CHAPTER 6 Railway Planning

CHAPTER 6 RAILWAY PLANNING

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CHAPTER 6 RAILWAY PLANNING

Since the opening of the Karachi to Kotri section in 1861, Pakistan Railways has expanded its routes, and traffic volumes have also increased steadily. However, the percentage of investment for railways is decreasing in each Five-Year Plan in accordance with expanded investment for roads due to motorization. Amidst these circumstances, the Pakistan Railways is attempting to improve its operations while maintaining its overaged facilities.

However, these improvements do not always proceed favorably due to insufficient funds. Conditions which railways should satisfy as they are faced with intense competition from automobiles, airplanes, ships and other means of transportation are as follows.

- Safety
- High speed
- Promptness
- Environmental protection
- Comfort
- Energy conservation

Railways are of a nature which enables them to fully display all of these characteristics simultaneously as compared with other means of transportation. The government's and the people's expectations toward the Pakistan Railways are increasing. Therefore, measures were investigated which would allow the railways to manifest these characteristics.

6.1 Present Situation of Railway Transport

6.1.1 Facilities

(1) Tracks

The Pakistan Railways had a total length of 12,634.7 track kilometers at the end of 1992 - 93. This consists of 11,343.5 km of broad gauge, 555.10 km of meter gauge, and 726.10 km of narrow gauge. Double-tracked sections accounted for 1,037 km, and the details are shown below (Table 6.1.1.1):

Table 6.1.1 Route & Track Length by Gauge

	Route Kilometers	Track Kilometers
Broad-Gauge	7,718.37	11,343.52
Meter-Gauge	445.40	555.10
Narrow-Gauge	611.10	726.11
Total	8,774.87	12,624.73

Source : P.R. Yearbook, 1992-93

P.R. has not constructed any new routes since 1982. Conversely, although the tracks still exist, it has been abolishing narrow gauge and many broad gauge branch lines on unprofitable routes since 1991.

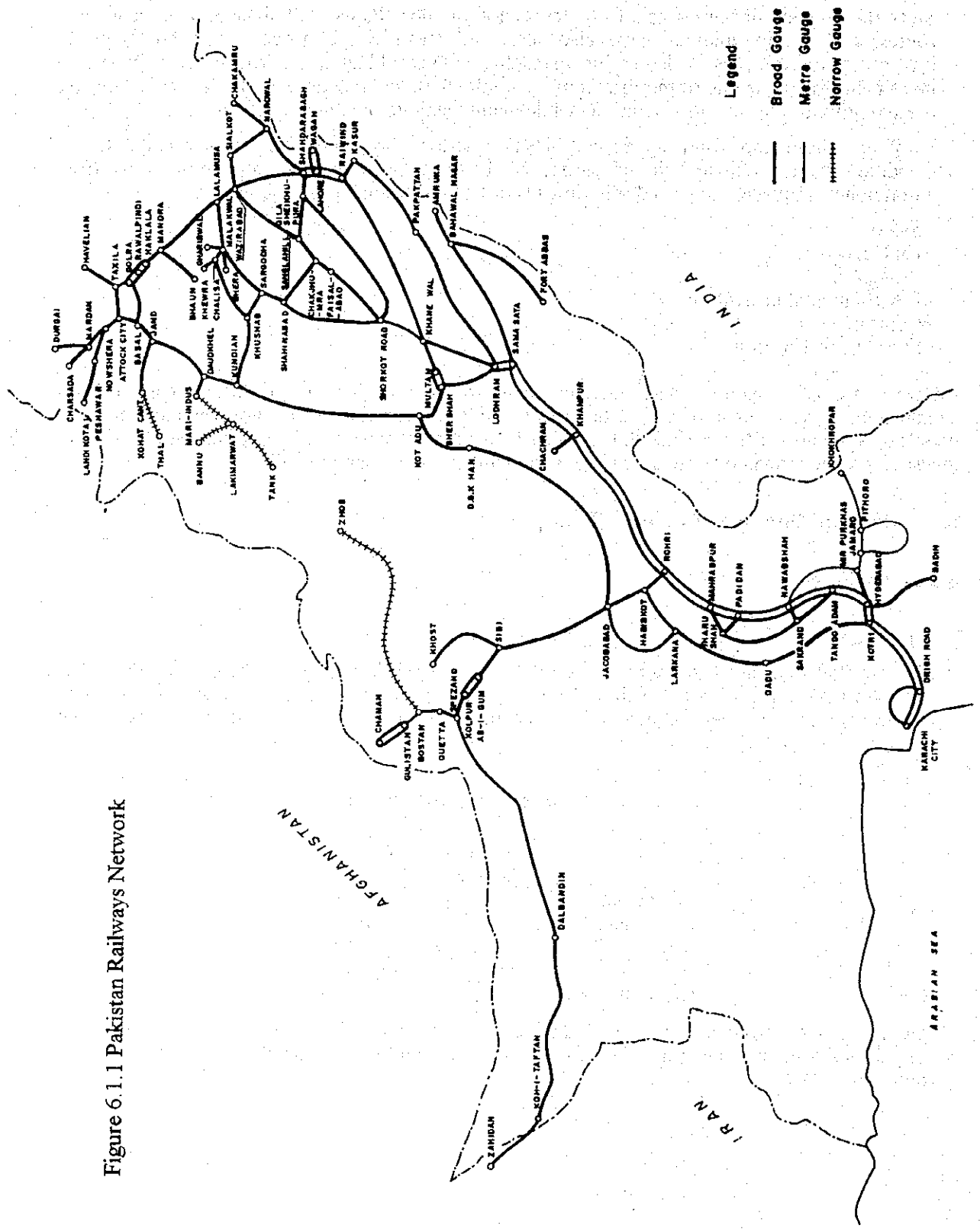


Figure 6.1.1 Pakistan Railways Network

(2) Signaling System

The interlocking systems in the Pakistan Railways are largely classified into four types: standard I and standard II types have no direct interlocking, and train speeds are restricted to 50 km/h and 75 km/h, respectively. The standard III type is a direct interlocking system and has a higher performance in terms of efficiency and safety. The relay interlocking system enables high-speed train operation and has the highest performance among all of these systems, requiring only a small number of personnel. The number of stations by type of signaling system is shown in Appendix 6.1.1.

The blocking systems on the main lines of the Pakistan Railways are largely classified into four types: token block instruments (single line), tokenless block instruments (single line), block instruments (double line) and automatic block systems.

The Pakistan Railways is planning to introduce station track circuits, a color light signaling system, electrical point interlocking and approach-locking.

6.1.2 Rolling Stock

(1) Locomotives

The Pakistan Railways has three types of locomotives: electric, diesel-electric and steam (yearly figures are shown in Appendix 6.1.2). Replacement of steam locomotives with diesel-electric locomotives has been gradually progressing for motive power modernization. The number of electric locomotives has not changed since their introduction in 1970-71 because there has been no progress in electrification (only the section between Lahore and Khanewal is electrified).

(2) Coaches

The total number of the Pakistan Railway's coaching vehicles at the end of 1992-93 was 2,832. This number includes 2,425 vehicles meant for the conveyance of passengers and 407 vehicles for conveyance of luggage, parcels, mail, automobiles, horses, etc., as well as departmental vehicles and does not include 356 coaching brake-vans. Air-conditioned passenger coaches operating between important towns are included.

In addition, there are 9 diesel-electric railcars and 136 trailers.

Yearly figures are shown in Appendix 6.1.3.

(3) Wagons

The number of freight wagons owned by the Pakistan Railways at the end of 1992-93 was 29,451 comprising 18,376 covered wagons, 5,920 opens, 3,744 special type (for carriage of liquids, explosives, machinery, livestock, timber, rails, etc.) and 1,411 departmental wagons, and does not include 432 brake-vans. 25,725 of these wagons are 4-wheelers, the rest are mostly 8-wheelers. Yearly figures are shown in Appendix 6.1.4.

6.1.3 Railway Transport

(1) Passenger Transport

In 1992-93, the number of passengers carried was 59.0 million as compared with 84.9 million in 1990-91, showing a decrease of 30% during the last 2 years. Passenger-kilometers, which is a product of the number passengers carried and the distance traveled, were 17,082.31 million in 1992-93 as compared with 20,373.3 million in 1989-90, thereby showing a decrease of 16.2% during the last 3 years.

The table below indicates the trend of passenger traffic, passenger-kilometers, average number of kilometers traveled per passenger and trains run.

Table 6.1.3.1 Parking Railways : Passenger Data

Year	No. of Passengers Carried (millons)	Total Passenger Kilometers (millions)	Average Number of Kilometers Travelled per Passenger	Total Number of Trains Run ('000 kms)
1983-84	107.1	18,287.1	170.7	34,807.0
1984-85	94.7	17,806.5	188.0	35,689.0
1985-86	82.9	16,849.6	203.2	35,553.0
1986-87	78.1	16,919.8	216.5	35,419.0
1987-88	81.2	18,541.5	228.2	36,513.0
1988-89	84.7	19,731.7	233.0	35,773.0
1989-90	84.6	20,373.3	240.8	36,649.0
1990-91	84.9	19,963.7	235.2	36,181.0
1991-92	73.3	18,158.0	247.7	34,570.0
1992-93	59.0	17,082.3	289.3	33,533.0

Note: Excludes differential on government traffic and Public Service Obligation
Source : P.R. Yearbook, 1992-93

There are seven classes of passenger services:

i) Air-conditioned Sleeper
ii) Air-conditioned Sitter
iii) Air-conditioned Lower
iv) First Class Sleeper
v) First Class Sitter
vi) Economy Class
vii) Second class (branch lines only)

Since 1990-91, the number of passengers has had a tendency to decrease (Appendix 6.1.5).

(2) Freight Transport

Chnges in freight traffic during the past 10 years are as shown in Table 6.1.3.2. Traffic as a whole has tended to decrease. In 1992-93, however, the total number of tons and ton-km were 7,770 thousand tons and 6,180 million ton-km showing an increase of 2.76% and 3.67% respectively. The average km travelled by ton was 797.8 km, almost the same as the peak of 805.1 km in 1988-89.

The major commodities handled by the Pakistan Railways include such items as wheat (13.47%), oil and oil products (13%), rice (4.26%), cement (3.82%) and fertilizer (10.62%).

6.1.4 Train Operation

(1) Passenger Trains

The largest amount of passenger trains run in the past 10 years was 36.6 million train-km in 1989-90, with no major changes occurring throughout this period.

The average train-km per train, 289 km in 1992-93, has been on the increase. It is thought that the number of short-distance trains is decreasing.

(2) Freight Trains

In the case of freight traffic, train-km have shown a tendency to decrease over the past 10 years, with a peak of 14 million km in 1988-89 and a low of 9.2 million km in 1992-93.

Table 6.1.3.2 Pakistan Railways : Freight Data

Year	Tonnage	Ton-Kilometers	Average Kilometers Travelled per Ton	Total Number of Trains Run ('000 kms)
1983-84	10,753	7,384,936	690.8	11,840
1984-85	10,520	7,202,861	690.1	11,708
1985-86	11,805	8,269,811	705.0	12,453
1986-87	11,646	7,819,819	675.0	12,672
1987-88	11,639	8,033,231	693.5	13,526
1988-89	10,427	8,363,916	805.1	14,443
1989-90	9,281	7,226,300	782.3	12,335
1990-91	7,717	5,708,551	742.3	10,162
1991-92	7,560	5,961,572	792.4	9,502
1992-93	7,769	6,180,276	797.8	9,209

Source : P.R. Yearbook, 1992-93

Changes in traffic by commodities are shown in Appendix 6.1.6.

The average number of wagons per train is 57 for diesel-electric locomotives and 61 for electric locomotives. This is considered as an efficient utilization of the tractive capacities of locomotives (Appendix 6.1.7).

6.1.5 Railway Performance

(1) Assets and Performance

Financial allocation for railways since the 1964-65 period is summarized in Table 6.1.5.1 Although the absolute allocation amount for railways has increased, the relative share against roads has drastically decreased.

Assets and performance of the Pakistan Railways are shown in Table 6.1.5.2. Expenditures on railways in the 7th Five Year Plan showed that more than 50% was for rehabilitation of the track and replacement of rolling stock. In terms of locomotives, the replacement of steam with diesel-electric locomotives progressed considerably during those years. However, the reduction in the total number of locomotives will decrease the efficiency of the transport service.

Large expenditures on replacement and rehabilitation will result in a small allocation for investments to improve efficiency, capacity and services within the limited amount of the budget.

(2) Review of the 7th Five Year Plan

Under the 7th Five Year Plan, it was originally proposed to transform the freight traffic share of railways and roads from 20:80 in 1982-83 to 26:74 in 1992-93. As for passenger traffic, an increase of 2.63% per annum was planned for the railway in terms of passenger-km with a target of 19.3 billion passenger-km in 1992-93.

Furthermore, in the initial stage of the 7th Five Year Plan, the following performance targets for the Pakistan railways were proposed. However, the targets listed below have not been achieved except for item b, and no significant changes have been observed so far.

Table 6.1.5.1 Financial Allocation : Land Transport Sub - Sector

Period	Railways	Road & Road Transport	Civil Aviation & Airlines	Ports & Shipping	Total Investment	Total Plan	Share in overall Plan (%) Transport	Railway
1st 1955-60	478	227	90	133	928	4,863	19.0	9.8
	(51.5)	(24.5)	(9.7)	(14.3)				
2nd 1960-65	1,138	318	47	3	1,506	10,606	14.2	10.7
	(75.6)	(21.1)	(3.1)	(0.2)				
3rd 1965-70	1,150	733	170	7	2,060	13,204	15.6	8.7
	(55.8)	(35.6)	(8.3)	(0.3)				
Non Plan	2,923	6,268	2,439	1,995	13,631	75,544	18.0	3.9
1970-78	(21.5)	(46.0)	(17.9)	(14.6)				
5th Plan	5,566	11,818	6,659	7,113	31,156	153,210	20.3	3.6
1978-83	(17.9)	(37.9)	(21.4)	(22.8)				
6th Plan	7,404	11,816	11,837	1,309	32,366	279,000	11.6	2.6
1983-88	(23.0)	(36.5)	(36.5)	(4.0)				
7th Plan	8,485	20,795	5,364	4,486	39,130	350,000	11.2	2.4
1988-93	(21.7)	(53.1)	(13.7)	(11.5)				

Table 6.1.5.2 Assets And Performance Of The Pakistan Railways

	NON Plan period year end 1977-78	5th plan end 1982-83	6th plan end 1987-88	7th plan end 1992-93	Remarks
Allocation of funds (million Rs)	(1970-1978) 2,923	(1978-1983) 5,566	(1983-1988) 7,033		
(Assets)					
Route-Km	8,815	8,774	8,774	8,774	
Track-Km	12,515	12,583	12,622	12,625	
Number of locomotives	978	979	792	703	
Steam	481	446	197	125	
Diesel-electric	468	504	566	549	
Electric	29	29	29	29	
Number of coaches	2,133	2,365	2,633	2,425	
(Passenger carriages)					
Number of wagons	36,406	35,990	36,506	29,451	
Persons employed	139,813	128,137	132,143	122,397	
Traffic volume (millions)					
Passenger	149	123	82	59	
Passenger-km	15,375	18,030	18,541	17,082	
Tons	13.0	11.8	11.6	7.8	
Ton-km	8,557	7,323	8,033	6,180	
Revenue and expenses (million Rs)					
Revenue	2,213	3,394	5,443	9,031	
Expenses	2,192	4,491	6,757	10,070	
Surplus	(+)21	(-)1,097	(-)1,314	(-)1,039	
Operating ratio	73.9	97.4	85.5	75.8	

Source : P.R.

Table 6.1.5.3 Target Figures Of The 7th Five - Year Plan

	1992-93 Target Figures	1992-93 Actual Figures
a)	Wagon turn around time to decrease from 18 to 14 days	15.4
b)	Locomotive utilization to increase by 20% (from 247 to 300 km per locomotive per day)	302.0
c)	System-wide loading of wagons to increase from 1,611 to 2,300 per day	1,120.0
d)	The percentage of ineffective locomotives to decrease from 18.1% to 13%	19.1

This is considered partly due to the decrease in traffic demand for the Pakistan Railways and to the shortage of funds to achieve the 7th Five Year Plan itself. Since the outset of the 7th Five Year Plan, traffic volume of the Pakistan Railways has been sluggish in both passenger and freight transport. As shown in Table 6.1.5.4, the actual results of the service did not meet the projections. As the railway is a complex system, increase in overall service cannot be shown by a single index. When some facilities are improved, it often happens that the total system's productivity does not increase. Thus, improvement in other facilities should be made simultaneously.

Table 6.1.5.4 Comparison Of Projected And Actual Traffic

(Fig. in Billions)

	Passenger (PKM)		Freight (TKM)	
Year	Projected	Actual	Projected	Actual
1987-88 (Bench mark)	17.000	18.541	7.800	8.933
1988-89	17.447	19.732	8.568	8.364
1989-90	17.906	20.373	9.412	7.226
1990-91	18.377	19.964	10.339	5.709
1991-92	18.860	18.158	11.358	5.962
1992-93	19.335	17.082	12.476	6.180

The Pakistan Railways, which carried 73% of freight and 42% of passenger traffic during the 1st Plan period (1955-60), had its share reduced to mere 20% of freight and only 13% of passenger traffic by the end of the 7th Plan. Even the targets fixed for the 7th Plan of 20% of freight traffic to be moved by rail could not be achieved. These set-backs to the transport capacity of the Pakistan Railways occurred due to rapidly overaging of assets, mainly due to inadequate investments. The share of railway investment in the national plan decreased from 10.7% in the second plan (1960-65) to a mere 2.4% in the 7th plan, and the share in the transport sector was reduced from 75.6% in the second plan to only 21.7% in the 7th plan. Though an amount of Rs. 27.9 billion was recommended by the sub-working group for investment in the railway sector in the 7th Five Year Plan, provision of only Rs. 8.85 billion was made, and the actual expenditure was only Rs. 5.682 billion. Such inadequate investments have adversely affected the transport capacity on account of rapid overaging of assets. At present, 50% of the assets of the entire system have outlived their economic life.

To serve the projected traffic, the Pakistan Railways has been implementing a plan to increase the speed of some passenger trains from 95 km/h to 120 km/h and freight trains from 55 km/h to 90 km/h during the Five Year Plan. At the same time, the strengthening and renewal of existing tracks and bridges have been implemented. Improvements in rolling stock performance, tractive power, and signaling and telecommunications systems have also taken place (Appendix 6.1.8).

6.1.6 Rates and Finance

(1) Rate Structure

Table 6.1.6.1 shows the passenger fare table. Passenger fares are classified, according to the quality of car accommodations, into seven types: air conditioned sleeper class, air conditioned sitter class, air conditioned lower class, first sleeper class, first sitter class, economy class and second class.

Three types of distance zones are also in use: 1 to 100 km, 101 to 500 km and 500 km or more. A decreasing fare system based on the distance travelled is in use. Table 6.1.6.2 shows commodity freight tariffs.

A discount of additional rate is applied according to the commodity: for example, 230% of the basic rate for wheat and 380% for petroleum.

Table 6.1.6.1 Pakistan Railways : Passenger Fare Table

Service Type		Paisa per Passenger per Kilometer		
		1 to 100 (km)	101 to 500 (km)	501 & above (km)
Air-conditioned	(sleeper)	148.16	86.47	69.20
Air conditioned	(sitter)	85.21	49.72	39.74
Air-conditioned	(lower)	39.53	32.08	29.66
First (sleeper)		42.63	35.49	28.40
Economy class		19.79	16.07	16.00
Second class		13.13	9.82	9.71

Source : P.R.

Table 6.1.6.2 Pakistan Railways : Freight Basic Rate Scale

Commodity	Rate Scale	Tariff (Rs./ton)	Average Lead (km)	Unit Tariff (Rs./ton-km)
Wheat	230	523.65	1252	0.418
Rice	170	206.16	498	0.414
Cotton	150	257.51	861	0.299
Edible Oil	250	555.18	1216	0.457
Sugar	230	446.37	1008	0.443
Cement	200	382.54	991	0.386
Fertilizer	230	401.29	871	0.461
Iron & steel	260	577.39	1203	0.480
Mining products	150	337.31	1228	0.275
Coal & coke	180	379.57	1129	0.336
Petroleum	380	297.28	144	2.064
Firewood	150	179.57	482	0.373
Sugarcane	120	93.88	187	0.502
Fruit & vegetable	150	215.51	650	0.332
Livestock	-	335.70	889	0.378
Rock phosphate	230	452.81	1025	0.442
Railway material	-	-	319	0.000
Railway oil	300	302.97	366	0.828
Others	250	387.18	724	0.535

Source : P.R.

Table 6.1.6.3 Financial Statements

(million Rs.)

