	
				Quantity	Cost	Quantity	Cost	Quantity	Cost
Improved Reliability	Improved Inspection Facilities at Workshops, etc.	The inspection facilities at workshops, etc. will be improved or replaced by new facilities. Environmental improvements will be made in regard to waste water treatment and others.			65.0		53.0		65.0
	Investment Sub-Total				(376.6)		(364.1)		(404.4)
Expansion of Trans-port-ation Capacity	New interchange stations and Expansion of Yard Facilities	New interchange stations will be constructed at those sections of insufficient track capacity due to the long distance between stations and/or bad alignment. Following the strengthening of the medium and long-distance through freight service, new storage track will be introduced at key freight stations.	Interchange Stations	4 stations	19.7	1 stations	17.6	2 stations	18.3
	Increased Rolling Stock	New rolling stock will be procured to meet the increased transportation demand.	D18Es, D12Es	72		72		69	
			PCs	0		185		50	
			FCs	4,800	233.4	3,800	262.1	4,200	228.6
	Investment Sub-Total				(253.1)		(279.7)		(246.9)
Improved Service Level	Station Square Improvement	The existing station squares do not take such feeder services as buses and taxis, etc. into consideration. The stations squares will be improved to ensure a smooth inter-modal traffic flow and environmental improvements will also be made.		6 stations	11.0	6 stations	11.0	6 stations	11.0
	Use of Long welded Rails	The number of rail joints will be reduced to reduce noise and vibration in view of improved comfort, maintenance and service speed.		1,200 km	37.6	200 km	6.0	1,100 km	34.7
	Introduction of High Speed Trains	New high speed trains will be introduced for improved train speed and passenger comfort.		40 trains	200.0	0 trains	0	13 trains	65.0
	Investment Sub-Total				(248.6)		(17.0)		(110.7)
Improved Transport Efficiency	Improvement of Train Operation Control, Passenger Information and Freight Information Systems	The aged communication network will be renovated to strengthen the train operation control and disaster control functions. A passenger information system will be introduced for reservation control and better passenger services. The introduction of a freight information system will improve the marketing control, transportation efficiency of freight cars and services for consignors.			109.2		87.2		87.2
	Investment Sub-Total				(109.2)		(87.2)		(87.2)
Investment Total				1,630.5		1,227.0		1,419.3	
Travelling Time (Hanoi – Ho Chi Minh City)		Limited Express Passenger Train		24 hours		30 hours		25 hours	
		Through Freight Train		40 hours		43 hours		41 hours	

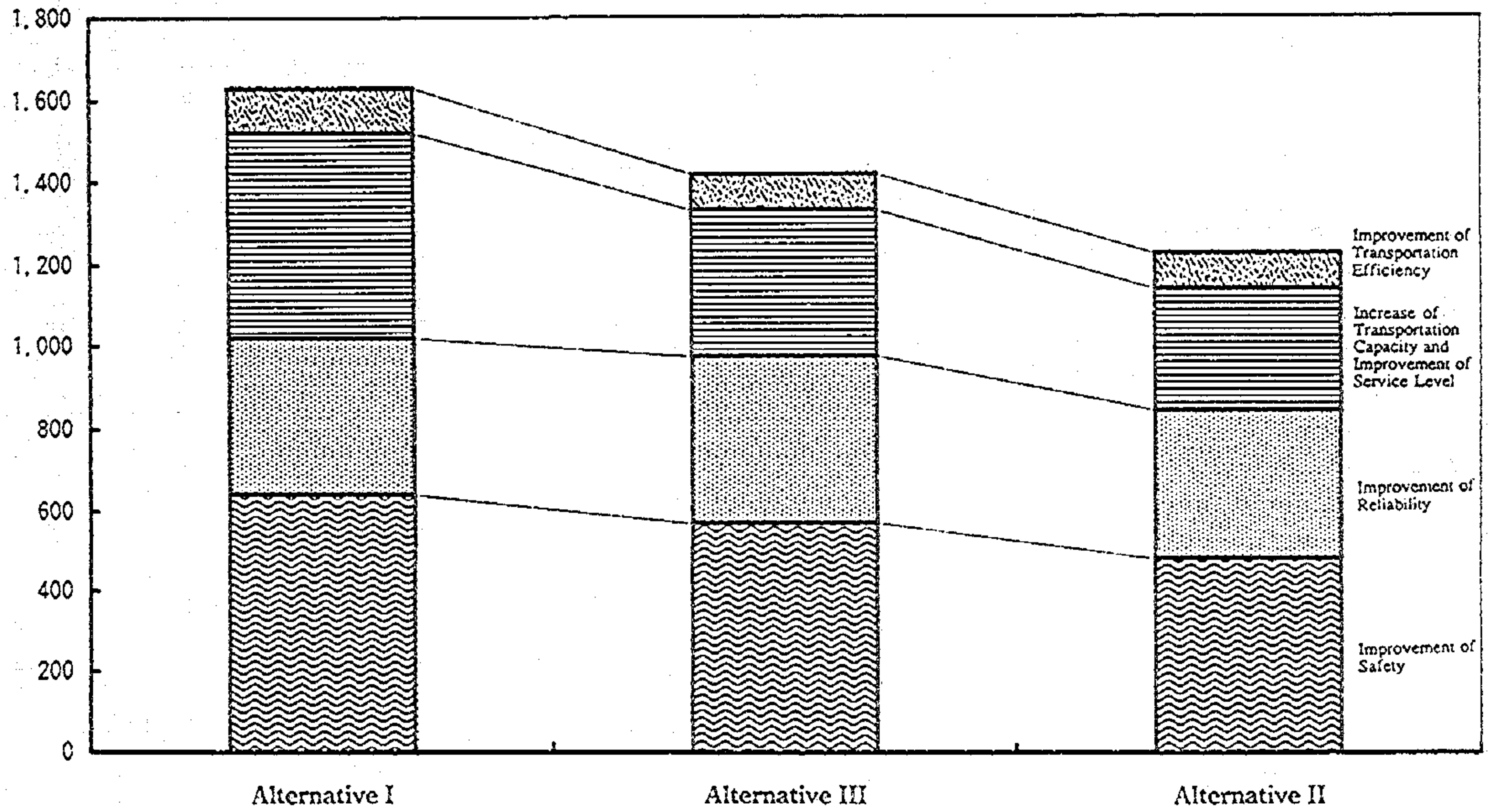


Fig. 6.4-1 Comparison of Investment Amount of Each Alternative of Master Plan for Hanoi – Ho Chi Minh Railway

6.4.2 Transport Modeling and Demand Forecast

This section sets forth the objectives and methodologies embodied in development and application of transport modeling procedure.

Demand forecast of railway (and any others) can be conducted with pre-requisite conditions that are crystal clear role of the railway and an objective of railway rehabilitation and improvement. Thus this quantitative forecast is dependent of the vision of railway's role and service levels.

(1) Objectives

The formulation of the Hanoi - Ho Chi Minh Railway Master Plan is guided by the socio-economic framework discussed in chapter 3, and some urgent tasks to be overcome described in chapter 5 and the strategic issues in the railway sector presented in the previous section. A transport model is, in turn, required to estimate levels of demand likely to be catalyzed by such the socio-economic framework, and to evaluate consequent impacts upon transport infrastructure.

The main objectives of demand forecast here is to estimate traffic volume on the railway between Hanoi and Ho Chi Minh City through application of a transport model and to investigate the variation of levels of demand due to the three Master Plan alternatives presented in the previous section.

(2) Planning Horizon

The transport analysis is consistent with the approach of the overall study, that is,

- Year 1994 is termed the "base year" against which changes in future transport activity are measured.

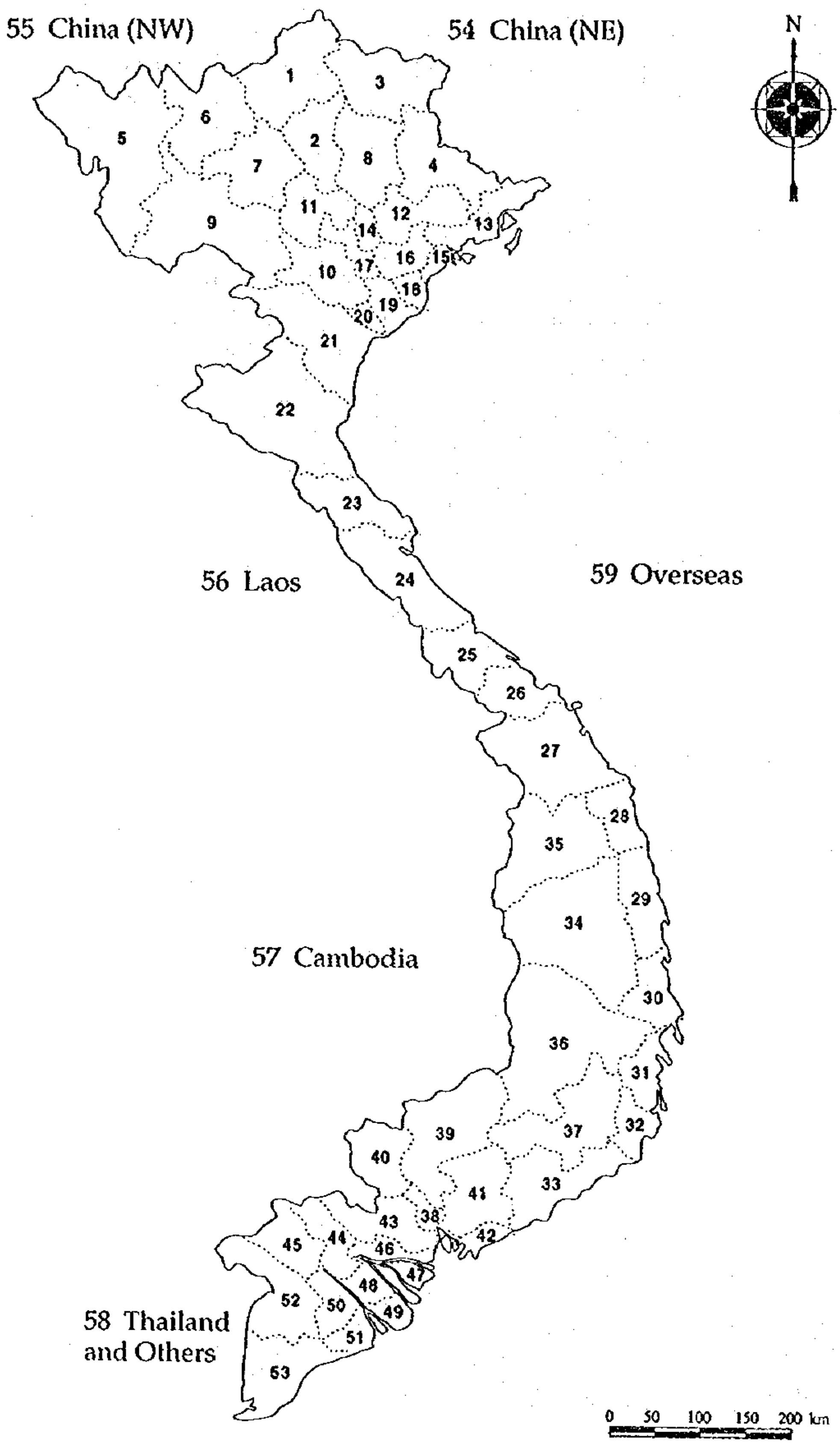
- Year 2000 is adopted as the near-term horizon until which priority projects are designated,

- Year 2010, which serves as the long-term horizon for which demand potential is estimated.

