2-4 Port Plan

2-4-1 Result of Demand Forecast

The cargo demand forecast for 1982/83, 1987/88 and 1999/00 has been based on cargo demand data of the last 10 years correlated with the GDP.

Dry Cargo and Liquid Cargo as well as Imports and Exports are indicated in this forecast.

The major commodities of Dry Cargo shall be Wheat, Sugar, Cement, Fertilizers, Iron & Steel, Coal, Iron Ore, Phosphate Rock/Sulphur, Rice, Cotton and Other Dry Cargo.

The major commodities of Liquid Cargo shall be Crude Oil & Petroleum, Edible Oil & Tallow, Petroleum Products and Molasses.

The total cargo volume's rate of increase has been indicated with a base value of 100 for 1980/81, 111 for 1982/83, 165 for 1987/88 and 299 for 1999/00 as shown in Table 2-4-1 Demand Forecast of Seaborne Trade.

The ratio of imported cargo volume to total cargo volume is at present quite large, but it is expected to decrease gradually.

The percent of imports out of the total cargo volume is expected to amount to 76% in 1980/81, 77% in 1982/83, 70% in 1987/88 and 65% in 1999/00 as shown in Table 2-4-2 Demand Forecast for Imports/Exports Cargo.

The ratio of Liquid Cargo to Dry Cargo is expected to amount to 100% in 1980/81, 103% in 1982/83, 87% in 1987/88 and 114% in 1999/00.

The container cargo forecast method employed in this study is almost the same as the one currently used in accordance with the Japanese Standard Method.

Basic commodities in the container cargo forecast are Cotton, Rice, Sugar, Iron & Steel and Other Dry Cargo.

Wheat, Fertilizer, Phosphate Rock/Sulphur and Cement are excluded from the container cargo forecast because these cargoes are carried by bulk carriers as bulk cargo, a less expensive transport method than by general cargo vessels.

Container cargo volumes are forecasted at 0.613 million tonnes in 1982/83, 1.720 million tonnes in 1987/88 and 6.196 million tonnes in 1999/00 as shown in Table 2-4-3 Container Cargo Forecast.

Table 2-4-1 Demand Forecast of Seaborne Trade

IMPORT/EXPORT TOTAL

Unit 1,000 Ton

Commodity	Year			
	1980/81	1982/83	1987/88	1999/00
Dry Cargo	7,476	8,152	13,176	20,894
Wheat	308	347	527	643
Sugar	74	63	94	266
Cement	444	142	1,467	2,208
Fertilizers	1,315	1,228	1,193	2,341
Iron & Steel	442	536	630	1,735
Coal	161	504	1,360	1,360
Iron Ore	244	754	2,030	2,030
Phosphate Rock/Sulpher	191	299	278	779
Rice	1,257	1,259	1,593	2,998
Cotton	315	185	334	492
Other Dry Cargo	2,725	2,835	3,670	6,042
Liquid Cargo	7,465	8,420	11,449	23,795
Crude Oil & Petroleum	5,598	6,264	8,533	18,146
Edible Oil & Tallow	608	632	685	636
Petroleum Products	994	1,222	1,825	4,436
Molasses	265	302	406	577
Grand Total	14,941	16,572	24,625	44,689
Rate of Increase	100	111	165	299

Source: JICA Study Team

Table 2-4-2 Demand Forecast for Imports/Exports Cargo

(000TON)

Commodity	1980/81	1982/83	1987/88	1999/00
Imports	11,323	12,773	17,227	29,168
Dry Cargo	5,117	5,877	8,009	10,386
Wheat	308	347	527	0
Sugar	74	63	0	0
Cement	444	142	0	0
Fertilizers	1,294	1,228	1,193	2,059
Iron & Steel	442	536	0	0
Coal	161	504	1,360	1,360
Iron Ore	244	754	2,030	2,030
Phosphate Rock/Sulpher	191	299	278	779
Other Dry Cargo	1,959	2,004	2,621	4,158
Liquid Cargo	6,206	6,896	9,218	18,782
Crude Oil & Petroleum	5,598	6,264	8,533	18,146
Edible Oil & Tallow	608	632	685	636
Export	3,618	3,799	7,398	15,521
Dry Cargo	2,359	2,275	5,167	10,508
Wheat	0	0	0	643
Rice	1,257	1,259	1,593	2,998
Cotton	315	185	334	492
Sugar	0	0	94	266
Cement	0	0	1,467	2,208
Fertilizers	21	0	0	282
Iron & Steel	0	0	630	1,735
Other Dry Cargo	766	831	1,049	1,884
Liquid Cargo	1,259	1,524	2,231	5,013
Petroleum Products	994	1,222	1,825	4,436
Molasses	265	302	406	577
Imports/Total (%)	76	77	70	65

Source: JICA Study Team

Table 2-4-3 Container Cargo Forecast

('000 M/T)

No.	Export	82/83	87/88	99/00	Import	82/83	87/88	99/00	Export/Import	82/83	87/88	99/00
1	Total	3,799	7,398	15,521	Total	12,773	17,227	29,168	Total	16,572	24,625	44,689
2	Total Liquid Cargo	1,524	2,231	5,013	Total Liquid Cargo	6,896	9,218	18,782	Total Liquid Cargo	8,420	11,449	23,795
21	Petroleum	1,222	1,825	4,436	Crude Oil/Petroleum Products	6,264	8,533	18,146				
22	Molasses	302	406	577	Edible Oil/Tallow	632	685	636				
3	Total Dry Cargo	2,275	5,167	10,508	Total Dry Cargo	5,877	8,009	10,386	Total Dry Cargo	8,152	13,176	20,894
31	Cement	-	1,467	2,208	Cement	142	-	-				
32	Cotton	185	334	492	Coal	504	1,360	1,360				
33	Rice	1,259	1,593	2,998	Iron Ore	754	2,030	2,030				
34	Wheat	-	-	643	Fertilizers	1,228	1,193	2,059				
35	Fertilizer	0	-	282	Phosphate Rock	299	278	779				
36	Sugar	-	94	266	Sugar	63	-	-				
37	Iron & Steel	-	630	1,735	Wheat	347	527	-				
38	Other Dry Cargoes	831	1,049	1,884	Iron & Steel	536	-	-				
39					Other Dry Cargoes	2,004	2,621	4,158				
4	Total Containerizable Cargo (32,33,36,37,38)	2,275	3,700	7,375	Total Containerizable Cargo (36,38,39)	2,603	2,621	4,158	Total Containerizable Cargo	4,878	6,321	11,533
	Containerized Routes				Containerized Routes				Containerized Routes			
41	Share, %	69.7	69.7	69.7	Share, %	64.3	64.3	64.3	Share, %	66.8	67.8	67.8
42	Quantity (4x41)	1,586	2,579	5,140	Quantity (4x41)	1,674	1,685	2,674	Quantity (4x41)	3,260	4,264	7,814
	Other Routes											
43	Share, %	30.3	30.3	30.3	Share, %	35.7	35.7	35.7	Share, %	33.2	32.5	32.2
44	Quantity (4x43)	689	1,121	2,235	Quantity (4x43)	929	936	1,484	Quantity (4x43)	1,618	2,057	3,719
5	Total Containerized Cargo (52+54)	304	923	3,759	Total Containerized Cargo (52+54)	309	797	2,437	Total Containerized Cargo	613	1,720	6,196
	Containerized Routes				Containerized Routes				Containerized Routes			
51	% of Containerization	17.0	33.6	60.6	% of Containerization	15.7	44.5	69.9	Share, % (52/42)	16.3	37.9	63.8
52	Quantity (42x51)	270	867	3,115	Quantity (42x51)	263	750	1,869	Quantity	533	1,617	4,984
	Other Routes				Other Routes				Other Routes			
53	% of Containerization	5.0	5.0	28.8	% of Containerization	5.0	5.0	38.3	Share, % (54/44)	5.0	5.0	32.6
54	Quantity (44x53)	34	56	644	Quantity (44x53)	46	47	568	Quantity	80	10.3	1,212

Source: JICA Study Team

2-4-2 Facility and Capacity

Large scale port facilities in Pakistan exist only at the ports of Karachi and Qasim.

In 1980/81 at Karachi Port these facilities consisted of 24 berths (total length 4,365 m) and 4 oil berths, while at Qasim port there was one Iron Ore & Coal berth and one Multipurpose Berth as shown in Table 2-4-4 Berth Facility.

The procedure for calculating the cargo handling capacity is as follows;

(1) Calculation of total berth length at Karachi and Qasim Ports;

(2) Case-1 and Case-2 estimations of yearly cargo handling capacity in tonnes per berth - meters (t/m.y) based on past figures.
Case-1 assumes 16 hours of port operation per day and Case-2 assumes 12 hours of port operation per day.

(3) Estimated port capacity for Case-1 is 1,000 t/m.y for General Cargo and 2,000 t/m.y for Dry Bulk.
Estimated port capacity for Case-2 is 750 t/m.y for General Cargo and 1,500 t/m.y for Dry Bulk.
The capacity of a Lighter Wharf would be 50% less than that of General Cargo Wharf.

(4) Next the necessary berth length for Dry Bulk is calculated using the above estimated capacity, and then this length is subtracted from the total berth length.

(5) The above remainder is then multiplied by the figure for General Cargo capacity.
Finally, dividing the above product into the figure for total General Cargo volume, divided the projected berth occupancy rates are obtained.

Capacities for the Oil berth and Iron Ore & Coal berth are based primarily on their respective design capacities.

Calculating from the 1980/81, total cargo handling volume of 14,941 thousand tonnes, Case-1 General Cargo at Karachi Port is 150% of berth capacity, and Case-2 is 270% of berth capacity as shown in Table 2-4-5 and 2-4-6.

Both cases exceed appropriate berth capacity limit 100%, thus revealing the high degree of congestion in Karachi port.

The Karachi Port facilities in 1982/83 will expand to 4 berths with a total length of 674 m (Juna Bunder Wharf), and the Qasim Port facilities will expand to 3 berths with a total length of 600 m (Multipurpose Wharf) after partial completion of the on-going project.

Total cargo handling volume is forecasted at 16,572 thousand tonnes thus General Cargo port capacity at Karachi Port will be 109% in Case-1 and 168% in Case-2 .

Though the above percentage is still over 100%, port congestion will be lessened as compared to 1980/81.

Three berths, having a total length of 600 m (multipurpose wharves) will be added by 1987/88 at Qasim Port, even without new port investment.

On the other hand, at Karachi Port, forecasted total cargo handling volume is 18,435 thousand tonnes and port capacity for Liquid Bulk will be 135%.

Port capacity for General Cargo at Karachi Port will be 128% in Case-1 and 225% in Case-2 , even assuming full operation of Qasim Port.

It should therefore be clear that new port expansion projects are required.

Forecasted total cargo handling volume for the year 1999/00 is 44,689 thousand tonnes.

If there is no new port investment after year 1987/88 then the port capacity for Liquid Bulk and General Cargo will be 183% and 162% respectively, figures indicating heavy port congestion.

To relieve this congestion, construction of an additional 4 berth, (1,200 m) is required for a Full Container Terminal at Karachi Port and Buoy Berth for Crude Oil at Qasim Port. (See Table 2-4-5, 2-4-6 Port Capacity)

2-4-3 Basic Outline for Masterplan

The basic outline for the Port Masterplan in Pakistan shall be based upon the following items:

(1) Selection of required projects based on the demand forecast.

(2) Emphasis on efficient use of existing port facilities.

(3) Selection of projects necessary for regional development.

The basic plan has been drawn up viewing Qasim and Karachi, the two representative ports of Pakistan, as one national port, introducing the concept of "functional divisions" so as to make full and efficient use of the facilities of both ports.

At Karachi Port, which will mainly handle General Cargo, top priority has been given to construction of a new Full Container Terminal in view of the rapid increase in container transits predicted by the demand forecast.

At Qasim Port which will handle mostly Bulk Cargo, top priority has been given to completion of on-going projects and construction of a new Fertilizer and Wheat Terminal, while major dredging projects for deepening and widening of the existing channel will not take place until the year 2000 because of the construction of Buoy Berth, except for maintenance dredging.

Construction of a Mini-Port at Gwadar in Baluchistan is being considered in order to promote regional development by utilizing the rich fishing resources in that area.

In addition, immediate upgrading and expansion of the Marine Academy at Karachi is being considered in order to meet the needs of Pakistani expanding merchant fleet as well as to facilitate smooth operation of the Full Container and Bulk Terminal.

2-4-4 Masterplan

In the year 2000, gateways for Pakistani sea transportation will be the improved and expanded Ports of Karachi and Qasim.

Total cargo handling volume in the year 2000 will be approximately 45 million tons, three times the present volume. With newly improved facilities and operations, both ports have sufficient capacity to meet future port demands.

The Port of Karachi has a long history and its facilities for general cargo handling of liner ships are highly developed.

On the other hand, Qasim Port's history is relatively brief, though it has experienced steady development through its import of raw materials for Pakistan Steel.

With this background, it is important to decide how to allocate functions between these two ports.

The area of influence for both ports is basically the same and the actual distance between both ports is quite close (42 km). It would be possible for both ports to be responsible for similar functions, but it would also be possible to divide functions between both ports.

From the viewpoint of both of these ports' administrations, the most natural type of port development would be a general and overall expansion of existing facilities and functions. The unintended outcome of such development would be that both ports would have near indentical functions, being in constant competition with each other.

Of course, from the viewpoint of the national economy, it is obvious that such a double investment is redundant, and such competition is wasteful. It would be better, in regards to port development, to adopt the idea of "divide functions". In this light, each port should ideally have distinct and supplementary functions, so as to make available to port users the finest possible services.

According to the policy proposed by the Planning Commission, Karachi Port will handle mainly general cargo, while Qasim Port will handle mostly bulk cargo. Based on the historical circumstances behind the current port facilities (including transportation to the hinterland) and distribution function as well as the existing degree of urban development near the ports, the Planning Commission's policy shall be continuously supported.

(1) Karachi Port

Prior to the year 2000, the following projects are considered necessary for port development.

1) Full Container Terminal

According to the demand forecast, 6.2 million tonnes of container cargo will be handled in the year 2000.

6 berths, each 300 m long and -12 m deep, will be constructed on the west side of West Wharf.

Estimated total cost is 3,314 million Rs. Two of the berths shall be constructed by the year 1988 as the urgent project.

Operation of the new container berth will be the responsibility of KPT and containers for long haul upcountry destinations will be transported to the Inland Dry Port in Lahore by Pakistan Railways.

2) New Oil Berth

After dismantling of the existing oil berths Nos. 2 and 3, a new oil berth will be constructed at the same location.

After completion of this new oil berth, Karachi Port will be able to handle up to 10 million tonnes of liquid cargo per year.

The berth will be opened for general use in the year 1985. It's cost is estimated at 120 million Rs.

3) Equipment

Several container spreader type heavy fork lifts having a maximum capacity of 35 tonnes, are required in order to facilitate prompt handling of containers until the container terminal project is completed in 1988. Severe regulations will be made for the prevention of pollution of the sea by oil.

The purchase of an Oil Skimmer Ship will be necessary by 1988 in order to clean up the leakage of oil and bilge from berthing ships.

4) Marine Academy

To assure smooth operation of the container terminal, personnel training will be an important factor in the near future.

The Marine Academy at Mauripur, Karachi City serves as a training facility for nautical and engineer department. However, the academy lacks sufficient staff and equipment to adequately fulfill its role, therefore urgent improvement is required.

The estimated cost through the year 2000 is 240 million Rs.

(2) Qasim Port

Prior to the year 2000, the following projects are considered necessary for port development.

1) Bulk Cargo Terminal

According to the demand forecast, 3.8 million tonnes of bulk cargo will be handled in the year 2000.

An independent Fertilizer Terminal will be constructed in the port and multi-purpose berth No. 7 will be converted to Wheat Terminal.

The capacity of Fertilizer Terminal is estimated to handle total 3,120 thousand tonnes of bulk cargoes, that is composed of 2,341 thousand tonnes of fertilizer and 779 thousand tonnes of Phosphate Rock/Sulphur.

They will be equipped with unloaders, storage facilities and a bagging plant at an estimated cost of 746 million Rs.

2) Oil Berth and Buoy Berth

According to the demand forecast, 14 million tonnes of liquid cargo will be handled in the year 2000 and 1.5 million tonnes in the year 1988.

To help meet this demand, one oil berth having a capacity of 3 million tonnes per year, will be constructed by 1988 and the estimated cost is 158 million Rs.

To handle the large volume of liquid cargo expected by the year 2000, a buoy berth outside the approach channel is being considered.

It is assumed that an oil refinery might be constructed near the port and the refined products might be transported to the upcountry (Multan) near the consuming place by pipeline.

3) Equipment

One Trailing Hopper Suction Dredger and related equipments will be required for self-maintenance channel dredging.

(3) Other Ports

As a center for regional development in Baluchistan, a fishing port with a small general cargo berth will be constructed at Gwadar by the year 1988.

This project consists of a 500 m revetment, 980 m groin, 330 m fishing berth, 70 m general cargo berth, 321,000 m^3 of dredging, etc.

The estimated project cost is 326 million Rs.

Table 2-4-4 Berth Facility

Port	Name of Berth	1980/81			1982/83			1987/88			1999/00		
		No.of Berth	Total(L) m	Depth m	No.of Berth	Total(L) m	Depth m	No.of Berth	Total(L) m	Depth m	No.of Berth	Total(L) m	Depth m
KPT	East Wharf	17	2,604	-10.2	17	2,604	-10.2	17	2,604	-10.2	17	2,604	-10.2
	West Wharf	7	1,254	-11.4	7	1,254	-11.4	7	1,254	-11.4	7	1,254	-11.4
	Juna Bunder Wharf	-	-	-	4	674	-9.0	4	674	-9.0	4	674	-9.0
	Full Container Terminal	-	-	-	-	-	-	2	600	-12.0	6	1,800	-12.0
	Lighter Wharf	-	507	-7.2	-	507	-7.2	-	507	-7.2	-	507	-7.2
	Oil Berth	4	854	-13.5	4	854	-13.5	2	540	-13.5	2	540	-13.5
	New Oil Berth	-	-	-	-	-	-	1	240	-13.5	1	240	-13.5
	Small Boat Harbour	-	1,194	-3.6	-	1,194	-3.6	-	1,194	-3.6	-	1,194	-3.6
PQA	Iron Ore & Coal Berth	1	279	-12.8	1	279	-12.8	1	270	-12.8	1	279	-12.8
	Marginal Wharf	1	200	-11.0	4	800	-11.0	6	1,200	-11.0	6	1,200	-11.0
	Fertilizer Terminal	-	-	-	-	-	-	1	280	-12.0	1	280	-12.0
	Wheat Terminal	-	-	-	-	-	-	1	200	-12.0	1	200	-12.0
	Oil Berth	-	-	-	-	-	-	1	240	-11.3	1	240	-11.3
	Buoy Berth	-	-	-	-	-	-	-	-	-	1	One Buoy	-15.0

Source: JICA Study Team

Table 2-4-5 Port Capacity (Case -1)

Before Commencement of New Project:

(Unit: 1,000t)

Port	Type of Cargo	1980/81		1982/83		1987/88		1999/00	
		Quantity	Occupancy %	Quantity	Occupancy %	Quantity	Occupancy %	Quantity	Occupancy %
KPT	General Cargo	3,482	150	3,556	109	4,634	128	8,269	527
	Dry Bulk	3,589	100	3,038	100	2,352	100	6,435	100
	Liquid Bulk	7,465	88	8,420	99	11,449	135	23,795	280
PQA	Dry Bulk	-	-	500	31	2,800	100	2,800	100
	IOC Berth	405	12	1,258	38	3,390	103	3,390	103
	Liquid Bulk	-	-	-	-	-	-	-	-

After Completion of New Project:

(Unit: 1,000t)

Port	Type of Cargo	1980/81		1982/83		1987/88		1999/00	
		Quantity	Occupancy %	Quantity	Occupancy %	Quantity	Occupancy %	Quantity	Occupancy %
KPT	General Cargo	3,482	150	3,556	109	4,634	72	8,269	91
	Dry Bulk	3,589	100	3,038	100	763	100	3,354	100
	Liquid Bulk	7,465	88	8,420	99	10,000	100	10,000	100
PQA	Dry Bulk	-	-	500	31	4,398	75	5,881	100
	IOC Berth	405	12	1,258	38	3,390	103	3,390	103
	Liquid Bulk	-	-	-	-	1,449	48	13,795	100

Notes: (1) Basic Conditions for Calculation .... Operation Hour of Port, 16 hours/day
Cargo Handling Capacity, General Cargo 1,000 t/m.year
" " , Dry Bulk 2,000 "

(2) Dry Bulk include Wheat, Sugar, Cement, Fertilizer, Phosphate Rock/Sulpher and Rice.

(3) Liquid Bulk include Crude Oil, Edible Oil & Tallow, Petroleum Products and Molasses.

(4) General Cargo include Iron & Steel, Cotton and Other Dry Cargo.

Source: JICA Study Team

Table 2-4-6 Port Capacity (Case -2)

Before Commencement of New Project:

(Unit: 1,000t)

Port	Type of Cargo	1980/81		1982/83		1987/88		1999/00	
		Quantity	Occupancy	Quantity	Occupancy	Quantity	Occupancy	Quantity	Occupancy
KPT	General Cargo	3,482	270 %	3,556	168 %	4,634	225 %	8,269	Over 1,000%
	Dry Bulk	3,589	100	2,938	100	3,052	100	7,135	100
	Liquid Bulk	7,465	88	8,420	99	11,449	135	23,795	280
PQA	Dry Bulk	-	-	400	33	2,100	100	2,100	100
	IOC Berth	405	12	1,258	38	3,390	103	3,390	103
	Liquid Bulk	-	-	-	-	-	-	-	-

After Completion of New Project:

(Unit: 1,000t)

Port	Type of Cargo	1980/81		1982/83		1987/88		1999/00	
		Quantity	Occupancy	Quantity	Occupancy	Quantity	Occupancy	Quantity	Occupancy
KPT	General Cargo	3,482	270 %	3,556	168 %	4,634	94 %	8,269	109 %
	Dry Bulk	3,589	100	2,938	100	1,363	100	3,954	100
	Liquid Bulk	7,465	88	8,420	99	10,000	100	10,000	100
PQA	Dry Bulk	-	-	400	33	3,798	72	5,281	100
	IOC Berth	405	12	1,258	38	3,390	103	3,390	103
	Liquid Bulk	-	-	-	-	1,449	48	13,795	100

Notes: (1) Basic Conditions for Calculation .... Operation Hour of Port, 12 hours/day
Cargo Handling Capacity, General Cargo 750 t/m-year
" " Dry Bulk 1,500 "

(2) Dry Bulk include Wheat, Sugar, Cement, Fertilizer, Phosphate Rock/Sulpher and Rice.