Item	1988-89	1989-90	1990-91	1991-92	1992-93
1 Gross Earnings	5,308	5,645	6,761	8,236	9,031
Passenger	1,861	1,961	3,354	3,868	4,135
Luggage, Mails, etc.	258	311	298	365	474
Freight	3,109	3,275	2,962	3,823	4,287
Miscellaneous	80	98	147	180	13
2 Operation Expenses	4,888	5,228	5,829	6,665	6,846
Repair & Maintenance	2,279	2,462	2,601	3,076	3,090
Operation Costs	1,889	2,015	2,374	2,534	2,636
Others	720	751	854	1,055	1,120
3 Appropriating to D.R.F.	993	993	993	993	993
4 Net Earnings	-574	-576	-61	577	1,192
5 Interest Charges	940	546	628	588	614
6 Other Revenue Expenditures	1,254	1,050	1,078	1,451	1,647
7 Gain (+) / Loss (-)	-2,767	-2,172	-1,768	-1,461	-1,039
Operating Ratio	92.1	92.6	86.2	80.9	75.8

Source : P.R. Yearbook

(2) Financial Condition

The financial condition of Pakistan Railways for the past 5 years is shown in Table 6.1.6.3. The operation ratio, the ratio of expenditures to operating revenue, is improving every year, and in 1992-93 reached 75%. This, and other factors seem to indicate that over the last three years there has been a striking turnaround to profitability. However, although there were fare revisions, government aid for PSO (Public Service Obligation) contributed greatly. Expenditures as a whole, including payment of interest, payments to the Depreciation Reserve Fund, worker welfare-related expenses and other items greatly exceed revenue, so that a stern operating condition of unprofitability continues.

Revenue and operation expenses for the past 10 years are itemized in Appendices 6.1.9 and 6.1.10. While revenue varies from year to year, majority is accounted for by freight, although in 1990-91, when PSO was introduced, freight and passengers accounted for about the same amount of revenue.

In the area of operation expenses, Maintenance and Repair is stable at about 45% of operation expenses. The ratio of Maintenance and Repair to revenue has decreased since fiscal 1991-92, but due to aging of facilities, a future increase is desirable.

Under Pakistan Railways' Corporate Plan 1994-95, freight will be profitable if either Variable Costs or Full Costs are considered, while the profitablity of passengers is not sufficient to cover Variable Costs. Consequently, more efficient passenger transportation is necessary, with fares set in a manner that takes costs into consideration.

6.1.7 Capacity Analysis of Existing Railways

Let us make a bold estimate of the Pakistan Railways' transport capacity on the assumption that it utilized its route network to the fullest extent. Of course, since sections which are not actually being operated are also taken into consideration for the calculation, this figure will be somewhat detached from reality. However, calculating the overall transport capacity possessed by the Pakistan Railways allows us to give a fixed estimate of its present transport capacity.

(1) Calculation of the Number of Trains on Each Section

Line capacity is defined as the maximum number of trains which can be run in one day in a section. This is determined by various factors including single or double line tracks, signaling systems, alignment, equipment conditions and train speed.

Generally, the line capacity can be obtained from the following formula, also known as "Scott's Formula".

$N = T/(t + c) * f$

where,

N : Line Capacity (Number of Trains per Day)

T : 60 min. * 24 hrs. = 1440 min.

f : Track Use Ratio

t : Running Time of One Train between Stations

c : Time Required for Blocking

In order to calculate "t", the following assumptions are adopted here.

1) The same number of passenger and freight trains are operated in each section.

2) Train speed is 70% of maximum speed, and permanent/temporary speed restrictions are not taken into consideration.

3) Running time is shown below.

$t = 60 * L/V$

where,

t : Running Time (min.)

L : Length of the Block Section (km)

V : Train Speed (km/h)

Below are two Case-studies. Case I uses the Pakistan Railway's method, and the other one uses the Japan National Railway method. Utilization figures are as follows.

CASE		I (P.R. Method)	II (J.N.R Method)
Track Use Ratio		0.7	0.6
Train Speed		Slowest Speed	Average Speed
Length of the Block Section		Longest Section	Average Section
Time Required for Blocking	Automatic and Double Line	0	1.5
Tokenless		2	1.5
Token		5	2.5

The result of the calculation of line Capacity is shown in Table 6.1.7.1 As there are few differences between two cases, total traffic volume (as shown in Table 6.1.7.2) and the following calculations are based on Case I.

Table 6.1.7.1 Calculation Of Line Capacity

Sections		Block Signaling	Max. Speed (pass.) (km/h)	Max. Speed (freight) (km/h)	Line Capacity Case I (No.)	Line Capacity Case II (No.)
Karachi	Hyderabad	Automatic	95	70	118	127
Hyderabad	Samasata	Double	95	70	59	76
Samasata	Lodhran	Double	95	70	69	80
Lodhran	Shershah	Tokenless	95	70	30	44
Shershah	Multran	Double	95	70	91	93
Multran	Khanewal	Tokenless	95	70	35	55
Lodhran	Khanewal	Tokenless	95	70	28	46
Khanewal	Raiwind	Tokenless	95	70	30	29
Raiwind	Lahore	Double	95	70	118	129
Lahore	Shahdara Bagh	Automatic	95	55	129	157
Shahdara Bagh	Lalamusa	Tokenless	95	55	29	48
Lalamusa	Chaklala	Tokenless	65	50	32	45
Chaklala	Rawalpindi	Double	65	50	118	96
Rawalpindi	Golra	Double	65	50	98	102
Golra	Taxila	Others	65	50	23	27
Taxila	Peshawar	Others	65	50	21	33
Rohri	Jacobabad	Tokenless	80	55	20	39
Jacobabad	Sibi	Others	80	55	19	24
Sibi	Ab-i-Gum	Others	40	30	14	21
Ab-i-Gum	Kolpur	Double	30	24	29	34
Kolpur	Spezand	Others	80	30	16	29
Spezand	Quetta	Others	80	55	19	24
Quetta	Gilistan	Others	65	50	11	22
Gilistan	Chaman	Others	40	30	9	11
Kotri	Habibcot	Others	80	55	13	31
Hyderabad	Badin	Others	70	55	20	29
Hyderabad	Mirpur Khas	Others	95	70	29	43
Jacobabad	Larkara	Others	40	40	11	16
Bahawalnagar	Fort Abbas	Others	50	50	21	25
Samasata	Bahawalnagar	Others	70	55	15	21
Bahawalnagar	Amuruka	Others	70	55	18	22
Jacobabad	Kot Adu	Others	55	55	15	22
Lodhran	Pakpattan	Others	50	50	14	23
Pakpattan	Raiwind	Others	70	55	20	33
Sher Shah	Kundian	Others	65	55	18	31
Kundian	Attock City	Others	75	55	16	34
Khanewal	Faisalabad	Tokenless	90	55	29	45
Faisalabad	Sanglahill	Tokenless	95	55	29	50
Sanglahill	Wazirabad	Tokenless	65	55	21	36
Shorkot Cant	Lalamusa	Others	70	55	15	38
Qila Sheikhupura	Shorkot Cant	Others	65	55	21	34
Shadara bagh	Sanglahill	Others	90	55	26	51
Chakjumra	Shahinabad	Others	80	55	21	36
Sargodha	Kundian	Others	75	55	15	29
Shadara bagh	Narowal	Others	65	50	20	42
Narowal	Chak Amuru	Others	55	40	19	27
Wazirabad	Sialkot	Others	65	50	21	33
Khushab	Malakwal	Others	50	50	18	31
Golra	Jand	Others	70	55	12	28
Jand	Kohat Cant	Others	60	50	12	20
Peshawar	Landi Kotal	Others	55	40	12	13
Nawshera	Durgai	Others	50	40	16	26
Taxila	Havelian	Others	30	30	11	15
Spezand	Zahidan	Others	30	30	1	3
Sibi	Khost	Others	50	40	7	13
Lahore	Wagah	Others	80	55	35	65

Table 6.1.7.2 Calculation Of Taffic Volume

Sections		Total No. of Trains (a)	Distance (km) (b)	Train-km (1,000) (c=a*b*2)	No. of Pass./ Train (d)	Pass.-km (mill.) (e=a*b*d)	No. of Wagons/ Train (f)	Ton-km (mill.) (g=a*b*f*20)
Karach	Hyderabad	118	174	40.9	1,500	30,694	72	29,466
Hyderabad	Samasata	59	636	74.8	1,500	56,095	72	53,851
Samasata	Lodhran	69	27	3.7	1,500	2,788	72	2,667
Lodhran	Shershah	30	72	4.3	1,500	3,261	72	3,130
Shershah	Multran	91	15	2.7	1,500	2,058	72	1,976
Multran	Khanewal	35	49	3.5	1,500	2,601	72	2,496
Lodhran	Khanewal	28	91	5.1	1,500	3,839	72	3,686
Khanewal	Raiwind	30	246	14.9	1,500	11,140	72	10,695
Raiwind	Lahore	118	40	9.4	1,500	7,056	72	6,774
Lahore	Shahdara Bagh	129	7	1.8	1,500	1,358	62	1,123
Shahdara Bagh	Lalamusa	29	125	7.2	1,500	5,374	53	3,798
Lalamusa	Chaklala	32	152	9.8	975	4,753	53	5,168
Chaklala	Rawalpindi	118	5	1.2	975	573	53	623
Rawalpindi	Golra	98	14	2.7	975	1,338	45	1,235
Golra	Taxila	23	18	0.8	975	399	45	369
Taxila	Peshawar	21	159	6.7	975	3,275	45	3,023
Rohri	Jacobabad	20	84	3.3	1,500	2,502	70	2,336
Jacobabad	Sibi	19	156	5.9	1,500	4,398	70	4,104
Sibi	Ab-i-Gum	14	63	1.8	975	885	37	671
Ab-i-Gum	Kolpur	29	38	2.2	975	1,067	35	766
Kolpur	Spezand	16	16	0.5	975	256	35	184
Spezand	Quetta	19	24	0.9	975	440	35	316
Quetta	Gilistan	11	82	1.8	975	873	30	537
Gilistan	Chaman	9	60	1.0	975	497	30	306
Kotri	Habibcot	13	347	9.3	1,500	6,953	72	6,675
Hyderabad	Badin	20	100	4.0	1,500	2,993	40	1,596
Hyderabad	Mirpur Khas	29	66	3.9	1,500	2,893	72	2,778
Jacobabad	Larkara	11	136	3.0	1,500	2,249	50	1,499
Bahawalnagar	Fort Abbas	21	102	4.3	1,500	3,232	65	2,801
Samasata	Bahawalnagar	15	183	5.3	1,500	3,997	72	3,837
Bahawalnagar	Amuruka	18	74	2.6	1,500	1,971	72	1,893
Jacobabad	Kot Adu	15	428	12.5	1,500	9,349	44	5,485
Lodhran	Pakpattan	14	204	5.7	1,500	4,301	72	4,129
Pakpattan	Raiwind	20	167	6.7	1,500	4,998	72	4,798
Sher Shah	Kundian	18	303	10.8	1,500	8,072	72	7,750
Kundian	Attock City	16	195	6.2	975	3,043	50	3,121
Khanewal	Faisalabad	29	170	9.7	1,500	7,309	72	7,016
Faisalabad	Sanglahill	29	44	2.5	1,500	1,892	72	1,816
Sanglahill	Wazirabad	21	111	4.7	1,500	3,523	72	3,382
Shorkot Cant	Lalamusa	15	314	9.1	1,500	6,859	70	6,401
Qila Sheikhupura	Shorkot Cant	21	221	9.4	1,500	4,049	55	5,169
Shadara bagh	Sanglahill	26	83	4.4	1,500	3,278	72	3,147
Chakjumra	Shahinabad	21	68	2.9	1,500	2,169	72	2,082
Sargodha	Kundian	15	131	3.8	1,500	2,861	50	1,908
Shadara bagh	Narowal	20	79	3.1	1,500	2,336	50	1,557
Narowal	Chak Amuru	19	52	2.0	1,500	1,487	48	952
Wazirabad	Sialkot	21	43	1.8	1,500	1,363	60	1,090
Khushab	Malakwal	18	95	3.5	1,500	2,632	45	1,579
Golra	Jand	12	102	2.5	1,500	1,888	45	1,133
Jand	Kohat Cant	12	61	1.4	1,500	1,080	45	648
Peshawar	Landi Kotal	12	52	1.2	975	586	45	541
Nawshera	Durgai	16	98	3.2	975	1,568	45	1,447
Taxila	Havelian	11	83	1.7	975	852	45	787
Spezand	Zahidan	1	708	2.0	975	984	44	888
Sibi	Khost	7	133	1.8	975	888	25	456
Lahore	Wagah	35	23	1.6	975	788	72	1,163
Total				353.8		252,956		228,825

Actual Figure in 1992-93

Total Passenger-km per Year	92,329 million	17,082	18.5%
Total Ton-kms per Year	83,521 million	6,180	7.4%

(2) Calculation of the Number of Locomotives

According to the P.R. Year Book 1992-93, P-90 "Performance of locomotives during the last 5 years", average engine-kms per day per engine in use is approximately 300 kms.

Total train-km is also shown in Table 6.1.7.2. Therefore, in order to obtain the calculated figure, calculation of necessary number of locomotives is shown below.

Necessary Number of Locomotives = Total train-km/Average engine-kms

= 353,800/300

= 1,180

However, according to the P.R Year Book, P-68, P.R has only 668 locomotives for broad-gauge tracks. Furthermore, it is said that the actual number of locomotives in use for passenger and freight are 186 and 140 respectively. This figure is less than 1/3 of the necessary number for full utilization of existing facilities.

(3) Calculation of the Number of Coaches

On the assumption that the number of coaches is directly proportionate to passenger-kms, calculation of the number of coaches is shown below. According to the P.R. Year Book, performance for passenger traffic is shown in Table 6.1.7.3.

From Table 6.1.7.3, the maximum passenger-kms per coach is 7,270,000 (in 1990-91), in order to transport the calculated volume, the necessary number of coaches can be found as follows:

Necessary Number of coaches = Total Number of Passenger-kms per day

/Average Passenger-kms per coach = 12,700 coaches

where,

Total Number of Passenger-kms per year	:	92,329 mill.
(Shown in Table 6.1.7.2)		
Average Passenger-kms per coach	:	7,270,000

However, according to the P.R Year Book, P-69, P.R. has only 2,655 coach vehicles for broad-gauge track. This figure is nearly 1/5 of the necessary number for full utilization of existing facilities.

(4) Calculation of the Number of Wagons

According to the P.R. Year Book 1992-93, the latest 10 years of freight traffic data are as follows.

Maximum kms traveled per ton	:	805.1 kms
Maximum wagon load	:	20.2 tons
Minimum turn-around for wagons	:	15.4 days

From the above, ton-kms per wagon per year can be calculated as follows:

805.1 kms * 20.2 ton * 365/15.4 = 385,000 ton-kms

(Average kms traveled per ton) * (Average wagon load)*

(Annual transport frequency)

If the average turn-around time for wagons is decreased to 7 days in accordance with World Bank's recommendation, above figure improves to 848,000 ton-kms. Then, in order to transport the calculated volume, the necessary number of wagons can be found as follows:

83,521 mill. ton-kms/848,000 ton-kms/wagon = 98,500 wagons

However, according to the P.R Year Book, P-70, P.R. has only 28,547 wagons for broad-

gauge track. This figure is less than 1/3 of the necessary number for full utilization of existing facilities.

Table 6.1.7.3 Passenger Traffic Data

Year	Total Passenger kms (1,000)	No. of Passenger Carriage (a)	No. of Other Coaches (b)	Total Coaching Vehicles (a+b)	Passenger kms per Coach (1,000)
1983-84	18,287,127	2,405	609	3,014	6,067
1984-85	17,806,545	2,487	591	3,078	5,785
1985-86	16,849,639	2,722	506	3,228	5,220
1986-87	16,919,758	2,656	522	3,178	5,324
1987-88	18,541,470	2,663	494	3,157	5,873
1988-89	19,731,693	2,598	514	3,112	6,341
1989-90	20,373,278	2,474	488	2,962	6,878
1990-91	19,963,696	2,339	407	2,746	7,270
1991-92	18,158,007	2,425	407	2,832	6,412
1992-93	17,082,314	2,425	407	2,832	6,032

(5) Analysis on Existing Capacity of Pakistan Railways

As shown in Table 6.1.7.2, P.R.'s inherent passenger and freight transport capacities are 92,329 million passenger-kms and 83,521 ton-kms respectively.

However, existing train operation is restricted by a shortage of rolling stocks as mentioned above. Therefore, taking into consideration the actual rolling stock figures, the existing capacity is calculated in Table 6.1.7.4.

The existing capacity of Pakistan Railways is 19,302 million passenger-kms for passengers and 10,991 million ton-kms for freight, compared with the actual figures of 17,082 million passenger-kms and 6,180 million ton-kms in 1992-93. The utilization ratio is 88.5% for passenger trains and 56.2% for freight trains respectively. Concerning freight traffic, this figure seems to be rather low. Taking into consideration that most of the freight traffic is one way direction transport, however, this figure is considered to be not so bad.

On the other hand, the utilization ratio for passengers is almost 90%, this situation is satisfactory for the Pakistan Railways.

(6) Conclusion

Railway carrying capacity has been calculated on a trail basis and under some bold assumptions. However, the following can be pointed out:

a. P.R.'s inherent line capacity, calculated under the assumption that tracks are well maintained and minor existing bottlenecks such as local speed restrictions are removed, is sufficient to meet a far larger demand than the actually transported volume.

b. Although discrepancies between capacity and traffic demand by section were not taken into account, P.R.'s freight operation seems to have failed in utilizing its capacity to the maximum extent, even compared with its passenger operation.

c. At present, the largest reason for P.R.'s poor performance is the shortage in number of locomotives and coaches/wagons.

- For freight traffic, the largest barrier is the lack of wagons at present. When turn-around time is improved, however, lack of locomotives becomes the largest barrier. Considering the fact that locomotives are also needed to shorten turn-around time, the first priority should be given to purchasing/manufacturing locomotives and wagons at the same time.
- For passenger traffic, the largest bottleneck seems to be the lack of coaches. However, due to the fact that passenger train operation is performed at a very low fare level which results

one of the major causes of P.R.'s financial loss, the improvement priority largely depends on government policies which allow P.R. to strengthen passenger operation under the current fare level.

Table 6.1.7.4 Calculation Of Existing Capacity

No.		Passenger	Freight	
a	Inherent Capacity	92,329 mil. pass.-kms	83,521 mil. ton-kms	
b	Necessary No. of Locomotives	590	590	
c	Actual No. of Locomotives	186	140	
d	Shortage Ratio (c/b)	0.135	0.237	
e	Capacity after Loco. limitation (a*d)	29,107 mil. pass.-kms	19,819 mil. ton-kms	
f	Capacity per Coach/wagon (turn around time)	7.27 mil. pass.-kms	0.385 mil. ton-km (15.4 days)	0.848 mil. ton-kms (7days)
g	Necessary No. of Coaches/wagons (e/f)	4,004	51,477	23,371
h	Actual No. of Coaches/wagons	2,655	28,547	28,547
i	Shortage Ratio (h/g)	0.633	0.555	-
j	Existing Capacity after C/W limit (e*i)	19,302 mil. pass.-kms	10,991 mil.ton-km	21,654 mil. ton-kms
k	Actual Figures for 1992-93	17,082 mil. pass.-kms	6,180 mil. ton-km	6,180 mil. ton-kms
l	Ratio (k/j)	88.5%	56.2%	28.5%

6.2 Current Issues

6.2.1 Passenger Transport

Passenger transport changed remarkably under the 7th Five Year Plan. For the first three years of the plan, transport capacity improved steadily, only to plunge over the following two years. As a result, in the final year of the plan (1992-93), the number of passengers decreased to a historical low of 59 million people, while passenger-km retreated to the benchmark of the final year of the 6th Five Year Plan.

According to the 1993 winter schedule, the total number of passenger trains is 350, of which one third are express trains. As shown in Figure 6.2.1.1, express trains in operation are concentrated on the main Karachi - Lahore - Rawalpindi - Peshawar trunk line, the Khanewal - Faisalbad - Lahore bypass trunk line and the line toward Quetta. Frequency is greatest along the section between Karachi and Lahore, with 14 trains per day, or one train arriving almost every hour. In other sections, however, even on the trunk lines the problem of infrequency has become severe, with trains arriving only every two to three hours.

The scheduled speeds between Karachi and Lahore and between Lahore and Rawalpindi are quite slow, averaging 65-80 km/h and 45-65 km/h respectively. Furthermore, Pakistan Railways has a problem with punctuality. The Mail & Through Express long-distance express train manages to keep on schedule only 60-70% of the time, seriously affecting the reliability of passenger trains.

6.2.2 Freight Transport

Issues regarding freight transport remain the same as pointed out in the previous study, and are indicated below:

a. Nonscheduled operation;
b. Delays due to priority given to passenger trains;
c. Large number of accidents due to overaging and poor performance of freight wagons;
d. Lack of tractive power to handle sections with steep gradients; and
e. Insufficient train speeds.

