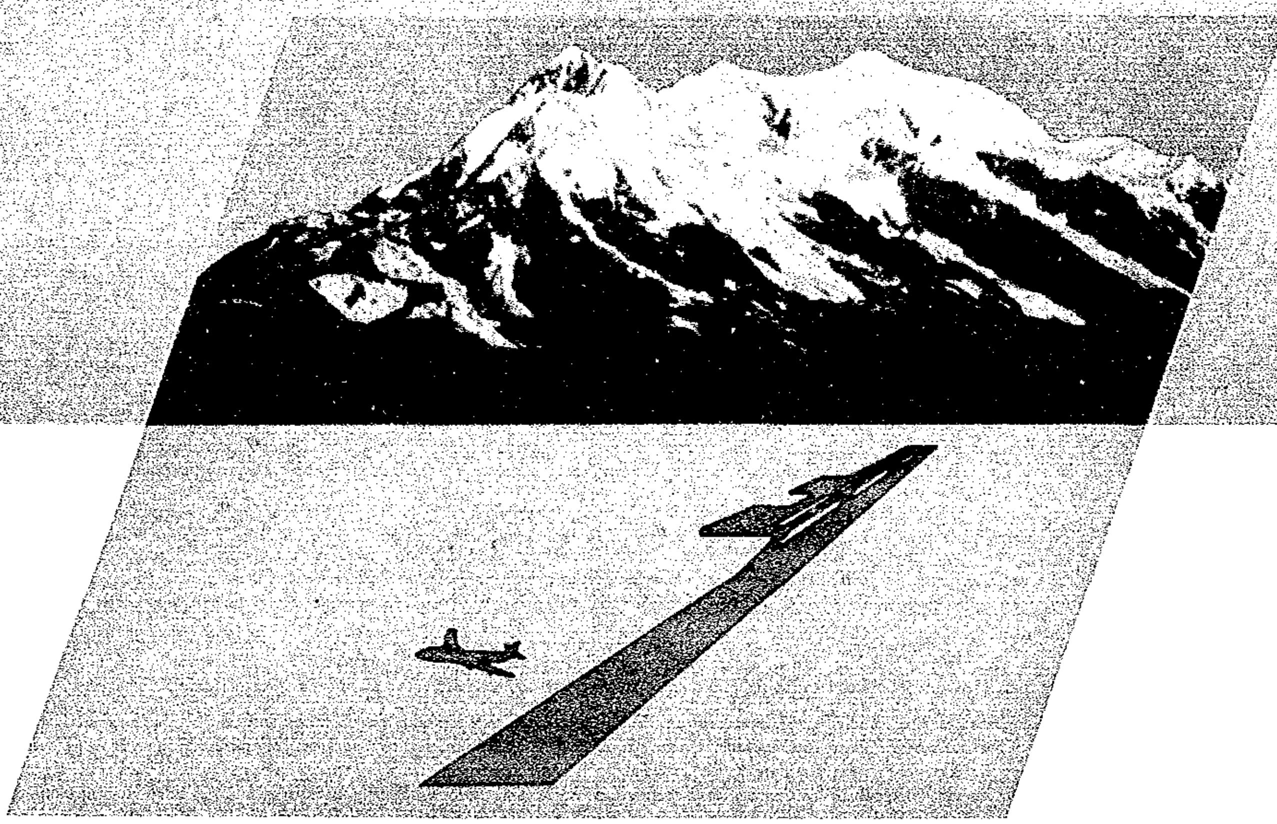
社会開発協力部報告書

No. 7

REPUBLIC OF BOLIVIA

FEASIBILITY STUDY ON EL ALTO AIRPORT MODERNIZATION PROJECT

SUPPORTING INFORMATION REPORT



FEBRUARY 1988

JAPAN INTERNATIONAL COOPERATION AGENCY

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88-002 (3/3)

REPUBLIC OF BOLIVIA FEASIBILITY STUDY ON EL ALTO AIRPORT MODERNIZATION PROJECT SUPPORTING INFORMATON REPORT FEBRUARY 1988

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CHAPTER 4 EVALUATION OF EXISTING AIRPORT FACILITIES

ABBREVIATION LIST

Decipherment List of Abbreviations Used in This Report

- A -

AASANA	Administracion de Aeropuentos y Servicios Auxiliares a la Navegacion Aerea
ACB	Air Circuit Breaker
ABN	Aerodrome Beacon
ACC	Area Control Center or Airport Consultative Committees
AFTN	Aeronautical Fixed Telecommunication Net work
AGL	Approach Guidance Lights or Above Ground Level
AFL	Air Field Lights
ALB	Approach Light Beacon
ALS	Standard Approach Light System
ALT	Altitude or Alternative
ARTS	Automated Radar Terminal System
ASDE	Airport Surface Detection Equipment
ASR	Airport Surveillance Radar
ASS	Airport Security System
APT	Automatic Picture Transmitter
ATC	Air Traffic Control
ATIS	Automatic Terminal Information Service
AR	Aerolimeas Argentinas
ADM	Administration
ARP	Aerodrome Reference Point
ATS	Air Traffic Services
ATZ	Aerodrome Traffic Zone
AMSL	Above Mean Sea Level
A/G	Air-Ground
ACFT	Aircraft
ANT	Antenna
APP	Approach Control or Approach Control Office
ARR	Arrival
AC	Alternating Current
AVR	Automatic Voltage Requlator

- B -

BLDG	Building
BOD5	Biochemical Oxygen Demand (5 days)
B/C	Benefit Cost

- C -

CAT	Category
COM	Communications
CCR	Constant Current Regulatons
CGL	Circling Guidance Lights
CIS	Central Information System
COMIBOL	Corporation Minera de Bolivia, Bolivian Mining Corportaion
CONAVI	Concejo Nacional de Vivienda, National Housing Bureau of the Ministry of Urbanization and Housing
COBEE	Compania Boliviana de Energia Electrica, Bolivian Electricity Company
CIQ	Customs, Immigration and Quarantine
C-VOR	Conventional VOR
CBR	California Bearing Ratio
CS	Cone Sampling
CTR	Control Zone
CRT	Cathode-Ray Tube

- D -

DF	Direction Finding
DME	Distance Measuring Equipment
DML	Runway Distance Marker Lights
DOM	Domestic
DIST	Distance
DL	Datum line
DEP	Departure
DH	Decision Height
DC	Direct Corrent
dB	decibel
DS	Disconnecting Switch

- E -

EA	Eastern Air Lines
ENTEL	National Telephone Company
ELEV	Elevation
EIRR	Economic Internal Rate of Return
EMG	Emergency

- F -

FAA	Federal Aviation Administration
FIC	Flight Information Center
FIRR	Financial Internal Rate of Return
FIR	Flight Information Region
FAB	Fuerza Aerea Boliviana, Bolivian Air Force
FAP	Final Approach Point
FIS	Flight Information Services
F/S	Fire Station
F/P	Flap
FAF	Final Approach Fix

- G -

GA	General Aviation
GRDP	Gross Regional Domestic Product
GS	Glide Slope
GSE	Ground Service Equipment
GDP	Gross Domestic Product
GND	Ground

- H -

HF	High Frequency (3000 to 30,000 kHz)
HI	High
HR	Hour(s)

- I -

ICAO	International Civil Aviation Organization
ILS	Instrument landing System
INE	Instituto nacional de Estadistica, Bolivia
INTL	International
ISB	Independent Sideband
IM	Inner Marker
IFR	Instrument Flight Rule
IDR	Instrument Departure Route
IF	Intermediate Fix
ISA	International Standard Atmosphere
ITV	Industrial Television

IMM	Immiguration
IATA	International Air Transport Association
IRR	Internal Rate of Return
IDF	Intermediate Distribution Frame

- J -

JCAB	Japan Civil Aviation Bureau
JJM	Jambo Jet mixed pax/freighten
JJP	Jambo Jet for Pax
JICA	Japan International Cooperation Agency

- K -

KVA	kilo Volt Ampere
KHZ	Kilohertz
KIAS	Knots Indicated Air Speed
KTAS	Knots True Air Speed

- L -

LAB	Lloyd Aereo Boliviano(LB)
LH	Lufthansa German Airlines
LJ	Large Jet Aircraft
LO	Locator, outer
LA	Lan Chile
LAI	Lina Aerea Imperial
LLZ	Localizer
LM	Locator, Middle
L/D	Landing
lbs	Pound
LBS	Load Break Switch

- M -

MET	Meteorological or meteorology
MJ	Medium Jet Aircraft
MLS	Microwave Landing System
MM	Middle marker

MHZ	Megahertz
MNM	Minimum
MAPt	Missed Approach Point
MDA	Ministerio de Aeronautica
MTOW	Maximum Take Off Weight
MIN	Minute
MSL	Mean Sea Level
MPX	Multiplex (equipment)
MOF	Metering Out fit

- N -

NDB	Non Directional Radio Beacon
NJ	Narrow Jet Aircraft
NM	Nautical Miles
NPV	Net Present Value
NA	Not Authorized

- O -

OCA	Obstacle Clearance Altitude
ACH	Obstacle Clearance Height
OL	Over run Lights
O/R	Over Run
OEW	Operating Empty Weight
OAT	Outside Air Temperature
OPS	Operations

- P -

PAPI	Precision Approach Path Indicator
PAR	Precision Approach Radar
PAX	Passenger
PCC	Portland Cement Concrete
PCN	Pavement Classification Number
PL	Aeroperu
P	Propeller driven Aircraft
POL	Petrol, Oils and Lubricants
P.F	Power Fuse

- Q -

QNH	Altimeter Sub-scale Setting to Obtain Elevation when on the Ground

- R -

RC	Rigid Concrete
REIL	Runway End Identification Lights
RWY	Runway
RWCL	Runway Center Line Lights
RWTL	Runway Touch-down Zone Lights
RWYL	Runway Edge Lights
RWL	Runway Edge Lights
RVR	Runway Visual Range
RX	Receiver

- S -

SALS	Simplified Approach Lighting System
SC	Cruzeiro
SFL	Sequenced Flashing Lights
SSB	Single Sideband
SSR	Secondary Surveillance Radar
SECT	Sector
SAMAPA	Servicio Autonomo Municipal de Agua Polable y Alcantarillado
SJ	Small Jet Aircraft
SMC	Surface Movement Control
SCF	Standard conversion Factors
SID	Standard Instrument Departure
SE	South-East

- T -

TACAN	UHF Tactical Air navigation Aid
TDZL	Touchdown Zone Light
TGS	Txiing Guidance Signs
TTY	teletype writer
TWCL	Taxiway Center line Lights
TWL	Taxiway Edge Lights

TWR	Aerodrome Control Tower
TAB	Transportes Aereos Bolivianos
TTL	Total
TMA	Terminal Control Area
THR	Threshold
TKOF	Take off
TX	Transmitter
T/O	Take Off
TWY	Taxiway
TEMP	Temperature
TOR	Take Off Run
TOD	Take Off Distance
TOA	Take Off Run Available
TP	Test Pits
TR	Transformer

- U -

UHF	Ultra High Frequency (300 to 3,000 MHz)
USAF	Fuerza Aerea de los EE, UU., United States Air Force
UK	United Kingdom
UPS	Uninterruptible Power System

- V -

VASIS	Visual Approach Slope Indicator System
VHF	Very High Frequency (30 to 300 MHz)
VOR	VHF Omnidirectional Radio Range
VCL	Vintical Curve length
VFR	Visual Flight Rule
VIP	Very Important Person
Vs	Stall speed
VIS	Visibility
VAR	Magnetic Variation
VCB	Vacuum Circuit Breaker

- W -

WDIL	Wind Direction Indicator Light
WECPNL	Weighted Equivalent Continuous Perceived Noise Level
WMO	World Meteorological Organization

WC	Water Closet
WX	Weather

– X –

YPFB	Yacimiento Petroliferos Fiscales Bolivianos (Boliviau national Petroleum Corporation)

City/Airport Codes Used in This Report

ARI	Arica, Chile
ASU	Asuncion, Paraguay
BUE	Buenos Aires, Argentina
CBB	Caracas, Venezuela
CLO	Cali, Colombia
FRA	Frankfurt International Airport, Federal Republic of Germany
IQQ	Iquique, Chile
JUJ	Jujuy, Argentina
LIM	Lima, Penu
LPB	La Paz, Bolivia
MAO	Manaus, AM Brazil
MAU	Maupiti Island, Society Is.
MIA	Miami International Airport, FL, USA
MTY	Monterrey General Mariano Escobedo Airport, Mexico
PTY	Panama City Omar Torrijos H Airport, Panama
RBQ	Rurrenabaque, Bolivia
RIO	Rio De Janeiro, RJ Brazil
SAO	Sao Paulo, SP Brazil
SCL	Santiago Comodoro Arturo Merino Benetez, Chile
SJU	San Juar, Puerto Rico
SLA	Salta, Argerlina
SRE	Sucre, Bolivia
SRZ	Sauta Cruz El Trompillo Airport, Bolivia
TDD	Trinidad, Bolivia
TJA	Tarija, Bolivia
UIO	Quito, Ecuador

Note : The above codes are assigned in accordance with ABC World Airways Guide.

CHAPTER 1 BACKGROUND OF THE PROJECT

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1.1 Socio - Economic Conditions in Bolivia

1.1.1 Natural Conditions

(1) Altiplano

This region comprises three departments namely; La Paz, Oruro and Potosi.

The climate is typical for a highland area. The annual average temperature is approximately 6° to 12°C, with the daily variation ranging from below 0° to more than 20°C during the daytime. The annual precipitation is 300 mm to 600 mm. La Paz city, the largest city in Bolivia, is the capital in practical with a population of nearly one million. (See Figure 1.1.1) Potosi and Oruro are centers of the mining industry particularly for tin.

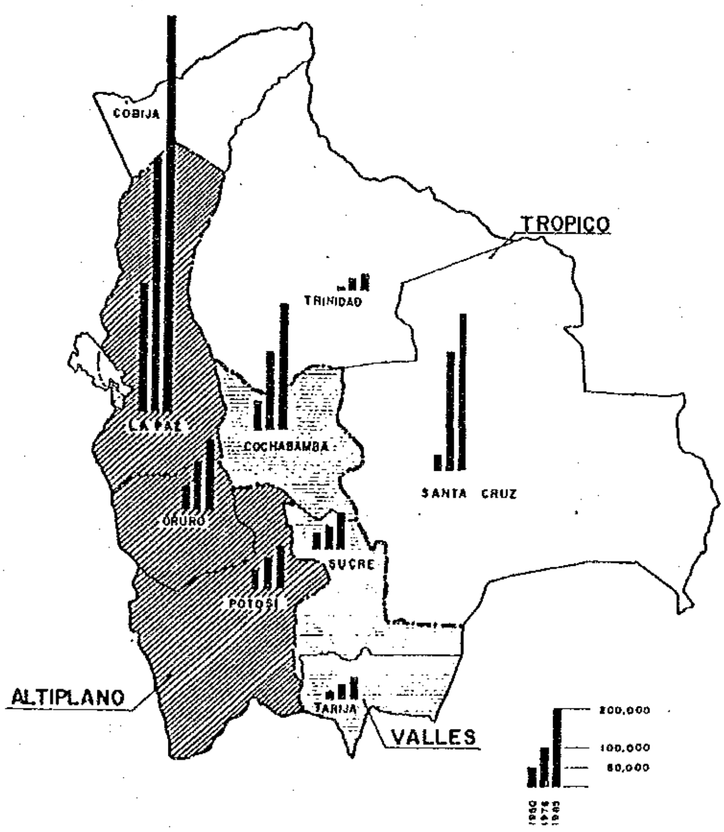


Figure 1.1.1 Three Regions and Population of Capital Cities

(2) Valles

This region comprises three departments namely; Cochabamba, Chuquisaca and Tarija.

Valles has a subtropical climate with an average annual temperature of 14° to 20°C. The precipitation is 500 mm to 800 mm annually.

Sucre city, is the constitutionally designated capital of Bolivia as well as the capital city of Chuquisaca Department. Cochabamba is the third largest city in Bolivia and is the center of agriculture. Tarija produces 7 % of the petroleum found in Bolivia.

(3) Tropico

This region adjacent to the Amazon River is a tropical rain forest zone with an annual average temperature of more than 24°C. The southern part near Argentina is less humid and more temperate.

The city of Santa Cruz has rapidly grown to be the second largest city in Bolivia particularly since the commencement of exploitation of petroleum and natural gas.

Beni and Pando have a poor for infrastructure land transportation. Beef produced in this region is transported by road and air to La Paz and other cities. The volume carried by road however is increasing particularly during the dry season.

1.1.2 Economic Conditions

(1) GDP in the Past

Bolivia enjoyed a favorable growth of the gross domestic product (GDP), at an annual rate of increase of 7.3 % up to year 1973, a little higher compared with the average of Latin American or developing countries. This was partly due to brisk business in the mining industry.

After 1973, however, the increase in the GDP rapidly decreased because of a flat market for mining which was a leading industry for Bolivian economic growth as well as for export during the 1960's and early 1970's. (See Figure 1.1.2)

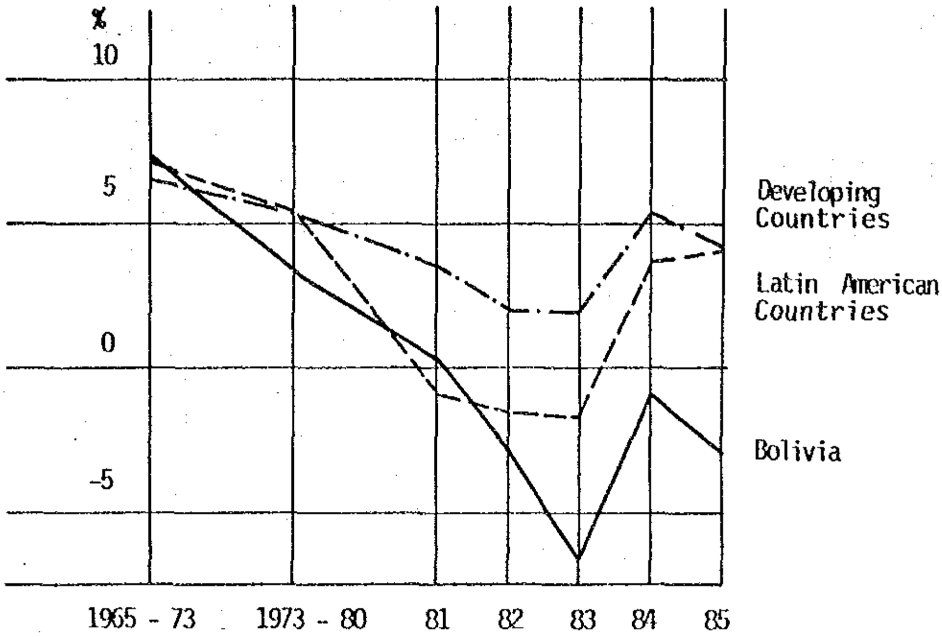


Figure 1.1.2 Growth Rate of GDP

In the 1980's, many developing countries suffered from a slowdown in economic development, although they maintained a 4 to 5 % growth rate despite two oil crises. Latin American countries, in particular, were faced with a decrease in per capita income and imports because of an unprofitable investment of loans and increase in the interest rate leading to tight money and decrease in exports.