(3) Liquid Bulk include Crude Oil, Edible Oil & Tallow, Petroleum Products and Molasses.

(4) General Cargo include Iron & Steel, Cotton and Other Dry Cargo.

Source: JICA Study Team

Table 2-4-7 List of Port Project (Masterplan)

Name of Project	Location	Project Amount (Million Rs.)		
		L/C	F/C	Total
Full Container Terminal	Karachi Port	1,230	2,090	3,320
New Oil Berth	Karachi Port	40	80	120
Small Boat Harbour	Karachi Port	150	150	300
Onshore Equipment	Karachi Port	41	76	117
Offshore Equipment	Karachi Port	-	500	500
Oil Berth	Qasim Port	63	95	158
Buoy Berth	Qasim Port	390	910	1,300
Fertilizer Terminal	Qasim Port	289	201	490
Wheat Terminal Equipments & Storage	Qasim Port	140	116	256
Dredger & Equipment	Qasim Port	-	445	445
Mini - Port	Gwadar	56	270	326
Marine Academy	Mauripur	-	240	240
Jinnah Bridge Phase II	Karachi Port	150	50	200
Total		2,549	5,223	7,772

Source: JICA Study Team

2-5 Shipping Plan

2-5-1 Liner Trade

It is considered that containerization in liner trade is an irreversible trend in world shipping.

Containerization in Shipping and an innovation in transportation system require intensive capital investment in various facillities including container ship, containers, container terminal and inland transport. An establishment of container services is to be coordinated with national and international cooperation among governments, port authorities, ship operators, railways, road hauliers, forwarders and shippers.

Therefore, it is strongly recommended that introduction of containerization in Pakistan should be promoted as a comprehensive national project in view of its huge impacts on all other modes of transport.

Feasibility Study Report on the Introduction of Containerization in Pakistan conducted by JICA (Japan International Cooperation Agency) by the request of Pakistan Government has concluded recommendation for the construction of full container terminal at Karachi with two berths untill 1988 as urgent plan and six berths in total until 2000 as Master-Plan. Acquisition of full container ships should be introduced at the time of completion of full container terminal taking into consideration of the coordinated planning with the Masterplan of port projection. In case of delay on the terminal construction program up to 1988, acquisition of self-sustained container ship is to be identified as the alternative case, instead of immediate acquisition of full container ships.

Although carrying capacity in liner trade increases tremendously by the introduction of container ships as its quicker turnround, there exists the necessity to strengthen tonnage of multi-purpose ships in order to maintain 40% loading share of general cargo in main liner trade.

So-called 40:40:20 principle set forth in the Code of Conduct for Liner Conference by UNCTAD is a guideline to be observed in determining shares in pooling arrangements or the like among the member-lines of liner conferences (equal shares for the shipping lines of mutually trading countries and an approximately 20 percent share for others).

The Code cannot solve the problems of the activities of non-conference ships which carry big share of liner cargo in world shipping. Hastened expansion of national fleets to meet the target share is not necessarily be the right answer. The fleets composition at each stage should be studied carefully by taking into consideration all other aspects such as financial impact, managerial view points, and flexibility for technical innovation.

2-5-2 Bulk Trade

Tramp shipping is operated essentially, based on the competitive. freemarket system.

The market of freight rate in bulk shipping fluctuates according to the imbalance of supply and demand in ships tonnage and seaborne cargo movements. As for bulk carriers, fleet arrangement should be decided by user of the service seeking most competitive freight rate. The introduction of a governmentally imposed formula into the sharing of bulk trade brings rather disadvantage for both user of the service and ship operator because of its operational inflexibility. Therefore, acquisition of bulk carriers for Steel Mill and bulk oil tanker are to e identified, based on a capacity analysis of total required tonnage, not on any pre-fixed loading share.

The concept of share that a fixed proportion of any nation's cargo should be carried by her own national fleet is now under debate in UNCTAD. The Policy for acquisition of specialized ships and trampers in bulk trade should be guided by the economic criteria, instead of number of vessels calculated based on a governmentally imposed loading share.

2-6 Airport and Aviation Plan

2-6-1. Air Traffic Volume

The target annual air traffic demands by route for key years were established as indicated in IV-2, for the planning basis of this Study. They are summarized in Table 2-6-1 to 3.

Table 2-6-1 Annual Air Traffic Volumes Projected (Domestic)

Item / Airport	Standard				Maximum	
	1987 / 1988		1999 / 2000		1987 / 1988	1999 / 2000
	Pax	Cargo	Pax	Cargo	Pax	Pax
PESHAWAR	349,460	1,152	575,741	1,896	440,755	750,176
D. I. KHAN	45,150	41	81,088	73	-	-
SAIDU SHARIF	28,950	17	48,701	29	-	-
CHITRAL	35,757	112	57,386	180	-	-
ISLAMABAD	1,209,913	12,237	1,960,096	19,811	1,463,552	2,474,451
LAHORE	1,478,807	18,538	2,410,550	30,197	1,656,866	2,799,568
FAISALABAD	106,273	363	176,589	602	-	-
MULTAN	241,885	875	407,396	1,473	-	-
KARACHI	2,373,097	34,034	4,020,397	57,619	2,528,303	4,300,720
HYDERABAD	1,850	9	1,872	9	-	-
NAWABSHAH	4,018	8	6,680	13	-	-
MOENJODARO	30,632	106	51,232	177	-	-
SUKKUR	29,799	40	51,347	69	-	-
QUETTA	230,540	989	398,319	1,708	279,906	492,287
PANJGUR	21,226	10	36,568	18	-	-
TURBAT	55,963	116	100,578	207	-	-
PASNI	28,666	118	44,548	183	-	-
GWADAR	48,242	196	79,600	324	72,687	126,220
JIWANI	7,699	14	12,337	23	-	-
SUI	10,390	33	16,263	52	-	-

Source: JICA Team estimation

Table 2-6-2 Annual Air Traffic Volumes Projected (Int'l)

Item / Airport	1987/1988		1999/2000	
	Pax	Cargo	Pax	Cargo
PESHAWAR	15,317	1,053	29,791	2,569
ISLAMABAD	371,802	19,730	627,768	44,472
LAHORE	99,591	6,605	185,765	17,874
KARACHI	3,425,515 *	103,457	5,913,529 *	247,800
GWADAR	4,292		6,905	

Source: JICA Team estimation *: Not included transit passenger

Table 2-6-3 Annual Air Traffic Volumes Projected (New Local Airport)

Year / Airport	1987 / 1988	1999 / 2000
BANNU	10,232	15,174
SARGODHA	66,612	132,156
D. G. KHAN	11,444	17,688
BAHAWALPUR	20,358	31,724
RAHIMYAR KHAN	20,402	34,804
ZHOB	4,570	6,938
SIBI	1,540	2,604
KHUZDAR	27,960	50,276
ORMARA	15,478	24,520

Source: JICA Team estimation

2-6-2 Breakdown of Air Traffic Volume

As the basis for the airport facility planning, the traffic demands expected for a peak hour of an average day of the peak month for the years 1988 and 2000 were used as recommended by ICAO (International Civil Aviation Organization), JCAB (Civil Aviation Bureau of Japan) and FAA (Federal Aviation Administration).

In this section, the above annual air traffic demands for 1988 and 2000 were broken down for various planning values for daily and hourly bases as formulated in Fig. 2-6-1.

All the coefficients and ratios are assumed as items (1) through (7).

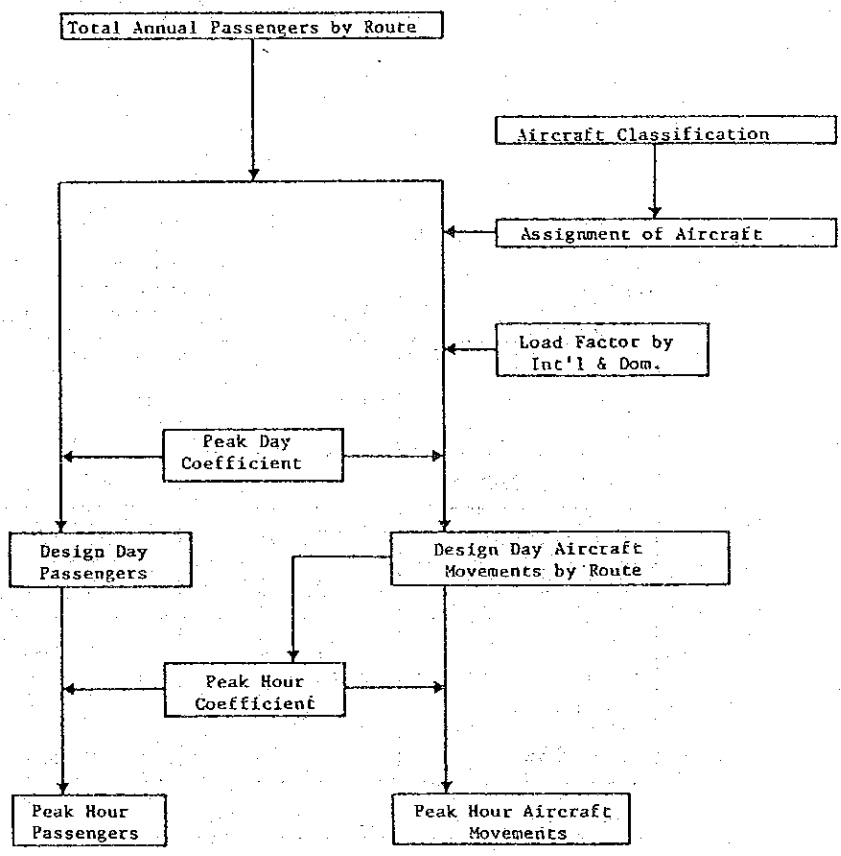


Fig. 2-6-1 Flow Chart for Breaking Down of Air Traffic Volume

(1) Aircraft Classification

For planning of airports, the aircraft expected to be operated in Pakistan are classified by type and size as follows.

Table 2-6-4 Aircraft Classification (Dom.)

Aircraft	No. of Seats	Remarks
B-747 class	500	The average No. of seats of B-747 SR (all economy)
Airbus class	320	The No. of seats of A-300 - B4 (all economy)
Twin jet class	150	The No. of seats of DC-9-80 as model aircraft of Twin jet
F27 class	50	The assumed No. of seats of this class in the future

Table 2-6-5 Aircraft Classification (Int'l)

Aircraft	No. of Seats	Remarks
B-747 class	400	The average No. of seats of PIA's (380 seats) and other airline's B-747
Wide I	270	The average No. of seats of PIA's DC-10 (280 seats) and A300 (250 seats)
Wide II	200	The general planning value
Twin jet class	150	same as domestic
F27 class	50	same as domestic

(2) Assignment of Operating Aircraft

1) Standard on Assignment of Operating Aircrafts for Domestic Flight Operation

The selection of aircraft type to be operated by route have been established based on mainly the above aircraft classification and the economical considerations.

Therefore, the standard on assignment of aircrafts for domestic flight operation is assumed as below according to annual passenger volume by route.

Table 2-6-6 Assignment of Operating Aircraft for Domestic Flight Operation

Aircraft	No. of Seats	Annual PAX in one way
F27 class	50	UP TO 80,000
Twin jet class	150	80,000 - 200,000
Airbus class	320	200,000 - 600,000
B-747 class	500	600,000 -

Note: It is assumed that
- any route has more than one aircraft movement per one way, in one week
- jet routes have more than two aircraft movements per one way, in one day.

2) Standard on Aircraft Mix for International Flight Operation

The assumption of aircraft mix for international flight in the future, were made as Table 2-6-7 based on the present pattern at Karachi Airport and the forecast of aircraft appear in market in the world.

Table 2-6-7 Aircraft Mix for International Flight in Each Stage

1987/1988 (Percentage)

aircraft / route	B-747 class	Wide I	Wide II	TOTAL
MIDDLE EAST & AFRICA	25	45	30	100
EUROPE	65	30	5	100
FAR EAST	70	20	10	100
INDIA	35	50	15	100

1999/2000

aircraft / route	B-747 class	Wide I	Wide II	TOTAL
MIDDLE EAST & AFRICA	30	45	25	100
EUROPE	75	25	-	100
FAR EAST	80	15	5	100
INDIA	45	45	10	100

(3) Design Day Coefficient

Design day coefficient is presumed based on Japanese standard as follows.

Table 2-6-8 Design Day Coefficient

Route	Domestic	International
Design day Coefficient	1 / 330	1/300

(4) Peak Hour Coefficient

Peak hour coefficient is calculated according to the following by Japanese standard as follows.

Domestic ..... $\alpha = 1.51 / A + 0.1151$ $(A \leq 100)$

$\alpha = 6.61 / A + 0.0641$ $(A \geq 100)$

International ..... $\alpha = 1.05 / A + 0.114$

Where, α : Peak hour coefficient

A : Peak day aircraft movements by airport

(5) Load Factor on Design Day

Load factor on design day is assumed 80% for domestic routes, and 70% for international routes, considering PIA'S1981 experience on domestic routes and general planning value used in international airport plan.

(6) Design Day Aircraft Movements by Route

Design day aircraft movements by route

$$= \frac{\text{Annual Passengers by route x Design day coefficient}}{\text{Aircraft seats capacity x Design load factor}}$$

(7) Peak Hour Aircraft Movements and Passengers

Peak hour aircraft movements = Design day aircraft movements x α

Peak hour passengers = Annual passengers x peak day coefficient x α

2-6-3 Summary of Air Traffic Planning Volume

As the results of the calculations according to the procedure indicated in Fig. 2-6-1, the planning volume are summarized.

Table 2-6-9 to 12 indicate the annual passengers volume, design day movements and operating aircraft by OD (Origin and Destination.) Table 2-6-13 to 16 indicate the planning numbers broken down.

Table 2-6-9 Annual Pax and Aircraft Daily Movement by Route (Domestic)

1987/1988

ORIGIN \ DESTINATION		PEW	DSK	SDT	CJL	RWP	LHE	LYP	MUX	KHI	HDD	WNS	MJD	SKZ	UET	PJG	TUK	PSI	GWD	JIW	SUL	PDM (Dep.)	B	A	T	F
NWFP	PESHAWAR		9,737 F 5W	4,217 F 2W	17,942 F 1	41,770 F 3	22,357 F 2		3,229 F 2W	84,921 T 2			515									8 9W			2	6 9W
	D. I. KHAN	6,785 F 4W				5,265 F 3W	2		10,365 F 6W	601												13W				13W
	SAIDU SHARIF	7,058 F 4W				9,529 F 5W																9W				9W
	CHITRAL	17,815 F 1																				1				1
PUNJAB	ISLAMABAD	29,751 F 2	4,120 F 2W	8,146 F 4W			142,652 F 4		4,031 F 2W	350,529 A 4					17,603 F 1							11 8W		4	4	3 8W
	LAHORE	21,868 F 2				146,445 T 4		1,331 F 1W	50,363 F 4	506,166 A 6					24,918 F 2							18 1W		6	4	8 1W
	FAISALABAD					1,155 F 1W	1,799 F 1W		2,479 F 1W	48,105 F 4												4 3W				4 3W
	MULTAN	3,904 F 2W	8,275 F 4W			4,630 F 2W	49,614 F 4	3,663 F 2W		47,398 F 4			602	1,229 F 1W								8 11W				8 11W
SIND	KARACHI	77,591 F 6				341,889 A 4	485,150 A 6	47,741 F 4	49,634 F 4		387	1,493 F 1W	12,510 F 1	11,859 F 6W	66,281 F 5	8,728 F 5W	22,354 F 2	10,398 F 6W	19,768 F 1	3,014 F 2W	3,475 F 2W	33 22W		10		23 22W
	HYDERABAD									413			262	156												
	NAWABSHAH									1,460 F 1W			361	49								1W				1W
	MOENJODARO								757	14,662 F 1	391	571										1				1
	SUKKUR								1,712 F 1W	11,480 F 6W	241	63									1,579 F 1W	8W				8W
BALUCHISTAN	QUETTA					18,793 F 1	26,140 F 2			69,121 F 5							3,287 F 2W					8 2W				8 2W
	PANJGUR									10,114 F 5W								60	1,207 F 1W			6W				6W
	TURBAT									23,098 F 2		21			4,230 F 2W			1,791 F 1W	6	7		2 3W				2 3W
	PASNI									11,741 F 6W					167	391	1,122 F 1W		700	236		7W				7W
	GWADAR									23,351 F 2						697	47	1,911 F 1W		394		2 1W				2 1W
	JIWANI									3,738 F 2W								149	160			2W				2W
	SUI									3,904 F 2W				1,431 F 1W								3W				3W
PEAK DAY MOV. (Arr.)		11 10W	11W	6W	1	12 11W	18 1W	4 3W	8 12W	30 22W		1W	1	8W	8 2W	5W	2 3W	8W	1 1W	2W	3W					
	B-747																									
	Airbus					4	6			10																
	T jet					4	4			2																
	F 27	11 10W	11W	6W	1	4 11W	8 1W	4 3W	8 12W	18 22W		1W	1	8W	8 2W	5W	2 3W	8W	1 1W	2W	3W					

Note: W - Weekly Aircraft Movement

Table 2-6-10 Annual Pax and Aircraft Daily Movement by Route (Domestic)

1999/2000

	ORIGIN \ DESTINATION	PEW	DSK	SDT	CJL	RWP	LHE	LYP	MUX	KHI	HDD	WNS	MJD	SKZ	UET	PJG	TUK	PSI	GWD	JIW	SUL	PDM (Dep.)	B	A	T	F
NWFP	PESHAWAR		17,345 F1	7,205 F 4W	28,791 F 2	64,488 F 5	34,424 F 3		5,253 F 3W	145,994 T 4			804									15 7W			4	11 7W
NWFP	D. I. KHAN	12,037 F 6W				9,153 F 5W	4		18,985 F 1	1,164 F 1W												1 12W				1 12W
NWFP	SAIDU SHARIF	12,011 F 6W				15,894 F 1																1 6W				1 6W
NWFP	CHITRAL	28,595 F 2																				2				2
PUNJAB	ISLAMABAD	45,757 F 3	7,165 F 4W	13,590 F 1			214,428 A 3		6,401 F 3W	88,362 A 7					28,410 F 2							16 7W		10		6 7W
PUNJAB	LAHORE	33,589 F 3				220,412 A 3		1,993 F 1W	79,854 F 6	348,438 J 6					40,160 F 3							21 1W	6	3		12 1W
PUNJAB	FAISALABAD					1,737 F 1W	2,699 F 1w		3,928 F 2W	80,604 T 2												2 4W			2	4W
PUNJAB	MULTAN	6,356 F 3W	15,234 F 1			7,386 F 4W	78,946 F 6	5,811 F 3W		84,211 T 2			972 F 1W	2,060 F 1W								9 12W			2	7 12W
SIND	KARACHI	133,091 T 3				574,781 A 7	813,447 J 6	79,818 F 6	87,906 T 2		411	2,549 F 1W	21,256 F 2	20,933 F 2	119,315 T 3	15,246 F	40,641 F 3	16,469 F 1	32,940 F 2	4,937 F 3W	5,530 F W	38 7W	6	7	8	17 7W
SIND	HYDERABAD									435			251	155												
SIND	NAWABSHAH									2,477 F 1W			557	78								1W				1W
SIND	MOENJODARO								1,218 F 1W	24,920 F 2	377	885										2 1W				2 1W
SIND	SUKKUR								2,875 F 2W	20,376 F 2	243	102									2,382 F 1W	2 3W				2 3W
BALUCHISTAN	QUETTA					30,389 F 2	42,157 F 3			124,464 T 3							5,748 F 3W					8 3W			3	5 3W
BALUCHISTAN	PANJGUR									17,698 F 1								88	1,873 F 1W			1 1W				1 1W
BALUCHISTAN	TURBAT									42,156 F 3		35			7,423 F 4W			2,765 F 1W	10	11		3 5W				3 5W
BALUCHISTAN	PASNI									18,470 F 1					253	573	1,713 F 1W		980 F 1W	325		1 2W				1 2W
BALUCHISTAN	GWADAR									39,114 F 3						1,089 F 1W	76	2,708 F 1W		578		3 2W				3 2W
BALUCHISTAN	JIWANI									6,051 F 3W								204	231			3W				3W
BALUCHISTAN	SUI									6,207 F 3W				2,144 F 1W								4W				4W
PEAK DAY MOV. (Arr.)		11 15W	2 4W	1 4W	2	18 10W	21 1W	6 4W	9 11W	36 8W		1W	2 1W	2 2W	8 4W	1 1W	3 4W	1 2W	2 2W	3W	4W					
	B-747						6			6																
	Airbus					10	3			7																
	T jet	3							2	11					3											
	F 27	8 15W	2 4W	1 4W	2	8 10W	12 1W	6 4W	7 11W	12 8W		1W	2 1W	2 2W	5 4W	1 1W	3 4W	1 2W	2 2W	3W	4W					

Note: W - Weekly Aircraft Movement

Table 2-6-11 Annual Pax and Aircraft Daily Movement by Route (International) 1987/1988

Airport \ Route		MIDDLE EAST & AFRICA	EUROPE	FAR EAST	INDIA	Peak day Mov.	B4	W1	W11	TJ	F27
PIA	PESHAWAR	15,317				4W				4W	
		4W									
	ISLAMABAD	176,707	163,686	11,908		6	2	2		2	
		4W 2 2	2 6W 2W	2W		14W	4W	8W		2W	
	LAHORE	52,663			10,532						
		2W 2W 4W			2W	10W	2W	4W		4W	
	KARACHI	1,337,653	115,953	219,744	301,326	34	8	12		14	
		4 10 12	6W 4W 2W	2 6W 4W	2 2 2	22W	6W	10W		6W	
	GWADAR	4,292				2W					
		2W		-							
FOREIGN CARRIER	ISLAMABAD		19,501			2W	2W				
			2W								
	LAHORE				36,396						
					2W 2W	4W	2W	2W			
	KARACHI	720,578	751,432	460,235	648,390	42	14	18	10		
		2 6 6	6 4 6W	4 2 2	2 6 2	6W			6W		
TOTAL	PESHAWAR	15,317				4W				4W	
	ISLAMABAD	176,707	183,187	11,908		6	2	2		2	
						16W	6W	8W		2W	
	LAHORE	52,663			46,928						
						14W	4W	6W		4W	
	KARACHI	2,058,231	867,385	679,979	949,716	76	22	30	10	14	
						28W	6W	10W	6W	6W	
	GWADAR	4,292				2W					2W

Note: (1) The numbers in column of foreign carrier include the transit Pax.
(2) W indicates the weekly aircraft movement.