Problem a. above is caused by the lack of locomotives. There may be no way to remedy b., but b. and c. tend contributed to tardiness of existing trains. The causes of accidents in the past are outlined in Table 6.2.2.1. Incidents of detailed freight trains are extremely high - in the 30-40% range every year-seriously damaging customers' faith in railway freight transport. Table 6.2.2.2 shows the limitations of the freight trains' tractive power, especially in the precipitous section between Sibi and Quetta. As this table also shows, the Pakistan Railways have failed to raise the maximum speed of freight trains to the current target of 75 km/h. Bolstering speed will remain an important issue.

Figure 6.2.1.1 Train Operation System Diagram (Mail & Express)

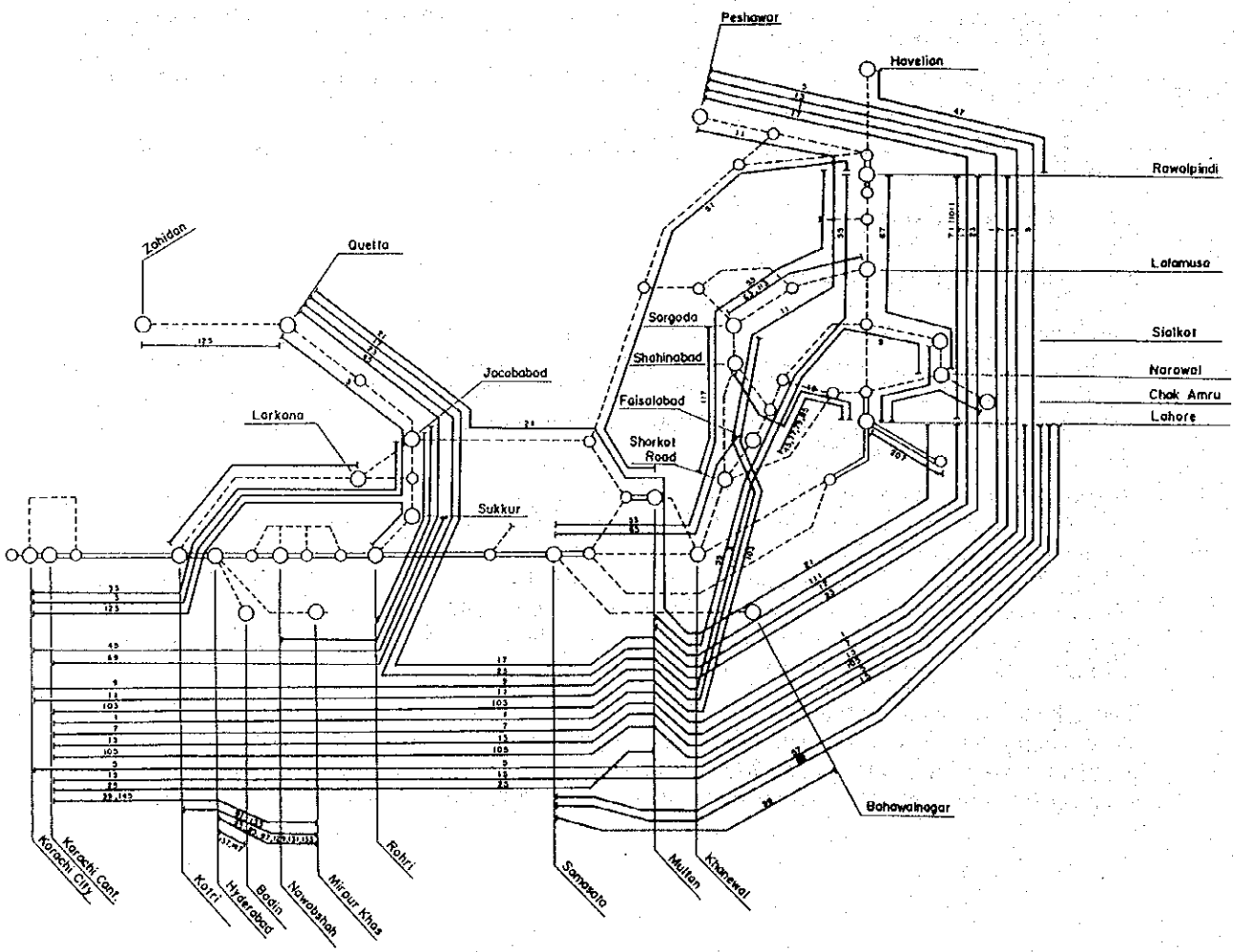


Table 6.2.2.1 Position Of Accidents

Description of Accidents	1986	1987	1988	1989	1990	1991	1992	1993
1. Collisions of Passenger Trains	5	3	5	6	2	6	5	2
2. Collisions of Freight Trains	4	1		3	2	1		2
3. Collisions of Light Engines			2					
4. Derailments of Passenger Trains	37	39	39	44	61	40	28	38
5. Derailments of Freight Trains	44	62	50	46	40	51	39	44
6. Collisions of Manned Level Crossings	11	10	8	4	11	6	6	7
7. Collisions at Un-manned Level Crossings	27	22	30	34	33	17	37	19
8. Fire in Trains	2	2	2		3	1	2	7
9. Averted Collisions	2		1	1	1	2		
Total	132	139	137	138	153	124	117	119

Source : P.R.

Table 6.2.2.2 Tonnage Ratings For Typical Locomotives

Section	Groupof Locos.	Speed (km/h)	Load (Tons)	Ascending Grade	Braking Distance	Remarks
(Passenger)						
Karachi - Lalamusa	3,000 HP	105	20 = 850	Flat	1.2 km	
	3,000 HP	105	16 = 690	Flat	1.2 km	
	3,000 HP	95	16 = 740	Flat	1.2 km	
	2,000 HP	105	16 = 630	Flat	1.2 km	
	2,000 HP	95	16 = 690	Flat	1.2 km	
Lalamusa - Peshawar	2,400 HP	65	13 = 640	1:100	1.2 km	
	2,000 HP	65	13 = 490	1:100	1.2 km	
	1,500 HP	65	12 = 425	1:100	1.2 km	
Daud Khel - Attock City	2,000 HP	55	13 = 490	1:83	1.2 km	
	1,500 HP	55	12 = 425	1:83	1.2 km	
Sibi - Quetta	2,000 HP		15 = 510	1:55	0.5 km	SIB-ABG with Single Locos.
	2,000 HP		12 = 510	1:33	0.5 km	ARB-MCH with Single Locos.
	2,000 HP		12 = 460	1:25	0.5 km	MCH-KLH with Two Locos.
			12 = 510	1:25	0.5 km	MCH-KLH with Three Locos.
	2,000 HP		15 = 610	1:150	0.5 km	KLR-Qta with Single Locos.
(Freight)						
Karachi -Rahore	3,000 HP	70	60 = 1800	Flat	1.2 km	
	3,000 HP	55	72 = 2250	Flat	1.2 km	
	2,000 HP	55	72 = 2000	Flat	1.2 km	
	2,000 HP	55	72 = 2000	Flat	1.2 km	
Rohri - Sibi	2,000 HP	55	72 = 2000	Flat	1.2 km	
Lalamusa - Peshawar	2,400 HP	50	53 = 1600	1:100	1.2 km	
	2,000 HP	50	53 = 1200	1:100	1.2 km	
Kundian - Attock City	2,000 HP	40	35 = 1000	1:83	1.2 km	
Sibi - Quetta	2,000 HP	48	35 = 610	1:55	1.2 km	
	2,000 HP	30	35 = 406	1:33	0.5 km	ARB-MCH with Single Locos.
			40 = 815	1:33	0.5 km	ARB-MCH with Two Locos.
	2,000 HP	24	35 = 510	1:25	0.5 km	MCH-KLH with Two Locos.
			35 = 760	1:25	0.5 km	MCH-KLH with Three Locos.
	2,000 HP	48	40 = 1066	1:150	0.5 km	KLR-Qta with Single Locos.

Source : P.R.

6.2.3 Facilities

(1) Tracks, bridges and roadbeds

The major issue concerning Pakistan Railways' tracks and other structures is that their durable periods have passed in various sections. In a large number of sections, train speeds are reduced due to overaged sleepers, rails, bridges, insufficient ballast. Plans in the 7th Five Year Plan for improvement and renewal but were not implemented due to budgetary limitations, and these remain a serious problem for train operation. As of November 1993, speed limitations are imposed in 19 sections of trunk line and 234 sections of branch line.

Main causes of speed restrictions are:

a. Poor condition of rails;

b. Poor conditions of sleepers;

c. Shortage of ballast;

d. Overaging of bridges; and

e. Poor condition of roadbeds.

Of these, planned and realized replacements in the previous Five Year Plan for a. and b. are shown in Table 6.2.3.1. Measures called for in the 7th Five Year Plan include replacement of 1,050 km of rail and 1,250 km of sleepers. Only 35% of these have been implemented, however, and the number of overaged sections increases year by year. Investments in c. were also made at the same time a. and b. were addressed, but in terms of absolute quantity these are still a long way from being sufficient. As for d., speed restrictions are imposed on the 10 bridges; more than half of the restrictions are due to unacceptable aged condition in the substructure. During the 7th Five Year Plan more than 300 bridges are under repair, including those carried over from the 6th Plan.

Table 6.2.3.1 Projection Of Track Renewals During the 7th Five Year Plan

No.	Route Classification	Length of the Running Line (km)	Rails		Sleepers	
			Overaged Length (km)	Projected Renewals for 1992-93	Overaged Length (km)	Projected Renewals for 1992-93
1	Primary A	2,803.75	568.63	310	944.97	510
2	Primary B	2,152.81	1,536.71	265	1,098.47	265
3	Secondary	2,462.45	1,920.39	285	1,617.41	285
4	Tertiary	1,339.78	1,285.07	140	1,221.26	140
5	Metre Gauge	445.40	436.34	50	362.10	50
6	Narrow Gauge	611.12	544.24	0	571.07	0
	Total	9,815.31	6,291.38	1,050	5,815.28	1,250

Actual Renewals during The 7th Five Year Plan

Rails	368km
Sleepers	437km

(2) Signals and Communication Equipment

Signals on most trunk lines use semaphore, mechanical interlocking and mechanical switch devices. The section from Karachi to Lodhran uses nothing more advanced than color-light signals, relay interlocking devices and electrical switch devices.

This equipment is generally antiquated and unsuitable for the current program of improving speed. Upgrading is necessary on the trunk lines whoes role in transport is significant.

SHF circuits are arranged between Karachi and Rawalpindi as a trunk communication circuit, while UHF wireless is used as a medium-distance circuit. A VHF circuit is used between the main station yard and locomotives, but this network is not yet fully implemented even on many trunk line sections. To correct these problems, to improve safety, and to transmit large volumes of information (on passengers, freight, control, etc.); cables will need to be installed, instead of wire, in the future.

(3) Power Supply Equipment

The section from Lahore to Khanewal has been electrified for some 30 years, and overaging of facilities is worsening.

It is necessary during the current plan to expand electrified sections, replace facilities and promote modernization.

6.2.4 Rolling Stock

(1) Locomotives

The number of locomotive is listed by type and by age is shown below:

Table 6.2.4.1 Number Of Locomotives

Age	0 - 10	11 - 20	21 - 30	31 -	Total
Steam				90 (above 49)	90
Diesel-Electric	90	140	62	241 (including 97 already revamped)	533
Electric			29		29

Steam locomotives in particular are extremely old. These locomotives will need to be scrapped.

Approximately 40% of diesel engines have exceeded their service life, having been built over 20 years ago. These need to be rebuilt or replaced.

As shown in Appendix 6.2.1, out of the total fleet of 532 diesel electric locomotives, 40% are overaged and require replacement (service life taken as 20 years). These overaged locomotives require extensive maintenance which is more costly.

About 70% of machines installed in major workshops have outlived their service life and require replacement. These old facilities result in increased down-time of locomotives during major overhauls.

Electric locomotives were procured in 1967 (i.e. at the beginning of electric traction in Pakistan). Since then, technology has changed completely, making these vehicles difficult to maintain. Replacements for these locomotives are also not available in the international market and whatever parts are available often have to be specially manufactured for Pakistan Railways, leading to exorbitant costs. Thus, revamping of these locomotives is required to incorporate new technology and provide equipment for which replacements are easily available.

(2) Coaches (Broad Gauge)

The number of coaches by age is listed below:

Table 6.2.4.2 Number of Coaches

	0-5	6-10	11-15	16-20	21-25	26-30	31-35	35-	Total
Passenger coaches	104	322	555	330	226	354	220	95	2,206

Although currently only 95 vehicles have exceeded an operating life of 35 years, budget constraints and unavailability of spare parts have made it difficult to maintein properly on vehicles used more than 15 years. This rolling stock needs to be corrected adequately.

Another concern is air conditioning. Roughly 10% of all coaches are equipped with air conditioning, and the Pakistan Railways must further expand air conditioning to lower-class coaches initiated in 1989-90.

Presently 750 vehicles are equipped with air-brakes in order to provide higher speeds and increased loads. The remaining rolling stock needs to be converted from vacuum brakes to air brakes.

(3) Wagons

The Pakistan Railways has 25,000 non-bogic wagons and 3,500 bogic wagons. For high-speed operation, non-bogic wagons will need to be converted to bogic wagons. Further steps required to improve speeds are to change axles over bearings in order to prevent hot-axle accidents and reduce maintenance.

6.3 Mid-Term Proposals for 2005-06

6.3.1 Future Traffic Demand for Railway Transport

(1) Future Traffic Volume

In 1992-93, passenger and freight transport was 17,082 million passenger-kms and 6,180 million ton-kms respectively. As mentioned in Projection of Land Traffic, 3.4, projections of future demand are shown in Table 6.3.1.1 and Appendix 6.3.1

Table 6.3.1.1 Projected Traffic Demand For Railway Transport

		1992-93	1997-98	2005-06
Passenger	Total	17,082	22,795	36,141
(million pass-kms)	Inter-zonal	16,511	22,790	36,089
		(1.00)	(1.26)	(2.00)
Freight	Total	6,180	13,361	20,852
(million ton-kms)	Inter-zonal	6,051	13,692	21,131
		(1.00)	(2.16)	(3.37)

Source : JICA Study Team

The results of demand projections by section are shown in Figure 6.3.1.1-2. The same passenger transport distribution as today was assumed, and freight estimates were based on the strategy of shifting freight traffic back to the railways. The long term objective is to achieve a freight traffic distribution ratio of 27:73 between the rail and the road as compared with 15:85 in 1992-93.

(2) Estimated Number of Trains for the Year 2005-06

The total number of trains required for each section was obtained by adding the number of passenger and freight trains. The results are shown in Figure 6.3.1.3 and Appendix 6.3.2.

The method of calculating the necessary number of trains is the same as in the analysis of the capacity of the existing railways.

6.3.2 Planning Direction

Railways surpass other modes of transportation on a number of aspects. These include not only capacity, safety and efficiency, but also environmental impact and energy conservation, which have recently become the focus of intense debate worldwide. Also, the country's topography and the distribution of urban areas give Pakistan Railways advantages over other modes. To take these advantages to the fullest, the Pakistan Railways need to improve services to users by enhancing speed and punctuality.

With a nationwide network already in place, Pakistan Railways should now explore investment options to make these facilities function at the fullest possible efficiency.