Bolivia was not an exception. The GDP sharply decreased due to cumulative debts, and depressed export prices for primary products in mining. (See Table 1.1.1 and Figure 1.1.3)

Table 1.1.1 GDP in Bolivia (1980-86)

(Unit: Million Bolivian Peso in 1980 Constant Prices)

	1980	1981	1982(p)	1983(p)	1984(p)	1985(e)	1986(e)
Government Consumption	15,904	17,351	17.073	16.612	16,462	16.116	15,600
Private Consumption	82,258	82.475	79.479	76.234	76.114	76.624	75.910
Increase in Stocks	544	3.329	143	-2.029	-1.636	-2.036	-2.193
Gross Fixed Capital	17,514	17.085	14.887	14.188	13.146	13.104	13.522
Exports	31,521	32.125	32.821	31.311	31.937	31.522	30.928
Less Imports	-24.795	-28.990	-24.498	-24.266	-24.969	-26.217	-27.790
G D P	122.946	123.375	119.905	112.050	111.054	109.113	105.977

Source : Banco Central de Bolivia - Departamento de Cuentas Nacionales
Note : (p) Preliminary
(e) Estimated

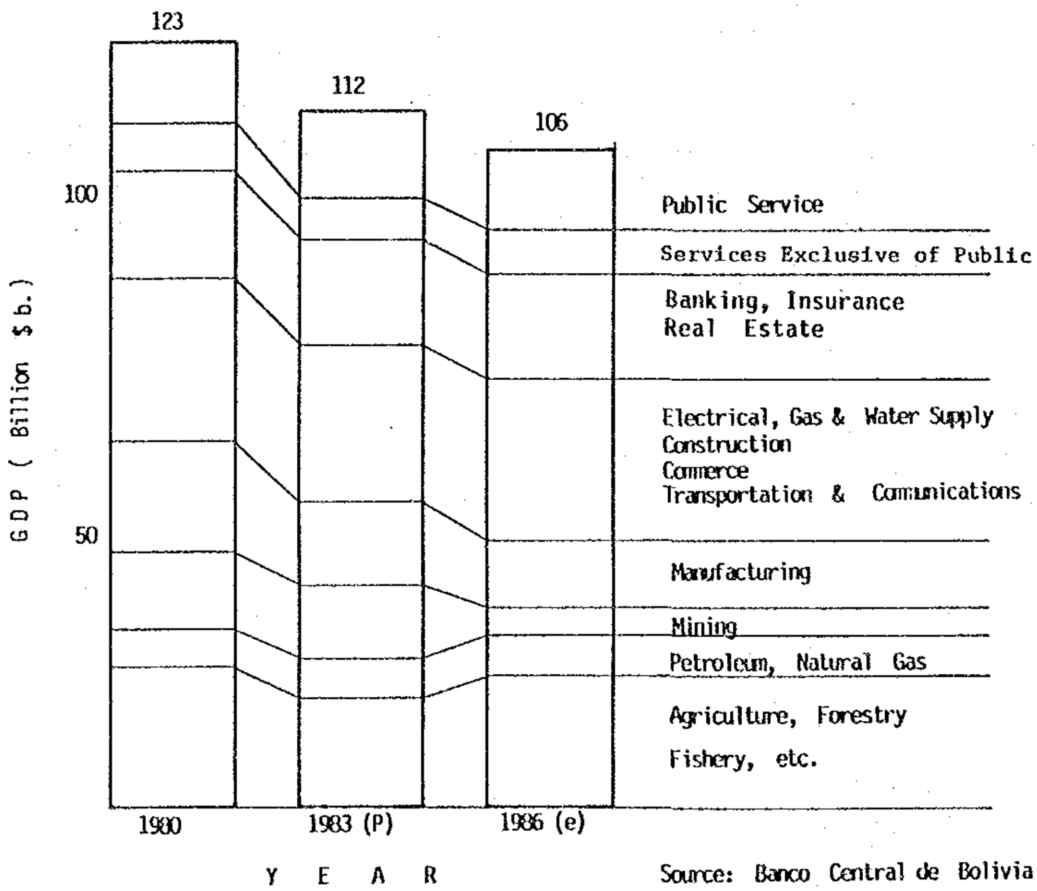


Figure 1.1.3 GDP by Economic Activity

(2) Hyper-Inflation

In 1982, when Bolivia suffered from a negative growth in GDP, the nation was beginning to experience a wide variation between the official exchange rate and an unofficial one against U.S. dollars due to an increased money supply to cover deficit finance and overestimated value of Bolivian pesos, which was followed by a excessive inflation. (See Figure 1.1.4)

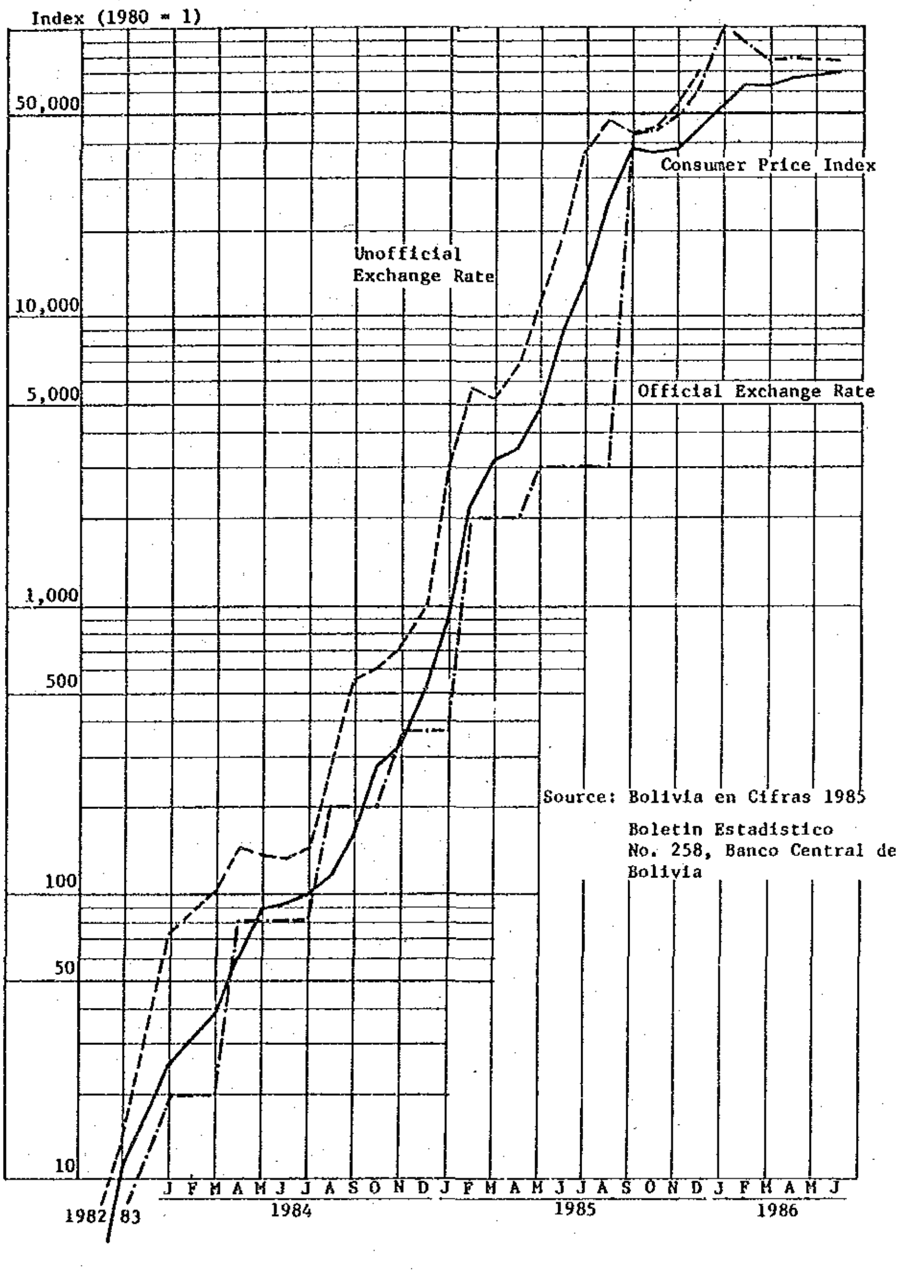


Figure 1.1.4 Consumer Price Index and Variation in Exchange Rate

The situation became more serious in 1983 when the Government was forced to abolish internal commercial transactions in U.S. dollars. The consumer price index skyrocketed 12,650 times, while the wholesale price index rose 13,900 times from 1982 to September 1985 when the Government implemented the flotation of exchange rate against U.S. dollars. Since then the prices have drastically stabilized. In the first half of 1986, the consumer price index increased by 17.8 %. The Bolivian economy will be restored by the stabilized prices.

(3) External Public Debt

Bolivia is one of the countries facing cumulative external debts. As of June 30, 1986, the total external public debt amounted to US$ 3,435 million, 4.4 times higher than all the exports in 1984. This may be a negative factor related to Bolivian economic growth in the future.

1.2 Socio-Economic Conditions in La Paz Department

1.2.1 Population

The population in La Paz Department was estimated to be 2,091 thousand in 1985. Nearly one third of the population lives in La Paz Department. The annual growth rate was 4.0 % from 1976 to 1985, a little lower than that for Santa Cruz Department which showed a 7 % annual growth rate from 1950 to 1976. The concentration of population in La Paz Department has increased again.

The city of La Paz is also estimated to have a high growth in population. From 1976 to 1985, the population of the City was said to increase by 5.1 % per annum, reaching 993,000 inhabitants, 44 % of the total population of the capital cities of all departments.

This is partly because the mine workers who lost their job due to the depressed mining industry migrated to the large cities to try to find opportunities for employment. This tendency will probably continue in the near future based on the fact that a brisk market for mining can not be seen in the foreseeable future.

Table 1.2.1 presents the employed and unemployed population in La Paz city.

Table 1.2.1 Employed and Unemployed Population in La Paz

Year	Economic Active Population	Employed	Unemployed	Rate of Unemployment (%)
1980	328,887	297,510	31,377	9.5
1981	326,895	303,145	23,750	7.3
1982	291,697	270,025	21,672	7.4
1983	309,754	269,983	39,771	12.8
1984	373,882	326,482	47,400	12.7

Source : Bolivia en Cifras 1985

1.2.2 Economy

The gross regional domestic product (GRDP) of La Paz Department was Bs. 28.307 billion in 1985 expressed in 1980 fixed prices. This was 27 % lower than that in 1978. The share of La Paz economy in GDP decreased from 31.1 % in 1978 to 27.6 % in 1985. This resulted from a drastic decrease of production in agriculture (-40.0 %), mining (-44.3 %), industry (-36.6 %) and construction (-44.3 %).

The Bolivian economy has been aggravated due to a flat market for mining. La Paz Department whose share in mining was 97 % suffered most from the aggravated Bolivian economy. In addition, the rapid population growth in recent years led to a sharp decrease in per capita GRDP.

The future GRDP for La Paz will largely depend on the growth of other economic activities such as industry, construction, commercial, government and private services in order to offset the decrease of production in mining.

Table 1.2.2 shows some socio-economic features of La Paz compared with other departments.

Table 1.2.2 Socio-Economic Conditions in Bolivia (1985)

	Area		Population		Population Density	G R D P		Per Capita G R D P	Share in G R D P by Sector						Road Traffic Counted at Traffic Control Post 1984	
	(1000Km)	(%)	(x1000)	(%)	(prsns/Km)	Share (%)	Annual Growth Rate (%)	(1980 US$)	Agriculture (%)	Mineral (%)	Petroleoum (%)	Industry (%)	Commercial (%)	Gobernment (%)	Passengers (x1000)	Cargo (x1000ton)
Bolivia	1,099	100.0	6,429	100.0	5.8	100.0	-2.0	692	100.0	100.0	100.0	100.0	100.0	100.0	17,590	2,242
Altiplano	306	27.8	3,382	52.6	11.1	44.6	-4.1	552	21.6	97.3	0.0	48.1	46.7	53.9	10,824	1,061
La Paz	134	12.2	2,091	32.5	15.6	27.6	-4.3	553	12.8	34.6	0.0	36.9	28.9	42.0	7,165	498
ORURO	54	4.9	413	6.4	7.6	7.9	-3.6	797	2.9	23.7	0.0	8.5	8.7	4.8	1,967	349
Potosi	118	10.7	878	13.7	7.4	9.1	-3.8	437	5.9	39.0	0.0	2.7	9.1	7.1	1,692	214
Valles	145	13.2	1,712	26.6	11.8	29.4	-1.8	721	48.3	2.7	13.5	27.4	28.1	24.2	5,436	918
Cochabamba	56	5.1	979	15.2	17.5	19.3	-1.2	827	32.3	2.7	0.0	20.7	17.4	17.5	4,162	381
Chuquisaca	51	4.6	463	7.2	9.1	5.9	-3.1	535	9.8	0.0	6.3	3.8	6.2	4.1	457	289
Tarija	38	3.5	270	4.2	7.1	4.2	-2.6	657	6.2	0.0	7.2	2.9	4.5	2.6	817	248
Tropico	648	59.0	1,335	20.8	2.1	26.0	-0.9	816	30.2	0.0	86.5	24.5	25.2	21.9	1,330	263
Santa Cruz	371	33.8	1,048	16.3	2.8	21.8	-0.5	870	21.8	0.0	86.5	23.1	20.8	19.3	1,330	263
Beni	213	19.4	240	3.8	1.1	3.4	-2.5	602	7.4	0.0	0.0	1.1	3.5	1.7	-	-
Pando	64	5.8	47	0.7	0.7	0.8	-2.9	703	0.9	0.0	0.0	0.3	0.9	0.9	-	-

Source: Bolivia en cifras 1985
Data from informacion Política y Economica (IPE) Edición 1121

1.2.3 Tourism

La Paz is rich in tourism resources compared with other departments in Bolivia. More than half of the foreign visitors stop over at La Paz, which is one of the important sources of foreign currency.

Hotel accommodation for foreign tourists is more abundant than that in other cities. Table 1.2.3 indicates the number of rooms and beds in hotels rated more than three stars that the major cities can provide.

Table 1.2.3 Hotel Accommodation in Major Cities (1984)

Cities	No. Hotels 3 - 5 Stars	No. of Rooms	No. of Beds
La Paz	9	968	1,849
Cochabamba	3	137	252
Oruro	1	108	119
Santa Cruz	3	308	660
Trinidad	1	36	72

In order to promote the tourism industry, it is necessary for La Paz to invest more for transport infrastructure and for software in the tourism industry. It will be worthwhile to plan a tourism development to promote economic growth in La Paz considering the economic conditions at the present time.

1.2.4 Urban Development Plan

La Paz allocated more public works funds for road pavement in the 1970's. The cumulative investment in this field from 1965 to 1981 reached 28 % of total budget of public works in La Paz City.

La Paz City asked a French Consultant to provide an urban development plan for La Paz. In the 1980's, however, the plan was deadlocked mostly due to lack of funds and an unstable political situation.

A future development plan may be reviewed to cope with the present situation in La Paz.

1.3 Air Transportation in Bolivia

1.3.1 Airports and Air Routes in Bolivia

(1) Airports

The airports under control by AASANA are shown in Figure 1.3.1.

The custom control airports which are designated in accordance with the provision of Article 10 of the Convention on International Civil Aviation (Chicago 1944) are nine airports as shown in Table 1.3.1. Among these custom airports, El Alto and Santa Cruz/Viru Viru airports are operated on a 24 hour basis.

The present air traffic volume handled at the airports in Bolivia is shown in Table 1.3.2 on domestic and Table 1.3.3 on international.