Table 2-6-12 Annual Pax and Aircraft Daily Movement by Route (International) 1999/2000

	Airport \ Route	MIDDLE EAST & AFRICA	EUROPE	FAR EAST	INDIA	Peak day Mov.	B4	WI	WII	TJ	F27
PIA	PESHAWAR	29,791 6W				6W				6W	
	ISLAMABAD	302,777 2 2 2	276,255 2 2	21,947 2W		10 2W	4 2W	4		2	
	LAHORE	91,601 2W 6W 6W			21,593 2W	16W	2W	8W		6W	
	KARACHI	2,259,204 8 18 18	182,558 2 6W	398,843 4 2 4W	587,221 4 4 2	62 10W	18	24 6W		20 4W	
	GWADAR	6,905 4W				4W					4W
FOREIGN CARRIER	ISLAMABAD		26,789 2W			2W	2W				
	LAHORE				72,571 2W 4W 2W	8W	2W	4W	2W		
	KARACHI	1,026,334 4 8 6	1,096,211 10 4	719,512 6 2 6W	1,106,130 6 8 2	56 6W	26	22	8 6W		
TOTAL	PESHAWAR	29,791				6W				6W	
	ISLAMABAD	302,777	303,044	21,947		10 4W	4 4W	4		2	
	LAHORE	91,601			94,164	24W	4W	12W	2W	6W	
	KARACHI	3,285,538	1,278,769	1,118,355	1,693,351	118 16W	44	46 6W	8 6W	20 4W	
	GWADAR	6,905				4W					4W

Note: (1) The numbers in column of foreign carrier include the transit Pax.
(2) W indicates the weekly aircraft movement.

Table 2-6-13 Air Traffic Planning Numbers (Domestic) 1987/1988

Item / Airport	Passenger			Cargo	Movement			Aircraft
	Annual	Peak day	Peak hour	Annual	Annual	Peak day	Peak hour	
PESHAWAR	349,460	1,059	193	1,152	8,253	22.6	4	T jet, F27
D. I. KHAN	45, 150	137	77	41	1,248	3.4	2	F27
SAIDU SHARIF	28,950	88	73	17	780	2.1	2	"
CHITRAL	35,757	108	94	112	730	2.0	2	"
ISLAMABAD	1.209,913	3,666	637	12,237	9,383	25.7	4	Airbus T jet, F27
LAHORE	1,478,807	4,481	702	18,538	13,244	36.3	6	Airbus T jet, F27
FAISALABAD	106,273	322	92	363	3,232	8.9	3	F27
MULTAN	241,885	733	142	875	7,036	19.3	4	"
KARACHI	2,373,097	7,191	984	34,034	25,283	69.3	9	Airbus, F27
HYDERABAD	1,850	6		9				
NAWABSHAH	4,018	12		8	104	0.3		F27
MOENJODARO	30,632	93	81	106	730	2.0	2	"
SUKKUR	29,799	90	69	40	832	2.3	2	"
QUETTA	230,540	699	144	989	6,048	16.6	3	"
PANJGUR	21,226	64		10	572	1.6		"
TURBAT	55,963	170	72	116	1,772	4.9	2	"
PASNI	28,666	87	73	118	780	3.3	2	"
GWADAR	48,242	146	84	196	1,199	3.3	2	"
JIWANI	7,699	23		14	208	0.6		"
SUI	10,390	31		33	312	0.9		"

Table 2-6-14 Air Traffic Planning Numbers (Domestic) 1999/2000

Item / Airport	Passenger			Cargo	Movement			Aircraft
	Annual	Peak day	Peak hour	Annual	Annual	Peak day	Peak hour	
PESHAWAR	575,741	1,745	291	1,896	10,634	29.1	5	T jet, F27
D. I. KHAN	81,088	246	98	73	1,927	5.3	2	F27
SAIDU SHARIF	48,701	148	83	29	1,250	3.4	2	"
CHITRAL	57,386	174	86	180	1,460	4.0	2	"
ISLAMABAD	1,960,096	5,940	930	19,811	13,294	36.4	6	Airbus, F27
LAHORE	2,410,550	7,305	1,102	30,197	15,434	42.3	6	B-747 Airbus, F27
FAISALABAD	176,589	535	150	602	3,336	9.1	3	T jet, F27
MULTAN	407,396	1,235	230	1,473	7,766	21.3	4	" "
KARACHI	4,020,397	12,183	1,644	57,619	27,790	76.1	10	B-747, Airbus T jet, F27
HYDERABAD	1,872	6		9				
NAWABSHAH	6,680	20		13	104	0.3		F27
MOENJODARO	51,232	155	72	177	1,564	4.3	2	"
SUKKUR	51,347	156	68	69	1,720	4.7	2	"
QUETTA	398,319	1,207	246	1,708	6,204	17.0	3	T jet, F27
PANJGUR	36,568	111	86	18	834	2.3	2	F27
TURBAT	100,578	305	98	207	2,658	7.3	2	"
PASNI	44,548	135	94	183	938	2.6	2	"
GWADAR	79,600	241	93	324	2,033	5.6	2	"
JIWANI	12,337	37		23	312	0.9		"
SUI	16,263	49		52	416	1.1		"

Table 2-6-15 Air Traffic Planning Numbers (International)

1987/1988

Item / Airport	Passenger			Cargo	Movement			Aircraft
	Annual	Peak day	Peak hour	Annual	Annual	Peak day	Peak hour	
PESHAWAR	15,317	51		1,053	208	0.6		T jet
ISLAMABAD	371,802	1,239	298	19,730	3,022	8.3	2	B-747 WIDE-I, T jet
LAHORE	99,591	332	212	6,605	728	2.0	1	B-747 WIDE-I, T jet
KARACHI	3,425,515*	11,418	1,452	103,457	29,196	80.0	10	B-747, WIDE-I WIDE-II T jet
GWADAR	4,292	14			104	0.3		F27

*: Not include transit passenger

1999/2000

Item / Airport	Passenger			Cargo	Movement			Aircraft
	Annual	Peak day	Peak hour	Annual	Annual	Peak day	Peak hour	
PESHAWAR	29,791	99		2,569	312	0.9		T-jet
ISLAMABAD	627,768	2,093	446	44,472	3,858	10.6	2	B-747 WIDE-I T jet
LAHORE	185,765	619	262	17,874	1,248	3.4	1	B-747 WIDE-I WIDE-II T jet
KARACHI	5,913,529*	19,712	2,419	247,800	43,902	120.3	15	B-747 WIDE-I WIDE-II T jet
GWADAR	6,905	23			208	0.6		F27

*: Not include transit passenger

Table 2-6-16 Air Traffic Planning Numbers (New Local Airport)

1987/1988

Item / Airport	Passenger			Movement			Aircraft
	Annual	Peak day	Peak hour	Annual	Peak day	Peak hour	
BANNU	10,232	31		312	0.9		F-27
SARGODHA	66,612	202	74	2,190	6.0	2	"
D.G. KHAN	11,444	35		312	0.9		"
BAHAWALPUR	20,358	62	54	730	2.0	2	"
RAHIMYAR KHAN	20,402	62	54	730	2.0	2	"
ZHOB	4,570	14		104	0.3		"
SIBI	1,540						"
KHUZDAR	27,960	85	74	730	2.0	2	"
ORMARA	15,478	47	41	730	2.0	2	"

1999/2000

Item / Airport	Passenger			Movement			Aircraft
	Annual	Peak day	Peak hour	Annual	Peak day	Peak hour	
BANNU	15,174	46	40	730	2.0	2	F-27
SARGODHA	132,156	400	106	3,650	10.0	3	"
D.G. KHAN	17,688	54	47	730	2.0	2	"
BAHAWALPUR	31,724	96	84	730	2.0	2	"
RAHIMYAR KHAN	34,804	105	91	730	2.0	2	"
ZHOB	6,938	21		208	0.6		"
SIBI	2,604	8		104	0.3		"
KHUZDAR	50,276	152	75	1,460	4.0	2	"
ORMARA	24,520	74	64	730	2.0	2	"

2-6-4 Facility Requirement

This chapter sets forth the airport facility requirements which are estimated based on the volume of air traffic forecast reported in the previous chapter, and also in compliance with the relevant standards, recommended practices and/or regulations of ICAO, JCAB and FAA.

(1) Runway

Runway lengths at each airport were estimated respectively according to the requirement by operating aircraft.

1) The major airports which will handle B-747 and Airbus in the future were checked the possibility of taking off and landing under the conditions of maximum pay load, airport altitude and temperature, utilizing the ICAO standard.

2) The airport to which Twin Jet will be introduced has already the runway suitable for B-707 which require the longer runway length, existing runway of such airport suffice future requirement.

3) The local airports which F-27 class aircraft will be introduced in the future, will require the runway of 2000M (6500FT) according to the FAA. However, some airports now in service have shorter runway length than 2000M. In this case, existing runway were justified to be enough. But the runway of Gwadar Airport was planned to extend 2,000 m suitable for the international flight.

(2) Taxiway

At Karachi, Islamabad and Lahore Airports the instrument approaches will exceed scarecely four flights during the peak hour after 1988 and operation of the wide bodied jet aircraft will become frequent. Therefore, a complete parallel taxiway with perpendicular exits will be necessary in 1988.

(3) Apron

1) Calculation Method for Required Number of Aircraft Stands

The following formula is used to obtain the required number of aircraft stands for the key years.

$$S = Ti / 60 \times Ni \times 1.2 + \alpha$$

Where S : Required number of aircraft stands,

Ti: Gate occupancy time in minutes,

Ni: Number of arriving aircrafts during the peak hour,

α : One extra stand for the largest aircraft of the planning year for unexpected peaking occasion. (1 extra for every 10 stands)

2) Gate Occupancy Time

The gate occupancy time for each category is assuming as tabulated in Table 2-6-17, with a margin for delay considering current condition.

Table 2-6-17 Gate Occupancy Time (minutes)

Flight or Airport		Occupancy time	
		L jet	Others
Dom	Primary Airport	80	55
	Others	70	45
Int'l	PIA	130	70
	Foreign Carrier	70	

Notes: (1) Primary Airports-Karachi, Islamabad, Lahore, Peshawar, Quetta
(2) L jet- B-747, Airbus class

3) Apron Space

Apron Space is decided as Table 2-6-18 taking into account wing span, overall length and operating procedure of aircraft on the apron.

Table 2-6-18 Parking Space Requirement (meters)

Dom / Int'l	Aircraft \ Procedure / Airport	Width	
		Nose-in /Push-out	Self Maneuvering
		KARACHI, ISLAMABAD LAHORE	Other
Dom	B-747, Airbus	70	-
	Twin Jet	45	60
	F-27	-	50
Int'l	B-747, Wide I	70	-
	Wide II	60	-

*: Each figure includes the clearance between each aircraft

(4) Passenger Terminal Building

The floor area required for the passenger terminal building is calculated by multiplying the number of the hourly peak passengers by the unit floor area.

The unit floor area per hourly peak passenger at each airport is established to be 15 m^2 for domestic use and 35 m^2 for international use taking into consideration Japanese standard and rather high well-wisher at Pakistan. (ICAO has no definite standard, and some of the advanced countries now adopt the standard similar to that of Japan.)

In addition to these space for embarkment or disembarkment passengers requires 10 m^2 for the unit floor area is required for the international transit passengers.

(5) Cargo Terminal Building

In case of manual handling system on cargo, JCAB recommends following cargo handling capacities for the airline offices and agency offices.

Table 2-6-19 Cargo Handling Capacities

	Airline office	Agency office
Dom.	0.067	0.02
Int'l	0.166	0.06

Unit : ton/sq.m.

Therefore, cargo handling space required is calculated by multiplying the above mentioned values by cargo demand.

(6) Car Parking

The following formula is used to calculate the required car parking spaces.

$A = P \times C \times L$

Where, A : Required car parking spaces

P : Number of peak hour passengers

C : Number of parking spaces per peak hour passenger (0.8 by Japanese and FAA standard)

L : Unit space for one lot (35 m^2 including incident space by general planning value)

(7) Air Navigation Systems

Air navigation systems will generally include radio navigational aids, air traffic control, aeronautical telecommunications, meteorological and aeronautical lighting systems.

Air navigation systems have been planned in this study for air routes and airports in compliance with the international standards, i.e., Standards and Recommended Practice of International Civil Aviation Organization (ICAO). However, detailed planning practices which are not included in those of ICAO Standards have been supplemented by the standards of Civil Aviation Bureau of Japan.

The basic planning criteria of major navigation equipment are as follows;

1) Radar Approach Control

Radar Approach Control Unit will be justified when annual aircraft operations would exceed 10,000 movements under instrument flight rules (IFR). Equipment necessary for the unit will include a terminal ASR/SSR and associated control consoles.

2) ILS Category-I / Lighting Category-I

Installation of navigational aids and lighting equipment which will allow the category-I operation will be justified for an airport where turbo jet aircraft operate as scheduled civil transport.

Equipment necessary for Cat.-I operations will be as follows;

ILS Category-I
Approach Lighting System Category-I
Visual Approach Slope Indicator System
Runway Edge Lights
Runway Threshold Lights
Runway End Lights
Taxiway Edge Lights, etc.

Terminal DME allocated with ILS will be applicable where outer marker could not justified for geographical and/or economical reasons.

3) ILS Category-II / Lighting Category-II

Installation of Category-II equipment will be justified to the highly congested international airport provided that such installation could result in, to the great extent, the economic benefits and contribution to aircraft operations safety.

Those equipment will include the followings;

ILS Category-II

Approach Lighting System Category II

Visual Approach Slope Indicator System

Runway Edge Lights

Runway Threshold Lights

Runway End Lights

Runway Center Line Lights

Touch Down Zone Lights

Taxiway Edge Light

Taxiway Center Line Light, etc.

4) VOR/DME

Installation of VOR/DME will be justified for airport where scheduled civil aircraft would be operated. NDB will be also applicable instead of the VOR/DME under conditions that the annual aircraft movements should not exceed 3,000 operations and interception to the airport of destination could be safely made by an adjacent VOR/DME or VORTAC located within 40NM radius from the airport.

2-6-5 Development Plan for Airport Facilities

Based on the facility requirements discussed in previous chapter and other informations about existing condition of facilities, development plan of each airport were made through layout plan, pavement design and cost estimation.

(1) Basic Consideration

Basic considerations on development planning are outlined as follows.

(a) Karachi International Airport which will handle 10.0 million passengers in the year of 2000, plays an important role in Pakistan aviation as a main gateway to the country for international air traffic and as the most advanced air base for domestic air routes.

Therefore, the terminal facilities are desirable to be developed with high priority and to be improved radically in the face of additional demands. And as no major repair or maintenance works can be undertaken for main runway because of the continuous traffic operation secondary runway shall be extended, strengthened and new several taxiways shall be installed for use of these during the main runway repaired and strengthened.

(b) Islamabad and Lahore Airport which is estimated to handle 2.6 million passengers in the year of 2000, are secondary major international airport next to Karachi International Airport and they are the air bases in northern part of Pakistan. Therefore, the development plans of these airports are also to be made emphasising priority to another airports.

The existing terminal area should be to relocated from the view point of its function and future expansibility.

The present runway strength of Lahore Airport is too weak for improvement in response to expected future traffic volume and for withstanding aircraft weight without complete closing down of the runway. Suitable sites of new terminal area were selected respectively to north side of the runway for Islamabad Airport and to east side of the runway for Lahore Airport.

To solve this problem, it is suggested that new parallel runway shall be provided and the existing runway shall be converted to parallel taxiway.

The plan of parallel taxiway at Islamabad Airport is effective to reduce the waiting time of holding aircraft and assessed feasible.

(c) Nawabshah Airport is desirable to be developed as an alternative airport for both international and domestic flights to Karachi Airport in case of emergency.

(d) In order to strengthen the pavement to meet the increasing traffic volume and heavier aircraft, the runways and taxiways shall be overlayed at each airport. And, even if the existing condition of the pavement will continue in the future, the runway and taxiway shall be overlayed to prevent deterioration and to maintain the smooth surface.

(e) Construction of local airports which has low rate of traffic demand may be justified feasible from the view point of civil minimum. And they shall be planned suitable for F-27 class in near future.

(2) Development Plan

(a) Development plan at each airport are summarized as Table 2-6-20.

(b) Development plans for maximum demand at several main airports, which were projected in "Traffic Demand Forecast",were carried out for reference purpose only.

Table 2-6-20 Airport Masterplan

The value in each column indicates airport master plan in the year of PRESENT / 1988 / 2000 .

	AIRPORT	RUNWAY	TAXIWAY	APRON	CAR PARKING	PAX TERMINAL BLDG.	CARGO TERMINAL BLDG.
N.W.F.P.	PESHAWAR	2,750 m / Ditto / Ditto	840 m / Ditto / Ditto	2:Airbus 2:B-737 1:F-27 / Ditto / Ditto	/ 11,280 m^2 / 14,030 m^2	5,900 m^2 / 10,250 m^2 / 11,720 m^2	/ 2,500 m^2 / Ditto
					DOM. / 5,400 / 8,150	DOM. / 2,900 / 4,370	
					INT'L / 5,880 / Ditto	INT'L / 7,350 / Ditto	
	D.I. KHAN	1,500 m / Ditto / Ditto	260 m / Ditto / Ditto	2:F-27 / Ditto / Ditto	/ 1,600 m^2 / Ditto	/ 1,200 m^2 / Ditto	
	SAIDU SHARIF	1,830 m / Ditto / Ditto	75 m / Ditto / Ditto	2:F-27 / Ditto / Ditto	/ 1,600 m^2 / Ditto	/ 1,200 m^2 / Ditto	
	CHITRAL	1,830 m / Ditto / Ditto	75 m / Ditto / Ditto	1:F-27 / 2:F-27 / Ditto	/ 1,600 m^2 / Ditto	/ 1,200 m^2 / Ditto	
PUNJAB	ISLAMABAD	2,750 m / 3,200 m / Ditto	900 m / 3,140 m / Ditto	2:B-747 2:B-707 4:F-27 / 6:B-747 2:T-JET 1:F-27 / 7:B-747 1:T-JET 2:F-27	19,000 m^2 / 26,180 m^2 / 38,530 m^2	8,300 m^2 / 19,990 m^2 / 29,560 m^2	2,250 m^2 / 5,520 m^2 / 11,770 m^2
				DOM. / 3:B-747 1:T-JET 1:F-27 / 4:B-747 2:F-27	DOM. / 17,840 / 26,040	DOM. / 9,560 / 13,950	
				INT'L / 3:B-747 1:T-JET / Ditto	INT'L / 8,340 / 12,490	INT'L / 10,430 / 15,610	
	LAHORE	2,750 m / 3,250 m / Ditto	3,090 m / 4,105 m / Ditto	2:DC-10 1:B-707 4:F-27 / 5:B-747 2:T-JET 2:F-27 / 6:B-747 1:WIDE-II 2:F-27	3,200 m^2 / 25,600 m^2 / 38,200 m^2	8,300 m^2 / 17,950 m^2 / 25,700 m^2	/ 3,100 m^2 / 6,650 m^2
				DOM. / 3:B-747 1:T-JET 2:F-27 / 4:B-747 2:F-27	DOM. / 19,660 / 30,860	DOM. / 10,530 / 16,530	
				INT'L / 2:B-747 1:T-JET / 2:B-747 1:WIDE-II	INT'L / 5,940 / 7,340	INT'L / 7,420 / 9,170	
	FAISALABAD	2,750 m / Ditto / Ditto	463 m / Ditto / Ditto	1:B-707 2:F-27 / Ditto / Ditto	3,620 m^2 / Ditto / 4,200 m^2	816 m^2 / 1,380 m^2 / 2,250 m^2	/ 800 m^2 / Ditto
	MULTAN	2,750 m / Ditto / Ditto	3,800 m / Ditto / Ditto	1:B-707 2:F-27 / Ditto / 2:T-JET 2:F-27	2,500 m^2 / 3,980 m^2 / 6,440 m^2	1,050 m^2 / 2,130 m^2 / 3,450 m^2	30 m^2 / 2,000 m^2 / Ditto
SIND	KARACHI	3,200 m / Ditto / Ditto 2,285 m / 3,200 m / Ditto	5,070 m / 6,710 m / Ditto	8:B-747 4:B-707 4:F-27 / 13:B-747 1:WIDE-II 3:T-JET 4:F-27 / 17:B-747 1:WIDE-II 4:T-JET 2:F-27	15,000 m^2 / 68,210 m^2 / 113,760 m^2	27,800 m^2 / 67,970 m^2 / 112,320 m^2	7,500 m^2 / 26,350 m^2 / 61,050 m^2
				DOM. / 4:B-747 1:T-JET 4:F-27 / 4:B-747 2:T-JET 2:F-27	DOM. / 27,550 / 46,030	DOM. / 14,760 / 24,660	
				INT'L / 9:B-747 1:WIDE-II 2:T-JET / 13:B-747 1:WIDE-II 2:T-JET	INT'L / 40,660 / 67,730	INT'L / 53,210 / 87,660	
	HYDERABAD	2,150 m / Ditto / Ditto	150 m / Ditto / Ditto	2:F-27 / Ditto / Ditto			
	NAWABSHAH	2,750 m / Ditto / Ditto	175 m / 1,186 m / 1,606 m	1:F-27 / 3:B-747 2:F-27 / 6:B-747 2:F-27	/ 1,600 m^2 / Ditto	/ 6,980 m^2 / 13,810 m^2	
	MOHENJODARO	1,980 m / Ditto / Ditto	230 m / Ditto / Ditto	2:F-27 / Ditto / Ditto	4,000 m^2 / Ditto / Ditto	500 m^2 / 1,200 m^2 / Ditto	
	SUKKUR	2,750 m / Ditto / Ditto	2,990 m / Ditto / Ditto	1:F-27 / 2:F-27 / Ditto	/ 1,600 m^2 / Ditto	225 m^2 / 1,200 m^2 / Ditto	
BALUCHISTAN	QUETTA	3,660 m / Ditto / Ditto	600 m / Ditto / Ditto	2:Airbus 2:F-27 / Ditto / Ditto	2,400 m^2 / 4,030 m^2 / 6,890 m^2	5,800 m^2 / Ditto / Ditto	/ 90 m^2 / 150 m^2
	PANJGUR	1,560 m / Ditto / Ditto	120 m / Ditto / Ditto	1:F-27 / Ditto / 2:F-27	/ 1,600 m^2 / Ditto	360 m^2 / 1,200 m^2 / Ditto	
	TURBAT	1,800 m / Ditto / Ditto	370 m / Ditto / Ditto	1:F-27 / 2:F-27 / 3:F-27	/ 1,600 m^2 / Ditto	240 m^2 / 1,200 m^2 / Ditto	
	PASNI	2,750 m / Ditto / Ditto	150 m / Ditto / Ditto	2:F-27 / Ditto / Ditto	/ 1,600 m^2 / Ditto	220 m^2 / 1,200 m^2 / Ditto	
	GWADAR	1,500 m / 2,000 m / Ditto	235 m / Ditto / Ditto	2:F-27 / Ditto / 3:F-27	/ 1,600 m^2 / Ditto	150 m^2 / 1,200 m^2 / Ditto	
				DOM. / 2:F-27 / Ditto			
				INT'L / - / 1:F-27			
	JIWANI	1,650 m / Ditto / Ditto	300 m / Ditto / Ditto	1:F-27 / Ditto / Ditto	/ 1,600 m^2 / Ditto	160 m^2 / 1,200 m^2 / Ditto	
	SUI	1,500 m / Ditto / Ditto	150 m / Ditto / Ditto	/ 1:F-27 / Ditto	/ 1,600 m^2 / Ditto	/ 1,200 m^2 / Ditto	
NEW LOCAL AIRPORT		/ / 2,000 m	/ / 75 m	/ / 2:F-27	/ / 1,600 m^2	/ / 1,200 m^2	

2-6-6 Development Plan of Air Navigation Systems

The major planning objectives and concept of air navigation systems are described hereinunder.