Figure 6.3.2.1 Assigned Traffis Volume , Passengers

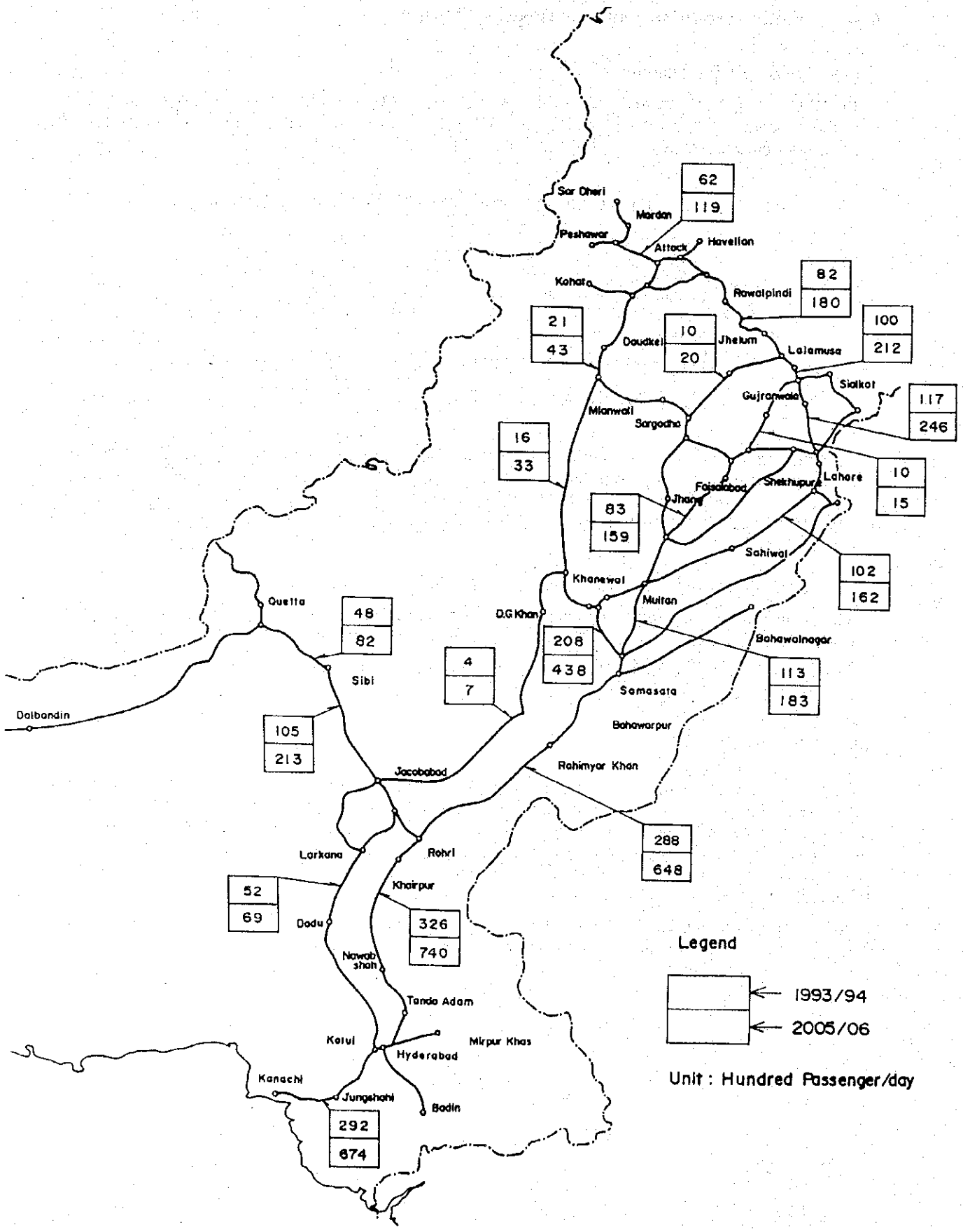


Figure 6.3.2.2 Assigned Traffic Volume , Freight

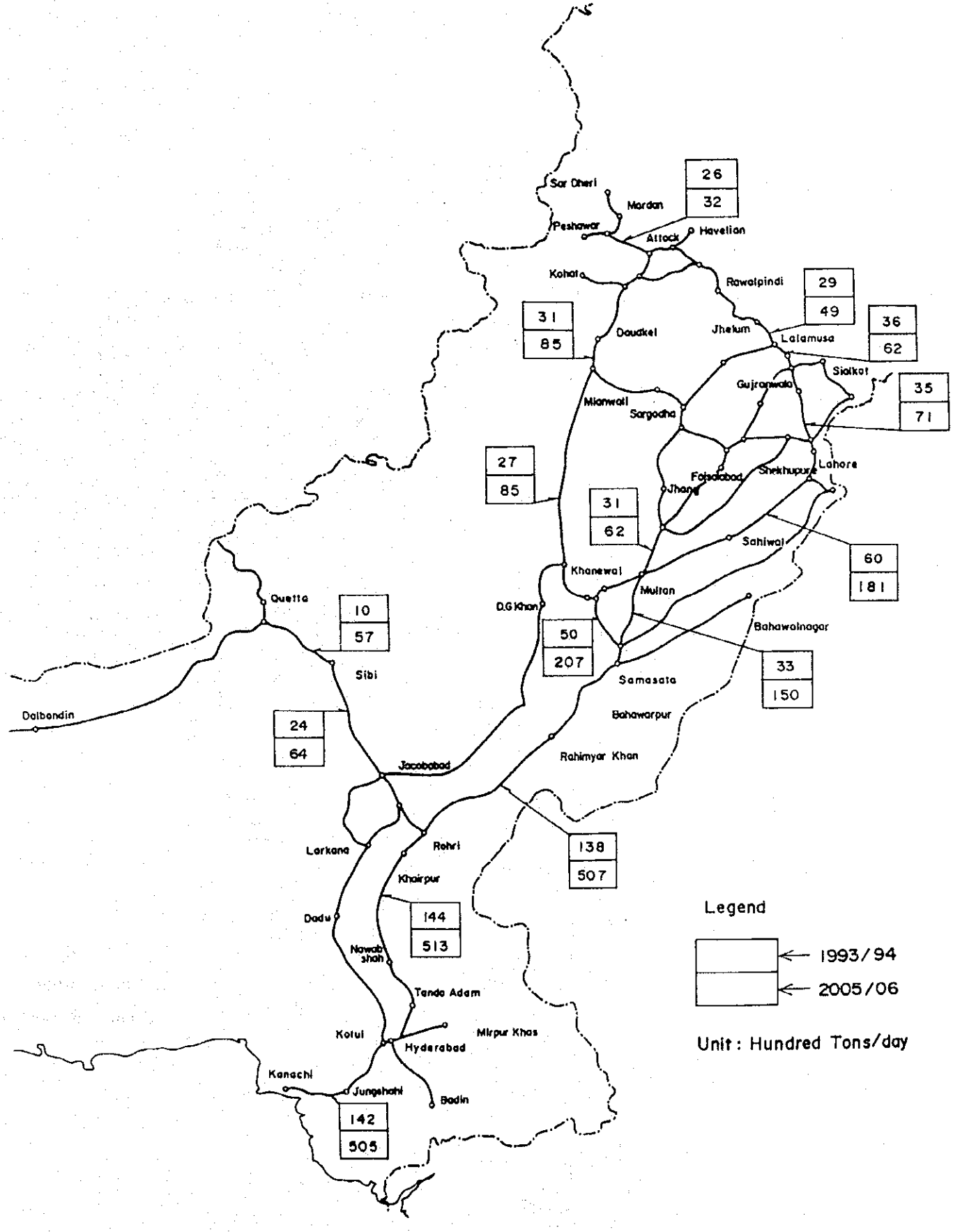
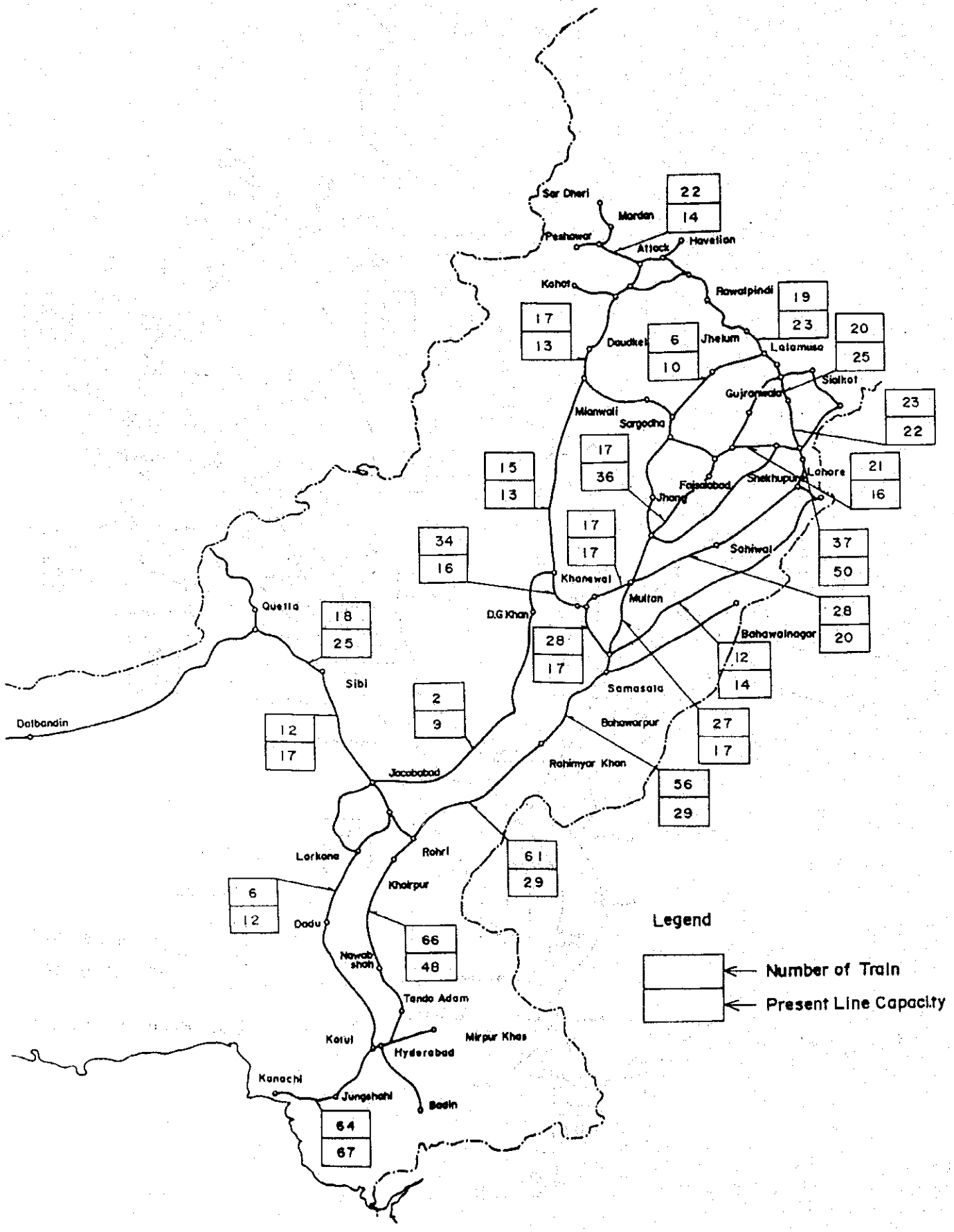


Figure 6.3.2.3 Total Number. of Traffic Required in the Year 2005-06



On the other hand, insufficient investment in the past has led to worsening overaging of facilities on a number of fronts. It is unrealistic to expect to replace and upgrade all these obsolete facilities at the same time.

For this reason, limited investment resources must be allocated to carry out efficient capital improvements. Rather than scattering investment recklessly around the existing rail network, the Railways must concentrate its investment on rolling stock to those lines to engender railway operations in speed, capacity and punctuality.

Pakistan Railways is currently planning to operate high speed trains from Karachi to Peshawar, and must, therefore, establish guidelines regarding future investment and train operations, restricting priority to the most important sections (particulary primary A & B and secondary sections). This report recommends the following measures.

(1) Strengthening Transport Capacity (Facilities)
- Doubling tracks
- Electrification
- Rehabilitation of tracks
- Revamping of signaling
- Repair of bridges
- Revamping of alignment

(2) Strengthening Transport Capacity (Rolling Stock)
- Increasing the amount of rolling stocks
- Raising the performance of rolling stocks
- Revamping of the maintenance system/facilities

(3) Revamping Passenger Transport
- Increasing train speeds
- Improvement of frequency
- Improvement of comfortability (Increasing the number. of air-conditioned coaches)

(4) Improving Freight Transport
- Increasing train speeds
- Operation of regular through trains
- Expansion of container transport
- Improvement of freight handling equipment

(5) Modernization
- Management Information System
- Revamping of communication equipment

6.3.3 Prospective Plan

(1) Strengthening Transport Capacity (Facilities)

1) Doubling Tracks

Double track is known to have roughly three times the track capacity of single track; making expansion of double track is the most effective method of expanding the line capacity.

From the national point of view, the trunk-line from Karachi to Peshawar is the main artery for the country, and therefore, it is the lifeline for the nation. In order to implant this concept in the people's minds, high-speed, punctual and safe train operations by double track is the most effective measure.

Demand forecasts indicates that implementation of double track on the Lodhran - Sher Shah and Multan - Raiwind sections in the Karachi - Peshawar section as well as Shahdara Bagh - Faisalabad section in the Lahore - Faisalabad section is advisable to relieve capacity bottlenecks caused by single track.

2) Electrification

The major benefits expected of electrification are reductions in operating costs and increases in speed due to the expansion of transport capacity and improvements in energy efficiency.

The first priority is to extend existing electrification in the section between Khanewal and Lahore. Considering the trends in transport demand in the section from Karachi to Lahore, the sections between Khanewal and Samasata and from Kiamari to Samasata should be electrified first.

This would boost the operating efficiency of locomotives by allowing electric through trains to run along the most important section of the trunk line, from Karachi to Lahore.

The next sections consided for electrification, as explained in the previous report, are the Lahore - Rawalpindi and Sibi - Quetta sections, whose problems regarding traction power have been mentioned.

In this report, it is assumed that the section between Khanewal and Samasata will be completed and the construction on the section Sibi - Quetta will be started in 2005-06.

3) Rehabilitation of Track

According to PC-1 of "Rehabilitation and Improvement of Track" in the Pakistan Railways 7th Five Year Plan (1988-93), overage rails and sleepers likely to exist in running line track on June 30, 1993 are shown in Table 6.2.3.1.

Pakistan Railways made commitments to a 650 km-rail-renewal project and the conversion of a 1,000 km section to a sleeper route during the 7th Five Year Plan. However, budget constraints have reduced these to 370 km and 440 km respectively, and overaging continues to progress. Presently 60% of rails and 54% of sleepers are overage. In order to achieve high-speed and safe train operations, these overaged tracks should be replaced immediately.

Details of Overage Rails and Sleepers by Section (Broad Gauge) is shown in Table 6.3.3.1.

Table 6.3.3.1 Detail Of Overage Rails And Sleepers By Section (Broad Gauge)

Section		Length of running lines (km)	Overaged Rails and Sleepers (km)		Remarks
			(Rails)	(Sleepers)	
(primary 'A')					
Karachi	Tando Adam	468.58	12.30	145.48	
Tando Adam	Khan pur	916.98	53.54	210.13	
Khan pur	Sahiwal	659.52	94.15	220.82	
(via chord & Loop)					
Sahiwal	Lalamusa	345.10	29.40	76.80	
Khanewal	Shorkot Cant	64.37	64.37	56.10	
Shorkot Cant	Sanglahill	149.54	120.14	82.52	
Sanglahill	Shahdra Bagh	90.19	85.25	48.23	
Sanglahill	Wazirabad	109.47	109.47	104.89	
Sub Total		2,803.75	568.62	944.97	
(primary 'B')					
Lalamusa	Rawalpindi	161.98	46.59	12.36	
Rawalpindi	Peshawar	188.27		57.44	
Rohri	Sibi	241.79	197.73	145.56	
Shershah	Kundian	300.15	250.00	108.56	
Kundian	Daudkhel	49.04	24.00	21.00	
Chak Jhumra	Shahinabad	68.80	68.80	8.26	
Shahinabad	Lalamusa	164.85	161.33	31.26	
Kotri (Dadu)	Habibkot	346.16	211.04	191.43	
Lodhran	Pakpattan	204.58	203.79	178.79	
Pakpattan	Kasur	138.91	138.91	112.34	
Raiwaid	Kasur	26.95	26.95	25.11	
Shorkot Cant	Shahinabad	147.46	127.52	112.92	
Hyderabad	Mirpur khas	66.87	65.69	66.87	
Wazirabad	Sialkot	47.00	14.36	26.55	
Sub Total		2,152.81	1,536.71	1,098.45	
(Secondary)					
Sibi	Quetta	178.71	145.74	37.23	
Jacobabad	Kashmor	126.38	119.86	119.50	
Kashmor	Kot Adu	305.00	206.07	26.13	
Daud Khel	Attok City	147.75	136.86	100.93	
Jand	Kohat Cantt	60.34	58.81	50.78	
Golsa	Basal	75.29	70.68	75.26	
Taxila	Havelian	55.11	33.15	30.23	
Sargodha	Khushab	44.93	44.93	43.91	
Khushab	Kundian	84.60	9.00	33.11	
Malakwal	Khushab	95.32	75.05	85.36	
Shahdara Bagh	Narowal	72.14	19.08	14.74	
Narowal	Sialkot	60.81	60.81	47.45	
Qila Sheikupura	Shorkot	218.00	209.79	197.81	
Lahore	Wagha	40.97	21.56	32.56	
Spezand	Kohitaftan	612.34	501.06	522.52	
Sibi	Khost	132.38	66.57	67.09	
Hyderabad	Badin	99.77	91.75	88.77	
Malir Colony	Spur	8.09	8.09	8.09	
KCR		28.86	25.87	25.63	
Landhi	Korangi	5.95	5.95	0.50	
Daudkhel	Mari Indus	9.72	9.71	9.72	
Sub Total		2,462.46	1,920.39	1,617.32	
Total		7419.02	4025.72	3660.74	
Renewed Length during the 7th FYP			368	437	
Grand Total			3657.72	3223.74	

Source: P.R.

Figure 6.3.3.1 Doubling Track (Master Plan)

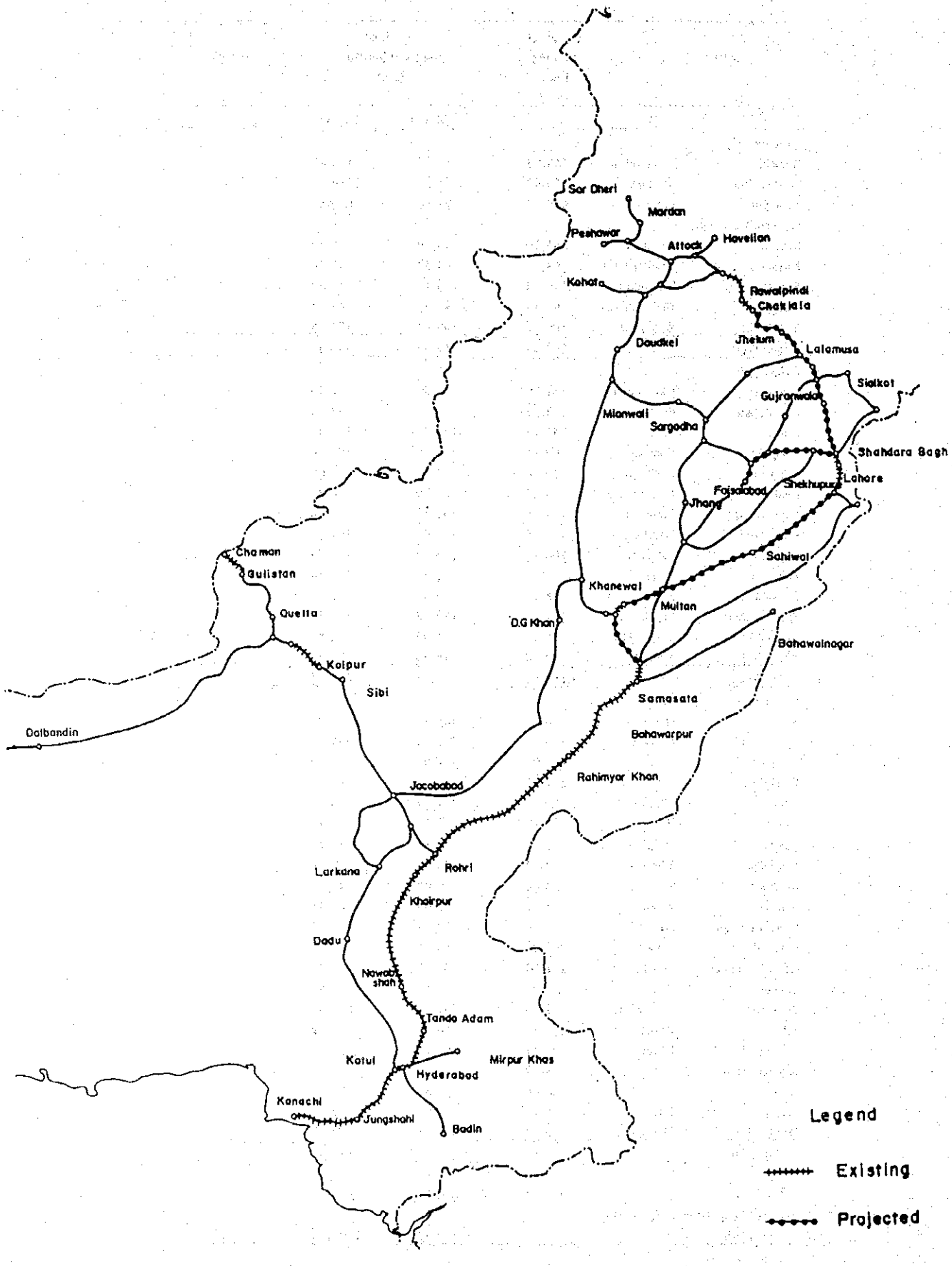


Figure 6.3.3.2 Electrification (Master Plan)

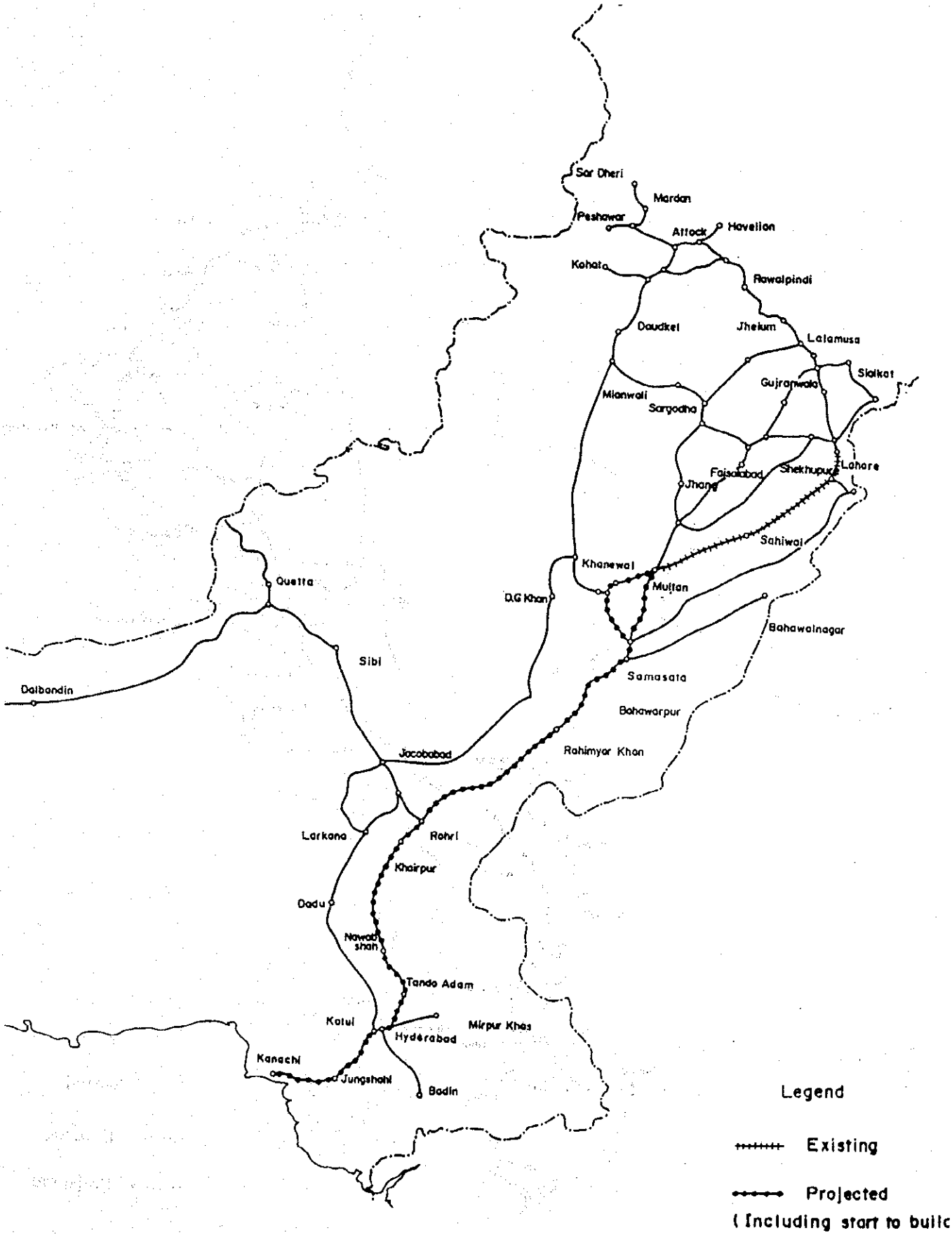


Figure 6.3.3.3 Automatic Block Signating (Master Plan)

