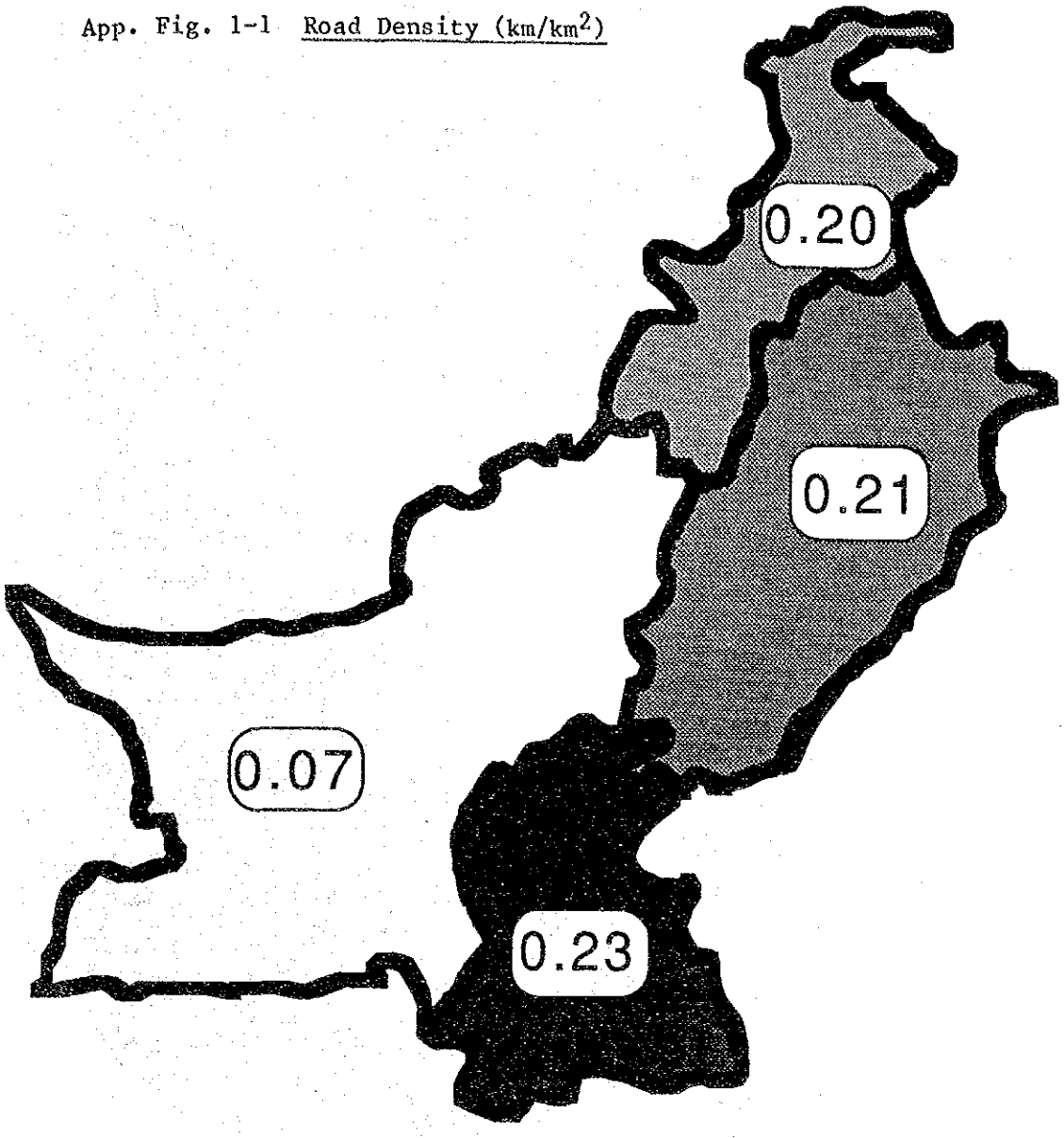
App. Fig. 1-1 Road Density (km/km^2)



	PUNJAB	SIND	N.W.F.P.	BALUCHISTAN	PAKISTAN
LENGTH in Km	44059	31810	14999	23817	114686
AREA in Sq. Km	205345	140914	74521	347190	796096
ROAD DENSITY	0.21	0.23	0.20	0.07	0.14

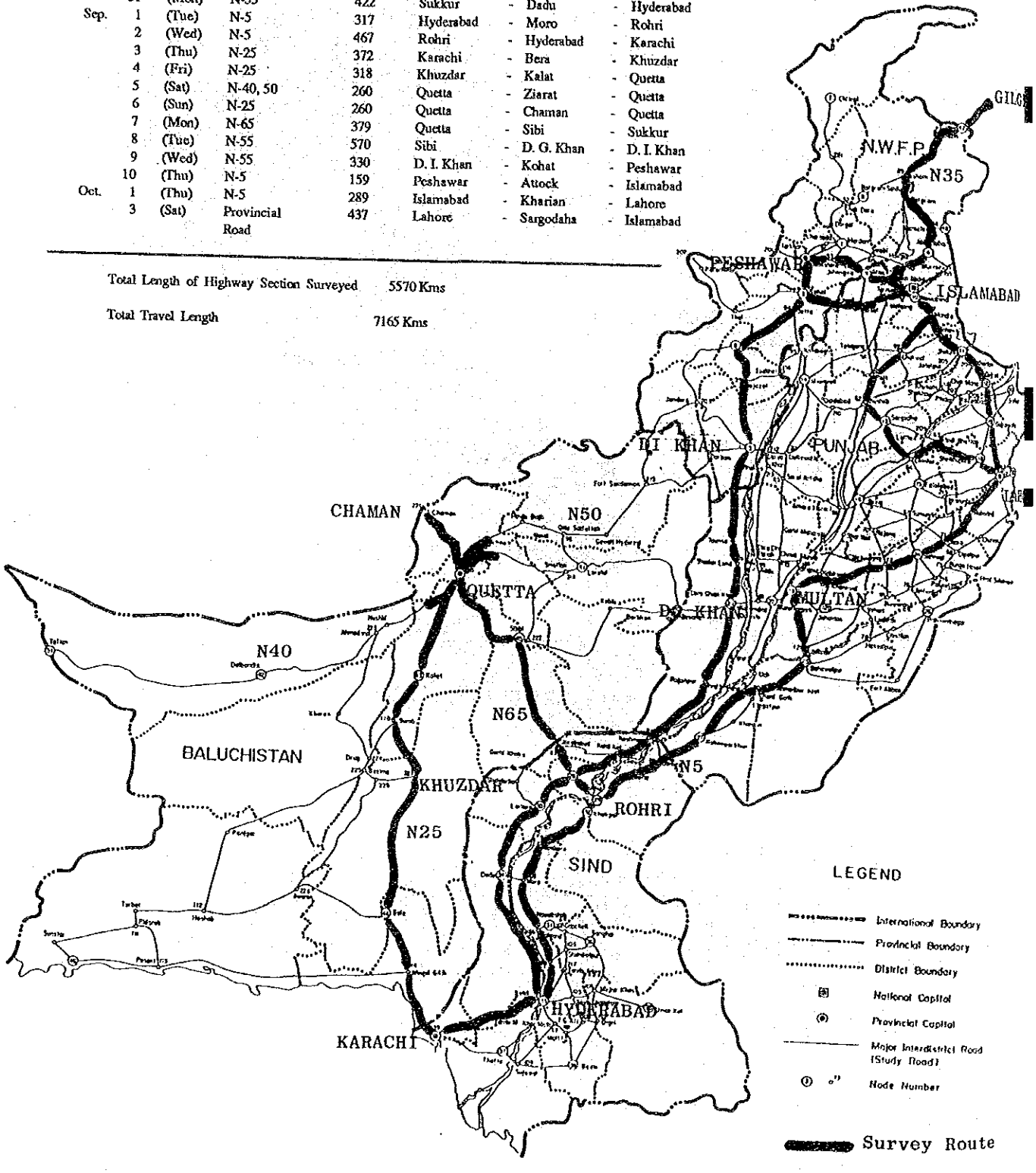
App. Fig. 1-2 Survey Route Map

Survey Schedule

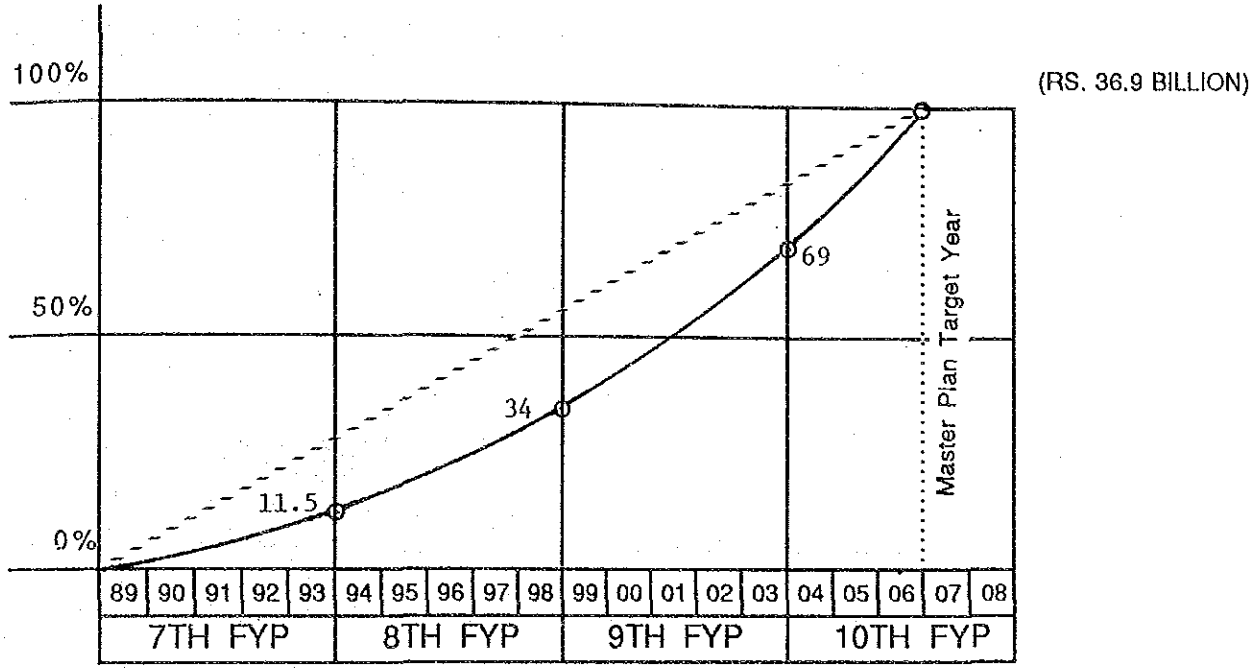
Date			Route	Length (Km)	Survey Section		
1987							
Aug.	14	(Fri)	N-5, Provincial Road	393	Islamabad	- Kohat	- Islamabad
	21	(Fri)	N-35	570	Islamabad	- Mansehra	- Gilgit
	22	(Sat)	N-35	570	Gilgit	- Mansehra	- Islamabad
	28	(Fri)	N-5	289	Islamabad	- Kharian	- Lahore
	29	(Sat)	N-5	310	Lahore	- Sahiwal	- Multan
	30	(Sun)	N-5	453	Multan	- Bahawalpur	- Sukkur
	31	(Mon)	N-55	422	Sukkur	- Dadu	- Hyderabad
Sep.	1	(Tue)	N-5	317	Hyderabad	- Moro	- Rohri
	2	(Wed)	N-5	467	Rohri	- Hyderabad	- Karachi
	3	(Thu)	N-25	372	Karachi	- Bera	- Khuzdar
	4	(Fri)	N-25	318	Khuzdar	- Kalat	- Quetta
	5	(Sat)	N-40, 50	260	Quetta	- Ziarat	- Quetta
	6	(Sun)	N-25	260	Quetta	- Chaman	- Quetta
	7	(Mon)	N-65	379	Quetta	- Sibi	- Sukkur
	8	(Tue)	N-55	570	Sibi	- D. G. Khan	- D. I. Khan
	9	(Wed)	N-55	330	D. I. Khan	- Kohat	- Peshawar
	10	(Thu)	N-5	159	Peshawar	- Attock	- Islamabad
Oct.	1	(Thu)	N-5	289	Islamabad	- Kharian	- Lahore
	3	(Sat)	Provincial Road	437	Lahore	- Sargodaha	- Islamabad

Total Length of Highway Section Surveyed 5570 Kms

Total Travel Length 7165 Kms



App. Fig. 3-1 Investment Cost Allocation for the Roads Outside of Study Network



FIVE YEAR PLAN	PERIOD	INVESTMENT COST (Rs. billion) INSIDE	OUTSIDE	TOTAL
7th7th	5 years	24.2	4.3 (11.5%)	28.5
8th	5 years	16.2	8.3 (22.5%)	24.5
9th	5 years	11.6	12.9 (35.0%)	24.4
10th(05/06)	3 years	3.3	11.4 (31.0%)	14.7
Total		55.3 (60 %)	36.9 (100 %) (40 %)	92.2

Source: JICA Study Team

Appendix to Chapter 1 (Section 1.4.2)

Highway Capacity Analysis

(1) Methodology

Generally, the design capacity of highway can be defined by the following equations:

Multi Lane Highways

$$DHV = CB(M) \times fW \times fH \times fE \times fP \times (V/C) \times N$$

Two-Lane Highways

$$DHV = CB(T) \times fW \times fH \times fD \times (V/C)$$

where;

- DHV : Design Hourly Volume (veh/hour)
- CB(M): Basic capacity per lane under ideal condition (PCU/hour)
- CB(T): Basic capacity in both directions under ideal conditions (PCU/hour)
- fW: Adjustment factor for lane width and/or lateral clearance restriction
- fH: Adjustment factor for the presence of heavy vehicles in the traffic stream
- fE: Adjustment factor for development environment and type of multi-lane highway
- fP: Adjustment factor for driver population
- fD: Adjustment factor for directional distribution of traffic
- V/C: Maximum volume-to-capacity ratio for level of service (Highway Planning level).

(2) Basic Capacity

Basic Capacity means the maximum rate of flow under ideal conditions.

According to HCM '85, ideal condition for multilane highways include:

- Level terrain
- 12-ft. lane widths
- A minimum of 6-ft lateral clearance between the edge of travel lanes and obstructions at the roadside or in the median.
- Passenger cars only in the traffic stream.
- A divided highway cross section in rural environment.

While, ideal condition for two lane highways are defined as no restrictive geometric, traffic, or environmental conditions. Specifically, they include:

- Design Speed greater than or equal to 60 mph.
- Lane widths greater than or equal to 12-ft.
- clear shoulder wider than or equal to 6-ft.
- No "no passing zones" on the highway
- All passenger cars in the traffic stream.
- A 50/50 directional split of traffic.
- No impediments to through traffic due to traffic control or turning vehicles.
- Level terrain.

This basic capacity has been studied in the several countries upto date. The following capacity is commonly used in USA and Japan:

Type of Highway	Unit	USA	Japan	Recommendation for this study
Multilane Highway	Per Lane (PCU/hr)	2,000	2,500 *(2,200)	2,500
Two Lane Highways	Per both directions (PCU/hr)	2,800	2,500	2,800

*( ) shows basic capacity revised in 1984.

Considering the local condition in Pakistan, the specified basic capacity for Multilane highways in USA (2,000 PCU/hr) and the basic capacity for two lane highways in Japan (2,500 PCU/hr) seems to be a lower side capacity for Pakistan's highway planning. Therefore, the recommendation was made taking the highest capacity both of USA and Japan standard as shown in table above.

(3) Adjustment Factor

1) Lane Width/Lateral clearance (fW)

Ideal conditions for highways include the provision of 12-ft lanes and 6-ft lateral clearance, i.e. roadside obstructions must be located at 6-ft from the edge of the travel lanes. Designs that fail to meet either or both of these criteria will have an adverse impact on traffic flow. This effect is accounted for by adjustment factor (fW), given in Table below:

Multilane (4-Lane Divided)

Distance from edge of travelled way to Obstruction (ft.)	Obstruction on One Side, Lane Width (ft.) 12	11	10
≥ 6	1.00(1.00)	0.97(0.97)	0.91(0.91)
4	0.99(0.98)	0.96(0.95)	0.90(0.89)
2	0.97(0.94	0.94(0.91)	0.88(0.86)

( ) shows adjustment factor in case of obstruction on both sides.

Two-Lane, Two-way

Shoulder Width (ft.)	Level of Service A-D, Lane Width (ft.) 12	11	10
≥ 6	1.00	0.93	0.84
4	0.92	0.85	0.77
2	0.81	0.75	0.68

Source: HCM '85

Since the lane width and shoulder width of Pakistan highway are wide enough, no adjustment factor is necessary to apply except the class IV Highway.

2) Heavy Vehicle (fH)

Adjustment factor for the presence of heavy vehicles in the traffic stream, computed as:

$$fH = 1/1 + PH\ (E-1)$$

where,

PH: Proportion of heavy vehicles (trucks and buses) in the traffic stream.

E : Passenger-car equivalent for heavy vehicles

Judging from the traffic count data obtained from NTRC, on most of the rural highways the percentage of heavy vehicles is between 60-85. Since the road link (260 Links) of the study road indicates various percentage of heavy vehicles, the design capacity of each category of roads is proposed to be estimated on the PCU base (PCU /day) not mixed traffic base (veh/day) for study convenience.

In this case, no adjustment factor is necessary to be applied. Instead of this adjustment, the traffic volume of each link will have to be estimated by PCU base also using passenger-car equivalent factors proposed as follows:

Average Passenger-Car Equivalents for Trucks and Buses on Two-Lane Highways (Multilane Highways)

Standard	Pakistani 1/ Standard	Japan		AASHTO (HCM '85)			Recommendation for this Study		
Terrain		F	M	F	H	M	F	H	M
Trucks	3 (3)	2 (2)	3.5 (3)	2.2 (1.7)	5 (4)	10 (8)	3 (3)	4 (4)	6 (6)
Buses	3 (3)	2 (2)	3.5 (3)	2 (1.5)	3.4 (3)	6 (5)	3 (3)	4 (4)	6 (6)

Terrain; F: Flat Area
H: Hilly Area
M: Mountainous Area

Note: 1/ Source: Highway Design Manual (Punjab 1971)

3) Other Adjustment Factor (fE/fP/fD)

The following adjustment factor is recommended to be applied in Pakistan.

Items	Adjustment Factor	Remarks
Develop environment (fE)	* 0.90	Divided Multilane highway, rural.
Driver Population (fP)	1.00	Regular User
Directional distribution (fD)	0.94	60/40 distribution

Note * Generally, adjustment factor for type of multilane highway and development environment (fE) is applied 1.0 in case of divided multilane in rural area. 0.90 is considered for the factor affected by slow moving traffic such as animal drawn vehicles or animals itself.

Source: HCM '85

(4) Level of Service

Level of service is a key factor for the estimation of road capacity and for the road improvement planning. This means the maximum volume-to-capacity ratio allowable while maintaining the performance characteristics of level of service.

According to MCM '85, level of service criteria is defined as shown in Table - A.

App. Table A Level of Service Criteroa (HCM '85)

TABLE 7-1. LEVEL-OF-SERVICE CRITERIA FOR MULTILANE HIGHWAYS

LEVEL OF SERVICE	DENSITY (PC/MI/LN)	70 MPH DESIGN SPEED			60 MPH DESIGN SPEED			50 MPH DESIGN SPEED		
		SPEED[a] (MPH)	v/c	MSF[b] (PCPHPL)	SPEED[a] (MPH)	v/c	MSF[b] (PCPHPL)	SPEED[a] (MPH)	v/c	MSF[b] (PCPHPL)
A	≤ 12	≥ 57	0.36	700	≥ 50	0.33	650	—	—	—
B	≤ 20	≥ 53	0.54	1,100	≥ 48	0.50	1,000	≥ 42	0.45	850
C	≤ 30	≥ 50	0.71	1,400	≥ 44	0.65	1,300	≥ 39	0.60	1,150
D	≤ 42	≥ 40	0.87	1,750	≥ 40	0.80	1,600	≥ 35	0.76	1,450
E	≤ 67	≥ 30	1.00	2,000	≥ 30	1.00	2,000	≥ 28	1.00	1,900
F	> 67	< 30	[c]	[c]	< 30	[c]	[c]	< 28	[c]	[c]

[a] Average travel speed.
[b] Maximum rate of flow per lane under ideal conditions, rounded to the nearest 50 pcphpl.
[c] Highly variable.

TABLE 8-1. LEVEL-OF-SERVICE CRITERIA FOR GENERAL TWO-LANE HIGHWAY SEGMENTS

LOS	PERCENT TIME DELAY	v/c RATIO[a]																	
		LEVEL TERRAIN						ROLLING TERRAIN						MOUNTAINOUS TERRAIN					
		AVG[b] SPEED	PERCENT NO PASSING ZONES						AVG[b] SPEED	PERCENT NO PASSING ZONES						AVG[b] SPEED	PERCENT NO PASSING ZONES					
			0	20	40	60	80	100		0	20	40	60	80	100		0	20	40	60	80	100
A	≤ 30	≥ 58	0.15	0.12	0.09	0.07	0.05	0.04	≥ 57	0.15	0.10	0.07	0.05	0.04	0.03	≥ 56	0.14	0.09	0.07	0.04	0.02	0.01
B	≤ 45	≥ 55	0.27	0.24	0.21	0.19	0.17	0.16	≥ 54	0.26	0.23	0.19	0.17	0.15	0.13	≥ 54	0.25	0.20	0.16	0.13	0.12	0.10
C	≤ 60	≥ 52	0.43	0.39	0.36	0.34	0.33	0.32	≥ 51	0.42	0.39	0.35	0.32	0.30	0.28	≥ 49	0.39	0.33	0.28	0.23	0.20	0.16
D	≤ 75	≥ 50	0.64	0.62	0.60	0.59	0.58	0.57	≥ 49	0.62	0.57	0.52	0.48	0.46	0.43	≥ 45	0.58	0.50	0.45	0.40	0.37	0.33
E	> 75	≥ 45	1.00	1.00	1.00	1.00	1.00	1.00	≥ 40	0.97	0.94	0.92	0.91	0.90	0.90	≥ 35	0.91	0.87	0.84	0.82	0.80	0.78
F	100	< 45	—	—	—	—	—	—	< 40	—	—	—	—	—	—	< 35	—	—	—	—	—	—

[a] Ratio of flow rate to an ideal capacity of 2,800 pcph in both directions.
[b] Average travel speed of all vehicles (in mph) for highways with design speed ≥ 60 mph; for highways with lower design speeds, reduce speed by 4 mph for each 10-mph reduction in design speed below 60 mph; assumes that speed is not restricted to lower values by regulation.

As seen from the Table, V/C radio in USA seems to be a little bit on the excess side of planning level for Pakistan. In order to maximum use of the limited financial resources, the following level of service ratio is recommended to apply to the design standard of Pakistan both of multilane and two-lane highways as a guideline.

Level of Service	(Highway Planning Level) V/C Ratio	Application
A	0.35	N.A
B	0.55	N.A
C	0.70	Class I-IV Highways
D	0.85	Class V Highway
E	1.00	N.A

(5) Peak Factor

The design hourly volume (DHV) means usually the 30th highest hour, two-way unless specified.

The design capacity for road planning is generally determined by average daily traffic (ADT) using peak factor (K). The peak factor, ratio of DHV to ADT, to be applied in the study was estimated by traffic data obtained from NTRC. In the NTRC's traffic count stations, Attock, Jhelum, Bahawalpur and Kandiaro were selected for this analysis purpose in which it indicates the typical traffic characteristic of the inter-provincial road traffic in Pakistan. Table-B shows the peak factor of each station calculated by the weekday traffic. As seen from the table, the peak factor ranging between 5.9 to 8.3 at the time of survey in 1985-86, the peak factor 7.0 is proposed to be adopted in this study.

Estimated Highway Design Capacity

(1) Multilane and Two-lane, Two-way Highways

The estimated design capacity (PCU/day) of the each category of highways is presented in Table-C. Table-E shows the capacity of mixed traffic calculated based on several percentages of heavy vehicles for reference.

(2) One-Lane, Two-way road

The theoretical capacity of one lane, two-way roads can be calculated on the assumption that passing vehicles can pass each other only where the passing area is provided at carriageway sides.

However, the actual traffic is generally observed more than the theoretical estimated volume where the road shoulder is wide enough and well maintained (it is usually seen in Pakistan that vehicles on the one lane, two-way roads runs with high speed similar to two-lane, two-way roads).