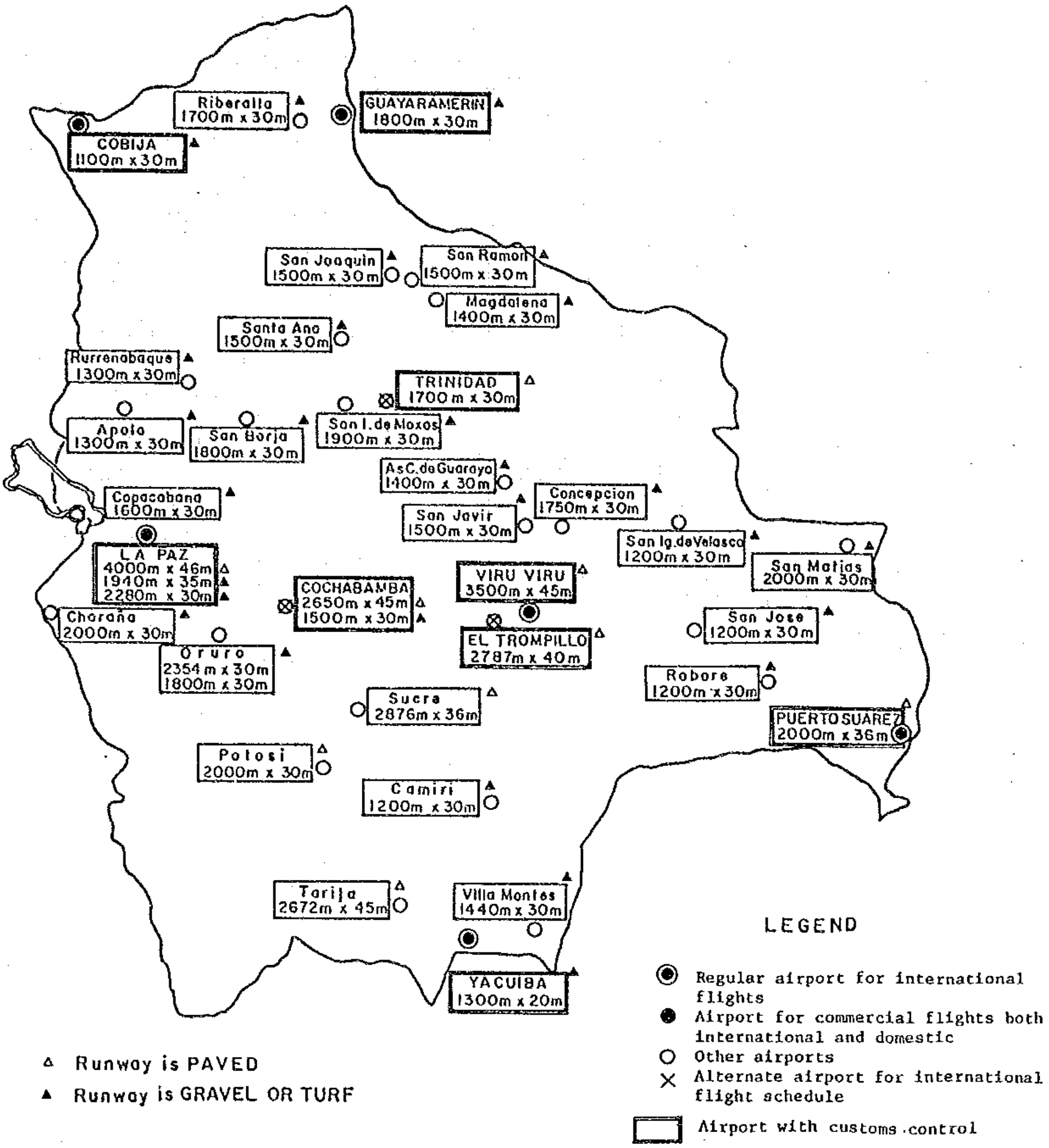


Figure 1.3.1 Airport Distribution in Bolivia

Table 1.3.1 List of Customs Airports in Bolivia

AEROPUERTOS INTERNACIONALES											
			TRAFICO			DESPACHOS					
CIUDAD/Aeródromo	Designador Art. 10	Aeródromo Sanitario	Regular	No Regular	Privado	Aduanas	Inmigración	Sanidad	HORAS DE SERVICIO	LIMITACIONES RELATIVAS AL USO DEL AERODROMO	INSTALACIONES PARA EL TRANSITO Y OBSERVACIONES
1	2	3	4	5	6	7	8	9	10	11	12
COBIJA	x		x	x	x	x	x	x*	HJ		*Se aplican medidas de Sanidad de acuerdo al párrafo 1.2.3 parte FAL 1-2
COCHABAMBA/Jorge Wilsterman	+ x		x	x	x	x	x	x	HJ		+De alternativa Internacional
GUAYARAMERIN	x		x	x	x	x	x	x*	HJ		++ 0900/2400 - 21 Sep/20 Jun 1000/2400 - 21 Jun/20 Sep
LA PAZ/John F. Kennedy	x		x	x	x	x	x	x*	H24		
PUERTO SUAREZ/Cap. de Av. S. OGAYA G.	x		x	x	x	x	x	x*	HJ		
SANTA CRUZ/EL Trompillo	+ x		x	x	x	x	x	x	++		
SANTA CRUZ/VIRU VIRU	x		x	x	x	x	x	x*	H24		
TRINIDAD/Tte. de Av. Jorge Henrich A.	+ x		x	x	x	x	x	x*	HJ		
YACUIBA	x		x	x	x	x	x	x*	HJ		

Table 1.3.2 Present Domestic Air Traffic Volume (As of 1985)

Airport		Passengers		Cargo (kg)		Aircraft Movements	
Category	Name	Scheduled	Non-scheduled	Scheduled*a	Non-scheduled	Scheduled	Non-scheduled*b
1	La Paz	409,798	2,984	3,642,033	12,291,447	4,376	5,420
	Santa Cruz	584,889	9,538	4,882,850	819,467	6,336	23,292
2	Cochabamba	445,436	595	3,082,518	4,181,478	5,712	4,606
	Trinidad	111,679	179	1,716,761	1,512,075	2,248	17,524
	Sucre	130,373	2,260	712,689	51,868	1,650	432
	Puerto Suarez	24,133	620	131,745	100,141	234	926
	Tarija	88,708	329	962,487	42,848	1,104	186
3	Oruro	-	-	-	17,776	-	68
	Yacuiba	1,310	376	5,162	22,939	54	248
	Guayaramerin	15,663	49	142,473	75,513	792	3,750
	Cobija	1,795	47	18,619	159,337	108	184
	San Borja	1,928	435	18,330	1,727,013	116	4,324
	Santa Ana	7,758	335	64,784	686,399	282	13,922
	Camiri	9,406	16,553	74,231	613,791	434	1,682
	Riberalta	6,305	-	106,478	4,951	388	2,902
	Potosi	-	-	-	-	-	334
4	Magdalena	3,698	70	37,446	808,003	286	1,570
	Apolo	-	12	-	138,484	-	110
	Robore	-	5	-	50,138	-	282
	San Ignacio de Velasco	5,101	-	24,663	-	184	1,420
	San Jose	-	19	-	230	-	98
	Rurrenabaque	-	22	-	238,096	-	348
	San Ignacio de Moxos	-	406	-	1,650,568	-	566
	San Joaquin	3,092	2	27,074	77,529	264	2,092
	Reyes	1,183	101	13,852	730,307	68	-
	San Ramon	-	9	-	77,386	2	3,630
	Villamontes	1,479	190	12,447	76,329	112	118
	San Matias	-	16	-	108,886	-	-
	Bermejo	244	1,637	1,478	67,446	6	12
	Varios	-	16,517	-	9,667,109	-	-
	Concepcion	1,038	-	2,850	-	86	262
	Others	-	-	-	-	-	896
TOTAL		1,855,016	53,306	15,680,970	36,034,554	24,842	91,204

Source: Boletin Estadistico 1985, AASANA
Note, *a: Including paid cargo and excess baggage
*b: Including general aviation and small carriers for meat cargo

Table 1.3.3 Present International Air Traffic Volume (As of 1985)

Airport	Passengers		Cargo *a (kg)	Aircraft Movements	
	Embarked/Disembarked	Transit		Scheduled	Non-scheduled
La Paz	132,530	6,062	5,789,411	2,566	74
Santa Cruz	98,746	1,299	4,165,035	2,676	158
Cochabamba	29,397	-	1,007,047	58	8
Others	2,149	-	15,647	100	80
Total	262,822	7,361	10,977,140	5,400	320

Source: Boletin Estadistico 1985, AASANA

Note, *a: Including paid cargo and excess baggage

1.3.2 Airline Companies

The fleet possessed by LAB is shown in Table 1.3.4.

Table 1.3.4 Fleet Possessed by LAB

Type of aircraft	Number of seats	Number of Aircraft
B - 727 - 100	122	3
B - 727 - 200	164	3
B - 707 - 320	178	1
B - 707 - 320F	-	1
Fairchild F - 27	40	2
Fokker F - 27	40	1
Total		11

1.3.3 Air Transportation Trend

(1) Domestic Passengers

The number of domestic passengers in Bolivia and at El Alto airport are summarized in Table 1.3.5 for the past 15 years.

Table 1.3.5 Embarked/Disembarked Domestic Passengers

(Unit : 1000 Passengers)

Year	Bolivia	El Alto Airport	Share (%)
1971	434	113	26
1972	495	126	25
1973	458	111	24
1974	618	156	25
1975	791	196	25
1976	923	242	26
1977	1,116	307	28
1978	1,410	398	28
1979	1,658	472	28
1980	1,865	489	26
1981	1,648	445	27
1982	1,660	412	25
1983	2,006	444	22
1984	1,896	441	23
1985	1,908	413	22
Annual Growth Rate (%)			
1971-75	16.2	14.8	
1975-80	18.7	20.1	
1980-85	0.5	-3.3	
1971-85	11.2	9.7	

Source : Boletin Estadistico, AASANA

The number of domestic passengers increased rapidly in the 1970's. In the 1980's the increase slowed down and El Alto airport showed a little decrease in the number of passengers.

The number of passengers between El Alto airport and the other major airports is presented in Figure 1.3.2. Passenger traffic between La Paz and Santa Cruz reached more than 40 % of the total between El Alto and the other airports in Bolivia.

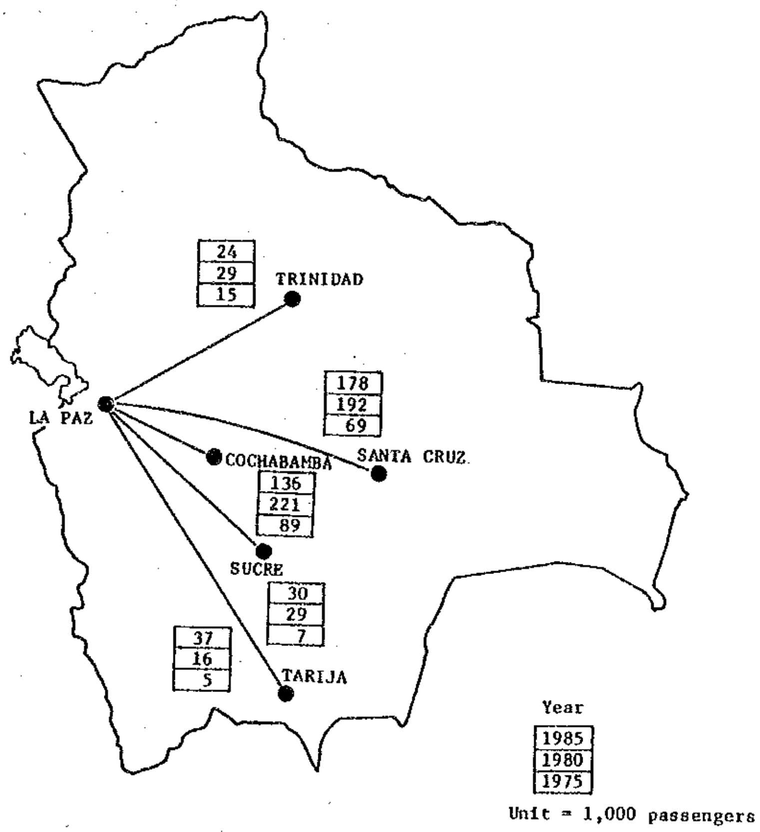


Figure 1.3.2 Domestic Passengers between La Paz and Other Major Cities (As of July 1987)

(2) International Passengers

The number of international passengers in Bolivia and at El Alto airport are summarized in Table 1.3.6.

Table 1.3.6 Embarked/Disembarked International Passengers

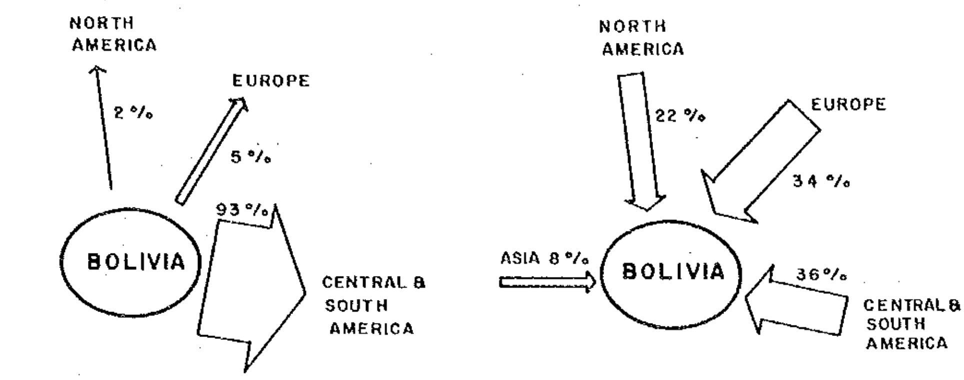
(Unit : 1000 Passengers)

Year	Bolivia	El Alto Airport	Share (%)
1971	103	77	75
1972	122	90	74
1973	128	96	75
1974	160	111	69
1975	195	131	67
1976	232	143	62
1977	257	162	63
1978	275	166	60
1979	301	171	57
1980	309	163	53
1981	299	161	54
1982	206	113	55
1983	232	135	58
1984	247	133	54
1985	263	133	51
Annual Growth Rate (%)			
1971-75	17.3	14.2	
1975-80	9.6	4.5	
1980-85	-3.2	-4.0	
1971-85	6.9	4.0	

Source : Boletin Estadistico, AASANA

In 1982, the number of international passengers suddenly decreased by 30 %, however they have been gradually increasing in recent years.

Figure 1.3.3 illustrates where the Bolivian people go for international travel and where foreign visitors come from to Bolivia.



BOLIVIANS DEPARTING TO　　　　FOREIGNERS ARRIVING FROM

Figure 1.3.3 International Passengers by Zone

(3) Domestic Cargo

Data on domestic cargo provided by AASANA includes general aviation traffic, particularly for hauling meat. Since the hauling of meat will be treated separately, the domestic cargo without meat hauled in Bolivia was summarized from the ICAO Digest of Statistics. Domestic cargo handled at El Alto airport was estimated by determining the actual share of the airport of all domestic cargo in Bolivia, the results of which are summarized in Table 1.3.7.

Table 1.3.7 Domestic Cargo

Unit: ton

Year	Bolivia*	El Alto Airport	
			Share (%)**
1971	7,234	3,255	50
1972	7,816	3,126	40
1973	6,278	2,197	35
1974	6,186	1,485	24
1975	5,006	1,452	29
1976	6,608	2,108	32
1977	7,102	2,393	34
1978	8,960	3,261	36
1979	10,868	3,782	35
1980	11,082	4,056	37
1981	9,332	3,098	33
1982	8,928	3,089	35
1983	14,306	5,093	36
1984	15,492	6,135	40
Annual Growth Rate (%)			
1976-80	13.8	17.8	
1980-84	8.7	10.9	
1976-84	11.2	14.3	

SOURCE: * ICAO Digest of Statistics
** Boletin Estadistico, AASANA

Domestic cargo which decreased in 1982 was increased two fold in 1984.

Meat cargo, which was at the highest level in 1978 was decreasing at an annual rate of 7.5 %. The past trend of meat cargo at El Alto airport is shown in Table 1.3.8.

Table 1.3.8 Meat Cargo at El Alto Airport

Unit: ton

Year	All Cargo	Meat Cargo	Share of G.A. (%)
1976	22,873	20,765	91
1977	27,265	24,872	91
1978	31,021	27,760	90
1979	29,285	25,503	87
1980	27,274	23,218	85
1981	26,515	22,417	88
1982	18,396	15,307	83
1983	23,931	18,838	79
1984	23,492	17,357	74

Note: Estimated by the Study Team on the Basis of data from the ICAO Digest of Statistics and Boletin Estadistico, AASANA

(4) International Cargo

International cargo in Bolivia and at El Alto airport is presented in Table 1.3.9 for the past 15 years.

Table 1.3.9 International Cargo

(Unit : Ton)

Year	Bolivia	El Alto Airport	Share (%)
1971	3,214	2,081	65
1972	3,690	2,007	54
1973	4,357	2,526	58
1974	3,971	3,428	86
1975	4,602	3,848	84
1976	5,835	4,310	74
1977	8,865	5,100	58
1978	11,368	5,940	52
1979	11,199	5,534	49
1980	11,652	4,498	39
1981	15,936	6,833	43
1982	8,121	3,722	46
1983	5,481	3,295	60
1984	8,015	4,938	62
1985	10,978	5,790	53
Annual Growth Rate (%)			
1971-75	9.4	16.6	
1975-80	20.4	3.2	
1980-85	-1.2	5.2	
1971-85	9.2	7.6	

Source : Boletin Estadistico, AASANA

Around 70 % of international cargo was incoming one at El Alto airport in early 80's, but the percentage exceeded 80 % in 1984 and 85.

(5) Aircraft Movements

Aircraft movements in Bolivia are classified based on the statistical bulletin of AASANA as follows:

Classification

Classification	(Note 1)
Commercial Aviation	
Domestic	
Scheduled	: LAB
Non-scheduled	
General Aviation	: TAB, LAI, Aero Inca, etc.
Small carriers for meat cargo	: Frigorifico Reyes, etc.
International	
Scheduled	: LAB, Lufthansa, etc.
Non-scheduled	: Ditto
Military and Training	: FAB, Pilot School, USAF, etc.

Note 1,

LAB : Lloyd Aereo Boliviano
TAB : Transportes Aereos Bolivianos
LAI : Linea Aerea Imperial
FAB : Fuerza Aerea Boliviana, Bolivian Air Force
USAF: Fuerza Aerea de los EE.UU., United States Air Force

The proportions of aircraft movements by classification in Bolivia and La Paz are shown in Tables 1.3.10 and 11.

Table 1.3.10 Proportion of Aircraft Movements in Bolivia

Classification	Proportion (%)		
	1976	1980	1985
Commercial Aviation			
Domestic			
Scheduled	18.3	18.5	14.8
Non-scheduled			
General Aviation	47.7	46.6	49.6
Small Carriers for Meat Cargo	11.1	8.0	4.7
International			
Scheduled	4.6	4.5	3.2
Non-scheduled	0.3	0.2	0.2
Military and Training	18.0	22.2	27.5
Total	100	100	100

Source : Boletin Estadistico, AASANA, 1976 - 1985

Table 1.3.11 Proportion of Aircraft Movements in La Paz

Classification	Proportion (%)		
	1976	1980	1985
Commercial Aviation			
Domestic			
Scheduled	16.8	21.9	21.2
Non-scheduled			
General Aviation	9.4	5.5	9.3
Small Carriers for Meat Cargo	30.9	24.4	17.0
International			
Scheduled	14.2	12.1	12.4
Non-scheduled	0.3	0.02	0.4
Military and Training	28.4	36.1	39.7
Total	100	100	100

Source : Boletin Estadistico, AASANA, 1976 - 1985

a) Commercial Aviation

i) Domestic Aircraft Movements

Annual domestic aircraft movements and their annual growth rate in Bolivia and La Paz are shown in Tables 1.3.12 and 13 respectively.