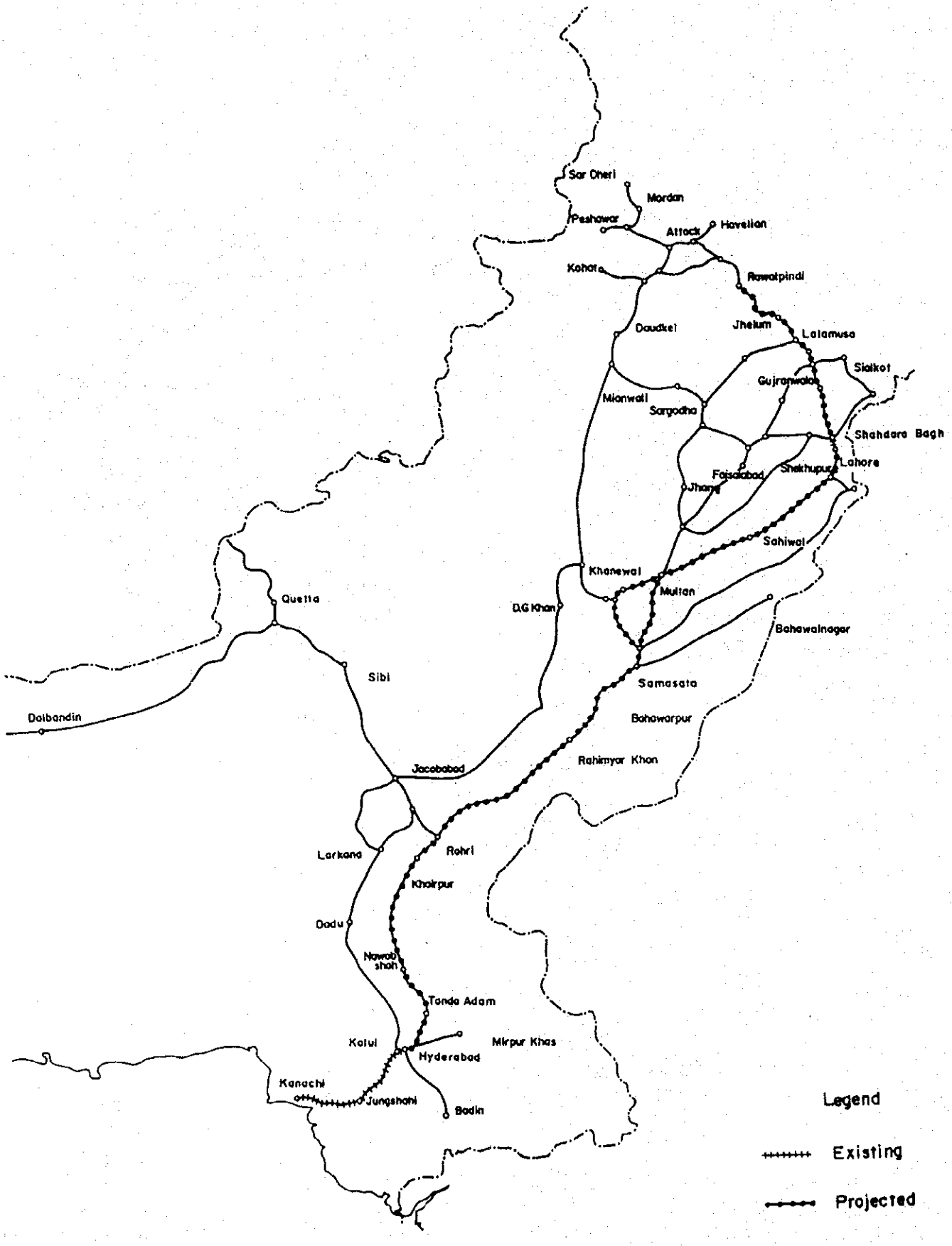


Figure 6.3.3.4 Tokenless Block Signsling & Color Light Signal (Master Plan)

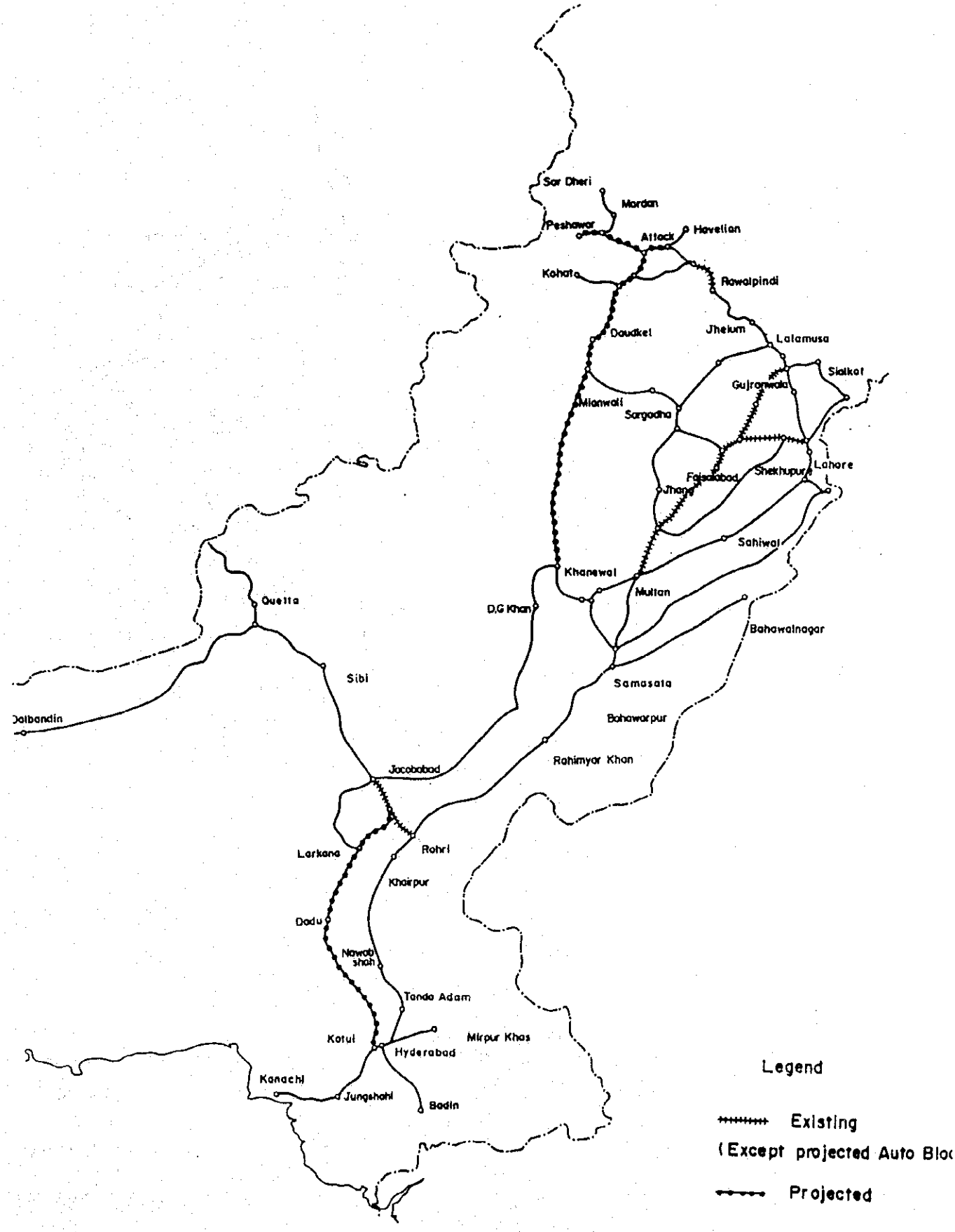


Figure 6.3.3.5 Electric / Relay Interlocking (Master Plan)

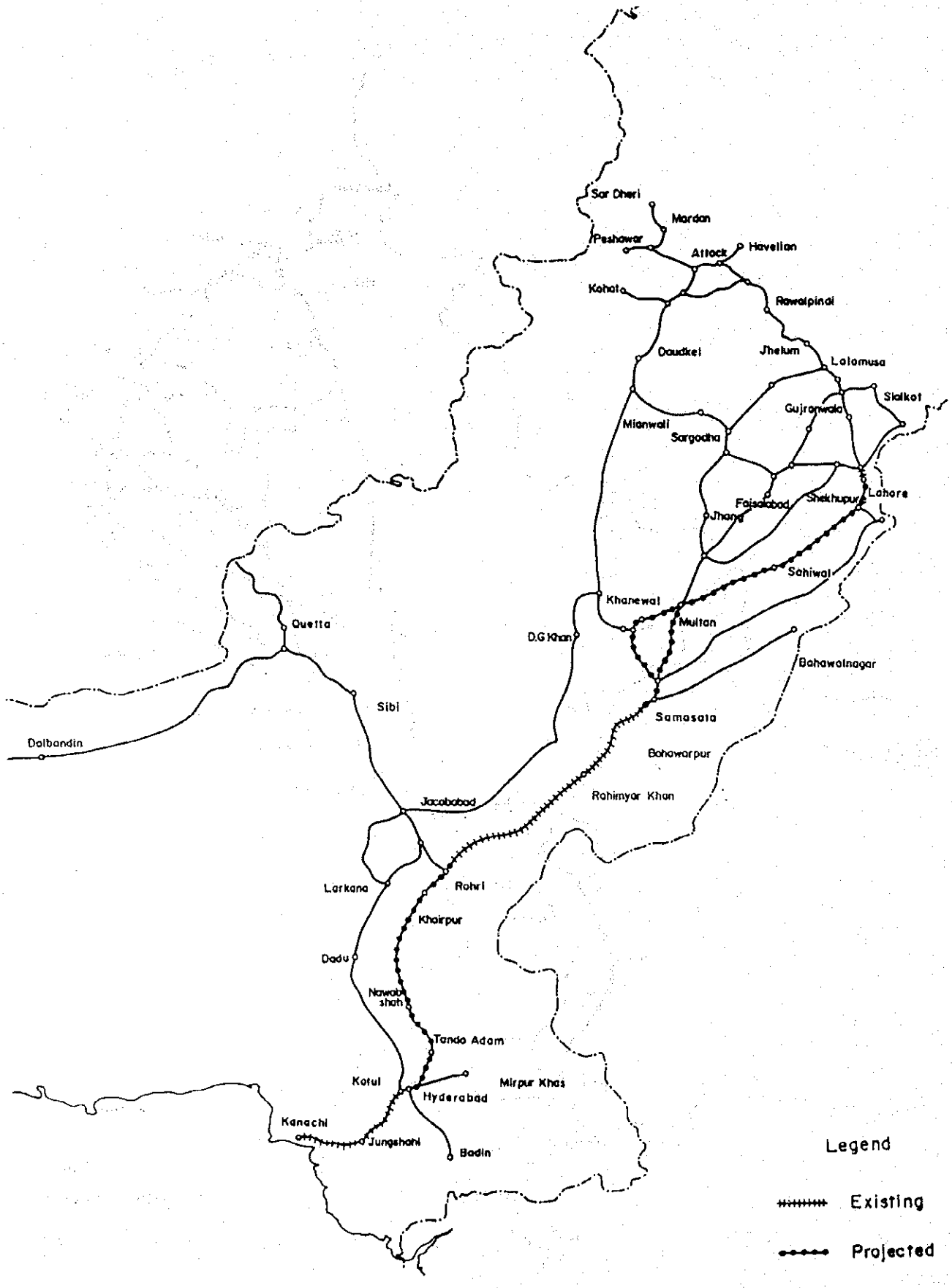


Figure 6.3.3.6 Centralized Traffic Control System (Master Plan)

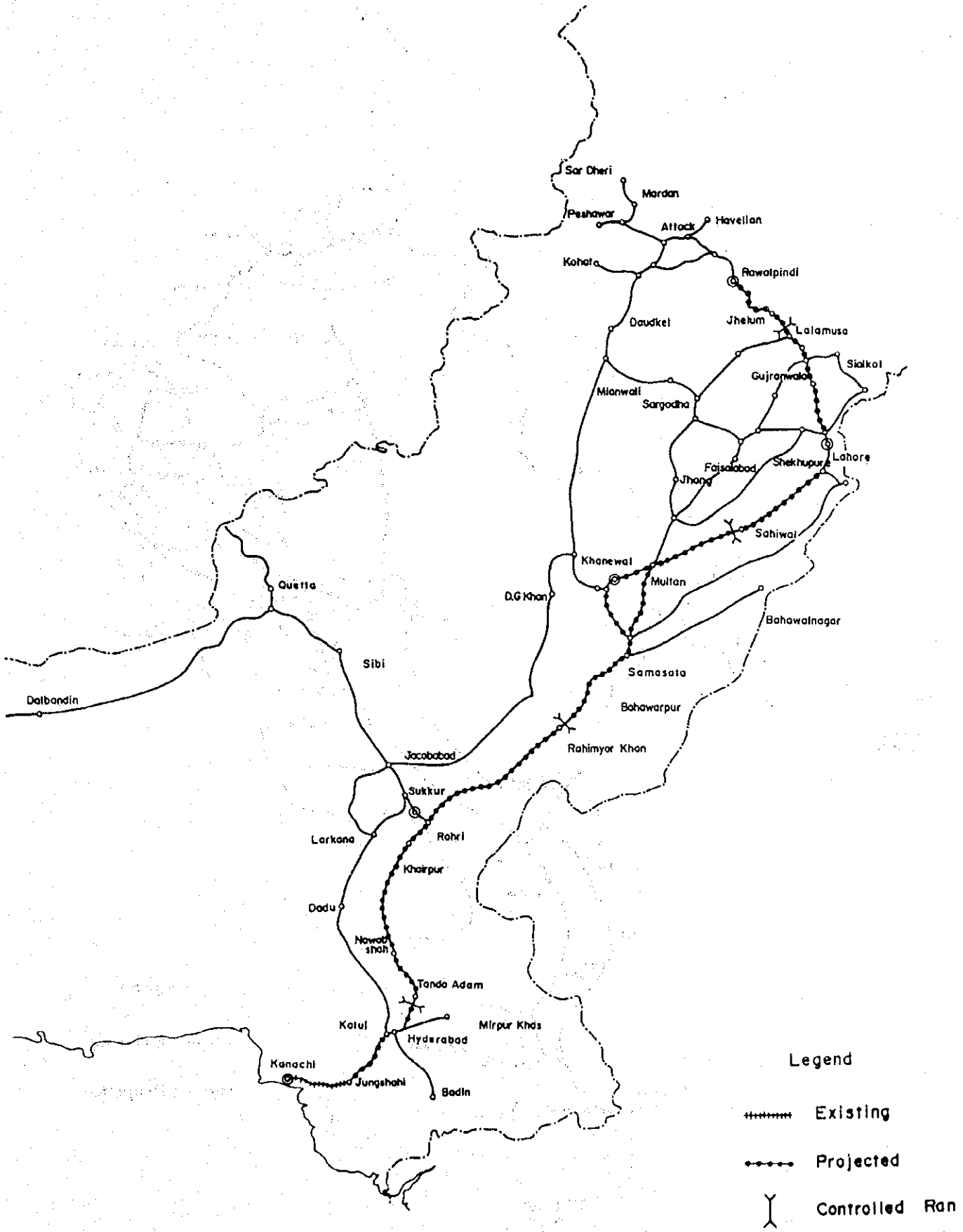
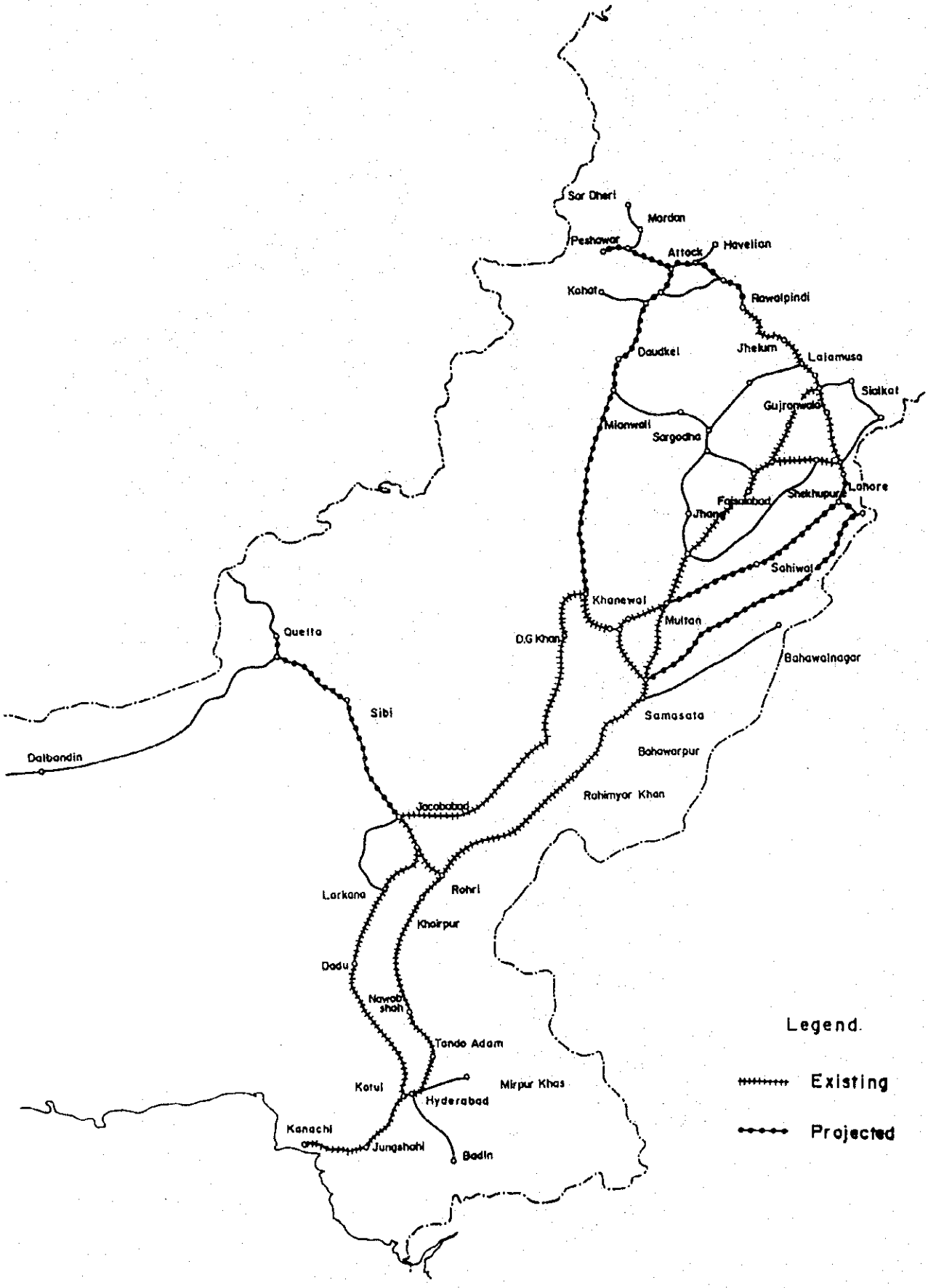


Figure 6.3.3.7 Communication Network (Master Plan)



4) Revamping of Signaling.

The grade of operating safety devices is determined by the P.R. management policies. However, the revamping of signal facilities is indispensable in order to deal with future increases in traffic volume and currently planned speed increases. The following measures are particularly necessary in consideration of high speed operation at a maximum speed of 160 km/h on trunk lines.

a. Introduction of automatic blocking systems

Including the Bin Qasim - Meting section which is currently being automated, automated sections do not exceed the approximately 180 km Karachi - Hyderabad section. In the future, it would be advisable to extend automation to Peshewar on the trunk line for which high speed operation is planned. At present, however, extending automation to Lahore and quickly achieving high speed operation and increased transport capacity between Karachi and Lahore is important. The next step would be to extend automation to Rawalpindi, and then finally to Peshawar. Automation is planned to be extended to Rawalpindi by 2005-06 in this master plan.

b. Introduction of relay interlocking devices

Both relay interlocking and mechanical interlocking devices are presently being used as interlocking devices. However, expanding relay interlocking to all sections would be advisable in consideration of safety for high speed transport. Accordingly, it is first necessary to equip the section between Pakistan's two major cities of Karachi and Lahore with relay interlocking to establish high speed operation. In addition, signals should be changed to colored lamps and day and night visibility ensured.

c. CTC (Centralized Traffic Control) conversion

Operation control must be improved for the introduction of high speed trains, and understanding and being able to control trains' running conditions at all times is required. To achieve this, extending the CTC currently in place on the Karachi - Bin Qasim section to Peshawar would be advisable.

d. Automationof major crossings

Operation of high speed trains at 160 km/h requires sufficient stopping distances. For this purpose, crossings should be automated, traffic on crossing roads completely cut off, and measures taken to ensure sufficient visibility for crossing signals.

In addition, regarding lines other than trunk lines, the following sections have been raised as sections which should be revamped from the current token blocks to tokenless blocks.

Kotri - Habibkot
Kot Adu - Attock City
Taxila - Peshawar

e. Repair of bridges

Train speed restrictions are currently imposed for 10 bridges. In order to lift these restrictions at the earliest opportunity, these overaged bridges need to be repaired.

f. Revamping of alignment

In order to achieve high-speed operation of 160 km/h from Lalamusa to Peshawar, permanent restrictions caused by sharp curves should be removed.