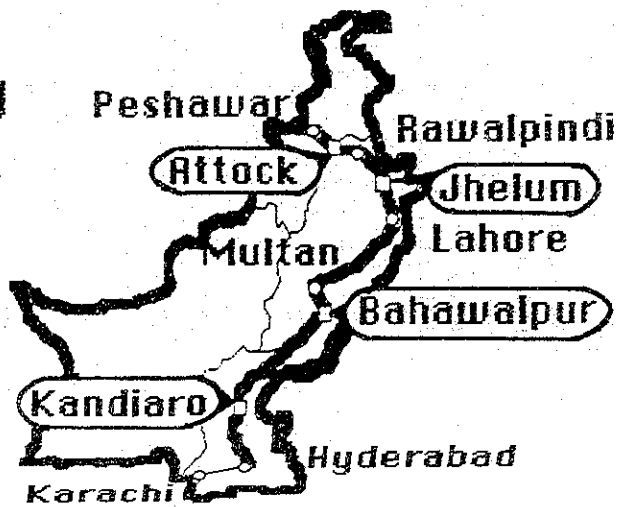
App. Table B Weighted Peak Factor at Attock, Jelum, Bahawalpur and Kandiaro on N-5

	Survey Station	Attock			Jhelum			Bahawalpur			Kandiaro		
	Month / Year	A	B	C (%)	A	B	C (%)	A	B	C (%)	A	B	C (%)
1	August '85	95294	6799	7.1	178687	11599	6.5	---	--	---	---	---	---
2	September	99622	7212	7.2	189701	12004	6.3	116396	7358	6.3	---	---	---
3	October	93797	7262	7.7	183079	11590	6.3	112116	6978	6.2	94880	5620	5.9
4	November	90810	7528	8.3	183669	11866	6.5	119126	7332	6.2	104196	6520	6.3
5	December	88414	7321	8.3	187091	12586	6.7	116635	7808	6.7	94428	5694	6.0
6	January '86	91469	7285	8.0	190427	12618	6.6	111406	7282	6.5	94990	5862	6.2
7	February	93797	7583	8.1	186612	11902	6.4	117138	7551	6.4	92022	5786	6.3
8	March	99347	7754	7.8	193760	12366	6.4	127465	7748	6.1	91127	5659	6.2
9	April	112902	8212	7.3	203875	12601	6.2	117294	6793	5.8	90773	5403	5.9
10	May	95869	6192	6.5	187951	11150	5.9	110076	6272	5.7	---	---	---
11	Jun	101579	6332	6.2	192714	11371	5.9	100104	5883	5.9	87431	5805	6.6
12	July	110501	7448	6.7	198402	11767	5.9	110198	6465	5.9	93724	6323	6.7
13	August	---	---	---	---	---	---	148275	9425	6.4	63790	4554	---
	Total	1173401	86928	7.4	2275968	143420	6.3	1406229	86895	6.2	907361	57226	6.2

Abbreviation

1 : Monthly Weekday Traffic Volume
2 : Total Weekday Peak Hourly Volume
3 : Weighted Peak Factor

Location of Survey



App. Table C Estimated Theoretical Capacity

ITEM	LANE WIDTH (m)	LATERAL CLEARANCE (m)	ADJUSTMENT FACTOR fW	fE	fP	fD	TOTAL	BASIC CAPACITY (PCU/h)	POSSIBLE CAPACITY (PCU/h)	SERVICE LEVEL [V/C]	DHV (PCU/h)	K (%)	DESIGN CAPACITY PER LANE (PCU/day)	LANE NO.	CAPACITY (PCU/day)
ADT Multiple Lanes CLASS I	3.65	3.65	1.00	0.90	1.00	---	0.90	2500	2250	C [0.70]	1580	6	26500	4	106000
												7	22500		90000
												8	20000		80000
												9	17500		70000
										D [0.85]	1910	6	32000		128000
												7	27500		110000
												8	24000		96000
												9	21000		84000
										E [1.00]	2250	6	37500		150000
												7	32000		128000
												8	28000		112000
												9	25000		100000
ADT Two-Lane Two-Way CLASS II,III	3.65	3.65	1.00	0.90	---	0.94	0.85	2800	2380	C [0.70]	1670	6	---	2	28000
												7	---		24000
												8	---		21000
												9	---		19000
										D [0.85]	2020	6	---		33500
												7	---		29000
												8	---		25500
												9	---		22500
										E [1.00]	2380	6	---		39500
												7	---		34000
												8	---		30000
												9	---		26500
ADT Two-Lane Two-Way CLASS IV	3.00	3.65	0.84	0.90	---	0.94	0.71	2800	1990	C [0.70]	1390	6	---	2	23000
												7	---		20000
												8	---		17500
												9	---		15500
										D [0.85]	1690	6	---		28000
												7	---		24000
												8	---		21000
												9	---		19000
										E [1.00]	1990	6	---		33000
												7	---		28500
												8	---		25000
												9	---		22000

App. Table D Design Capacity (Mixed Traffic) by Rate of Heavy Vehicles

(VEH / DAY)

ITEM	SERVICE LEVEL	K (%)	CAPACITY (PCU/day)	FLAT				HILLY				MOUNTAINOUS			
				50%	60%	70%	80%	50%	60%	70%	80%	50%	60%	70%	80%
ADT Multiple Lanes CLASS I	C	6	106000	53000	48000	44000	41000	42500	38000	34000	32000	30500	26500	23500	21000
		7	90000	45000	41000	37500	34500	36000	32000	29000	27500	25500	22500	20000	18000
		8	80000	40000	36500	33500	31000	32000	28500	26000	24000	23000	20000	18000	16000
		9	70000	35000	32000	29000	27000	28000	25000	22500	21000	20000	17500	15500	14000
	D	6	128000	64000	58000	53500	49000	51000	45500	41500	39000	36500	32000	28500	25500
		7	110000	55000	50000	46000	42500	44000	40000	35500	33500	31500	27500	24500	22000
		8	96000	48000	43500	40000	37000	38500	34500	31000	29000	27500	24000	21500	19000
		9	84000	42000	38000	35000	32500	33500	30000	27000	25500	24000	21000	18500	17000
	E	6	150000	75000	68000	62500	57500	60000	53500	48500	45500	43000	37500	33500	30000
		7	128000	64000	58000	53500	49000	51000	45500	41500	39000	36500	32000	28500	25500
		8	112000	56000	51000	46500	43000	45000	40000	36000	34000	32000	28000	25000	22500
		9	100000	50000	45500	41500	38500	40000	35500	32500	30500	28500	25000	22000	20000
ADT Two-Lane Two-Way CLASS II,III	C	6	28000	14000	12500	11500	11000	11000	10000	9000	8500	8000	7000	6000	5500
		7	24000	12000	11000	10000	9500	9500	8500	7500	7500	7000	6000	5500	5000
		8	21000	10500	9500	9000	8000	8500	7500	7000	6500	6000	5500	4500	4000
		9	19000	9500	8500	8000	7500	7500	6800	6000	6000	5500	5000	4000	4000
	D	6	33500	17000	15000	14000	13000	13500	12000	11000	10000	9500	8500	7500	6500
		7	29000	14500	13000	12000	11000	11500	10500	9500	9000	8500	7500	6500	6000
		8	25500	13000	11500	10500	10000	10000	9000	8000	7500	7500	6500	5500	5000
		9	22500	11500	10000	9500	8500	9000	8000	7500	7000	6500	5500	5000	4500
	E	6	39500	20000	18000	16500	15000	16000	14000	12500	12000	11500	10000	9000	8000
		7	34000	17000	15500	14000	13000	13500	12000	11000	11000	9500	8500	7500	7000
		8	30000	15000	13500	12500	11500	12000	10500	10000	9000	8500	7500	6500	6000
		9	26500	13500	12000	11000	10000	10500	9500	8500	8000	7500	6500	6000	5500
ADT Two-Lane Two-Way CLASS IV	C	6	23000	11500	10500	9500	9000	9000	8000	7500	7000	6500	6000	5000	4500
		7	20000	10000	9000	8500	7500	8000	7000	6500	6000	5500	5000	4500	4000
		8	17500	9000	8000	7500	6500	7000	6500	5500	5500	5000	4500	4000	3500
		9	15500	8000	7000	6500	6000	6000	5500	5000	4500	4500	4000	3500	3000
	D	6	28000	14000	12500	11500	11000	11000	10000	9000	8500	8000	7000	6000	5500
		7	24000	12000	11000	10000	9500	9500	8500	7500	7500	7000	6000	5500	5000
		8	21000	10500	9500	9000	8000	8500	7500	7000	6500	6000	5500	4500	4000
		9	19000	9500	8500	7900	7500	7500	6800	6000	6000	5500	5000	4000	4000
	E	6	33000	16500	15000	14000	12500	13000	12000	10500	10000	9500	8500	7500	6500
		7	28500	14500	13000	12000	11000	11500	10000	10000	8500	8000	7000	6500	5500
		8	25000	12500	11500	10500	9500	10000	9000	8000	7500	7000	6500	5500	5000
		9	22000	11000	10000	9000	8500	9000	8000	7000	6500	6500	5500	5000	4500

The possible capacity of one-lane, two-way road was analyzed by the relation between the estimated traffic volume at peak hour (PCU/hr) and width of carriageway (m) as shown in Figure-A. The traffic volume at peak hour (peak factor; 7%) was estimated using traffic count data obtained from NTRC (31 stations, surveyed in 1985/86, See Table-E).

The possible capacity can be defined by the following equations:

$$V = \frac{900}{5.5 - 3.65} \quad (W - 3.65) + 300$$

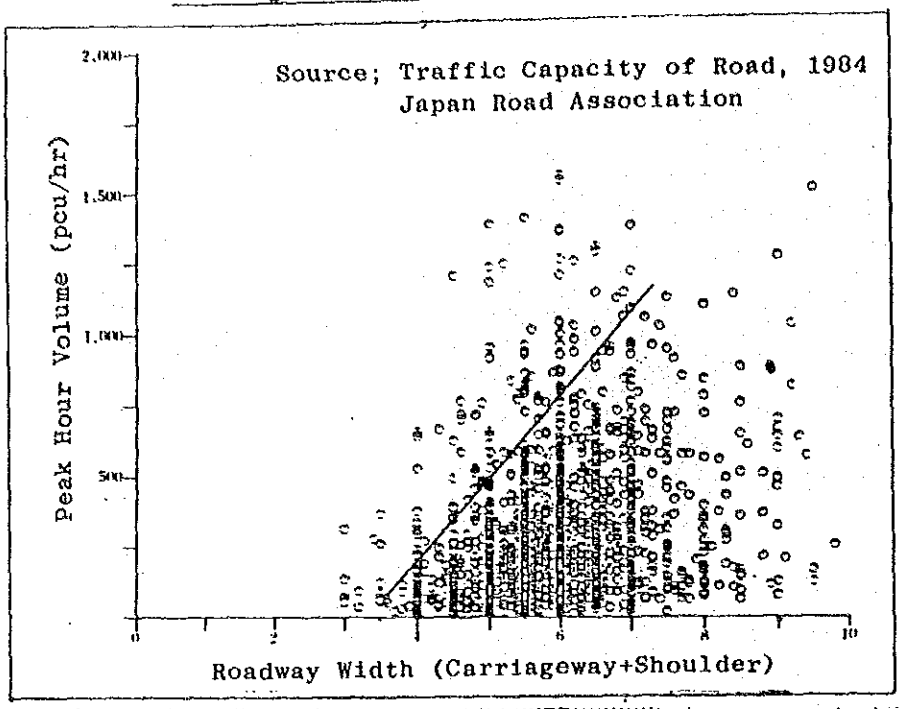
where;

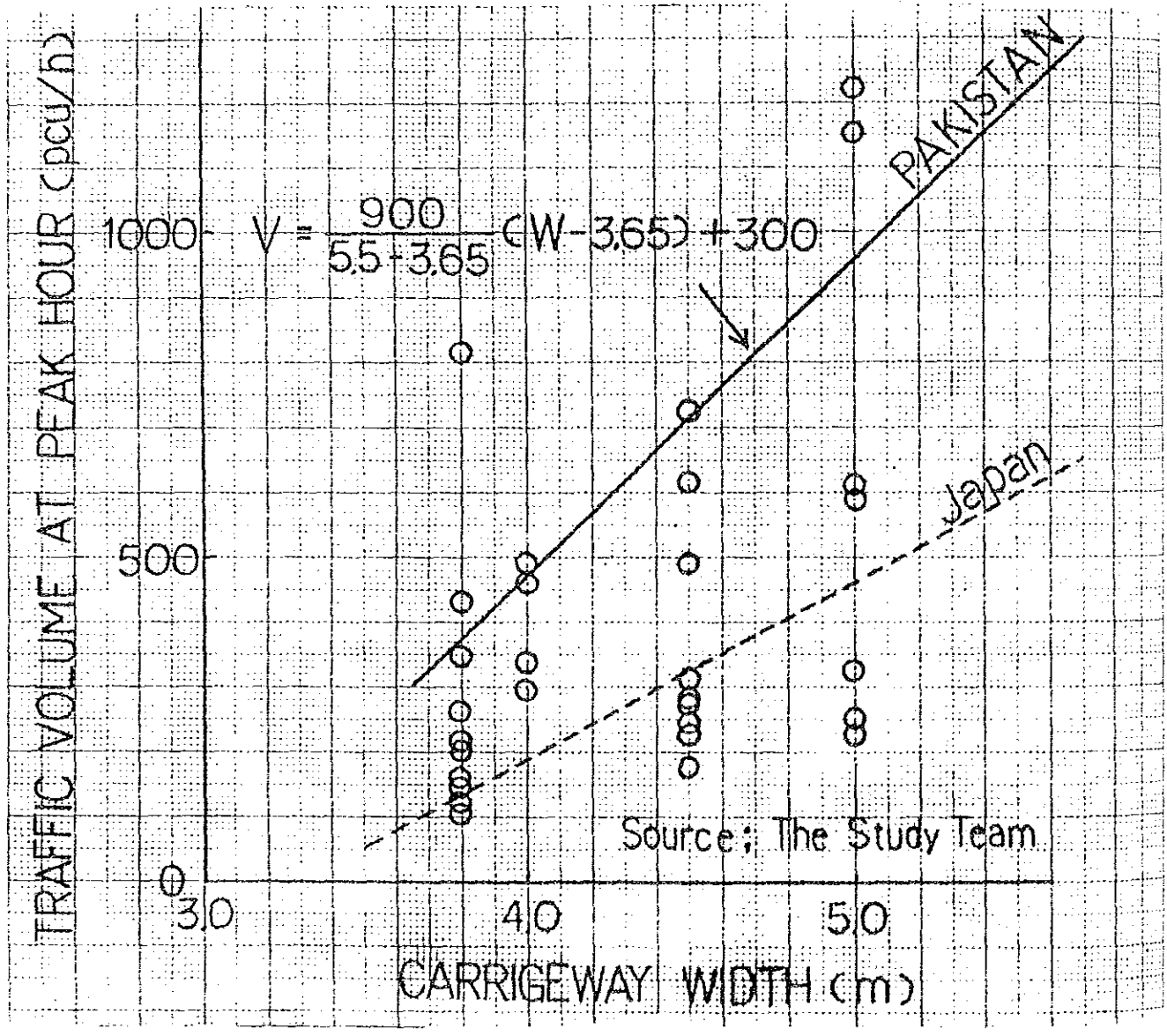
V = Possible capacity of one-lane, two-way roads (PCU/hr)

W = Width of carriageway

The estimated design capacity of one-lane, two-way roads are summarized in Table - F.

App. Fig. A Relation between Traffic Volume at Peak Hour and Carriageway Width of One-Lane, Two-Way Road





App. Table E Traffic Volume of One Lane Road

LINK NO.			NODE NO.	TERRAIN	CARRIGEWAY WIDTH (m)	TRAFFIC VOLUME (veh/day)					PCU/day	ESTIMATED PEAK HOUR TRAFFIC VOLUME (PCU/day)
ROAD NO.	PROVINCIAL NO.	SERIAL NO.				MOTER CYCLE	CAR	BUS	TRUCK	TOTAL		
0	1	27	95-14	F	4.5	470	664	163	472	1769	2804	393
0	1	29	158-68	F	3.0	29	207	130	205	571	1227	172
55	1	32	159-21	F	3.8	280	149	123	277	829	1489	208
55	1	33	21-74	F	4.5	417	185	157	232	991	1561	218
55	1	34	74-160	F	4.5	157	149	102	153	561	993	139
0	1	39	66-65	F	3.8	28	93	98	171	390	914	128
0	1	40	65-213	F	4.5	32	150	182	162	526	1198	168
0	1	42	97-21	M	4.5	88	70	25	645	828	4134	579
0	1	44	22-101	F	4.5	101	117	97	375	690	1584	222
0	1	46	66-62	F	5.0	198	249	143	223	813	1446	202
0	1	47	62-60	M	5.0	245	388	282	798	1713	6991	979
0	1	48	60-92	F	3.8	399	717	177	341	1634	2471	346
0	1	55	16-13	F	5.0	761	775	390	395	2321	3511	491
0	1	62	19-20	F	5.0	702	1541	930	636	3809	6590	923
0	1	65	25-78	F	4.5	347	289	186	194	1016	1603	224
0	1	72	27-80	F	4.5	838	645	221	595	2299	3512	492
0	1	95	14-58	F	5.0	661	635	140	670	2106	3396	475
0	1	98	68-9	H	3.8	225	798	27	235	1285	1959	274
0	1	100	93-92	F	4.5	148	426	117	182	873	1397	196
0	1	101	92-58	F	4.0	499	908	155	328	1890	2607	365
0	1	102	16-67	F	4.0	468	216	138	266	1088	1662	233
0	1	126	214-100	F	3.8	95	67	109	122	393	808	113
0	1	106	100-101	F	3.8	152	84	32	147	415	697	98
55	2	14	118-34	F	3.8	27	320	126	1312	1785	4648	651
0	2	41	107-109	F	5.0	93	183	106	295	677	1433	201
0	3	12	59-156	H	5.0	65	441	30	318	854	1866	261
0	3	14	3-202	M	4.0	12	1008	113	184	1317	2796	391
55	3	16	160-5	F	4.0	114	327	151	360	952	1917	268
0	4	11	40-218	M	3.8	58	46	12	75	191	597	84
0	4	12	41-97	F	3.8	85	43	29	313	470	1112	156

App. Table F Estimated Theoretical Capacity (One-Lane, Two-Way)

ITEM	LANE WIDTH (m)	POSSIBLE CAPACITY (PCU/h)	SERVICE LEVEL [V/C]	DHV (PCU/h)	K (%)	DESIGN CAPACITY (PCU/day)
ADT One-Lane Two-Way CLASS V	3.65	300	C [0.70]	210	6	3500
					7	3000
					8	2500
					9	2500
			D [0.85]	260	6	4500
					7	3500
					8	3500
					9	2900
			E [1.00]	300	6	5000
					7	4300
					8	4000
					9	3500

Appendix to Chapter 1 (Section 1.8.3)

Pavement Distortions

(1) General

Many pavement distortions on the existing highways in Pakistan were observed through the site reconnaissance conducted.

Pavement distortion is any change of the pavement surface from its original shape. It usually is caused by such things as too little compaction of the pavement course, too many fines in surface mixtures, too much asphalt, swelling of underlying course, or settlement. Like cracks, distortion takes a number of different forms: grooves or ruts, shoving, corrugations, depressions and upheaval.

As with any other defect, the type of distortion and its cause must be determined before the correct remedy can be applied. Repair techniques range from levelling the surface by filling with new material to complete removal of the affected area and replacing with new material.

(2) Pavement Destortion and its Cause

Major causes of the pavement distortion are summarized as follows:

Distortion	Form	Cause
RUTTING	There are channelized depressings which may develop in the wheel tracks of an asphalt pavement.	Ruttings may result from consolidation or leteral movement under traffic in one or more of the underlying courses, or by displacement in the asphalt surface layer itself. They may develop under traffic in new asphalt pavements that has had too little compaction during construction. They may develop from plastic movement in a mix that does not have enough stability to support to traffic.

CORRUGATION AND SHOVING	Corrugation is a form of plastic movement typified by ripples across the asphalt pavement surface. Shoving is a form of plastic movement resulting in localized bulging of the pavement surface.	Corrugation and shoving usually occur in asphalt layers that lack stability. Lack of stability may be caused by a mixture which is too rich in asphalt, has too high a proportion of fine aggregate, has coarse of fine aggregate which is too round or too smooth textured, or has asphalt cement which is too soft. It may also be due to excessive moisture, contamination due to oil spillage, or lack of aeration when placing mixes using liquid asphalt.
UPHEAVAL	Upheaval is the localized upward displacement of a pavement due to swelling of the subgrade or some portion of the pavement structure.	Upheaval is more commonly caused by expansion of ice in the lower course of the pavement or the subgrade. But it may also be caused by the swelling effect of moisture on expansive soils.

3) Comment on Rutting Problem

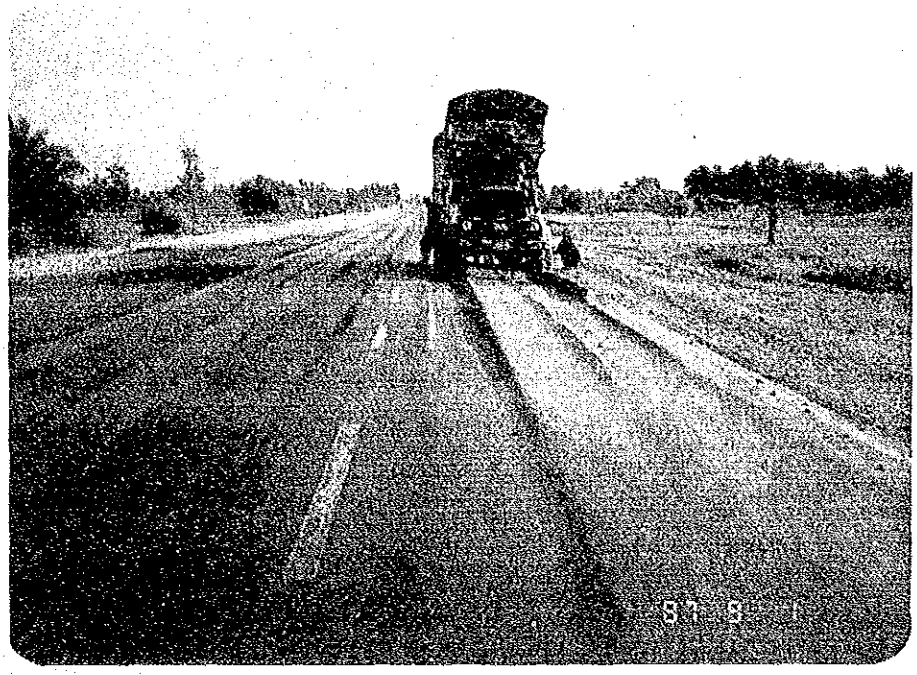
There are several rutting problems in the newly constructed roads in Pakistan. Photograph A shows one of serious rutting on the pavement structure which consists of asphaltic wearing course, binder course and asphaltic base course, on the existing road surface.

Rutting is not generally caused by a simple reasons but also several phenomena behaving among sets such as width of carriageway, number of lanes, traffic volume and its characteristic, pavement structure, mix desitn methods for asphalt concrete and material used, and compaction of pavement layers, etc.

Since detailed inspection and sampling survey for these rutting problems in Pakistan have not been conducted by the Study Team, it could not be defined for its cause. However, the following general comments can be made through visual observation;

i) Since pavement distortion was seen from a asphaltic wearing course on RC Bridge located near the section where rutting occured, it is estimated that the rutting is mainly due to the poor quality of mixed asphaltic base and surface course.

Photograph A Rutting Problems



ii) According to the specification for the project, a penetration of cut-back asphalt is specified as 80 - 120. An asphalt cement with a penetration of approximately 60 - 80 is generally used in order to prevent pavement distortion.

iii) Constructed pavement layers seems to be caused by too rich asphalt mixture consisting of high asphalt contents, poor aggregate gradations, and fractions that do not have enough stability to support the heavy traffic.

iv) The rutting occurring in Pakistan is not caused by asphaltic base course used but poor quality asphaltic base used. Asphaltic base course itself is one of effective pavement layers which prevent it from pavement distortion if proper mix design taken into account traffic, material and construction condition at site will be made.

The design criteria for standard mix design methods are applicable only to the prescribed test procedure within the limits of the original correlation. All necessary design modification should be made at the construction site on the basis of fully suppoted with additional correlation data covering the new limits or condition of design.

It is recommended that said asphaltic base course should be positively adopted for the pavement design introducing modern design, test, construction techniques in the future.

Appendix to Chapter 2 (Section 2.4)

THE ROLE AND WEIGHT OF THE ROAD NETWORK SELECTED FOR STUDY IN COMPARISON WITH THE ENTIRE NETWORK

- In the year 2005/06, it was forecasted that the road would carry 243,349 million passenger-kms and 46,390 ton-kms as a whole.

- On the other hand, the following traffic was allocated onto the study network according to the traffic assignment practices for the year 2005/06:

Car	14,335	(000 vehicle-kms/day)
Bus	8,962	(")
Truck	20,414	(")

- On the assumption that a car (including wagon) carries 5.32 passengers and a bus carries 38.39 passengers and that there are 330 working days a year, the annual passenger-kms can be calculated at 138,709 million. This is 57% of the forecasted total.

- Similarly the annual ton-kms can be calculated at 40,823 million on the assumption that the average load of a truck is 6.06 tons. This accounts for 88% of the forecasted total.

Appendix to Chapter 3 (Section 3.4.2)

Comparative Study of Pavement Design

The design of structural layers of flexible pavement for new carriageway of typical highways in the study highway network worked out with two different design methods for 10 years design life. For comparison purpose, 6% of the design CBR is used for both design methods.

(1) Flexible Pavement Design Using Road Note 29

In the Road Note 29 the thickness of each pavement component is determined by use of nomograms showing the relation between cumulative number of standard axles and required thickness.

The minimum thickness of pavement component are specified in the Road Note 29 as follows:

Granular Subbase	:	150 mm
Base Course		
Wet-mix and dry bounded Macadam base	:	100 mm
Rolled Asphalt base	:	120 mm (C.S.A.[1]/ 11.0×10^6)
Surfacing	:	100 mm (C.S.A. 11.0×10^6)
Wearing course	:	40 mm
Binder course	:	60 mm

According to this design procedure the thickness of subbase depends upon the design CBR value of subgrade soil and minimum requirements of Subbase for design CBR values of 8% and above upto 30% would remain the same for a particular range of standard axles. The thickness of other layer components however, are related with standard axles only.

In the present case the design CBR values for the entire range reach between 8% and 25% and hence the subbase thickness requirement would be uniformly the same, for both design lives. The thickness requirement for base course and surfacing would however, change according to the design life. Comparison result is presented in Table BB.

(2) Flexible Pavement Design Using AASHTO INTERIM GUIDE

The following criteria is applicable to AASHTO pavement design.

Serviceability Index (P): A serviceability index of 2.5 is recommended by AASHTO for the design of major highways. This index value has been used for the design of flexible pavement structures.

1/ C.S.A: Cumulative Number of Standard Axles

Soil Support Value (S): The design CBR of the project area is assumed at minimum 6., and the soil support value as converted from the CBR is determined at S = 4.67. (S = 0.807 + 4.59656 x Log (CBR))

Regional Factor (R): A regional factor was included in the AASHTO design procedure to make the design equation applicable for an area with climatic and environmental conditions different from those at the AASHTO Road Test site.

The regional factor of 1.0 has been adopted.

Structural Number (SN): The structural number is an abstract number expressing the structural strength of the pavement required for a given soil support value (S), total accumulated equivalent single axle loads (8.2 ton), serviceability index and regional factor.

