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Abbreviations and Acronyms

AADT	Average Annual Daily Traffic
ASEAN	Association of Southeast Asia Nations
AG	Alluvial Gravel
AS	Alluvial Sand
B/C	Benefit Cost Ratio
BCF	Border Control Facility
BS	British Standard
DPS	Deputy Permanent Secretary
DSN	Design Structure Number
DWA	Zambian Department of Water Affairs
ECZ	National Environment Council of Zambia
EIA	Environmental Impact Assessment
EMSC	Environmental Management Sub-Committee
EMP	Environmental Management Plan
ESCO	Engineering Services Corporation Ltd.
EU	European Union
FIRR	Financial Internal Rate of Return
GEARV	Great East Africa Rift Valley
IEE	Initial Environmental Evaluation
IRR	Internal Rate of Return
JICA	Japan International Co-operation Agency
KBA	Kazungula Bridge Authority
MENR	Ministry of Environment and Natural Resources
MOPS	Zambian Ministry of Public Works and Supply
MWTC	Botswanan Ministry Works and Transportation and Communication
NEAP	National Environmental Action Plan
NPV	Net Present Value
ODA	Official Development Assistance
OOF	Other Official Flow
PS	Permanent Secretary
SACU	South African Customs Union
SADC	Southern African Development Community
SATCC	Southern Africa Transport and Communications Commission
SPT	Standard Penetration Test
STRADA	System for Traffic Demand Analysis
TS	Top Soil
TMH-7	Technical Method For Highways –7
VOC	Vehicle Operating Costs
VOCS	Vehicle Operation Cost Saving
VS	Volcanic Sand
WHO	World Health Organization
WID	Women in Development
ZESCO	Zambia Electricity Supply Corporation Limited
ZRA	Zambia Revenue Authority

1. Introduction

1.1 Background

The Southern African Development Community (SADC) has increased the number of member states to fourteen following the admission of the People's Republic of Congo. Also, with peace developing in Angola and Mozambique, SADC is dynamically working to promote and activate the economies of the member states. This can only be achieved by promotion of the free and unobstructed movement of both cargo and people within and out of the region to improve its overall accessibility.

A reliable road network has been identified as the sole basis for the intended economic growth in the region. Botswana and Zambia are two of the major member states of SADC and play important economic roles in the region. However, free movement of trade goods and people between the two countries has been obstructed due to lack of a reliable road network across the Zambezi River. This has been one of the great causes of hindered economic integration among the member states of SADC. It is expected that the improvement of river crossing method at Kazungula and border facilities located nearby the site may come up with following socio-economic impacts to the SADC region:

- Strengthening of socio-economic and political integrity among SADC nations,
- Inducement of balanced economic development among SADC nations in a long term, with the realisation of homogeneous regional economies,
- Expansion of South African economic sphere within SADC and promotion of specialisation in industrial activities among SADC nation's, and
- Strengthening of industrial inter-dependencies in the region.

Bottlenecks which exist in the river crossing at Kazungula, where the only civilised form of crossing is by use of ferries, has been identified as one of the major bottlenecks requiring rectification in order to promote an unobstructed and free flow of traffic. This can only be done by construction of a bridge and by improvement of border facilities situated near the crossing.

The expected benefits from the project, both in tangible and in intangible, are described as below:

1) Effects on National Economies

    - Enhancement of GDPs,
    - Strengthening o inter-dependencies among domestic industries,
    - Reduction of socio-economic disparities between urban and rural areas,
    - Promotion of employment, and

- Expansion of export/import.

2) Effects on Regional Economies

- Promotion of local industries,
- Enhancement of farm-gate prices of agricultural products due to reduction of transportation cost,
- Reduction of consumer's prices of agricultural products due to reduction of transportation cost,
- Activation of socio-economic activities at community level, and resultant tax revenue increase for local governments, and
- Promotion of area-wise development plans including those at community levels.

3) Effects on Transportation

- Promotion of new type of transportation methods including containerised transportation system,
- Realisation of reliable transportation system that is not affected by weather,
- Reduction of damages to cargo and preservation of freight values,
- Promotion of related road development plans, and
- Development of transportation infrastructure for tourism promotion.

4) Others

- Control on smuggling, drug abuse and terrorism,
- Prevention of epidemic and control on HIV infection,
- Reduction of traffic accidents, and
- Dissemination of outside information, especially in the case of emergency.

1.2 Objectives of the Study

The major objectives of the Study are as follows:

(1) To formulate development plans for Kazungula Bridge across the Zambezi River between Botswana and Zambia, and to formulate improvement plans for border facilities located near the bridge.

(2) To confirm technical & economic feasibility of the optimal development plan of the bridge and improvement plan of border facilities.