(2) Strengthening Transport Capacity (Rolling Stock)

1) Increasing the amount of rolling stock

The method of calculating the necessary quantity of rolling stock is shown in Appendix 6.3.3. The necessary number of vehicles is calculated based on the demand forecast for passenger and freight traffic, as well as consideration of current Pakistan Railways performance.

a. Locomotives

The necessary number of locomotives for passengers (N1p) is estimated with the following equation:

N1p = Train-km for Passenger / Engine-km * factor for ineffective allowance

Similarly, N1f for freight is as follows:

N1f = Train-km for freight / Engine-km * factor + N1s

N1s: The number of locomotives for shunting.

The number of locomotives to be acquired is estimated with consideration that the existing locomotives will become "overaged" in the future.

The results of this calculation are shown in Table 6.3.3.2.

b. Wagons

The necessary number of wagons (Nw) is estimated using the following equation:

Nw = Nwb * Ton-km of the target year / Ton-km of the base year * Turn around of the target year / Turn around of the base year * factor for inspection & repair

Nwb: The number of wagons in the base year.

The number of wagons to be acquired is estimated with consideration that the existing wagons will become "overaged" in the future. The result of this calculation is shown in Table 6.3.3.2.

c. Carriages

The necessary number of coaches (Nc) is estimated with the following equation:

Nc = Ncb * Passenger-km of the target year / Passenger-km of the base year

Ncb : The base number of coaches in the base year including a factor for inspection & repair.

The number of coaches to be acquired is estimated with consideration that the existing coaches will become "overaged" in the future. The result of this calculation is shown in Table 6.3.3.2.

Table 6.3.3.2 The Number Of Rolling Stock To Be Acquired

	As of 1993	Necessary Number 2005 - 06	Overaged Number 2005 - 06	No. to be Acquired 2005 - 06
EL	29 (BG)	51	0	22
DEL	533 (BG)	670	203	377
SL	90 (BG)	0	90	0
Wagon (No. of Equivalent to Bogie)	32,000 (BG) (16,000)	24,600 (12,300)	18,800 (9,400)	11,400 (5,700)
Coach	2,200 (BG)	4,970	650	3,420

Source : JICA Study Team

2) Raising the Performance of rolling stocks

a. Revamping of Locomotives

More than 200 of the current complement of 532 diesel-electric locomotives exceeded their normal service life, not including the 97 locomotives that were revamped. By 2005, another 140 locomotives will have exceeded their normal service life. Of these, 190 are

in the 1,800 HP-and-over class. These locomotives are the most worthwhile targets for revamping. Similarly, many electric locomotives are difficult to maintain and need to be revamped.

b. Installation of Air Brakes

Rolling stock presently outfitted with vacuum brakes should be converted to air brakes, with emphasis on vehicles less than 30 years old.

Locomotives	Approx. 300
Coaches	Approx. 1,900
Bogie Wagons	Approx. 3,500

c. Installation of Roller Bearings

Bogie wagons and all 4-wheeled wagons 30 years old or less, 20,000 vehicles in all, should be equipped with roller bearings.

d. Others

- Remodeling of coaches with air conditioning
- Revamping of coupling equipment into automatic coupling
- Refurbishing of coaches

3) Revamping of the maintenance system/facilities

Pakistan Railways has stated the standard number of days required for overhaul and semi-overhaul of locomotives as follows:

Overhaul 25 days

Semi-overhaul 15 days

However, the actual days required for overhaul are twice the standard and three times for semi-overhaul. The long period required is an obstacle to full execution of overhaul and semi-overhaul. These problems are caused by old systems which were originally arranged for steam locomotives, and overaged machinery and lack of testing equipment. Therefore, in order to improve the performance of locomotives, modernization of workshops is necessary.

About 90% of plant and machinery installed in Carriage and Wagon Shops is overage and cannot produce the required output. Therefore, the overaged plant and machinery should be replaced as soon as possible.

(3) Revamping Passenger Transport

P.R. plans to operate high-speed trains at 150 km/h from Karachi to Lalamusa and 100 km/h from Lalamusa to Peshawar. However, operation of such high-speed trains requires:

- New types of locomotives and coaches
- Reinforcement of infrastructure (including doubling tracks)
- Revamping of signalling & associated safety devices
- Expansion of the telecommunications network
- Improvement of level crossings

In addition, one of the most important measures is improving freight train operation.

See Appendix 6.3.4 for a list of general measures related to increasing speeds.

(4) Improving Freight Transport

Freight transport has been a focus of the revamping program for the past 1 or 2 years, but has nonetheless fallen sharply compared with the average level in the past 10 years.

The average transport distance, however, is approximately 800 km--equal to the best previous

level. Transported items show a tendency to specialize, concentrating on wheat, petroleum and oil products, cement, fertilizer, mining products and containers.

Therefore, preparations need to be made to implement a long-distance through freight system.

1) Installation of the freight terminals

In order to improve the utilization of assets through reduced shunting and an increase in the average speed of freight trains, it is planned that stations open for goods booking will be reduced from 466 stations to 100 stations.

Also, collection and delivery centers need to be established for the operation of specialized through trains for petroleum and oil products, cement, fertilizer and wheat.

2) Revamping of container transport

Container transport is growing steadily. The Lahore Dry Port is now operating at over 90% of total handling capacity. Expansion of existing Lahore Dry Port and planning of construction of New Lahore Dry Port are currently advancing. These improvements need to be continued and other dry ports need to be improved as well.

- Lahore Dry Port — Improvement and new construction
- Sargogha Dry Port — New construction
- Kundian Dry Port — New construction

(5) Modernization

1) Management Information System

It is proposed that the scope of the Management Information System be extended to cover the majority of Pakistan Railways activities. Computerization activities is shown as follows:

- Wagon control system
- Locomotive control
- Fuel and lubricant oil control
- Stores budgeting, provisioning and procurement
- Payrolling and personnel system

2) Expansion of the communications network

A communications network is needed to promote safe train operation management, manage information on passengers and freight, and to provide information to railway users. The trunk microweb networks currently in use should be installed on the sections listed below. In this way, most of the main rail lines can be equipped with networks.

- Rawalpindi - Peshawar
- Khanewal - Sahiwai - Raiwind - Lahore
- Kot Adu - Attock City
- Jacobabad - Sibi - Quetta

In the future, however, as the volume of information increases and these systems become overaged and out of date, they should be replaced by an optical fiber cable network. The Karachi - Lahore - Rawalpindi - Peshawar section should receive first priority. However, in order to implement this replacement, feasibility studies should be performed.

6.3.4 Investment Targets

The list of projects and cost estimates for the Master Plan in 2005-06 is shown in Table 6.3.4.1 Total investment costs for the Master Plan are estimated at Rs. 146 billion, out of which the investment for the major ground facilities is estimated at Rs. 50 billion, for the rolling stock at Rs. 83 billion, and for minor projects and miscellaneous items at Rs. 13 billion.

Table 6.3.4.1 Summary Of Proposed Project For Master Plan

No.	Projects	Estimated Cost (Rs. million)		Remarks
1	Automatic Block Signaling	2,220		
	Karachi - Lahore		1,760	
	Lahore - Rawalpindi		460	
2	Electric/Relay Interlocking	2,340		
	Karachi - Lahore			
3	Tokenless Block Signaling	1,630		
	and Color Light Signal		340	
	Jacobabad - Quetta		400	
	Kotri - Habibkot		270	
	Chakjhumra - Lalamusa		570	
	Attock City - Shershar		50	
	Wazirabad -Sialkot			
4	Centralized Traffic Control System	1,100		
5	Track Renewal	7,120		
	Rail		6,510	
	Sleeper		610	
6	Electrification	17,420		
	Samasata - Khanewal		1,170	
	Kiamari - Samasata		16,250	
7	Double Tracking	7,760		
	Lodhran - Shershar		720	
	Multan - Raiwind		2,950	
	Shardara Bagh - Rawalpindi		2,820	
	Shardara Bagh - Faisalabad		1,270	
8	Upgrading KYC - LLM section	5,500		
9	Electric Locomotives	4,350		
	Procurement		3,300	
	Revamping		1,050	
10	Diesel Electric Locos.	43,800		
	Procurement (3,000 HP/2,000 HP)		40,300	
	Rehabilitation		3,000	
	Traction Motor		500	
11	Procurement of Wagonmovers	4,700		
12	Procurement of Wagons	13,000		
13	Replacement of Coaches	13,700		
14	Improvement of Rolling Stocks	3,000		
	Air Brake		1,000	
	Roller Bearing		1,000	
	Air Conditioning		1,000	
15	Improvement of Container Traffic	2,400		
	Karachi Dry Port		400	
	Lahore Dry Port		1,600	
	Other Dry Ports		400	
16	Information System and Communication System	2,230		
	Management Information System		330	
	Seat Reservation System		400	
	Communication System		1,500	
17	Misc. and Minor Projects	13,330		
	Total	145,600		

6.4 Short-Term Proposals for 1997-98

The Pakistan Railways faced extremely severe conditions during the 7th Five-Year Plan. Investment results during this period fell Rs. 1.7 billion below the amount invested during the 6th Five-Year Plan. As a result, the overaging of facilities progressed even further and transportation capacity decreased, causing both passenger and freight transportation results to fall well short of their targets.

Amidst these circumstances, a corporate plan was prepared which produced policies to rationalize and modernize the railways. The government also recognized the superiority of railways regarding mass transport over great distances in terms of economy and energy efficiency on a national level. Therefore, increased investment for the railways was approved with great expectations for the 8th Five-Year Plan.

In order to meet the expectations of the government and the people, policies must be implemented to maximize the use of railway as of high-speed, mass and safe transportation. Pakistan Railways must first increase transport capacity, and priority should be focused on establishing high-speed, reliable operation along the main Karachi - Lahore - Peshawar corridor, and particularly on enhancing freight transport which provides an important source of revenue.

In the following areas, the number of trains required to cope with the forecast demand for 1997-98 exceeds the route capacity (Fig. 6.4.1):

Rohri —— Lodhran
Lodhran —— Multan
Lodhran —— Khanewal
Shershah —— Kot Adu
Shadara Bagh —— Sangola Hill
Attock City —— Peshawar

Consequently, high priority will be given to investment to strengthen the transport capabilities of these areas. Similarly, areas where demand will exceed route capacity in 2005-06 will be given the next highest priority.

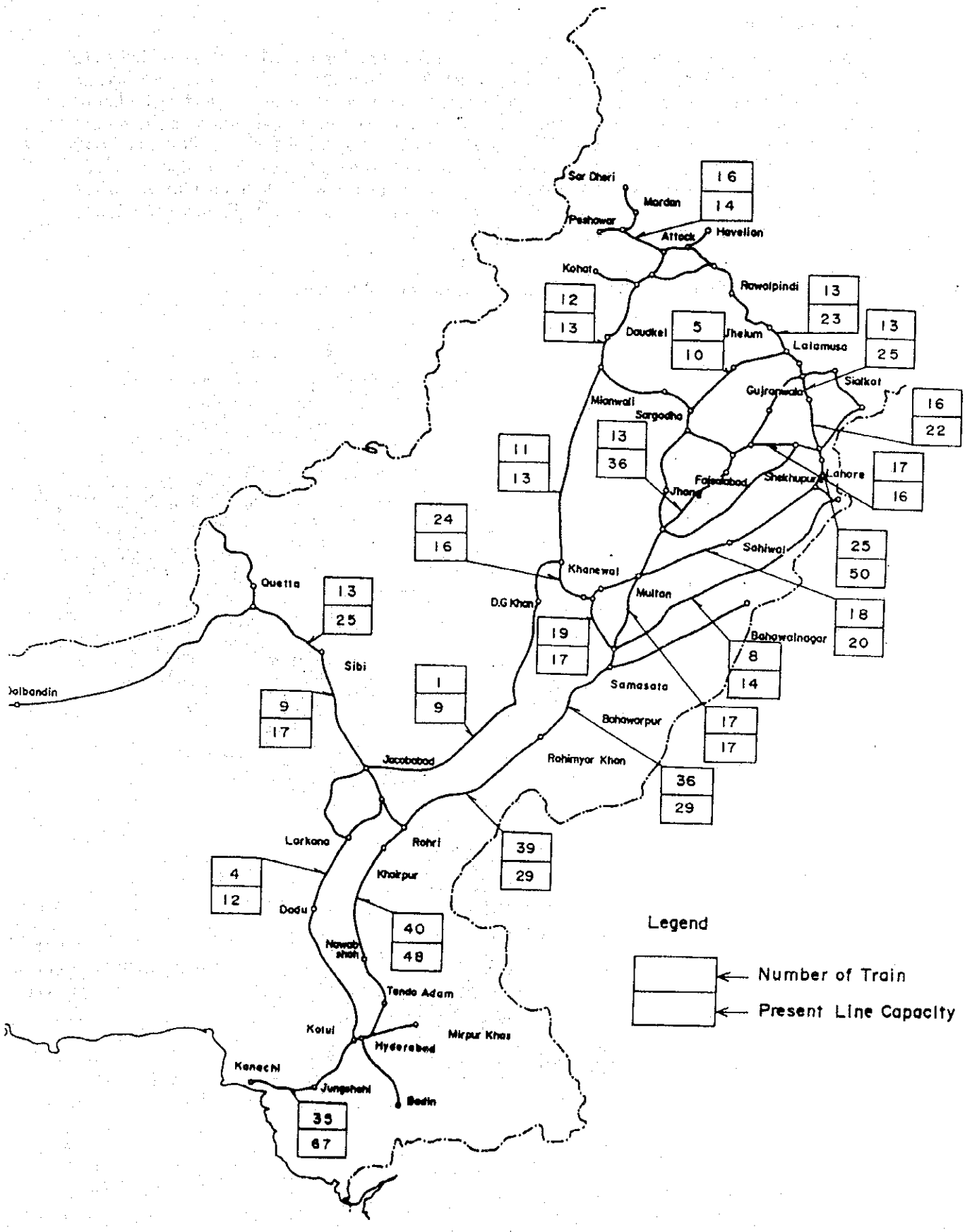
The Pakistan Railways' final targets for the 8th Five-Year Plan have been set as shown in Table 6.4.1. To achieve these targets, there are many points for improvement not only in terms of facilities and rolling stock, but also for the railway system as a whole.

Table 6.4.1 Targets of the 8th Five Year Plan

No.	Performance	Target Figures
1	Wagon Turn around time	7 days
2	Daily Engine-kms per Engine in use (goods)	300 kms
3	Daily System Loading of Wagons	2,300 wagons
4	Percentage of ineffective locomotives	15%

Source : P.R.

Figure 6.4.1 Total Number. Of Trains Required In The Year 1997-98



6.4.1 Expanding Transport Capacity

(1) Track Renewal

As mentioned previously, the majority of planned track renewal in the 7th Five-Year Plan were carried over to the 8th Five-Year Plan due to insufficient investment. As a result, there is currently 5,920 km of overaged track for which rail replacement is necessary, and 5,380 km of track for which sleeper replacement is necessary. However, these figures also include both meter-gauge and narrow gauge sections. As of March, 1993, these figures will reach 3,660 km and 3,220 km respectively when limited only to Primary A and B and Secondary sections. Since renewing all of these sections would require huge investments, limiting renewal to the main lines would be realistic at present. Main sections are shown in Figure 6.4.1.1 and candidate sections in Table 6.4.1.1.

Figure 6.4.1.1 Important Corridors On P.R. Network

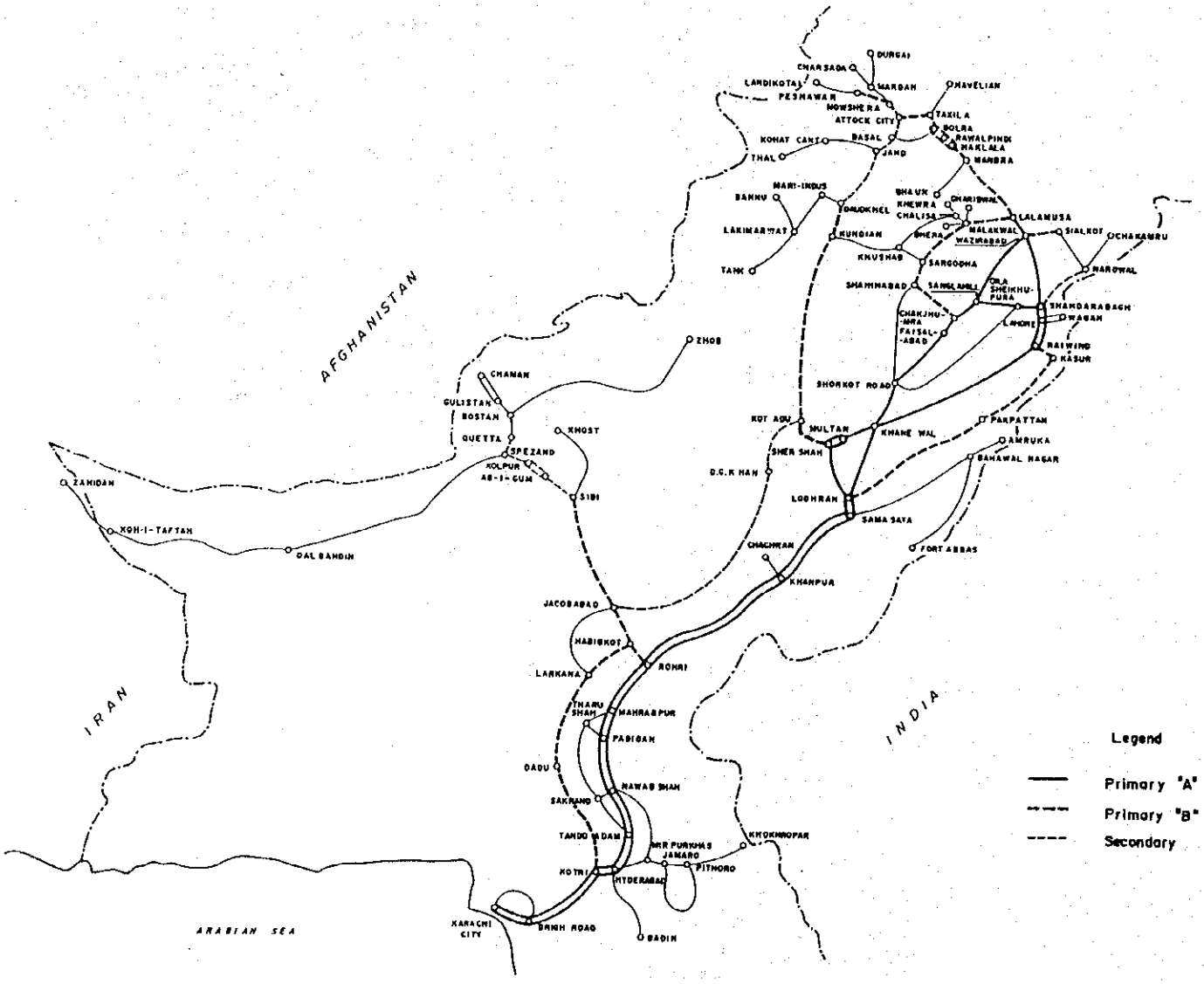


Table 6.4.1.1 Details Of Renewal Of Rails And Sleepers in Sections (Broad Gauge)

Section		Length of running lines in (kms)	Overaged Rails and Sleepers Remarks (Rails)	(Sleepers)
(Primary A)				
Khanewal	Shorkot Cant	64.37	64.37	56.10
Shorkot Cant	Sanglahill	149.54	120.14	82.52
Sanglahill	Shahdara Bagh	90.19	85.25	48.23
Sanglahill	Wazirabad	109.47	109.47	104.89
Sub Total		413.57	379.23	291.74
(Primary B)				
Lalamusa	Rawalpindi	161.98	46.59	12.36
Rawalpindi	Peshawar	188.27		57.44
SherShah	Kundian	300.15	250.00	108.56
Kundian	Daudkhel	49.04	24.00	21.00
Chak Jhumura	Shahinabad	68.80	68.80	8.26
Shahinabad	Lalamusa	164.85	161.33	31.26
Kotri (Dadu)	Habibkot	346.16	211.04	191.43
Lodhran	Pakpattan	204.58	203.79	178.79
Pakpattan	Kasur	138.91	138.91	112.34
Raiwaid	Kasur	26.95	26.95	25.11
Wazirabad	Sialkot	47.00	14.36	26.55
Sub Total		1,696.69	1,145.77	773.10
(Secondary)				
Daud Khel	Attok City	147.75	136.86	100.93
Shahdara Bagh	Narowal	72.14	19.08	14.74
Narowal	Sialkot	60.81	60.81	47.45
Sub Total		280.70	216.75	163.12
Total		2,390.96	1,741.75	1,227.96

Source : P.R.

(2) Double Tracking

Double tracking is the most effective method of increasing transport capacity. In particular, demand on the Karachi - Lahore section is approaching the carrying capacity. Double tracking the remaining single tracked Lodhran - Shershah and Multan - Raiwaid sections on this main corridor would secure the necessary passenger and freight transport capacity, and contribute to restore the faith of the people.