It should, however, be noted that the designation of an ultimate year represents a somewhat artificial, if necessary, future-year linkage. It is, from a transport perspective, more correct to state that future-year demand projections reflect the achievement of a stated socio-economic condition, which may or may not occur precisely in the postulated year.

(3) Zone System

The 53 provinces, whose transport activities can be described in socio-economic and demographic terms, are designated as comprising the study area's whole zone structure (Figure 6.4-2). Additional six external zones represent transport activity between 53 Vietnamese provinces and outside of Vietnam. Thus, the study area includes a total of 59 zones. However, external traffic flow to and from outside of Vietnam is not explicitly treated when we focus on the traffic demand between Hanoi and Ho Chi Minh because it consists of mostly domestic traffic demands.



Region / Province

TOTAL

I Northern Mountain

1 Ha Giang
2 Tuyen Quang
3 Cao Bang
4 Lang Son
5 Lai Chau
6 Lao Cai
7 Yen Bai
8 Bac Thai
9 Son La
10 Hoa Binh
11 Vinh Phu
12 Ha Bac
13 Quang Ninh

II Red River Delta

14 Ha Noi
15 Hai Phong
16 Hai Hung
17 Ha Tay
18 Thai Binh
19 Nam Ha
20 Ninh Binh

III North Coastal

21 Thanh Hoa
22 Nghe An
23 Ha Tinh
24 Quang Binh
25 Quang Tri
26 Thua Thien-Hue

IV South Coastal

27 Quang Nam-Da Nang
28 Quang Ngai
29 Binh Dinh
30 Phu Yen
31 Khanh Hoa
32 Ninh Thuan
33 Binh Thuan

V Western Highlands

34 Gia Lai
35 Kon Tum
36 Dac Lac
37 Lam Dong

VI Eastern Nam Bo

38 T.P Ho Chi Minh
39 Song Be
40 Tay Ninh
41 Dong Nai
42 Ba Ria-Vung Tau

VII Mekong River Delta

43 Long An
44 Dong Thap
45 An Giang
46 Tien Giang
47 Ben Tre
48 Vinh Long
49 Tra Vinh
50 Can Tho
51 Soc Trang
52 Kien Giang
53 Minh Hai

The Feasibility Study on the Rehabilitation and Improvement of the Railways in Viet Nam	Figure 6.4-2 Zone System

(4) Methodology Overview

As it is likely that any trend based-transport demand model can not reflect a drastic structural change in Vietnam, it is a key task to build a transport model which can trace the present travel pattern in the most fitted manner, and can be compatible with structural changes in the future. In this context, trip generation/attraction models as function of socioeconomic data, trip distribution models in the form of gravity and a diversion curve model for railway transport mode were developed.

Traffic demand forecasting process in the study can be summarized as consisting of the three essential steps below.

1) Demand model calibration:

The NSTR 1991 trip matrices and The JICA 1993 trip matrices were calibrated to 1994 conditions. Assuming that zonal demand is correlated with socio-economic data, regression based-trip generation and attraction models were developed as function of socio-economic indicators.

2) Transport demand projections:

The framework of national and regional socio-economic conditions are utilized as "inputs" for the traffic demand models. Key aspect of this process is that estimated future traffic demands are regarded as consequence of achievement of future national and regional settings. The estimated future traffic demand is distributed through the trip distribution model. The railway traffic demands between zones are calculated via diversion curve models.

3) Trip assignments:

Trip demand is loaded onto the base year and future year networks, thus providing the basis for evaluation of the base year railway system and designation of the master Plan railway system.

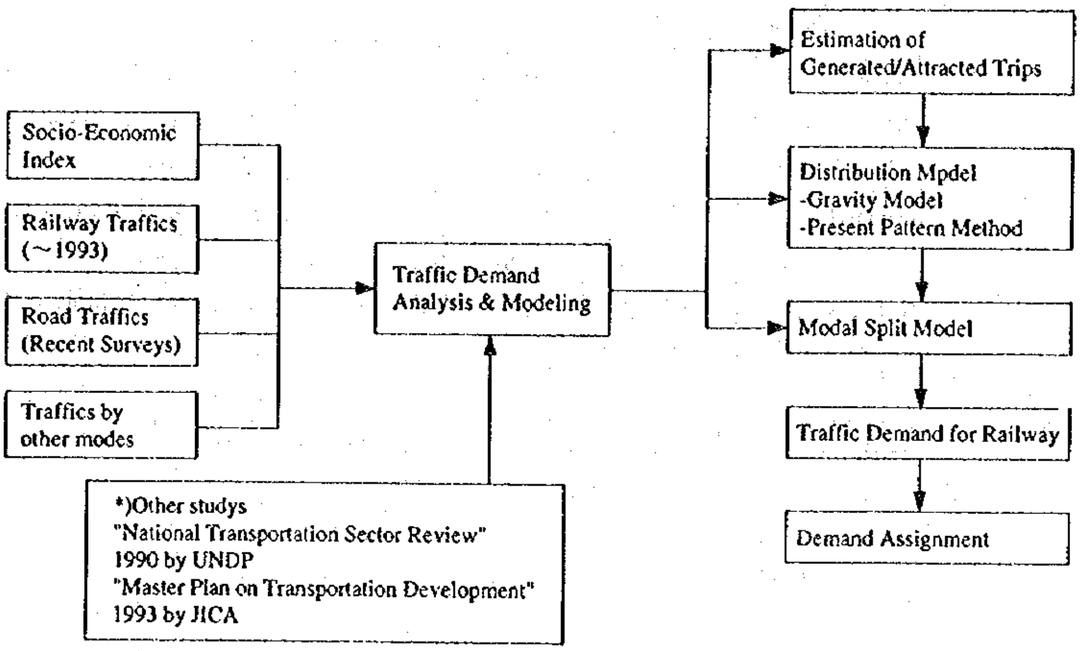


Figure 6.4-3 Flow of Traffic Demand Forecast

(5) The Base Year Trip Matrix Calibration

The two trip matrices, those are the NSTR 1991 trip matrices and the JICA 1993 trip matrices, were used as the base trip matrices for developing the 1994 base year trip matrix. The 1994 base year matrix consists with road and railway transport modes, while sea and air transport modes are excluded due to the following reasons.

This study limits its analytical scope to the land transport; road and railway, and excludes sea and air transport modes. Estimation of modal shares among road, railway, sea and aviation proves that the sea transport and aviation have negligibly small shares and justifies that the demand forecast of railway can be carried out in a manner independent from traffic demand of sea and aviation

Reasons why demand forecast of railway limits its scope to road and railway transports are briefly explained below. Detail explanation will be provided below.

1) Air Transport

Volume of air cargo account for very small portion of all since that in 1993 is 1,400 ton at Hanoi (loaded), and 2,000 ton at Ho Chi Minh City (loaded).

It is judged that increase of air cargo is not so large. This is (1) because infrastructure development such as information system and physical distribution service networks (by trucks) have not yet well developed, and (2) because production of high value added commodities is not well developed enough to afford high transportation charge of air service. Authorized government's forecast indicates that cargo by air in 2010 is 3,000 ton at Hanoi (loaded), and 7,600 ton at Ho Chi Minh City (loaded). Therefore it is judged that air transport has no impact in estimating traffic volume of other transport modes.

At present, an air transport accounts for less than 0.2% of the land transport trips. Air carries 0.25 million person trips in 1993 according to the government statistics, while total number of land transport trips is estimated 87 million person trips in 1994 (the Team's estimation).

However, as for the long distance trips between Hanoi and Ho Chi Minh, aviation service accounts for about 30% of total. Major reason is partly because total size of the long distance trips is very limited, and (2) partly because influential area of aviation service is far wider than that of railway service.

Present high share of aviation in the long distance trips does not prove the competitive power of the aviation against the land transport. Because passengers are limited to the high income class and businessmen who can afford the aviation charge. Now aviation service is a mode for the special class.

As for the air charge (100-150 US$) is very expensive compared with average income per month (30-50 US$). This suggests that the air service is not a one of the alternative for the ordinal people, and is a mode for high income class only. This situation would be kept unchanged even thought GDP per capita in 2010 increased three times as high as the present level.

In addition, since there is a wide difference in travel time between air and other transport modes, mode selection is not so flexible. This suggests that there is no competition between air and other modes. All of these prove rationale that the demand of air should be determined independently from other modes.

(2) Coastal and River Transport

There is no service of passenger service by this mode of transport.

Cargo handling volume by coastal and river transports have been declining. Future prosperity of shipping service is dependent of transportation charge, convenience, punctuality of delivery and other factors.

At present, any shipping service company make its future policy open, struggling to catch up the drastic change in market. Even the master plan of shipping service has not yet been formulated in Vietnam. In this situation, there is no foundation to forecast the future system of coastal and river transport network, charge policy, necessary service time etc. Future prosperity is in vague.

Major items of commodities transported by coastal and river transport mode are coal, cement and rice. Coal and cement are transported form the North to the South, while rice from the south to north. As for these commodities, there is no competition in selecting the transport mode since all modes play roles of connecting transport modes and never induce a diversion from one to other. It is judged that it is more appropriate not to estimate modal split curve between land transport modes and this coastal and river transport mode.

There is some possibility that transport mode of some commodities might be replaced with other mode. Volume transported by coastal and river transport mode in 2000 is estimated 1,269 million ton-km by UNDP, and 1,434 million ton-km by the JICA Study Team. These figure is one tenth of that by land transport. Therefore, diversion between coastal transport and railway would have a very limited impact on the modal split of railway, which is estimated less than 5% of total cargo.

For all these reasons, we concluded that it is more appropriate to estimate the demand of coastal and river transport independently from other modes.