(1) Basically air navigation systems will be newly planned and/or upgraded to meet the aircraft operation requirements in correspondence with the increased air traffic volume forecast and introduction of newly developed larger aircraft, taking into consideration internationally acknowledged standard level and future tendency of navaids development.

(2) Obsolescent facilities which are neither fully operational nor reliable to the air safety will be replaced preferentially, in order to eliminate the significant hazards.

(3) New facilities which allow to expedite safe and orderly aircraft operations will be positively planned, thus the delays, excessive fuel consumptions and diversions could be reduced to the minimum.

(4) En route navigation aids such as en-route VOR/DME and remote controlled VHF Air to Ground communications facilities will be preferentially upgraded to the international level to provide adequate en route guidance of major international airways G2, G52, AI and G72.

(5) En route air traffic control facilities, i.e., ARSR/SSR and the related VHF/HF communication network are planned to provide safe and efficient traffic flow in Pakistan Airspace after the terminal ASR/SSRs could be in full services.

(6) Aeronautical telecommunications facilities for both mobile and fixed services are planned to improve the communications difficulties due to equipment absolescent and insufficiency of serviceable coverage.

Those facilities include ATS direct speech circuits, Aeronautical Fixed Telecommunications Network (AFTN) and related automatic message exchange, VHF/UHF A/G radios and UHF/VHF links.

(7) Buildings for Flight Information Center, Air Traffic Control Center, Search and Rescue Coordination Center, etc. are proposed for modernization of air traffic services.

(8) Training facilities and centralized maintenance centre (depot) are proposed for familialization to the highly sophisticated radio equipment and to maintain those equipment to the satisfactorily operational conditions.

(9) ASR/SSRs are proposed for the major airports in order to expedite safe and efficient aircraft operations especially in the congested Controlled Terminal Area (CTA).

(10) Precision Approach Category-I (ILS Cat.-I and Lighting Cat.-I) is proposed for the major airports during fiscal years of 1983/1988.

During the same period, non-precision IFR approach (VOR/DME or NDB) is proposed for the minor airports where the forecast does not allow turbo jet operations.

(11) Precision Approach Category-I will be upgraded to Category-II in the major airports during the fiscal years of 1989/2000. Non precision IFR approach is proposed for the minor airports where the forecast still does not encourage the turbo jet operation.

(12) It is noted that the equipment installed during the fiscal years of 1983/1988 shall be partly replaced within 10 years to improve the expected obsolescent condition except mechanically rigid parts such as antennas, cables, etc.

The proposed air navigation systems plan is summarized in Table 2-6-21,22.

2-6-7 Fleet Plan

Based on the estimated aircraft movements on peak day by route, the forecasted number of aircraft required by PIA (Pakistan International Airlines) were roughly estimated as tabulated in Table 2-6-23, under the study of flight hours by route and annual operating hours by aircraft.

Assuming the aircraft service period in PIA to be about 15 years in average, fleet of PIA up to 2000 is planned as shown in Table 2-6-24.

Table 2-6-21 Air Navigation Systems Plan

X : EXISTENCE
O : PLAN(New / Upgrade / Replacement)

No.	AIRPORT NAME	PHYSICAL CHARACTERISTICS	RADIO AIDS							COM.	LIGHTING AIDS					MET.	REMARKS
			ASR /SSR	ILS	VOR	DME	T-DME	NDB	OTHERS	COM.	ALS	RWL	VASIS	TWL	APRON	RVR	
1	PESHAWAR							X	VDF X	X	X	X	X				GCA is available
					O	O				O			O	O	O		
2	D.I.KHAN							x									
					O	O							O				
3	SAIDU SHARIF																*By DAC
							O	O *					O				
4	CHITRAL																
							O						O				
5	ISLAMABAD			X	X			X		X	X	X					
			O	O	O	O	O	O		O	O	O	O	O	O	O	
6	LAHORE			X	X			X		X	(1) X	(2) X	(3) X				(1) Cat.-I not available (2) (3) 2BarVASIS
			O	O	O		O			O	O	O	O	O	O	O	
7	FAISALABAD							X		X		(4) X					(4) Cat.-I Not Available
				O *	O *	O	O	O		O	O	O	O	O	O		*By DAC
8	MULTAN				X			X		X		(5) X					(5) Ditto
				O *	O	O		O		O	O	O	O	O	O		*By DAC
9	KARACHI		X	X	X	X		X		X	X	X	X	X	X		
			O	O	O	O	O		O VOR-2	O	O	O	O	O	O	O	
10	HYDERABAD							O				O	O	O			

Table 2-6-22 Air Navigation Systems Plan (cont'd)

X : EXISTENCE
O : PLAN(New / Upgrade / Replacement)

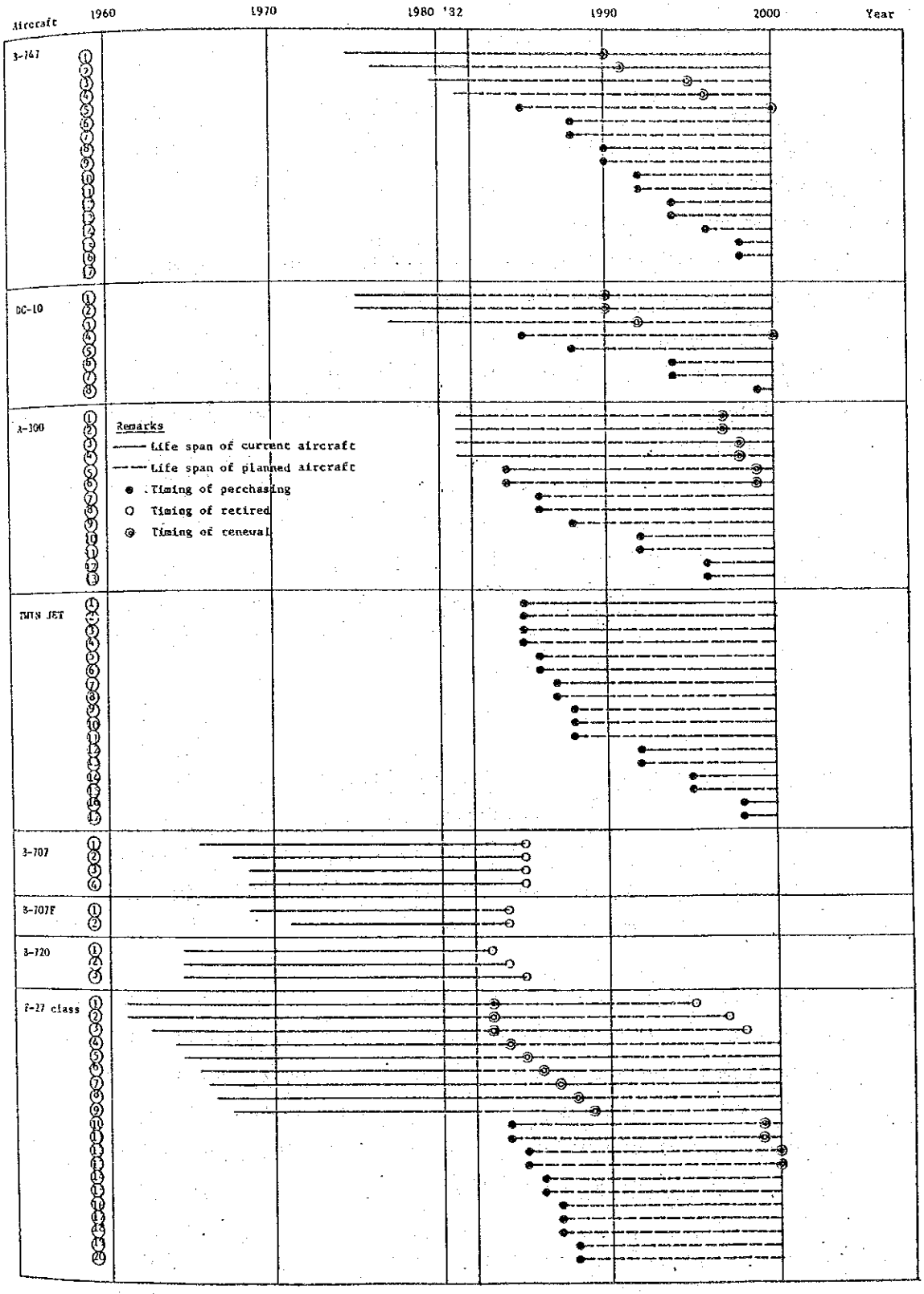
No.	AIRPORT NAME	PHYSICAL CHARACTERISTICS	RADIO AIDS							COM.	LIGHTING AIDS					MET.	REMARKS
			ASR /SSR	ILS	VOR	DME	T-DME	NDB	OTHERS	COM.	ALS	RWL	VASIS	TWL	APRON	RVR	
11	NAWABSHAH				X			X	UDF X	X		X					*By DAC
				O*	O*	O	O	O		O	O	O	O	O	O	O	
12	MOHENJODARO							X									
								O				O	O				
13	SUKKUR																
								O				O	O				
14	QUETTA							X		X			X				*By DAC
				O*	O*	O*		O*	O MLS	O	O	O	O	O	O		
15	PANJGAR				X			X									
								O					O				
16	TURBAT																
					O	O						O	O				
17	PANSI																
								O				O	O				
18	GWADAR																
					O	O						O	O				
19	JIWANI				X			X									
					O	O		O					O				
20	SUI																
								O					O				

Table 2-6-23 Fleet Forecast

Type of Aircraft \ Year	1982	1988		2000		Remarks
B-747	3 (4)	Int'l 7 Dom. -	7	13 3	16 (17)	
DC-10	3	Int'l 3 Dom. 2	5	6 2	8	
A-300	4	Int'l 6 Dom. 2	8 (9)	10 2	12 (13)	
B707/720	7	Int'l - Dom. -	-	- -	-	and 2 Freighters
Twinjet	-	Int'l 10 Dom. 1	11	13 3	16 (17)	
F-27	9	Int'l 1 Dom. 19	19 (20)	1 15	16 (17)	
TOTAL	26 and 2 Freighters	Int'l 27 Dom. 24	50 (52)	43 25	68 (72)	

Note: Mark ( ) indicate the number including spare aircraft

Table 2-6-24 Fleet Plan of PIA



2-7 Others

2-7-1 Inland Water Transportation

For determination of possibility and feasibility in utilization of the River Indus and the canal network mainly concentrated in the Provinces of Punjab and Sind as a means of transport , some studies and reconnaissances were carried out in the past.

According to the results of these studies, transport costs by inland waterway will be less than that by other modes of transport when the physical and engineering factors are not concerned. At the same time, in consideration of anticipated increase of the cost of energy, inland waterway transportation might become more economical than the other modes of transport.

However, there exists many serious problems which had been pointed out in these studies and also there are many issues to be raised by the officials in charge, which are noted as the following:

(1) Many bridges don't have sufficient freespan and air clearance over the maximum water level.

(2) There are many obstacles which prevent the introduction of Inland Water Transportation. These are low bridges, regulators, locks, barrages and dams. For example, a) there are bridges every 3 kms and dams every 80 kms at the outskirts of Lahore, b) the goods sent from Peshawar to Karachi have to be transshipped at least four times, c) there are locks every 13-16 kms on the average.

(3) Since the river water is almost supplied from rain and snow melt in the mountains, the flood discharge in summer is much greater than in winter, and consequently the fluctuation is very powerful and the course shifts seasonally. It is also to be noted that there is not sufficient water depth during spring season and in some canals navigation is possible only for a few months.

(4) Some of the railway and roads structures cross over the rivers and canals. Because these structures were constructed without taking navigation into consideration.

(5) In water-logged areas, stability of canal slopes is a serious problem.

(6) Navigation in the Indus River is not a smooth sailing affairs, because a great deal of risk is involved. For example, floods, storms, insufficient water depth and banks are parts of such navigational hazards.

As mentioned above, for utilizing rivers and canals as a regular mode of transportation of goods to up country and vice versa, obstacles to be removed are too many.

To establish the Inland Water Transportation Systems, a huge investment for removal of many obstacles in the rivers and canals will be required, that is, extensive remodelling of canals is needed for navigation purposes. That will make the navigation schemes very expensive and uneconomical.

Therefore, the canal network has not been utilized for transport. Up to now, the water has been brought into extensive use as a valuable source of irrigation water and generation of electric power. It plays an important role in irrigation in particular, that is, it is essential for the production of certain crops, such as fruits, sugarcane and tobacco, etc. The canals are the major sources which account for about 73% of the total irrigated area. In other words, canal network needs a series of barrages, locks and canal headworks which control the diversion of flows into the designated canals for irrigation.

Accordingly, there is no on-going and expected project of Inland Water Transportation for the Indus River and various canals. In conclusion, it is to be suggested that the in-depth study shall be conducted on all the issues as above mentioned in close coordination with the Ministries concerned.

2-7-2 Pipeline for POL Transport

According to the result of micro scopic traffic demand forecast with compound growth rate of about 5 percent per annum, it is estimated that the volume of the POL products to be consumed in the two provinces of Punjab and NWFP will be about 6.5 million tons in 1999/2000.

As a calculation purpose,if the aforesaid demand is to be met by the pipeline with a bare assumption that a new oil refinery will be constructed close to the PQA premise and the line will be running from the refinery to

the Multan Terminal for transport of POL products, it is estimated that the length for same would be about 870 km if it is running in parallel with the existing one.

With such assumption, a very rough cost for construction of the new pipeline would be about Rs. 1,440 million including pump station and storage facility at the terminal.

However, at the present stage, there is no concrete plan nor the detailed study and therefore, the specific study for the need of the refinery and connecting pipeline shall be carefully conducted and then, if the need for such is justified, the feasibility study is to be followed before determination of the implementation, because the pipeline construction is very closely related with the existence of new refinery.

As to the need for expansion or new development of the pipeline for transport of POL products to the Provinces of NWFP and Punjab for the Sixth Five Year Plan period, it is estimated that the existing pipeline would be sufficient to cover the demand which would reach about 3.0 million tons in 1987/88, because the capacity of the existing one is 4.0 million tons per year.

3. Preliminary Project Evaluation

3-1 General

3-1-1 Objectives and Approaches

The major objective of preliminary project evaluation in this Study is to provide some significant indicators for decision-makings in the later stages of preparing the Masterplan, plan of action and implementation programme.

As for the approach of project evaluation, the following ways will be basically applied.

(1) Economic analysis and/or financial analysis in quantitative terms will be conducted for those projects who require more than empirical discussions for their justification and comparative importance and whose major components of cost and benefits are measurable in reasonably reliable terms. For the evaluation of some important projects involving large uncertainty, sensitivity analysis will be applied.

(2) For a number of projects of the same kind which can not be evaluated one by one due to either the work limitation of the study or some unidentifiability of project formulation, a so-called screening analysis will be provided to typified projects for rough evaluation. In actual, road projects and some railway projects fall in this case.

(3) For those projects whose benefit components are either unmeasurable (intansible) or unavailable, descriptive evaluation will take place from an empirical point of view. One of the important aspects in such discussions would be the safety, which is prerequisite to the development of transport systems.

Incidentally, those projects of minor development/rehabilitation/improvement or the evidently justifiable projects will bypass the preliminary evaluation and be handed over directly to the later stages of planning. It should be also noted that project evaluation of this Study will not reach much detail and give just an insight of the concerned projects good for a planning purpose. Any projects proposed in this Study will, therefore, require a separate full feasibility study before implemented.

3-1-2 Methodologies and Presentations

While methodologies applied to any specific modes or projects will be introduced in the concerned parts as occasion calls, this subsection is limited to the discussion of ones which are commonly in use.

The decision criterion of cost-benefit analysis which is of frequent use in the study is the internal rate of return. The internal rate of return criterion consists of calculating the discount rate at which a project has a net present value of zero. Such a discount rate is called internal rate of return (IRR)r, and only those projects whose IRR is higher than the pre-determined opportunity value of capital rate r are considered to be justifiable. In equation form, the IRR criterion may be expressed as:

$$\sum_{t=1}^{N} \frac{Bt-Ot}{(1+r)^t} - \sum_{t=1}^{N} \frac{Kt}{(1+r)^t} = 0 \ ,$$

where Bt designates benefit in t, and Ot operating cost, Kt capital investment and N project life. The financial interpretation of IRR would be the highest interest rate which the project can pay while redeeming the initial borrowing.

In estimating costs and benefits of economic analysis, border prices are adopted. Market prices of costs and benefits can be converted to border prices by applying the appropriate conversion factors to various broken-down traded and non-traded components (see below for the estimation of standard conversion factor as an example). For a reasonably small portion of the components whose international market prices are not identifiable, standard conversion factor is applied to convert to border prices. Also, border prices of labor can be obtained by multiplying its marginal productivity by the conversion factor for consumption.

Table 3-1-1 Trade Statistics (Total)

(Million Rupees)

Year	Value of imports M(t)	Value of exports X(t)	Value taxes on imports T(t)	Value taxes on exports D(t)
1976-77	23,012.2	11,293.9	6,074.2	180.4
1977-78	27,814.7	12,980.4	8,251.3	346.5
1978-79	36,388.1	16,925.0	10,065.7	279.3
1979-80	46,929.1	23,410.1	12,041.1	445.3
1980-81	53,343.7	29,279.5	13,854.8	706.5

Source: Central Board of Revenue, Statistical Bulletin

Estimation of Standard Conversion Factor

$$SCF(t) = \frac{M(t)+X(t)}{(M(t)+T(t))+(X(t)-D(t))}$$

M(t): Value of imports
X(t): Value of exports
T(t): Value taxes on imports
D(t): Value taxes on exports

$$SCF = \sum_{t} SCF(t)/N$$

N: Number of observed years

Calibrating the above formula based on the data in the Table 3-1-1 .

SCF = 0.851

To compare mutually exclusive projects, differential cost-benefit analysis is conducted. If the IRR on the hypothetical project, whose cost and benefit stream is the differential between those of the two mutually exclusive projects, is in excess of the pre-determined opportunity value of capital rate, the larger project is to be preferred to the former. Some further devices on cost-benefit analysis are also provided depending upon the conditions of preliminary evaluation works as can be seen later.

As for the presentation of preliminary project evaluation in this Study, this text contains a summarized stream of approaches/methodologies and major outcomes of each mode. More specific description of preliminary evaluation for each project is provided in the concerned part of project list. Also, follow-ups of the data and methodologies to be referred to are prepared separately.

3-2 Preliminary Evaluation of Road Projects

3-2-1 Road Project Optimum Timing Test

As a part of preliminary project evaluation, a system complex, named ROPOTT, has been developed to provide the basis for selecting the optimum timing of road projects. Actuated by the input of a case setting or a series of case settings, ROPOTT executes the examination of project timings in economic terms based upon the marginal benefit-cost ratio. This criterion defines the optimum timing of a project as the point in time when its net present value or its internal rate of return is at a maximum. The objective of ROPOTT is to offer some significant systematic criteria for the screening process of the projects with the potential benefits likely to offset their costs. In case of the projects whose net benefits are monotonously increasing over time, the marginal benefit cost ratio can be applied to provide the optimum implementation timings. This method is known as the first year rate of return test. The road projects in Pakistan are well - adapted for the application of this method, since they basically satisfy the condition of monotonously increasing net benefits. The first year rate of return test calculates the marginal benefit-cost ratio (r_1) and compares it with the appropriate discount rate ($\hat{r}$). The result can be interpreted as :

(1) if $r_1 < \hat{r}$ premature to implement yet,

(2) if $r_1 > \hat{r}$ deferred too much, and

(3) if $r_1 = \hat{r}$ optimum timing to implement.

The mechanism of the model can be demonstrated as follows. Suppose the traffic (Xt) is increasing over time (t), and the benefits relate to unit cost savings (b), so that total benefits (Bt) are given by

$$Bt = bXt.$$

On the other hand, the annual unit maintenance costs (a) gives total operating costs (Ct):

$$Ct = aXt.$$

Subtracting the capital cost of the road (Ko), the net present value (Z(i)) is given by

$$Z(i) = \sum_{t=i}^{N+i} \frac{(b-a)Xt}{(1+\hat{r})^t} - \frac{Ko}{(1+\hat{r})^{i-1}},$$

where N = project life, $\hat{r}$ = discount rate and i = year of installation.