Moreover, since high-speed operation of 160 km/h is also planned for this section, double tracking would play an important role in ensuring safe, high-speed operation and in reducing the growing waiting time for freight trains. In addition, transport conditions over the Lahore - Faisalabad section have reached a state of saturation, and it is thought that work should also start on double tracking this section as soon as possible. These candidate sections are shown in Figure 6.4.1.2.

(3) Improvement of Signaling

Current signaling related projects include the "Providing Track Circuits on Berthing Passenger Lines at 94 Stations on the Main Line from Hyderabad to Peshawar" and "Improved Signaling Works" continued from the 7th Five-Year Plan. These projects should be finished as soon as possible. Safe and stable train running must be ensured to achieve high-speed operation at 160 km/h on the main trunk line from Karachi to Peshawar. For this purpose, in addition to the establishment of automatic block signals and the establishment of electric and relay interlocks at each station, a centralized train control system must be introduced and a reliable high-speed operation system provided (Figure 6.4.1.3 - 5).

(4) Increasing and Improving Rolling Stock

Converting to high-speed train operation requires providing an infrastructure while at the same time increasing and modernizing rolling stock. In particular, the following renewal and improvement projects for overaged rolling stock for which supplying spare parts is difficult and for rolling stock whose performance is not suitable for high-speed, mass transportation are proceeding with the financing of the World Bank and OECF.

- Recommissioning of Locomotives
- Procurement and Rehabilitation of Traction Motors
- Figment of Roller Bearing
- Rehabilitation of 101 Locomotives

To complete improvement projects for existing rolling stock and to deal with future speed increases on the trunk lines, it is necessary to adopt high-output locomotives and equip all rolling stock with air brakes and automatic couplers.

Figure 6.4.1.2 Doubling Track (1997-98)

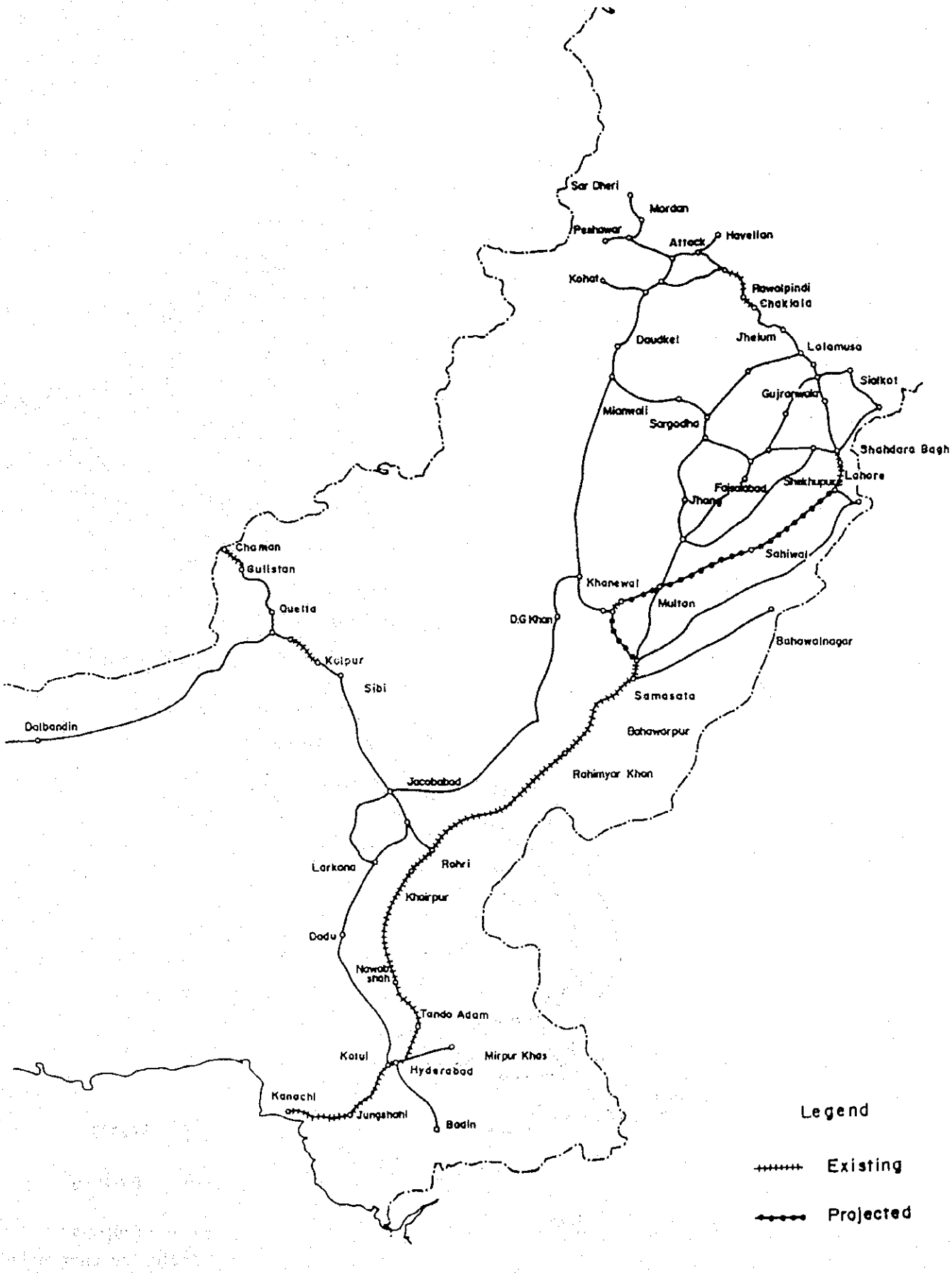


Figure 6.4.1.3 Automatic Block Signaling (1997-98)

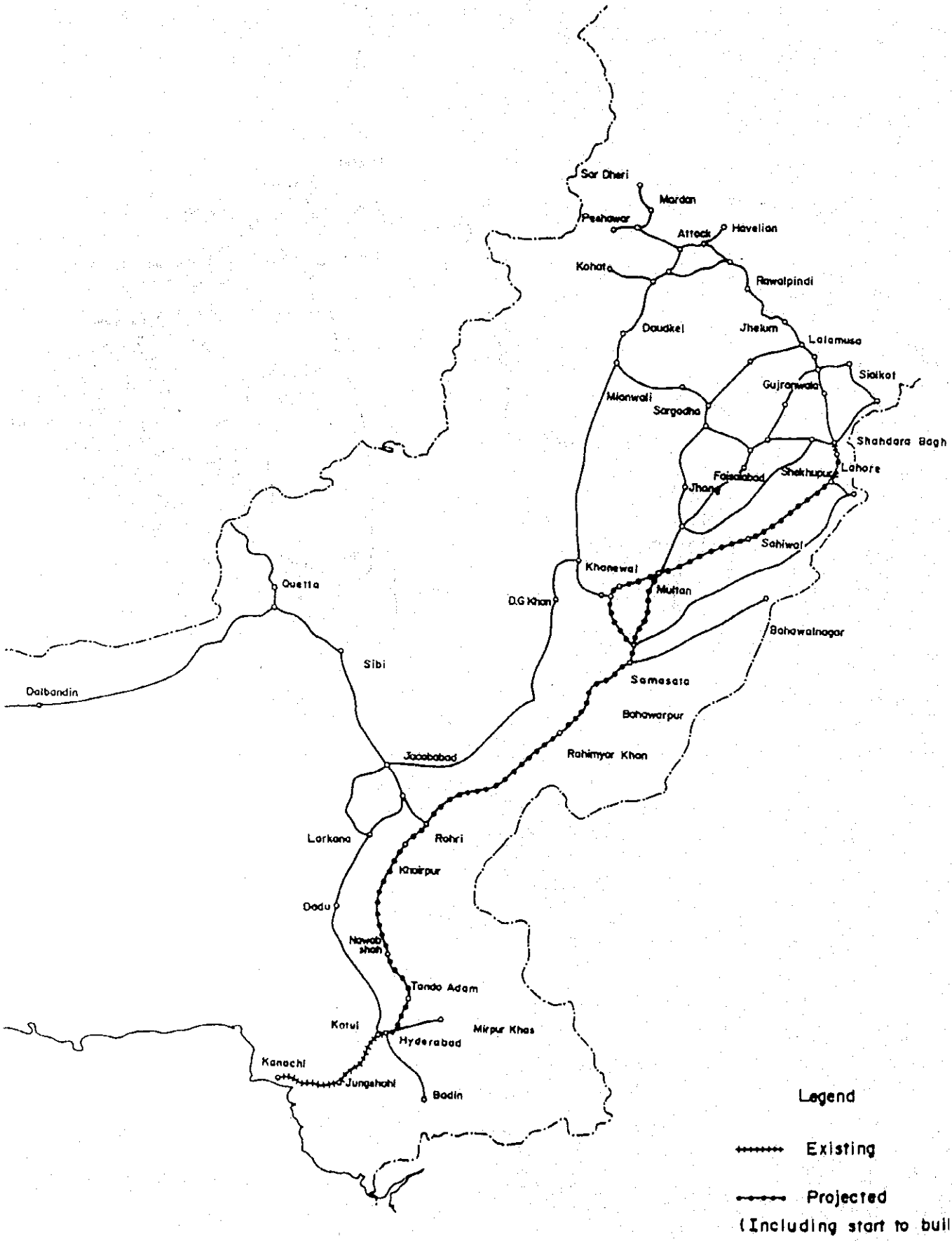


Figure 6.4.1.4 Electric - Relay Interlocking (1997-98)

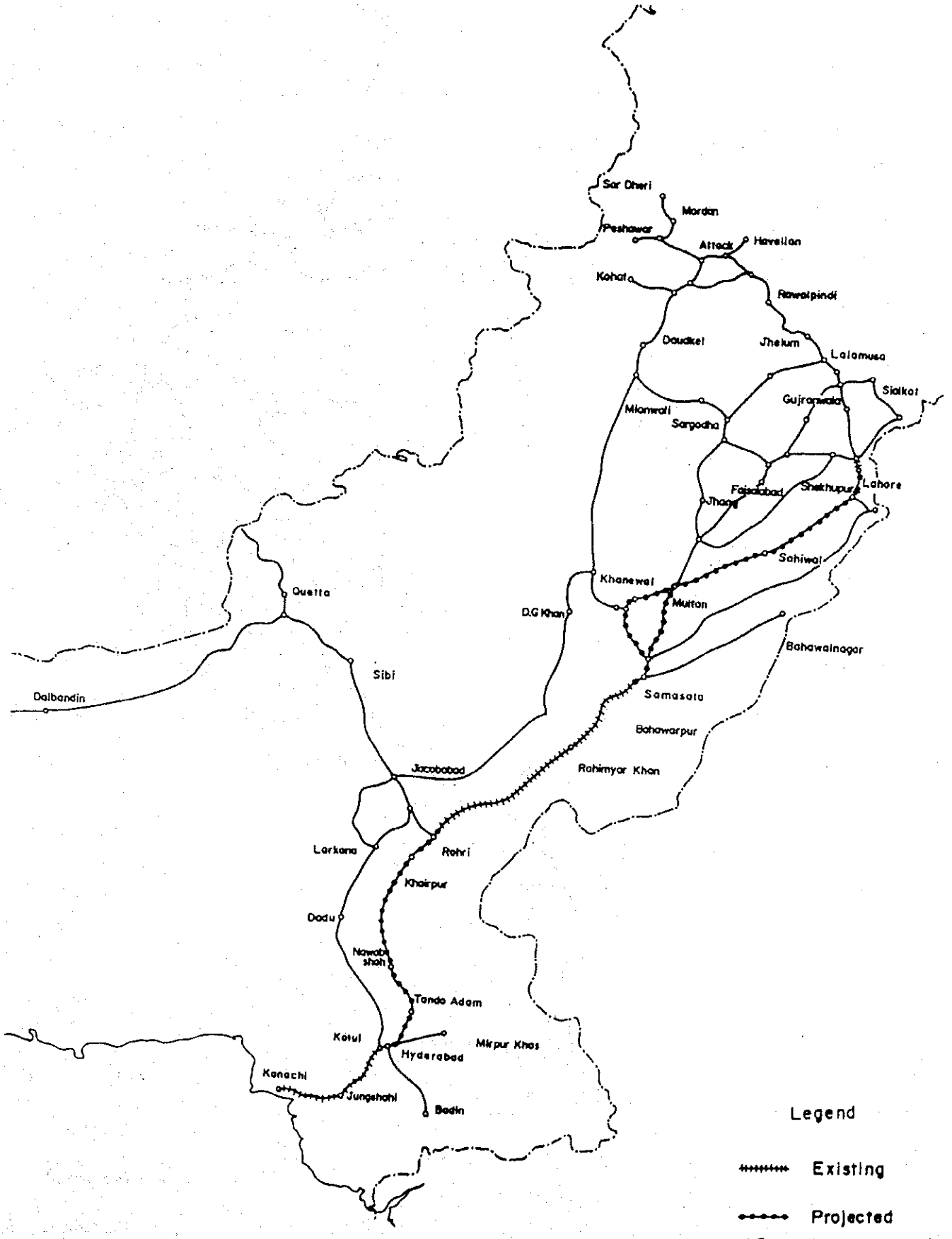


Figure 6.4.1.5 Centralized Traffic Control System (1997-98)

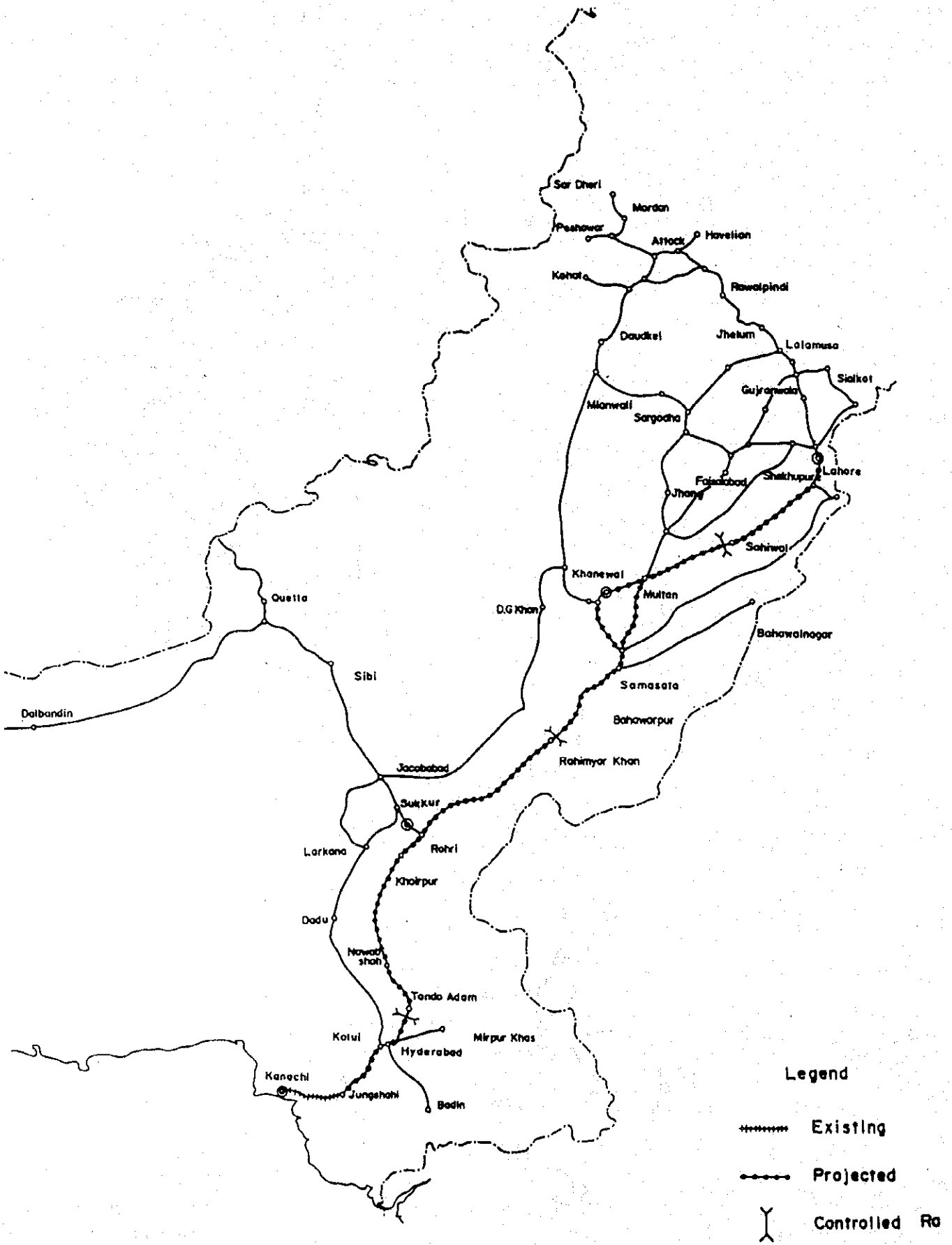
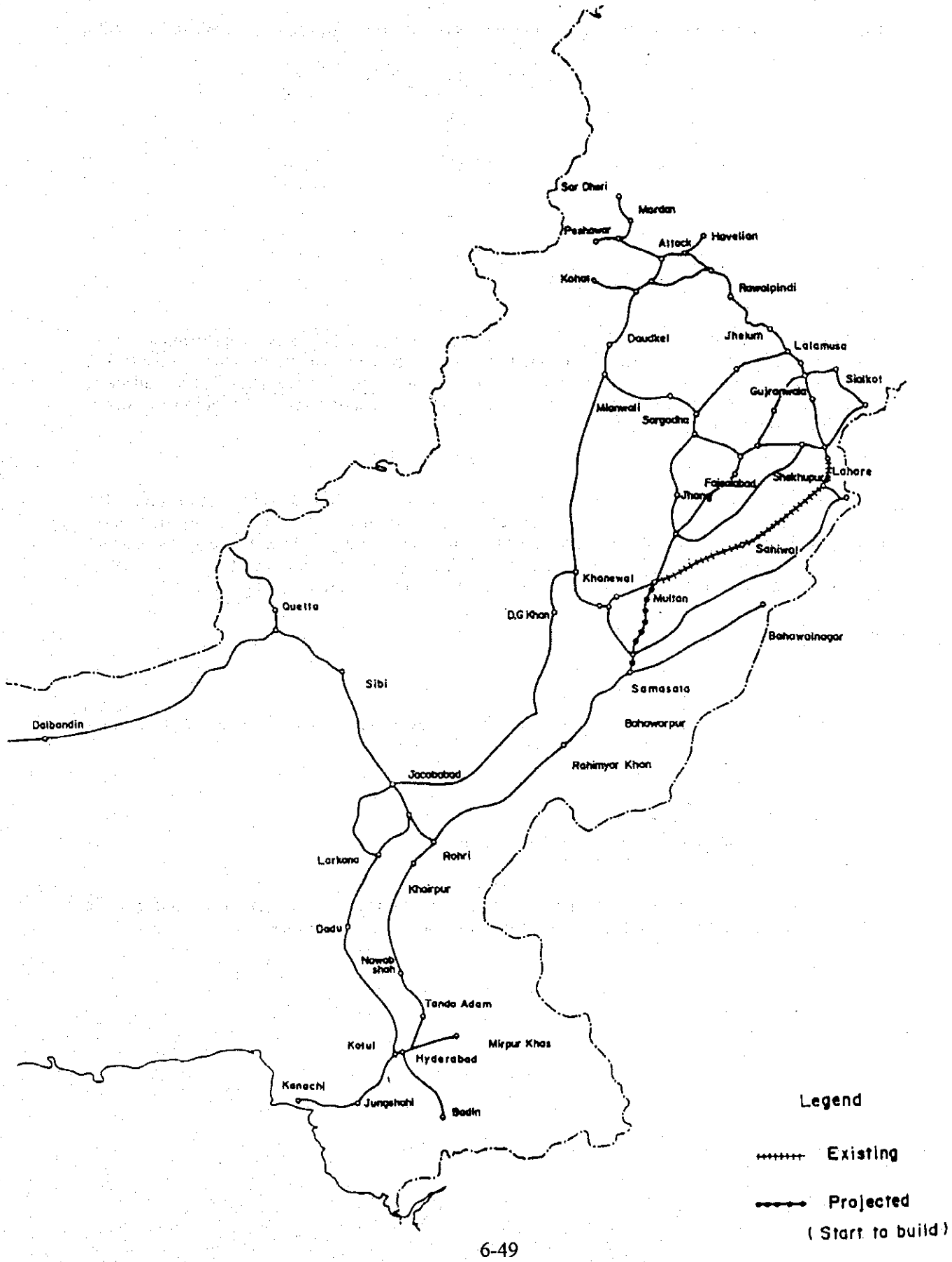


Figure 6.4.1.6 Electrification (1997-98)



In addition, necessary new procurement of rolling stock for which shortages are predicted due to forecast demand is shown in Table 6.4.1.2.