This relationship is solved graphically by use of the nomograph presented as Figure AA which is based upon a serviceability index (P) of 2.5. The SN as obtained from Figure AA and its relation with the actual thickness is expressed by the following equation based on the structural layer coefficients:

$$SN = a_1D_1 + a_2D_2 + a_3D_3$$

where:

a_1, a_2, & a_3 = layer coefficients for surfacing, base course and subbase, respectively

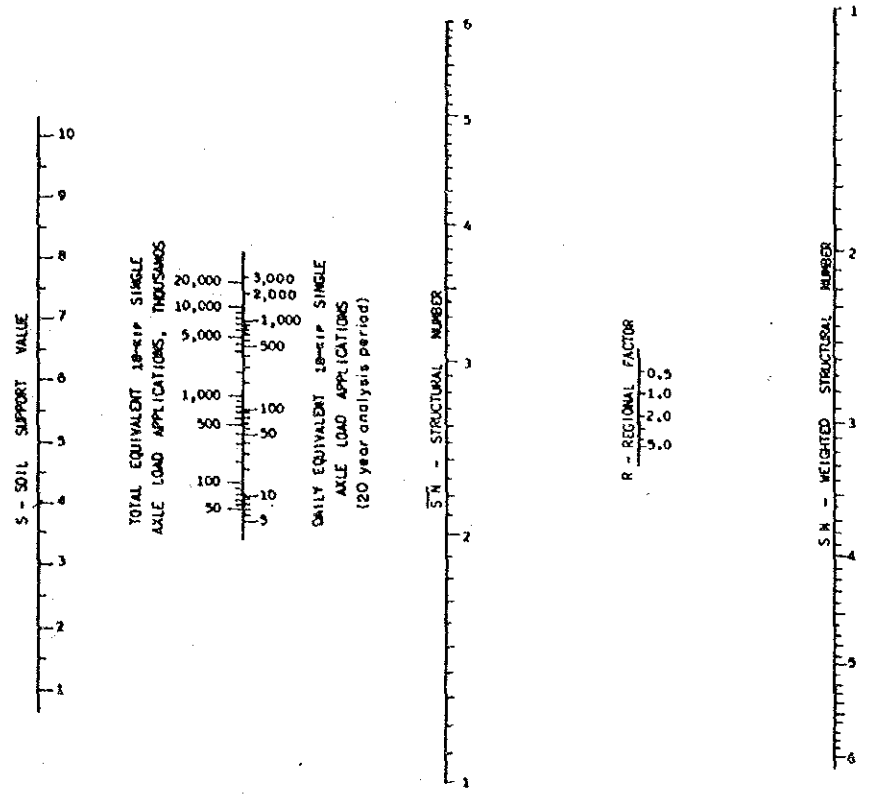
D_1, D_2, & D_3 = layer thickness of surfacing, base course and subbase, respectively.

Pavement Component Material	Layer Coefficients
- Asphaltic concrete wearing course (high stability). (use 1500 lbs)	0.44
- Asphaltic concrete wearing course with min. stability of 1000 lbs.	0.40
- Asphalt treated base course with min. stability of 1200 lbs.	0.34
- Asphalt treated base course with min. stability of 800 lbs.	0.30
- Crushed stone base course/subbase (min. BCR = 100%)	0.14
- Cement treated base course 400 to 650 psi	0.20
- Sand-gravel subbase (min. CBR = 25%)	0.11

Determination of the Pavement Component Thickness

Base on the criteria hereinbefore, using the typical axle loading of the various classes of highway, the typical thickness of the pavement components for a 10 year period is determined and summarized as Table AA.

Fig. AA Design Chart for Flexible Pavements. Pt-2.5



Source: AASHTO Interim Guide for Design of Pavement Structure, 1972

Table - AA Pavement Design for 10 Years Design Life by AASHTO Method

C.S.A (x 10^6)		20.0	10.0	5.0	0.5
Design Parameters					
Serviceability Index (Pt)	=	2.5	2.5	2.5	2.5
Design CBR (%)	=	6	6	6	6
Soil Support Value (S)	=	4.67	4.67	4.67	4.67
Regional Factor (R)	=	1.0	1.0	1.0	1.0
Structural Design					
Required Structural Number over sub-grade soil (SN)	=	5.10	4.65	4.15	2.83
Soil Support Value for base course (CBR = 80%)	=	9.55	9.55	9.55	9.55
Required Structural Number over-base course (SN)	=	2.70	2.40	2.08	1.30
Soil Support Value for Sub-base course (CBR=25%)	=	7.23	7.23	7.23	7.23
Required Structural number over sub-base (SN_2)	=	3.70	3.35	2.92	1.93
Mini Thickness of Asphaltic Concrete ($D_1 = SN_1/a_1$) $a_1 = 0.40$	=	6.75'	6.0'	5.2'	3.25'
Mini Thickness of Base Course $a_2 = 0.14$ $(D_2 = \frac{SN_2 - SN_1}{a2})$	=	7.14'	6.79'	6.0'	4.5'
Mini Thickness of Sub-base $a^3 = 0.11$ $(D_3 = \frac{SN - SN_2}{a3})$	=	12.73'	11.82'	11.18'	8.18'

Design of Structural Components

		mm	mm	mm	mm
Surfacing : Thickness and (SN)	=	170 (2.68)	150(2.36)	130(2.05)	80(1.26)
Base Course: Thickness and (SN)	=	180 (0.99)	170(0.94)	150(0.83)	120(0.66)
Sub-base : Thickness and (SN)	=	330 (1.43)	300(1.30)	280(1.21)	210(0.91)
Total SN :	=	(5.10)	(4.60)	(4.09)	(2.83)

Table - BB Comparative Study of Pavement Design Worked out with Different Methods

(Design CBR 6%)

Design Period	10 Years			10 Years			10 Years			10 Years		
Typical C.S.A[1]	20.0×10^6			10.0×10^6			5.0×10^6			0.5×10^6		
Highway Class	I/II			II/III			IV			V		
Design Method	AASHTO[2]	NO.29[3]	JICA[4]	AASHTO	NO.29	JICA	AASHTO	NO.29	JICA	AASHTO	NO.29	JICA
Selected Subbase (mm)	330	220	250	300	200	200	280	200	200	210	150	150
Granular Base (mm)	180	240	250	170	220	250	150	200	200	120	135	150
Asphaltic Base & Binder, Wearing Course (mm)	170	160	160	150	100	100	130	100	100	80	60	70
Total Thickness (mm)	680	620	660	620	520	550	560	500	500	410	345	370

Note 1/ Typical Cumulative Number of Standard Axles for Comparison

2/ AASHTO Interim Guide for Design of Pavement Structures, 1972

3/ Road Note 29 (UK)

4/ Pavement Structure used for this study

ROAD TRANSPORT PLANNING

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ROAD TRANSPORT PLANNING

CHAPTER 1 PRESENT CONDITION AND PROBLEMS

CHAPTER 1 PRESENT CONDITION AND PROBLEMS

This chapter discusses existing condition and characteristics of road transport sector; studies were made on organizational structure, road transport industry, vehicle fleet, present fleet capacity analysis for inter-city operations, traffic data, traffic characteristics, road accidents and road safety measures. Present vehicle fleet capacity for inter-city operation was carried out giving assumption to the annual usage, load factor and urban inter-city split.

The actual performance in the current Sixth Five Year Plan period was also reviewed. Vehicle operating costs for representative vehicles were estimated for the analyses of vehicle efficiency both passenger and freight vehicles and for estimation of marginal transport costs per passenger·km and ton·km.

As a result, problem area of road transport sector is discussed at the end of this chapter.

1.1 Organization and Road Transport Industry

1.1.1 Administration

(1) Functions

Road transport administrations are responsible for vehicle registration, driving licence, route permit, fare structures on the basis of Motor Vehicle Act of 1965 and the Motor Vehicle Ordinance, both federal and provincial levels.

(2) Administration

1) Federal

The Ministry of Communications is responsible for Road Transport Sector at Federal level. National Logistic Cell having over 1,750 truck trailers/bowsers has recently come under the function of Planning Division.

2) Province/District

Provincial Government has responsibilities for Road Transport on registration, route permit and fare.

The PTA's deal with the private sector and are concluding bilateral agreements with the other provinces for route permits of inter-provincial route. PTA's are also issuing licences of the General and Company bus stands.

Route permits have been freely issued since the 1970's for public passenger vehicles. Trucking industry has complete freedom as to

routes, the type of vehicles used for different cargoes and tariff setting.

RTA's functioning under the control of PTA's are issuing route permits to the owners of private vehicles and licence to body building workshops. For the transportation of goods, licences are issued to the goods forwarding agencies.

3) NTRC

National Transport Research Centre (NTRC) was established in 1974 and has been conducting a series of research and surveys in the matter of road and road transport.

4) Road Safety Wing

Road Savety Wing of MOC is responsible for driver training school at Islamabad.

1.1.2 Transport Industry

(1) Public and Semi-Public Transport Corporations

In the passenger transport, there are five Semi-Public Corporations, namely Karachi Transport Corporation (KTC), Sind Road Transport Corporation (SRTC), Punjab Road Transport Corporation (PRTC), NWFP Road Transport Board (NWFP RTB) and Northern Area Transport Corporation (NATCO).

KTC alone caters for urban transportation while other Board/Corporations operate both urban and inter-city passenger services. NATCO established in 1974 as a private limited company under the Companies Act 1913 is mainly responsible for providing transport service, both passengers and goods, for the Northern Areas.

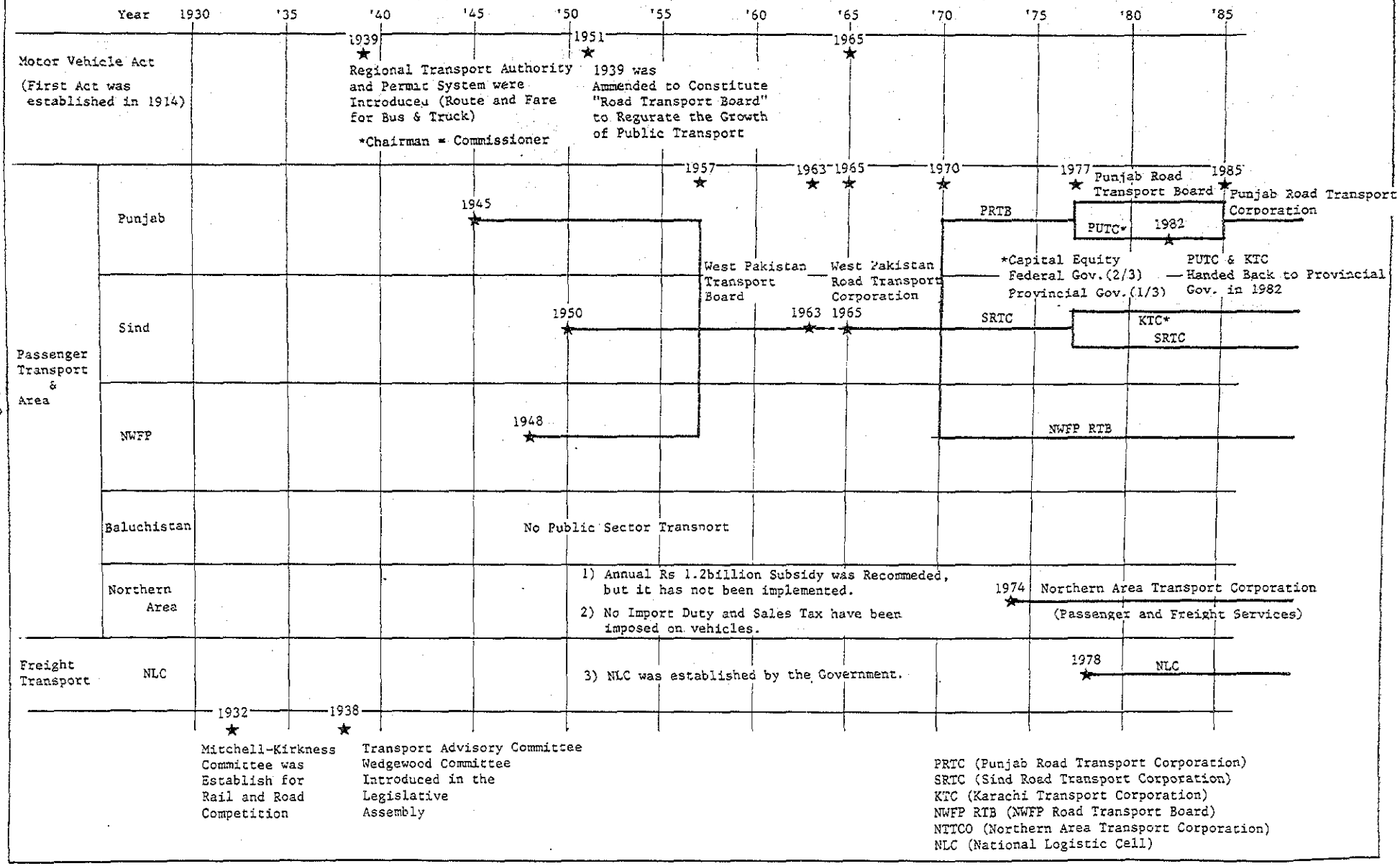
It is to be noted that there is no public sector bus transport services in the Province of Baluchistan. Buses are operated by private firms.

Public sector trucking operations started by the National Logistic Cell (NLC) within the army was established in 1978 by the Government to facilitate the movement of essential goods. A chart of historical development of public and semi-public transport corporations are cited in Fig. 1.1.1.

1) Semi-public Bus Corporations

Government bus operations are poorly maintained especially PRTC, the for effective management. It has been said that operation, care and maintenance of buses is very poor due to the staff's performance. A large number of buses are, therefore, out of order.

Fig. 1.1.1 Historical Development of Public Road Transport in Pakistan



PRTC's inter-city operations have deteriorated and given up recently to use leased private buses of 317 units which earned Rs. 56.48 million in 1985/86. The Punjab Government once decided to sell PRTC's inter-city operations but has not executed it so far. As far as operating ratio of costs to revenues is concerned, PRTC was 163, SRTC 113 and NWFP RTB only 110 in 1985/86.

However, Government buses are providing services on unprofitable routes in accordance with the time table that can not serve the private sector. It means that only government bus services will be able to cope with the political needs and Basic Human Needs for the local people especially isolated areas. For example NWFP RTB has bus service routes for areas such as Kalam, Dasu, Dir and Naran.

Table 1.1.1 shows the present situation of inter-city bus operations by semi-public bus corporations in 1985/86. Semi-public bus corporations own the bus fleet of some 1,100 vehicles, which shares only 5.5 percent out of the inter-city buses on the road of 20,463 units in 1986.

In order to find the service share of semi-public inter-city bus operations out of total inter-city bus operations, the Study Team first compiled the time tables obtained from semi-public bus corporations in Sept. 1987. Secondly, the study team found the share of semi-public bus corporations, in terms of vehicle·km province-wise on the basis of Inter-Zonal Bus O-D Table in 1985/86.

Table 1.1.2, shows that the actual share of Semi-Public Corporations in the inter-zonal operation was 11.02% and share of PRTC, SRTC, NWFP RTB and NATCO are 3.99%, 1.52%, 5.30% and 0.21% respectively, in terms of passenger·km. Total inter-zonal passenger·km in 1986 was 45,969 million as against inter-city passenger·km of 97,374 million. The actual share of semi-public bus corporations in inter-city operations will be 5.1% out of the total bus passenger·km.

Semi-public bus corporations own large buses which have a seating capacity of 42 - 48 persons for inter-city bus services.

As far as NWFP RTB inter-city bus operation is concerned, about 50% of bus service is found in the NWFP and the rest is in Punjab.

Route coverage by Semi-public and air-conditioned mini bus operating routes are 43.4 and 19.3 percent out of about 18,270 km of the Network.

Route Map of Semi-Public Inter-City Bus Service is presented in Fig. 1.1.2.

NWFP RTB is being induced to use 100 buses for inter-city services, and PRTC having lots of aged buses over 12 years, gave up to use the leased buses recently. The estimated share of Semi-public Corporations will be changed in the near future.

Table 1.1.1 Inter-City Public Bus Operations by Corporation in 1985/86

Item	Inter-City Bus Operation		
	PRTC	SRTC	NWFP RTB
1. No. of Buses on Roads	379	185	564 1987(745)1/
2. Average age	12	7.5	4.5
3. No. of Bus Make	4	4	3
4. Seating Capacity	52	64	48
5. Average load and No. of Passenger Carried per Bus/day	42/147	-/281	70% 86
6. Total km Operated per Annum (million) and per Day (km)	26.4/215	19.4/336	46.1/237
7. Staff per Bus	18	9	4
9. Total Length of Routes (km)	103	61	135
10. Average Length of Route (km)	14,881	8,956	23,058
10. Average length of Route (km)	145	147	171
11. Average Income per km (Rs)	3.57	4.26	3.95
12. Average Cost/km (Rs)	5.83	4.81	4.36
13. Average Loss/km (Rs)	2.26	0.55	0.41
14. Subsidy from Government	(261.4*)	-	3.39
15. No. of Leased Buses	317 1987 (0)2/		-
16. Earnings from Leased Buses (Rs Million)	56.48	-	-
17. Capital Investment	-	-	238.35
18. Share of Total Bus Traffic inter-city services	3.37	1.29	4.47

PRTC: Punjab Road Transport Corporation

SRTC: Sind Road Transport Corporation

NWFP RTB : NWFP Road Transport Board

Source: Report of the Sub-Working Group for Seventh Plan.

* Both for Inter-City and Urban Operation.

1/ No. of Buses in 1987

2/ PRTC stoped to use Leased Buses in 1987

Table 1.1.2 Operating Share of Semi-Public Inter-Zonal Bus Service on the Network in 1987

Unit: 1,000

	Semi-Public Bus Corporation									
	PRTC		SRTC		NWFP RTB		NATCO		Semi-Public Total	
Organization	Pass.-Km	(Share%)	Pass.-Km	(Share%)	Pass.-Km	(Share%)	Pass.-Km	(Share%)	Pass.-Km	(Share%)
Province										
Punjab	4,232	97.88	42	2.49	2,916	49.72	33.00	14.58	7,314	60.00
(Share%)	6.00		0.06		4.14		0.05		10.37	
Sind	0	0.00	1,642	97.51	0	0.00	0.00	0.00	1,642	13.46
(Share%)	0.00		6.85		0.00		0.00		6.85	
NWFP	61	1.38	0	0.00	2,949	50.28	194.00	85.42	3,204	26.27
(Share%)	0.65		0.00		31.51		2.07		34.23	
Baluchistan	33	0.74	1,684	0.00	0	0.00	0.00	0.00	33	0.27
(Share%)	0.48		24.63		0.00		0.00		0.48	
Total	4,417	100.00	1,684	100.00	5,865	100.00	227.00	100.00	12,193	100.00
(Share%)	3.99		1.52		5.30		0.21		11.02	

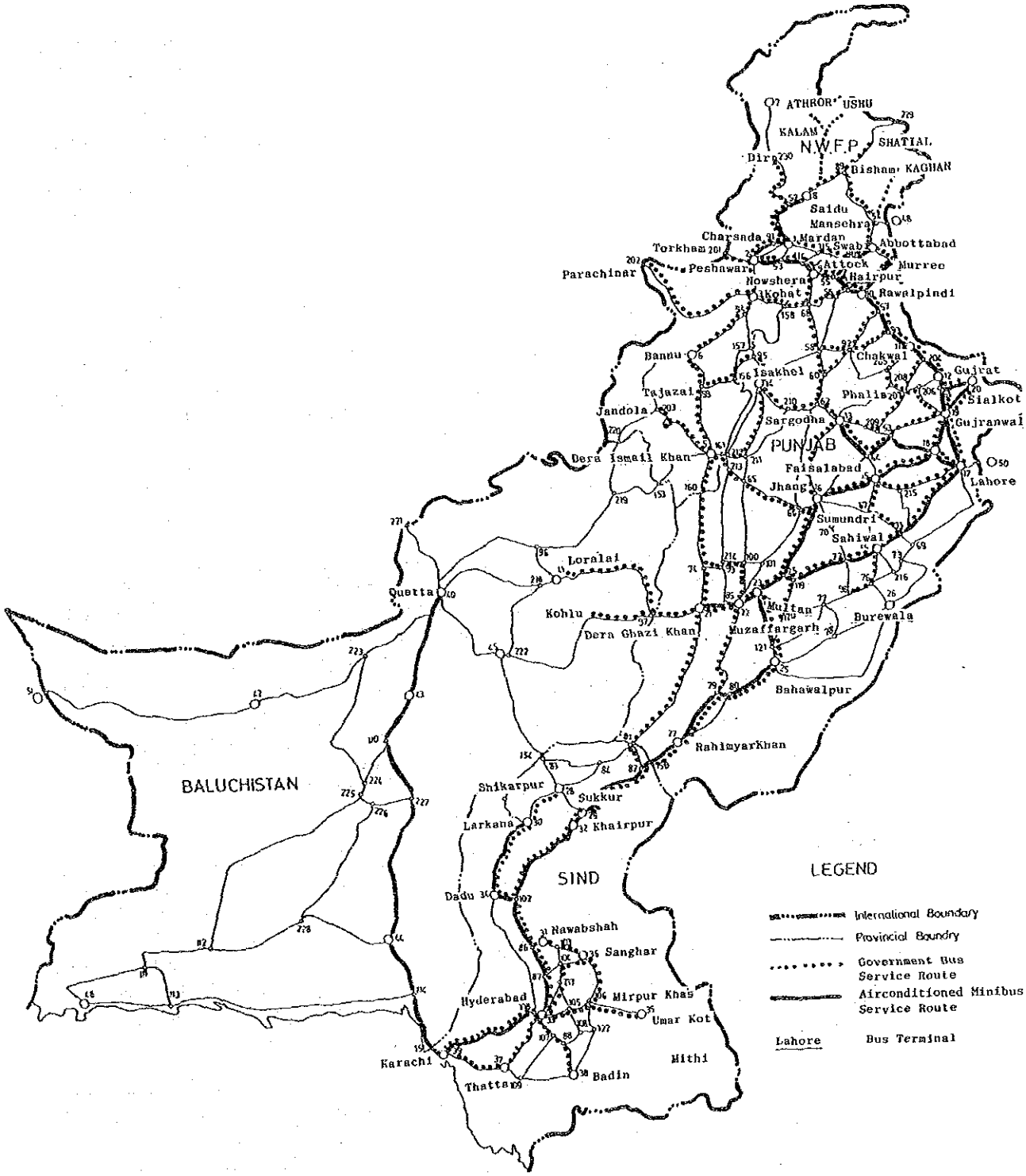
	Private Sector						Total Assigned Inter-Zonal Passenger-Km	
	Air Con. Mini Bus		Ordinary Bus		Private Total			
	Pass.-Km	(Share%)	Pass.-Km	(Share%)	Pass.-Km	(Share%)	Pass.-Km	(Share%)
	3,670	68.69	59,519	63.91	63,189	64.17	70,503	63.71
	5.21		84.42		89.63		100.00	
	1,057	19.78	21,259	22.83	22,316	22.67	23,958	21.65
	4.41		88.73		93.15		100.00	
	400	7.49	5,756	6.18	6,156	6.25	9,360	8.46
	4.27		61.50		65.77		100.00	
	216	4.04	6,589	7.08	6,805	6.91	6,838	6.18
	3.16		96.36		99.52		100.00	
	5,343	100.00	93,123	100.00	98,466	100.00	110,659	100.00
	4.83		84.15		88.98		100.00	

1 Data Compiled from the time table obtained from Semi-Public Corporation in Sep. , 1987
2 Data Compiled from the Survey conducted by the Study Team

Note: Inter-Zonal Passenger-km in 1986 : 45,969 million
Inter-City Passenger-km in 1986 : 97,374 million

Note: Inter-Zonal Passenger·Km in 1986; 45,969 million
Inter-City Passenger·Km in 1986; 97,374 million

Fig. 1.1.2 Route Map of Semi-Public Inter-City Bus Operations



2) National Logistic Cell

The NLC is the largest freight transporter in the road transport industry. The NLC also has a coordinating function in the transport of bulky commodities by allocating the service to other hauliers including railways.

As shown in App. Table 1-1 NLC's fleet consists of 1,765 vehicles including bowsers in 1987. The total capacities are about 33,000 tons of dry cargo and 10,424 tons of liquid cargo.

Since the setting up of the NLC organization, NLC extended their operations serving transport of crude oil from oil fields to refineries and export/import of goods from/to Karachi and Qasim Ports. The operating routes of NLC are shown in Fig. 1.1.3 with NLC stations, dry ports and other facilities.

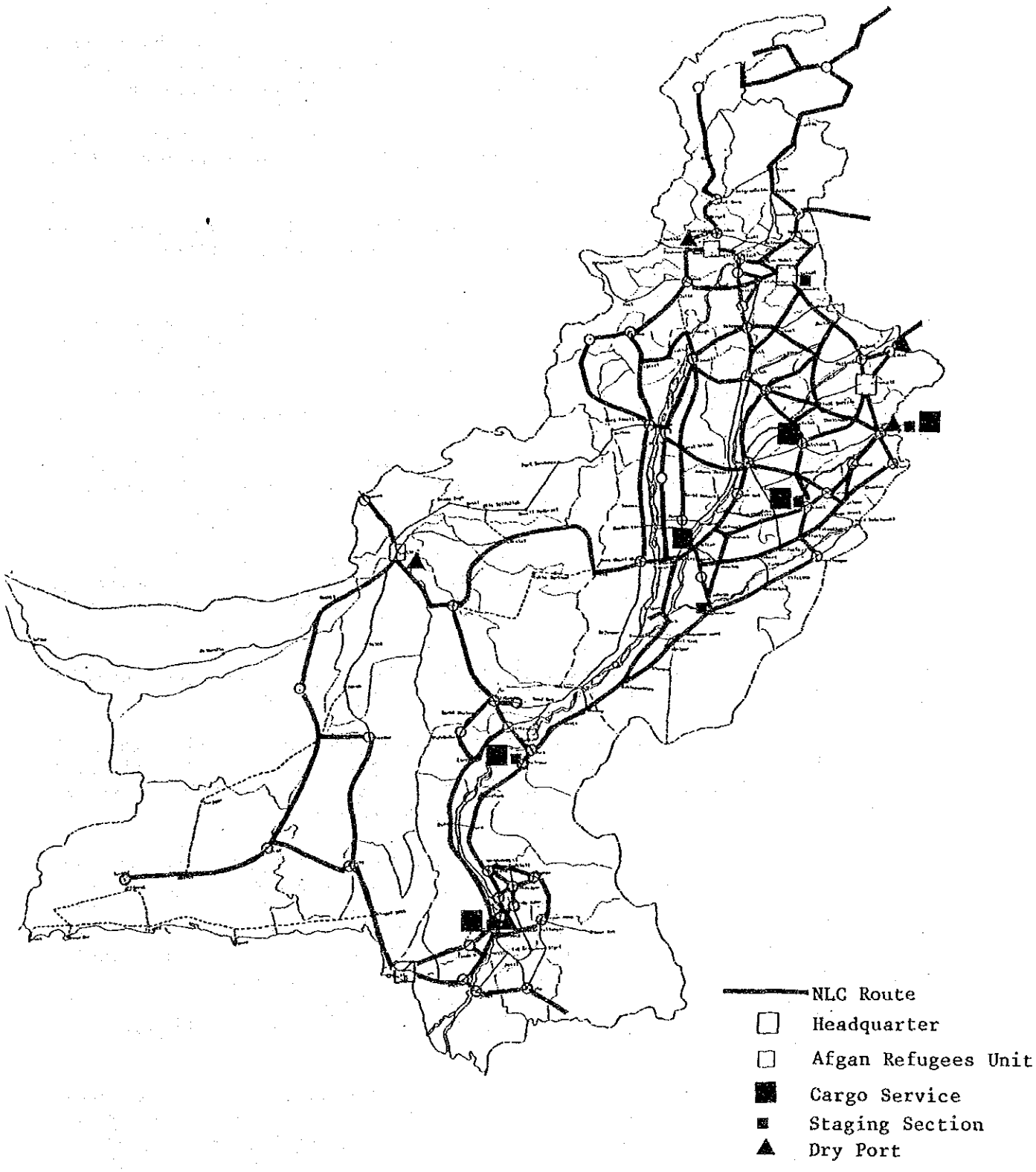
As shown in App. Table 1-2 NLC trucks carried an average of 1.6 million tons of dry cargo from 1979 to 1985. Although, 1.6 million ton amounts to only 4.2 percent of the total dry cargo road traffic of 38,414 million ton is 1985/86. It is concentrated on a few essential commodities of wheat, fertilizer, cement and rice. In 1984/85, NLC carried 37 percent of imported wheat, 50 percent of imported fartilizer, 20 percent of imported cement, and 60 percent of exported rice with Hired Mechanical Trucks. In addition to dry cargoes, as mentioned in App. Table 1-3, NLC carried Liquid cargoes of 337 million ton·km in 1986/87.