Table 6.4-3 Estimation of Inter-Province Trips in Vietnam; 1994 and 2010

		1994				2010			
		Passenger (unit; 000/year)	(%)	Cargo (unit; 000/year)	(%)	Passenger (unit; 000/year)	(%)	Cargo (unit; 000/year)	(%)
Land	Sub-Total	187,354	99.9	40,577	77.0	831,892	99.1	174,926	90.5
	Road	181,114	96.5	38,210	72.5	818,808	97.6	166,592	86.2
	Railway	6,240	3.3	2,367	4.5	13,084	1.5	8,334	4.3
Aviation (*)		254	0.1	4	0.0	7,418	0.9	6	0.0
Inland water-way (**)	Sub-Total			11,626	22.1			17,206	8.9
	Red River Delta			5,936	11.3			8,785	4.5
	Mekong Delta			5,690	10.8			8,421	4.4
Coastal Shipping (***)				471	0.9			1,119	0.6
Grand Total		187,608	100	52,678	100	839,310	100	193,257	100

Note;(*) Source: Aviation Department and Transportation Department of State Planning Committee, 1993 and Target

(**) 1993; Results of UNDP Study. 4% growth assumed.

(***) 8% growth up to 2000 and 5% thereafter assumed.

Trip length of 1,700km assumed.

Review of Proposed Service Level (= Demand Expansion Measures)

Various projects are proposed in this study in order to achieve the targeted service levels and also to make the railway play its roles in a country-wide transport network. Concrete and practical targets are required to design the demand forecast even though railway has rather small share among all transport modes. In this section, those are reviewed for reference.

In any railway projects, at least five (5) aspects are covered in its master plan study when railway's role and target of service levels are set. These five aspects provide a framework in forming all the rehabilitation projects with a comprehensive recognition of the status quo. Those are clarified in this following space.

- Safety ; It is assumed that safety operation at design speed is guaranteed by rehabilitating (1) the bridges with insufficient load bearing capacity, (2) tracks with insufficient cant and curve radius and (3) slopes.

  Natural disaster prevention measures are planned for some sections. As for the train accidents, a cause-and-effect analysis of the actual accident and a proposal of countermeasures will be conducted at the next study stage in depth.

- Operation Assurance ; Two factors are subjects: falling rocks and flood. The former is removed by rock fall prevention measures.

  Submergence of the track will be prevented from in the section of 50km out of about 180km in total, which includes a tunnel. Duration of service disruption is not clearly envisaged at this stage.

- Speed ; We assume that shorter travel time attracts much passengers and cargo.

  Speed restriction will be removed by rehabilitation or new construction of bridges, tunnels, track, and improvement of curves.

  Three alternatives set three kinds of travel time of a limited express train; 24, 25, and 30 hours between Hanoi - Ho Chi Minh city and corresponding train speeds are set.

- Convenience ; This relates with feeder service, frequency of train operation, treatment of local passengers, and ticketing system.

  Good feeder service can attract travelers inhabiting far from the railway stations to the railway service. Station squares (plazas) are planned at the major six (6) stations. Connecting transport services such as bus are not envisaged.

  Frequency of train service is set according to the volume of demand, a capacity and a fixed load ratio of train. The higher a frequency of train operation is, the more it is convenient to passengers.

  As for the local passengers coach, (1) high speed trains are introduced, and (2)existing coaches for local train are maintained.

  Ticketing system improve its service by introducing a new system of advance ticket booking and sales.

- Comfortability ; New coaches are introduced for the limited express. No improvement of existing coaches are planned.

Those are the pre-conditions of the demand forecast. Results are thus totally dependent of the saving of travel time.

Railway OD Matrices Calibration

First, 1994 inter-provincial railway passenger and commodity trip generation and attraction models are estimated, while intra-trips are excluded because of the above presented reason. Correlation coefficients between the base year generated/attracted trips and the socio-economic parameters are as follows.

Table 6.4-4 Correlation Coefficients

Correlation		Population		GDP	
		Urban	Rural	Urban	Rural
Passengers	Generated	0.565	0.319	0.498	0.313
	Attracted	0.574	0.333	0.523	0.326
Cargo	Generated	-0.003	0.588	0.025	0.572
	Attracted	0.267	0.499	0.197	0.488

Referring the above coefficients, regression based trip generation and attraction models were derived as follows.

Railway passenger trip generation and attraction model:

$G_{pt} = 239.9 \times Pop_{urban} + 30.4 \times Pop_{rural} + 68{,}422$ (R=0.580)

$A_{pt} = 238.3 \times Pop_{urban} + 32.5 \times Pop_{rural} + 66{,}484$ (R=0.592)

where,
Pop_{urban}: Population in urban area
Pop_{rural}: Population in rural area

Railway cargo trip generation and attraction model

$G_{cargo} = 715.3 \times GDP_{rural}$ (R=0.559)

$A_{cargo} = 7.528 \times GDP_{urban} + 662.5 \times GDP_{rural}$ (R=0.489)

where,
GDP_{urban}: Regional gross domestic product in urban area
GDP_{rural}: Regional gross domestic product in rural area

Next, trip distribution models for the base year were estimated in order to determine the base year trip distribution pattern. Since station-to-station OD matrices are obtained from the VNR statistics, they were consolidated into provincial OD matrices.

The trip distribution models were derived based on the above mentioned station-to-station OD matrices in the form of the gravity model as presented below;

Railway passenger trip distribution model;

$$P\,ij = e^{-12.932927} \times \frac{G^{1.092358406} \times A^{1.105195362}}{D^{0.63993089}} \quad (R=0.899)$$

Railway commodity movement distribution model

$$P\,ij = e^{-0.9301584} \times \frac{G^{0.5927333021} \times A^{0.507155833}}{D^{0.24334314}} \quad (R=0.800)$$

The estimated gravity models provide a likely trip distribution pattern, however in the case that actual traffic data are available, the estimated data were replaced by the actual data. In other words, the models' utilization was limited to the parts which cannot be obtained from the statistics, for example, OD pairs between different railway lines.

Land Transport OD Matrix Calibration

The base year land transport OD matrices (railway plus road) for passenger trips and cargo movements were estimated separately from the above railway OD matrices. Although the basic approach is the same as the procedure applied for the estimation of the railway OD matrices, utilized data for the model calibration are different.

The starting points was set at the NTSR's 1990 land transport OD matrices. Administrative system has been changed since 1990; total number of provinces in 1990, 44, has changed to 53 in 1994. Accordingly the traffic zone system and the zonal parameters are modified by using population and GDP as adjusting factors.

First, trip growth rates by zone were estimated based on zonal population and GDP growth rates, then trip generation and attraction for passenger and commodity were derived. Summing up the trip generation and attraction, trip rate per person and per GDP were checked at the national level.

Second, an initial 1994 land transport OD matrix(road plus railway) was estimated by the present pattern method(Fratar Model). In the estimation process, it was assumed that the inter trips between the northern part and the southern part has not been changed drastically.

Third, an initial 1994 road transport OD matrix was obtained by subtracting the above railway OD matrix from the initial land transport OD matrix. The road transport OD matrix was converted into vehicle trip base matrix and assigned on the road network. Comparing the simulation results with the road side traffic counts, a calibrated road transport OD matrix was obtained.

Forth, the calibrated vehicle OD matrix was checked by comparing it with the vehicle OD matrix established in "Master Plan Study on Transport Development in the Northern Part of Viet Nam" (JICA, 1993). Through this checking process, the calibrated 1994 road transport matrix was modified and fixed.

Finally, the 1994 land transport OD matrices was obtained by merging the railway transport OD matrix and the calibrated road transport OD matrix.

(6) Consolidated Trip Demand Model

Since the 1994 land transport OD matrices were obtained both for cargo and passenger trip as described in the previous section, transportation demand forecast models for land transport were developed by analyzing the present travel demand and socio-economic data.

Regression based consolidated passenger trip generation and attraction models were obtained as follows;

$G\,pt = 7{,}469{,}700 \times W + 4{,}538.8 \times GDP$ (R=0.817)

$A_{pt} = 7,471,101 \times W + 4,521.3 \times GDP$ (R=0.817)

where

W: Population density(thousand persons per square kilometers)
GDP: Regional gross domestic product in million US dollars

The models for cargo trips are as follows;

$G_{rail} = 157,664.7 + 2,381.3 \times GDPurban + 814.1 \times GDPrural$ (R=0.600)
$A_{rail} = 156,519.4 + 2,395.1 \times GDPurban + 796.0 \times GDPrural$ (R=0.817)

where

GDPurban: Regional gross domestic product in urban area in million US dollars
GDPrural: Regional gross domestic product in rural area in million US dollars

The models imply that higher population density and/or higher regional GDP generate more travel demand. The high correlation coefficients indicate that the models describe properly a structure of person travel demand. there exist , however, discrepancy between the observed value and the estimated since each zone has individual characteristics. In the province Quang Nam where Da Nang is located, for instance, the observed value is larger than the estimated value. These discrepancies are utilized as adjustment factors to reflect regional characteristics.

It is likely that as regional economy develops, discrepancy between regions decrease. Thus, it is assumed that the above adjustment factors would be 1.0 after 30 years from the base year.

(7) Trip Distribution Model

The following gravity models were obtained as function of trip generation, trip attraction and time distance.

<u>Passenger trip distribution model</u>

$$P_{ij} = e^{-0.56694} \times \frac{G^{0.571887} \times A^{0.577805}}{D^{1.3908}} \quad (R=0.739)$$

Railway commodity movement distribution model

$$P_{ij} = e^{-5.51972} \times \frac{G^{0.6935} \times A^{0.702867}}{D^{0.87143}} \quad (R=0.709)$$

The derived gravity models show high correlation, however, they do not necessarily give exact present trip distribution. In order to overcome these error, adjustment factors are estimated, then trend of these adjustment factors are utilized for estimating future trip distribution.

Another trip distribution method, that is the present pattern method, is the methodology in which future trip distribution is estimated by iteration based on the present trip distribution pattern. The calibration method is known as the Fratar method, shown in the following;

Present Pattern Method (Fratar Model)

$$T_{ij}^{m} = T_{ij}^{m-1} \times Gf_i \times Af_j \times \frac{(Gl_i + Al_j)}{2}$$

where

$$Gf_i = \frac{Gi}{\sum_{k=1}^{n} T_{ik}^{m-1}}$$

$$Af_j = \frac{Aj}{\sum_{k=1}^{n} T_{kj}^{m-1}}$$

$$Gl_i = \frac{\sum_{k=1}^{n} T_{ik}^{m-1}}{\sum_{k=1}^{n} (T_{ik}^{m-1} \times Af_k)}$$

$$A1_j = \frac{\sum_{k=1}^{n} T_{kj}^{m-1}}{\sum_{k=1}^{n} (T_{jk}^{m-1} \times Gf_k)}$$

The present pattern method is based on the idea that the present travel pattern would remain the same. On the contrary, the gravity model assumes that travel demands depend on impedance(distance) and the magnitude of regional trip generation/attraction. It is known that present pattern method is adequate for short-term forecasting in any region or country. While, it is still disputable which model is adequate for long-term projections.