The optimum timing of a project is the point in time when its net present value is at a maximum. If this timing is defined as year i, the conditions of optimality for the NPV criterion can be represented by:

$$Z(i-1) < Z(i) \geq Z(i+1)$$

or

$$\begin{cases} Z(i) - Z(i-1) > 0 \\ Z(i) - Z(i+1) \geq 0 \end{cases}$$

Now,

$$Z(i)-Z(i-1) = \left\{ \sum_{t=i}^{N+1} \frac{(b-a)Xt}{(1+\hat{r})^t} - \frac{Ko}{(1+\hat{r})^{i-1}} \right\} - \left\{ \sum_{t=i-1}^{N+i-1} \frac{(b-a)Xt}{(1+\hat{r})^t} - \frac{Ko}{(1+\hat{r})^{i-2}} \right\}$$

$$= \frac{-(b-a)Xi-1 + \hat{r}Ko}{(1+\hat{r})^{i-1}} ,$$

and on the other hand,

$$Z(i)-Z(i+1) = \left\{ \sum_{t=i}^{N+1} \frac{(b-a)Xt}{(1+\hat{r})^t} - \frac{Ko}{(1+\hat{r})^{i-3}} \right\} - \left\{ \sum_{t=i+1}^{N+i+1} \frac{(b-a)Xt}{(1+\hat{r})^t} - \frac{Ko}{(1+\hat{r})^{i}} \right\}$$

$$= \frac{(b-a)Xi - \hat{r}Ko}{(1+\hat{r})^{i}}$$

Therefore, the conditions of optimality can be rewritten as:

$$\begin{cases} -(b-a)Xi-1 + \hat{r}Ko > 0 \\ (b-a)Xi - \hat{r}Ko \geq 0 , \end{cases}$$

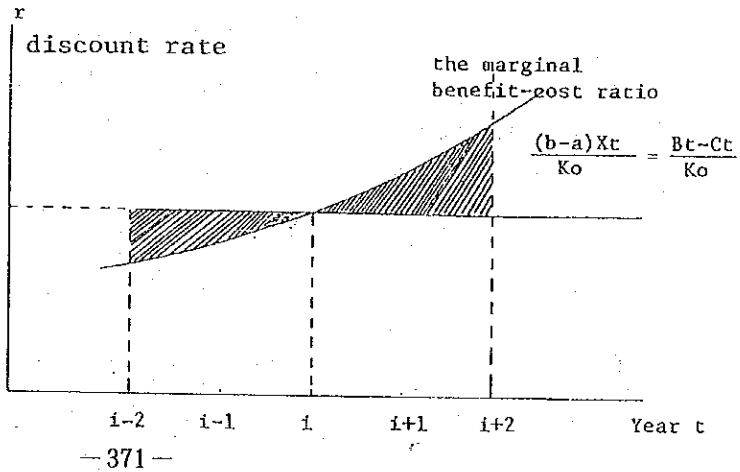
that is

$$\frac{(b-a)Xi-1}{Ko} < \hat{r} \leq \frac{(b-a)Xi}{Ko} .$$

Since $(b-a)Xi-1 = Bi-1-Ci-1$ and $(b-a)Xi = Bi - Ci$, it can be interpreted that the year whose first year return r1 (net benefit Bi-Ci over capital cost Ko) equals or just exceeds the discount rate $\hat{r}$ is the optimum timing of the project. And it can be also observed from the above equation that this can be applied only when $Xi-1 \leq Xi$ or verbally the traffic Xt is monotonously increasing.

In applying the optimum timing test of road projects the basic model explained above will be expanded as well as revised in use of such supplemental criteria as B/C ratio and net present value (NPV), as introduced in the subsequent subsection.

Fig. 3-2-1 Optimum Project Timing



3-2-2 Application and Major Outcomes

(1) Application

The flow of the preliminary evaluation for the road projects is shown in Fig.3-2-2 . The road network in this study consists of 208 links, which means 832 projects (=208x4) to be evaluated for two cases (Case A, Case B) and for two target years (1987/88, 1999/00). These projects were evaluated in terms of IRR, B/C, NPV and were also tested in terms of the optimum implementation timing.

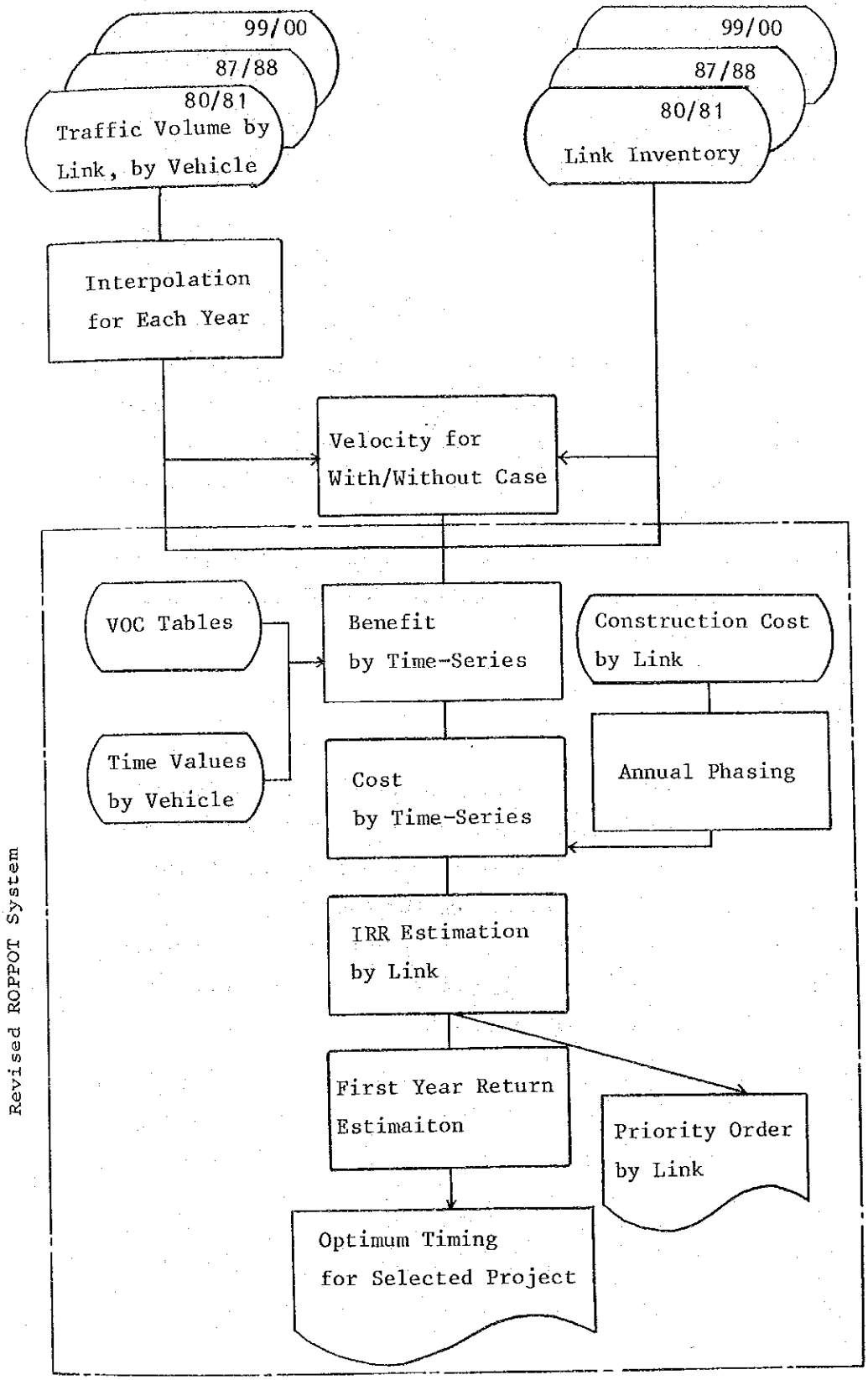
The following data and assumptions were adopted for the evaluation.

(i) Benefit stream is estimated from the difference of vehicle operating cost (VOC) and time difference with and without scenario, assuming 20 years project life.

(ii) VOC table prepared by MOC in 1981 is adopted, which gives financial cost by cost items and by vehicle type for improved and unimproved roads as a function of velocity.
It is, therfore, necessary to convert to economic cost and to assume modification factors as to the terrain and the type of surface.

(iii) Economic benefits of time saving by types of vehicle are 5.89, 56.26 and 10.70 Rs/hour for car, bus and truck respectively, where the time saving by truck includes both the crew cost and time cost of freight.

Fig. 3-2-2 Preliminary Evaluation for the Road Projects



(iv) The annual phasing for road projects is carried out on the basis of the size of the projects, as follows.

(%)

Year	1	2	3	4
Investment Cost<200MRs	30	50	20	
Investment Cost>200MRs	20	35	35	10

The implementation timings are assumed to be 1983/84 the candidate projects of next five year plan and 1993/94 for the rest of the projects. This cost stream, together with the benefit stream, is used for the evaluation.

(v) First year return is calculated for the testings of the optimum implementation timing.

(vi) The discount rate is assumed to be 12% as the opportunity cost in Pakistan, for the calculation of B/C, NPV and optimum timing.

(2) Major Outcomes

The Table 3-2-1 shows the sample output of the evaluation system, where IRR, discounted benefit, discounted cost, B/C, NPV, priority order with B/C, cost stream, first year return for the optimum implementation and optimum timing are displayed for each project.

These informations are utilized for the priority rating and the annual phasing for the projects of next five year plan after testing the sensitivity for several discount rates.

Table 3-2-1 Sample Output for the Evaluation of Road Projects

*** OPTIMUM TIMING BY ROAD LINK ***
(IMPROVEMENT FOR MASTER PLAN B --ECONOMIC -->)

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DISCOUNT RATIO 12.0%

SEQ	LINK-NO	LENGTH	1987/88 PLAN IRR	BENEFIT	COST	B/C	B-C	PRIORITY	CONSTRUCTION COST 1ST	2ND	3RD	4TH	1ST Y.R.	OPTIMUM TIMING
1	52001	160	46.9	3763.53	479.99	7.84	3283.54	15	195.42	341.98	341.98	97.71	0.54	83/84
2	52002	15	70.0	643.75	51.76	12.44	591.99	3	30.10	50.17	20.07		0.93	83/84
3	52003	55	42.8	1197.89	186.45	6.42	1011.44	21	75.91	132.84	132.84	37.95	0.49	83/84
4	52004	38	33.6	491.49	122.82	4.00	368.68	65	71.43	119.05	47.62		0.27	83/84
5	52005	68	41.7	1576.34	261.74	6.02	1314.60	30	106.56	186.48	186.48	53.28	0.48	83/84
6	52006	132	54.1	3619.52	335.15	10.80	3284.38	7	136.45	238.79	238.79	68.22	0.70	83/84
7	52007	22	49.6	819.34	105.11	7.80	714.23	16	61.13	101.88	40.75		0.50	83/84
8	52008	109	31.2	1467.30	344.29	4.26	1123.01	55	140.17	245.30	245.30	70.08	0.18	83/84
9	52009	13	0.0	0.0	19.33	0.0	-19.33	173	11.24	18.73	7.49		****	*****
10	51001	48	40.2	282.53	90.54	3.12	192.00	85	52.66	87.76	35.10		0.47	83/84
11	51002	100	33.2	469.76	184.42	2.55	285.34	99	75.08	131.39	131.39	37.54	0.48	83/84
12	51003	12	41.4	122.59	22.72	5.40	99.87	38	13.21	22.02	8.81		0.26	83/84
13	51004	70	37.8	478.01	129.24	3.70	348.77	73	52.62	92.08	92.08	26.31	0.43	83/84
14	51005	18	10.4	114.20	125.66	0.91	-11.46	144	73.08	121.80	48.72		0.13	84/85
15	51006	75	60.2	1026.45	120.98	8.48	905.48	10	70.36	117.26	46.91		0.65	83/84
16	51007	44	49.9	1360.93	160.41	8.48	1200.52	11	65.31	114.29	114.29	32.65	0.64	83/84
17	51008	13	81.2	221.34	19.81	11.17	201.53	5	11.52	19.20	7.68		1.24	83/84
18	51009	79	56.4	1136.29	149.67	7.59	986.63	17	60.93	106.63	106.63	30.47	0.88	83/84
19	51010	40	41.4	574.71	131.64	4.37	443.07	52	53.59	93.79	93.79	26.80	0.58	83/84
20	51011	37	54.5	996.79	125.96	7.91	870.83	13	73.26	122.09	48.84		0.63	83/84
21	51012	130	43.9	1311.11	201.79	6.50	1109.32	20	82.16	143.77	143.77	41.08	0.45	83/84
22	51013	67	33.9	2437.50	570.73	4.27	1866.78	54	232.36	406.63	406.63	116.18	0.33	83/84
23	51014	32	32.5	578.70	138.59	4.18	440.10	62	56.43	98.75	98.75	28.21	0.29	83/84
24	51015	15	18.8	314.99	178.36	1.77	136.63	121	72.62	127.08	127.08	36.31	0.13	83/84
25	51016	52	17.3	723.06	453.14	1.60	269.92	125	184.49	322.85	322.85	92.24	0.13	84/85
26	51017	38	27.6	829.01	272.50	3.04	556.52	86	110.94	194.15	194.15	55.47	0.24	83/84

3-3 Preliminary Evaluation of Railway Projects

3-3-1 Approaches

Types of the railway projects widely range from electrification, track and station development, signalling improvement to rolling stock provision. Correspondingly, the approaches of preliminary evaluation vary from differential cost-benefit analysis, marginal cost-benefit analysis, cost comparison analysis to descriptive analysis.

It seems more appropriate that the applied methodologies are introduced together with the concerned major outcomes in the subsequent subsection.

3-3-2 Methodologies and Major Outcomes

(1) Electrification

The major benefits of electrification as compared with dieselization, in theory, include better energy efficiency, less maintenance cost of locomotives and increased line capacity, particularly better performance in gradient sections. More specifically, the energy cost of EL is 62 % of DEL in a financial term and 53 % of DEL in an economic term. Also, the maintenance cost of EL is 0.6 % of the cost of a new EL per 10,000 km, while that of DEL is 1.9 % in the analogous term.

While a number of railway line sections in Pakistan are coming up under discussion, first of all, a generalized model can be introduced to test the optimum timing of electrification projects over any double track sections of flat terrain. Taking into account such costs as the development and maintenance costs of electrification ground equipments, the acquisition and maintenance costs of EL and DEL , and the energy cost of electricity and diesel, the model indicates the number of trains at an optimum electrification timing under the different conditions. As for the mechanism of marginal cost-benefit ratio which is known as the first year return, the explanation provided in Subsection 3-2-1 can be reffered to.

Table 3-3-1 and Figure 3-3-1 present results of the model in tabulated and graphical forms, respectively. On the other hand, the number of trains and the share of goods trains for the concerned section in 1999/2000 are projected as:

Table 3-3-1 Optimum Electrification Timing of Flat Double Track Section

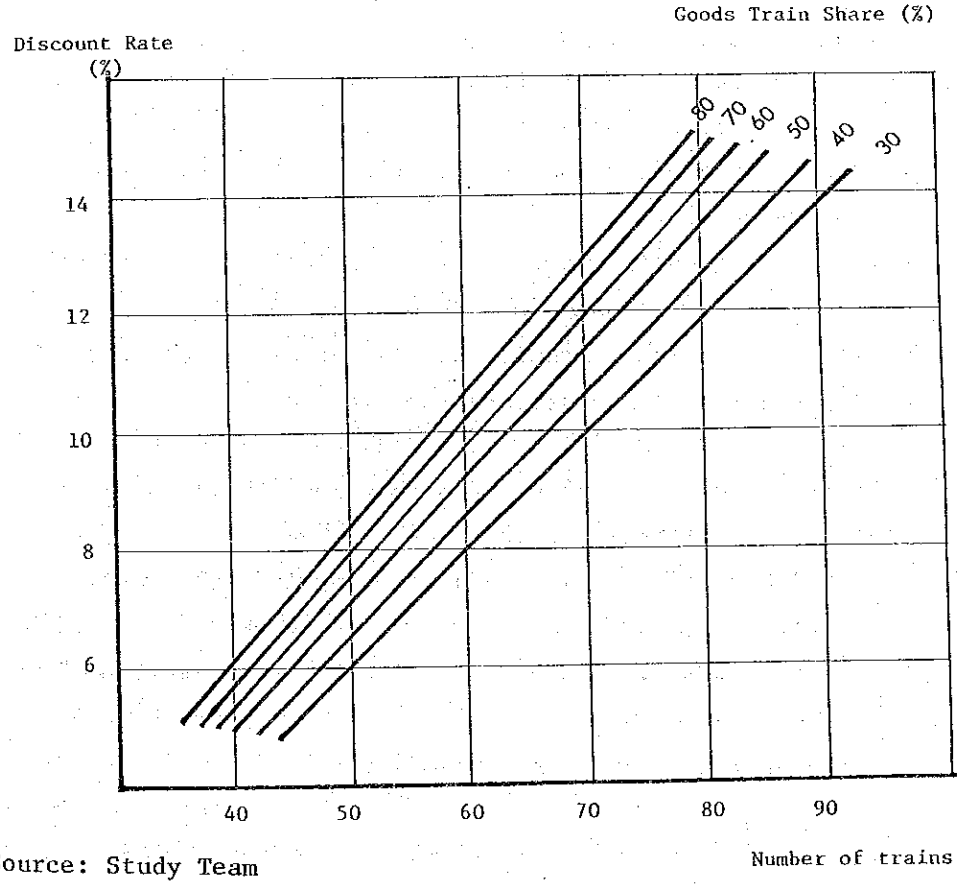
(Number of Trains)

Discount Rate (%)	Share of Goods Trains (%)					
	80	70	60	50	40	30
14	75	78	80	83	88	92
12	67	69	72	75	79	83
10	58	60	63	65	70	73
8	49	51	53	55	59	62

Note: Number of trains for both ways

Source: Study Team

Fig. 3-3-1 Optimum Electrification Timing of Flat Double Track Section



Source: Study Team

	(Number of trains)	(Goods train share)
Kiamari - Rohri	122-132	51-55 %
Rohri - Samasata	158	63 %
Samasata - Khanewal via Chord	101	80 %
Samasata - Khanewal via Loop	58-68	34-41 %
Lahore - Lala Musa	82-90	61-58 %

Since the discount rate (the opportunity value of capital) for railway projects can be estimated to be somewhere around 12 %, it can be understood from Table 3-3-1 that all above sections with one exception are justified for electrification by 1999/2000. It is most desirable if these electrification projects are implemented at the number of trains indicated in Table 3-3-1. If not, they are recommended to be implemented as early as possible after the number of trains exceed the ones indicated in Table 3-3-1.

From a point of view of train operation beside the traffic volume factor pointed out above, the Chord line of Samasata - Khanewal is recommended to be electrified at a relatively early point of time. Although the loop line of Samasata - Khanewal does not reach the train number required for electrification even by 1999/2000, the electrification of this section is also preferred from an operational point of view by considering it as a set project with the Chord line electrification. Incidentally, the Sher Shah - Mahmud Kot section is proposed to be electrified also from an operational point of view to ensure the smooth operation of tank wagons carrying liquid products from Mahmud Kot.

Since the project environments of electrification in the Sibi - Kolpur and Lala Musa - Rawalpindi sections do not fit the conditions of optimum electrification timing test model, that is, double track of flat terrain, these two important projects are analyzed independently from the generalized model. They take differential cost-benefit analysis between the two mutually exclusive cases of electrification and diesel operation. These two sections have relatively small traffic volume and do not seem to fully enjoy the usual benefits of electrification against its development cost of ground facilities. Due to the desirable performance of EL on the gradient sections, however, electrification in these sections is expected to save the provision of some supplemental locomotives which are required otherwise if diesel operation is continued.

The differential cost-benefit analysis applied to the electrification project of the Sibi - Kolpur section during the 6th Plan period is conducted with the IRR of 10.9 %. While such other benefits as regional development effect of Baluchistan regions can be also seen, it can not be quite convinced that the project is feasible, yet. However, if regenerative brakes are introduced to take advantage of the steep slopes, a considerable amount of electricity can be saved. Table 3-3-2 is the economic cost-benefit stream of electrification project of the section with regenerative brake systems. The resulting IRR is 12.5 % and proves the economic feasibility of project. The electrification project of Sibi - Kolpur section therefore is recommended to be implemented during the 6th Plan period with the system design of regenerative brakes.

The electrification of Lala Musa - Rawalpindi section is proposed to be implemented during the 8th Plan period. This project is also expected to experience the benefit of saving the energy and supplemental locomotives. The differential cost-benefit analysis with the resulting IRR of 16.0 % insists that the electrification during the 8th Plan period in this section is preferable to the continuation of diesel operation.

(2) Improvement of Terminals and Stations

In order to cater for the new programs of innovative train operation, a few projects of terminal and station improvement are proposed. One of the innovative programs is the introduction of 3,000-ton traction. Since 104 wagons will be hauled for one train in this program, the improvement of terminals at Karachi City and Lahore and the sidetrack extension and improvement at a number of way stations are required. While the initial cost of such improvement is Rs. 56 million, the procurement cost of a smaller number (30) of 3,000-HP ELs is less than that of 44 2,000-HP ELs which are otherwise needed by approximately Rs. 178 million. Based upon this cost comparison analysis, and in further consideration of such effect of train number reduction, 3,000-ton traction program is recommended.