Present NLC fleet of 1,765 units account for only 3.4 percent of the total inter-city trucks on the road of 52,331 units in 1985/86. While, present capacity of NLC fleets in terms of ton·km in conjunction with the Capacity Analysis is concerned, NLC was able to carry 1,835 million ton·km on the basis of an average load capacity of NLC trailer of 23.4 ton with an annual usage of 65,000 km and an average load factor of 70 percent. However, the Team obtained actual ton·km data carried by NLC in 1986/87 of 1,442 million ton·km that would be 5.4 percent out of the total inter-city road freight traffic of 26,859 million ton·km as compared to 6.8 percent of the Capacity.

In addition, NLC hires private trucks of the so called HMT so as to carry essential commodities such as rice from public sector agencies. For example, in 1984/85 HMT carried 37 percent of rice to Karachi as compared to 20 percent of NLC out of the total rice movement including Pakistan Railway. Therefore, actual ton·km carried by NLC and HMT trucks might be more than 6 percent in spite of NLC having a higher tariff rate against the private sector.

In 1985, Pakistan Railways was given the priority to move imported wheat and was able to move it satisfactorily, resulting in NLC having surplus trucking capacity. After that, NLC extend their operations carrying cross-country traffic and crude oil as well as their original up-country traffics.

Fig. 1.1.3 NLC Routes and Facilities



(2) Private Operators

Private element in the passenger service sector means the private owner and enterprises engaged in the service. No statistical data showing the performance of the private element are available.

Besides the Flying Coach Companies, the big bus companies have been disintegrated before the enforcement of the Transport Policy in the Sixth Five Year Plan.

The private bus industry is not disciplined and the travelling passengers are not properly provided required facilities such as General Bus Stands.

The Pakistan Motor Transport Federation is the only representative body of the private bus transporters who look after their problems/difficulties being faced by them from time to time, such as maintenance of roads, increase in bus fares, maintenance of General Bus Stands and other operational difficulties.

And, the West Pakistan Transporters Mutual Assistance Co-Operative Society Limited took the responsibility of paying compensation to the victims of road accidents on behalf of its members.

On the other hand, in the last five years, a number of companies started to operate the so-called Flying Coach air-conditioned inter-city mini-bus services. These operations have been growing rapidly in spite of the doubled fare of ordinary buses.

Large size air-conditioned buses having 43 seats is becoming popular instead of Toyota Coaster having 19 seats.

As far as freight transport is concerned, the trucking industry also comprises both private firms and the public (NLC). The NTRC survey financed by the UK ODA indicates that 88 percent of the trucking fleet was owned by private operators.

Truckers usually obtain loads from the so-called forwarders who are the interface between the shippers and the operators.

Since the trucking industry was deregulated from 1960's, the free freight market in Pakistan is well organized. Forwarders usually own warehouses and trucks, and their run business on a family basis with partners or contractors in other cities obtaining 6 to 7 percent commission from shippers, including compensation for the cargoes.

Freight tariffs fluctuate from day to day according to the market demand. The forwarders found it substantially less costly per ton·km after using Japanese trucks as compared to Bedfords; when their chassis are modified by dummy third axle or converted to a semi-trailer.

These private operators have often increased vehicle capacity by strengthening the chassis and mounted larger tyres so as to carry

11 to 13 ton cargoe against 7 tons of original capacity and 30 to 40 tons as against 25 to 30 ton original capacity.

Overloading of trucks are common but not strictly enforced. Major problems with private operators are banking and insurance facilities. Banks and Insurance Companies do not deal with private transporters because of lack of trust.

1.2 Vehicle Fleet and Capacity Analysis

1.2.1 Vehicle Fleet

(1) Motor Vehicles on Road

Since the registration statistics are not reliable because scrapping of damaged and worn-out vehicles are not enforced exactly according to the registration, the data of "Motor Vehicle on Road"[1/] is adopted for this study.

An example of difference between the registered vehicles and the actual vehicles on the road is shown below:

Total Vehicles

		1980	1983
(A)	Registered[2/]	1,171,074	1,606,951
(B)	Net[1/] Vehicle on Road	689,763	951,240
(C)	(B)/(A)	0.589	0.592

It is apparent that the statistical data showing the registered vehicles are almost 40% higher than the actual movable and registered vehicles.

In Table 1.2.1, motor vehicles on the road with population and GDP per capita in Pakistan are shown between the year 1976 and 1985. According to this table, there was 1.17 million motorized vehicles in 1985 of which 520,000 motorcycles share 45% of the total and 170,000 tractors 15%. The remaining vehicles of sedans to trucks account for 480,000 (40%).

Table 1.2.2 shows the vehicles on roads is 1975 and 1985 and their composition percentages in respective years. Fig. 1.2.1 shows the changes in composition percentage between these two years. Increase of vehicles in those ten years are high: small vehicles of cars, jeep, wagon, taxi increased at 13% p.a., small and pickups at 29% p.a., buses at 8% and trucks at 10%. Percent share of small vehicles and tractors increased while other types decreased in the ten years.

(2) Production of Vehicles in Pakistan

Following the nationalization of the transport industry in 1972, Pakistan Automobile Corporation, Ltd. (PACO) was established in 1973.

1/ NTRC Transport statistics 1984
2/ Ibid

Table 1.2.1 Motor Vehicles on Roads in Pakistan[1/]

	Type of Vehicle / Year	Motor Cycle/ Scooter	Motor Car, Jeep, Wagon	Tractor	Bus	Taxi	Motor Rickshaw	Delivery Van	Truck	Others	Total	GDP (Million Rs)	Population ('000)	GDP/ Capita (Rs)	GDP/ Capita (US$)
	1976	134,293	88,031	21,653	18,253	10,960	18,235	1,739	24,569	5,528	323,261	267,767	75,444	3,549	197
	1977	165,757	102,589	30,102	19,082	11,658	19,457	2,576	26,218	6,810	384,249	288,952	77,752	3,716	206
	1978	205,136	120,428	38,446	20,371	12,546	22,287	3,591	28,640	8,310	459,755	305,023	80,130	3,807	212
	1979	240,377	138,914	45,855	22,052	14,271	25,725	5,144	31,030	9,940	533,308	326,958	82,581	3,959	220
	1980	289,328	183,694	68,625	25,548	16,819	32,226	8,300	36,341	28,882	689,763	348,027	84,254	4,131	230
	1981	328,346	189,373	79,660	27,144	17,699	34,001	10,069	38,750	38,378	763,420	372,477	87,758	4,244	236
	1982	370,189	207,782	91,173	26,987	19,245	34,682	11,996	42,282	46,587	850,923	396,481	90,480	4,382	243
1)	1983	418,684	228,463	108,544	29,300	20,364	36,521	13,134	44,539	51,691	951,240	414,979	93,286	4,448	247
	1984	476,855	236,341	146,578	29,955	21,226	38,013	16,827	47,015	47,143	1,059,953	451,828	96,180	4,698	261
2)	1985[2/]	519,959	279,261	170,521	33,486	22,508	40,398	17,762	54,275	30,053	1,168,223	485,210	97,649	4,969	276
	1992											751,337	120,955	6,212	345
	1997											1,006,461	139,975	7,190	399
	2005											1,571,158	172,485	9,109	506

Source 1/ NTRC Transport Statistics, 1984
Source 2/ Report of the Sub-Working Group for Seventh Plan

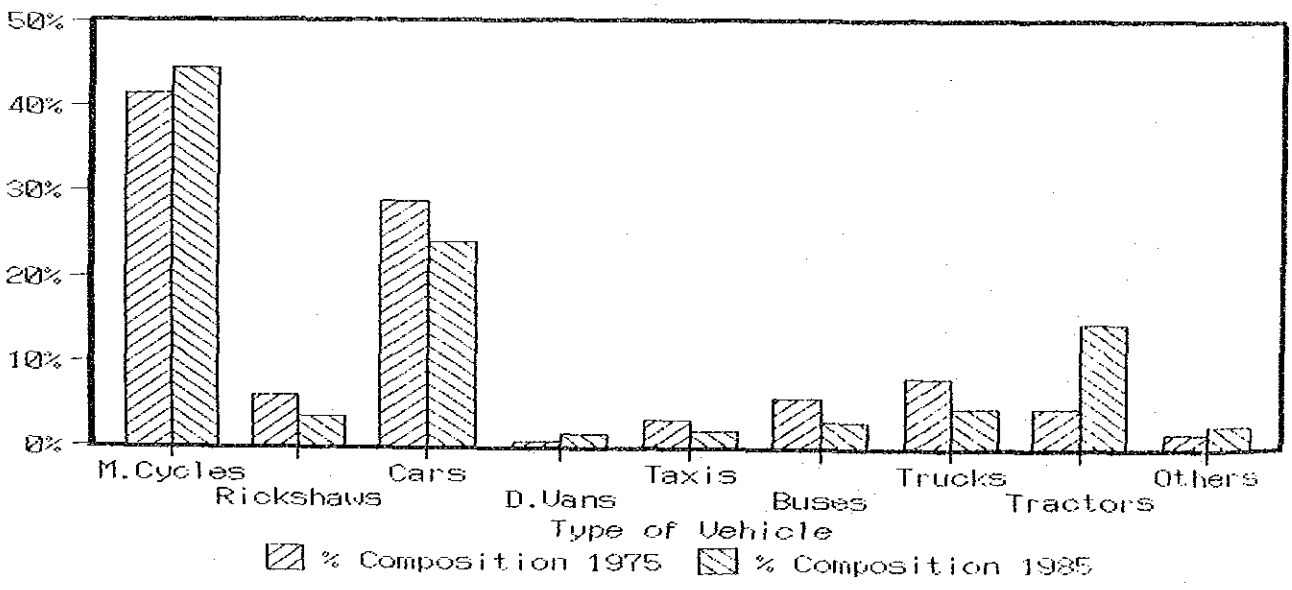
US$ = 18 RS

Table 1.2.2 Motor Vehicles on Roads 1975 and 1985 (Pakistan)

St. No.	Vehicle Type	No. of Vehicle		% Composition		ACGR (1975-1985)
		1975	1985	1975	1985	
1	Motorcycle	112,295	519,959	41.55%	44.51%	16.56%
2	Rickshaws	15,832	40,398	5.86%	3.46%	9.82%
3	Cars, Jeeps & Wagon	77,730	279,261	28.76%	23.90%	13.64%
4	Delivery Van	1,378	17,762	0.51%	1.52%	29.13%
5	Taxi	8,530	22,508	3.16%	1.93%	10.19%
6	Buses	15,538	33,486	5.75%	2.87%	7.98%
7	Trucks	21,977	54,275	8.13%	4.65%	9.46%
8	Tractor	12,691	170,521	4.70%	14.60%	29.67%
9	Others	4,287	30,053	1.59%	2.57%	21.50%
Total		270,258	1,168,223	100.00%	100.00%	15.76%

Note :
1: Motor Cycle 2: Rickshaws 3: Motor Cars, Jeeps and Station Wagons
4: Delivery Van 5: Taxi 6: Buses
7: Trucks 8: Tractor 9: Others

Fig. 1.2.1 Composition of Motor Vehicle on Road 1975 and 1985 (Pakistan)



Source: Table 1.2.2

The corporation has 14 operating units; 3 units in assembly and manufacture of tractors, 5 units in assembly of vehicles, one unit in assembly and manufacture of motorcycle/vehicles, one unit in assembly of engines, one unit in manufacture of refrigerators and air-conditioners, one unit in manufacture of trailers, one unit in manufacture of wheel rims and one unit in automotive castings.

Names of the 14 units of the corporation are as follows:

Public Limited Companies

- Bela Engineers
- Millat Tractor
- National Motors
- Mack Trucks
- Al-Ghazi Tractors
- Pak Suzuki Motor Company
- Baluchistan Wheels
- Bolan Casting (Since July 1986)

Private Limited Companies

- Domestic Appliances
- Naya Daur Motors
- Hino Pak Motors
- Sind Engineering
- Trailer Development
- Pakistan Motorcar Company (Pvt). Limited (Since 1st Sept. 1987)

Rated capacity and production of PACO subsidiaries in 1985/86 and 1986/87 are shown in App. Table 1-4.

The production between 1973/74 and 1984/85 is shown in App. Table 1-5. The total produced was 52,000 in 1984/85, while it was 36,400 in 1980/81. The average growth was 7.4% p.a. in those years.

(3) Import of Motor Vehicles

Most of the motor vehicles have been imported under the personal baggage (expatriate remittance) scheme, which permits the import of an assembled vehicle at the interval of every 2 years without a licence and at reduced rate of duty. The scheme allows the import of buses, trucks and LVCs. App. Table 1-6 gives details of import of vehicles. As shown in the Table, total import of vehicles peaked and import of tractors were stopped in 1979/80. Import in 1983/84 was 123,000 for the total and motorcycles 50,298 (41.0%) followed by cars 43,370 (35.4%), and trucks 13,844 (11.2%).

(4) Sales of Motor Vehicles in Pakistan

App. Table 1-7 shows details of sales of motor vehicles in Pakistan between 1973/74 and 1984/85. Vehicle sales consist of the produce in assembly plants, inventory and parts of the import.

Sales total was 18,859 in 1973/74, 37792 in 1977/78, and 52169 in 1984/85. The average annual growth rate during the above 11 years was 9.5%, which in the recent five years from 1979/80 to 1984/85, the average growth was 7.0% p.a. Trucks and buses decreased their sales, while others increased in the five years.

1.2.2 Present Vehicle Fleet Capacity Analysis

(1) Annual Usage, Load Factor and Average Life of Vehicles

As shown in Table 1.2.3, annual usage (km) and vehicle load factor are compared from relevant studies already conducted in Pakistan including the Sub-Working Group Report.

The annual usage, load factor and average life by type of vehicle are quite essential for calculation of fleet capacity analysis, vehicle operating cost, vehicle·km passenger·km and ton·km. These figures would also be directly reflected on the cost items of depreciation and interest in the vehicle operating costs.

After discussions with persons concerned in Pakistan and reviewing data mentioned in following Table 1.2.3 the adopted figures mentioned in the bottom line are determined. They are mostly same as those used in the Sub-Working Group for the Seventh Five Year Plan.

Table 1.2.3 Annual Usage (km) & Load Factor

	Relevant Studies		Passenger Traffic									Freight Traffic		
			1*	2*	3*	4*	5	6	7*	8*	9*	10*	11*	12
			Bus	Mini Bus	Wagon	Pick-up	Taxi	Pickshaw	Car	Jeep	Motor Cycle	Truck	Truck Trailer	Van
1	Sub Working Group Report	· Annual Usage (AU)	75,000	60,000	50,000	40,000	25,000	30,000	14,000	14,000	10,000	70,000	64,000	40,000
		· Vehicle Life (VL)	10	10	10	10	10	10	10	10	10	10	10	10
		· Average Load (AL)	38	16	12	8	3	2	3	3	1	8.3	11.4	0.5
2	National Highway Maintenance Study	· Annual Usage	65,000	38,000		25,000			13,000			70,000	70,000	
		· Vehicle Life	7	8		8			12			12	12	
		· Average Load												
3	Motor Vehicle Utilization Survey NTRC-77	· Annual Usage	44,000		30,000	17,000		16,000	19,000		7,500	47,000		
		· Vehicle Life	13		12	12		12	15		15	16		
		· Average Load	38.4		12				3.2			Ⓐ		
4	Vehicle User Cost Pakistan 1977 MOC	· Annual Usage	63,000	50,000					15,000			60,000		
		· Vehicle Life	7	8					12			10		
5	JICA 1982	· Annual Usage	65,990									75,000		
6	Truck & Bus Survey	· Annual Usage	54,717									70,860		
7	Traffic Count Data 1974-75		79,010									82,620		
8	Survival Rate of Motor Vehicle in Pakistan NRTC-90	· Annual Life Private	11			12	14	10	16	12	14	12		12
		Public	8											
9	Survey of Mechanized Road Transport, NTRC	· Annual usage	63,000	56,000			34,000					60,000		
10	Adopted Figures for This Study	· Average Usage	65,000	55,000	50,000	25,000	30,000	30,000	14,000	14,000	10,000	75,000	65,000	40,000
		· Vehicle Life Private	11	10	10	12	10	10	10	12	13	12	12	12
		Public	8											
		· Average Load	43.7	18	12	8	3	2	3	3	1	5.65	16.00	0.5

Ⓐ Average Load (Tons)

Cement	11.10	Coal	9.84	Iron and Steel	8.32
Rice	10.23	Sugar	9.35	Fruit and Vegetable	8.03
Wheat	10.17	Edible Oil	8.35	Other Commodity	7.63
Fertilizer	10.20	Fire Wood	8.36	Cotton	7.37

Unit: AU: km/year
VL: year
AL: Passenger & Ton

As far as load factors of bus and truck are concerned, the Study Team cross-checked with the figures used in the demand forecast and the 1982 JICA study. The demand forecast of this study and the JICA 1982 deal with three types of vehicle modes such as Bus, Motor Car and Truck. The demand forecast of this study has revised and the adopted average load factors for Bus, Motor Car and Truck of 38.4, 5.3 passengers and 6.06 tons respectively.

In order to incorporate the demand forecast of this study, road transport sector adopted the above cited figures and further readjusted an average load factor for each type of sub-categorized vehicles in bus, motor car and truck modes. As a result, load factors of ordinary size bus, conventional truck and truck trailer are 43.7 passengers, 5.68 and 16.0 tons per vehicle respectively. Average loads for other sub-categorized vehicles in each vehicle mode are same as the figures of the Sub-Working Group. Details are shown in Table 1.2.4 of Present Fleet Capacity Analysis.

(2) Present Inter-City Vehicle Capacity Analysis

Flow Chart of Present Fleet Capacity Analysis for Inter-City Operations is shown in the following Fig. 1.2.2.

1) Vehicle Composition on Roads in 1986 from the Sub-Working Group Report

As mentioned in Fig. 1.2.2, load factors for sub-categorized vehicles are determined considering the average loads of Bus, Motor Car and Truck modes.

Since, present number of vehicles on the road in 1986 are not available in the statistical data, the Team, therefore, adopted the figures from the SWG Report Table 4.5 as mentioned in Fig. 1.2.2 and Table 1.2.4.

2) Urban Inter-City Vehicle Split in Terms of Vehicle on Road

In order to carry out the present intercity vehicle fleet capacity analysis, the Study Team worked out the ratio on urban inter-city split in terms of vehicle on roads as cited in Table 1.2.4. These ratio on each vehicles are basically determined from the ratio used in the SWG Report, and the Team cross checked the share of vehicle·km in terms of Bus, Wagon, Motor Car, Motorcycle and Truck modes against average composition of traffic count. Then, finally the Team adjusted the ratio of motorcycles.

3) Present Inter-City Vehicle Fleet Capacity Analysis

Present inter-city vehicle fleet on road capacity in 1986 amounted to 82,655 million passenger·km and 23,715 million ton·km on the basis of inter-city vehicle on road, average annual kilometeres and load factor operated by different types of vehicles.

On the other hand, the demand forecast estimated the allocated inter-city passenger·km and ton·km in 1986 by road are 97,374 million passenger·km and 26,859 million ton·km respectively.

As mentioned in Table 1.2.4 the present inter-city vehicle fleet on road capacity in terms passenger·km is 85% and ton·km is 88% as compared to actual passenger and ton·km estimated by the demand forecast.

It can be envisaged that present actual load factors of intercity operation by different types of vehicles could be more than the load factors assumed for different types of vehicles in this capacity analysis. However, the Team adopt the assumed load factors for the future vehicle fleet planning so as to solve the present overloaded condition of vehicles both passenger and freight vehicles.

Fig. 1.2.2 Flow Chart of Present Fleet Capacity Analysis of Inter-City Operation

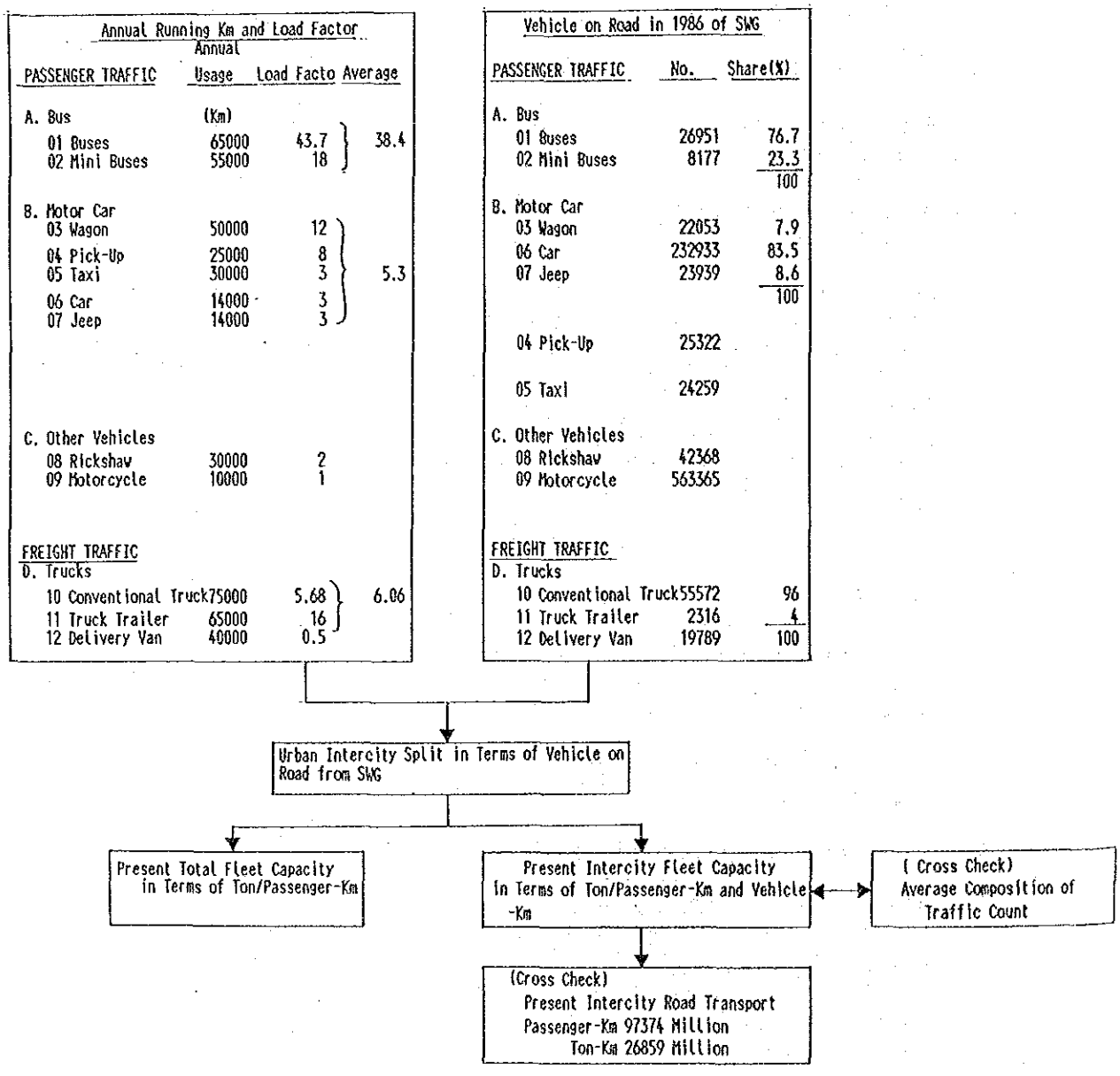


Table 1.2.4 Present Fleet Capacity Analysis

Present Fleet Capacity Analysis

	Utilization			Ratio on Urban Rural Split		Vehicle on Road 1985 1/			Present Fleet Capacity in Terms of Pass./Ton-Km			Cross Check: Composition of Intercity Traffic		
	Km Per Year	Load/Factor (Pass/Tons)		Urban	Intercity	Urban	Intercity	Total	Urban	Intercity	Total	Vehicle.Km (million)	Share of Vehicle .Km (%)	Average Composition of Traffic Count 3/ (%)
		Unit	Average											
I Passenger Traffic														
A: Bus														
1. Bus	65,000	43.7	38.4	24	76 1/	6,468	20,483	26,951	18,372	58,182	76,554	1,331	16.7	15
2. Mini Bus	55,000	18.0		62	38 1/	5,070	3,107	8,177	5,019	3,076	8,095	171		
Sub Total						(11,538)	(23,590)	(35,128)	(23,391)	(61,258)	(84,649)	(1,502)		
B: Motor Car														
3. Wagon	50,000	12		11	89 1/	2,426	19,627	22,053	1,456	11,776	13,232	981	10.9	10
4. Pick-up	25,000	8		13	87 1/	3,292	22,030	25,322	658	4,406	5,064	551		
5. Taxi	30,000	3	5.3	100	--	24,259	--	24,259	2,183	--	2,183	--	22.1	25
6. Car	14,000	3		60	40 1/	139,760	93,173	232,933	5,870	3,913	9,783	1,304		
7. Jeep	14,000	3		60	40 1/	14,363	9,576	23,939	603	402	1,005	134		
Sub Total							(144,406)	(328,506)	(10,770)	(20,497)	(31,267)	(2,970)		
C: Others														
8. Rickshaw	30,000	2		100	--	42,368	--	42,368	2,542	--	2,542	--		
9. Motorcycle	10,000	1		90	10 2/	473,365	90,000	563,365	4,734	900	5,634	900	10.0	10.0
Sub Total						(515,733)	(90,000)	(605,733)	(7,276)	(900)	(8,176)	(900)		
Passenger Total								969,367	41,437	82,655	124,092	5,373		
								Share(%)	(33.4)	(66.6)	(100)			
II Freight Traffic														
10. Conventional Truck	75,000	5.68	6.06	10	90 3/	5,557	50,015	55,572	2,367	21,306	23,674	3,890	40.4	40
11. Truck Trailer	65,000	16.0		--	100	--	2,316	2,316	--	2,409	2,409	150		
12. Delivery Van	49,000	0.5		100	--	19,789	--	19,789	396	--	396	--		
Sub Total						(25,346)	(52,331)	(77,677)	(2,763)	(23,715)	(26,479)	(3,636)	(100.0%)	(100.0%)

Present Fleet Capacity for Intercity Transport:

$$\frac{\text{Passenger Vehicle Capacity}}{\text{Passenger.Km}} = \frac{82,655 \text{ million pass.Km}}{97,374 \text{ million pass.km}} = 85\%$$

$$\frac{\text{Freight Vehicle Capacity}}{\text{Ton.Km}} = \frac{23,715 \text{ million Ton.Km}}{26,859 \text{ million Ton.Km}} = 88\%$$

1 Source: Suburking Group
2 Team Estimated
3 Source: Road User Charge - MTRC

1.3 Road Traffic Characteristics and Traffic Safety

1.3.1 Traffic Data

(1) Vehicle·Km

Historical growth and activities of road transport is expressed in terms of vehicle·km. Since, vehicle·km of past years are not indicated in official documents, the study team estimated the vehicle·km for the year between 1980 and 1985 on the basis of number of motor vehicles on the road and annual usages discussed in detail in item 1.2.2 (1). The results of estimation are stated in App. Table 1-8. In 1985, total vehicle·km of 18,973 million was made up by 979,670 vehicles, excluding agricultural tractor and some other type vehicles.