Table 1.3.12 Annual Domestic Aircraft Movements in Bolivia

Year	Scheduled		Non-scheduled			
			General Aviation		Small Carriers for Meat Cargo	
	Aircraft Movements	Growth Rate (%)	Aircraft Movements	Growth Rate (%)	Aircraft Movements	Growth Rate (%)
1976	21,482		55,916		13,050	
1977	22,542	4.9	62,470	11.6	11,552	-11.5
1978	23,292	3.3	57,416	-8.0	13,494	16.8
1979	25,292	8.6	81,488	41.9	14,428	6.9
1980	28,930	14.4	72,892	-10.5	12,576	-12.8
1981	24,910	-13.9	64,204	-11.9	12,208	-2.9
1982	25,300	1.6	84,110	31.0	11,024	-9.7
1983	26,058	3.0	85,908	2.1	10,508	-4.7
1984	23,514	-9.8	92,938	8.2	8,764	-16.6
1985	24,842	5.6	83,314	-10.4	7,890	-10.0

Source : Boletin Estadistico, AASANA, 1976 - 1985

Table 1.3.13 Annual Domestic Aircraft Movements in La Paz

Year	Scheduled		Non-scheduled			
			General Aviation		Small Carriers for Meat Cargo	
	Aircraft Movements	Growth Rate (%)	Aircraft Movements	Growth Rate (%)	Aircraft Movements	Growth Rate (%)
1976	3,594		2,010		6,606	
1977	4,142	15.2	4,052	101.6	4,880	-26.1
1978	5,150	24.3	1,988	-50.9	7,220	48.0
1979	5,594	8.6	2,160	8.7	6,686	-7.4
1980	5,988	7.0	1,490	-31.0	6,654	-0.5
1981	5,442	-9.1	2,086	40.0	7,590	14.1
1982	5,066	-6.9	2,240	7.4	5,232	-31.1
1983	4,876	-3.8	2,706	20.8	5,370	2.6
1984	4,644	-4.8	2,890	6.8	4,318	-19.6
1985	4,376	-5.8	1,912	-33.8	3,508	-18.8

Source : Boletin Estadistico, AASANA, 1976 - 1985

ii) International Aircraft Movements

Annual international aircraft movements and their annual growth rate in Bolivia and La Paz are shown in Tables 1.3.14 and 15 respectively.

Table 1.3.14 Annual International Aircraft Movement in Bolivia

Year	Scheduled		Non-scheduled	
	Aircraft Movements	Growth Rate (%)	Aircraft Movements	Growth Rate (%)
1976	5,368		330	
1977	5,724	6.6	530	60.6
1978	6,156	7.5	944	78.1
1979	7,546	22.6	334	-64.6
1980	7,046	-6.6	280	-16.2
1981	6,472	-8.1	296	5.7
1982	5,170	-20.1	82	-72.3
1983	4,968	-3.9	178	117.1
1984	5,210	4.9	256	43.8
1985	5,400	3.6	320	25.0

Source : Boletin Estadistico, AASANA, 1976 - 1985

Table 1.3.15 Annual International Aircraft Movements in La Paz

Year	Scheduled		Non-scheduled	
	Aircraft Movements	Growth Rate (%)	Aircraft Movements	Growth Rate (%)
1976	3,020		70	
1977	3,320	9.9	2	-97.1
1978	3,386	2.0	104	52.0
1979	3,660	8.1	60	-42.3
1980	3,308	-9.6	6	-90
1981	3,030	-8.4	16	166.6
1982	2,418	-20.2	34	112.5
1983	2,692	11.3	34	0
1984	2,612	-3.0	62	82.4
1985	2,566	-1.8	74	19.4

Source : Boletin Estadistico, AASANA, 1976 - 1985

b) Military and Training Aircraft Movements

The annual number of aircraft movements and the annual growth rate of military and training in Bolivia and La Paz are shown in Table 1.3.16.

Table 1.3.16 Annual Military and Training Aircraft Movements in Bolivia and La Paz

Year	Bolivia		La Paz	
	Aircraft Movements	Growth Rate (%)	Aircraft Movements	Growth Rate (%)
1976	21,102		6,070	
1977	26,352	24.9	6,072	0.03
1978	27,138	3.0	5,632	-7.2
1979	40,050	47.6	9,674	71.8
1980	34,766	-13.2	9,848	1.8
1981	62,836	80.7	11,436	16.1
1982	68,290	8.7	11,248	-1.6
1983	44,578	-34.7	8,498	-24.4
1984	47,848	7.3	9,196	8.2
1985	46,158	-3.5	8,176	-11.1

Source : Boletin Estadistico, AASANA, 1976 - 1985

1.4 Other Transportation Systems

1.4.1 Road Transportation

The total length of the road network in Bolivia is 40,987 Km, of which only 1,538 Km are paved. Road density by department is tabulated in Table 1.4.1.

Table 1.4.1 Road Density by Department (1984)

DEPARTMENT	Road Length (Km)				Road Density (Km/ 1,000 Km^2)
	Total	Paved	Gravel	Earth	
Bolivia	40,987	1,538	9,268	30,181	37.3
Altiplano	21,861	476	4,497	16,888	71.4
La Paz	6,199	294	2,146	3,759	46.3
Oruro	6,571	174	1,157	5,240	121.7
Postosi	9,091	8	1,194	7,889	77.0
Valles	10,583	599	3,019	6,965	73.0
Cochabamba	3,078	539	1,089	1,450	55.0
Chuquisaca	4,598	13	902	3,683	90.2
Tarija	2,907	47	1,028	1,832	76.5
Tropico	8,543	463	1,752	6,328	13.2
Santa Cruz	6,348	456	1,073	4,819	17.1
Beni	1,617	5	640	972	7.6
Pando	578	2	39	537	9.0

Source : Bolivia en Cifras 1985

Some road construction work and planning is now under way to extend a road network to the north in Tropico. (See Figure 1.4.1)

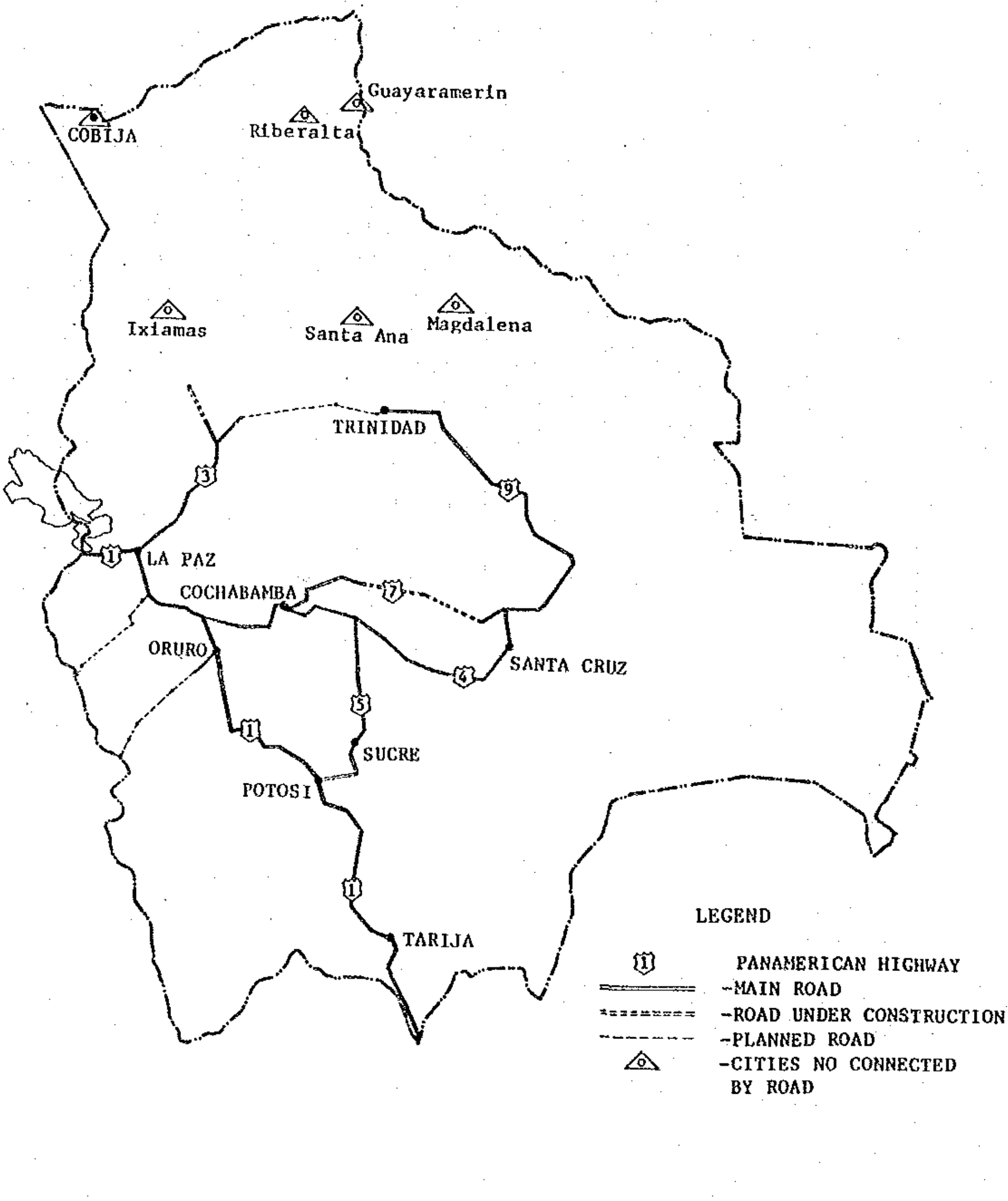


Figure 1.4.1 Road Network in Bolivia

The existing road network in Bolivia consists of three trunk roads, i.e., Pan American Highway (National Highway Route 1), National Highway Route 4 and Route 5.

The Pan American Highway starts at the border to Peru and passes through La Paz, Oruro and Potosi continuing to the Argentina border. National Highway Route 4 connects Oruro with the fast-growing city of Santa Cruz via Cochabamba. Construction is under way between Cochabamba and Santa Cruz on a new alignment. When this new route is completed, the travel time by vehicle will be reduced by half, to about 6 hours between these two cities. Route 5 is diverted from Route 4 between Cochabamba and Santa Cruz to Potosi via Sucre.

Using this road network, road transportation has played a most important role in the movement of passengers and cargo. The number of registered vehicles increased steadily with an annual growth rate of 7.5 % from 1980 to 84. Road transportation will continue to play a leading role in the domestic transportation both system for passengers and cargo.

1.4.2 Railroad Transportation

The railroad system in Bolivia is divided into two parts, i.e., Eastern and Western networks. There is no connecting line between these systems. The western line is 2,202 Km long, while the eastern line is 1,426 Km long. The section between Santa Cruz and Cochabamba has no railroad.

The passengers and cargo carried by the railroad are illustrated in Figures 1.4.2 and 3. The schedule is sometimes cancelled due to the lack of rolling stock.

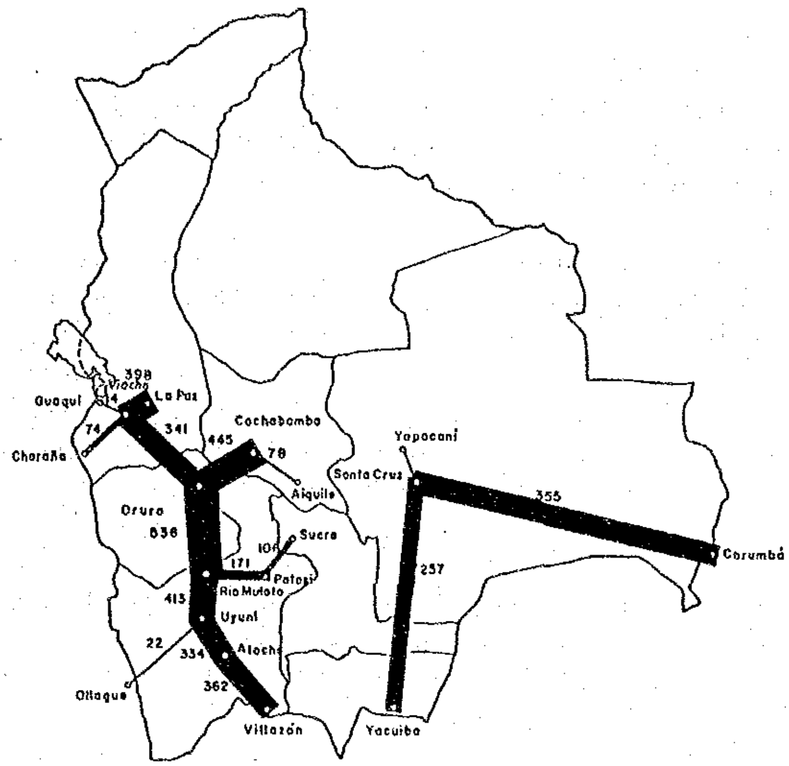


Figure 1.4.2 Passengers Carried by Railroad

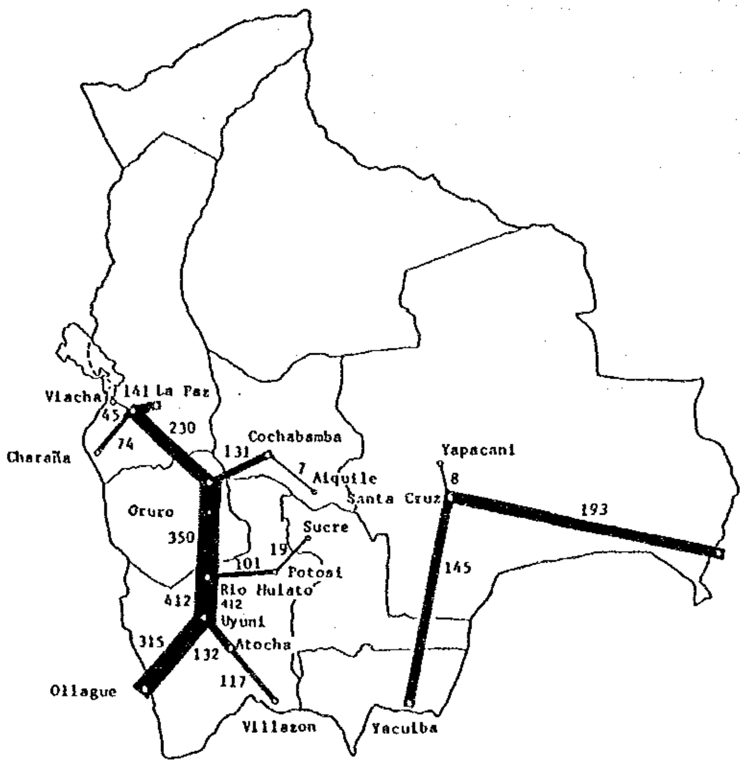


Figure 1.4.3 Cargo Carried by Railroad

1.4.3 Others

In order to evaluate the competitive role of each transport mode, Table 1.4.2 summarizes the present travel time and tariff by mode between La Paz and other major cities in Bolivia.

Table 1.4.2 Travel Time and Tariff by Transportation Mode

	DISTANCE (km)	TIME (hour)	PRICE (Bs)
La Paz - Oruro			
BUS	230	3.3-6.0	5.2
TRUCK	-	4.0	2.8
RAILROAD	248	5.0	5.0
AIRCRAFT	-	-	-
To Cochabamba			
BUS	454	8.0-10.3	12.2
TRUCK	-	12.0	4.4
RAILROAD	498	7.8	11.2-16.8
AIRCRAFT	-	0.3	40.0
To Postosi			
BUS	585	10.0-13.0	16.0-18.2
TRUCK	-	40.0	7.2
RAILROAD	688	14.0	12.8-19.2
AIRCRAFT	-	1.0	-
To Sucre			
BUS	740	13.3-18.0	21.0-25.0
TRUCK	-	48.0	10.2
RAILROAD	945	-	12.4-18.6
AIRCRAFT	-	0.7	48.0
To Tarija			
BUS	973	24.0	34.2-35.5
TRUCK	-	50.0	11.28
RAILROAD	-	-	-
AIRCRAFT	-	1.0	62.0
To Santa Cruz			
BUS	951	24.0-35.0	30.0-34.2
TRUCK	-	48.0	10.23
RAILROAD	-	-	-
AIRCRAFT	-	0.8	71.0

Source : Empress Nacional de Ferrocarriles
Estimated by the Study Team based on available data

CHAPTER 2 AIR TRAFFIC ANALYSIS AND DEMAND FORECAST

CHAPTER 2 AIR TRAFFIC ANALYSIS AND DEMAND FORECAST

2.1 Demand Forecast Annual Air Traffic Passengers

2.1.1 Methodology

(1) Correlation with GDP in the Past

In the 1970's the trend of domestic and international passenger traffic showed a close correlation with that of the GDP in Bolivia as presented in Figure 2.1.1.

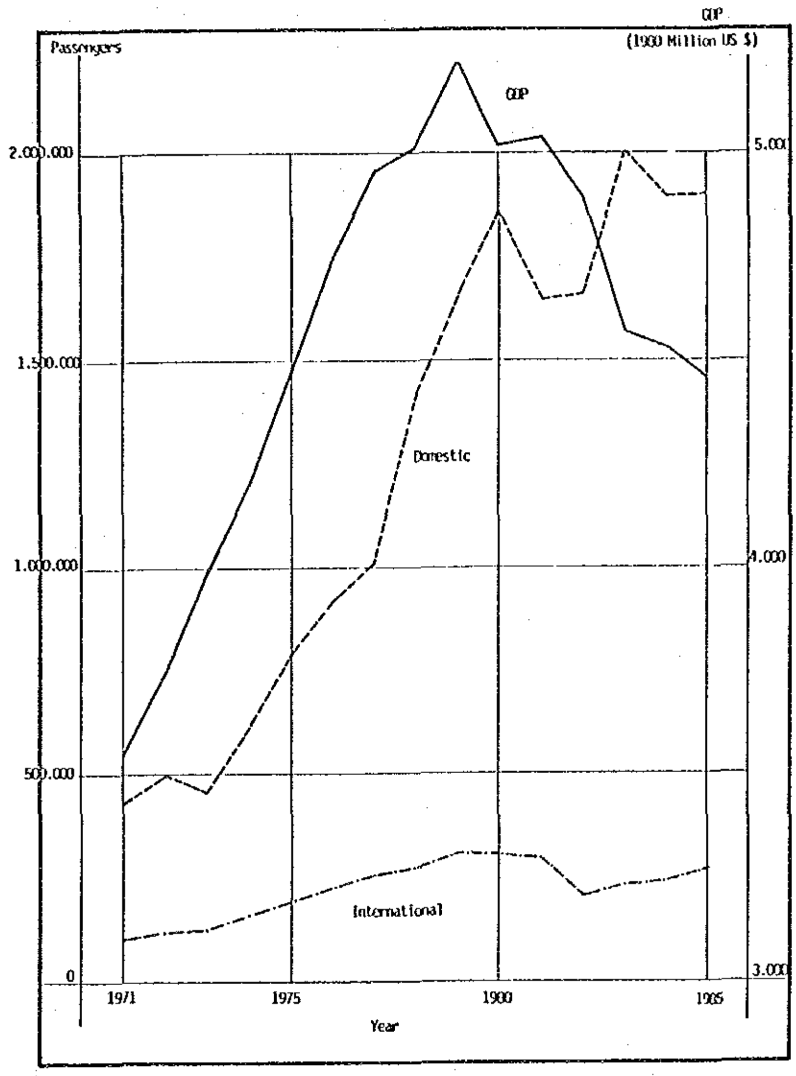


Figure 2.1.1 Comparison of Air Passenger Traffic with GDP in Bolivia

This close relationship was suddenly disrupted in 1980. The GDP has decreased continuously since 1980 except for a slight improvement in 1981. Air passenger traffic also decreased in 1981 and 1982 maintaining pace with the depressed economic activity. Domestic and international passenger traffic, however, has been increasing since 1983 despite the fact that the GDP has been declining. Some attempts have been made to explain this disrupted correlation between air traffic demand and GDP.