A enormous amount of infrastructure development is still required in Vietnam where regional economy grows rapidly. This perspective indicates that it is better to employ the present pattern method first, then modified by the gravity model. Besides, analyses and travel demand projections made in the previous studies provide valuable information. In this context, the final trip distribution patterns were established through integrating the results from the gravity model and Fratar Model with a special attention to the previous studies.

(8) Diversion Curve Model

In general, several methods have been proposed and applied for estimating a railway share. Those are;

1) All or nothing method based on the impedance including travel cost,

2) Capacity constraint method

3) Diversion curve method

The first method was not adopted in this study, since the railway share would be estimated either 0 % or 100 %. The second method is widely utilized for traffic simulation on road network but this method is not appropriate for estimating modal share between road and railway. Consequently railway share was estimated by the third method, diversion curve method.

Person Trip Diversion Curve Model

After testing several combination of variables such as travel time difference, travel time ratio, combination of time difference and time ratio, the following formulation was found best in terms of fitness.

$$P_{rail} = \frac{1}{1 + 328.4143\,(T_{road} - T_{rail})^{-0.82346} \times e^{-0.0081 \times T_{road}}} \times S$$

(Multiple regression coefficients R= 0.533)

where

P_{rail}:	Railway share
T_{rail}:	Travel time by railway (1/10 hours)
T_{road}:	Travel time by roadway (1/10 hours)

$$s = 1 + 3.70366 \times \frac{(T_{road} - T_{rail})}{1000}$$

Cargo Trip Diversion Curve Model

As cargo trip distribution indicates that there is little correlation with time distance, railway share of cargo trips shows little correlation with travel time difference or travel time ratio as well. This implies that cargo distribution routes are fixed by commodity type and the market principle does not work.

However, it is expected that transport mode will be selected according to the market principle in the long term perspective. The railway share model for cargo trip was formulated in the same formula as those for person trips;

$$C_{rail} = \frac{1}{1 + 12.85718\,(T_{road} - T_{rail})^{-0.36132} \times e^{0.002213 \times T_{rail}}}$$

(R= 0.255)

where

P_{rail}:	Railway share
T_{rail}:	Travel time by railway (1/10 hours)
T_{road}:	Travel time by roadway (1/10 hours)

The above model estimates, however, lower share of railway against longer railway travel time. This is against the common observation on railway transportation in other countries. Therefore, the following model was adapted since this model structure is consistent with past experience in other countries, even though the formula is different from the one for person trips and correlation coefficient is lower than the initially derived.

$$Crail = \frac{1}{1 + 12.56118\,(Troad - Trail)^{-0.16629}} \qquad (R= 0.178)$$

where

Crail: Railway share
Trail: Travel time by railway (1/10 hours)
Troad: Travel time by roadway (1/10 hours)

(9) Result of Travel Forecast

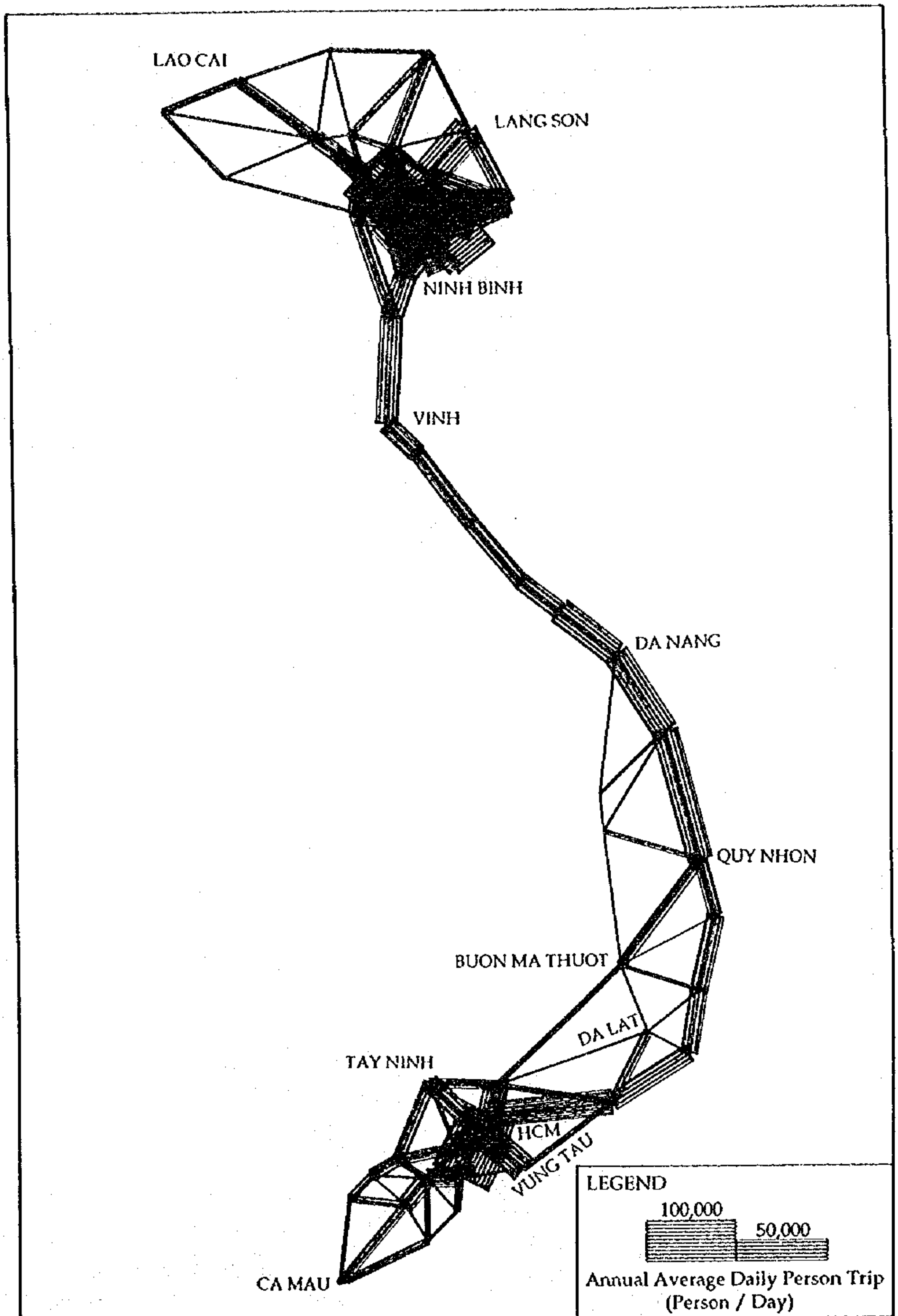
1) Travel Demand

Annual inter zonal traffic demand in 2010 was summarized in Table 6.4-5. Figures 6.4-4 and 6.4-5 illustrate a loaded spider network in 2010 for person trip and cargo trip respectively (refer Figures 4.2-2 and 4.2-3: Loaded spider network in 1994).

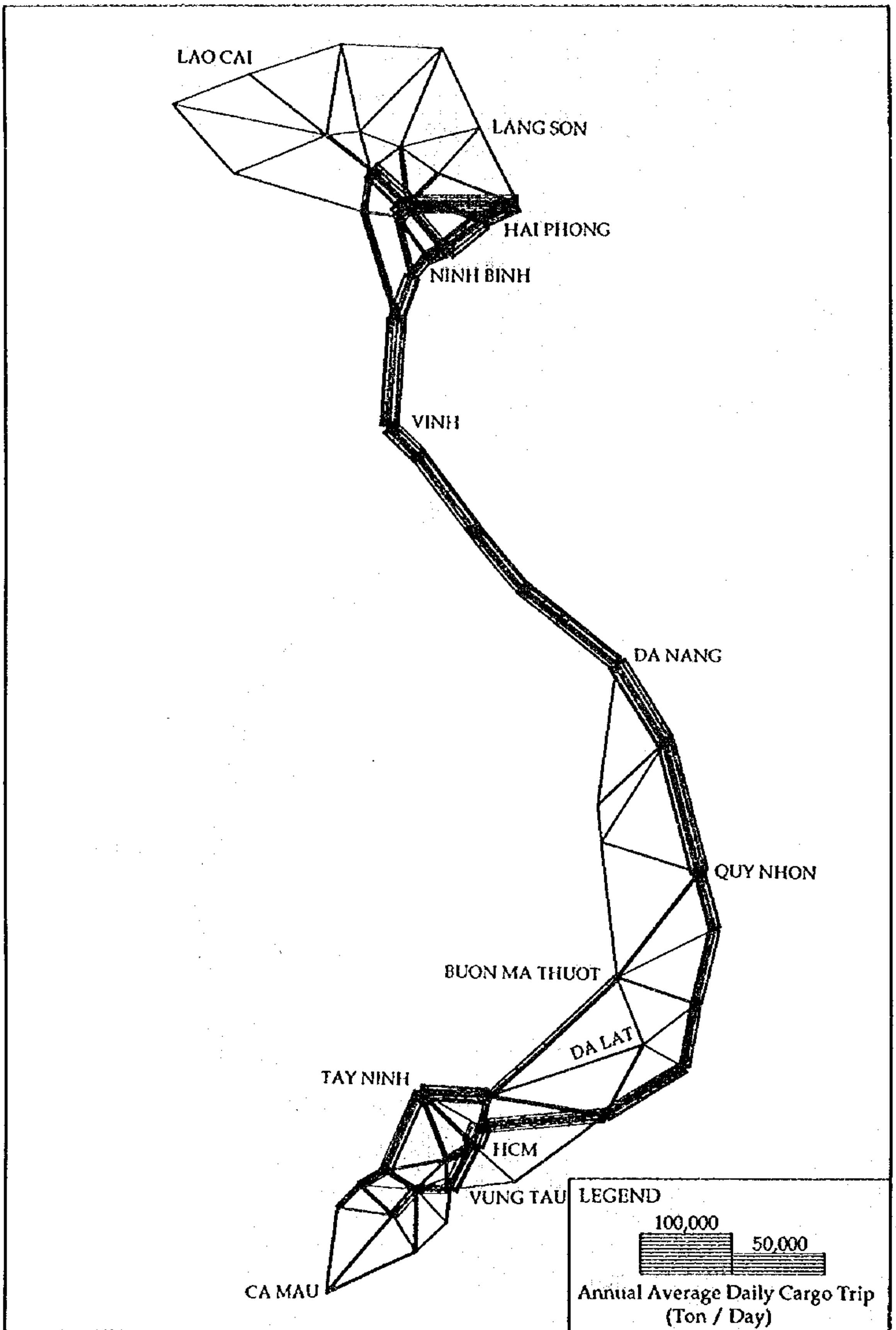
The compressed person trip OD matrix by land transport (road and railway) and the cargo OD matrix are shown in Tables 6.4-6 and 6.4-7.