The share by type of vehicle in 1985 are summarized as follows;

Type of Vehicle	Vehicles on Road in 1985	Vehicle·Km (million)	Share of Vehicle·Km (%)
1) Buses	33,486	2,109	(11.1)
2) Car, Wagon, Pick-up and Jeep	291,282	5,014	(26.4)
3) Taxi and Rickshaw	62,906	1,887	(10.0)
4) Motorcycle	519,959	5,200	(27.4)
5) Truck and Van	72,037	4,763	(25.1)
Total	979,670	18,973	(100.0)

As shown in the above passenger vehicles occupied 75%, and freight vehicles 25% of vehicle·km of the whole country in 1985. In case of excluding motorcycles, passenger vehicles occupied 65% and freight vehicles 35% of vehicle·km of 1985, in which buses occupied 25% and small passenger vehicles 75% in passenger vehicle·km.

In order to examine the growth rate in vehicle·km, App. Table 1-8 is summarized in the following Table 1.3.1.

Table 1.3.1 Yearly Trend of Vehicle·Km Estimated

(unit: million)

	Passenger Traffic		Freight Traffic		Total
	Vehicle·Km	Passenger·Km	Vehicle·Km	Ton·Km	Vehicle·Km
1980	9,364	87,681	3,045	16,428	12,409
1981	10,125	93,452	3,296	17,542	13,421
1982	10,993	95,913	3,636	19,160	14,629
1983	12,126	105,064	3,851	20,141	15,977
1984	13,423	112,010	4,311	22,142	17,734
1985	14,211	118,972	4,762	24,642	18,973

As shown in the above table, total vehicle·km grew at 8.9 percent p.a., passenger·km grew at 6.3 percent p.a. and ton·km grew at 8.5 percent p.a. from the year 1980 to 1985 in the whole country.

The Sixth Plan Targets showed that inter-city passenger·km would increase at 6.1% p.a. between 1982 and 1987. Freight ton·km was forecast to increase at 6.7% p.a. in the whole country. It is very likely that actual increase would be larger than those used in the targets.

(2) Traffic Counting

Traffic count data of 1985/86 was collected from NTRC and provincial governments except Sind Province because the traffic count survey crew of the Province have not existed since 1984. These traffic count data of each link on the road network were compiled into five types of vehicles namely motorcycles, cars, buses, trucks and others in order to compare the data in 1985/86 with that of the data in 1980/81 compiled during the course of the existing master plan. They are edited in App. Table 1-9.
Average composition of traffic counts shows that 12.6% for motorcycle, 36.1% for motorcar, 13.1% for bus, 38.0% for truck and 0.2% for others.

As shown in the table, the annual growth rate by vehicle type between these years on each link are studied.

Fig. 1.3.1 shows total traffic volume in terms of mixed traffic in 1980/81 and 1985/86 on selected links of the road network.

Traffic volume on the rest of the national highways varies from 400 to 5,600, and on provincial highways vary from 200 to 8,363 on Peshawar -Charsada road.

Fig. 1.3.2 shows that total motorized traffic in 1980/81 and 1985/86 in terms of mixed traffic. Traffic volumes on provincial highways in Punjab and NWFP have doubled between 1980/81 and 1985/86.

1.3.2 Characteristics

Traffic counting data on N-5 at Jhelum; Sadiqabad and Super Highway in 1982 and 1986 are selected to discuss characteristics on vehicle composition, trucks by axles, and hourly, weekly and monthly variations of inter-regional road traffic.

As for the peak factor, available data for the whole year from Attock, Jhelum, Bahawalpur and Kandiaro were studied.

Fig. 1.3.1 Traffic Count Volume in 1980/81 and 1985/86 on Typical Link of Road Network for National Transport Study (Mixed Traffic)

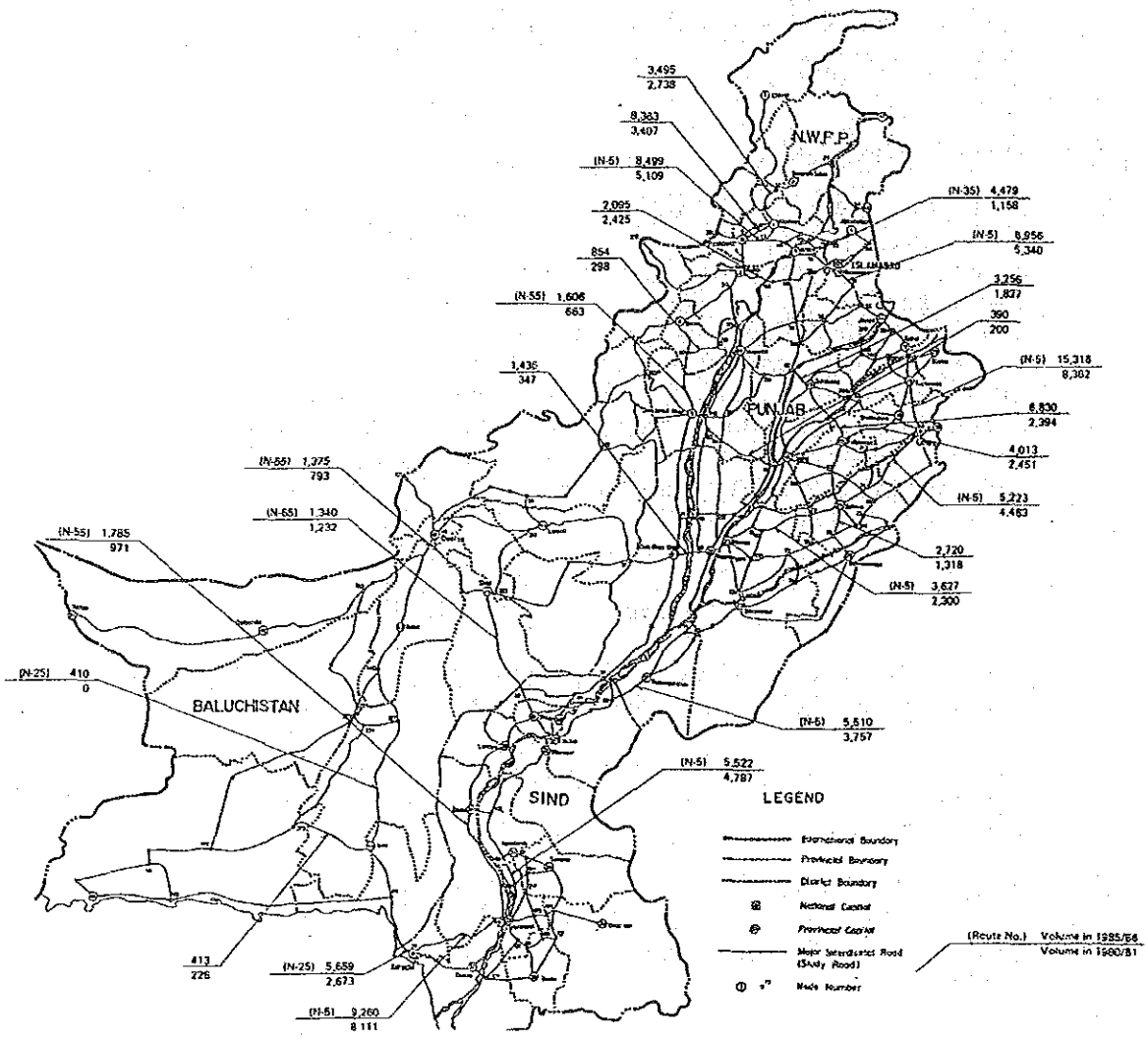
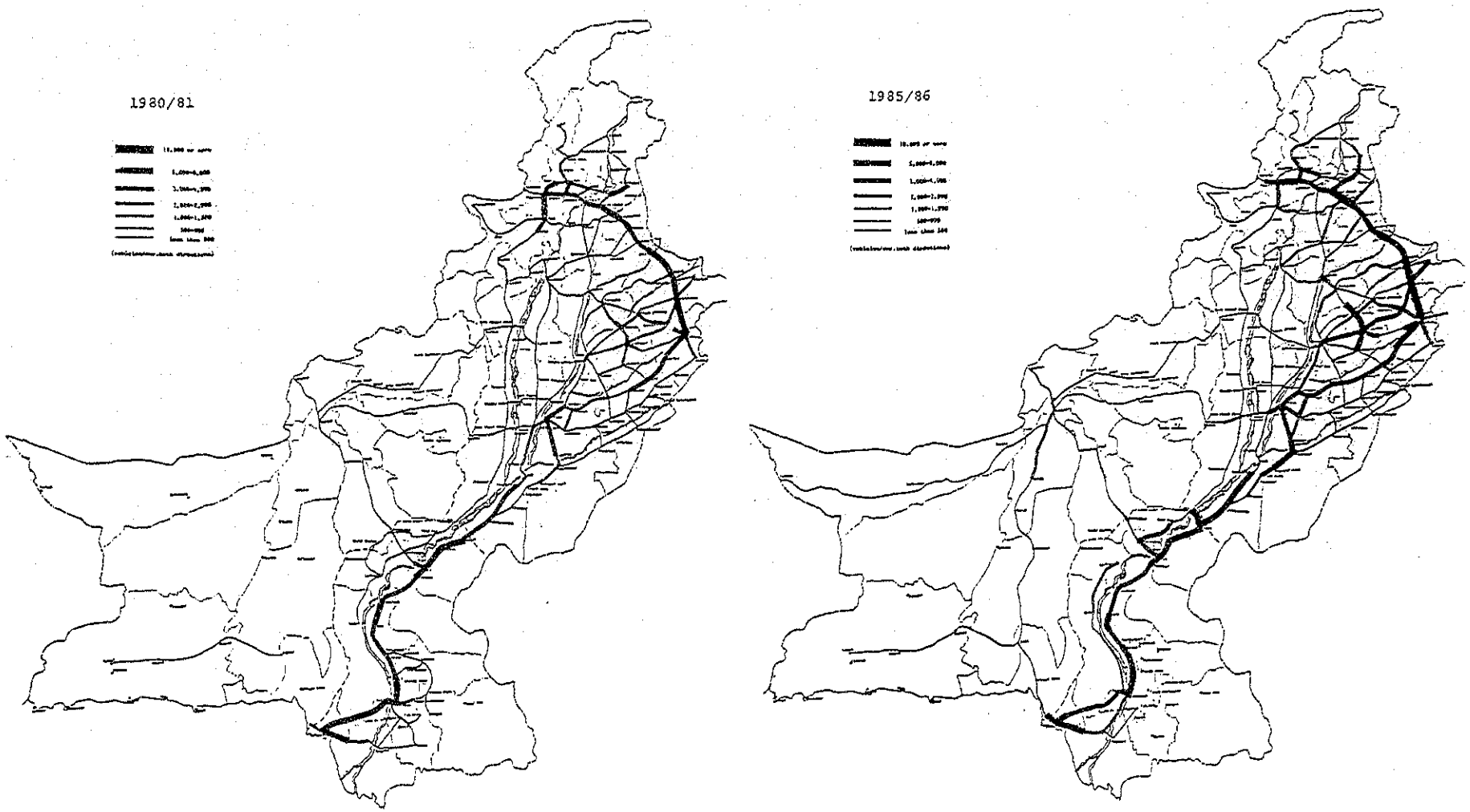


Fig. 1.3.2 Total Motorized Traffic in 1980/81 and 1985/86



(1) Vehicle Composition

At these three locations, the average traffic volume increased from 5,873 in 1982 to 6,398 per day in 1986. Volume by vehicle-type has increased in most cases, except the trucks on the Super Highway, where the volume decreased from 5,374 to 3,615. Composition percentages showed modest changes in those years, generally increased the percent shares of motorcycles, small vehicles, buses, while decreased for that of trucks. The average volume shows that 8.9% for MC, 24.8% for cars/jeeps, 4.9% for wagons, 10.0% for buses and 51.4% for trucks in 1986. These data are shown in Table 1.3.2 and Figs. 1.3.3 and 1.3.4. On the other hand, the report of NTRC Road User Charge shows the average composition of traffic count of 10% for MC, 10% for wagons, 25% for jeep, pickup and cars, 15% for buses and 40% for trucks.

(2) Truck by Axles

NTRC recently started automatic and periodical traffic count including the multi axle classification, where trucks are divided into 5 categories of 2-axles to 6-axles.

On the other hand, traffic count data in 1982 having compositions of multi axle vehicles are available at Jhelum, Sadiqabad and on Super Highway. Data shown in Table 1.3.3, Figs. 1.3.5 and 1.3.6 show that the number of trucks decreased on Super Highway while they increased at the other stations during the years from 1982 to 1986.

On the contrary, changes of composition on truck axles are shown in Table 1.3.3. The table indicates the decrease of 2-axle vehicles and increase in multi axle vehicle traffic in terms of percentage at these traffic count points.

It might have been caused by the policy to regulate over-loading trucks in Pakistan during the course of the IBRD's Third Highway Project period. Therefore, some 2- and 3-axle vehicles shifted to 4-axle and 5-axle vehicles so as to reduce the axle load factor.

(3) Hourly, Daily and Monthly Variations

1) Hourly Variation

Data examined for hourly and daily variations are extracted from the above cited NTRC multi axle vehicle survey in 1982 at Jhelum, Sadiqabad and on Super Highway. The percent distribution per hour is shown in App. Fig. 1-1 and App. Table 1-10. Hourly variation of passenger vehicle traffic are quite different from truck traffic. Passenger vehicles of cars, buses, wagons and motorcycles are mainly observed during the day time and trucks are on the contrary observed during the night time generally at every station.

Daytime traffic between hours 6.00 - 18.00 was 55.8% at Jhelum, 58.7% it Sadiqabad, 51.8% on the Super Highway.

Table 1.3.2 ADT and Vehicle Composition on National Highway N-5 in 1982 and 1986

Oct., 1982 Daily Traffic

No.	Vehicle Type	Jhelum		Sadiqabad		Super Highway		Average	
		Number	%	Number	%	Number	%	Number	%
1	M. Cycle, Scooter	1,194	17.10%	55	1.75%	78	1.04%	442	7.53%
2	Car, Jeep, Taxi,Pick-up	2,344	33.58%	186	5.91%	1,379	18.41%	1,303	22.19%
3	Wagon, Mini Bus	540	7.74%	21	0.67%	85	1.13%	215	3.67%
4	Bus	326	4.67%	206	6.54%	565	7.54%	366	6.23%
5	Truck	2,556	36.61%	2,649	84.15%	5,374	71.74%	3,526	60.04%
6	Others	21	0.30%	31	0.98%	10	0.13%	21	0.35%
	Total	6,981	100.00%	3,148	100.00%	7,491	100.00%	5,873	100.00%

1986 ADT

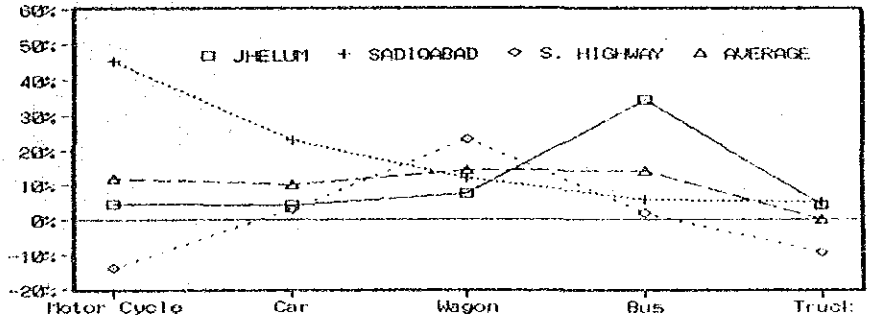
No.	Vehicle Type	Jhelum		Sadiqabad		Super Highway		Average	
		Number	%	Number	%	Number	%	Number	%
1	M. Cycle, Scooter	1,418	15.76%	244	5.84%	43	0.71%	568	8.88%
2	Car, Jeep, Taxi,Pick-up	2,775	30.83%	425	10.17%	1,553	25.81%	1,584	24.76%
3	Wagon, Mini Bus	719	7.99%	33	0.79%	195	3.24%	316	4.93%
4	Bus	1,058	11.76%	257	6.15%	610	10.14%	642	10.03%
5	Truck	3,030	33.67%	3,218	77.04%	3,615	60.09%	3,288	51.39%
6	Others	0	0.00%	0	0.00%	0	0.00%	0	0.00%
	Total	9,000	100.00%	4,177	100.00%	6,016	100.00%	6,398	100.00%

1982-86

No.	Vehicle Type	Jhelum	Sadiqabad	Super Highway	Average
		%	%	%	%
1	Motor Cycle, Scooter	4.39%	45.13%	-13.83%	11.90%
2	Car, Jeep, Taxi & Pickup	4.31%	22.95%	3.02%	10.09%
3	Wagon, Mini Bus	7.42%	11.96%	23.07%	14.15%
4	Bus	34.22%	5.69%	1.93%	13.95%
5	Truck	4.34%	4.98%	-9.44%	-0.04%
6	Tractor and Others				

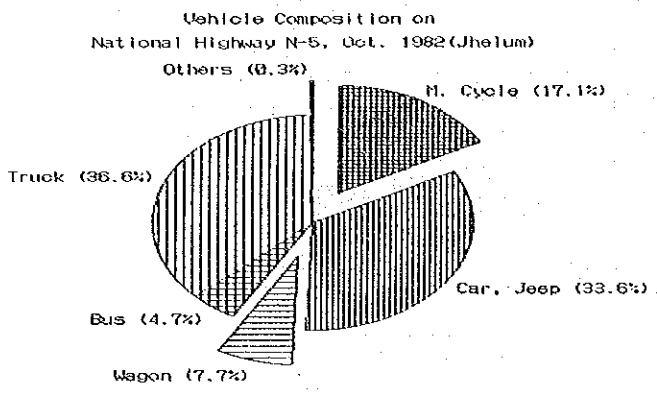
Source: NTRC-63 Multi Axle Vehicle Survey, Oct., 1982

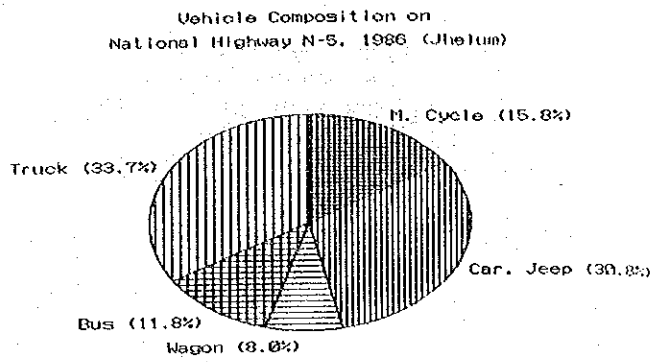
Fig. 1.3.3 Annual Growth Rate of Traffic by Section (1982-1986)

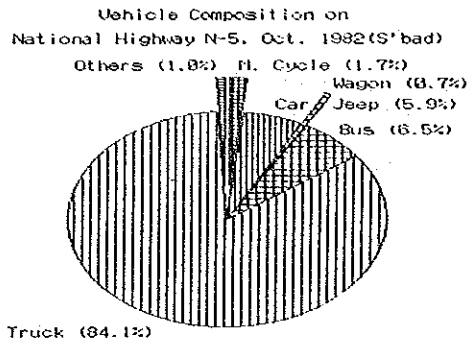


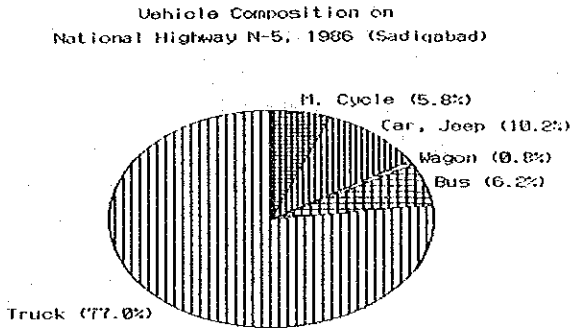
Source: Table 1.3.2

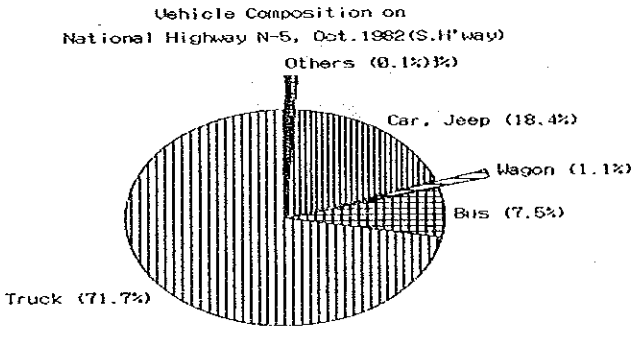
Fig. 1.3.4 Vehicle Type Compositions

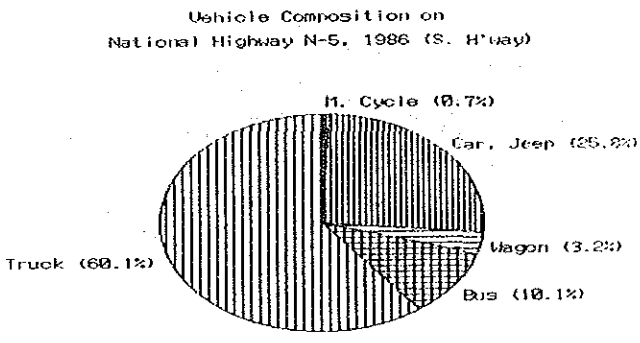


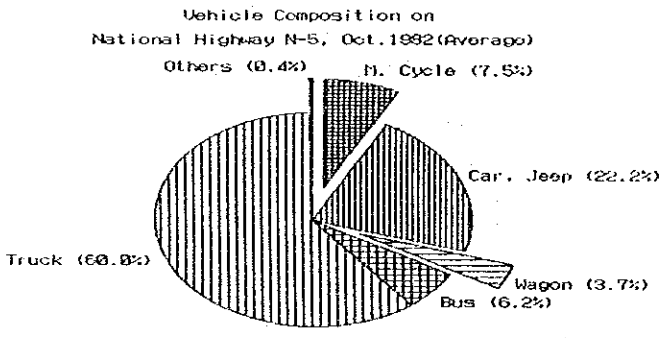


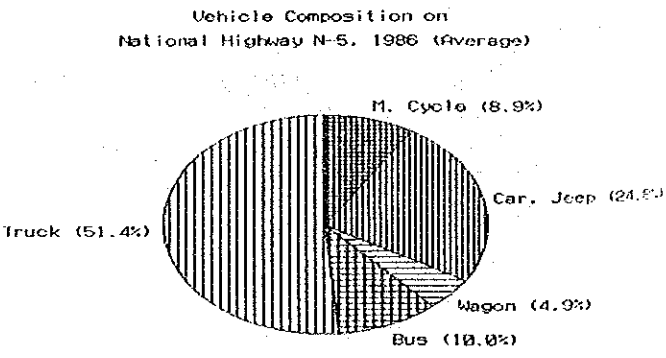












From Table 1.3.2

Table 1.3.3 Truck by Axles

Oct. 1982 Daily Traffic

No.	Axle Type	Jhelum		Sadiqabad		Super Highway		Average	
		Number	%	Number	%	Number	%	Number	%
1	2-Axle	2,486	97.22%	2,560	96.64%	5,106	95.01%	3,384	95.95%
2	3-Axle	47	1.84%	27	1.02%	33	0.61%	36	1.01%
3	4-Axle	19	0.74%	53	2.00%	229	4.26%	100	2.84%
4	5-Axle	5	0.20%	9	0.34%	6	0.11%	7	0.19%
5	6-Axle	0	0.00%	0	0.00%	0	0.00%	0	0.00%
	Total	2,557	100.00%	2,649	100.00%	5,374	100.00%	3,527	100.00%