In order to evaluate the recent tendencies in adjacent countries, domestic passenger and cargo traffic demand were compared with GDP growth in several countries. (see Figure 2.1.2) In general, the correlation between air traffic demand and GDP was high in 1970's in almost all countries. In the 1980's, however, the correlation decreased in several countries such as Peru, Mexico and Colombia, while other countries such as Argentina, Brazil and Chile maintained a high correlation between the two economic factors. The disrupted correlation in Bolivia, therefore, can not be explained as a general tendency in adjacent countries. Another explanation will be required.

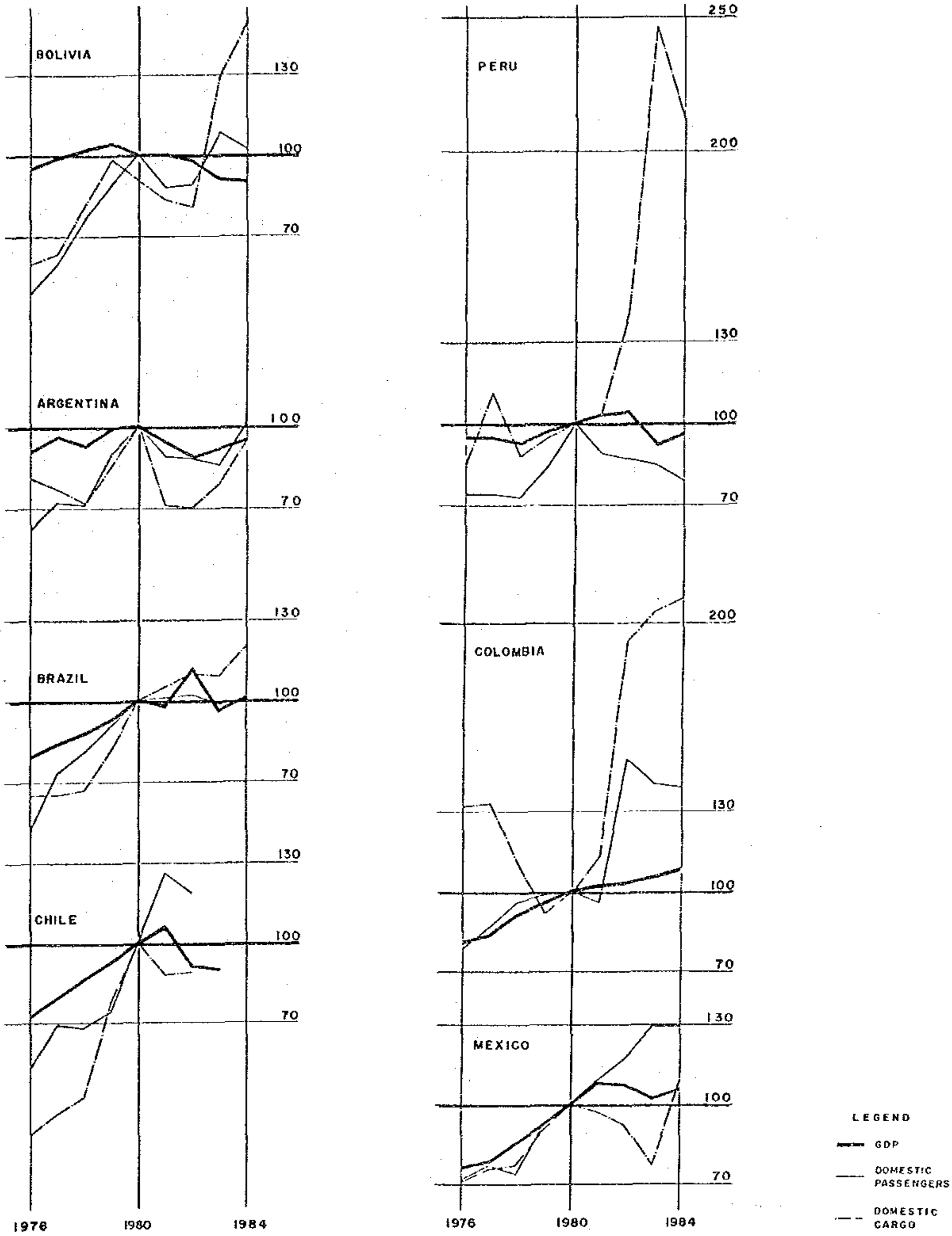


Figure 2.1.2 Air Traffic Demand and GDP in Latin American Countries

(2) <u>Disrupted Correlation in 1980's</u>

Several analyses were made to explain the increase in passenger traffic since 1983 in spite of the decline in the GDP.

a) Foreign Visitors

Among official statistics, the increase in the number of foreign visitors may explain the increase in air passengers in 1983. (see Table 2.1.1). However, for the following reasons, the factor of number of foreign visitors has not been adopted as an explanatory variable for forecasting future passenger traffic demand.

i) When explaining the increase in the number of foreign visitors in connection with the GDP in their countries, the growth of GDP is so variable from country to country that it will not be a satisfactory explanation for the sudden increase in 1983.

ii) It is considered that due to a wide gap between the official and unofficial exchange rates which began in 1982, tourism to Bolivia seemed to be available at a moderate price for foreigners holding dollars. This phenomenon is considered one explanation for the boom in 1983, but only a temporary one.

Table 2.1.1 Passenger Traffic and Foreign Visitors

(Unit : % Over Previous Year)

Year	1981/82	1982/83	1983/84
Domestic Passenger	0.7	20.8	-5.5
International Passenger	-31.1	12.6	6.5
Foreign Visitors	-3.5	17.2	-7.2

Source : Boletin Estadistico, AASANA
Bolivia en Cifras 1985

b) Underground Economy

The passenger traffic demand which had fallen drastically between 1981 and 1982 because of a worldwide depression and unstable political situations increased in 1983. This can be partly explained with the existence of an underground economy which is not reflected in the official statistics, and therefore, not accounted for in the GDP.

According to "La Economia Informal en Bolivia" authored by Samuel Doria Medina, the informal GDP derived from the underground economy is estimated to be 51% of the total GDP inclusive of formal and informal statistics in 1985. By utilizing data in the book, as well as some assumptions, the correlation between traffic and GDP including the informal one was analyzed for two cases. The multiple correlation became 0.92 for both cases.

The underground economy may influence traffic demand not only for passengers but also for cargo since the air cargo demand increased substantially between in 1983 and 1984. The underground economy is said to have doubled from 1983 to 1984. Some of the people may have gained vast profits from some illegal business which may have increased the traffic demand. This is probable, but it will be impossible to obtain the entire picture of the underground economy in terms of a trip generation mechanism.

Although multiple correlation is rather high, the underground economy involves too many unknown factors to be utilized as an explanatory variable for a future traffic forecast.

(3) Methodology Adopted in the Study

Several attempts to clarify the trend of passenger traffic since 1983 with some explanatory variables failed to determine reliable variables which would be able to explain not only the past but also future trends. The close relationship between air traffic and GDP as seen in Figure 2.1.2 has remained stable in the 1980's in such countries as Argentina, Brazil and Chile which are more or less suffering from cumulative debts, high inflation and political instability.

Other countries such as Colombia, Mexico and Peru where the close relationship has been lost may have their own particular and temporary factors which influence the air traffic demand similar to a sudden increase of foreign visitors and the growth of an underground economy in Bolivia.

A drastic increase of air traffic demand in 1982 in Colombia might be attributed to the exploitation of potential air traffic demand by newly established airlines. These particular and temporary factors are important and critical to the explanation of the past situation and to forecast the immediate future.

They will, however, become minor and some more constant and stable explanatory factors will be required for medium and long term forecasting. In the case of forecasting medium and long term air traffic demand, the GDP or per capita GDP has been generally utilized as an explanatory variable.

Taking these situations into account, it is considered most appropriate to forecast the future traffic demand based on the past trend of correlation between air traffic demand and GDP or per capita GDP.

a) Domestic Passengers

Correlation between domestic passengers and GDP was analyzed for several cases.

i) Correction with Per Capita GDP

Domestic passenger trip generation per 1,000 population shows a close correlation with per capita GDP in many countries in the world. The countries shown in Figure 2.1.3 are at different stages of economic development and air transport development but have a rather high flexibility of air traffic demand related to per capita GDP.

Compared with these countries, Bolivia had higher flexibility of trip generation to per capita GDP particularly in the 1970's, although trip generation tended to increase in accordance with the decrease in per capita GDP in the 1980's. It can be safely assumed that this high flexibility is due to the geographic conditions and absolute lack of a land transportation network in the country.

It is judged, therefore, at this stage that the correlation between domestic passenger trip generation per 1,000 population and per capita GDP in the countries presented in Figure 2.1.3 is not appropriate at least for an air traffic demand forecast in Bolivia for several years in the future.

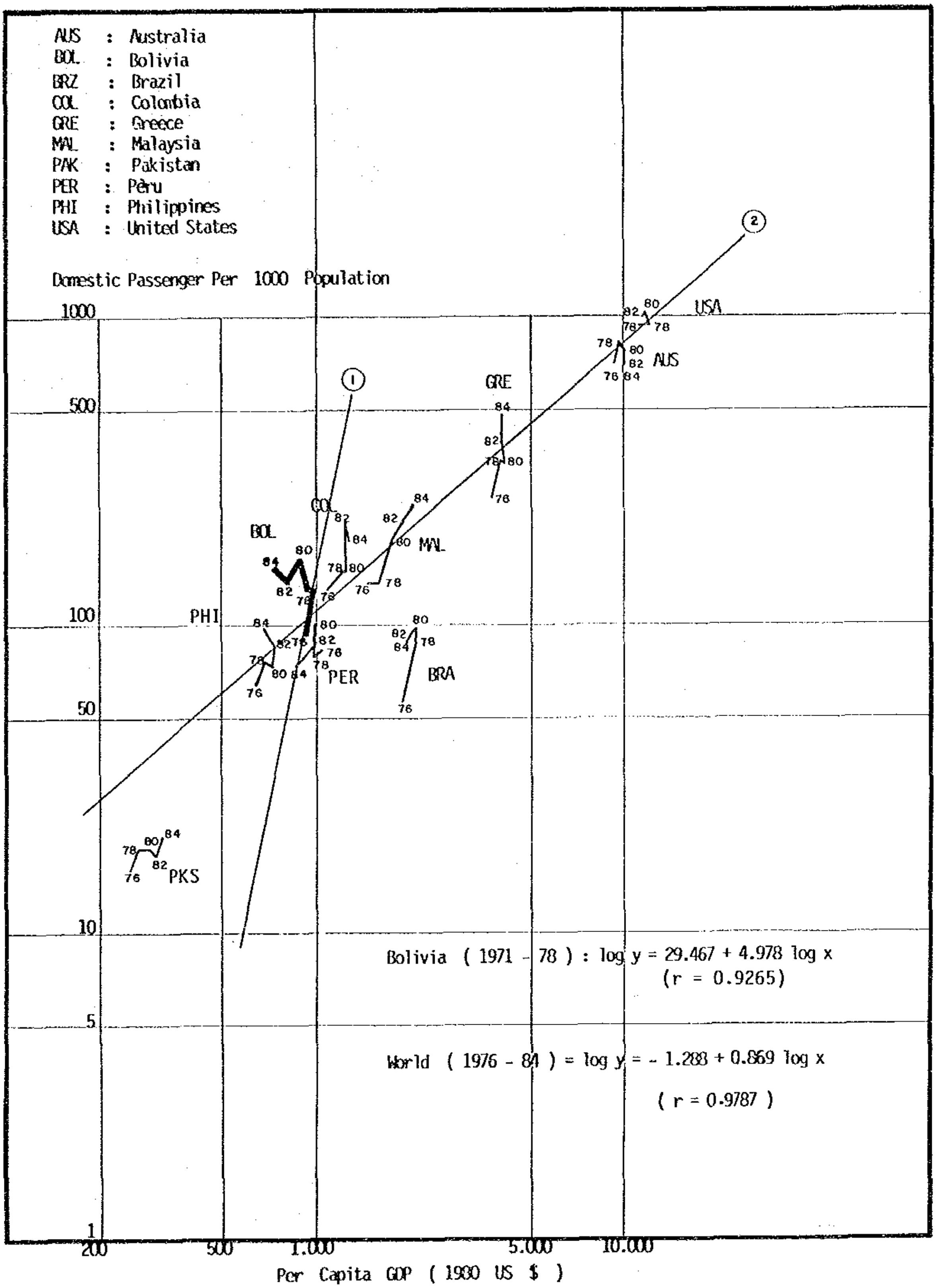


Figure 2.1.3 Number of Domestic Passengers per 1,000 Population and Per Capita GDP

ii) Correlation with GDP

A correlation between GDP and air traffic demand was analyzed for several cases including the case where GDP influences air traffic demand with some time lag. Judging from having used the number of data as many as possible up to the latest year, the following equation will be the most adequate to forecast the future traffic demand according to the work flows as shown in Figure 2.1.4.

$$Y_n = -2,727 + 0.851\ X_{n-1} \quad (r=0.9681)$$

Where, Y: Embarked/disembarked domestic passengers in Bolivia
X: GDP in Bolivia expressed in U.S. dollars at 1980 constant prices.
n: Year (1972-1982)

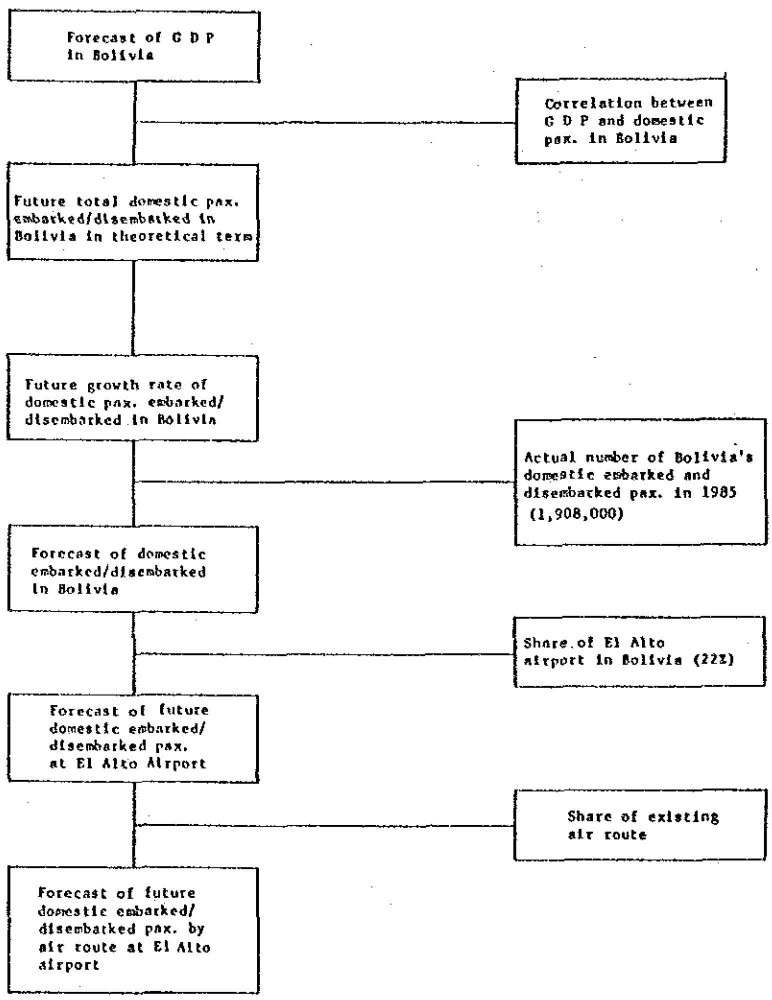


Figure 2.1.4 Work Flow of Forecasting Domestic Passenger Demand

b) International Passengers

According to the analyses of the past trend in passenger traffic demand, the forecast of international passengers will be made based on the past correlation between GDP and traffic with some consideration of time lag.

The equation derived from the data available between 1972 to 1981 is expressed below:

$$Y_n = -310.3 + 0.119\ X_{n-1} \quad (r=0.9915)$$

Where, Y: Number of International passengers
X: GDP in Bolivia expressed in U.S. dollars at 1980 constant prices.

2.1.2 Projection of Economic Factors

(1) Projection of Population

The population grew at an annual rate of 2.3% from 1950 to 1976. The growth rate was accelerated between 1976 and 1985 to 2.8% per annum. The average life span of the Bolivians is estimated to be 49 years for males and 53 for females. The birth rate decreased from 46 per 1,000 population in 1965 to 43 per 1,000 population in 1984. The death rate was also reduced from 21 to 15 during the same period.

The forecast of future population has been made by comparing three projections prepared by three institutes, i.e. Instituto Nacional de Estadistica, Bolivia (INE), Centro de Prospectiva y Estudios Nacionales, Bolivia and the World Bank.

(2) Projection of GDP

As already mentioned in Sections 1.1 and 1.2, Bolivia and La Paz are suffering from a serious economic recession. By the enforcement of floating quotation of exchange rate however the economy has been stabilized in accordance with eased inflation.

For the future GDP in Bolivia, the Government of Bolivia planned to grow the Bolivian economy at 5.4% per annum from 1984 to 88 in the "Four Year National Development Plan" proposed in 1984. The situation, however, was not so favorable for economic development in Bolivia. The GDP in 1986 is estimated to have decreased by 2.9% compared with that in 1985.