Table 6.4-6 Passengers by Road and Railway(unit :000 passengers/year)

		1	2	3	4	5	6	7	TOTAL
1	Northern Mountain	98,576	79,239	700	229	131	86	116	179,077
2	Red River Delta	79,703	276,294	8,839	1,606	441	793	295	367,971
3	North Coastal	674	8,874	6,804	6,318	380	845	178	24,071
4	South Coastal	224	1,625	6,315	18,968	9,643	7,104	1,004	44,884
5	Western Highlands	129	430	383	9,653	459	4,592	383	16,028
6	Eastern Nam Bo	83	792	835	7,096	4,587	61,955	44,388	119,736
7	Mekong Delta	114	290	179	1,002	381	44,399	33,759	80,124
	TOTAL	179,504	367,543	24,055	44,873	16,022	119,773	80,122	831,892



The Feasibility Study on the Rehabilitation and Improvement of the Railways Viet Nam	Figure 6.4-4 Loaded Spider Network (Person Trip in 2010)



The Feasibility Study on the Rehabilitation and Improvement of the Railways in Viet Nam	Figure 6.4-5 Loaded Spider Network (Cargo Trip in 2010)

Table 6.4-5 Inter Province Trips by Road and Railway ; 2010

*) Total trips = (Generated + Attracted)/2

		Passengers		Cargo	
		(Persons/Year	(2010/1994)	(Tons/Year	(2010/1994)
1	Ha Giang	3,527,332	7.74	258,498	14.11
2	Tuyen Quang	9,213,385	10.21	330,462	14.36
3	Cao Bang	8,401,121	11.01	307,553	20.55
4	Lang Son	23,011,814	8.03	783,314	2.50
5	Lai Chau	5,594,718	15.41	317,416	19.14
6	Lao Cai	8,858,479	13.55	446,363	3.44
7	Yen Bai	4,859,789	5.72	783,745	4.03
8	Bac Thai	12,234,704	3.73	2,068,813	3.02
9	Son La	2,738,259	5.00	433,362	---
10	Hoa Binh	11,114,930	5.32	860,580	3.05
11	Vinh Phu	23,761,832	6.65	6,787,469	2.62
12	Ha Bac	54,898,220	8.32	2,722,301	4.43
13	Quang Ninh	22,190,821	7.36	14,434,653	2.52
14	Hanoi Capital	142,308,744	4.94	16,264,770	4.98
15	Hai Phong	48,790,020	7.34	13,104,483	5.38
16	Hai Hung	35,955,165	8.13	5,409,310	5.54
17	Ha Tay	74,941,354	7.95	4,710,497	4.66
18	Thai Binh	12,145,444	7.29	1,264,850	6.76
19	Nam Ha	28,962,952	5.22	5,786,577	4.07
20	Ninh Binh	13,538,234	5.84	1,416,495	3.02
21	Thanh Hoa	6,796,006	6.45	4,299,487	2.79
22	Nghe An	4,703,115	5.48	1,780,408	5.36
23	Ha Tinh	3,820,555	10.59	1,321,604	13.23
24	Quang Binh	2,076,325	3.42	592,876	5.99
25	Quang Tri	1,888,155	6.81	746,147	4.80
26	Thua Thien - Hue	4,778,900	3.24	1,194,816	9.27
27	Quang Nam - Da Nan	14,596,586	5.57	6,291,296	9.25
28	Quang Ngai	3,415,925	3.59	1,233,775	3.60
29	Binh Dinh	6,619,766	3.87	2,820,338	4.54
30	Phu Yen	3,260,751	4.66	1,073,034	10.85
31	Khanh Hoa	8,102,832	4.08	3,448,638	5.27
32	Ninh Thuan	4,762,741	9.40	1,595,257	5.19
33	Binh Thuan	4,120,009	5.43	1,897,309	5.99
34	Gia Lai	2,832,163	3.28	1,015,131	4.71
35	Kon Tum	1,742,203	6.11	885,154	5.92
36	Dac Lac	4,902,093	5.75	3,307,515	3.22
37	Lam Dong	6,548,696	3.29	2,016,294	6.76
38	Ho Chi Minh City	76,132,717	2.00	19,644,147	4.76
39	Song Be	3,781,170	2.54	1,120,846	3.30
40	Tay Ninh	7,247,399	1.63	1,691,193	3.76
41	Dong Nai	17,354,361	5.12	10,777,048	4.78
42	Ba Ria - Vung Tau	15,238,799	1.10	721,067	1.54
43	Long An	7,011,478	2.63	2,396,556	4.63
44	Dong Thap	5,217,892	7.25	1,617,141	6.78
45	An Giang	9,128,117	5.90	4,086,620	4.79
46	Tien Giang	15,507,381	1.47	3,437,530	2.94
47	Ben Tre	5,271,826	3.81	939,386	7.42
48	Vinh Long	5,601,877	7.58	1,440,659	4.29
49	Tra Vinh	3,311,192	5.54	801,652	3.94
50	Can Tho	10,450,170	7.01	4,768,494	5.97
51	Soc Trang	5,102,467	5.29	1,946,362	4.54
52	Kien Giang	5,991,706	5.73	2,626,951	6.08
53	Minh Hai	7,528,924	4.55	2,899,711	6.96
Total		831,891,559	4.44	174,925,940	4.31

Table 6.4-7 Cargo by Road and Railway

(unit: 000 tons/year)

	1	2	3	4	5	6	7	TOTAL
1 Northern Mountain	4,144	23,598	843	291	62	619	122	29,680
2 Red River Delta	23,546	17,223	4,402	2,044	110	1,221	293	48,839
3 North Coastal	851	4,200	2,744	1,477	110	456	93	9,931
4 South Coastal	302	2,110	1,303	6,639	2,888	4,271	807	18,319
5 Western Highlands	64	112	123	2,880	60	3,225	764	7,227
6 Eastern Nam Bo	636	1,250	429	4,262	3,228	7,763	16,394	33,962
7 Mekong Delta	126	303	95	806	764	16,392	8,482	26,968
TOTAL	29,668	48,796	9,939	18,400	7,221	33,947	26,954	174,926

2) Railway Demand

The passenger and cargo OD matrices(road and railway) are decomposed into the trips of road and railway via the diversion models. Travel time by road is calculated based on the expected design speed of the National Road 1 after rehabilitation.

Planned travel speed of railway varies due to the three alternatives. In calculating the railway travel time for alternative I andIII, a speed of express type train was adopted. However, as alternative II uses rather many local type trains compared with other alternatives, an average speed was adopted.

Travel time of each alternative between Hanoi and Ho Chi Minh City is summarized in Table 6.4-8. As for other zone pair, individual time distances are calculated and applied to diversion model.

Table 6.4-8 Time Distance between Hanoi and Ho Chi Minh City

(unit; hours)

	by Road	by Railway			
		Alt. I	Alt. III	Alt. II	Without Case
Passenger	45	24	27	30	same as 1994
Cargo	50	40	41	43	same as 1994

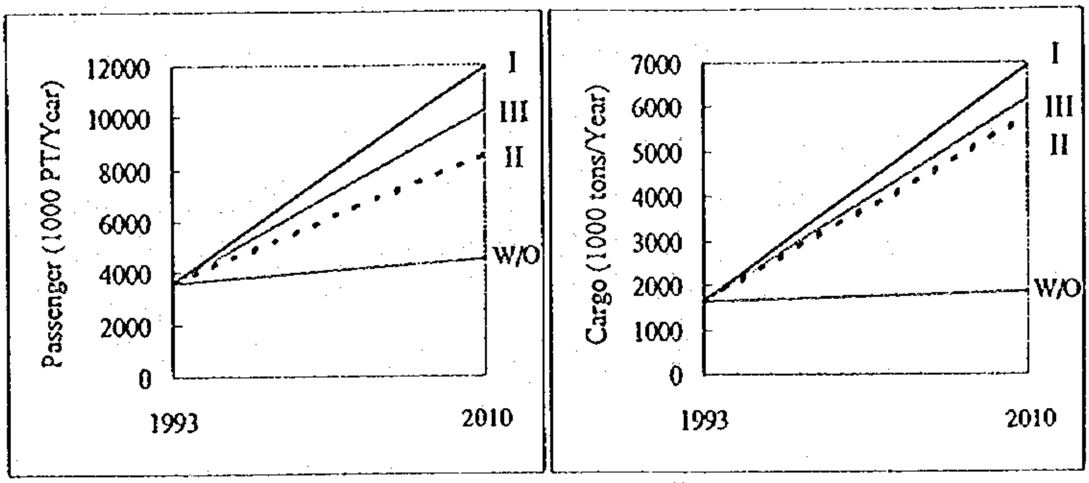


Figure 6.4-6 Number of Trips by Alternative

Figure 6.4-6 shows total trip of passenger and cargo in 1993 and 2010. The highest figure is recorded by Alternative I, followed by Alternative III, Alternative II, and without case. Passenger of Alternative I in 2010 is estimated to expand 3.8 times as much as that in 1993. Expansion ratio of Alternative III is 2.8, and Alternative II is 2.4. On the other hand, cargo transport in Alternative I is to expand 4.3 times as much as that in 1993, and followed by 3.8 times for Alternative III, and 3.6 times for Alternative II.

Cargo demand shows higher rate of growth than that of passengers. This is attributable to the fact that transport demand of cargo is more sensitive to economic growth, and that travel demand of passenger is less sensitive to economic activities.

In case of "without project", demand of railway is expected to increase at a very marginal rate in spite of remarkable expansion of overall traffic demand in Vietnam. Since rehabilitation of National Road 1 will be carried out independently, railway's competitive power against the road transport would be lost if no improvement of railway were done, and in the worst case there would occur a diversion from railway to road and the railway can not keep the necessary demand level at present. It causes a problem that demand of the road transport exceeds the road capacity and endless expansion of road network are required. This gives a rational on railway rehabilitation and improvement project.

The attracted and generated traffic are tabulated in Tables 6.4-9 and 6.4-10.