1986 ADT

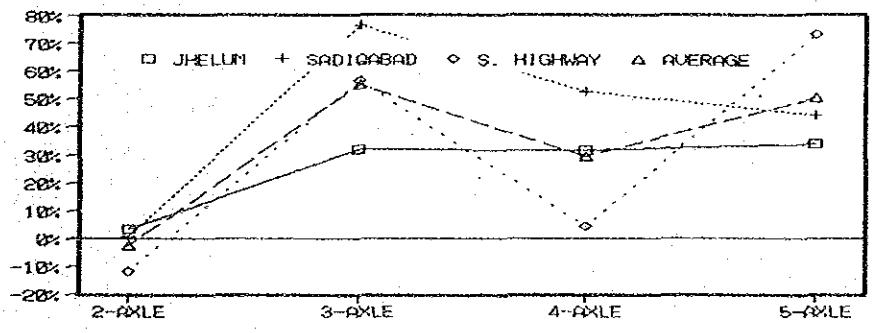
No.	Axle Type	Jhelum		Sadiqabad		Super Highway		Average	
		Number	%	Number	%	Number	%	Number	%
1	2-Axle	2,810	92.74%	2,625	81.57%	3,088	85.42%	2,841	86.41%
2	3-Axle	143	4.72%	263	8.17%	199	5.50%	202	6.13%
3	4-Axle	57	1.88%	287	8.92%	270	7.47%	205	6.23%
4	5-Axle	16	0.53%	39	1.21%	54	1.49%	36	1.11%
5	6-Axle	4	0.13%	4	0.12%	4	0.11%	4	0.12%
	Total	3,030	100.00%	3,218	100.00%	3,615	100.00%	3,288	100.00%

1982-1986

No.	Vehicle Type	Jhelum	Sadiqabad	Super Highway	Average
		%	%	%	%
1	2-AXLE	3.11%	0.63%	-11.81%	-2.69%
2	3-AXLE	32.07%	76.66%	56.71%	55.15%
3	4-AXLE	31.61%	52.55%	4.20%	29.45%
4	5-AXLE	33.75%	44.28%	73.21%	50.41%
5	6-AXLE				

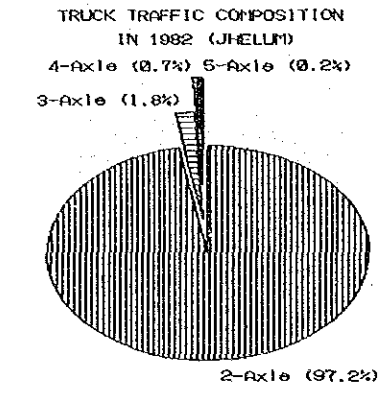
Source: NTRC-63 Multi Axle Vehicle Survey, Oct., 1982

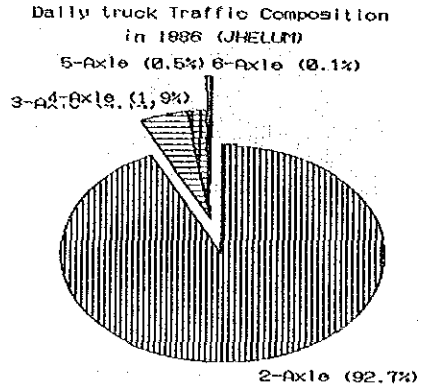
Fig. 1.3.5 Annual Growth Rate of Trucks by Section (1982-1986)

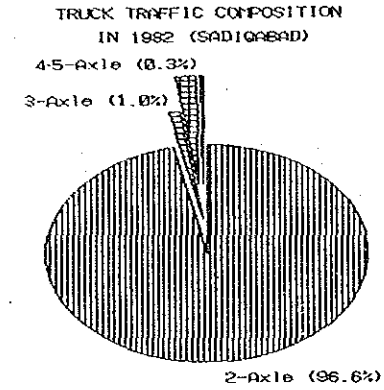


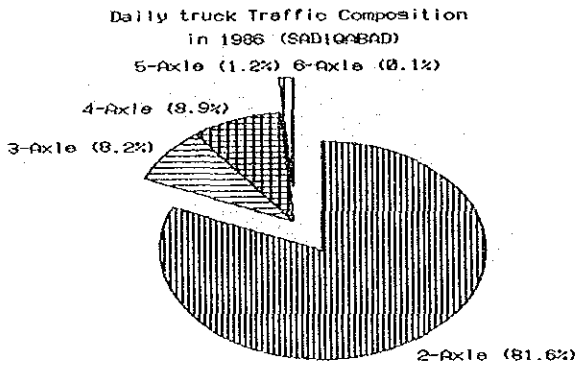
From Table 1.3.3

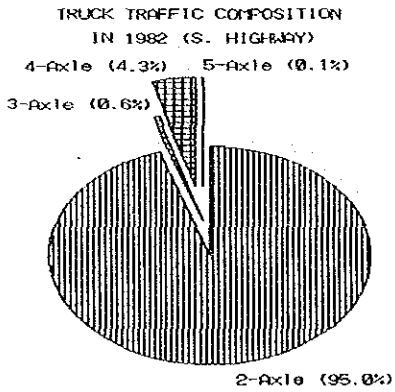
Fig. 1.3.6 Composition of Trucks by Axle

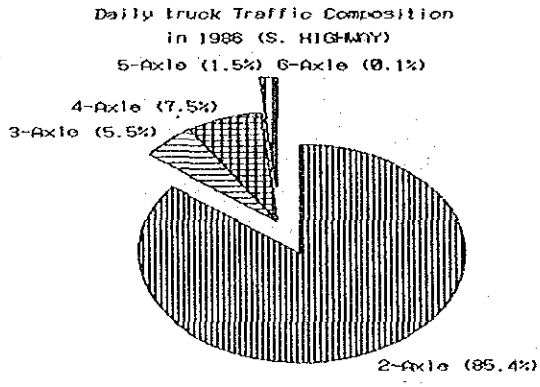


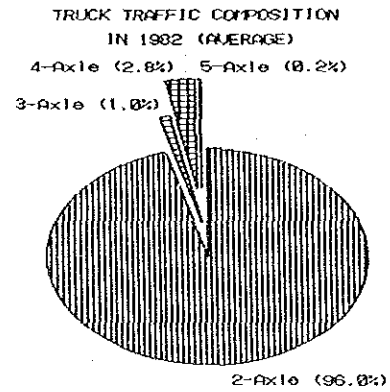


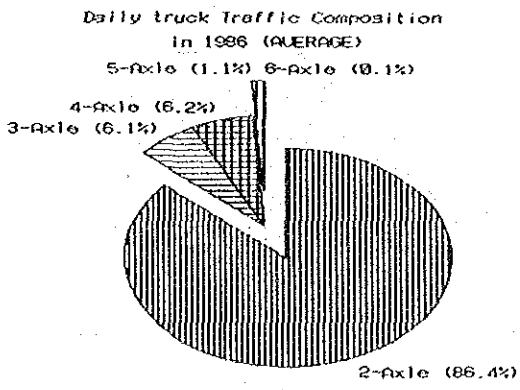












From Table 1.3.3

2) Weekday Variations

Weekday variations at these stations in 1982 are shown in App. Fig. 1-2 and App. Table 1-11. Changing patterns are different among these stations, however, the range of variation is mostly between 83 and 107%, only on Super Highway the total volume on Friday is less than the average.

3) Monthly Variation

The Study Team collected automatic traffic count data for the whole year from four stations located on N-5 namely Attock, Jhelum, Bahawalpur and Kandiaro.

Monthly traffic variations on the four stations are illustrated in App. Fig. 1-3. The Figures shows no typical variation even during the rainy and Hajj seasons respectively. Monthly fluctuation varies from station to station and specially at Khairpur there is no fluctuation for the whole year.

(4) Peak Factor

As far as the Highway Capacity is concerned, peak factor is an essential item also to calculate the capacity.

Since, manual traffic counts have been conducted for two hours per day and for 24 hours counts only on the 1st of every month in parallel with automatic traffic counts, the Team therefore, obtained daily and peak hourly traffic volume from NTRC Automatic Traffic Counts Data as in terms of mixed traffic. NTRC has already compiled data for the whole year automatic traffic count data for the four stations out of twenty namely Attock, Jhelum, Bahawalpur and Kandiaro.

In order to estimate a weighted peak factor, the Team took daily and peak hourly traffic volumes from week day data between Sunday and Thursday for four weeks per month.

The results in terms of weighted annual peak factor was 7.4%, 6.3%, 6.2% and 6.2% at Attock, Jhelum, Bahawalpur and Kandiaro respectively.

(5) Truck Axle Load

Cumulated numbers of the equivalent standard axle load of 8.2 ton over the pavement life span are one of the essential factors required to determine the required pavement thickness.

Rule 216 of the Motor Vehicle Ordinance specifies a maximum axle load of 6 tons and gross vehicle weight of 10 tons (It is 12-ton in Punjab). Unfortunately the rule is not strictly enforced, resulting in rapid deterioration of pavement.

NTRC conducted axle load survey in May/April 1982 at 35 stations selected on main roads across the country. It studied 30,112 loaded and 1,634 empty trucks in total. An average axle load of loaded and empty trucks resulted from the survey is shown below.

Average Axle Loads of Loaded and Empty Trucks

(Unit: kg)

Condition	No. of Samples	Front Axle	Rear Axle	Gross Weight
Loaded	30,112	4,343	10,020	14,363
Empty	1,634	2,868	3,308	6,177
			Average Load =	8.2 ton

As shown in the above, average rear axle load exceeded both legal axle load of 6 tons and equivalent standard axle load of 8.2 tons. It also shows that the average gross vehicle weight exceeded legal gross vehicle weight of 10 tons (12 tons in Punjab).

It was found during the field survey that private operators have often increased truck load capacity by strengthening chassis and mounted larger tyres so as to carry 11 to 13 tons cargo as against 7 tons of original two axle truck load capacity, and 30 to 40 tons as against 25 to 30 tons original truck trailer capacity.

The survey[1/] also studied "damaging effect" of excessive loading. It concluded that nearly 100% of the loaded trucks exceeded the ordinance axle load of 6 tons and 85% of the loaded vehicles were over the standard axle load of 8.2 tons.

The Study Team estimated equivalent standard axle load of trucks from NTRC Axle Load Study giving assumption to the share of empty truck of 30%. The survey shows that equivalent axle loads of loaded truck is 3.31 and an average rear axle load of empty truck is 3.308 tons.

Formula;

Empty Trucks Loaded Trucks

$$\left(\frac{3.308}{8.2}\right)^{4.5} \times 0.3 + 3.31 \times 0.7 = 0.017 + 2.317 = 2.49$$

Say 2.50

Therefore, the Team adopted 2.5 for pavement the design.

1/ Economic Implications of Vehicle Overloading (NTRC, April 1984)

1.3.3 Road Accidents and Highway Safety Measures

(1) Road Accidents in Pakistan

In 1983, from NTRC Transport Statistics of 1984, 12,867 accidents were reported of which 3,793 were fatal, 4,434 peoples died and 11,384 were injured.

The rate of road accidents per 100 million vehicle·km in Pakistan is studied on the basis of estimated vehicle·km from the year 1980 to 1983. Figures for the average killed per vehicle·km, average injured per vehicle·km and accidents per vehicle·km of these four years are shown in Table 1.3.4.

In order to compare these accident rates with the figures of other countries, Table 1.3.5 is presented.

Table 1.3.5 shows that 30.4 killed persons per 100 million vehicle·km in Pakistan appear to be higher than other countries except Korea of 60. Figures of injured and accident rate per 100 million vehicle·km have very little difference between Pakistan and other countries except Korea.

In addition, it has been reported[1/] that in Punjab Province, it was found that 27 percent of the fatal accidents in the Province occurred on National Highway N-5.

As far as type of vehicles involved in accidents are concerned, the above report explained that the buses and mini-buses were most often involved in the accidents and their share was 46 percent in Punjab, 30 percent in Sind and 47 percent in NWFP, respectively. It shows that 90 percent of accidents were caused by driver's error.

(2) NTRC Studies on Road Safety

Following are quoted from the NTRC Reports;

1) Road Markings

Experimental road markings and traffic signs have been introduced to try and reduce the accidents but it appears that they have little impact on accident reduction. NTRCs study results from interviews suggested that the lack of effect was probably due to many drivers not identifying the road markings and traffic signs and to the low level of knowledge.

The results also indicated that professional drivers knew less than other drivers.

1/ Road Accident Counter Measures in Pakistan (NTRC, 1985)

Table 1.3.4 Road Accidents per 100 Million Vehicle·Km in Pakistan

Year	No. of Casualties		No. of Total Accidents	Vehicle·km[1] (100 million)	Killed/ Vehicle ·km	Injured/ Vehicle ·km	Accidents/ Vehicle ·km
	Killed	Injured					
1980	3974	9773	11,824	124.1	32.0	78.8	95.3
1981	4220	10,498	11,448	134.2	31.4	78.2	85.3
1982	4427	10,635	11,563	146.3	30.3	72.7	79.0
1983	4434	11,384	12,867	159.8	27.7	71.2	80.5
				Average	30.4	75.2	85.0

Source: NTRC Transport Statistics 1984

Note: 1) Study Team estimate

Table 1.3.5 Comparison of Accident per 100 Million Vehicle·Km in Selected Countries

	Killed/Vehicle·km	Injured/Vehicle·km	Accidents/Vehicle·km
Pakistan Average	30.4	75.2	85.0
UK 1982	2.0	110.6	85.0
France 1982	3.5	89.0	63.0
W. Germany 1982	3.4	143.0	109.0
Italy 1982	3.0	79.0	58.0
USA 1982	1.7	114.0	81.0
Japan 1982	2.34	160.9	129.4
Korea 1982	60.0	1,340.0	1,055.0
Thailand 1982	15.0	50.0	95.0

Source: World Road Statistics 1979 - 83 IRF

The findings of the NTRC studies suggest that the improvement of road signs and markings on their own is least likely to have the desired effect in Pakistan unless other mesures such as improved training and enforcement are also introduced.

2) Bus Driver Retraining Course

Although, the course was established to have improved knowledge and behaviour, observations of drivers on their routes indicated that these improvements shown under test durings the course were not generally transferred to their actual driving manner. Therefore the study was calculated on the basis that the training be required to be backed up with appropriate law enforcement so as to be changed with the driver behaviour.

3) Traffic Law Enforcement

The study indicated that the old practice of deploying most of the traffic police on point duty in Pakistan had little effect on drivers moving violations.

However, after the establishment of a special training course for the traffic police in Highway Safety Wing, particularly in the methods of enforcing moving violations, was shown to result in a significant change in the pattern of driving behaviour. Also the setting up of a mobile highway patrol on rural highways brought about a drop in road accidents of 6 percent on the patrolled roads compared to an increase of 37 percent in the area.

4) Recommendations

The report of "Road Accident Counter Measures in Pakistan" NTRC-85 suggest some recommendations for Highway Safety in Pakistan are outlined below.

- Traffic police are given specialized training in traffic law enforcement and in driving.

- The driving test should be on assessing a driver's ability to carry out these procedures safely. And driving examiners should be trained to make these assessment by conducting 'on the road' test on predetermined routes using simple assessment form.

(3) Planning Direction of Highway Safety Measures under the 4th Highway Project

1) General

As the result of extensive research conducted by NTRC and other experts for the last decade, it is becoming very clear that the basic cause of the problems are highlighted as follows;

a) Ignorance of road users regarding traffic safety rules;
b) Ineffective traffic enforcement; and
c) Extremely outmoded traffic laws.

The Government of Pakistan has already taken some action since 1977 so as to solve the problems on following items.

a) Education Campaign

Extensive traffic safety education campaign conducted through the media has not been successful due to the programme broadcasting hour was not suitable for public transport drivers, and T.V sets are not popular in their society.

b) Driving School

In order to overcome very poor driver training in Pakistan, the Government has been encouraging setting up of driver training schools in public and private sectors. However, it did not have the desired impact primarily because of lack of trained instructors.

c) Enforcement

In order to overcome the difficulty, a plan of re-organization of traffic police was approved by the Government in December, 1978. The scheme aimed at stabilizing the traffic police force and giving them proper training, equipment and the powers to enforce those violations which cause accidents such as speeding, reckless driving, etc.

d) Outmoded Laws

Although, the existing Motor Vehicle Laws were set up in 1965, the part pertaining to traffic safety rules were copied from the Motor Vehicle Act of 1939.
In order to overcome the deficiency, Ministry of Communications, in January 1978, prepared a revised draft of the Road Safety Ordinance.

e) Accident Recording

It is envisaged, that the fundamental reason for lack of success in overcoming the problem of highways safety was its inaccurate diagnosis. From this point, it would be essential to identify the exact location of the accident. It is, therefore, proposed that kilometer stones should be erected along all highways so that the accidents can be accurately recorded.

2) Proposal for Highway Safety Measures under the 4th Highway Project

It is evident from the preceeding paragraph that road safety is a multifaced problem and requires comprehensive treatment.

As a result of the detailed discussions held with the IBRD 4th Highway Project Mission and on the advice of TRRL of U.K., the following have been identified as most appropriate for IBRD financing on highway safety is Pakistan under the 4th Highway Project;

a) Establishment of a Driving Instructor Training School at the Federal Level

b) Introduction of a Model Highway Patrol along a part of N-5

c) Fixing of kilometer stones all along N-5

Under the 4th Highway Project, a pilot-scale highway patrol will be established by the Road Safety Wing, MOC, and the Punjab Division of the Pakistan Police, on National Highway N-5 in Punjab. The existing driver training school headquarter of Road Safety Wing will be expanded into a new building with its own driving range.

1.4 Road Transport Sector Sixth Five Year Plan and Performance

1.4.1 Objectives and Recommendations of the Sixth Five Year Plan

The objectives and programmes of the road transport subsector during the Sixth Five Year Plan[1/] are as follows:

- Urban transport would continue to be a joint responsibility of the Government and the private sector.

- Inter-city passenger and freight transport, too, would continue to be shared as at present by the public and private sector, public transport service in this field will be strengthened. But the bulk of the investment will continue to be made by the private sector. In addition, the number of light commercial vehicle in service will be doubled.

In order to obtain private sector investment in road transport, the following policy measures were proposed in addition to the above objectives.

- The fares, both for inter-city and urban transport, will be gradually increased to enhance the profitability of transport operation.

- To evolve an alternative and more national system of concessions to discourage misuse and to channelize any concessions considered necessary through the concerned administrative institutions.

- Effective measures will be taken to improve the labour situation in the transport sector.

- In view of the significantly higher level of private investment envisaged in this sector during the Sixth Five Year Plan, transport and transport related facilities should be made eligible for credit facilities for financing capital investments.

The Sixth Five Year Plan also mentioned the requirement for stringent remedial measures to reduce the financial losses in the semi-public sector bus transport system in urban areas and other problems and issues which would receive appropriate consideration during the Sixth Five Year Plan. Problems and issues are listed below:

- to improve training facilities for drivers and mechanics
- to reduce different makes of vehicles to 2 to 3 makes
- to introduce time tables so as to improve service quality and safety

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1/ The Sixth Five Year Plan, 1983-88 (Planning Commission Government of Pakistan, 1983)

- to encourage large size trucks subject to axle load limitations of 10 tonnes for single and 18 tonnes for tandem axles
- to introduce highway safety programme through driver education and enforcement of rules.

Table 1.4.1 is quoted for the Sixth Five Year Plan Chapter-15 on Transport and Communications. Total allocation for the road transport stood at Rs. 25,821 million against the actual requirement of Rs. 34,769 million due to the resource constraints.

Table 1.4.1 Sixth Plan Provision, Road Transport

(Rs. Million)

	Item	Type of Vehicle	Number	Allocation	Remarks
1.	PUBLIC SECTOR				
	National Logistic Cell	Trucks	1,000	671	Self financing by NLC (large size trucks)
2.	SEMI PUBLIC SECTOR				
	Urban Transport	Buses	2,000	1,000	For Karachi, Lahore, Rawalpindi and Peshawar, only
	Intercity	Buses	850	1,150	For PRTB, SRTC and NWFP RTB. No. not specified. Estimated induction target.
3.	PRIVATE SECTOR				
	Urban	Buses L.C.Vs	3,200 78,000	23,000	LCVs to be doubled. However number not specified. Estimated induction target.
	Intercity	Buses Trucks	18,000 29,000		
	Total:	132,050	25,821		

Source: The Sixth Five Year Plan (1983-88) Chapter-15 on Transport and Communications: Providing the Missing Infrastructure (Planning Commission, 1983)

1.4.2 Performance

In the case of new fleet induction, 132,050 vehicles were targeted to be purchased. However, an estimated induction by 1987/88 would be about 107,000, a short fall by 20%. The target and achievement are shown below:

Table 1.4.2 Induction of Motor Vehicle Fleet in the Sixth Plan

	Sixth Plan Targets		Sixth Plan Achievements			Variation
	No. (Vehicles)	Allocation (Rs. Million)	No. (Vehicle)	Achievement (%)	Allocation (Rs. Million)	
Semi Public						
Buses	2,850	2,150	1,000	35%	550	-1,850
Trucks (NLC)	1,000	671	-		-	
Private:						
Buses	21,200		14,685	69%	29,735	-6,515
Trucks	29,000	23,000	36,133	125%		+6,133
I.C.Vs	78,000		44,139	71%		-22,861
Mini Bus			(5,844)			
Wagon			(14,175)			
Pick-up			(18,020)			
Delivery Van			(17,100)			
Total	132,050	25,821	106,957		30,285	-25,093

Source: Report of the Sub-working Group for the Seventh Plan Road Transport Jan., 1987

Notes: Figures in ( ) mean breakdown of actual induced LCVs.

As far as public and semi-public transport sectors are concerned, NLC has achieved the induction of a fleet target already by the year 1986. In the private sector vehicle fleet induction, detailed figures are not available but it is assumed that only trucks will be able to achieve the target besides buses and LCVs. The shift of freight traffic from rail to road and a high growth rate of the economy during the current Sixth Five Year Plan would demand a larger truck transport.

The number of truck induction during the current five year plan, therefore, will reach 120 percent against the target. Induction of new buses both in semi-public and private sectors were slower than envisaged. Although, actual growth rate of LCVs is higher, induction of LCVs were also slower than targeted.

Other policy measures and issues in bus operations as shown in the objectives and recommendation of the plan are partially improved on custom duties during the current five year plan.

1.5 Vehicle Operating Cost and Vehicle Efficiency

1.5.1 Vehicle Operating Costs

The vehicle operating costs are calculated for representative vehicles traveling on level tangent paved road and on existing roads at different speeds, different terrains, different roughness and surface types. Vehicle operating costs expressed as Rs. per 1,000 km are shown in terms of financial and economic costs.

Elements of Vehicle Operating Costs are;

Running Costs, including

- Fuel consumption
- Engine oil consumption
- Tyre wear
- Maintenance parts consumption
- Maintenance labour-hour
- Depreciation

Standing Costs including

- Interests
- Insurance
- Wage
- Overhead

} for Commercial Vehicles

(1) Representative Vehicles and Characteristics

Fifteen types of vehicles are selected to calculate the vehicle operating costs. Passenger vehicles are represented by seven types of vehicles such as motorcycle, sedan, jeep, pick-up, wagon, mini bus, and bus. Bus is further divided into two categories on the basis of life of service one for private and other for public. And air-conditioned mini bus, public bus and private bus are included. Freight vehicles are represented by three types of vehicles namely 2-axle truck, 3-axle truck and truck trailer. Truck trailer is also further divided into two categories one for private and other for NLC. In total, therefore, number of representative vehicles is 15 types.

Characteristics of representative vehicles are shown in detail in Table 1.5.1 with make, dimension, horse power, type of fuel, vehicle service life, annual usage, etc.

These representative vehicles are selected on the basis of sold share, popularity of users and referring to other relevant reports such as vehicle operating costs of NTRC-79 and National Highway Maintenance Study, Nov. 1986.

Table 1.5.1 Characteristics of Representative Vehicles

Specifications	Passenger Traffic							Freight Traffic			
	Motorcycle	Sedan	Jeep	Pick-up	Wagon	Mini-Bus	Bus	2 Axle Truck	3 Axle Truck	Truck Trailer	
	Suzuki 100	Toyota Carolla 1300	Toyota Land Cruiser LJ70RV-KR	Toyota Hilux	Toyota Hiace LH-61RR-QR	Mazda T3500	(Hino AK176KA)	(Hino FF173)	Hino FL176KA	Hino HR345R	
										Truck	Trailer
Length (m)	1.915	4.185	4.060	4.730	4.725	5.879	11.105	7.560		5.320	12.610
Width (m)	0.735	1.635	1.690	1.620	1.690	1.995	2.490	2.385	2.385	2.490	2.490
Height (m)	1.025	1.385	1.915	1.945	1.945	2.000	3.040	2.565	2.565	2.980	1.600
Number of Axles	2	2	2	2	2	2	2	2	3	4	
Number of Wheels	2	4	4	4	4	6	6	6	10	14	
Tyre Size	3.00	615-13 -6PR	750-16 -8PR	650-14 -6PR	650-14 -8PR	7.00-16	900-20 -14PR	1000-20 14PR	1000-20 14PR	1100-20 16PR	
Engine Capacity (cc)	98	1295	2,446	2,237	2,446	3,445	6443	6443	6443	13,267	
Gross Horse Power	12	71	79	70	79	90	165	165	165	270	
Loading Capacity	2	5	7	8	15	26	45 - 64	11	13.7	25	
Curb Weight		0.85	1.55	1.12	1.52	3.0	4.3	4.00	6.9	4.9 + 8.0	
Gross Vehicle Weight		1.10 (F 0.6 / R 0.5)	2.21 (F 1.0 / R 1.21)	2.48 (F 1.0 / R 1.48)	2.75 (F 1.30 / R 1.45)	5.64 (F 2.30 / R 3.34)	14.0 (F 5.0 / R 9.0)	15.0 (F 5 / R 10)	20.6 (F 4.3 / R 16.3)	37.9(5.0+9.5+23.3)	
Type of Fuel	Gasoline	Gasoline	Diesel	Diesel	*Diesel	Diesel	Diesel	Diesel	Diesel	Diesel	
Vehicle Service Life	13	10	12	12	10	10	Private 11 Public 8	12	12	12	
Average Year Round Speed (km/hr)	40	50	45		45	45	50	40	40	40	
Annual Usage (km)	10,000	14,000	14,000	25,000	50,000	55,000	65,000	75,000	75,000	65,000	
Axle Equivalence Factor			0.0003	0.0005	0.0006	0.0208	1.6282	2.5504	2.2646	12.96	

Table 1.5.2 Summary of Vehicle Prices

(Unit: Rs)

Vehicle Group	Motorcycle	Passenger Traffic						Freight Traffic		
		Sedan	Jeep	Pick-up	Wagon	Mini Bus	Bus	2-Axle	3-Axle	Truck Trailer
Financial Costs										
Vehicle (Less Tyres)	21,000	240,000	365,000	225,000	358,000	Mazda 375,000 Coaster 750,000	Hino 540,000 Aircon 950,000 Bedford 470,000	450,000	554,000	NLC: 657,000 900,000
Fuel/Liter	8.58	8.58	3.85	3.85	3.85	3.85	3.85	3.85	3.85	3.85
Oil/Liter	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50
Tyre	140	550	2,000	2,000	1,300	1,700	2,750	4,000	4,000	4,500
Maintenance Labour/hr	10	10	10	10	10	10	10	10	10	10
Crew/hr					20	20	20	20	20	20
Interest %	25	25	25	25	25	25	Private: 25 Public: 16	25	25	Private: 25 NLC: 16
Passenger Time/hr	1.31	1.31	1.31	1.31	1.31	1.31	1.31			
Economic Costs										
Vehicle (Less Tyres)	8,800	88,800	186,000	114,750	218,000	Mazda 301,000 Coaster 410,000	Hino 513,000 Aircon 902,500 Bedford 446,500	349,000	426,000	657,000
Fuel/Liter	3.81	3.81	2.00	2.0	2.00	2.00	2.00	2.00	2.00	2.00
Oil/Liter	11.50	11.50	11.50	11.50	11.50	11.50	11.50	11.50	11.50	11.50
Tyre	80	320	1,150	1,150	750	980	1,600	2,320	2,320	2,320
Maintenance Labour/hr	10	10	10	10	10	10	10	10	10	10
Crew/hr					20	20	20	20	20	20
Interest %	12	12	12	12	12	12	12	12	12	12
Passenger Time/hr	1.31	1.31	1.31	1.31	1.31	1.31	1.31			

(2) Unit Prices of Vehicles and Components

The unit prices in terms of financial and economic costs were reviewed on the basis of market prices and new tax rates and presented in Table 1.5.2.