In order to activate the Bolivian economy, the Government is making every effort to rationalize public enterprises, particularly in the mining industry. Among the 26,000 mining workers, approximately 19,000 workers lost their jobs under this rationalization policy, although creation of new employment opportunities is an urgent problem. The Government is also encouraging export of minerals other than tin, such as lead, silver and zinc. The shift of public enterprises to private operation is another important rationalization policy. A new market in natural gas to Brazil in addition to these rationalization efforts will contribute to the survival of the Bolivian economy which was depressed in the first half of 1980's.

2.1.3 Annual Domestic Passengers

(1) Domestic Passengers at El Alto Airport

The share for El Alto airport of the total number of embarked and disembarked passengers in Bolivia has decreased from 25 to 28% to 21 to 23% since 1983 as shown in Table 2.1.2. This change can be attributed partly to brisk economic activity and the opening of Viru Viru airport in Santa Cruz which is directly connected by air with Sucre, Tarija and Puerto Suarez where airport improvement and regional development have been in progress since around 1980, and partly to the relatively depressed economy in La Paz. Without any modernization of El Alto airport, the decreasing trend will continue in the future.

Table 2.1.2 Shares of Major Airports in Total Domestic Passengers

Year	SHARE OF EACH AIRPORT (%)			
	El Alto		Santa Cruz	Others
1976	26.2		23.2	50.6
1977	27.5		23.8	48.7
1978	28.3		23.8	47.9
1979	28.5	25-28	25.1	46.4
1980	26.2		27.1	46.7
1981	27.0		25.5	47.5
1982	24.8		27.7	47.5
1983	22.2		29.9	47.9
1984	23.2	21-23	30.3	46.5
1985	21.6	Ave. 22	31.1	47.3

The modernization project for El Alto airport, however, will modify this tendency.

2.1.4 Annual International Passengers

(1) International Passengers at El Alto Airport

The share of El Alto airport of the total number of international passengers in Bolivia has been decreasing for the past ten years as presented in Table 2.1.3. This can be attributed to diversified regional development, particularly in Santa Cruz. The opening of Viru-Viru airport may be another reason.

El Alto airport is the international front door to La Paz which is the capital of Bolivia and is rich in tourism resources. It will not therefore be probable that the share of El Alto airport will continue to decrease in the future.

International transit passengers at Al Alto airport are estimated based on the assumption that the proportion of transit passengers to embarked and disembarked passengers will remain fairly stable in the coming years.

Table 2.1.3 Distribution of total International Passengers at Major Airport

Year	SHARE OF EACH AIRPORT (%)			
	El Alto		Santa Cruz	Others
1976	62		28	10
1977	63		28	9
1978	61	Decrease	30	9
1979	57		33	10
1980	53		36	11
1981	54		34	12
1982	55	Increase	36	9
1983	58		34	8
1984	54	Decrease 58-50	36	10
1985	50	Ave. 54	38	12

2.2 Demand Forecast for Air Cargo

2.2.1 Methodology

(1) Correlation with GDP in the Past

The relationship between GDP and air cargo demand is, in general, more scattered than that of air passenger demand as illustrated in Figure 2.1.2 which shows the relationship between the two in Latin American countries. Bolivia is not an exception (see Figure 2.2.1). One of the reasons may be that the absolute volume of cargo carried by air is rather small in Bolivia, therefore, the actual volume carried by air varies widely depending upon whether or not there is some particular demand during some particular year.

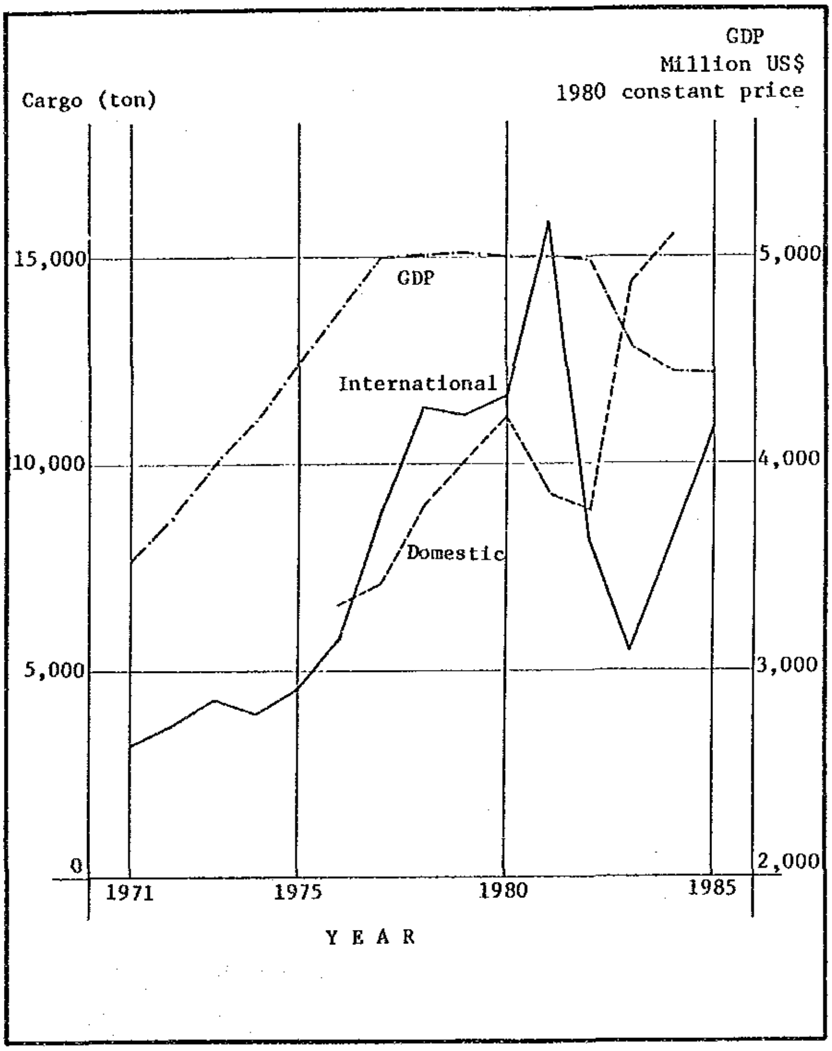


Figure 2.2.1 Comparison of Air Cargo with GDP in Bolivia

As already stated in Section 1.3.3, the air cargo demand drastically increased in 1983 for domestic and in 1984 for international in spite of continued decrease of the GDP. According to the hearing survey, the cargo carried by air mainly consists of necessities and electronic equipment. Whether or not the sharp rise in air cargo demand between 1983 and 1984 was for carrying the necessities of life cannot be evaluated due to insufficient available information. It may have some relationship with the underground economy.

(2) Domestic Cargo

A correlation between GDP and air cargo traffic demand was analyzed for several cases. Through these analyses, the following equation is considered adequate to forecast the future traffic demand.

$$Y_n = -19,997 + 5.873\ X_{n-1} \quad (r=0.9656)$$

Where, Y: Domestic Cargo Carried (tons)
X: GDP in Bolivia expressed in U.S. dollars at 1980 constant prices.
n: Year (1975-1982)

(3) International Cargo

Judging from the present volume of international air cargo demand, the forecast has been made on the basis of the relationship between GDP and air cargo traffic between 1972 and 1981 in Bolivia. The regression equation is as shown below:

$$Y_n = -19,973 + 6.242\ X_{n-1} \quad (r=0.8844)$$

Where, Y: International Cargo Carried (tons)
X: GDP in Bolivia expressed in U.S. dollars at 1980 constant prices.
n: Year (1972-1981)

2.2.2 Annual Domestic Cargo

(1) Domestic Cargo at El Alto Airport

The share for El Alto airport of total domestic cargo in Bolivia has been 30% for the past ten years as shown in Table 2.2.1.

Table 2.2.1 Shares of Total Domestic Cargo for Major Airports

Year	SHARE OF EACH AIRPORT (%)				
	El Alto		Santa Cruz	Cochabamba	Others
1976	31.9		3.4	8.0	56.7
1977	33.7		3.7	6.2	56.4
1978	36.4		3.5	8.6	51.5
1979	34.8	32-37	6.6	9.8	48.8
1980	36.6		4.4	8.4	50.6
1981	33.2		4.1	8.4	54.3
1982	34.6		6.5	10.8	48.1
1983	35.6	36-40	9.5	11.1	43.8
1984	39.6	Ave. 38	9.2	11.1	40.1

2.2.3 Annual International Cargo

(1) International Cargo at El Alto Airport

The share for El Alto airport of total international cargo in Bolivia has irregularly varied from 39 to 74% in the past ten years as shown in Table 2.2.2.

Table 2.2.2 Share of Total International Cargo for Major Airports

(Unit : Percent)

Year	SHARE OF EACH AIRPORT			
	El Alto		Santa Cruz	Others
1976	73.9	39-74	17.7	8.4
1977	57.5		33.1	9.4
1978	52.3		33.0	14.7
1979	49.4		37.3	13.3
1980	38.6		46.1	15.3
1981	42.9		43.3	13.8
1982	45.8		43.0	11.2
1983	60.1	53-60 Ave. 58	31.5	8.4
1984	61.6		30.6	7.8
1985	52.7		37.9	9.4

2.3 Meat Cargo

As stated in Section 1.3.3, meat transport comprises 70% of the total domestic air traffic at El Alto airport in recent years. The cost of meat largely depends upon the cost required for transport.

At present, some road construction work and planning are under way in Beni or neighboring areas. When these road projects are implemented, transport will be diverted to roads with the introduction of refrigerator cars and far-cheaper cost than that by air. This trend has already been reflected in the actual volume carried by air which has been decreasing at an annual rate of 7.5% since 1978, although the demand for meat is supposed to increase due to high population growth and depressed agriculture production in La Paz.

Meat transport in the future is projected by the following regression equation calculated on the basis of a time-series analysis based on past statistics, provided that a sudden decrease of transport in 1982 is not considered in this analysis because the traffic recovered to the past trend line in the next year and as cargo traffic in general also decreased sharply in 1982, some economic disorder might have caused this sudden decrease.

$$Y = 28,638 - 5,195 \times \log_e t \quad (r=0.9553)$$

Where, Y: Hauling volume of meat (ton)
t: Year, 1978 = 1

2.4 Breakdown of Air Traffic Volume

2.4.1 Aircraft Classification and Movement

(1) Annual Aircraft Movement in La Paz

a) Propotion of Domestic Passengers on Non-scheduled Flights

With regard to the domestic passengers, the past proportion of the non-scheduled related to all traffic at El Alto airport is shown in Table 2.4.1.

Table 2.4.1 Proportion of Domestic Passengers on Non-scheduled Flights

Year	Proportion (%)	
1976	1.6	
1977	1.9	
1978	1.7	
1979	1.6	
1980	1.2	
1981	2.3	
1982	1.9	
1983	2.0	
1984	1.6	Average 1.43
1985	0.7	

Source: BOLETIN ESTADISTICO 1985, AASANA

b) Scheduled Passengers by Routes

Based on the assumption that the future shares of scheduled passengers by routes is the same as at present, the future shares for domestic and international passengers are projected as shown in Tables 2.4.2 and 3.

Table 2.4.2 Projected Proportion of Domestic Passenger Demand by Route

Origin/ Destination	Number of Passengers (as of 1985) (x 1,000)	Share (%)	
		Actual	Projected
SANTA CRUZ	178	43.4	43.0
COCHABAMBA	136	33.2	33.0
TRINIDAD	24	5.9	6.0
SUCRE	30	7.3	7.5
TARIJA	37	9.0	9.0
PUERTO SUAREZ	3	0.7	1.0
OTHERS	2	0.5	0.5
TOTAL	410	100.0	100.0

Source: BOLETIN ESTADISTICO 1985, AASANA

Table 2.4.3. Projected Proportion of International Passengers Demand by Route

Route	Passengers as of 1985 (x 1,000)	Share (%)	
		Actual	Projected
(LB) LPB-SRZ-PTY-MIA or LPB-SRZ-MAO-CCS-MIA	16,386	12.5	12.5
(LB) LPB-SRZ-SAO-RIO	3,840	2.9	3.0
(LB) LPB-SRZ-SLA-BUE	6,585	5.0	5.0
(LB) LPB-SCL	6,345	4.8	5.0
(LB) SRZ-CBB-LPB-ARI	9,462	7.2	7.0
(LB) SRZ-CBB-LPB-LIM	20,015	15.2	15.0
(LH) LPB-LIM-UIO-SJU-FRA	15,135	11.5	11.5
(EA) ASU-LPB-CLO-MIA	18,235	13.8	14.0
(SC) LPB-SAO-RIO	9,234	7.0	7.0
(PL) LPB-LIM	10,269	7.8	7.5
(AR) LPB-JUJ-BUE	7,656	5.8	6.0
(LA) LPB-ARI-IQQ-SCL	8,505	6.5	6.5
TOTAL	131,667	100.0	100.0

NOTE: Excluding transit

SOURCE: Boletin Estadistico 1985, AASANA
Boletin Estadistico, LAB

ABBREVIATIONS:

ARI:	ARICA	MAO:	MANAOS
ASU:	ASUNCION	MIA:	MIAMI
BUE:	BUENOS AIRES	PTY:	PANAMA
CBB:	COCHABAMBA	RIO:	RIO DE JANEIRO
CCS:	CARACAS	SAO:	SAO PAULO
CLO:	CALI	SCL:	SANTIAGO
FRA:	FRANKFURT	SJU:	SAN JUAN
IQQ:	IQUIQE	SLA:	SALTA
JUJ:	JUJUY	SRZ:	SANTA CRUZ
LIM:	LIMA	VIO:	QUITO
LPB:	LA PAZ		

2.4.2 Peak Air Passengers and Aircraft Movements

(1) Peak Month Coefficient

Assuming that the peak month coefficient at La Paz remains unchanged in the future, the peak month coefficients are projected as follows:

Peak Month Coefficient

	Passengers	Aircraft Movements
Domestic	1/9.6	1/10.7
International	1/10.6	1/11.6
Domestic and International	1/10.1	1/10.9
Total including Military, etc.	-	1/10.2

Note: The above values are based on the ICAO Digest of Statistics, Airport Traffic 1984.

(2) Design Day Coefficient for Aircraft Movements

Design day coefficient for aircraft movements is basically established to be a product of peak month coefficient and number of days in a month (1/30.4) as follows:

Design Day Coefficient for Aircraft Movement

	Peak Month Coefficient	Design Day Coefficient
Domestic	1/10.7	1/320
International	1/11.6	1/350
Domestic and International	1/10.9	1/330
Total including Military, etc.	1/10.2	1/310

Some of the projected design day aircraft movements are adjusted to be not less than present aircraft movement on peak day shown as follows:

Design Day Aircraft Movement at Present

Domestic	13 *1
International	18 *1
Domestic and International	23 *1
Total including Military, etc.	59 *2

Note; *1: As of July 1, 1987 and based on ABC World Airways Guide

*2: As of December, 1986 and based on Record of Aircraft Movement, AASANA

(3) Design Day Passengers

Design day passengers are estimated based on the design day aircraft movement.

In this estimation, load factors on the design day are assumed to be basically as follows based on the consideration that these are higher than annual average load factors.

Load Factor on Design Day

Domestic:	80%
International:	70%

(4) Peak Hour Aircraft Movements

Actual peak hour coefficients are shown as follows,

Actual Peak Hour Coefficient

	Design Day Aircraft Movement	Peak Hour Aircraft Movement	Peak Hour Coefficient
Domestic:	13	3	1/4.3
International:	18	3	1/6.0
Domestic and International:	23	4	1/5.8
Total including Military, etc.:	59	11	1/5.4

The coefficients of "Domestic" and "International" shown above coincide with the values calculated from the following formulas which are adopted in the planning manual of JCAB (Japan Civil Aviation Bureau).

Formula for Peak Hour Coefficient

Domestic: $a = \frac{1.51}{A} + 0.1151$

International: $a = \frac{1.05}{A} + 0.114$

Where; a: Peak hour coefficient
A: Design day aircraft movements

Therefore, peak hour aircraft movements for "Domestic" and "International" are projected based on the peak hour coefficient calculated using the formulas stated above.

Peak hour aircraft movements for "Domestic and International" are projected based on the coefficients calculated using the assumed formulas shown below.

Formula for Peak Hour Coefficient of Domestic and International

$$a = \frac{1.3}{A} + 0.115$$

Peak hour characteristic of total aircraft movement including military etc. is different from that of scheduled aircraft movement. The following formula for peak hour coefficient is therefore assumed based on the actual data and is used for the projection of peak hour movement of total aircraft.

Formula for Peak Hour Coefficient of Total Aircraft Movements

$$a = \frac{7.9}{A} + 0.053$$

(5) Peak Hour Passengers

Peak hour passengers are estimated based on the peak hour aircraft movement.

In this estimation, load factors on the peak hour are assumed to be basically as follows based on the consideration that these are higher than load factors on the design day.

Load Factor on Peak Hour

Domestic: 90%
International: 80%

(6) Aircraft Movement of Heavy Direction on Peak Hour

Actual heavy direction coefficients as of July 1, 1987 are as follows:

Actual Heavy Direction Coefficient

	Peak Hour Aircraft Movement	Aircraft Movement of Heavy Direction	Heavy Direction Coefficient
Domestic	3	2	0.67
International	3	3	1.00
Domestic and International	4	3	0.75

Based on the actual coefficient, the coefficients are assumed to be as follows:

Projected Heavy Direction Coefficient

Domestic:	0.6
International:	0.7
Domestic and International:	0.6

Aircraft movements in the heavy direction on peak hour are estimated using the above listed coefficients.

(7) Passengers of Heavy Direction on Peak Hour

Passengers in the heavy direction on peak hour are estimated based on the same coefficient as for aircraft movements.

CHAPTER 3 AIRPORT FACILITY REQUIREMENTS ANALYSIS

CHAPTER 3 AIRPORT FACILITY REQUIREMENTS ANALYSIS

3.1 Airside Facilities and Obstacle Limitation Requirements

3.1.1 Aerodrome Reference Code and Operational Requirements

An aerodrome reference code, viz., code number and code letter, will be established as shown in Table 3.1.1 in accordance with the largest aircraft anticipated. (Refer to the subsection 1.3 "Reference code" in Annex 14, Aerodromes, ICAO)

Table 3.1.1 Aerodrome Reference Code

Year	1990	1995	2000	2005	2010
Code number	4	4	4	4	4
Code letter	E	E	E	E	E

The runway should be a precision approach category-I runway.
(Refer to Section 4.1.1, (5) in Chapter 4.)