(10) Results of Assignment

The person and railway traffic demand assigned onto road network and railway network. As a major city is regarded as a traffic centroid, there are some possibility that person-km and ton-km will slightly deviate from actual volume. Even though, it still provides valuable information for the study because the condition for simulation of road and railway is same.

Assignment results both for the Hanoi - Ho Chi Minh railway and the National Root I are presented in Table 6.4-11. The present average passenger occupancy ratio, 4.17 person/pcu, is used for calculation of share for National Road I.

It is proved that in Alternative I, 16% of passengers will use the railway. However, the present share of 5.5% will be kept constant even in the future if it will not be improved.

Table 6.4-11 Share of Railway and Road : Passenger

	Railway (000 person-km/year)	Vehicles by Road (000 pcu-km/year)	Share of Railway (%)
Alternative I	6,299,344	33,170,941	16.0%
Alternative III	5,118,790	34,359,249	13.0%
Alternative II	3,945,186	35,540,660	10.0%
Without Case	2,179,076	37,253,232	5.5%

Note; Share of railway
= (Railway) / (Railway + Vehicles by Road x 4.17 persons/pcu)

Traffic volume of cargo by railway will increase remarkably. As shown in Table 6.4-12, railway share is expected to be 2.7% for alternative I, 2.3% and 2.1% for Alternative III and II respectively. However its share of railway will not increase in parallel with the total cargo volume of railway because total land traffic volume will also extremely increase at the same time. Cargo share of railway is estimated approximately 2-3%. When railway share is calculated, 4.28 ton/vehicle is adopted.

Table 6.4-9 Passenger Density by Railway

(UNIT:Passengers/Year)

ZONE	PROVINCE	1993 (by VNR)		2010 Case (I)		2010 Case (III)		2010 Case (II)		2010 Without Case	
		Depature	Arrival	Depature	Arrival	Depature	Arrival	Depature	Arrival	Depature	Arrival
14	Ha Noi Capital	547,013	507,037	1,498,444	1,475,560	1,286,646	1,242,371	1,073,022	1,007,269	637,584	591,262
17	Ha Tay	15,183	28,255	386,697	378,237	330,192	328,139	272,395	276,929	15,903	29,591
19	Nam Ha	214,354	196,884	710,877	708,300	551,234	542,376	388,828	373,717	225,180	206,818
20	Ninh Binh	29,538	30,397	208,638	212,587	173,149	175,550	137,017	137,852	31,115	32,018
21	Thanh Hoa	232,300	227,505	449,585	470,318	420,812	435,832	392,262	401,615	250,518	254,400
22	Nghe An	339,404	325,926	664,465	649,061	637,431	619,887	610,550	590,846	409,641	394,455
23	Ha Tinh	83,719	90,264	297,574	299,106	245,372	247,988	192,875	196,624	87,911	94,772
24	Quang Binh	475,361	477,025	776,429	778,601	776,429	778,601	776,429	778,601	502,263	501,171
25	Quang Tri	75,851	82,504	193,959	201,887	164,043	172,076	133,916	142,066	86,580	93,678
26	Thua Thien - Hue	323,677	338,251	575,342	601,349	573,848	599,890	572,369	598,445	372,292	385,577
27	Quang Nam - Da Nang	414,729	400,844	1,438,449	1,427,296	1,064,040	1,048,730	691,458	671,971	472,256	459,162
28	Quang Ngai	67,812	73,938	210,201	210,922	182,826	186,039	155,370	161,127	78,133	85,398
29	Binh Dinh	109,986	113,723	322,446	321,442	285,154	286,473	247,905	251,559	133,186	136,524
30	Phu Yen	18,718	15,057	227,063	228,024	190,257	190,891	153,020	153,311	38,549	33,225
31	Khanh Hoa	117,850	120,306	513,073	513,037	429,888	432,588	346,134	351,521	211,161	217,500
32	Ninh Thuan	25,604	27,299	295,335	291,975	237,765	236,937	179,817	181,553	33,099	34,970
33	Binh Thuan	75,576	74,311	248,165	247,348	216,341	216,239	184,367	184,987	83,054	81,175
37	Lam Dong	-	-	406,243	402,153	333,316	329,823	260,567	257,662	154,799	153,292
41	Dong Nai	1,809	941	658,117	659,496	573,771	574,998	490,146	491,223	2,264	1,342
38	Ho Chi Minh City	450,159	489,068	1,877,314	1,881,717	1,570,591	1,597,677	1,265,922	1,315,491	701,395	740,553
	TOTAL	3,618,643	3,619,535	11,958,416	11,958,416	10,243,105	10,243,105	8,524,369	8,524,369	4,526,883	4,526,883

Table 6.4-10 Cargo Density by Railway

(UNIT:Tons/Year)

ZONE	PROVINCE	1993		2010							
		(by VNR)		Case (I)		Case (III)		Case (II)		Without Case	
		Load	Unload	Load	Unload	Load	Unload	Load	Unload	Load	Unload
14	Ha Noi Capital	55,438	281,331	740,303	1,136,234	589,407	1,052,261	501,122	1,003,124	124,678	284,511
17	Ha Tay	0	9,308	451,991	437,555	439,480	417,323	432,190	405,545	0	10,052
19	Nam Ha	6,216	24,609	503,084	488,427	484,350	461,856	473,399	446,322	6,735	26,612
20	Ninh Binh	175,699	41,630	490,620	181,949	490,620	175,565	490,620	171,835	190,893	45,152
21	Thanh Hoa	529,557	477,548	1,084,410	1,004,547	1,084,410	994,937	1,084,410	989,315	563,033	506,846
22	Nghe An	269,985	146,987	593,749	387,257	593,749	381,210	593,749	377,673	285,954	155,409
23	Ha Tinh	10,414	14,617	152,315	159,856	148,101	147,350	145,636	140,034	11,148	15,620
24	Quang Binh	54,982	74,537	138,437	174,150	138,267	170,104	138,167	167,737	58,658	79,347
25	Quang Tri	108,853	62,531	242,606	165,549	242,606	156,527	242,606	151,248	117,214	68,557
26	Thua Thien - Hue	27,455	88,542	132,882	245,040	126,617	235,512	122,952	229,939	34,984	98,042
27	Quang Nam - Da Nan	57,387	130,074	425,908	534,778	274,724	440,224	186,217	384,865	67,013	148,038
28	Quang Ngai	36,727	36,413	137,853	149,592	136,541	136,177	135,774	128,334	39,848	38,720
29	Binh Dinh	3,937	65,318	175,710	220,620	151,589	205,450	137,474	196,572	8,114	73,824
30	Phu Yen	10,510	17,475	107,648	107,596	84,209	83,712	70,488	69,728	15,785	22,598
31	Khanh Hoa	34,592	37,036	190,281	211,450	137,435	150,971	106,496	115,562	42,452	43,479
32	Ninh Thuan	50,353	27,713	204,019	160,065	197,654	143,689	193,929	134,106	55,733	35,212
33	Binh Thuan	5,888	17,383	137,769	131,930	103,334	101,396	83,203	83,541	8,257	20,669
37	Lam Dong	-	-	147,985	150,295	130,206	126,345	119,813	112,340	45,608	39,748
41	Dong Nai	12,053	16,228	251,189	260,031	142,030	160,686	78,223	102,621	13,616	18,579
38	Ho Chi Minh City	127,922	90,453	603,012	604,850	501,738	455,772	442,492	368,519	140,396	99,104
	TOTAL	1,577,968	1,659,733	6,911,771	6,911,771	6,197,067	6,197,067	5,778,960	5,778,960	1,830,119	1,830,119

Table 6.4-12 Share of Railway and Road : Cargo

	Railway (000 ton-km/year)	Vehicles by Road (000 vehicle-km/year)	Share of Railway (%)
Alternative I	2,799,600	104,868,937	2.6%
Alternative III	2,448,956	106,319,810	2.3%
Alternative II	2,243,561	107,170,909	2.1%
Without Case	621,033	113,698,046	0.5%

Note; Share of railway
= (Railway) / (Railway + Vehicles by Road x 4.28 ton/vehicle)

The results of demand forecast reveals that the railway will not loss any significant share in future compared with the present status, even though facing a sever competition with the road traffic. This figure is a quantitative results of the direct effect attributable to saving in traveling time, and is also an effect that the proposed plans of rehabilitation and improvement can generate.

6.4.3 Economic Evaluation

6.4.3.1 Method of Economic Evaluation

(1) Purpose of Economic Evaluation

Economic evaluation is defined as an evaluation of project investment efficiency in terms of national economy. And this evaluation clarifies how efficiently the national resources are allocated by means of the project, and indicates how superior (or inferior) the project is in comparison with other competing projects.

Analytical frame of economic evaluation shows a sharp contrast from that of financial analysis since the latter is an analysis in terms of one investment entity such as a company or entrepreneur. In financial analysis, there is no relation with any project's impact on national economy.

Economic analysis is utilized by the policy makers in selecting the best policy among many competing alternatives. In formulating the national policy, numerous projects will be given a priority by the policy makers. Economic analysis aims at providing one of the best information in screening the projects.

Economic analysis adopts economic prices and economic benefit instead of nominal price and return. Economic cost is set equivalent to real productivity of the inputs and excludes non-productive monetary transfers such as tax, subsidy. Economic benefit is any preferable effect to the whole national economy and is measured as a improvement in productivity.

(2) Method

Evaluation itself is carried out by comparing economic benefit with economic cost. Economic benefit is calculated as a net benefit between "without project case" and "with project case." In this analysis, direct tangible effects are quantified, and indirect and non-tangible effects are not involved in the benefit calculation.

Economic internal rate of return (EIRR) is adopted in this analysis as a evaluation indicator. This is defined as a rate at which the present value of net benefit becomes zero, and its position suggests in comparison with opportunity cost of capital in Vietnam how efficient the project is.

In the following space, economic cost is described, and followed by economic benefit, comparison of benefit and cost. Result of evaluation concludes this section.

6.4.3.2 Economic Cost

(1) Total Economic Cost

Table 6.4.3-1 summarizes total economic cost of the project by alternative. Nominal financial cost is converted into economic cost by utilizing the shadow prices about working compensation and all the domestic materials. The former relates with the actual productivity of labor forces, while the latter relates with the tax structure in Vietnam. In this Study, we set the shadow prices by reducing turn-over tax from prices of all domestic material.

(2) Calculation of Economic Cost (= Shadow Pricing)

1) Working Compensation of Domestic Work Forces

Income tax is not incorporated in this analysis. This is because income tax is a subject of high income classes with more than 650,000 dongs per month as of September 1994. Table 6.4.3-2 shows the structure of income tax ratios by income class. Average level of working compensation (from one source) is estimated far less than 500,000 dong, and thus the majority of people is exempted from the income tax.