The container transport is another innovative program introduced to railway, requiring the development of Lahore Dry Port. This is a part of the adopted intermodal containerization program which holds the IRR of 14.3 % as will be introduced in subsection 3-4-1, and is in turn a prerequisite to the containerization program. Similarly, the good terminal improvement project is involved in the railway transport enhancement program through

Table 3-3-2

Comparative Cost Streams of the Sibi-Kolpur Projects

(with Regenerative Brake Systems)

(Million Rupees)

Year	Electrification				Diesel		
	Ground Equipment	EL	Electricity	Total	DEL	Diesel	Total
1	89.79	-	-	89.79	-	-	-
2	209.98	183.78	-	393.76	298.98	-	298.98
3	1.20	21.84	3.98	27.02	23.88	11.35	35.23
4	1.20	21.99	4.57	27.77	40.89	12.54	53.43
5	1.20	22.15	4.98	28.33	41.70	13.77	55.47
6	1.20	22.31	5.08	28.59	25.89	14.13	40.02
7	1.20	22.46	5.50	29.16	59.52	15.40	74.92
8	1.20	22.62	5.91	29.74	44.12	16.71	60.83
9	1.20	22.78	6.34	30.32	28.32	18.05	46.37
10	1.20	22.94	6.47	30.60	45.33	18.53	63.86
11	1.20	23.09	6.91	31.20	46.14	19.94	66.08
12	1.20	23.25	7.35	31.80	30.33	21.39	51.72
13	1.20	23.41	8.10	32.71	63.96	23.78	87.74
14	1.20	23.56	8.58	33.34	48.56	26.25	74.81
15	1.20	23.72	9.00	33.93	32.75	27.81	60.57
16	1.20	3.46	9.00	13.66	16.55	27.81	44.36
17	1.20	3.46	9.00	13.66	16.55	27.81	44.36
18	1.20	3.46	9.00	13.66	16.55	27.81	44.36
19	1.20	3.46	9.00	13.66	16.55	27.81	44.36
20	1.20	3.46	9.00	13.66	16.55	27.81	44.36
21	1.20	3.46	9.00	13.66	16.55	27.81	44.36
22	1.20	3.46	9.00	13.66	16.55	27.81	44.36
23	Δ119.91	Δ179.49	-	Δ299.40	Δ275.23	-	Δ275.23

Source: Study Team

the development of base stations. This project aims at increasing the goods handling capacity of such base stations by improving their arrival/departure and loading/unloading tracks. This project is prerequisite to the railway transport enhancement program which, designated as Case B, is selected in the evaluation of Masterplan alternatives.

(3) Improvement of Signalling

The objectives of signalling improvement projects are firstly to ensure the security of train operation through the introduction of more reliable systems, and then to increase the average train speeds by quicker interlocking systems and clearer signals. The standards applied as criteria to make signalling improvement plans can be summarized in the following Table 3-3-3.

Table 3-3-3 Combination of Major Train Control Systems

Interlocking Systems	Block Working Systems		
	Token Block	Tokenless Block	Automatic Block Signalling
Standard-I	1-a	1-b	1-c
Standard-II	2-a	2-b	2-c
Standard-III	3-a	3-b	3-c
Relay Interlocking	4-a	4-b	4-c

The highest priority is given on the signalling improvement of main line single track sections. In order to maintain the security and increase the line capacity of such sections for rapidly increasing traffic, the 3-b systems have to be improved to 4-c. Some main line single track sections with large volume of traffic are to be provided with 4-c systems even during the 6th Plan period. The next priority is given to the improvement projects from 3-b to 4-c over the main line double track sections. This is followed by the improvement of some busiest branch line from 3-a.b to 4-c, and then that of major branch lines from 2-a.b to 3-b.

(4) Others

The other projects which, as a matter of fact, have pretty much share of the proposed budget include track works and rolling stock provisions. The programs for track renewal and rolling stock provision are made to support the safe and smooth implementation of projects introduced above in consideration of the present inventories. Finally, the requirement for track doubling is dependent on the single track line capacity n, which is the function of station-to-station running time $(\frac{1}{2}(\frac{1}{v_1}+\frac{1}{v_2}))$, block handling time t, and the traffic intensity f:

$$n = \frac{1{,}440 \quad f}{\frac{1}{2}(\frac{1}{v_1}+\frac{1}{v_2}) + t.}$$

While the exact future line capacity of single track connot be determined due to some uncertainty about the progress of operation condition improvement, the entire main line between Karachi and Rawalpindi is proposed to be doubled based upon the present performance and future operation policy.

3-4 Preliminary Evaluation of Port Projects

3-4-1 Approaches and Methodologies

Preliminary evaluation of the port projects in this Study also takes various approaches depending upon the types and study environments of projects. They vary from the introduction of economic/financial analyses , cost comparison analysis to the provision of descriptive analysis. Besides, the discussion often involves queueing theory for the justification of proposed projects to meet the estimated future demands. Queueing theory allows verification of the required number of berths taking into account the probability if distribution of vessels' inter-arrival and service times which, in turn, consider peak/off-peak and other factors.

Let λ the mean arrival rate (expected number of arriving vessels per day), μ the mean service rate (expected number of served vessels per day) and S the number of berths. The ratio, $\rho=\lambda/S\mu$, is called the traffic intensity since it represents the average fraction of time that the berths will need to be busy serving vessels in order to keep up with the incoming vessels.

When ρ is less than 1.0, the system will approach a steady-state condition where its statistical properties are in statistical equilibrium. However, when $\rho \geq 1.0$, the berths are unable to keep up with incoming traffic and statistical equilibrium cannot be achieved. Incidentally, $1/\lambda$ and $1/\mu$ can be interpreted as the expected interarrival time and expected service time, respectively.

As no significant attempt is made to control the arrivals in Pakistan, every time period of fixed length has the same probability of an arrival occurring. This can be referred to as "random arrivals". Mathematically, this stochastic process can be expressed as the number of arrivals falling in a Poisson process with parameter λ . It is also equivalent to say that interarrival times, represented by T_1, has an exponential distribution with parameter λ . Its probability density function is

$$f_{T1}(t)=\lambda e^{-\lambda t}$$

Arising from a certain variety of vessel sizes, loads and some other factors, on the other hand, service time T_2 has a certain degree of

variability somewhere between the great variability of the exponential distribution and the zero variability of the degenerate distribution. A probability that fills in this middle ground is called the Erlang distribution of phase 2 or 3, expressed as:

$$f_{T_2}(t)=\frac{(\mu k)^k}{(k-1)!}t^{k-1}e^{-k\mu t} \quad \text{(see Figure 3-4-1)}.$$

The Erlang distribution of phase 1 can be understood as the exponential distribution while that of phase ∞ as the degenerate distribution, and at the same time the standard deviation for the kth phase Erlang distribution is $\frac{1}{\sqrt{k}\cdot\mu}$ against those of $\frac{1}{\mu}$ for the exponential distribution and zero for the degenerate distribution.

Phase k of the Erlang distribution is the "shape parameter" determining the degree of variability. The Erlang distribution of phase k with the mean of $\frac{1}{\mu}$ can be understood as the sum of k probability variables each of which follows an independent exponential distribution with the mean of $\frac{1}{k\mu}$. For a practical purpose in comprehensive transport analysis, the Erlang distributions of phase 2 and 3 do not make so significant differences.

Fig. 3-4-1 Berth Occupancy Time of Tankers at Karachi Port

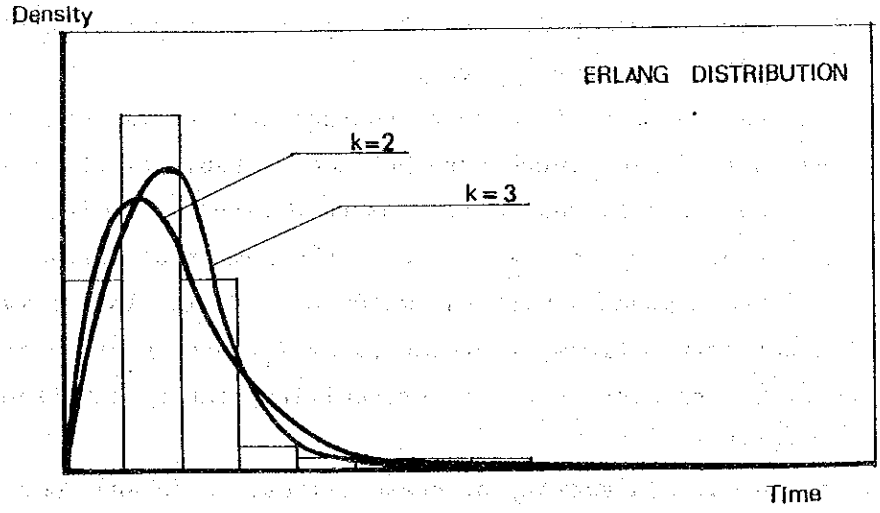


Table 3-4-1 can be referred to in order to obtain the expected length Lq for the berths system with $M/E_3/S$ behavior, that is, random arrival and Erlang service time. Then the expected waiting time Wq can be estimated as $Wq = Lq/\lambda$.

Table 3-4-1 Expected Length of Queue for $M/E_3/S$

ρ	S				
	1	2	3	4	5
0.10	0.74074E-02	0.14829E-02	0.31947E-03	0.71166E-04	0.16161E-04
0.20	0.33333E-01	0.11975E-01	0.46423E-02	0.18660E-02	0.76599E-03
0.30	0.85714E-01	0.41923E-01	0.22024E-01	0.11991E-01	0.66699E-02
0.40	0.17778E 00	0.10620E 00	0.67576E-01	0.44429E-01	0.29808E-01
0.50	0.33333E 00	0.22975E 00	0.16697E 00	0.12481E 00	0.94971E-01
0.55	0.44815E 00	0.32724E 00	0.25061E 00	0.19688E 00	0.15720E 00
0.60	0.60000E 00	0.46098E 00	0.36945E 00	0.30284E 00	0.25196E 00
0.65	0.80476E 00	0.64697E 00	0.53948E 00	0.45890E 00	0.39539E 00
0.70	0.10889E 01	0.91164E 00	0.78740E 00	0.69617E 00	0.61433E 00
0.75	0.15000E 01	0.13027E 01	0.11609E 01	0.10490E 01	0.95669E 00
0.80	0.21333E 01	0.19155E 01	0.17552E 01	0.16264E 01	0.15179E 01
0.85	0.32111E 01	0.29722E 01	0.27929E 01	0.26461E 01	0.25206E 01
0.90	0.54000E 01	0.51395E 01	0.49405E 01	0.47751E 01	0.46316E 01
0.95	0.12033E 02	0.11751E 02	0.11532E 02	0.11347E 02	0.11184E 02
0.98	0.32013E 02	0.31717E 02	0.31486E 02	0.31288E 02	0.31115E 02
0.99	0.65340E 02	0.65040E 02	0.64804E 02	0.64603E 02	0.64425E 02

Source: Hillier and Yu, Queueing Tables and Graphs

3-4-2 Major Outcomes

(1) Full Container Terminal

The development project of full container terminal is perhaps one of the largest projects in the port sector of Pakistan. The major quantifiable benefits include: 1) reduction in cargo handling costs by raising cargo handling productivity through mechanization and containerization, 2) reduction in ship costs for berth waiting time and for loading/unloading cargo, mainly through increases in cargo handling capacity and productivity, 3) reduction of transport period, inland transport period, and port area freight accumulation through the increase of efficiency of inland transportation, and 4) reduction in container rental fees through the the shortening of transport periods.

Among the other benefits are contribution to the country's economic development, cargo damage reduction, packing cost reduction and so on.

Taking into account the major quantifiable benefits, economic analysis is conducted in the Feasibility Study of the Introduction of Containerization. If Karachi Port is selected as the development site, the internal rate of return for the containerization development project of the port terminal is calculated to be 16.2 % (if the costs related to railway facilities are included, 14.3 % as shown in Table 3-4-2). In the case that Port Qasim is assumed to be the development site, on the other hand, it comes down to 13.9 % (if the costs related to railway facilities are included, 12.2 %). Both results recognizably exceed the opportunity value of capital, and the project is considered to be justifiable from an economic point of view.

As for the site selection, Karachi Port is considered to be more advantageous for the containerization development of port terminal than Port Qasim. This can be partly observed from the results of economic analysis which are reported to be well established figures. In addition, since almost all existing port-related functions, facilities and know-how are situated in and around Karachi Port, selecting Port Qasim for a container port is considered likely to result in roundabout transportation of upcountry containers and container cargoes, that is, to Port Qasim, to the Karachi Port area and then to upcountry. Furthermore, it is discussed that from a liner operators' point of view, Karachi Port will be more favorable in consideration of the lower tariff levels and some other conditions of facilities and services.

On the assumption that 1) Karachi Port is selected as the port development site, 2) the interest rate of loan for both foreign and local currency portions is 11.6 %, and 3) the current tariff will be raised by 25 % on and after 1982/83, the financial rate of return is calculated to be 11.2 %. It is analyzed that the increase of current tariff is by any means necessary.

(2) Liquid Berths

A new oil berth is proposed to be constructed at Karachi Port replacing the two existing berths, namely No.2 which is a temporary structure and No.3 which is deteriorated. If the proposed project is not implemented, ρ for berths No.1 and No.4 in and after 1985/86 is estimated to be 1.23 (λ = 0.96, μ = 0.48, 300 day operation per year), and the system will

Table 3-4-2 Costs/Benefits and IRR - Shadow Price (Karachi Port - Feedback Ratio 30%)

IRR = 14.3%

(Unit; '000 Rs)

No.	Fiscal Year	Costs				Benefits			
		Total	Construction	Equipment	Operation/ Maintenance	Total	Reduction in Ships' Staying Cost	Reduction in Cargo Handling Cost	Reduction in Time Cost
1	1982/'83	11,692	11,692						
2	'83/'84	77,240	77,240						
3	'84/'85	225,591	225,591						
4	'85/'86	306,633	306,633						
5	'86/'87	482,110	148,460	333,650					
6	'87/'88	12,672			12,672	71,468	53,896	4,732	12,840
7	'88/'89	21,394			21,394	117,374	70,072	25,186	22,117
8	'89/'90	33,848			33,848	238,392	160,806	44,025	33,561
9	'90/'91	43,778			43,778	270,904	177,180	49,807	43,916
10	'91/'92	43,778			43,778	270,904	177,180	49,807	43,916
11	'92/'93	43,778			43,778	270,904	177,180	49,807	43,916
12	'93/'94	43,778			43,778	270,904	177,180	49,807	43,916
13	'94/'95	43,778			43,778	270,904	177,180	49,807	43,916
14	'95/'96	43,778			43,778	270,904	177,180	49,807	43,916
15	'96/'97	43,778			43,778	270,904	177,180	49,807	43,916
16	'97/'98	43,778			43,778	270,904	177,180	49,807	43,916
17	'98/'99	43,778			43,778	270,904	177,180	49,807	43,916
18	'99/2000	43,778			43,778	270,904	177,180	49,807	43,916
19	2000/'1	43,778			43,778	270,904	177,180	49,807	43,916
20	'1 /'2	43,778			43,778	270,904	177,180	49,807	43,916
21	'2 /'3	43,778			43,778	270,904	177,180	49,807	43,916
22	'3 /'4	43,778			43,778	270,904	177,180	49,807	43,916
23	'4 /'5	43,778			43,778	270,904	177,180	49,807	43,916
24	'5 /'6	43,778			43,778	270,904	177,180	49,807	43,916
25	'6 /'7	43,778			43,778	270,904	177,180	49,807	43,916
26	'7 /'8	43,778			43,778	270,904	177,180	49,807	43,916
27	'8 /'9	43,778			43,778	270,904	177,180	49,807	43,916
28	'9 /'10	43,778			43,778	270,904	177,180	49,807	43,916
29	'10/'11	43,778			43,778	270,904	177,180	49,807	43,916
Total		2,090,514	769,616	333,650	987,248	6,116,210	4,005,560	111,989	990,762

Source: Feasibility Study Report on the Introduction of Containerization in the Islamic Republic of Pakistan, 1982

be unable to keep up with the incoming traffic. With the proposed project, on the other hand, ρ for the three berths including the proposed is estimated as 0.90 (λ = 1.06), indicating that the system is assumed to approach the statistical equilibrium. In consequence, the proposed project is required early in the 6th Five Year Plan period. Incidentally, since Wq is estimated to be 4.7 days based upon $M/E_3/S$ (Lq = 4.94), efforts are most encouraged to reduce Wq by various short-term and long-term devices including the handling rate increase.

Based upon the Policy that liquid products beyond 10 million tons per year will be handled at Qasim Port, an oil berth needs to be developed at Qasim Port before flowing demand reaches a considerable amount. One oil berth of 1.5 million ton capacity proposed to be constructed by 1988 aims at meeting this demand.

The rest of demand for liquid berth at Qasim Port can be estimated as shown in Table 3-4-3. Handling this demand by the buoy berth at the outer anchorage area instead of the conventional oil berth presumably at Bundal Island is advantageous under the given conditions in the respects including the following;

1) The total construction cost is estimated less.
2) The congestions in the channel expected in the long-term future can be partly eased.
3) The navigation of tankers along the channel of approximately 15km portion can be saved.
4) The security from accidents can be maintained due to avoidance of large tankers coming into the channel.

The first point can be further elaborated based upon cost comparison analysis in use of queueing theory as follows. If four conventional berths are planned for the year 2000, ρ is estimated to be 1.03 (the apparent service rate = 0.38), while ρ for five berths is 0.82. Therefore, five berths are actually required, and four berths seem to be the least requirement even upon successful improvement of berth operation. The construction of four oil berths at Qasim Port is estimated to cost approximately 1.4 billion Rupees, which is more than the estimated cost of the buoy berth and related facilities of equivalent capacity.

Table 3-4-3 Estimated Demand for Liquid Berths
Excluding the First One at Port Qasim

Year	Import/Export(1000t)	Number of Vessels per Year	Number of Vessels per Day
1988 / 89	670	26	0.07
1989 / 90	1,437	56	0.15
1990 / 91	2,252	87	0.24
1991 / 92	3,118	120	0.33
1992 / 93	4,039	156	0.43
1993 / 94	5,018	193	0.53
1994 / 95	6,059	234	0.64
1995 / 96	7,165	276	0.76
1996 / 97	8,341	321	0.88
1997 / 98	9,591	369	1.01
1998 / 99	10,920	420	1.15
1999 / 00	12,295	473	1.30

Source: Study Team

Notes: (1) A constant annual average growth rate is assumed to project the intermediate years.
(2) The average load per vessel is assumed to be 26,000t.

(3) Mini-Port at Gwadar

The construction of a mini-port in Gwadar was studied by JICA in 1980 and the following benefits were identified:

1) The availability of a modern fishing port will improve the fishing productivity in the region and increase the protein supply in the region as well as Pakistan.
2) The export of a large quantity of high-grade shrimp will become possible, contributing to international balance of payment.
3) 150-ton class coastal steamers will become able to berth at the proposed mini-port, accelerating the use of coastal shipping.
4) After the development of mini-port, larger barges may be used, reducing the cargo-handling time and the anchorage days of coastal trade vessels.

5) The project is expected to play an important role for the development of Baluchistan Province and in particular Gwadar City.

Quantifying the first four effects, the cost benefit analysis can be concluded with the internal rate of return of 3.8 %. This appears to be a rather low return. Upon implementation of the project, therefore, the expansion of Gwadar based fishery activities in an efficient manner will have to be most encouraged. At the same time, the indirect effects of the project including the last one in the above list are to be taken into consideration.

(4) Others

By the conventional fertilizer unloading system of 1,750-ton daily handling rate, the berth occupancy of a vessel with the average load of 13,000 tons is more than eight days. Without the proposed fertilizer terminal development at Qasim Port, the required number of berths to keep up with the estimated volume of incoming fertilizer and phosphate/sulpher of 1·5 million tons in 1987/88 and 3.1 million tons in 1999/2000 are about four and seven, respectively. The proposed development of equipments, whose cost is almost equivalent to the construction cost of 1·5 berth, is expected to enable one terminal of 279m long to handle the demand for 1999/2000.

The major aim of wheat terminal development at Qasim Port is to clear the apron occupancy of bulk wheat by the conventional handling way. Although the project is not necessarily requisite from a point of view of berth congestions (ρ of one berth for wheat products in 1999/2000 = 0.5), an early implementation is favored from a point of view of berth apron management.

The small boat harbor basin is presently occupied during peak hours by 300 to 400 small boats, which are of many and still-increasing motor launches offering access to the public, approximately 50 sail boats stationed in the basin, and roughly 200 launches belonging to KPT, Navy, Coast Guard and oil companies. As stated in KPT Act (V-30), Karachi Port is to provide such public landing facilities free of charge. The existing facilities which were built in 1920 and are becoming deteriorated and need to be rebuilt before too late.

3-5 Preliminary Evaluation of Airport Projects

3-5-1 Approaches and Methodologies

Among development expenditures of the airports and navigation systems to cater for the projected demands, the most expensive is civil works for airport facilities. The expansion and maintenance of runways, taxiways and aprons including periodical overlays are essential to keep the safe aircraft movements from an engineering point of view. Since the required number of apron berths are planned based upon the forecasted peak hour movements and apron occupancy time of aircrafts as criteria, the development of additional apron berths needs to be implemented without delay.

The requirement of terminal buildings and car parkings are also planned based upon the forecasted peak hour traffic. While some flexibility concerning the implementation timing is allowed within the permissible extent of congestions, excessive postponement of such facility development will involve serious confusions beside the problems of low amenity.

Another important system element to maintain the safe aircraft operations is navigation systems of airports and enroutes. To ensure the safety performances of such systems as radars, communications, radio navigation aids and aeronautical lightings, such systems are to be improved so as to meet with the international standards.

Beside safety and amenity factors, policies play an important role in discussing the priorities of projects. The policy factor was taken into account based upon discussions with the concerned Pakistani officers, particularly for development of major airports and new local airports. Approaches of preliminary evaluation involving such factors as safety, amenity and policy usually take descriptive analysis as demonstrated for each project in the project list.

On the other hand, quantitative analysis is effective for preliminary evaluation of projects which aim at economic efficiency improvement. Since safety is the first condition in aircraft operation, absence of the necessary facilities is often forced to neglect the operation efficiency in order to secure the least safety. Cost-benefit analysis is conducted in such a manner to compare the development cost of the missing facilities and the saving of economic losses. Table 3-5-1 and 3-5-2 show the hours

and costs of aircraft holding respectively which are often introduced in the analyses.