3.1.2 Runway Length and Width

At present, B-747, B-707 and B-727 are the main aircraft operated at El Alto airport. Among these jet aircraft, B-727 aircraft is the most critical aircraft in terms of its operation performance and route configuration.

The performance of B-727 at El Alto airport was evaluated based on the following assumptions:

a) Structural Maximum Take-off Weight(MTOW) : 197,000 lbs/89,359 Kg

b) Operating Empty Weight (OEW) plus two hours reserved fuel : 119,765 lbs/54,325 Kg

c) Allowable Cabin Load (164 seats x 220 lbs/90.7 Kg) : 36,080 lbs/16,366 Kg

d) Maximum structural payload : 42,490 lbs/19,376 Kg

e) Average fuel consumption : 13.7 lbs/6.2 kg/km

f) Altitude : 13,000 feet

g) OAT : ISA + 27°C

i) The gross take-off weight due to the climb limit at OAT 16°C, altitude 13,000 feet is as follows:

Flap 5° 155,900 lbs (case I)
Flap 15° 149,500 lbs (case II)

ii) The weight restriction for maximum tire speed at wind calm is as follows:

Flap 5° 163,500 lbs
Flap 15° 179,600 lbs

iii) As a result of evaluation i) and ii) above, the gross take off weight of B-727 at El Alto airport is considered to be 155,900 lbs with flap 5° or 149,500 lbs with flap 15°.

The Take Off Run (T.O.R.) and the Take Off Distance (T.O.D.) required for B-727 with flap 5° and 15° were determined as shown in Table 3.1.2.

Table 3.1.2 Take-Off Runway Length

Flap	Gross Take Off Weight	Take Off Run	Take Off Distance
5°	155,900 lbs	14,100 ft (4,297m)	14,800 ft (4,511m)
15°	149,500 lbs	11,000 ft (3,352m)	11,150 ft (3,551m)

When B-727 aircraft operate at a gross take off weight of 149,500 lbs with flap 15°, the existing runway 09R/27L of 4,000 meter length is sufficient in length. If the gross take off weight is intended to be increased to 155,900 lbs for increment of payload which is the maximum allowable take off weight at El Alto airport, the runway should be extended by 300 m and a 250 m length clearway should be provided.

The runway extension to 4,300m with a 250 m length clearway, however, is considered not feasible from the economical view point based on the cost benefit analysis described in Section 3.1.3.

3.1.3 Cost Benefit Analysis on Runway Extension to 4,300 m

(1) General

The existing allowable take-off weight of 149,500 lbs for B-727-200 can be increased to 155,900 lbs with a 300m runway extension from 4,000m to 4,300m. This runway extension may contribute to the national economy through improvement in aircraft operational efficiency. The feasibility of a 300m runway extension has been evaluated in this study using a cost-benefit analysis.

(2) Benefit

A passenger who would have cancelled his trip because of payload restriction can travel using air transport when the payload restriction is relieved by the runway extension. The benefit for such a passenger is quantified based on the assumption that the benefit is equivalent to his willingness to pay, i.e. sum of airfare and airport facility charge. The annual benefit due to the runway extension is shown in Table 3.1.3 (Details of calculation are presented in Tables 3.1.6 and 7).

Table 3.1.3 Annual Benefit

Route	Annual Passengers Increased by Runway Extension (Bolivianos)*1	Airfare plus Airport Facility Charge (US$)*2	Annual Benefit (US$1,000)*2
La Paz -Santiago	2,784 (1,392)	160.2	223
La Paz -Arica	1,080 (540)	78.2	42
Total	3,864 (1,932)	--	265

Note *1: Share of Bolivianos in total route passengers is assumed to be 50%.
*2: US$1.00=Bs1.95 as of March 1987

In this analysis, annual benefit is assumed to be maintained constant, because the flight frequency of LAB B-727-200 is not considered to increase regardless of the demand increase due to the future introduction of the same class of aircraft with improved take-off and landing performance.

Of the foreign airlines, only Eastern Air Lines utilizes B-727-200 and the present passenger load factor for departing flights from La Pas is extremely low.

Bolivian passengers on LAB B-727-200 therefore will only benefit from the runway extension. For such benefit, consideration actual economic cost is assumed to equal financed cost. The runway extension produces annual benefits of US$265,000 in terms of financed cost.

(3) <u>Cost</u>

The cost for the 300m runway extension is estimated as shown in Table 3.1.4. The estimated financed cost is converted into actual (economic) cost by standard conversion factors (SCF) assumed as follows.

-- For the foreign portion of the cost SCF=0.80
(due to 20% flat taxation on imported goods)

-- For the local portion of the cost SCF=0.92

Table 3.1.4 Cost for Runway Extension

	Financed Cost (US$1,000)	Actual Cost (US$1,000)
Local Portion	862	793
Foreign Portion	4,498	3,598
Total	5,360	4,391

Note: Breakdown of the cost estimates is presented in Table 3.1.8

(4) Evaluation of Feasibility

The cash flow for the runway extension project is shown in Table 3.1.5. If a 10% discount rate is assumed, the net present value of the project is negative. Therefore, a 300m runway extension is not considered feasible from the viewpoint of the national economy.

Table 3.1.5 Evaluation of Economic Feasibility
(Runway Extension)

Unit: 1000 US$, 1987 Economic Prices

YEAR	COST	BENEFIT	PRESENT VALUE OF BENEFIT (10% DIS.)	ACCUM-LATED VALUE OF BENEFIT	NET PRESENT VALUE
	(A)	(B)	(C)	(D)	(D)-(A)
0	4,931	-	-	-	-
1	-	265	241	241	-4,690
2	-	265	219	460	-4,471
3	-	265	199	659	-4,272
4	-	265	181	840	-4,091
5	-	265	165	1,005	-3,926
6	-	265	150	1,154	-3,777
7	-	265	136	1,290	-3,641
8	-	265	124	1,414	-3,517
9	-	265	112	1,526	-3,405
10	-	265	102	1,628	-3,303
11	-	265	93	1,721	-3,210
12	-	265	84	1,806	-3,125
13	-	265	77	1,882	-3,049
14	-	265	70	1,952	-2,979
15	-	265	63	2,016	-2,915
16	-	265	58	2,073	-2,858
17	-	265	52	2,126	-2,805
18	-	265	48	2,173	-2,758
19	-	265	43	2,217	-2,714
20	-	265	39	2,256	-2,675
21	-	265	36	2,292	-2,639
22	-	265	33	2,324	-2,607
23	-	265	30	2,354	-2,577
24	-	265	27	2,381	-2,550
25	-	265	24	2,405	-2,526
26	-	265	22	2,428	-2,503
27	-	265	20	2,448	-2,483
28	-	265	18	2,466	-2,465
29	-	265	17	2,483	-2,448
30	-	265	15	2,498	-2,433

EIRR = 3.407%

Table 3.1.6 Increase in Passengers per LAB B-727-200

Upper: Passengers
Lower: Load Factor

Route		Increase in Passengers	
		Peak 3 Months	Off Peak 9 Months
Domestic	LA PAZ ↓ COCHABAMBA	131 → 131 + 0 80% 80%	115 → 115 + 0 70% 70%
	LA PAZ ↓ SANTA CRUZ	131 → 131 + 0 80% 80%	115 → 115 + 0 70% 70%
	LA PAZ ↓ TARIJA	131 → 131 + 0 80% 80%	115 → 115 + 0 70% 70%
	LA PAZ ↓ SUCRE	131 → 131 + 0 80% 80%	115 → 115 + 0 70% 70%
International	LA PAZ ↓ SANTIAGO	9 → 38 + 29 5% 23%	9 → 38 + 29 5% 23%
	LA PAZ ↓ ARICA	116 → 131 + 15 71% 80%	98 → 98 + 0 60% 60%

Note: Average passenger load factors are assumed as follows for no payload restriction.

	Peak 3 Months	Off Peak 9 Months
Domestic	80%	70%
International	70%	60%

Table 3.1.7 Increase of Passengers per Year

Route	Peak or Off Peak	Increase in Passengers per Aircraft (A)	Weekly Aircraft Movements (B)	Increase in Passengers per year (C)
International	Peak	29	2	696
LA PAZ SANTIAGO	Off Peak	29	2	2,088
			Total	2,784
International	Peak	15	6	1,080
LA PAZ ARICA				
			Total	1,080

Formula :

Peak 3 months: (A) x (B) x 4 weeks x 3 months = (C)

Off Peak 9 months: (A) x (B) x 4 weeks x 9 months = (C)

Table 3.1.8 Cost Estimates for 300 m Runway Extension

Item	Description	Quantity	Unit Price		Total Price ('000)		Remarks
			Bolivian P.	Foreign P.	Bolivian P.	Foreign P.	
1. Direct Cost							
1) Embankment		110,000 cu.m	3 US$/cu.m	12 US$/cu.m	330 US$	1,320 US$	Night works
2) RWY Pavement		13,800 sq.m	10 US$/sq.m	40 US$/sq.m	138 US$	552 US$	Ditto
3) RWY Shoulder		4,500 sq.m	5 US$/sq.m	16 US$/sq.m	23 US$	72 US$	Ditto
4) TWY Pavement		11,140 sq.m	10 US$/sq.m	40 US$/sq.m	111 US$	446 US$	Ditto
5) TWY Shoulder		7,980 sq.m	5 US$/sq.m	16 US$/sq.m	40 US$	128 US$	Ditto
6) Relocation of LLZ					(10%) 28 US$	(90%) 248 US$	
			Total of Direct Cost		670 US$	2,766 US$	
2. Indirect Cost	30% of Direct Cost				(10%) 103 US$	(90%) 928 US$	
				Sub-total	773 US$	3,694 US$	
3. Cost of Engineering Services and Construction Supervision					(10%) 89 US$	(90%) 804 US$	
	20% of Sub-total						
Note : Excluding contingency			GRAND TOTAL		862 US$	4,498 US$	

3.1.4 Runway Strip

The runway strip should be 4,120 m x 300 m for precision approach category-I runway.

3.1.5 Obstacle Limitation Requirements

The dimensions and slopes of the obstacle limitation surfaces required for El Alto airport are shown in Table 3.1.9 in accordance with ICAO Standards.

Table 3.1.9 Dimensions and Slopes of Obstacle Limitation Surfaces

APPROACH RUNWAYS

Surface and dimensions[a]	Runway classification									
	Non-instrument				Non-precision approach			Precision approach category I		Precision approach category II or III
	Code number 1	2	3	4	Code number 1,2	3	4	Code number 1,2	3,4	Code number 3,4
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
CONICAL										
Slope	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Height	35 m	55 m	75 m	100 m	60 m	75 m	100 m	60 m	100 m	100 m
INNER HORIZONTAL										
Height	45 m	45 m	45 m	45 m	45 m	45 m	45 m	45 m	45 m	45 m
Radius	2 000 m	2 500 m	4 000 m	4 000 m	3 500 m	4 000 m	4 000 m	3 500 m	4 000 m	4 000 m
INNER APPROACH										
Width	-	-	-	-	-	-	-	90 m	120 m	120 m
Distance from threshold	-	-	-	-	-	-	-	60 m	60 m	60 m
Length	-	-	-	-	-	-	-	900 m	900 m	900 m
Slope								2.5%	2%	2%
APPROACH										
Length of inner edge	60 m	80 m	150 m	150 m	150 m	300 m	300 m	150 m	300 m	300 m
Distance from threshold	30 m	60 m	60 m	60 m	60 m	60 m	60 m	60 m	60 m	60 m
Divergence (each side)	10%	10%	10%	10%	15%	15%	15%	15%	15%	15%
First section										
Length	1 600 m	2 500 m	3 000 m	3 000 m	2 500 m	3 000 m	3 000 m	3 000 m	3 000 m	3 000 m
Slope	5%	4%	3.33%	2.5%	3.33%	2%	2%	2.5%	2%	2%
Second section										
Length	-	-	-	-	-	3 600 m[b]	3 600 m[b]	12 000 m	3 600 m[b]	3 600 m[b]
Slope	-	-	-	-	-	2.5%	2.5%	3%	2.5%	2.5%
Horizontal section										
Length	-	-	-	-	-	8 400 m[b]	8 400 m[b]	-	8 400 m[b]	8 400 m[b]
Total length	-	-	-	-	-	15 000 m	15 000 m	15 000 m	15 000 m	15 000 m
TRANSITIONAL										
Slope	20%	20%	14.3%	14.3%	20%	14.3%	14.3%	14.3%	14.3%	14.3%
INNER TRANSITIONAL										
Slope	-	-	-	-	-	-	-	40%	33.3%	33.3%
BALKED LANDING SURFACE										
Length of inner edge	-	-	-	-	-	-	-	90 m	120 m	120 m
Distance from threshold	-	-	-	-	-	-	-	d	1 800 m[c]	1 800 m[c]
Divergence (each side)	-	-	-	-	-	-	-	10%	10%	10%
Slope	-	-	-	-	-	-	-	4%	3.33%	3.33%

a. All dimensions are measured horizontally unless specified otherwise.
b. Variable length (see 4.2.9 or 4.2.17).
c. Or end of runway whichever is less.
d. Distance to the end of strip.

Source: Annex 14 - Aerodrome, ICAO

Table 3.1.9 (Cont.)

TAKE-OFF RUNWAYS

Surface and dimensions[a]	Code number		
	1	2	3 or 4
(1)	(2)	(3)	(4)
TAKE-OFF CLIMB			
Length of inner edge	60 m	80 m	180 m
Distance from runway end[b]	30 m	60 m	60 m
Divergence (each side)	10%	10%	12.5%
Final width	380 m	580 m	1 200 m 1 800 m[c]
Length	1 600 m	2 500 m	15 000 m
Slope	5%	4%	2%[d]

a. All dimensions are measured horizontally unless specified otherwise.
b. The take-off climb surface starts at the end of the clearway if the clearway length exceeds the specified distance.
c. 1 800 m when the intended track includes changes of heading greater than 15° for operations conducted in IMC, VMC by night.
d. See 4.2.24 and 4.2.26.

Source: Annex 14 - Aerodrome, ICAO

3.1.6 Taxiway

A complete parallel taxiway with perpendicular exit taxiways can generally be justified when the number of instrument approaches exceed four instrument approaches during the peak hour and wide bodied jet aircraft are operated more frequently.

A complete parallel taxiway with perpendicular exit taxiways however, will not be required for El Alto airport because the preferential operations of RWY 09R landings and RWY 27L take-offs prevail over the normal operations in one year.

A partial parallel taxiway in relation with the apron taxiway will therefore be sufficient.

3.1.7 Aprons

(1) Passenger Terminal Apron

a) 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.

$$S = \sum_{i}^{n} \left(\frac{i}{60} \times Ni\right) + \alpha$$

Where;

S : Required number of aircraft stands

Ti: Gate occupancy time of aircraft of Category (i) in minutes

Ni: Number of arriving aircraft of Category (i) during the peak hour

: One extra stand for the largest aircraft of the planning year for the unexpected peak occasion
(1 extra for each 10 stands)

b) Classification of Aircraft

Apart from the aircraft classification by seating capacity, the classifications as shown in Table 3.1.10 are made for the planning of aircraft parking area taking into account wing span, overall length, etc., of aircraft dimensions (Table 3.1.11).

Not only LAB fleet but also foreign fleet are taken into consideration for the apron classification.

Table 3.1.10 Aircraft Classification for Passenger Terminal Apron

Category of Aircraft Parking Position	Aircraft Type to be Accommodated	Design Aircraft	Wing Span (m)	Clearance (m)
B-747 Class	B-747,DC-10 L-1011,B-767 A-300,B-707 A-310	B-747-300 (B-747-400)	60 (65)	7.5 (7.5)
B-757 Class	B-757,A-320 B-727, MD80 F27, B-737 DC-9, DASH8 ATR-42,SF-340	B-757-200	38	7.5

Note 1, Clearance: Interval between adjacent aircraft wing tips.

Note 2, B-747-400 may be operated at El Alto airport after the year 2000.

Note 3, The small propeller planes including F27, DASH 8 etc. also use the apron for the B-757 class, however these aircraft movements are few in comparison to the total number of aircraft movements.

Table 3.1.11 Size of Aircraft

(meter)

Aircraft Model	Wing Span	Overall Length	Height
B-747-400	64.7	70.7	19.3
B-747-300	59.6	70.5	19.3
B-747-200	59.6	70.5	19.3
DC-10	50.4	55.5	17.4
L-1011	47.4	54.2	16.9
B-767-200	47.2	48.5	15.9
A-300	44.8	53.6	16.5
B-707-320	44.4	46.6	12.9
A-310-200	43.9	46.7	15.8
B-757	38.0	47.3	13.6
A-320	34.5	37.4	11.8
B-727-200	32.9	46.7	10.5
MD80	32.9	45.1	9.2
B-727-100	32.9	40.6	10.4
F27	29.0	25.1	8.7
B-737-300	28.9	33.4	11.1
DC-9-40	28.4	38.3	8.5
B-737-200	28.4	30.5	11.3
DASH8	25.6	22.2	7.6
ATR-42-100	24.6	22.5	7.6
SF-340	21.4	19.7	6.7

c) Gate Occupancy Time

Table 3.1.12 shows the gate occupancy time for various aircraft types, which is estimated based on the actual parking time for aircraft in Bolivia. The gate occupancy time for planning includes a margin for delay.

Table 3.1.12 Gate Occupancy Time

(Minute)

Aircraft Category	Actual Gate Occupancy Time		Gate Occupancy Time for Planning	
	INTL	DOM	INTL	DOM
JJP,JJM	165	--		
LJ	--	--	130	70
MJ	--	--		
NJ	45,60,70,100	60		
SJ	40,45,60	60	70	70
P	--	30		

d) Required Number of Aircraft Stands

The number of stands has been planned based on the aforementioned assumptions and the following considerations:

- The LAB aircraft for mix flight is parked at the international apron.

- An extra stand is provided at the international apron

The required number of aircraft stands is summarized in Table 3.1.13.

Table 3.1.13 Required Number of Aircraft Stands

Year	International		Domestic		Total
	B-747Class	B-757Class	B-747Class	B-757Class	
1990	2	1	-	2	5
1995	2	1	-	3	6
2000	2	2	-	3	7
2005	2	2	1	2	7
2010	3	1	2	2	8

Figure 3.1.1 shows the required space for the passenger terminal apron forecast for the year 2005.