However, productivity of work forces is adjusted because enormous number of un-employment and under-employment apparently exist in Vietnam. "Un-employment ratio is estimated 20% of total population of work forces and this reaches 27-28% if under-employment is included" explained the Party's Secretary Mr. Do Muoi. In this analysis, real average productivity of labor forces is set 80% of nominal wage.

Table 6.4.3-1 Summary of Total Economic Cost

Table 6.4.3-2 Structure of Income Tax

Average Monthly Income	Tax Ratio
less than 650,000	0%
650,000-1,300,000	10%
1,300,000-1,900,000	20%
1,900,000-2,900,000	30%

Table 6.4.3-3 Structure of Turn-over Tax

Sector	Tax Ratio
Manufacturing Sector	1 - 10%
Consturction Sector	3 - 5%
Transportation Sector	1 - 4%
Commercial Sector	1 - 16%

Table 6.4.3-4 Life of Project Property

Property	Tax Ratio
Bridge	more than 50 years
Tunnel	more than 50 years
Rail	35 years
Ballast and Concrete Sleeper	more than 50 years
Communication Equipment	20 years
Signalling Equipment	20 years
New Rolling Stock	25 years
Rehabilitated Rolling Stock	25 years
Workshop & Depot	20 years

2) All Domestic Materials

All the domestic materials are subject of shadow pricing. However, the structure of subsidies and tax are so complicated and difficult to seize its actual magnitude in price structure. This is partly attributable to a lack of clear record of subsidies and a perplexing system of a pricing procedure. In this system, the most clear tax item (= turn-over tax) is adopted in reckoning the shadow prices. And it should be noted that this is a preliminary result and there is a large room to improve in the shadow price calculation.

State government imposes a turn-over tax in Vietnam and all the transactions of manufacturing sector, construction sector, transport sector, commercial and other service sectors are subject of this turn-over tax. Table 6.4.3-3 shows a structure of turn-over tax.

Nominal financial prices of construction materials are converted into economic prices by reducing this turn-over tax ratio. Its ratio is set 3%, and 97% of nominal price is set as a economic price.

3) All the Foreign Materials

All the prices of the foreign materials are used as economic prices. This is because foreign exchange rate is decided in the free market, and because a few items are subject of import tax concerning the materials of railway projects as a public infrastructure project.

Shadow price of foreign exchange ratio is not calculated in this analysis. This is because (a) there is no direct control of the foreign exchange market by the government, and (b) sufficient data is not available concerning volume and value of traded commodities.

Vietnamese government replaced a fixed foreign exchange system with a floating exchange system in 1989, and established a foreign exchange market in Hanoi and Ho Chi Min City in 1991. No durable exchange ratio is prevailing in Vietnam. It is judged that foreign exchange ratio is completely dependent on the market mechanism.

Furthermore, price distortion attributable to import and export taxes on the materials for the pubic infrastructure project, especially for railway project, is negligibly small. Import tariff table ("Export and Import Tariff for Commercial Goods" in effective in 1993) shows that there is few taxable items in the materials of the railway project.

4) Replacement Cost

Construction materials and operation equipment are all replaced with a new property when property life is over. Property life is set according to VNR standard, and is shown in Table 6.4.3-4.

Replacement cost is set as same as the original one. It is assumed that the rehabilitated rolling stocks can be operated for a full life period of new rolling stock.

5) Residual Value

Residual value of property was incorporated in the analysis. Every properties are depreciated year by year, and there remains some value of property when the project life is over before its depreciation period is expired. This residual value is listed as a negative cost of each investment item at the very last year of the project life.

However, residual value is incorporated only when property concerned can be utilized for other project. This study limits a scope of residual value to four items: rail, signal and communication equipment, rolling stocks, and equipment in workshop and depots.

6) Operation and Management Cost

This cost is converted by adjusting working compensation from financial cost concerned.

6.4.3.3 Economic Benefit

(1) Total Economic Benefit

This project expects eight (8) items of tangible economic benefit to generate and contribute to national economy. Of these economic items, five (5) items are measured in this project. Figure 6.4.3-1 shows eight items of economic benefits and an actually measured five items are listed in Table 6.4.3-5 with estimated scale of benefit.

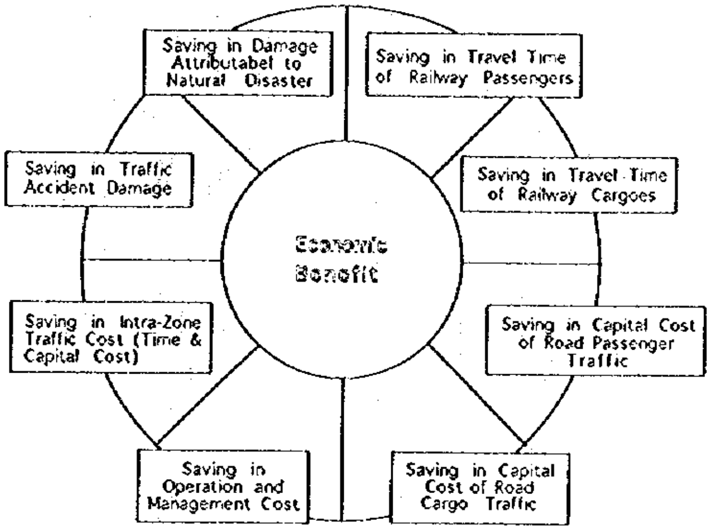


Figure 6.4.3-1 Items of Economic Benefit

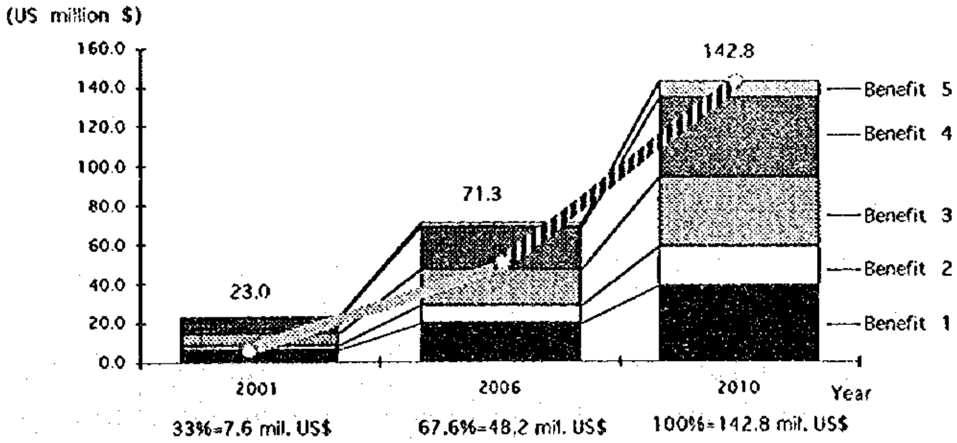


Figure 6.4.3-2 Actual Size of Economic Benefit

(unit; million US$)

Items	1993	1994	2001	2006	2010	Growth Rate ('93-2010) (%)
1. Saving in Travel Time ; Passenger						
Alternative I		0.0	5.9	19.1	38.4	
Alternative II		0.0	2.3	7.1	13.5	
Alternative III		0.0	3.6	12.2	24.7	
2. Saving in Travel Time ; Cargo						
Alternative I		0.0	2.4	9.3	19.9	
Alternative II		0.0	1.1	4.0	8.1	
Alternative III		0.0	1.4	5.8	0.0	
3. Saving in Road Transport Vehicles ; Passenger						
Alternative I		0.0	6.5	18.9	36.0	
Alternative II		0.0	2.8	8.2	15.1	
Alternative III		0.0	4.3	13.2	0.0	
4. Saving in Road Transport Vehicles ; Carogo						
Alternative I		0.0	7.3	21.1	40.2	
Alternative II		0.0	4.9	14.2	26.2	
Alternative III		0.0	5.3	16.3	0.0	
5. Saving in O&M						
Benefit Summary						
Alternative I		0.0	15.4	40.2	72.0	18.7321
Alternative II		0.0	13.3	31.0	50.3	15.9757
Alternative III		0.0	13.3	34.4	60.3	18.2987
Without		0.0	16.4	43.1	80.4	19.3410
Net Benefit (=Alt.-W/O)						
Alternative I	0	0.0	1.0	2.9	8.4	
Alternative II	0	0.0	3.1	12.1	30.1	
Alternative III	0.0	0.0	2.4	8.2	20.1	
Total						
Alternative I		0.0	23.0	71.3	142.8	
Alternative II		0.0	14.3	45.7	92.9	
Alternative III		0.0	17.9	56.4	114.3	

Table 6.4.3-5 Summary of Economic Benefit

There is actually one more benefit items that is attributable to flood mitigation measures. This is included in each benefit item since flood-free operation of railway can guarantee each benefit generated in a full scale. A full scale of economic benefit attributable to flood mitigation measures are incorporated in this study since average duration of railway inundation is not clear. Even with the improvement plan in this study, there remains about 100 km (out of 150 km) of flood prone railway section. To be accurate, this negative benefit should be reduced from the result of this section.

Furthermore, benefit attributable to safety improvement are not incorporated since counter measures are not planned at 5 sections where VNR regards the most dangerous sections in the North-South line: Don Glao - Bim Son (133.6km-141.5km), Tan Ap - Kim Lu (408.7km-422km), Thua Luu - Thanh Khe (741.6km-788.3km), Hoa Son - Dai Lanh (1220.1km-1232.2km), and Duo Giay - Trang Bom (1661.3km-1677.5km).

In reckoning the economic benefit in 2000 and 2005, first we assumed that the project would have been completed by 2000 and 2005, and estimated the total benefit. Secondly we reduced the total benefit according to the progress of the project. In other word, the total benefit in the year 2000 and 2005 are divided by the share of investment up to the year 2000 and 2005 against the total investment amount up to 2010. This is diagrammatically shown in Figure 6.4.3-2.

(2) Calculation of Economic benefit

In calculating the economic benefit, a safety operation of the train at the designed speed would be assured after the rehabilitation of the North-South Railway line will be implemented as proposed in this study report.

Even with the flood mitigation measures, there remains approximately 100 km of flood prone section. This kind of un-assured operation of railway depresses a railway demand both of passengers and cargo. However, we assumed in this study that every days operation of railway be assured.

1) Saving in Travel Time of Railway Passengers

Each alternative guarantees the operation of passenger coaches at higher speed and results in saving in travel time. Railway passenger can enjoy this benefit, and a part of bus passengers also prefers this shorter travel time and diverts their transport mode from a long distance bus to the railway. It is assumed that the saving time will be assigned for additional production activities and contribute to the total GDP by means of increase of productivity. Scale of this contribution is quantified into saving in travel time of railway passengers.