(3) To promote technical transfer of knowledge and technology.

1.3 Study Area

The study covers the area adjacent to the Zambezi River, at a location near to where the international borders of four countries intersect namely Botswana, Zambia, Zimbabwe and Namibia.

2. Present Issues of Kazungula Crossing

2.1 Placement of Kazungula Crossing

It is expected that the Project will greatly contribute to the regional economic development and integration of SADC economy in total as the Project is directly related to the North- South corridor improvement in SADC region.

At present, transportation across the Zambezi River is conducted at two river bridges: Chirundu bridge and Victoria Falls bridge, both located on the border between Zambia and Zimbabwe. However, these bridges present the following difficulties to transportation:

Chirundu Bridge

- Although the bridge is located on the corridor connecting Zambia and South Africa via Zimbabwe, this transport corridor is not efficient for the long trip because of great border delay at Zimbabwe-South Africa border located at Limpopo River,
- In addition, strict customs clearance undertaken at the Zimbabwe-South Africa border for cargo being transported between SACU countries and non-SACU countries is causing additional delays at the border, and
- The steep and winding route sections, existing before and after the city of Harare, the capital city of Zimbabwe, are another bottleneck of transportation along the route.

Victoria Falls Bridge

- Heavy vehicle regulation is now being undertaken because of the dilapidated structure of the bridge as it was constructed in 1902,
- The bridge is a railway bridge by nature, and at present is used mainly for tourism as it is situated in the midst of the great tourism spot of Victoria Falls.

On the other hand, the North-South route via Kazungula crossing has comparative advantage in the following respects:

- Botswana is one of the member countries of SACU (South African Customs Union) along with South Africa and customs clearance at the border with South Africa is simple which result in less border delay,
- The route passes along a flat plain in Botswana, and
- The route sections adjacent to the Kazungula crossing are either preserved in good condition or improvement plans of substandard sections are being

scheduled.

With this context, the Project bridge is expected to produce great effects both in tangible and intangible forms. In terms of contribution to the macro-economy of SADC, expected effects, among other things, are as follows:

- Promotion of local industries through the realisation of efficient transport corridor,

- Strengthening of inter-dependence of existing industries beyond the national boundaries among SADC nations, and

- Expedition of regional and national development plans envisioned by relevant Governments.

2.2 Ferry Operation and Facilities

(1) Existing Ferry Operation

The ferry operation started in Kazungula in 1979, and the ferry has been replaced 3 times before. Existing ferries consists of Chobe Drifter and Zambezi Drifter of 70 tons flat barge with engine, and they were imported from UK. The dimension of ferry is length of 32 m and width of 7.5m.

The ownership and operation of ferry service has been carried out by Engineering Services Corporation Ltd. (ESCO), a semi-governmental corporation affiliated to Ministry of Works and Supplies of Zambia. ESCO has its headquarters in Lusaka and regional offices throughout Zambia including one in Livingstone for the Southern Region which is responsible for the ferry operation at Kazungula. ESCO of the southern region consists of three sections, management section, operation section and accounting section, and the number of staff which include regional manager is 35 persons.

(2) Issues of the Existing Ferry Operation

The existing ferry operation and facilities which are considered for future improvement.

- Onshore ramps .....concrete pavement damaged by heavy traffic
- Storage facilities .....no storage facility for spare part and fuel
- Parking lot .....insufficient parking areas
- Ferry engine .....engine trouble and oil leaking
- Ferry deck .....cracked wooden deck due to heavy loading
- Ferry propeller .....damaged by river sand and gravel

during loading and unloading
- Ferry ramp .....deformed by heavy vehicles
- Safety equipment .....replacement due to expiration data
- Inspection of ferry operation .....need periodic inspection

2.3 Border Control Facilities (BCF)

(1) Existing Border Control Facility

The nature of current traffic mode at Kazungula ferry border post is observed that about 45% of the total number of traffic are rigid or articulated trailers, at the existing border control facility of Botswana and Zambia, while at Kazungula road post in Zambia is 83% are passenger traffic cars. Tremendous delay of cross-border time has been observed through traffic survey.

(2) Issues of the Existing Border Control Facilities

The major findings are summarised below:

- Office spaces are inadequate to conduct proper formalities,
- Parking areas are also inadequate to accommodate current traffic,
- Inadequate number of officials and lack of appropriate welfare facilities,
- Lack of inspection facilities (inspection shed and warehouse),
- Manual formality recording is being done which may cause clerical error, and
- Lack of appropriate provision against wildlife attack.

2.4 Traffic at Kazungula Crossing

(1) Traffic Volume

Traffic volume at Kazungula is about 140 vehicles a day, which is the second largest traffic volume next to that at Chirundu among the major river crossings of the Zambezi River.