Table 3-5-1 Annual Holding Hours of the PIA Aircrafts (1981/82)

(Hours)

Aircraft	RWP	KHI	LHE	UET	Total
B747	30	103	-	-	133
DC10	90	180	10	-	280
A300	15	307	64	-	386
B707	25	148	11	5	189
B720	15	112	7	16	150
F-27	160	100	83	4	347
Total	335	950	175	25	1485

Source: PIA

Table 3-5-2 Holding Cost of the Aircrafts

(Rs / hr)

		B-747	DC-10	A300	B-707	B-720	F-27
Fuel	Financial	57,800	42,500	29,750	28,900	27,030	3,230
	Economic	56,644	41,650	29,155	28,322	26,489	3,165
Maintenance	Financial	8,000	5,400	3,100	2,000	2,000	1,500
	Economic	7,260	4,914	2,821	1,820	1,820	1,365
Standing Charges	Financial	25,477	19,578	22,105	4,261	2,721	600
	Economic	23,184	17,816	20,116	3,878	2,476	546
Crew Salaries	Financial	3,200	2,600	2,400	1,700	1,700	650
	Economic	2,861	2,324	2,146	1,520	1,520	581
Total	Financial	94,477	70,078	57,355	36,861	33,451	5,980
	Economic	89,969	66,704	54,238	35,540	32,305	5,657

Source: PIA for Financial Cost, Study Team for Economic Cost

3-5-2 Major Outcomes

(1) Civil and Building Works at Major Airports

Among the major civil work projects are the runway and taxiway development projects at Karachi and Lahore. The necessity of these projects mainly arises from that of rehabilitating, or expanding the existing runways. Since runway construction works take a period of runway closure which is not possible at such major airports, the development of the other runway to be fit for the substitute is proposed. Based upon the examination from an engineering point of view, they are urged to be implemented during the 6th Five Year Plan period.

Beside the runway and taxiway development project, Karachi Airport needs to undergo a number of projects including expansion and rehabilitation of various types of aprons, development of cargo terminal area, international passenger terminal and domestic passenger terminal. As discussed earlier, expansion and maintenance of such basic facilities should be regarded as requisite to cater for the rapidly increasing traffic. Also in view of the importance of Karachi Airport as the main gateway to the nation, it can be taken as a policy to give highest priority on the development of terminal facilities at Karachi immediately.

The development of Islamabad Airport can be divided into three phases, beside the periodical overlay of runway and taxiway. The major parts of the first phase include the extension of runway to make it more appropriate as a primary international airport and the development of parallel taxiway. The absence of parallel taxiway is a part of the causes for air traffic congestions at Islamabad shown in Table 3-5-1. This is because the runway occupancy by landed aircrafts becomes high for taxiing back on the runway. Table 3-5-3 shows the outcomes of cost-benefit analysis for the assumption sets of holding hour reduction and installation timing (see Table 3-5-4 for an example of cost-benefit stream). According to the discussion between the concerned Pakistani officers and the Study Team, the reduction of holding hours is expected to be a few tens percents. Therefore, the economic feasibility of the project's early implementation is not fully assured from the above quantitative analysis.

Table 3-5-3 Economic Return (IRR) of Islamabad Airport Parallel Taxiway Project

(%)

Reduction of Holding Hours (%)	Installation Timing (Project Start)		
	1983 / 84	1986 / 87	1988 / 89
10	-	-	-
20	3.43	5.20	6.34
30	9.21	11.24	12.54
40	13.77	16.12	17.61

Source: Study Team

Table 3-5-4 Islamabad Airport Parallel Taxiway Project, Stream of Economic Costs and Benefits

(Holding Hours: 20 % Reduction, Installation Timing: 1983/84)

Unit: Rs

Year		COST			Benefit
		Construction Cost	Maintenance & Operating Cost	Total	
1	1983 / 84	25,557,500		25,557,500	
2	1984 / 85	25,557,500		25,557,500	
3	1985 / 86		1,357,000	1,357,000	3,612,750
4	1986 / 87		1,357,000	1,357,000	3,934,284
5	1987 / 88		1,357,000	1,357,000	4,284,435
6	1988 / 89		1,357,000	1,357,000	4,460,097
7	1989 / 90		1,357,000	1,357,000	4,642,960
8	1990 / 91		1,357,000	1,357,000	4,833,321
9	1991 / 92		1,357,000	1,357,000	5,031,487
10	1992 / 93		1,357,000	1,357,000	5,237,777
11	1993 / 94		1,357,000	1,357,000	5,452,525
12	1994 / 95		1,357,000	1,357,000	5,676,077
13	1995 / 96	13,649,000	1,357,000	15,006,000	5,908,797
14	1996 / 97		1,357,000	1,357,000	6,515,056
15	1997 / 98		1,357,000	1,357,000	6,403,249
16	1998 / 99		1,357,000	1,357,000	6,665,781
17	1999 / 00		1,357,000	1,357,000	6,939,076
18	2000 / 01		1,357,000	1,357,000	7,223,578
19	2001 / 02		1,357,000	1,357,000	7,519,743
20	2002 / 03		1,357,000	1,357,000	7,828,052
21	2003 / 04		1,357,000	1,357,000	8,149,003
22	2004 / 05		1,357,000	1,357,000	8,483,111
IRR = 3.43					

Source: Study Team

Trafficwise, since the peak hour aircraft movements at Islamabad Airport are estimated 6 in 1987/88 and 8 in 1999/2000, the case is still controversial. In consideration of further factors, it can be pointed out the joint use of the airport for PAF and civil is actually making the traffic condition worse than explained above. Also, Islamabad Airport as the Capital International Airport of Pakistan is expected to receive some intangible benefit from the parallel taxiway provision project. Synthesizing the above discussion, the parallel taxiway is proposed to be developed late in the 6th Five Year Plan period. This is also desirable from a planning point of view, because the runway extension project and terminal area development project can be conveniently coordinated.

The rest of the first phase and the following two phases of Islamabad Airport Scheme are mostly for the development of terminal area including aprons, terminal building and car parkings. The Study is proceeded based upon the concept of developing the terminal area north of the existing runway. this concept is supported by the following points.

1) The capacity of existing terminal facilities is by any means inadequate for the estimated traffic in 1987/88, but the site has very limited area for expansion.
2) The existing runway is estimated to be capable of managing the estimated traffic if the parallel taxiway is constructed. The development of new terminal facilities north of the existing runway is expected to be successful in a) separation between the PAF and civil traffics, b) taking advantage of the existing terminal facilities and c) better access connection to Islamabad. Also, the area of site is large enough to design a terminal attractive enough as the Capital airport.
3) While no significant additional benefits can be found in developing a completely new airport at a different site, several losses and disadvantages can be identified. Included among them are construction of additional runway and related facilities, abandonment of the existing terminal facilities, and relatively disadvantageous access condition.

(2) Air Navigation System Development

Air navigation systems of airports and enroutes are planned applying certain standards as criteria. The enroute A/G communication, enroute radar and other enroute facilities will be brought to the international standard. Radio navigation aids and aeronautical lighting systems at the major three airports will be upgraded to Precision Approach Category II in a phased approach, while the airports with turbo jet operations will be upgraded to Precision Approach Category I and the airports without turbo jet operations to Non-precision IFR Approach.

Development of airport radars is expected not only to ensure the security but also to improve the economic efficiency of aircraft operations. The present ASR at Karachi Airport was installed in 1965 and is now operated only on a test basis during morning hours suffering from maintenance problems. It is observed that most of the congestions in the Controlled Terminal Area shown in Table 3-5-1 are due to the conflicting traffic during the absence of active ASR. Upon replacement of ASR at Karachi, therefore, much of the congestions are expected to be solved. Cost-benefit analysis on the assumption that 10 % of holding hours will be saved is concluded, as shown in Table 3-5-5, with IRR of 47.5 %. If 20 % of holding hours is assumed to be saved, IRR is estimated to be 95.5 %. Judging from these results, the project appears quite feasible in these cases. At the same time, the actual reduction of holding hours will without any doubt exceeds these percentages. It can be concluded that even an immediate implementation of the ASR/SSR project is justifiable.

The present aircraft holding at the Islamabad Airport is attributable partly to the absence of radar and also partly to the absence of parallel taxiway which increases the runway occupancy by the landed aircrafts for taxiing back. Table 3-5-6 shows the outcomes of cost-benefit analysis of the assumption sets of holding hour reduction and installation timing. In actual, discussion has been held between the concerned Pakistani officers and Study Team that nearly half of the holding hours is the least expectation for reduction due to the more skillful separation of aircrafts enabled by the radar. Taking into consideration such further benefits as the holding hour reduction of other Pakistani and foreign aircrafts and the prestage of the capital city airport, the installation project of remote radar at the Islamabad Airport is justifiable during the 6th Five Year Plan period.

Table 3-5-5 Stream of Economic Costs and Benefits
(Holding Hours: 10% Reduction) Karachi Airport ASR/SSR Project

(Rs)

Year		COST			Benefit
		Construction Cost	Maincenance & Operating Cost	Total	
1	1983 / 84	32,301,000		32,301,000	
2	1984 / 85		2,442,900	2,442,900	15,347,230
3	1985 / 86		2,442,900	2,442,900	16,575,008
4	1986 / 87		2,442,900	2,442,900	17,901,007
5	1987 / 88		2,442,900	2,442,900	19,333,086
6	1988 / 89		2,442,900	2,442,900	20,229,740
7	1989 / 90		2,442,900	2,442,900	21,314,725
8	1990 / 91		2,442,900	2,442,900	22,380,461
9	1991 / 92		2,442,900	2,442,900	23,499,482
10	1992 / 93		2,442,900	2,442,900	24,674,455
11	1992 / 93	12,920,400	2,442,900	15,363,300	25,908,178
12	1993 / 94		2,442,900	2,442,900	27,203,585
13	1994 / 95		2,442,900	2,442,900	28,563,761
14	1995 / 96		2,442,900	2,442,900	29,991,948
15	1996 / 97		2,442,900	2,442,900	31,491,545
16	1997 / 98		2,442,900	2,442,900	33,066,121
17	1998 / 99		2,442,900	2,442,900	34,719,428
18	1999 / 00		2,442,900	2,442,900	36,455,398
19	2000 / 01		2,442,900	2,442,900	38,278,163
20	2001 / 02		2,442,900	2,442,900	40,192,071
21	2002 / 03		2,442,900	2,442,900	42,201,663
IRR = 47.53					

Source: Study Team

Table 3-5-6 Economic Return (IRR) of Remote Radar Installation Project at Islamabad Airport

(%)

Reduction of Holding Hours (%)	Installation Timing (Project Start)			
	1983 / 84	1986 / 87	1988 / 89	1991 / 92
10	-	-	-	-
20	0.95	3.50	5.07	7.46
30	8.96	11.93	13.71	16.53
40	15.20	18.87	20.98	24.40
50	20.73	25.23	27.74	31.84
60	25.91	31.34	34.27	39.10
70	30.88	37.32	40.70	46.27
80	35.73	43.23	47.07	53.40
90	40.50	49.10	53.40	60.50
100	45.21	54.96	59.72	67.59

Source: Study Team

Due to the fact that the Lahore Airport is situated very close to the Indian border and there are a number of overflying traffic, some opinions support the installation of radar. The peak day aircraft movements at Lahore are forecasted to be 39 in 1987/88 and 46 in 1999/2000. Under such a circumstance, the installation of radar will be justified at least in future, but the installation timing is remaining controversial.
Table 3-5-7 shows the outcomes of cost benefit analysis of the crosssectional assumption of holding hour reduction and installation timing. It can be interpreted from these figures that 70 to 80 % of the reductuion of holding hours are expected to economically pay off the cost. This indicates that the air traffic congestions are much less serious at the Lahore Airport than Karachi or Islamabad and that the installation of remote radar at Lahore seems better to be left for the 7th Year Plan period or after.

Table 3-5-7 Economic Return (IRR) of Remote Radar Installation Project at Lahore Airport

(%)

Reduction of Holding Hours (%)	Installation Timing (Project Start)			
	1983 / 84	1986 / 87	1988 / 89	1991 / 92
10	-	-	-	-
20	-	-	-	-
30	-	-	-	-
40	-	1.09	2.65	5.00
50	2.95	5.55	7.14	9.60
60	6.52	9.31	10.99	13.64
70	9.64	12.68	14.49	17.36
80	12.48	15.81	17.76	20.89
90	15.13	18.78	20.89	24.30
100	17.64	21.65	23.93	27.63

Source: Study Team

(3) New Airport Development Projects

A number of candidate local airport sites which come up for discussion can be roughly grouped into three. Those of the first group including Zhob, Sibi and Khuzdar are situated in rather remote areas of Baluchistan, expecting relatively small public demand as shown in Table 3-5-8. The airport development at these sites is proposed for the future economic development of area and the administrative and other governmental purposes. Although it is admitted from an economic and safety point of view that highest priorities during the 6th Five Year Plan period are to be placed on the major and other existing airports, some airports out of the first group will be developed based upon the policy.

Table 3-5-8 Forecasted Demand for New Local Airports

(Trips)

Airport	1987 / 88	1999 / 2000
Bannu	10,232	15,174
Sargodha	66,612	132,156
D.G.Khan	11,444	17,688
Bahawalpur	20,358	31,724
Rahimyar Khan	20,402	34,804
Zhob	4,570	6,938
Sibi	1,540	2,604
Khuzdar	27,960	50,276
Ormara	15,478	24,520

Source: Study Team

The second group of candidate sites including Sargodha, Rahimyar Khan, Bahawalpur and D.G.Khan have relatively higher potentials for development in and after the 7th Five Year Plan period particularly in terms of forecasted demand volume. These sites are considered to make the nationwide airport network more extensive, occasionally taking advantage of some existing facilities developed in early days. Finally, a very limited number of airport sites might be developed before the year 2000 out of the third group candidate sites including Abbottabad, Jacobabad, Sialkot, Sahiwal, Sehwarsharief, Mirpurkhas and so on.

(4) Alternate Airport for Karachi

While the actual air traffic managed at the Nawabshah Airport is not much to speak of as a local airport, Nawabshah is supposed to maintain the function as the alternate aerodrome for Karachi Airport. Even though Nawabshah is designated so in AIP, the required facilities to meet this function are not made available yet. Due to this situation, the wide-bodied aircrafts of PIA are unable to plan to be diverted to Nawabshah in case of emergency. Then, these aircrafts are incurring extra expenditure of burning extra fuel for such more distant alternate airports as Islamabad and Lahore. According to PIA, the extra expenditure for 1981 is estimated as shown in Table 3-5-9 in financial terms.

Table 3-5-9 Extra Expenditure (Financial) Due to Non-availability of Nawabshah as the Alternate for Widebodied Aircrafts

Aircraft	Number of Incoming Flights	Extra Burn off(gal/Hr)	Average Price(Rs/gal)	Extra Expenditure(Rs)
B-747	832	148	15.3	2,825,971
DC-10	1,976	112	15.4	5,112,307
A-300	3,068	76	15.4	5,386,181
Total	5,876	-	-	13,324,459

Source: PIA

Note: Average flying time is assumed to be 1.5hrs.

Taking the saving of these extra burn off as the benefits, economic cost-benefit analysis has been conducted to analyze the development project of Nawabshah Airport to the full alternate aerodrome for Karachi. In the case the facilities are fully developed the internal rate of return is estimated to be 19.2 %, while that of the case the building development is in a half scale is 22.2 %. It can be interpreted that an early and full implementation is economically feasible. Taking into consideration such further benefits as the saving of fuel consumption brought to other aircrafts and the accomplishment of reliable image of Karachi Airport, this project is recommended to carry out in an early timing of the 6th Five Year Plan period.

4. Summary of Masterplan Alternatives

4-1 Masterplan Alternative A

Masterplan Alternative A is formulated taking into account the projects identified in each sub-sector, based on the present pattern modal split for road and railway.

Here, present pattern means that future demand in inland traffic volume is divided into road and railway with the same pattern of modal split of 1980/81 which leads to the situation where rapid expansion of road transport in secular trend results as seen internationally due to marginal efficiency of road being higher than that of railway also in Pakistan.

Present transportation infrastructure is not necessarily regarded as the situation of shortage in capacity except some portions of the road. Rather than this, main serious problem is the difficulty to provide the designed service level because of unsatisfied maintenance level. As for future traffic, shortage in capacity will occur without discussion by far amount.

4-1-1 Road and Road Transport

As for the capacity of road in future, it can be foreseen as follows.

(i) Assignment of the traffic in 2000 on the present road inventory.

(ii) Assignment of the traffic in 2000 changing the inventory of the road to the level of the standard which is now used in Pakistan for those links where the traffic becomes higher than capacity.

(iii) In case there existing a gap between traffic volume and capacity because of network combination, readjustment of road inventory is adopted up to acceptable level.

Above simulation is adopted since there occurs a serious distortion of traffic flow, then the road inventory is fixed.

Therefore, it should be considered that the differentials of present inventory to the inventory which is identified with the last one at the stage of the simulation shows deficit against the traffic demand at 2000.

The main targets necessary to achieve by this Masterplan are to practise appropriate road rehabilitation and maintenance and to shorten the overall traffic time through the smooth connection between different modes and the speed up of running of trains. Therefore, it should be strongly suggested that the level of road inventory should not be decreased than the original level with larger allocation of financial and human resources.

Due to limitation of scope and work in this Study, road maintenance project is not identified. According to the general survey, the works to maintain the service level of road has been implemented only about one third of the required level.

This Masterplan's indirect suggestion for maintenance of transportation infrastructure is to improve the level of standard of road than the present one in order not to suffer from the deterioration of road, especially from the large size vehicle because large size vehicle restriction is not realistic and it is almost impossible to charge the obligatory practise of overlay work after the completion of road at periodical intervals.

It is necessary to provide appropriate higher productivity of transport system in order to attain the projected high economic growth as the transport activity is one of the vital external economies for manufacturing, agricultural, mining and service industries. Otherwise, transportation infrastructure becomes the bottleneck for the socio-economic growth of the country.

As for the road, taking into account the economically accepted vehicle operating cost, maximum average speed being 80 km/h, admitting 40km/h for some portion of the road in general, metalled two lanes road with fair maintenance level should be fulfilled for trunk network roads.

Also as the civil minimum standard, it is necessary to provide the feeder road in order to make people access to the facilities of medical, educational and other cultural institutions reaching at least within, say, 120 mimutes to the trunk road from any place in the country.

Therefore, the improvement of National Road N-5 to 4 lanes which is the most important national economic corridor between North and South should be suggested as the strategic project for the core of road arrangement.

Further, in order to make the flow of traffic on trunk network fluent, the dissolution of bottleneck generated by the traffic, based on present traffic and future demand assignment, the level up of the minor road by the standpoint of estimated diverted traffic, the bridges on the Indus River, short cut, by-pass and access road to other modes are to be identified by the mode study and should be arranged, depending on its urgency.

Among the identified projects, the main route which goes directly from South to North in Punjab, diverting away from the National Highway N-5 should be arranged as the quasi-strategic project.

Other important items to be considered are as follows.

(i) Level up of East-West trunk road, due to the resource development in Baluchistan.

(ii) Concerning the insufficiency of road maintenance, level up of the road standard and project formation including compulsory over-lay work united to road project.

(iii) Arrangement of road and road transport in accordance with the strategic projects of railway's long distance intensive policy and port's containerization.

Considering above mentioned items, road and road transport should be arranged as one of the main mode of transportation in Pakistan.

Besides the projects based on economic feasibility, as the high social needs, for direct access route from Quetta to the economically accumulated areas of Islamabad/Rawalpindi and Lahore intending economic development effect, should be arranged,

As for the road transport, the arrangement plan of vehicle enough to handle the demand by public sector should be indentified.

Also on the road transport either in public and private, it is necessary to solve the various problems in management system in order to improve the productivity.

It is also necessary to advise that the programmes to prevent the traffic accidents are to be prepared with the highest priority.

4-1-2 Railway

Railway should provide the appropriate capacities both in line and rolling stocks in accordance with the future demand with reasonable service level such as average maximum speed in genaral, 100km/h including stop hour, admitting 50km/h for some portions and with the service level of which productivity of transport can contributes to the projected economic activity in 2000.

In order to realize the above mentioned items, drastic rationalization investment has to be necessitated as long distance intensive policy of railways for the commodity flow.

Other main projects for railway to improve the service level are considered as follows.

(i) Replacement of worn-out facilities in the present railway inventories, which make difficult to offer the designed service level.

(ii) Level up the service standard of the access, handling of cargo, ware-house and terminal for transportation continuity.

(iii) Necessity to improve the efficiency of such soft aspect in accordance with above mentioned rationalization investment as the system of railway is so complicated in institution and management aspects.

Further, independent projects which should be identified are as follows.

(i) Electrification to improve the energy efficiency.

(ii) Improvement of the route between East and West trunk route.

(iii) Improvement of facilities related to the containerization projects of port and shipping.

4-1-3 Port and Shipping

As for the port and shipping, it is preferrable to provide the sufficient facilities in quantitative and qualitative aspects by antecedent investment, not to make the bottleneck in coordinating the vital role of port and shipping for economic growth.

As the Ports of Karachi and Qasim are the main gateways in Pakistan, projects identified to meet the demand concerning warehouse, handling facilities and terminal keeping in view of productivity should be implemented considering the commodity splits for two ports.

For a chain of rationalization, containerization project of Karachi Port should be suggested as the strategic project.

As for shipping, 40% of liner trade by national flag ship is considered as acceptable share with reference to the UN code of conduct.

As for bulk cargo , it is suggested to be operated on the base of economic principle. Therefore, acquisition of bulk carrier for steel mill and oil tanker shall be further studied on the basis of world shipping market and based on capacity analysis of required tonnage instead of prefixed loading share.

As for the projects related to containerization of port, full container ship should be acquired.

4-1-4 Airport and Aviation

Aviation characterized to connect 2 places with a short time is considered as the compulsory mode in highly developed economic and cultural society.

Therefore, it is urgently necessary to adopt the large size airplane in accordance with the growth of demand, and purchasing program for larger size airplane together with the related development/improvement plans for airport should be the major schemes of these sub-sectors.

Besides the arrangement according to the quantitative measures, those projects for level up of service level of the navigation system for securing of traffic safety and the securities of airport should be implemented in coordination with other facilities.

4-1-5 Others

Although there has been no specific information and data available on pipeline for POL, to meet with the demand forecast, it might be necessary for Pakistan to have another pipeline connecting between Karachi and Multan Terminal with the assumption that a new oil refinery would be constructed close to the PQA premises. It is to be noted that the in-depth study on pipeline and refinery shall be necessary before any decision to be made on pipeline development.

Allocation of fund for each mode in the Masterplan Alternative A is as follows.