(3) Vehicle Operating Cost

Calculated vehicle operating cost is discussed in Appendix Vehicle Operating Cost. Selected results are shown in Table 1.5.3.

Table 1.5.3 Financial and Economic Vehicle Operating Costs in 1987

Unit: Rs. per 1,000 km

Financial VOC (Good Level)

Speed	Motor cycle	Sedan	Jeep	Pickup	Wagon	Mini bus	Air-Minibus	Bus (Private)	Bus (Public)	Air-Bus (Private)	Air-Bus (Public)	Truck (2Axle)	Truck (3Axle)	Trailer (Private)	Trailer (NLC)
30	742	6,643	6,270	3,260	4,146	4,642	7,825	5,551	5,385	9,114	8,014	5,531	6,611	9,723	8,515
35	677	5,989	5,708	2,951	3,773	4,244	7,150	5,126	5,018	8,393	7,464	4,979	5,973	8,823	7,743
40	628	5,489	5,268	2,714	5,486	3,944	6,634	4,817	4,748	7,854	7,049	4,556	5,487	8,142	7,160
45	592	5,101	4,914	2,530	3,263	3,710	6,229	4,588	4,546	7,442	6,728	4,235	5,125	7,635	6,736
50	567	4,793	4,623	2,384	3,089	3,533	5,908	4,426	4,401	7,128	6,485	4,004	4,874	7,281	6,456
55	549	4,552	4,380	2,266	2,948	3,395	5,652	4,319	4,304	6,893	6,301	3,857	4,722	7,061	6,308
60	541	4,361	4,179	2,173	2,837	3,291	5,445	4,255	4,247	6,720	6,168	3,781	4,661	6,962	6,284
65	538	4,214	4,009	2,100	2,751	3,215	5,279	4,235	4,228	6,607	6,085	3,776	4,686	6,981	6,379
70	540	4,107	3,867	2,044	2,686	3,166	5,152	4,249	4,240	6,538	6,039	3,838	4,793	7,109	6,589
75	548	4,031	3,748	2,003	2,638	3,136	5,053	4,299	4,286	6,515	6,033	3,966	4,980	7,345	6,913
80	561	3,986	3,649	1,973	2,609	3,130	4,984	4,380	4,359	6,532	6,061	4,153	5,244	7,680	7,345

Economic VOC (Good Level)

Speed	Motor cycle	Sedan	Jeep	Pickup	Wagon	Mini bus	Air-Minibus	Bus (Private)	Bus (Public)	Air-Bus (Private)	Air-Bus (Public)	Truck (2Axle)	Truck (3Axle)	Trailer (Private)	Trailer (NLC)
30	256	1,849	2,494	1,244	2,431	3,133	3,826	4,066	4,482	6,613	6,775	3,594	4,201	5,809	6,601
35	240	1,704	2,312	1,150	2,225	2,890	3,534	3,788	4,181	6,174	6,330	3,271	3,837	5,327	6,054
40	228	1,592	2,165	1,078	2,068	2,704	3,311	3,579	3,951	5,838	5,984	3,022	3,559	4,962	5,639
45	220	1,507	2,047	1,023	1,943	2,558	3,134	3,423	3,774	5,577	5,712	2,833	3,353	4,689	5,329
50	214	1,441	1,969	978	1,845	2,444	2,995	3,306	3,640	5,371	5,495	2,695	3,209	4,494	5,106
55	210	1,391	1,864	942	1,769	2,355	2,884	3,225	3,539	5,214	5,325	2,606	3,120	4,369	4,965
60	210	1,357	1,796	917	1,705	2,286	2,795	3,168	3,467	5,093	5,191	2,553	3,076	4,311	4,899
65	211	1,334	1,738	897	1,657	2,234	2,727	3,138	3,419	5,006	5,090	2,542	3,086	4,314	4,902
70	216	1,323	1,692	885	1,619	2,196	2,674	3,131	3,395	4,948	5,017	2,569	3,137	4,376	4,973
75	223	1,320	1,653	877	1,593	2,173	2,636	3,142	3,390	4,913	4,968	2,630	3,233	4,490	5,103
80	230	1,330	1,623	876	1,574	2,158	2,610	3,172	3,404	4,903	4,945	2,726	3,372	4,661	5,296

From Appendix Vehicle Operating Cost

1.5.2 VOC and Present Fare and Tariff Structures

(1) Fare

The fares of public transport both for urban and inter-city are determined by each Provincial Government under the provisions of Section 45 of the Motor Vehicles Ordinance 1965 basically keeping in view the increase in the prices of POL, spare parts, chassis, etc. The proposed increase in fare is publicized through the press for information of the public and vehicle operators. And objections and suggestions are invited from the concerned authorities. After considering the public objections and suggestions the fare structure is finally determined and notified by the Provincial Government.

Bus fare structures[1/] of four Provinces by type of road are as shown below:-

Bus Fare Structure

(Unit: Paisa per passenger·km)

	Type of Road	Punjab	Sind	NWFP	Baluchistan
A.	Main metalled road	11.0 (12.0)	9.0 (10.0)	10.5	10.5 (11.0)
B.	Side Roads	12.0	11.0 (12.0)	11.5	11.0 (12.0)
C.	Hilly Roads	13.0	-	12.5[2/]	12.0 (13.0)
D.	Desert Roads	-	20.0		16.0 (17.0)

However, bus fares in Sind and Baluchistan provinces have not been changed since 1983 and in NWFP since 1984. During the last three years market vehicle prices by more than double.

Some of the private sector investments have been shifting from 50 seat buses to wagons and air-conditioned minibuses. Because air-conditioned buses can be allowed to charge double the ordinary buses.

The team estimated the costs by type of public-vehicles from VOC[3/] in 1987 so as to compare the existing fare in terms of paisa per passenger·km. It should be noted, that the Government of Pakistan exempted import duty on big size buses quite recently. The results are tabulated as follows:-

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1/ Students are required to pay 50% of the actual fare.
2/ 13.5 Paisa for Gallies in Hazara Division.
3/ including interest and depreciation

Vehicle Operating Cost and Fare (Sind) per Passenger·Km

(Unit: Paisa per Passenger·Km)

	Wagon	Mini-Bus	Ordinary Bus		Airconditioned Bus	
	(Hiace)	(Mazda)	(Bedford-Private)	(Hino-Public)	(Coaster)	(Hino-Public)
Financial Cost	26	20	10	10	31	16
Economic Cost	15	14	8	10	16.5	15.5
Fare (Sind)	12	9	9	9	18	18

(2) Freight Tariff Rate

Freight tariffs fluctuate from day to day according to the market situation. The tariffs are not determined by type of commodity or ton·km but by truck unit. For example, in September, 1987 the tariff for coal from Quetta to Peshawar, Lahore and Karachi by Bedford were Rs. 4,000, Rs. 3,000 and Rs. 2,000 respectively.

On the other hand, there are fixed freight tariff rates for seaborne container both for 20 feet and 40-feet containers as mentioned below.

NLC changes less in container operations as compared with private operators. However, NLC changes Rs. 0.50 per ton·km as against Rs. 0.32 of private operators for other types of carges.

Charge (Rate) for Inland Transportation of Marine Containers (20Ft & 40Ft)

(Unit: Rs.)

(Full Load)	Private		N.L.C.	
Service Route	20 FT	40 FT	20 FT	40 FT
Karachi/Hyderabad/Karachi	2,400	3,500		2,400
Karachi/Lahore/Karachi	13,000	18,000	7,500	14,000
Karachi/Pindi/Karachi	17,000	22,000	14,500	14,500
Karachi/Peshawar/Karachi	22,000	24,000	17,700	17,000
Karachi/Quetta/Karachi	-	-	-	-
Karachi/Fisalabad/Karachi	12,000	17,000	12,000	12,000

Source: Interview made to forwarders

1.5.3 Vehicle Efficiency for Inter-City Operation

Vehicle efficiency by type of passenger and freight vehicles are examined in terms of; present share of passenger·km and ton·km carried by type of vehicle, passengers and tons can be carried per vehicle, vehicle operating cost per passenger·km and ton·km in terms of financial and economic cost, investment cost per passenger·km and ton·km and PCU per passenger and ton. Results are as shown in Table 1.5.4.

As mentioned in Table 1.5.4, ordinary bus having high efficiency as compared to mini-bus in bus mode and wagon has high efficiency in the motor car mode.

As for freight vehicles, truck trailer has more advantage against conventional trucks in truck mode.

Table 1.5.4 Vehicle Efficiency for Inter-City Operation

Vehicle Efficiency for Intercity Operation

No.	Vehicle Type	Average Load (Passenger)	Annual Average Kms	Vehicle on Road for Intercity Operation in 1986		Pass. and Ton-Km by Type of Vehicle		Vehicle Efficiency	Vehicle Operating Cost per Passenger and Ton		Investment Cost Per Annual Usage and Load Factor		PCU per Pass. & Ton
				No.	Share	Pass-Km	Share	Pass.-Km/ Vehicle	Financial	Economic	Financial	Economic	/ Pass.
I.	PASSENGER TRAFFIC(MPK)				(%)	(million per Year)	(%)	(million/ Year)	(Rs)	(Rs)	(Rs)	(Rs)	
A.	Bus												
	01. Busses	45.7	65,000	20,483	7.90	58,182	70.40	2.85	0.10	0.08	0.19	0.18	0.07
	02. Mini Busses	18.0	55,000	3,107	1.20	3,076	3.70	0.99	0.20	0.14	0.38	0.30	0.11
			(sub total)	23,590	9.10	61,258	74.10						
B.	Motor Car												
	03. Wagon	12.0	50,000	19,627	7.60	11,776	14.30	0.60	0.26	0.15	0.60	0.36	0.12
	04. Pickup	8.0	25,000	22,030	8.60	4,046	5.30	0.20	0.30	0.12	1.13	0.56	0.12
	05. Car	3.0	14,000	93,173	36.10	3,913	4.80	0.04	1.60	0.68	5.71	2.12	0.33
	06. Jeep	3.0	14,000	9,576	3.70	369	0.40	0.04	1.54	0.65	8.69	4.43	0.33
			(sub total)	144,406	56.00	20,455	24.80						
C.	Others												
	07. Motorcycle	1.0	10,000	90,000	34.90	900	1.10	0.01	0.57	0.21	2.10	0.90	0.59
Total(Passenger Traffic)				257,996	100.00	82,613	100.00						

No.	Vehicle Type	Average Load (Cargo.Ton)	Annual Average Kms	No.	Share	Ton-Km	Share	Ton-Km/ vehicle	Financial	Economic	Financial	Economic	/ Ton
B.	FREIGHT TRAFFIC												
08	Conventional Trucks	5.68	75,000	50,015	95.60	21,306	89.80	0.43	0.75	0.47	1.06	0.95	0.53
09	Truck Trailers	16.00	65,000	2,316	4.30	2,409	10.20	1.04	0.46	0.28	0.87	0.63	0.19
Total(Freight Traffic)				52,331	100.00	23,715	100.00						

Note: Delivery vans have not been observed on trunk roads during the survey.
The Team has not, therefore, been considerd delivery van for inter-city use.

1.5.4 Total Transport Costs and Size of Trucks

In order to obtain the appropriate truck size in Pakistan, the Study Team estimated the total transport costs for three types of trucks such as 2-axle, 3-axle and 4-axle truck trailers as mentioned in Table 1.5.5. As for the load condition, two cases are examined; one for an average loaded and the other for overloaded conditions.

The estimation is carried out on the basis of the assumption made to the given load of 11,000 tons on 2-lane 7.3 m width asphalt paved road.

Vehicle operating costs and pavement costs were calculated on the basis of number of vehicles required for given load and accumulated number of equivalent standard axle load for 10 years by vehicle type and load condition per 1,000 km.

It should be noted that the VOC changes with gross vehicle weight but change is proportionately less than the change in weight. Therefore, the unit-costs vary with payload.

As far as unit total transport cost in terms of Rs. per ton·km is concerned, the Study Team found minimum unit cost from overloaded truck trailers with tandem rear axle. However, its damaging factor of 30 it too much high to carry only 40 tons and easy to cause road deterioration. Traidem rear axle trailer should be introduced instead of tandem rear axle which can reduce about 25% of damaging effect as compared to tandem axle.

For the conventional trucks, the advantage of tandem rear axle truck is quite clear as against single axle trucks.

As far as legal maximum axle loads in various countries are concerned Belgium, France and Greek, have all been applying 13 and 20 tons and Japan is applying 10 and 20 tons for single and tandem axle.

In Pakistan the NTRC 1982 Axle Load Survey found that 3.5 percent of loaded trucks exceeded rear axle load of 13 tons and about 60 percent exceeded 10 tons in spite of the legal axle load of six tons.

However, no one can change the structure of existing truck industry and truck body fabrication systems in Pakistan. The Study Team, therefore, recommended 13 and 20 tons for maximum axle load of single and tandem trucks respectively.

Preferable conversion factor from single to tandem rear axle and truck trailer as estimated by forwarders is 20 to 30 percent. And it can be examined by the share of allocated inter-zonal ton·km in 2005 of 50 percent out of the allocated inter-city ton·km and it will become to know that 30 percent of truck trailer out of total truck on road is required so as to cater for allocated inter-zonal ton·km in 2005.

Table 1.5.5 Effect of Different Types and Load on Total Transport Costs (Financial Cost) (Given Load of 11,000 tons on 7.3 Asphalt Paved Road)

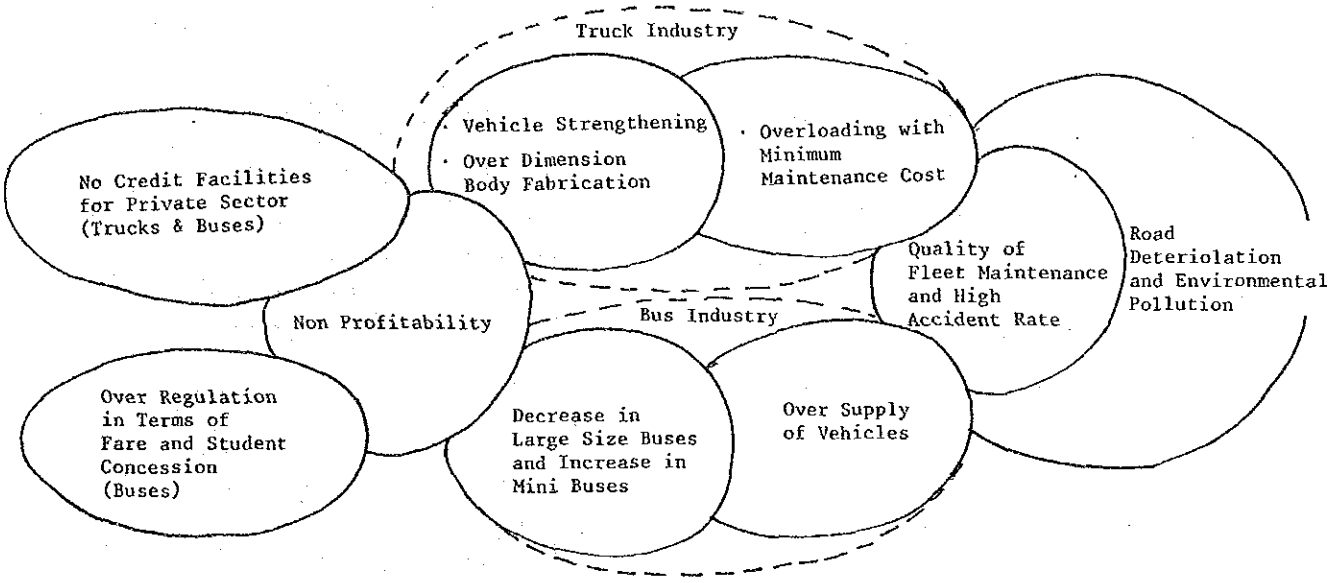
Description \ Type of Vehicle	2-Axle (Single Rear Axle)		3-Axle (Tandem Rear Axle)		4-Axle Truck Trailer (Tandem Rear Axle)	
	Average Load	Over Load	Average Load	Over Load	Average Load	Over Load
1. Pay Load Tons	11.0	13.0	13.7	20.0	25.0	40.0
2. Unladen Weight (ton)	4.0	4.0	6.9	6.9	4.9 + 8.0	4.9 + 8.0
3. Gross Vehicle Weight (ton)	15.0	17.0	20.6	26.9	37.9	52.9
4. Rear Axle Load (ton)	10.0	10.8	16.3	18.8	23.3	31.7
5. Standard Axle Equivalent Factor	2.55	3.45	2.26	4.0	12.96	30.0
6. Vehicle Required for Given Load (Daily)	1,000	846	800	550	440	275
7. ESA's for 10 years (million)	9.3	10.6	6.5	7.3	20.8	27.2
8. ESA's per Lane	4.7	5.3	3.3	3.7	10.4	13.6
9. Pavement Thickness (cm) Road Note 29						
Surface (1,250 Rs/m^3)	85	100	80	80	100	100
Base (400 Rs/m^3)	120	155	115	115	145	160
Sub-base (350 Rs/m^3)	240	260	230	240	260	260
Total	445	515	425	435	505	520
10. Pavement Cost per 1,000 km (Rs 1,000)	1,739,000	2,028,000	1,654,000	1,678,000	2,000,000	2,043,000
11. Pavement Cost per 1,000 km per day	526,970	614,545	501,212	508,485	606,061	619,090
12. VOC per 1,000 km of Vehicle Required of 50 km/h speed	4,004,000	3,387,384	3,899,200	2,680,700	3,203,640	2,002,275
13. Total Transport Cost per 1,000 km (Rs)	4,530,970	4,001,929	4,400,412	3,189,185	3,809,701	2,621,365
14. Unit Cost per ton·km (Rs)	0.412	0.364	0.400	0.290	0.346	0.238

Source: Study Team

1.6 Problem Areas

The mechanism of critical impediment of road transport industries in Pakistan discussed in the report of the Sub-Working Report and found facts and issues in the industries during the course of Phase 1 and 2 studies which are summarized as follows:

Mechanism of Critical Impediment of Road Transport Industries in Pakistan



In addition to above, as mentioned in the item 1.3.3, road accidents and highway safety measures, the basic cause of the problems in highway safety are highlighted as follows;

a) Ignorance of road users regarding the traffic safety rules;
b) Ineffective traffic enforcement
c) Extremely outmoded traffic laws; and
d) Poorly maintained accident recording

Major critical impediments and recommendations indicated for inter-regional transport in the report of Sub-Working Group are summarized as follows:

Major Critical Impediment and Recommendations Indicated for Inter-Regional Transport in Report of the Sub-Working Group

Critical Impediment	Recommendation
1) No Clear Cut Policy Interms of; • Privatization • Nationalization and • Mixed Approach;	1) Mixed Approach;
2) Lack of Coordination between Multifarious Transport Related Agencies	2) Establishment of National Transport Council
3) Over Regulation in Terms of Fare and Finances for Semi-Public Bus Corporations	3) • Fare Structure Determined on VOC including Depreciation and Interest
4) Non Credit Facilities for Private Sector and High Interest Rate of Lenders	4) Provide Institutional Arrangement • Transport Development Bank • Transport as Industry • Transport Credit Guarantee Scheme • National Transport Leasing Corporation
5) Oversupply of LCVs and Decrease in Large Size Buses	5) Import Control on LCVs and Incentives for Large Size Buses
6) Road Safety, Quality of Vehicle Fleet and Accident Compensation	6) • Setting Up Educated Traffic Police, Instructor Training School for Driving Licence Examinor, Politechnics/Engineering Technology, Institute and Traffic Engineering Unit • Introduction of "No Fault Accident Compensation Insulance"

CHAPTER 2 MASTER PLAN (For 2005/06)

2.1 General

In this Chapter 2, the required number of vehicles on the road and the investment plan for inter-city operations, Highway safety planning direction and recommendations, Planning policy on road transport to be incorporated in the Master Plan, and Candidate projects and investment costs for the Master Plan period are discussed for inter-city road transport.

It must be noted that since demand forecast conducted in this study deals with only inter-city road traffic including suburban and inter-zonal traffic in terms of passenger·km and ton· km in the year 1992/93 and 2005/06, the road transport planning will, therefore, be able to deal with inter-city road transport out of the total road transport for Case 2.

2.2 Required Number of Vehicles on Road and Investment Plan

Flow chart of estimation of future vehicle requirement on road and investment plan for inter-city operation is shown in Fig. 2.2.1 with the flow chart of the present fleet capacity analysis for inter-city transport.

2.2.1 Forecasted Inland Inter-City Modal Split and Inter-Zonal Suburban Split of Road Transport

Estimated inland inter-city modal split between road and railway in terms of passenger·km and ton·km is presented in the following Table 2.2.1 for the year 1985/86, 1992/93 and 2005/06 respectively.

In 1992/93 and 2005/06 road transport will have to cater for 12,300 and 32,468 million ton·km plus 160,817 and 268,259 million passenger·km respectively.

Present share of road transport in terms of passenger·km and ton· km of 86 and 76.4 percent will be 90.7 and 58.8 percent by the year 2005 accordingly in Case 2.

Fig. 2.2.1 Flow Chart of Estimation of Future Vehicle Requirement on Road and Investment Plan for Inter-City Operation

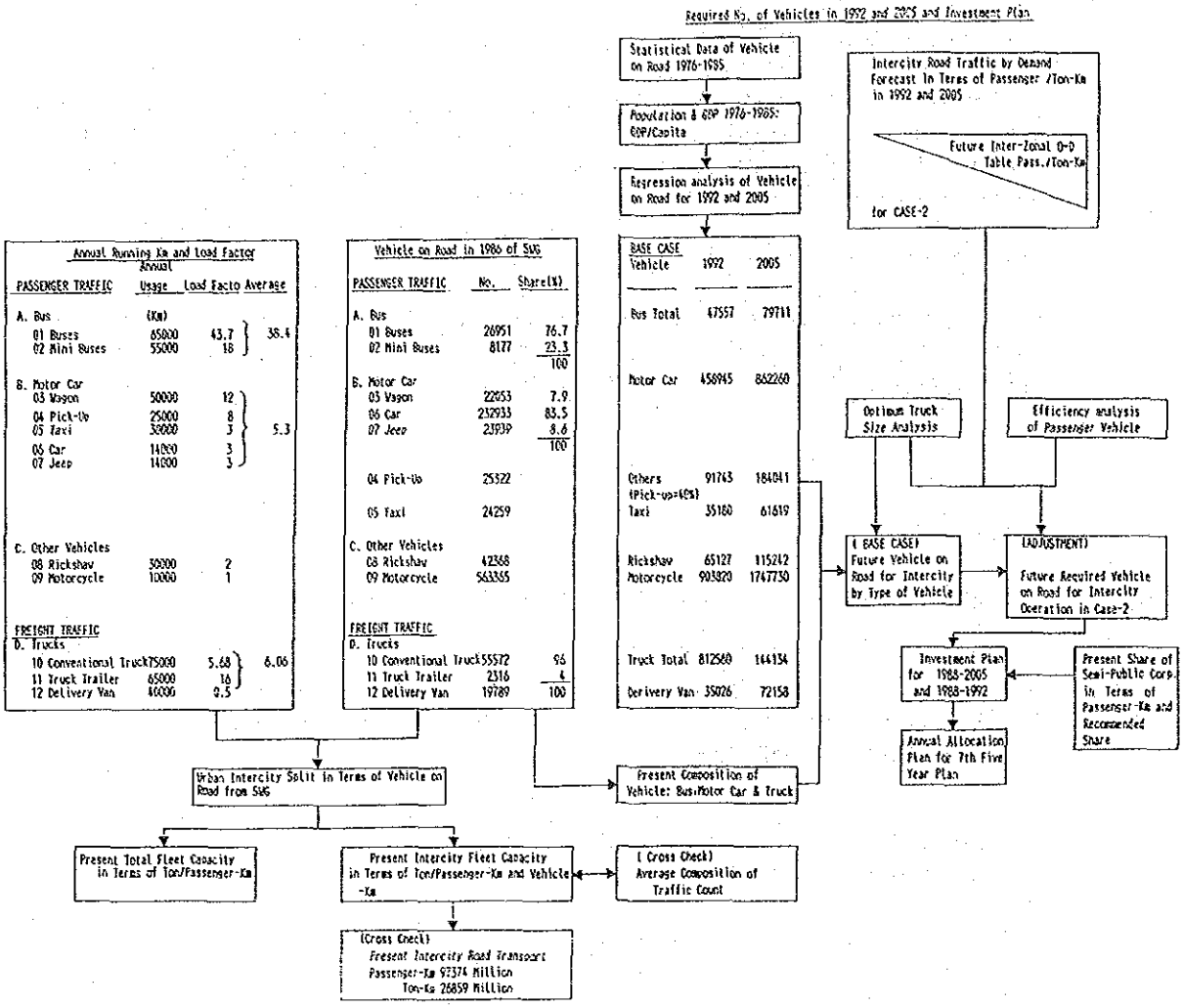


Table 2.2.1 Inland Inter-city Modal Split in Terms of Passenger·Km and Ton·Km

Unit: million

	1985/86		1992/93 Case 2		2005/06 Case 2	
	Pass. ·Km	Share (%)	Pass. ·Km	Share (%)	Pass. ·Km	Share (%)
Inter-City Pass.·Km						
Road	97,374	86.0	142,020	88.3	243,349	90.7
Railway	15,803	14.0	18,797	11.7	24,910	9.3
Total	113,177	100.0	160,817	100.0	268,259	100.0
Inter-City Ton·Km	Ton·Km		Ton·Km		Ton·Km	
Road	26,859	76.4	35,682	74.4	46,390	58.8
Railway	8,288	23.6	12,294	25.6	32,468	41.2
Total	35,147	100.0	47,976	100.0	78,858	100.0

Note: Inter-City Road Traffic = Inter-Zonal + Suburban
Suburban Inter-City Railway Traffic = Inter-Zonal

Figures of inter-zonal suburban split of road transport in 1992/93 and 2005/06 are shown in the following Table 2.2.2.