Table 2.1 Annual Average Daily Traffic

	15-Sep	16-Sep	Average
Car	34	22	28
Pick up	34	38	36
Minibus	6	10	8
Bus	1	0	0.5
2/3 Axle Truck	0	0	0
Rigid+Trailer	0	0	0
Articulated Truck	4	7	5.5
Artic+Trailer	46	75	58
Total	125	152	138.5

Traffic at Kazungula is greatly on the increase recently as compared with that counted in the SATCC study in 1992. This high increasing tendency seems to come from following reasons:

- At present, heavy vehicle control is undertaken at the Victoria Falls Bridge, and many vehicles divert their route to the Kazungula crossing.
- Because of two times of lengthy border clearance at Chirundu and Beit border posts, such traffic as Zambia-SA is tending to prefer Kazungula route to Chirundu route, furthermore, bad driving condition of Chirundu route in Zimbabwe force the drivers to use Kazungula route.

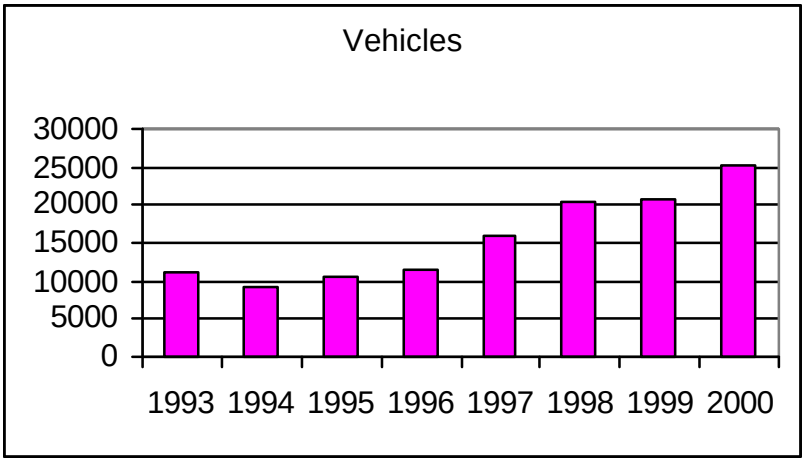


Figure 2.1 Annual Traffic Crossing at Kazungula

(2) Vehicle Composition

Heavy vehicle has a dominant share of total traffic at Kazungula (42%) followed by medium truck (26%) and passenger vehicles. The high composition of heavy traffic is for the following reasons:

- Diversion of traffic from the Victoria Falls Bridge, and
- Kazungula route has potential as one of the inter-regional trunk roads in the South Africa region.

(3) OD Composition

Traffic connecting Zambia and South Africa (51% of the total), and Zambia and Botswana (23% of the total) are two of the major OD traffic utilising present Kazungula crossing.

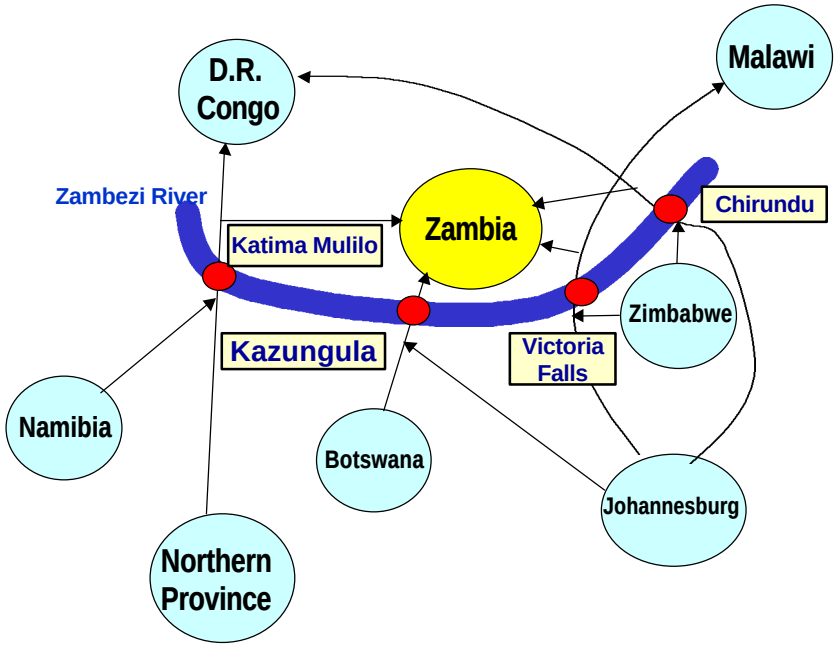


Figure 2.2 Origin – Destination Patterns at Zambezi River Crossings

(4) Type of Cargo Transported

Major cargo being transported at Kazungula crossing are follows:

North bound traffic: Processed foods (37%), Agricultural products (18%), Machinery (7%)
South bound traffic: Agricultural products (14%), Minerals (7%)

It is one of the great characteristics at Kazungula Ferry Crossing that the share of empty vehicles is extremely high (79%) in the south-bound vehicles.