Table 6.4.3-6 shows a calculation process of this benefit. Time value is estimated by dividing GDP by total number of labor forces.

Table 6.4.3-6 Saving in Travel Time of Railway Passengers

	Traffic Volume by Railway (mil. person-km/year)			Average Speed of Travel (km/h)		Saving of Travel Time (million hours)			Time Value	Saving of Time Value (million US$/year)		
	Total Traffic	Traffic Converted from Road	Residual	Bus	Railway	Traffic Converted from Road	Residual	Total	Unit (US$/hr)	Traffic Converted from Road	Residual	Total
Year 1994												
Alternative I	4,156	1,982	2,174	38.44	72.08	24.07	15.07	39.14	0.1853	4.46	2.79	7.25
Alternative II	3,415	1,241	2,174	38.44	57.67	10.77	7.54	18.30	0.1853	2.00	1.40	3.39
Alternative III	3,785	1,611	2,174	38.44	64.07	16.77	11.30	28.07	0.1853	3.11	2.09	5.20
Without	2,174	0	2,174	38.44	48.06							
Year 2010												
Alternative I	6,299	4,120	2,179	38.44	72.08	50.02	15.11	65.13	0.5890	29.46	8.90	38.36
Alternative II	3,945	1,766	2,179	38.44	57.67	15.32	7.56	22.87	0.5890	9.02	4.45	13.47
Alternative III	5,119	2,940	2,179	38.44	64.07	30.59	11.33	41.92	0.5890	18.02	6.67	24.69
Without	2,179	0	2,179	38.44	48.06							

Note; bus = 45 hours (Hanoi-HCMC) = 38.44 km/h
train = 24 hours (Hanoi-HCMC) = 72.08 km/h
train = 30 hours (Hanoi-HCMC) = 57.67 km/h
train = 36 hours (Hanoi-HCMC) = 48.06 km/h

Table 6.4.3-7 Saving in Travel Time of Railway Cargo

	Cargo Volume by Railway (mil. ton-km/year)			Average Speed of Cargo Travel (km/h)		Saving of Travel Time (million hours)			Cargo Value (million US$/year)	Time Value	Saving of Time Value (million US$/year)		
	Total Traffic	Traffic Converted from Road	Residual	Road	Railway	Traffic Converted from Road	Residual	Total		Unit (%/hr)	Traffic Converted from Road	Residual	Total
Year 1994													
Alternative I	1,495	881	614	41.19	42.20	0.51	4.61	5.13	52.6	0.00288	0.08	0.70	0.78
Alternative II	1,320	706	614	41.19	40.23	-0.41	3.90	3.49	46.4	0.00288	-0.05	0.52	0.47
Alternative III	1,385	771	614	41.19	41.19	0.00	4.26	4.26	48.7	0.00288	0.00	0.60	0.60
Without	614	0	614	41.19	32.04				21.6				
Year 2010													
Alternative I	2,800	2,179	621	41.19	42.20	1.27	4.67	5.93	1,164.2	0.00288	4.2	15.6	19.89
Alternative II	2,244	1,623	521	41.19	40.23	-0.94	3.95	3.01	933.0	0.00288	-2.5	10.6	8.08
Alternative III	2,449	1,828	621	41.19	41.19	0.00	4.31	4.31	1,018.3	0.00288	0.0	12.6	12.63
Without	621	0	621	41.19	32.04								

Note;
truck = 42 hours (Hanoi-HCMC) = 41.19 km/h
train = 41 hours (Hanoi-HCMC) = 42.20 km/h
train = 43 hours (Hanoi-HCMC) = 40.23 km/h
train = 42 hours (Hanoi-HCMC) = 41.19 km/h
train = 54 hours (Hanoi-HCMC) = 32.04 km/h

time value = 25.2%/(365*24) = 0.00288%
cargo value = freight revenue x 20

2) Saving in Travel Time of Railway Cargo

Higher speed of freight cars can contribute to save the total transport time of cargo. This also affect the demand of railway cargo, and diverts a part of cargo transportation from truck to railway. It is assumed that saving in cargo transport time can make it possible to collect bills of cargoes and save a total amount of interest payment according to a difference of duration.

Table 6.4.3-7 shows whole process of calculation of this benefit. Saving in interest is calculated by (1) dividing present interest rate by total hours per year, and (2) multiplying it with average value of cargo.

3) Saving in Capital Cost of Road Passenger Traffic

A diversion of passengers from bus traffic to railway will result in reduction in number of bus fleet and will lessen capital cost of buses. This saving of bus capital is estimated by multiplying capital cost of bus by total saving in passenger volume.

Value of bus is calculated at a base of vehicle-kilometer. Basic data are the imported price of bus and the average travel distance during its life. Table 6.4.3-8 shows a whole calculation flows.

4) Saving in Capital Cost of Road Cargo Traffic

Concept of this benefit is quite similar to "Saving in Capital Cost of Bus." A diversion of cargo transport mode form truck to railway will results in reduction in number of truck fleet and contribute to save capital cost of truck. Unit value of capital cost is derived by taking the same procedure as the capital cost of bus.

Table 6.4.3-8 shows this calculation procedure together with that of bus.

5) Saving in Operation and Management of Railway

This saving is attributable to increase in productivity of management and operation sector. Financial figures were converted into economic cost by adjusting working compensation.

Table 6.4.3-8 Saving in Capital Costs of Road Passenger and Cargo Traffic

	Import Price (US$, cif)	Travel Distance in Life (km)	Capital Cost per Unit Distance (US$/v-km)	PCU	Capital Cost per Unit Distance (US$/pcu-km)		
Sedan	9,800	200,000	0.0490	1.18	0.0415		
Bus	39,900	500,000	0.0798	2.50	0.0319	(average=)	0.0367
Truck	28,900	500,000	0.0578	2.21	0.0262		

	mil.veh-km	w-w/o	mil. pcu-km	Saving in Passenger Vehicle
Passenger Vehicle Related;				
Alternative I	7955	-979	0.0367	35.95
Alternative II	8523	-411	0.0367	15.09
Alternative III	8240	-694	0.0367	25.49
Without	8934			
Cargo Vehilce Related;				
Alternative I	24502	-1538	0.0262	40.22
Alternative II	25040	-1000	0.0262	26.15
Alternative III	24841	-1199	0.0262	31.36
Without	26040			

6.4.3.4 Economic Evaluation

(1) Assumptions

1) Investment period ; 1996 - 2010

2) Evaluation period ; a period which covers construction period and 30 years of benefit flow (1995-2030)

3) Opportunity cost of capital ; 8.4%

This is equivalent to a interest rate of "Capital Formation Loan" offered by Industrial and Commerce Bank of Vietnam. In addition, a general standard of World Bank for developing countries (12%) is also taken into consideration.

4) Benefit generation during construction period;

First year of benefit generated is set at 2001. Scale of benefit is reduced according into the share of investment amount up to the year concerned against a total project cost.

(2) Evaluation Indicators

EIRR for each alternative are summarized in Table 6.4.3-9 together with results of sensitivity analysis.

Alternative I shows the highest EIRR of 7.6%, followed by 5.5% of Alternative III, and 5.4% of Alternative II. These figures of investment efficiency show a bit lower than a opportunity cost of capital.

(3) Conclusion

1) Among three alternatives, Alternative I indicates the highest efficiency of investment. This is followed by Alternatives II and III. In other words plan to achieve 24 hour operation between Hanoi and Ho Chi Min City proves to be the most favorable plan among three alternatives under the condition of preliminary investment plan by phase.

Alternatives II and III prove to have almost same level of investment efficiency, and their gap of EIRR figures between Alternative I is

Table 6.4.3-9 EIRR and Results of Sensitivity Analysis

Benefit \ Cost	+20%	+10%	Normal	-10%	-20%
Alternative I					
-20%	na		5.3%		
-10%		5.5%	6.5%		
Normal	5.7%	6.6%	7.6%	8.8%	10.1%
+10%			8.7%		
+20%			9.7%		
Alternative II					
-20%	na		3.4%		
-10%		3.6%	4.5%		
Normal	3.8%	4.6%	5.4%	6.4%	7.5%
+10%			6.3%		
+20%			7.1%		
Alternative III					
-20%	na		3.6%		
-10%		3.8%	4.6%		
Normal	3.9%	4.7%	5.5%	6.5%	7.5%
+10%			6.4%		
+20%			7.2%		

Note 1; na means "less than 0."
Note 2; Period of service disruption is not clear and thus a full scale of benefit is incorporated in calculating EIRR. However, there remains about 100km of flood prone railway section, and actual economic benefit and EIRR would be lower than this figure according to the duration of service disruption.

2%. This gap proves that Alternatives I is surely superior to Alternatives II and III. Absolute levels of EIRR for Alternatives II and III are not sufficiently high to justify the project.

2) This evaluation limits its analysis on investment efficiency and clarified that Alternative I has EIRR close to an opportunity cost of capital but a little bit lower than that.

In estimating the economic benefit, major five direct effects are measured and incorporated in reckoning investment efficiency. However, the followings are not included:

a. Benefit concerning the intra-zone traffic, i.e. traffic within province

It is not possible to estimate this benefit since the traffic zone employed in the traffic forecast is a prefecture, and further study requires more detail traffic data in the zone, which is not available at present.

b. Saving in damage of railway traffic accident

This includes repair cost of rolling stock, track, rail etc. as well as the compensation expenditure to the persons injured and medical care expenditure. However, any detail data about the railway traffic damage are available at present,. Therefore this item was excluded from this study.

c. Saving in natural disaster relief expenditure

There are record about the inundation and the roadbed washed out by the flood. However, each report does not contain any actual magnitude of the damage.

In concluding the final evaluation, due attention should be paid to these tangible but not measured benefits because of lack of reliable data.

3) Due attention should be paid on the following items. Both are policy matters.

a. Role of the North-South Railway Line

North-South railway line is requested to play a important role in transportation network in Vietnam as well as National Road 1 (QL 1). Safety operation and an assurance of operation in any conditions, if achieved, can guarantee two vital traffic routes between the North and the South, and can supplement each other in any situations. Punctual operation of the train should also be appreciated by the users. With attention on these matter, it is required that the project evaluation criteria go beyond the criteria of investment efficiency.

b. Income redistribution effect (= regional development effect)

It is expected that railway has a development effect on the region along the railway line and can contribute to eradicate income disparity among the regions, especially between the North and the South. Effect to eradicate this development disparity has a high policy priority. This indirect effect should also be paid due consideration in concluding the final evaluation of the project.