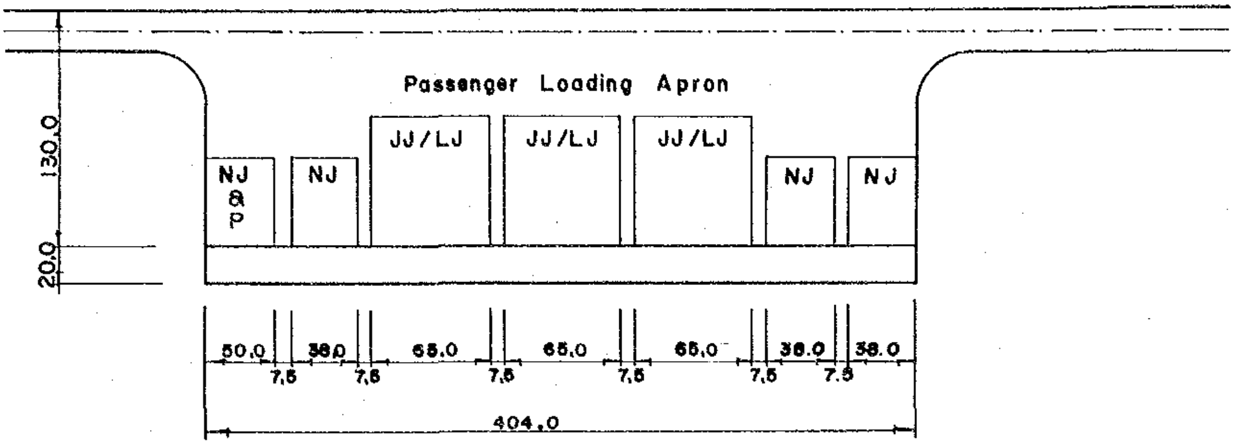


Figure 3.1.1 Required Space for Passenger Terminal Apron in Year 2005.

(2) Cargo Terminal Apron

At present one B-707 freighter owned by LAB is operated at El Alto airport.

With regard to the estimation of the number of aircraft stands required for the freighter, there is no data on the present cargo volume loaded unloaded from the freighter at El Alto airport.

Although B-707 is old aircraft and will be retired in the near future, the operation of B-707 freighter is anticipated to continue and to increase with an increase in international cargo volume until year 2000.

The number of aircraft stands on the cargo terminal apron is assumed as shown in Table 3.1.14, considering one spare stand and future aircraft type for the freighter.

Table 3.1.14 Required Number of Aircraft Stands on Cargo Terminal Apron

Year	Number of Aircraft Stand
1990 1995 2000	B-707 Class: 2
2005 2010	B-747 Class: 2

(3) Cargo Apron for Small Carriers

The required number of aircraft stands on the cargo apron for small carriers which mainly transport meat is projected as shown in Table 3.1.15, based on the present number of the aircraft stationed at El Alto airport and the future annual aircraft movement of the small carriers.

Table 3.1.15 Required Number of Aircraft Stands on Cargo Apron for Small Carriers

Year	Annual Aircraft Movement	Number of Aircraft Stands
1985	3,508	16
1990	3,160	14
1995	2,810	13
2000	2,560	12
2005	2,330	11
2010	2,170	10

(4) General Aviation Apron

The required number of aircraft stands for the general aviation apron is projectd as shown in Table 3.1.16, based on the present number of general aviation aircraft stationed at El Alto airport and the future annual general aviation aircraft movements.

Table 3.1.16 Required Number of Aircraft Stands on General Aviation Apron

Year	Annual Aircraft Movement	Number of Aircraft Stands
1985	1,912	9
1990	2,140	10
1995	3,190	15
2000	4,050	19
2005	4,240	20
2010	4,880	23

3.2 Buildings

3.2.1 Passenger Terminal Building

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

For a domestic passenger terminal, the standard floor area per peak hour passenger is in the range between 10 sq.m/passenger and 20 sq.m/passenger. Hence, the unit floor area of 15 sq.m/passenger for the domestic passenger terminal building has been assumed.

An international passenger terminal requires customs, immigration and quarantine facilities and large passenger amenities compared with a domestic passenger terminal.

A unit floor area of 30 sq.m/passenger is assumed for the international passenger terminal.

If the passenger terminal building is planned to be a combined one with domestic and international, the common usage area will be reduced. It is considered that approximately a 5% reduction of the total floor area is possible.

Table 3.2.1 shows the required floor area for the passenger terminal building.

Table 3.2.1 Floor Area Requirements for Passenger Terminal Building

Passenger Terminal	Item	1990	1995	2000	2005	2010
Domestic	Peak Hour Passenger (persons)	490	680	830	1,120	1,450
	Required Floor Area (sq. m)	7,400	10,200	12,500	16,800	21,800
Intl	Peak Hour Passenger (persons)	180	240	250	310	400
	Required Floor	5,400	7,200	7,500	9,300	12,000
Combination of Dom. and Intl	Required Floor Area (sq. m)	12,100	16,500	18,900	24,800	32,000

3.2.2 Cargo Terminal Building

The floor area for a cargo terminal building has been calculated by multiplying the forecast annual cargo volume by the unit cargo handling capacity.

Cargo handling capacity of 6 ton/sq.m and 12 ton/sq.m is used for international and domestic handling area respectively, based on values adopted for other projects.

The floor area of the cargo terminal building is required to be 1.33 times the cargo handling area in order to accommodate the office area needed by airlines and Government control, etc.

Table 3.2.2 shows the required floor area for the cargo terminal building.

Table 3.2.2 Cargo Terminal Building Requirements

Cargo Terminal	Item	1990	1995	2000	2005	2010
Domestic	Annual Cargo Volume (ton)	8,100	13,300	19,200	26,900	34,100
	Cargo Handling Area (sq.m)	680	1,100	1,600	2,240	2,840
Intl	Annual Cargo Volume (ton)	8,700	13,600	19,200	25,700	33,400
	Cargo Handling Area (sq.m)	1,450	2,270	3,200	4,280	5,570
Sub Total (sq.m)		2,130	3,370	4,800	6,520	8,410
Office (sq.m)		700	1,110	1,580	2,150	2,770
Total (sq.m)		2,830	4,480	6,380	8,670	11,180

3.2.3 Administration Building and Control Tower

An independent administration building with a control tower is required for the airport administration, operations and maintenance.

The required floor area including area control center, meteorological offices and lighting substation is shown in Table 3.2.3 based on the planning practices used in Japan.

Table 3.2.3 Required Floor Area for Administration Building

Year	1990	1995	2000	2005	2010
Required Floor Area (sq.m)	4,000	4,000	4,000	4,000	4,000

A control tower cab with a floor area of about 60 sq.m will be necessary for air traffic controllers and control consoles. The height of the tower cab floor will be set depending on the tower location based on FAA standards.

3.3 Landside Facilities

3.3.1 Car Parking

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

$$V = P \times C$$

Where; V: Required number of parking spaces

P: Number of peak hour passengers

C: Number of parking spaces per peak hour passenger (0.7 by traffic survey)

The required number of parking spaces is calculated based on the traffic survey at El Alto airport, which determined that C=0.7 (133 parked cars per 190 passengers) for cars. The proportion of private car, taxi and busses is also based on the results of the traffic survey. The amount of Space per parking lot is required to be 35 sq.m including a green zone. Table 3.3.1 shows the requirements for car parking space.

Table 3.3.1 Parking Lot Requirements

Item	1990	1995	2000	2005	2010
Number of Parking Lots:					
Total (100%)	410	560	710	960	1,100
Private Car(62%)	260	350	440	590	680
Taxi (35%)	140	200	250	340	390
Bus (3%)	10	10	20	30	30
Required Space (sq.m)	14,000	20,000	25,000	34,000	39,000

3.3.2 Access Road

The required number of lanes for access roads is calculated based on incoming and outgoing traffic from/to the airport terminal area. At present, the number of cars generated per peak hour passenger in each direction is estimated to be 1.2 based on the traffic survey. In the future this value is assumed to gradually decrease as shown in Table 3.3.2 with the increase of airport bus service.

The maximum capacity of an access road is usually considered to be approx. 1,000 cars/hour for 1 lane (each direction) and approx. 4,000 cars/hour for 2 lanes (each direction). Table 3.3.2 shows the required number of lanes for the access road.

Table 3.3.2 Required Number of Lanes

Item	1990	1995	2000	2005	2010
Peak hour passengers	580	800	1,020	1,370	1,610
Number of cars generated per peak passenger hour	1.2	1.1	1.1	1.0	1.0
Number of cars generated	700	880	1,100	1,400	1,600
Number of lanes (each direction)	1	1	2	2	2

3.4 Air Navigation Systems

Air navigation systems include radio navigation aids, air traffic control system, aeronautical telecommunications system, visual aids, meteorological system and power supply system.

Air navigation systems should be designed to meet the operational requirements as shown in Table 3.4.1, and should be sufficient to handle the forecast aircraft movements in a safe and effective manner.

Table 3.4.1 Operational Requirements

	1990	1995	2000	2005	2010
Operational Requirement	Precision Approach Category - I				
Radar Control	Justified				
ILS/MLS	ILS/MLS		MLS		

3.5 General Services

3.5.1 Rescue and Fire-Fighting Services

The facility requirements for the rescue and fire-fighting services are estimated in compliance with the ICAO Airport Service Manual, Part I.

The facilities are determined and tabulated in Table 3.5.1. Airport category is determined from the largest aircraft movements for the busiest consecutive 3 months of the year.

Table 3.5.1 Required Fire-Fighting Facilities

Item	1990	1995	2000	2005	2010
Airport Category	7	7	8	8	9
Extinguishing Agent					
- Water for Protein Foam Production (L)	18,200	18,200	27,300	27,300	36,400
- Discharge Rate (L/min)	7,900	7,900	10,800	10,800	13,500
- Dry Chemical Powders (kg)	225	225	450	450	450
or					
- CO^2 (kg)	450	450	900	900	900
or					
- Water for Aqueous Film Foaming Production (L)	12,100	12,100	18,200	18,200	24,300
- Discharge Rate (L/min)	5,300	5,300	7,200	7,200	9,000
- Dry Chemical Powders (kg)	225	225	450	450	450
or					
- CO^2 (kg)	450	450	900	900	900
Vehicles					
- Rapid Intervention	1	1	1	1	1
- Major	2	2	2 or 3	2 or 3	2 or 3
- Ambulance	1	1	1	1	1
Floor Area Required (sq.m)	450	450	550	550	650

3.5.2 Aviation Fuel

The daily fuel consumption is established by multiplying the trip fuel including that for an alternate airport, by the number of departing aircraft of each respective type. The required fuel storage capacity is estimated as tabulated in Table 3.5.2 based on the condition that the airport is provided with a 15 day storage capacity, which is the YPFB practice.

Table 3.5.2 Aviation Fuel Storage Requirement

Item \ Year	1990	1995	2000	2005	2010
Daily Consumpstion (KL)	100	123	150	183	217
15 days Storage (KL)	1,500	1,845	2,250	2,745	3,255
Tank Capacity (KL)	2,000	2,500	3,000	4,000	4,500
Area Required (sq. m)	7,000	8,500	8,500	8,500	10,500

3.6 Airport Utilities

The airport utility requirements are calculated based on the unit demand established as shown in Table 3.6.1.

Table 3.6.1 Unit Demand

Utilities	Unit demand/m^2
Electricity	Passenger Terminal Building : 100 VA/m^2 Cargo Terminal Building : 60 VA/m^2 Administration Building : 80 VA/m^2 Equipment : Calculated by Equipment
Water	Passenger Terminal Building : 0.023 ton/m^2/day Cargo Terminal Building : 0.003 ton/m^2/day Administration Building and others : 0.01 ton/m^2/day
Sewage	Passenger Terminal Building : 0.023 ton/m^2/day Cargo Terminal Building : 0.003 ton/m^2/day Administration Building and others : 0.01 ton/m^2/day
Waste	Passenger Terminal Building : 0.072 Kg/m^2/day Cargo Terminal Building : 0.144 Kg/m^2/day Administration Building and others : 0.024 Kg/m^2/day

(Source: Average unit demand for airports in Japan)

Table 3.6.2 shows the demand of public utilities.

Table 3.6.2 Airport Utilities Demand

Utilities	1990	1995	2000	2005	2010
Electricity Demand (KVA)	1,600	2,000	2,300	3,200	3,600
Water Demand (tons/month)	9,200	12,000	16,000	20,400	23,000
Sewage (ton/month)	9,200	12,000	16,000	20,400	23,000
Waste Disposal(tons/month)	45	60	80	110	130

Appendix 3.1 Result of Traffic Survey

1. Objective of Survey

The survey was executed to obtain the actual data on passenger processing time at the functional check points in the passenger terminal building, generated car traffic and parked car at present.

2. Date of the Survey

The survey was carried out on February 19, 1987.

3. Result of the Survey on the Passenger Processing Time

The results are shown in Tables 1 through 4.

Table 1 Passenger Processing Time at Check-in Counter

Flight Number	Number of Passenger (A)	Processing Time (second) (B)	Maximum Processing Time per Passenger (second)	Average Processing Time per Passenger (second) (B)/(A)	Number of Baggage (C)	Average Baggage per Passenger (C)/(A)
LAB 943	67	2,588	121	39	44	0.7
SC 880	36	4,351	244	121	46	1.3
Total	103	6,939	Maximum 244	Average 67	90	Average 0.9

Table 2 Passenger Processing Time at Departure Immigration Check (including airport tax and security check)

Flight Number	Number of Passenger (A)	Processing Time (second) (B)	Maximum Processing Time per Passenger (second)	Minimum Processing Time per Passenger (second)	Average Processing Time per Passenger (second) (B)/(A)
LAB 943 and SC 880	175	44,697	210	22	255

Table 3 Passenger Processing Time at Arrival Immigration Check

Flight Number	Number of Passenger (A)	Processing Time (second) (B)	Maximum Processing Time per Passenger (second)	Minimum Processing Time per Passenger (second)	Average Processing Time per Passenger (second) (B)/(A)
SC 880	12	212	37	4	18
LAB 944	74	1,025	31	9	14
LAB 917	38	807	58	7	21
LAB 908	120	1,916	99	2	16
Total	244	3,960	Maximum 99	Minimum 2	Average 16

Table 4 Passenger Processing Time at Arrival customs check

Flight Number	Number of Passenger (A)	Processing Time (second) (B)	Maximum Processing Time per Passenger (second)	Average Processing Time per Passenger (second) (B)/(A)	Number of Baggage (C)	Average Baggage per Passenger (C)/(A)
SC 880 LAB 944 LAB 917 and LAB 90B	125	8,447	278	68	172	1.4

The above results are evaluated for the facility planning as mentioned below.

(1) Required Time for Check-in

Average processing time for check-in per passenger is according to the considered to be usually in the range of 110 seconds per passenger (sec/pax) - 180 sec/pax. following values for reference.

Reference: IATA ACC* Example at London
111 sec/pax. (Long haul)
Bali International Airport Development Project
120 sec/pax.
Japan Air Lines 180 sec/pax.

* Airport Consultative Committees

Average processing time of LAB 943 was 39 sec/pax, and it is considered some special condition as group check-in etc. While, average processing time of SC 880 was 121 sec/pax. and it seems to be in the range of normal condition.

For the facility planning 120 sec/pax. will be applicable based on the result in the case of SC 880 and the above values for reference.

(2) Number of Baggage of Departure Passenger

Average number of baggage per passenger is considered to be in the range of 1 to 2.

The survey resulted to be 0.9 in total. On the other hand this value of arrival passenger was 1.4. This value of departure passenger is considered to be usually same as that of arrival passenger. Therefore, 1.5, which was rounded at 0.5 from 1.4, will be applicable for the facility planning based on the survey result and normal range.

(3) Required Time for Departure Immigration Check

Average processing time of immigration check per passenger is considered to be normally in the range of 15 sec/pax. - 60 sec/pax. according to the following values for reference.

Reference: IATA Airport Consultative Committees
15 sec/pax. (Domestic passenger)
25 sec/pax. (Foreign passenger)
Bali International Airport Development Project
45 sec/pax. (Departure)
60 sec/pax. (Arrival)

The result of the survey was 255 sec/pax. and it is considered to be too long as compared with the values for reference.

For the facility planning 60 sec/pax, which is the longest time in the range of above values for reference, will be applicable.

(4) Required Time for Arrival Immigration Check

Average processing time of immigration check per passenger is considered to be normally the same as that of departure which between 15 sec/pax. - 60 sec/pax.

The result of the survey was 16 sec/pax. and considered relatively short in comparison with the normal processing time.

However, arrival checking time is usually equal or longer than that of departure due to the government policy.

For the facility planning, 60 sec/pax. will be applicable as same as the departure immigration check.

(5) Required Time for Arrival Customs Check

Average processing time for customs inspection per passenger is considered to be usually in the range 75 sec/pax. - 90 sec/pax. according to the following values for reference.

Reference:	IATA ACC Example at London	75 sec/pax.
	Bali International Airport Development Project	89 sec/pax.

The result of the survey was 68 sex/pax. However, for the facility requirement, 75 sec/pax, which is low value in the above range will be applicable.

(6) Number of Baggage of Arrival Passenger

The result of the survey was 1.4. As mentioned in section (2), number of baggage of arrival passenger is considered to be usually same as that of departure passenger. Therefore, 1.5 adopted for the departure passenger will be applicable for the arrival passenger.

4. Result of the Survey on Parked Car and Traffic Volume

4.1 Number of Parked Car

As the result of survey, the number of parked cars at the peak time is shown in Table 5.

Table 5 Number of Parked Cars at Peak Time

Time	Private Car	Taxi	Bus	Total
15:45	82	47	4	133

As this time, number of passenger was 190 based on the information from airlines. Therefore, the proportion between number of parked car and number of passenger is estimated to be 0.7 as shown below:

$$133 / 190 = 0.7$$

4.2 Traffic Volume

Traffic volume at the peak hour is shown in Table 6.

Table 6 Traffic Volume at Peak Hour

Location	Direction	Time	Private Car	Taxi	Bus	Others	Total
Gate	In	15:00-16:00	140	60	-	17	217
Gate	Out	15:15-16:15	136	75	-	16	227
Entrance of Parking	In	15:00-16:00	128	45	-	15	188
Entrance of Parking	Out	15:15-16:15	116	71	-	15	202

Maximum of the above total volume was 227.
Traffic volume generated per peak hour passenger at each direction is estimated to be 1.2 as shown below:

$$227 / 190 = 1.2$$