The share of inter-zonal traffic in 1985/86 out of inter-city road traffic will be reduced in 1992/93 and 2005/06, especially ton·km marked 78.9 percent in 1985/86 will drop to 68.8 percent and 47.7 percent in 1992/93 and 2005/06 in Case 2 respectively.

Table 2.2.2 Inter-Zonal Suburban Split of Road Traffic

Unit: million

	1985/86		1992/93 Case 2		2005/06 Case 2	
	Pass. ·Km	Share (%)	Pass. ·Km	Share (%)	Pass. ·Km	Share (%)
Inter-City Pass.·Km						
Sub Urban	51,405	52.8	83,477	58.3	155,793	64.0
Inter Zonal	45,969	47.2	58,543	41.2	87,556	36.0
Total	97,374	100.0	142,020	100.0	243,349	100.0
Inter-City Ton·Km	Ton·Km		Ton·Km		Ton·Km	
Sub Urban	5,661	21.1	11,118	31.2	24,250	52.3
Inter Zonal	21,198	78.9	24,564	68.8	22,140	47.7
Total	26,859	100.0	35,682	100.0	46,390	100.0

Note: Inter-City Road Traffic = Inter-Zonal + Suburban
Suburban Inter-City Railway Traffic = Inter-Zonal

Traffic assignment for road planning deals with inter-zonal vehicle O-D tables, while, road transport planning deals with inter-city road traffic including inter-zonal and suburban road traffic in terms of passenger·km and ton·km.

2.2.2 Regression Analysis of Vehicles on the Road for the Year 1992 and 2005

Future vehicle fleets on the road in Pakistan are initially forecasted by extrapolating the past tendency of vehicles on the road as the Base Case.

The Study Team reviewed some regression model not only regression between number of vehicles on road and GDP but also regression between vehicle on road and population plus regression between vehicle on road and GDP per capita.

Among the above mentioned three models, the Study Team found appropriate results of regression between vehicle on road and GDP per capita on the basis of data from 1976 to 1985. These data are listed in Table 1.2.1 with vehicle on road, population and GDP per capita.

Parameter obtained from the regression model between vehicles on the road and GDP per capita by type of vehicles and estimated vehicles on road in the year 1992 and 2005 are shown as follows:

Formula: Vehicle on Road = A x (GDP per Capita) + B

Estimated Future Vehicle Fleet in 1992 and 2005

		Parametre			1992	2005
1)	Motorcycle	A = 291.303	B = -905,755	r = 0.99	903,820	1,747,730
2)	Group Motor Car, Jeep, Station Wagon	A = 139.218	B = -405,878	r = 0.98	458,945	862,260
3)	Bus	A = 11.0993	B = -21,391.6	r = 0.96	47,557	79,711
4)	Taxi	A = 9.12646	B = -21,513.5	r = 0.96	35,180	61,619
5)	Rickshaw	A = 17.2987	B = -42,332.4	r = 0.92	65,127	115,242
6)	Delivery Van	A = 12.8174	B = -44,595.1	r = 0.98	35,026	72,158
7)	Truck	A = 21.7066	B = -53,591.3	r = 0.99	81,250	144,134
8)	Others	A = 31.8597	B = -106,170	r = 0.55	91,743	184,041

2.2.3 Estimated Vehicles on Road in 1992 and 2005 for Inter-City Operation

(1) Base Case

As shown in Fig. 2.2.1 flow chart and former item of 2.2.2, 8 types of vehicles are forecasted for the year 1992 and 2005 by regression model. In order to break down the data into 12 types of sub-categorized vehicles, present vehicle compositions in Bus, Motor Car modes are adopted from the figure of vehicles on road in 1986 of the Sub-Working Group for passenger vehicles.

After examination of the optimum truck size, the Team assumed that the allocated future inter-zonal ton·km in 2005 out of inter-city ton·km should be carried by truck trailers so as to minimize the total transport cost.

Vehicles on the road for inter-city operation by type of vehicle for Base Case is estimated accordingly as shown in Table 2.2.3

Table 2.2.3 Estimated Vehicles on the Road for Inter-City Operation in 1992 and 2005 for Base Case

Vehicle Type	Estimated Vehicle on Road by Regression Model				Vehicle on Road in 1986 from Sub-Working Report		Estimated Vehicle on Road by Type for Base Case				Estimated Vehicle on Road by SWG in 1992	
	1992		2005		Vehicle on Road	Share(%)	1992	Share(%)	2005	Share(%)	1992	Share(%)
I Passenger Traffic	No.	share (%)	No.	share (%)								
A: Bus												
1. Bus					26,951	76.7	36,476	76.70	61,138	76.70	42,838	82.70
2. Mini Bus					8,177	23.3	11,081	23.30	18,573	23.30	8,965	17.30
Bus Total	47,557	2.8	79,711	2.4	35,128	100.0	47,557	100.00	79,711	100.00	51,803	100.00
B: Motor Car												
3. Wagon					22,053	7.9	36,257	7.90	68,119	7.90	32,238	7.80
4. Car					232,933	83.5	383,219	83.50	719,987	83.50	344,970	83.70
5. Jeep					23,939	8.6	39,469	8.60	74,154	8.60	35,083	8.50
Motor Car Total	458,945	26.7	862,260	26.4	278,925	100.0	458,945	100.00	862,260	100.00	412,291	100.00
C: Others	91,743	5.3	184,041	5.7								
6. Pick-up					25,322	40.0	36,697	40.00	73,616	40.00	37,768	
D:7. Taxi	35,180	2.1	61,619	1.9	24,259	100.0	35,180	100.00	61,619	100.00	26,996	
E:8. Rickshiv	65,127	3.8	115,242	3.5	42,368	100.0	65,127	100.00	115,242	100.00	47,012	
F:9. Motorcycle	903,820	52.6	1,747,730	53.5	583,365	100.0	903,820	100.00	1,747,730	100.00	652,764	
Passenger Total					665,733		1,547,326		2,948,178		1,228,634	
II Freight Traffic												
G: Truck												
10. Conventional Truck					55,572	96.0	73,937	90.00	108,101	75.00	61,832	95.00
11. Truck Trailer					2,316	4.0	7,313	10.00	36,033	25.00	3,254	5.00
Truck Total	81,250	4.7	144,134	4.4	57,888	100.0	81,250	100.00	144,134	100	65086	100.00
H: 12. Delivery Van	35,026	2	72,158	2.2	19,789		35,026	100.00	72,158	100.00	23,653	
Freight Total		100		100.0			116,276		216,292		88,739	

(2) Capacity Analysis of Base Case Against Allocated Road Traffic of Case 2

Capacity analyses of Base Case for inter-city operation in the year 1992 and 2005 are carried out as compared to allocated passenger·km and ton·km for Case 2 on the basis of assumed annual usage and average load factors.

Estimated passenger·km and ton·km of Base Case in the year 1992 and 2005 are mentioned in App. Table 2-1 and summarized with the allocated passenger·km and ton·km for Case 2 (Details are stated in App. Table 2-2) as follows;

(Unit: million)

	1992/93		2005/06	
	Base Case	Case 2	Base Case	Case 2
Passenger·Km	116,665	142,020	203,243	243,349
Ton·Km	35,953	35,682	78,920	46,390

From the above figures, there are differences between the Base Case and Case 2. Future vehicles on the road of Base Case estimated by regression model are, therefore, required to be readjusted to cope with the allocated passenger·km and ton·km for Case 2.

(3) Alternative Study; Invested on Wagons and Invested on Large Size Buses

In order to readjust the vehicles on road for Case 2 from the Base Case, alternative study is conducted from the national economy point of view to minimize the investment costs on vehicles.

Firstly, capacity of passenger vehicles of Base Case should be increased to cope with the allocated passenger·km of Case 2.

As mentioned earlier, it was found through vehicle efficiency analyses that large size buses and wagons have high efficiencies in bus and motor car modes as compared to other vehicle types in the mode. The Team studied 2 cases, one is intensively invested on large size buses and other is intensively invested on wagons.

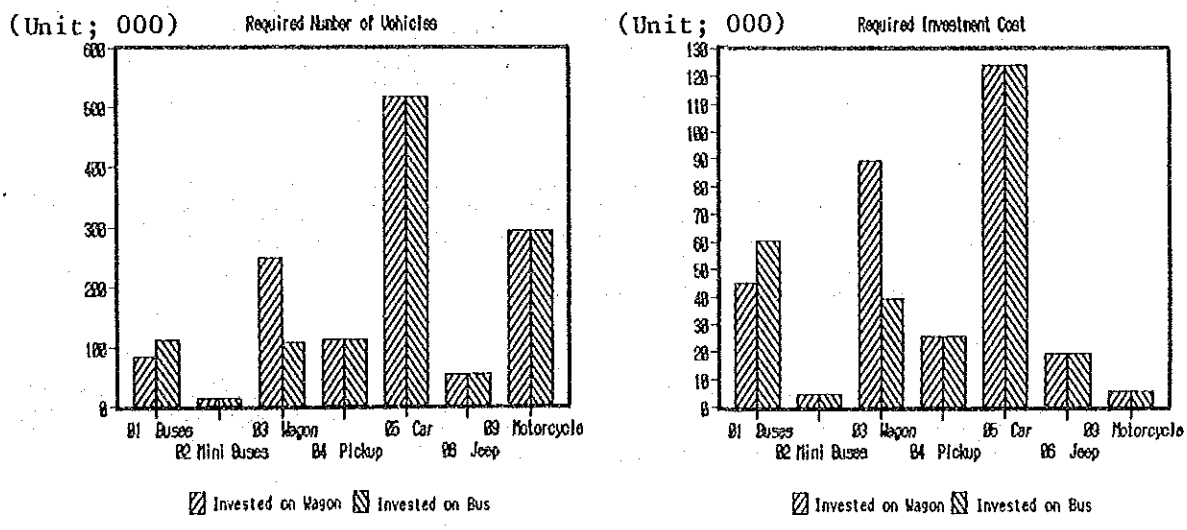
As shown in Table 2.2.4 and Fig. 2.2.2, investment case on large size buses of Rs. 280,546 million is more economical as against the case of wagons of Rs. 314,909 million during the Master Plan period.

The Study Team, therefore, adopted investment case on large size bus for Case 2.

Table 2.2.4 Alternative Study on Required Number of Passenger Vehicles and Investment Costs for Inter-City Operation

No.	Vehicle Type	Unit Cost (Rs Million)	Required No. of Vehicles: Case Invested on Wagon 1988-92	Case Invested on Wagon 1988-2005	Case Invested on Bus 1988-92	Case Invested on Bus 1988-2005	Required Investment Cost on vehicles: Case Invested on Wagon 1988-92	Case Invested on Wagon 1988-2005	Case Invested on Bus 1988-92	Case Invested on Bus 1988-2005
A.	Passenger Traffic									
01	Buses	0.54	18,124	83,112	27,908	112,557	9,787	44,880	15,070	60,781
02	Mini Buses	0.38	2,756	12,628	2,756	12,628	1,047	4,799	1,047	4,799
03	Wagon	0.36	70,093	248,644	23,616	109,024	25,233	89,512	8,502	39,249
04	Pickup	0.23	21,802	112,309	21,802	112,309	5,014	25,831	5,014	25,831
05	Car	0.24	112,221	517,938	112,221	517,938	26,933	124,305	26,933	124,305
06	Jeep	0.37	11,570	53,357	11,570	53,357	4,281	19,742	4,281	19,742
09	Motorcycle	0.02	45,414	291,986	45,414	291,986	908	5,840	908	5,840
	Total		281,980	1,319,974	245,287	1,209,799	73,204	314,909	61,756	280,546

Fig. 2.2.2 Alternative Study on Required No. of Passenger Vehicles and Investment Costs



(4) Truck Size

As mentioned earlier in the items of 2.2.1 and 2.2.3 (1) Base Case, the Study Team assumed that the allocated ton·km for inter-zonal traffic of some 50% out of inter-city freight traffic should be carried out by trucks trailer so as to minimize the total freight transport cost.

(5) Required Number of Vehicles by Type in 1992 and 2005 for Inter-City Operation

Readjusted number of vehicles by type on the basis of allocated road traffic in 1992 and 2005 for Case 2 are tabulated with the figures of Base Case in Table 2.2.5.

Table 2.2.5 Estimated Vehicles on Roads by Type in 1992 and 2005

No.	Vehicle Type	Average Load (Passenger)	Annual Average Kms	1992 Base Case No. of Vehicle	1992 Base Case Vehicle-Km per Year (Million)	1992 Base Case Pass.-Km per Year (Million)	1992 Case-2 No. of Vehicle	1992 Case-2 Vehicle-Km per Year (Million)	1992 Case-2 Pass.-Km per Year (Million)	2005 Base Case No. of Vehicle	2005 Base Case Vehicle-Km per Year (Million)	2005 Base Case Pass.-Km per Year (Million)	2005 Case-2 No. of Vehicle	2005 Case-2 Vehicle-Km per Year (Million)	2005 Case-2 Pass.-Km per Year (Million)
1	2	3	4	5	6	7	11	12	13	14	15	16	20	21	22
I.	PASSENGER TRAFFIC(MPK)														
A.	Bus														
	01. Busses	43.7	65,000	27,722.0	1,801.9	78,744.3	36,648.0	2,382.1	104,098.6	46,464.0	3,020.2	131,981.0	60,584.0	3,938.0	172,088.9
	02. Mini Busses	18.0	55,000	4,211.0	231.6	4,168.9	4,211.0	231.6	4,168.9	7,058.0	388.2	6,987.4	7,058.0	388.2	6,987.4
B.	Motor Car														
	03. Wagon	12.0	50,000	32,269.0	1,613.5	19,361.4	32,269.0	1,613.5	19,361.4	60,626.0	3,031.3	36,375.6	60,626.0	3,031.3	36,375.6
	04. Pickup	8.0	25,000	31,926.0	798.2	6,385.2	31,926.0	798.2	6,385.2	64,046.0	1,601.2	12,809.2	64,046.0	1,601.2	12,809.2
	05. Car	3.0	14,000	153,288.0	2,146.0	6,438.1	153,288.0	2,146.0	6,438.1	287,995.0	4,031.9	12,095.8	287,995.0	4,031.9	12,095.8
	06. Jeep	3.0	14,000	15,788.0	221.0	663.1	15,788.0	221.0	663.1	29,662.0	415.3	1,245.8	29,662.0	415.3	1,245.8
C.	Others														
	07. Motorcycle	1.0	10,000	90,382.0	903.8	903.8	90,382.0	903.8	903.8	176,773.0	1,747.7	1,747.7	176,773.0	1,747.7	1,747.7
Total(Passenger Traffic)				355,586.0	7,716.0	116,664.8	364,512.0	8,296.2	142,919.1	670,624.0	14,235.7	203,242.5	684,744.0	15,153.5	243,350.4

No.	Vehicle Type	Average Load (Cargo.Ton)	Annual Average Kms	No. of Vehicle	Vehicle-Km per Year (Million)	Ton-Km per Year (Million)	No. of Vehicle	Vehicle-Km per Year (Million)	Ton-Km per Year (Million)	No. of Vehicle	Vehicle-Km per Year (Million)	Ton-Km per Year (Million)	No. of Vehicle	Vehicle-Km per Year (Million)	Ton-Km per Year (Million)
1	2	3	4	5	6	7	11	12	13	14	15	16	20	21	22
II.	FREIGHT TRAFFIC(MTK)														
08	Conventional Trucks	5.68	75,000	65,543.0	4,999.7	28,347.3	64,486.0	4,836.5	27,471.0	97,290.0	7,296.8	41,445.5	54,655.0	4,084.0	23,197.0
09	Truck Trailers	16.00	65,000	7,313.0	475.3	7,605.5	7,889.0	512.8	8,204.6	36,033.0	2,342.1	37,474.3	22,302.0	1,449.6	23,194.1
Total(Freight Traffic)				73,856.0	5,466.1	35,952.8	72,375.0	5,349.2	35,682.0	133,323.0	9,638.9	78,919.9	76,755.0	5,533.6	46,391.1

Note; Base Case: Estimated Vehicle on Road by Regression Model

In the year 2005, 684,744 passenger vehicles and 76,755 trucks are required so as to cater for the allocated inter-city 243,350 million passenger·km and 46,391 million ton·km.

(6) Share of Large Size Buses in Inter-City Bus Operations

Two main types of buses are observed on inter-city routes in Pakistan. One is the smaller size having 42 seats and other is slightly large size having 52 seat capacity. The smaller size buses are locally built on truck chasis like the Bedford. It has been observed from the sample survey conducted at Lahore General Bus Stand that the majority of inter-city bus services are shared by 42 seaters smaller size buses besides large size semi-public buses which whares 5 percent in inter-city bus operations at present.

As far as future share of large buses in inter-city bus operations is concerned, the Study Team recommended to introduce large size buses for inter-city passenger services so as to carry allocated passenger traffic for Case 2.

Adjusted Share of Buses for Case 2

Unit: No. of Vehicle

Case / Year	Case 2 (1)	Base Case (2)	Balance (3)	Adjusted Share in Case 2 (3)÷(1)
1992	36,648	27,722	8,926	25%
2005	60,584	46,464	14,120	23%

As estimated above, in the future some 25 percent large size buses have been recommended to be induced in order to cater for allocated passenger·km for Case 2 against the Base Case of present trend. In addition, the Team recommended that 10 percent of bus passenger·km will be carried out by semi-public large size buses. Therefore, future share of large size buses will become 35 percent out of total inter-city bus operations.

An average equivalent standard axle load of inter-city buses is calculated as follows;

Large Size Bus | Small Size Bus

$$\left\{\left(\frac{5.0}{8.2}\right)^{4.5} + \left(\frac{9.0}{8.2}\right)^{4.5}\right\} \times 0.35 + \left\{\left(\frac{3.3}{8.2}\right)^{4.5} + \left(\frac{6.0}{8.2}\right)^{4.5}\right\} \times 0.65 = 0.57 + 0.17$$

$$= 0.74$$

Say 0.75

2.2.4 Investment Plan on Vehicles for Inter-City Operation During the Master Plan Period

(1) Required Number of Vehicles by Type

Required number of motor vehicle fleets to be induced from the year 1987/88 up to 2005/06 for the Master Plan period are estimated on the basis of average vehicle life of 10 years and 90% number of vehicles available from the previous year.

During the Master Plan period, 1,209,799 passenger vehicles and 147,358 truck are required to be allocated for inter-city traffic. Details are shown in App. Table 2-3 and the summary is presented in Table 2.2.6.

(2) Investment Plan on Vehicles for Inter-City Operation

During the Master Plan period from 1988 up to 2005, Rs. 362,244 million is required on a total vehicle fleet to be purchased of which Rs. 280,546 million is required for passenger vehicles and Rs. 81,698 million for trucks.

Number of buses will belong to semi-public bus corporations for inter-city operations which are also estimated giving an assumption to the present share of semi-public bus corporations in inter-city operations of 5.1 percent in terms of passenger·km will become 10 percent. Investment cost on buses belonging to semi-public bus corporations for inter-city operations will be Rs. 6,078 million during the Master Plan period.

Investment plan on vehicle fleets for inter-city operations by type of vehicle is shown in Table 2.2.6 with the figure of required number of vehicles.

Table 2.2.6 Required Number of Vehicles and Investment Costs for Inter-City Operation

No.	Vehicle Type	Unit Rs. million	Required No. of Vehicles Case - 2 1988-92	Required No. of Vehicles Case - 2 1988-2005	Required Investment Cost on Vehicles Case - 2 1988-92	Required Investment Cost on Vehicles Case - 2 1988-2005
A.	Passenger Traffic					
01	Buses	0.54	27,908	112,557	15,070	60,781
02	Mini Buses	0.38	2,756	12,628	1,047	4,799
03	Wagon	0.36	23,616	109,024	8,502	39,249
04	Pickup	0.23	21,802	112,309	5,014	25,831
05	Car	0.24	112,221	517,938	26,933	124,305
06	Jeep	0.37	11,570	53,357	4,281	19,742
09	Motorcycle	0.02	45,414	291,986	908	5,840
	Total		245,287	1,209,799	61,756	280,546
B.	Freight Traffic					
08	Conventional Truck	0.43	40,753	108,350	17,524	46,591
09	Truck Trailer	0.90	7,276	39,008	6,548	35,107
	Total		48,029	147,358	24,072	81,698
	Grand Total		293,316	1,357,157	85,827	362,244

2.3 Highway Safety Planning Direction and Recommendations

Pakistan appears to have a very high fatality rate and high volume of road accidents especially on N-5 and in bus operation.

Most of the accidents are caused by driver's carelessress and ignorance of road safety rules and also due to aged and badly maintained vehicles including speed, overtaking manner and lack of proper enforcement for moving violation.

The government has plans to implement improved road safety measures covering driver education installation of kilometer stones all along N-5, and the patrolling of highways. Highway Safety Wing of the Ministry of Communications is responsible for monitoring Highway Patrol and also the Driver Instructor Training School.

Under the 4th Highway Project, Highway Patrol would be extended from Attock Bridge to Jhelum Bridge, Driver Instructor Training School in Islamabad will also be expanded and kilometer stones will be installed all along N-5.

The Study Team recommended that the traffic rules should be taught through mass media at a proper hour for public vehicle drivers and to introduce a Highway Patrol system all along N-5 and N-65 excluding the section between Peshawar - Attock with installation of kilometer stones all along the road network of 18,000 km so as to identify the exact location of the accident. The team also recommended to establish a Driving Instructor Training School at the federal level under the 4th Highway Project.

2.4 Planning Policy on Inter-City Road Transport to be Incorporated in the Master Plan

The Study Team reviewed the situation and problems in the road transport industries through discussion in former Chapter 1 and this Chapter 2. On the basis of these fact findings, recommendations from policy oriented point of view are presented in Table 2.4.1 in terms of Safety, Quality Control, Vehicle Control, Institutional Arrangement and Future Requirement.

And the Study Team assumed that existing NLC fleet size of some 1,750 vehicles will be maintained as a national asset in the future in order to cater for essential commodities.

Table 2.4.1 Planning Policy Inter-City Road Transport to be Incorporated in the Master Plan

Policy Oriented	Objective	Recommendation
SAFETY		
1. Improvement of Highway Safety	• Reduction of Road Accidents and Improvement of Accident Recording	• Education Programme through Mass Media. • Establishment of Driving Instructor Training School at Federal Level under 4th Highway Project • Installation of Kilometer Stones All along Road Network of 18,600 km • Expansion of Highway Patrol on National Highways all along N-5 and N-65.
QUALITY CONTROL		
2. *Mixed Approach (Inter-City passenger road transport would continue to be shared by Public and Private Sectors).*	• *To create a sense of competition among transporters.*	• *Target share of Public and Private Sector in Inter-City transport will be 10% and 90% for Intercity Bus Operations in terms of Passenger·Km*[1/].
3. Revision of Bus Fare Structure	• Inducement of Private Sector Investment and Enhancement of profitability on Semi-Public Bus Corp.	• Fare Structure to be Determined on VOC including Depreciation and Interest.
4. Strengthening of Semi-public Bus Corporations. (For Inter-City Bus Services)	• To cope with the political needs and Basic Human Needs for local people on unprofitable routes. • To maintain punctual bus operation in accordance with a time table. • To create comfortable and profitable bus services. • To improve operational efficiency	• All Capital investment in Semi-public Bus Corporations to be financed by Provincial and Federal Governments as Grant-in-Aid in the ratio of 50:50 respectively. • Semi-public Bus Corporations will be required to introduce air-conditioned bus on profitable inter provincial and regional bus routes. • Induction of management techniques and maintenance facilities
5. Maintenance of NLC Existing Fleet Size	• To maintain the National Asset • To maintain smooth cargo flow of essential commodities	• 175 unit of truck trailers will be required annualy to maintain existing fleet size (50% of vehicles were induced before 1980)
VEHICLE CONTROL		
6. Revision of axle load limit	• To reduce total transport cost.	• Legal axle load limit of 6 ton will be revised to 13 tons for single and 20 tons for Tandem Axles.
	• To encourage large size trucks for inter-city operation.	• Target share of large size truck in Inter-city transport will be 50% by the year 2005 in terms of Ton·Km.
7. Revision of Vehicle Registration System on the basis of Axle Loads	• To find Actual Impact on Pavement Design and to Revise Taxation System on Vehicles	• Formulation of study team in NTRC
8. Incentive for Large Size Buses	• To Minimize Transport Cost and to Cater for the Allocated Passenger Traffic	• Encouragement of Induction of Large Size 52 Seater Buses for Intercity Operations
INSTITUTIONAL ARRANGEMENT		
9. Healthy Growth of Private Transport Industry both for Passenger and Freight	• Inducement of Private Sector investment in Transport Industry.	• Institutional arrangement on:- - Credit Facilities - Insurance - Mechanic Training.
FUTURE REQUIREMENT		
10. Improvement of Private Sector Operation of Bus and Terminal	• To understand the requirement of sub-sector.	• A detailed study is required for Private Sector Bus Operation including Air-conditioned Mini Bus, General and Company Bus Stands Operations.
11. Establishment of National Environmental Quality Standards	• To conduct Environments Inpact Assessment on Road Transport Projects	• To be Formulated

1/ Target share between public and private sector in inter-city bus operation proposed by the Report of Sub-Working Group for the 7th Five Year Plan are 16% and 84% respectively.

Note: The Pakistan Government already exempted the import tax of large size buses.