	Million Rs.	%
Road	85,445	43.5
Road Transport	10,991	5.6
Railway	38,092	19.4
Port	8,940	4.5
Shipping	11,522	5.9
Airport	8,905	4.5
Aviation	32,700	16.6
TOTAL	196,595	100.0

It is considered that the level of transport system after completion of the projects listed in Masterplan Alternative A can cover the transport demand with acceptable service level by each mode and that can contribute to the expected goal of GDP at 2000 in Pakistan and offer the serviceability meeting with the level of GDP/capita in 2000.

In consideration of above, the projects needed for the Masterplan Alternative A have been summarized and listed by mode as per attached.

List of Projects Constituent Masterpaln Alternative A

Million Rs., Financial, 1981 Price

Mode	Name of Project	Contents of Project	Remarks (Link No.)	Cost
1. Road	1. Widening of N-5 to 4 Lanes Project (N-5)	Widening and Grade up Work	52001-52009,51001-51022, 53001-53003 34 Links	16,235
	2. Grade up of Road of Quetta, Rohri Project (N-65)	Grade up	4010, 4009, 2012, 2011, 2013 5 Links	2,673
	3. Grade up of Road of Quetta, Lahore via D.G.Khan till Multan	"	4008, 4022, 4012, 1042, 1051, 1041, 1052, 1053 8 Links	1,620
	4. Short Cut Truckroad in Panjab of Kabirwala, Jhang, Sargodha, Khushab, Pail, Mandra Road	"	1054, 1055, 1059, 1047, 1048, 1049 6 Links	2,294
	5. Rehabilitation of Karachi, Quetta Road Project (N-25)	Rehabilitation	2010, 4001, 4002, 4003, 4004, 4005 6 Links	1,268
	6. Rehabilitation of Quetta, Taftan Road Project	"	4013, 4014 2 Links	900
	7. Grade up of Qila Saifullah, D.I. Khan Road Project	Grade up	4007, 3010 2 Links	352
	8. Indus Highway of Kotri, Peshawar Road Project	"	2014-2018, 1032-1034, 3016-3021, 2019 15 Links	2,602
	9. Bridge Construction between D.I.Khan, Sarai Krisha Project	New Bridge Construction	3022, 1040 2 Links	107
	10. Rehabilitation of Sarai Krisha, Gujranwala Project	Rehabilitation	1039, 1038, 1037, 1036, 1061 5 Links	1,094
	11. Rehabilitaion of Innd M. Fana, Atharan Hazari Road Project	"	1043, 1044, 1045 3 Links	697
	12. Rehabilitation of Lahore, Sargodha Road Project	"	1035, 1057, 1058 3 Links	939

13. Rehabilitation of Khushab, Tajazai Road Project	Rehabilitation	1060, 1027, 1026, 3012 4 Links	516
14. Rehabilitation of Pail Talagang, Fatehjang, Tarnual Road Project	"	1096, 1099, 1031 3 Links	264
15. Grade up of Hasan Abdal, Sazin Road Project (N-35)	Grade up	1023, 3006, 3007, 3008, 3009, 3005 6 Links	867
16. Grade up of Nowshera, Dir Road Project	"	3023-3025 3 Links	449
17. Construction of Sibi, Bewata Road Project	Rehabilitation	4023 1 Link	448
18. Construction of Wingai, Jiwani Road Project	"	4019, 1020 2 Links	895
19. Rehabilitation of Bela, Turbat Road Project	"	4015, 4016 2 Links	339
20. Construction of Pasni, Gwadar Ling Road Project	"	4021, 4017 2 Links	587
21. Construction of Surab, Hoshab Road Project	"	4018 1 Link	917
22. Grade up of Quetta, Chaman Road Project	Grade up	4006 1 Link	314
23. Rehabilitation of Kohat Parachinar Road Project	Rehabilitation	3014 1 Link	307
24. Grade up of Chak Dara, Bisham Road Project	Grade up	3030, 3031 2 Links	115
25. Construction of Jatta, Kalabagh Bypass Road Project	Rehabilitation	3013, 1028 2 Links	88
26. Rehabilitation of Rahimyarkhan Chani Goth Road Project	"	1072 1 Link	147
27. Rehabilitation of Sargodha, Gujrat Road Project	"	1056 1 Link	340

28. Rehabilitation of Jhang, Gujranwala via Chiniot Road Project	Rehabilitation	1089, 1090, 1091	3 Links	1,657
29. Rehabilitation of Multan, Jahanian, Kasur, Lahore Road Project	"	1078-1084	7 Links	510
30. Rehabilitation of Bahawalpur, Bunga Hayat Road Project	"	1065, 1066, 1073	3 Links	392
31. Rehabilitation of Lahore to India Road Project	"	1050	1 Link	123
32. Rehabilitation of Muzaffar-garh Mianwali Road Project	"	1092-1094	3 Links	712
33. Rehabilitation of Atharan Hazari, Khushab Road Project	"	1046	1 Link	153
34. Rehabilitation of Gujranwala, Sialkot, Wazirabad Road Project	"	1062, 1063	2 Links	301
35. Rehabilitation of Rawalpindi, Abbottabad Road Project	"	1024, 3011, 1025	3 Links	193
36. Rehabilitation of Peshawar, Charsadda, Mardan Road Project	"	3026, 3027	2 Links	63
37. Rehabilitation of Quetta, Loralai Road Project	"	4011	1 Link	309
38. Rehabilitation of Larkana, Jacobabad Road Project	"	2045	1 Link	54
39. Construction of Dadu, Moro Bridge to Project	"	2025	1 Link	214
40. Rehabilitation of Kashmir, Ubauro Bridge Project	"	2042	1 Link	40

41.	Grade up of Karachi, Hyderabad Road Project	Grade up	2023, 2024 2 Links	528
42.	Rehabilitation of Thatta, Sakrand Ling Road Project	Rehabilitation	2026-2033 8 Links	641
43.	Rehabilitation of Mir Pur Khas, Umar Kot Road Project	"	2022 1 Link	129
44.	Rehabilitation of Jacobabad, Kund Kot Road Project	"	2046 1 Link	110
45.	Rehabilitation of Mianwali, Talagang, Sohawa Road Project	"	1095, 1101, 1100 3 Links	415
46.	Rehabilitation of Faisalabad Lahore Road Project	"	1064 1 Link	154
47.	Rehabilitation of Kohat, Fatehjang Road Project	"	3015, 1029, 1030 3 Links	225
48.	Rehabilitation of Attock, Talagang Road Project	"	1097, 1098 2 Links	457
49.	Rehabilitation of Lodhran, Khanewal Road Project	"	1076, 1077 2 Links	209
50.	Rehabilitation of Jhang, Buruwald Road Project	"	1086-1088 3 Links	191
51.	Rehabilitation of Jhang, Dipalpur Road Project	"	1102, 1103, 1074 3 Links	163
52.	Rehabilitatioh of Rajana, Sargodha Road Project	"	1085, 1069, 1070, 1071 4 Links	834
53.	Rehabilitation of Mardan, Haripur Road Project	"	3028, 3029 2 Links	119
54.	Rehabilitation of Nowshera, Swabi Short Cut Road Project	"	3032 1 Link	28
55.	Rehabilitation of Shadan Lund, Ruknpur Road Project	"	1104-1106 3 Links	79

56.	Rehabilitation of Kot Addu, Karamdad Road Project	Rehabilitation	1107 1 Link	55
57.	Rehabilitation of Sahiwal, Bahawalnagar Road Project	"	1067, 1068 2 Links	177
58.	Rehabilitation of Vihari, Hassalpur Road Project	"	1075 1 Link	48
59.	Rehabilitation of Hyderabad, Badin Road Project	"	2034-2036 3 Links	179
60.	Rehabilitation of Matli, Copchali Road Project	"	2037-2040 4 Links	201
61.	Rehabilitation of Hala, Sanghar Road Project	"	2043, 2044 2 Links	176
62.	Rehabilitation of Hyderabad, Mirpur Khas Road Project	"	2020, 2021 2 Links	148
63.	Rehabilitation of Sujawal, Tando M. Khan Road Project	"	2041 1 Link	100
64.	Rehabilitation of Peshawar, Tor Kham Road Project	"	3004 1 Link	163
65.	Ghazi Ghat Bridge over River Indus	Bridge Construction	On-going Project	6
66.	Providing Carpetted Dual C/Way	Up Grade	"	30
67.	Special Repairs Karachi-Hyderabad Super Highway	Rehabilitation	"	49
68.	Const. of Dual C/Way between Nowshera-Peshawar	Construction of Dual C/Way	"	63
69.	Imp. & B/Topping of Darazinda Mughalkot Road	Improvement	"	5
70.	Const. of D.I.Khan-Darya Khan Bridge over River Indus	Construction of Bridge	"	165

71.	Imp. of Quetta-Sibi	Implementation	On-going Project	40
72.	Imp. and Wideneng of Quetta-Chaman Road	"	"	13
73.	Const. of Sind Hamid-Lora Bridge on N-25 at Mile 39	"	"	6
74.	Third H/Way Project	Third Highway Project	"	236
75.	Rd. Chakdara-Chitral 227 km	Rehabilitation	"	144
76.	W/R of Nawabshah-Sanghar Road	Wideneng	"	5
77.	Reconditioning of Badin Sujawal Thatta Road	Rehabilitation	"	1
78.	Ning of Tando Ghulam Ali Road	"	"	3
79.	Reconditioning of Gupjani Shahdadpur Road	"	"	10
80.	Reconditioning of Hala Shahdadpur Road	"	"	10
81.	Karachi- Hyderabad Super Highway	Karachi Hyderabad Super Highway	"	14
82.	W/R of Ubauro Guddo Rd.	Grade up	"	8
83.	Construction of Bridge over Bada Khawar in Mili 10, Swabi Topi Rd.	Construction of Bridge	"	7
84.	Improvement of Kohat Thal Road	Improvement	"	8
85.	Improvement & Widening of D.I. Khan-Bannu Rd.	"	"	5
86.	Improvement/Widening of Bannu -D.I.Khan Rd.Tajazai Fezu	"	"	9
87.	Construction of Dual Carriageway Nowshera-Mardan	Widening	"	35

88. Construction of Loralai D.G. Khan Road	Construction	On-going Project	7
89. Construction of Kanki Bridge	"	"	2
90. Construction of Sibi Harnai Road	"	"	16
91. Under Federal Budget		Outside the Study	8,789
92. Under Punjab Government Budget		"	11,896
93. Under Sind Government Budget		"	9,340
94. Under NWFP Government Budget		"	5,621
95. Under Baluchistan Government Budget		"	1,281
TOTAL			85,445

List of Projects Constituent Masterplan Alternatives A and B

Million Rs., Financial, 1981 Price

Mode	Name of Project	Cotents of Project	Remarks	Cost
2. Road Transport	1. Purchase Plan of Bus in Semi-Public Sector Project	4,660 Buses	Demand Forecast	3,936
	2. Purchase Plan of Bus by NLC Project	54 Buses	NLC Policy	46
	3. Purchase Plan of Trucks by NLC Project	2,550 Trucks	Replacement of Worn-out Facility	1,739
	4. Purchase Plan of New Truck by NLC Project	200 Trucks of 20 Ton Trucks	NLC Policy	136
	5. Purchase Plan of New Bowzer by NLC Project	55 Bowzers of 2,800 Litres Capacity	"	86
	6. Purchase Plan of Replacement of Bowzer by NLC Project	850 Bowzers	Replacement of Worn-out Facility	663
	7. Purchase Plan of New Trailer by NLC Project	150 Trailers 30 Ton Capacity	Copper Mining Project	115
	8. Purchase Plan of Container	1,190 Container Trucks of 40 ton Capacity	Containerization Project of Port	586
	9. Outside the Study	Purchase of Bus	Intra-city Use	3,686
	TOTAL			10,991

List of Projects Constituent Masterplan Alternative A

Million Rs., Financial, 1981 Price

Mode	Name of Project	Contents of Project	Remarks	Cost
3. Railway	1. Electrification of Samasata-Khanewal Project	Electrification	Speed up, Capacity Expansion, Energy Efficiency	314
	2. Electrification of Lodhran-Khanewal Project	"	"	297
	3. Electrification of Lahore Terminal Project	"	"	32
	4. Electrification of Sibi-Korpur	"	"	427
	5. Electrification of Karachi-Samasata Project	"	"	4,696
	6. Electrification of Lahore-Rawalpindi Project	"	"	568
	7. Rehabilitation of Karachi-Lalamusa Project	Replacement of Worn-out Track	Speed up	4,760
	8. Rehabilitation of Lalamusa-Peshawar Project	"	"	568
	9. Rehabilitation of Khanewal-Faisalabad-Wazirabad Project	"	"	711
	10. Rehabilitation of Shorkot-Sargodha Project	"	"	365
	11. Rehabilitation of Shershah-Kundian Project	"	"	664
	12. Rehabilitation of Rohri-Quetta Project	"	"	926
	13. Extension of Track in Main Stations Project	Construction of New Track Inside Station	Capacity Expansion	24
	14. Expansion of Terminals Project	Construction of New Terminal Expansion of 13 Stations	"	99

15. Inland Container Freight Station Project	Construction of Container Station	Containerization in Port	1,145
16. Freight Terminal Project	Construction of New Freight Terminal in Lahore	Capacity Expansion	173
17. Rehabilitation of Karachi-Lodhran, Signal and Communication Project	Level up and Rehabilitation of Signal and Communication Facilities	Rationalization	898
18. Rehabilitation of Lodhran-Multan-Khanewal Project	"	"	286
19. Rehabilatation of Lodhran-Lahore Project	"	"	680
20. Rehabilitation of Lahore-Rawalpindi Project	"	"	622
21. Rehabilitation of Rawalpindi-Peshawar Project	"	"	350
22. Rehabilitation of Khanewal-Faisalabad-Wazirabad Project	"	"	636
23. Regabilitation of Shorkot-Sargodha Project	"	"	330
24. Rehabilitation of Shershed-Kundian Project	"	"	507
25. Rehabilitation of Rohri-Quetta Project	"	"	683
26. Other Enforcement of Communication Facilities Project	"	"	28
27. Purchase Plan of EL for Samasata-Khanewal Project	Purchase of EL	Speed up, Capacity up	1,004
28. Purchase Plan of EL for Sibi-Kolpur	"	"	406

29. Purchase Plan of Passenger Wagon Project	Purchase of Passenger Wagon Project	Demand Forecast	2,143
30. Purchase Plan of Container Wagon Project	Purchase of New Wagon for Containerization	Containerization Project in Port	329
31. Replacement of EL Project	Purchase of 29 EL	Replacement of Worn-out Facilities and Capacity up	374
32. Replacement of DEL Project	Purchase of DEL	"	5,179
33. Purchase Plan of Passenger Wagon Project	Purchase of Passenger Wagon	Demend Forecast	3,041
34. Minor Projects		10% of the Amounts above Total	3,327
35. On-going Projects Loco Factory		On-going	800
36. On-Going Projects, Others		"	700
TOTAL			38,092

List of Projects Constituent Masterplan Alternatives A and B

Million Rs., Financial, 1981 Price

Mode	Name of Project	Contents of Project	Remarks	Cost
4. Port	1. Full Container Berth Project	Strategic Project of This Masterplan, Containerization in Port at Karachi	Containerization Project in Port	3,320
	2. Oil Berth Karachi Project	Oil Berth Construction at Karachi Port	Demand Forecast	120
	3. Small Boat Harbour Project	Small Boat Harbour Construction at Karachi		300
	4. Onshore Equipment Project	Equipment Installation at Karachi Port	Level up of Handling Capacity	117
	5. Offshore Equipment Project	Equipment Installation at Karachi Port	"	500
	6. Oil Berth Qasim Project	Oil Berth Construction	"	158
	7. Buoy Berth Project	Buoy Berth Construction at Qasim Port	"	1,300
	8. Fertilizer Terminal Project	Fertilizer Terminal Construction at Qasim Port	"	490
	9. Wheat Terminal Project	Wheat Terminal Construction at Qasim Port	"	256
	10. Dredger & Equipment Project	Dredger & Equipment Installation at Qasim Port	Level up of Handling Capacity	445
	11. Mini Port Project	Port Construction at Gwadar	Social Needs	326

12. Marine Academy Project	Marine Academy Establishment in Mauripur	Social Needs	240
13. Port Qasim Authority Project		On-going	1,168
14. Jinnah Bridge Phase II Project	Improvement of Jinnah Bridge at Karachi	Demand Forecast	200
TOTAL			8,740

List of Projects Constituent Masterplan Alternatives A and B

Million Rs., Financial, 1981 Price

Mode	Name of Project	Contents of Project	Remarks	Cost
5-1 Airport	1. Peshawar Airport Project	Car Parking, Terminal Building, Overlay Works for Runway and Taxiway	Demand Forecast	75
	2. D.I. Khan Airport Project	"	"	12
	3. Saidu Sharif Airport Project	"	"	17
	4. Chitral Airport Project	Apron, Car Parking, Overlay Works for Runway and Taxiway	"	20
	5. Faisalabad Airport Project	Car Parking, Terminal Building, Overlay Works for Runway and Taxiway	"	38
	6. Multan Airport Project	Apron, Car Parking, Terminal Building, Overlay Works for Runway and Taxiway	"	54
	7. Hyderabad Airport Project	Overlay Works for Runway and Taxiway	"	7
	8. Nawabshah Airport Project	Runway, Taxiway, Apron, Car Parking, Access Road, Terminal Building, Control Tower	"	186
	9. Moenjodaro Airport Project	Terminal Building, Overlay Works for Runway and Taxiway	"	24
	10. Sukkur Airport Project	Apron, Car Parking, Terminal Building, Overlay Works for Runway and Taxiway	"	29

11. Quetta Airport Project	Car Parking, Overlay Works for Runway and Taxiway	Demand Forecast	39
12. Panjgur Airport Project	Car Parking, Terminal Building, Apron, Overlay Works for Runway and Taxiway	"	23
13. Turbat Airport Project	Apron, Car Parking, Terminal Building, Overlay Works for Runway and Taxiway	"	23
14. Pasni Airport Project	Car Parking, Terminal Building, Overlay Works for Runway and Taxiway	"	20
15. Gwadar Airport Project	Apron, Car Parking, Terminal Building, Runway and Taxiway Expansion	"	57
16. Jiwani Airport Project	Car Parking, Terminal Building, Runway and Taxiway Expansion	"	33
17. Sui Airport Project	Car Parking, Terminal Building, Overlay Works for Runway and Taxiway	"	18
18. New Airport Project	Runway, Taxiway, Apron, Car Parking, Access Road and Terminal Building Construction for Local 8 New Airport	Social Needs	1,444

19. Islamabad Airport Porject	POL, Administration Office, Control Tower, VIP Bldg., Terminal Bldg., Car Parking, Apron, Taxiway, Runway, Overlay, Extension	Demand Forecast	927
20. Lahore Airport Project	Runway, Taxiway, Taxiway, Terminal Area Expansion	"	1,198
21. Karachi Airport Project	Runway, Taxiway, Pax Loading, Apron Expansion, Cargo Loading, Apron Expansion, Night Stay Apron, Existing Apron, International Pax Terminal, Car Parking, Domestic Pax Terminal	"	2,310
22. Pakistan Central and Network Project	Regional ATS Bldg., Training Facilities, Remotely Controlled VHF A/G Communication Facilities and up Grade of AFTN Network	Level up of Navigation System	616
23. ARSR/SSR En-Route Radar Network Plan Project	3 Sets of ARSR/SSR	"	491
24. Bannu Airport Project	Car Parking, Terminal Building, Overlay Works for Running and Taxiway	Demand Forecast	12
25. Ormara Airport Project	"	"	14
26. Air Navigation System Plan for Karachi International Airport		Level up of Navigation System	290

27. Air Navigation System Plan for Islamabad International Airport		Level up of Navigation System	234
28. Air Navigation System Plan for Lahore International Airport		"	194
29. Air Navigation System Plan in Minor Airports(1983-88)		"	211
30. Air Navigation System Plan in Minor Airports(1988-93)		"	108
31. Air Navigation System Plan in Minor Airports(1993-2000)		"	67
32. Interim Improvement of Terminal Building at Lahore Airport	Improvement	On-going Project	2
33. Interim Improvement of Terminal Building at Karachi Airport	"	"	2
34. Improvement and Expansion of Terminal Building at Ormara	"	"	2
35. Est. of Basic Aerodrome Facilities at Bannu	"	"	6
36. Improvement and Maderniza-tion of Aeronautical Commu-nication Facilities		"	27
37. Improvement of Existing Car Park and Payment of Army Land at Islamabad		"	1
38. Joint Fillin of Runway Apron and Taxi at Islamabad (UN-APP)		"	1

39.	Strengthening of Taxiway at Lahore Airport	On-going Project	3
40.	Emergent Repair of Runway at Lahore Airport	"	3
41.	Const. of Drain up to Charar. (Lahore Airport)	"	1
42.	Renovation of Electric System at Karachi Airport.	"	22
43.	Construction of Fillets on Intersection of Taxiway No. 233 at Karachi Apt.	"	2
44.	Filling of Joints of Runway Taxi and Apron at Karachi Airport	"	1
45.	Construction of Barracks Accommodation for ASF at Karachi Airport	Improvement	"	1
46.	Intruder Alarm System (Karachi Airport)	"	"	1
47.	Strengthening & Widening of Runway for Airbus Opr. (Faisalabad Airport)	"	"	37
48.	Barracks Accommodation for ASF at Peshawar Airport	"	"	1
49.	Construction of Residential Accommodation at Chitral Airport	"	"	1
	TOTAL			8,905

List of Projects Constituent Masterplan Alternatives A and B

Million Rs., Financial, 1981 Price

Mode	Name of Projects	Contents of Project	Remarks	Cost
5-2 Aviation	1. Purchase of Aircraft Project I	18 B-747	Demand Forecast	12,960
	2. Purchase of Aircraft Project II	9 DC-10	"	5,940
	3. Purchase of Aircraft Project III	15 A-300	"	6,750
	4. Purchase of Aircraft Project IV	19 Twin-jet	"	5,130
	5. Purchase of Aircraft Project V	24 F-27	"	1,920
	TOTAL			32,700

List of Projects Constituent Masterplan Alternatives A and B

Million Rs., Financial, 1981

Mode	Name of Project	Contents of Project	Remarks	Cost
6. Pipeline	1. Pipeline for POL Transport	Doubling Capacity of Karachi Multan Pipeline	Comprehensive Transport System	1,440
	TOTAL			1,440