Table 6.4.1.2 The Number of Rolling Stocks Necessary & to be Aquired by the Year 1997-98

	Necessary Number	No. to be Acquired
EL	29	0
DEL	555	53
SEL	0	0
Wagon	17,500	3,300
(No. of Equivalent to Bogie)	(8,750)	(1,650)
Coach	3,140	1,100

Source : JICA Study Team

(5) Electrification

In consideration of energy efficiency, maintenance costs, rolling stock performance, etc., electrification is the most desirable measure for the railways. However, since considerable investment is required for rolling stock and electrification works, a realistic goal would be to extend existing electrification to the Khanewal - Samasata section in consideration of current operation and maintenance systems.

(6) Others

In order to achieve high-speed operation of 160 km/h, level crossings which might hinder this operation must be avoided at all cost. Judging from the current situation, however, there is little chance of being able to separate tracks from road crossings along the entire Karachi - Lalamusa section. Therefore, in consideration of the site conditions, it is necessary to determine whether to improve the level crossings or change to grade separated crossings.

6.4.2 Modernization

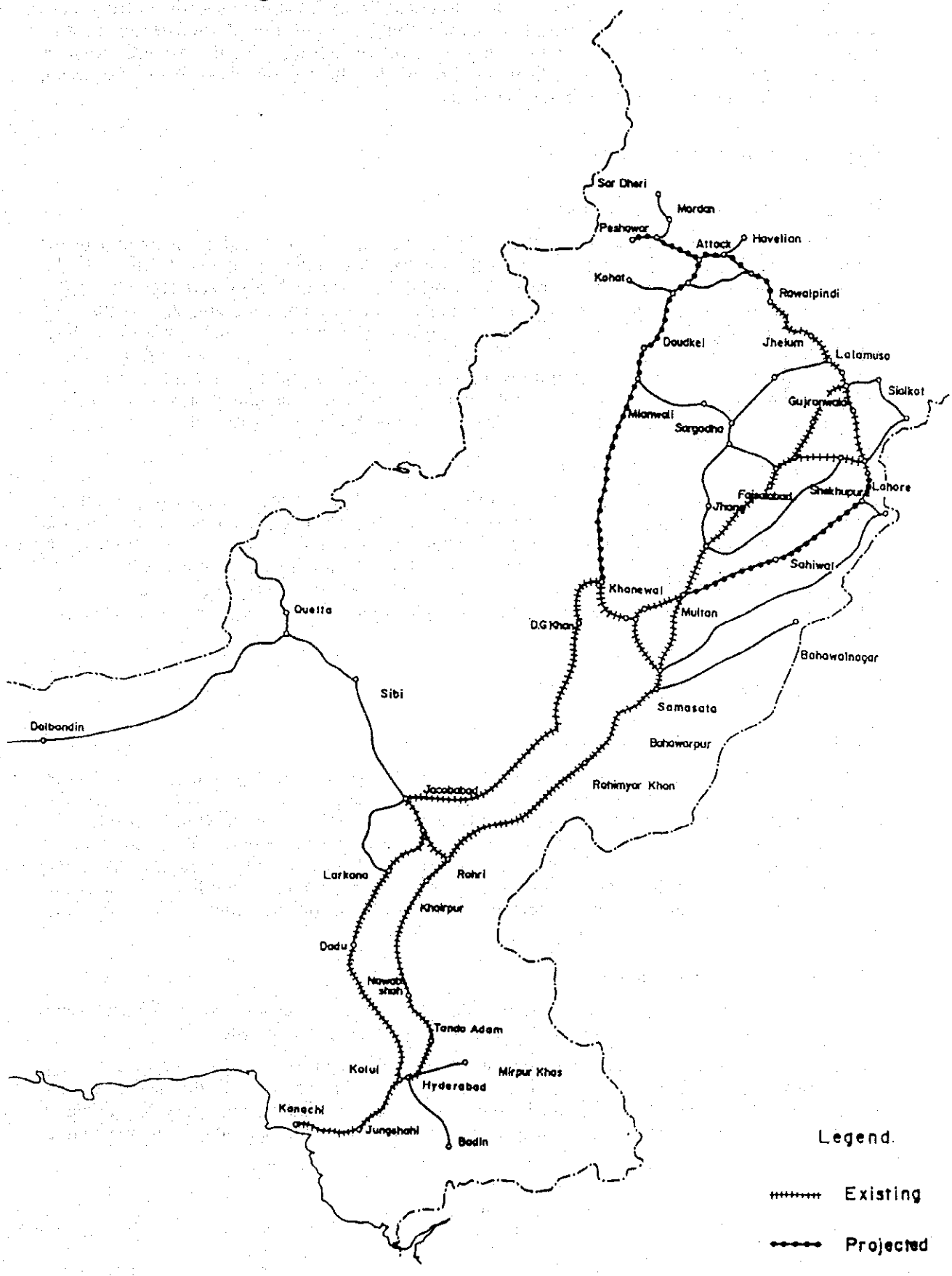
(1) Management Information System

Pakistan Railways is currently computerizing the following items using the existing microwave circuit network with financing from the World Bank

- Wagon control system
- Locomotive control
- Fuel & lubricant control
- Stores budgeting, provisioning & procurement
- Payrolling & personnel system

In addition to these items, it is also necessary to build a Seat Reservation and Freight Information System to respond to the demands of passengers and shippers.

Figure 6.4.2.1 Communication Network (1997-98)



(2) Expansion of Communications Network

Accurately conveying operating information is necessary to increase train speeds on trunk lines and to ensure safe and reliable operation. Establishing a Management Information System requires the construction of a communications network which includes the existing railways network, and completing the communications network for the sections listed below for which work currently in progress is considered necessary.

6.4.3 Improving Freight Transport

(1) Expanding Container Transport

Container transport is tending to increase year by year, and is predicted to become a major source of revenue for Pakistan Railways in the future. According to demand forecasts, the number of containers handled at dry ports for 1997-98 is expected to exceed 100,000 TEUs. However, there is presently a shortage of locomotives and freight cars, and due to the long transport time, only one container train per week runs between Karachi and Lahore Dry Port, which has the largest handling capacity. If reductions in the turn around time for freight trains can be achieved as planned by running regular freight trains, increasing train speeds, reducing handling time at container yards by contracting out container handling, and reducing the waiting time, etc., the daily freight handling capacity could be greatly increased.

(2) Expanding the Lahore Dry Port

The handling capacity of the existing Lahore Dry Port is limited due to shortages of holding yards and cargo handling lines, and there are plans to expand these facilities. However, the dry port is presently located in the center of Lahore, there is only one entrance to the access road and area surrounding the port is congested, all these factors make the current location of the dry port unsuitable for future expansion. Investigations are proceeding on plans to move the dry port to the outskirts of Lahore, and these plans must be advanced in parallel with the expansion plans.

6.4.4 Improving Passenger Transport

(1) Establishing Regular Operation

Current timetables contain a fair amount of leeway for actual running times and necessary stopping times, with the result that schedule speeds are quite low. To the passengers, the highest priority service is shortening the travel time. Therefore, as previously mentioned, projects to improve the infrastructure are necessary as measures to reduce actual running times by increasing train speeds. In addition, however, small-scale station improvement works such as providing passing facilities are also necessary in order to minimize the effect of other train delays to reduce stopping time by shortening the time for water filling, refueling, inspection and maintenance.

(2) Improving Accommodations

To provide comfort to passengers, station facilities must be clean and convenient, and passenger cars must be improved to allow passengers to endure long journeys.

Station facilities should be improved including the establishment of a seat reservation system, and in consideration of profitability for passenger cars, the number of air conditioned sitter and air conditioned lower coaches should be increased. It may also be necessary to gradually revamp air conditioned sleeper, first sleeper and first sitter rolling stock into the above rolling stock.

6.4.5 Others

The following items are included as miscellaneous items:

a. Plants and Machinery for Sheds
b. Depots and Workshops (Including Stores Inventory)
c. Electrical Works
d. Providing Track Circuiting
e. Bridge Renewal
f. Extension of Loops and Sidings at Stations
g. Investment for Minor Branch Lines
h. Office Facilities
i. Others

The cost for miscellaneous items and price contingencies are 10 % of the total cost of the major projects.

6.4.6 Cost Estimation

The list of projects and cost estimates for Short Term Proposals for 1997-98 is shown in Table 6.4.6.1.

The total amount is approximately Rs.41 billion, comprising Rs.14 billion for the main infrastructure, approximately Rs.23 billion for rolling stock related items and approximately Rs.4 billion for other items.

Table 6.4.6.1 Summary Of Proposed Project

No.	Projects	Estimated Cost (Rs. million)		Remarks
1	Track Renewal	3,550		
	Rail		2,700	
	Sleeper		850	
2	Double Tracking	4,000		
	Lodhran - Shershah		720	
	Multan - Raiwind		2,800	
	Shahdara Bagh - Faisalabad		480	Partial provision
3	Upgrading KYC-LLM section	3,300		
4	Automatic Block Signaling Karachi - Lahore	540		Partial provision
5	Electric/Relay Interlocking Karachi - Lahore	720		Partial provision
6	Centralized Traffic Control System Karachi - Lahore	300		Partial provision
7	Electric Locomotives Revamping	800		
8	Diesel Electric Locos	10,400		
	Procurement (3000 HP/2000 HP)		6,900	
	Rehabilitation		3,000	
	Traction Motor		500	
9	Procurement of Wagonmovers	300		
10	Procurement of Wagons	4,400		
11	Replacement of Coaches	4,400		
12	Improvement of Rolling Stocks	3,000		
	Air Brake		1,000	
	Roller Bearing		1,000	
	Air Conditioning		1,000	
13	Electrification Samasata - Khanewal	360		Partial provision
14	Information System and Communication System	930		
	Management Information System		330	
	Communication System		600	
15	Misc. and Minor Projects	3,700		
	Total	40,700		

6.4.7 Preliminary Evaluation of the Projects

(1) Methodology

In order to assess the economic viability of the proposed projects, a preliminary benefit-cost analysis was conducted. Benefit was derived from the vehicle operating cost savings and road construction savings calculated on the assumption that if no project was implemented for the railway any increase in railway traffic would have to shift to road transport (passenger to bus/wagon and freight to truck).

Cost of the proposed projects was estimated under the following classification:

a. Capital investment
   - Track renewal
   - Signalling
   - DEL engine
   - EL coach/wagon
   - Electrification/workshop and others
   - Track doubling

b. Maintenance/repair
c. Operation
d. Others

Economic benefit and cost calculated were formed into a year-by-year data stream by interpolation based on the 1992-93, 1997-98 and 2005-06 estimated values. Then benefit/cost ratio and internal rate of return were calculated.

(2) Benefit

For preliminary evaluation, economic benefit was estimated as follows:

1) VOC Savings

Increase of railway traffic volume from 1992-93

	Passenger-kms(million)	Ton-kms(million)
1997-98	6,279	7,641
2005-06	19,578	15,080

Unit economic VOC

Bus	9.77919 RS/km	- 30 kph, road condition "fair"
Wagon	4.59093 Rs/km	- do
Truck	5.92382 Rs/km	- do

Average load

Bus	42.7 pass./vehicle
Wagon	14.1 pass./vehicle
Truck	6.00 tons/vehicle

VOC savings

1997-98 6,279/2/42.7 x 9.77919 + 6,279/2/14.1 x 4.59093
+ 7,641/6.0 x 5.92382 = 9,285 (Rs million)

2005-06 19,578/2/42.7 x 9.77919 +19,578/2/14.1 x 4.59093
+ 15,080/6.0 x 5.92382 =20,318 (Rs million)

* Passengers were divided equally to bus and wagon.

2) Savings in Road Construction Cost

This was estimated as follows:

Increase of PCU-kms from 1992-93

Considering that passenger car unit (PCU) is 3.0 for bus and 3.2 for truck:

1997-98 6,279/42.7 x 3.0 + 7,641/6.0 x 3.2 = 4,516 (million PCUkms/year)

2005-06 19,578/42.7 x 3.0 +15,080/6.0 x 3.2 = 9,418 (million PCUkms/year)

Unit cost of additional road construction (widening)

Typical widening from 2-lane to 4-lane road	: Rs. 20 million/km
Typical construction of 2-lane road	: Rs. 40 million/km
Average	: Rs. 30 million/km

Additional capacity due to widening

Since typical capacity of 2-lane and 4-lane road is 19,200 PCUs/day and 74,600 PCUs/day respectively, 1 km of widened road can accommodate additional 18.3 million PCU-kms/year (330 days/year). Capacity of 2-lane road is 6.3 million PCU-kms/year. In this study, an average of 12.3 million PCU-kms/day was assumed.

Additional road construction cost

by 1997-98	30 x 4,516/12.3	= 11,015 (Rs. million)
by 2005-06	30 x 9,418/12.3 - 11,015	= 11,956 (Rs. million)

* These savings were allocated to each year equally. a conversion factor of 0.8 from financial to economic terms was assumed.

(3) Cost

The cost of the proposed projects was estimated as shown in Table 6.4.7.1. Then this cost was converted from market prices to economic prices using an assumed conversion factor of 0.8. The project life of capital investment is:

Track renewal	: 20 years
Signalling	: 20
DEL engine	: 18
EL coach/wagon	: 35
Electrification/workshop and others	: 30
Track doubling	: 60

Maintenance/repair and operation cost are only those related to the proposed investment.

(4) Benefit Cost Analysis

Using the benefit and cost calculated above, a benefit coct analysis was conducted. As shown in Table 6.4.7.2, the proposed projects upto the year 2005-06 proved to be economically viable as a whole. The projects proposed upto the year 1997-98 showed marginal viability as shown in Table 6.4.7.3. However, if other benefits including environmental impact, safety and speed (though not recognized at present) are taken into account, this viability would be further improved.

Table 6.4.7.1 Cost in Market Prices of the Proposed Projects

(million Rs.)

Year	Investment Cost							Maint. and Repair	Operating	Others	Total
	Track Renewal	Signaling	DEL Engines	EL Coach Wagon	Elect. W/S Others	Doubling Track	Sub-total				
1993-94	710	0	705	600	254	0	2,269	3,320	2,830	1,200	9,619
1994-95	710	0	825	2,800	711	1,000	6,046	3,370	2,890	1,200	13,506
1995-96	710	416	1,185	2,800	1,135	2,100	8,346	3,420	2,950	1,200	15,916
1996-97	710	416	2,385	2,800	1,206	2,100	9,617	3,470	3,010	1,200	17,297
1997-98	710	416	1,905	2,800	1,004	2,100	8,935	3,520	3,070	1,200	16,725
1998-99	450	576	2,820	2,200	1,527	2,100	9,673	3,570	3,130	1,200	17,573
1999-00	450	576	2,820	2,200	1,452	1,500	8,998	3,620	3,190	1,200	17,008
2000-01	450	576	2,820	2,200	1,342	400	7,788	3,670	3,250	1,200	15,908
2001-02	450	576	2,820	2,300	1,352	400	7,898	3,720	3,310	1,200	16,128
2002-03	450	576	2,820	2,300	1,344	400	7,890	3,770	3,370	1,200	16,230
2003-04	450	576	2,820	2,300	1,115	400	7,661	3,820	3,430	1,200	16,111
2004-05	450	528	2,820	2,300	1,110	400	7,608	3,870	3,490	1,200	16,168
2005-06	420	408	2,880	2,100	1,685	360	7,853	3,920	3,545	1,200	16,518

Table 6.4.7.2 Economic Evaluation of Railway Projects upto 2005-06

(Rs. million)

Year	Total Benefit	Discounted Benefit	Total Cost	Discounted Cost
1993-94	3,619	3,619	7,695	7,695
1994-95	5,746	5,130	10,805	9,647
1995-96	7,333	5,846	12,733	10,151
1996-97	9,190	6,541	13,838	9,849
1997-98	11,047	7,021	13,380	8,503
1998-99	11,860	6,730	14,058	7,977
1999-00	13,239	6,707	13,606	6,893
2000-21	14,618	6,612	12,726	5,757
2001-22	15,998	6,461	12,902	5,211
2002-23	17,377	6,266	12,984	4,682
2003-24	18,756	6,039	12,889	4,150
2004-25	20,135	5,788	12,934	3,718
2005-26	21,514	5,522	-50,329	-12,918
Total	170,432	78,284	100,222	71,316

Net Present Value : 6,968 (million Rs.)
B/C Ration at a Discount Rate of 12%year : 1.10
Internal rate of Return : 15.79%

Table 6.4.7.3 Economic Evaluation of Railway Projects upto 1997-98

(Rs. million)

Year	Total Benefit	Discounted Benefit	Total Cost	Discounted Cost
1993-94	3,619	3,619	7,695	7,695
1994-95	5,746	5,130	10,805	9,647
1995-96	7,333	5,846	12,733	10,151
1996-97	9,190	6,541	13,838	9,849
1997-98	11,047	7,021	-13,270	-8,434
Total	36,935	28,157	31,800	28,909

Net Present Value : -752 (million Rs.)
B/C Ration at a Discount Rate of 12%year : 0.97
Internal rate of Return : 9.95%

6.5 Policy Options

6.5.1 Elimination of Unprofitable Routes

During 1991-92 and after, PR eliminated unprofitable routes and cut back the number of routes in operation. This policy should be continued in the future. However, in regards to routes which need to be continued as a policy, it is vital to plan for more efficient operation, and set fares which reflect required expenses. These routes are difficult to make profit through Pakistan Railways' efforts alone. And as stated in the previous study, their management and operation by a third-sector method, through the introduction of autonomous bodies and private capital, is a matter which should be investigated.

However, even in the case of this third sector method, financial support from the government, and Pakistan Railways' cooperation in operation would be indispensable. In Japan, the operation of the railways is done through a third sector method. For a limited time, the government provides subsidy against operating losses, and also gives human support in the form of outplacement or job changes of former employees of the national railways or the post-privatized JR.

6.5.2 Links to Central Asian Republics

The ECO (Economic Cooperation Organization) countries include the central Asian countries created by the 1991-breakup of the Soviet Union, as well as Afghanistan and original members, Iran, Turkey, and Pakistan. With a common outlook, these countries are in the midst of refining their mutual cooperative system. As part of this trend, they are aiming for an expansion of exports, especially of the rich energy resources of the central Asian countries, as well as foodstuffs and raw materials. In order to route goods through the Arabian Sea, rail transportation is planned to either Iran, or Pakistan's Port of Karachi.

Currently, the connection of Pakistan Railways' network to the ECO countries consists of routes for Afghanistan from Landikotal and Chaman, and for Zahidan in Iran. However, in all cases, the rail network does not extend beyond these national borders. Further, due to the continuing civil war in Afghanistan, construction of new lines is impossible, and expansion of goods transportation through Afghanistan is not desirable until the end of the war.

A possibility that could be carried out is a connection with Iran, and that country is currently investigating a joint project with Pakistan to construct a new route from Kerman to Zahidan (550 km), which are currently not linked by rail. For this reason, strengthening of the Quetta - Zahidan track within Pakistan would be highly advantageous, and such a project is outlined in Pakistan Railways' 8th Five Year Plan. However, it should be handled carefully for the following reasons:

a. Taking into consideration the progress of construction of new lines by Iran (Bafu ⊦ Bandar Abbas and Kerman ⊦ Zahidan), it is unclear whether the project should be started early. Especially given the circulation of freight after the completion of the Bafu ⊦ Bandar Abbas route, whether a large-scale investment is needed is unclear.

b. Given such a large volume of freight that a large-scale upgradation is necessary, it is unclear whether the current transport capabilities of the steeply hilled Sibi ⊦ Quetta area will be able to handle it.

Consequently, at present, we will deal with the problem by revamping and strengthening the maintenance of the existing facilities. While doing so, there should be some problems which need settling.

6.5.3 Urban Rail Transport

Currently, the bulk of short-distance passengers rely entirely on road transport. The same is also true with intra-city transport. In 1965, a loop line was constructed in Karachi to provide a means of transport within the city. However, with only one or two trains a day, it completely failed to fulfill its intended function. Further, as the line does not meet the World Bank's recommended city plan for Karachi, it has completely lost the value of its existence. However, considering environmental and energy issues, to rely on automobiles as the only form of urban transport is extremely difficult, as was demonstrated by a number of cities. Consequently, it is essential that Pakistan's two large cities of Karachi and Lahore be joined by rail transport in the future.

a. Karachi

Efficient use of the current loop line and planning of required new lines are called for. However, sufficient analysis is needed of many of the studies done so far to arrive at the optimal plan. At the same time, there should be investigation of the methods of separating the lines' operation entirely from Pakistan Railways and unifying it with city development.

b. Lahore

Railways have been constructed only in the east of the city. However, few people live in the vicinity of the stations, so rather than using the existing railways, a means of rail transport needs to be set up which uses the paving of the main roads which go through the city.