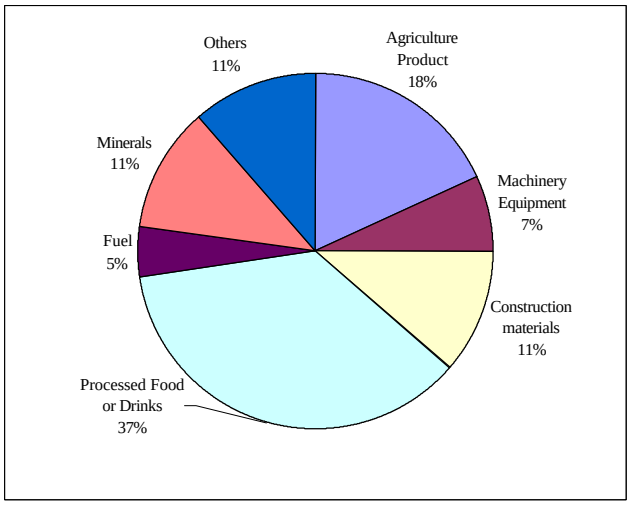


Figure 2.3 Loading Condition of Northbound Trucks at Kazungula

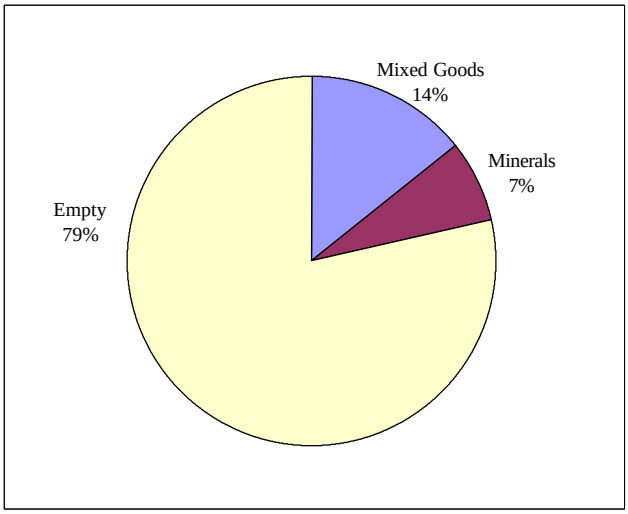


Figure 2.4 Loading Condition of Southbound Trucks at Kazungula

2.5 Measures to be undertaken for the Improvement

The measures to be undertaken for the improvement of i) Ferry Operation, ii) Border Control Facilities, and iii) Kazungula Crossing, will be as follows:

(1) Ferry Operation

To maintain the existing operation and future operation of the ferry, the measures required are the facilities improvement on the land including onshore ramp, parking lot expansion, etc. and the pontoon improvement including the upper deck, changing propeller, etc.

(2) Border Control Facilities

The present Two-Stop-Border-Control system, which requires clearance process two times, causes tremendous delay of traffic flow. A solution was recommended by SADC in 1996 to adopt One-Stop-Border-Control. In order

to solve traffic flow delay, it is necessary to plan a new set of border control facilities in consideration of One-Stop-Border-Control.

(3) Kazungula Crossing

There are two crossings nearby the Kazungula Crossing, the Chirundu Bridge, which is under construction with Japanese grant assistance, and Katima Mulilo Bridge, which is under detailed engineering preparation with German assistance. Kazungula Crossing is very effective for the traffic flow connecting the Southern Africa and the middle part of Africa in terms of topographical and geographical conditions. Therefore, improvement of the Kazungula Crossing is needed in relation to the traffic increasing.

3. Socio-economic Framework and Future Traffic Level

3.1 Recent Trend and Prospect of Future Economy

(1) Macroscopic Analysis of Present Economy

The economy in SADC during the 1990s, by and large, was stagnant level. GDP growth rate in the region during 1990-98 was about 1.4 % per annum and some of the member countries, such as Zambia, Angola and Malawi have shown negative economic growth during the period. Zambia is one of these countries and its growth rate during the period was minus 3.2%. Slump in copper industry, which is the key industry of Zambia, is the major cause of this stagnated national economy of the nation. On the other hand, Botswana has had quite a good achievement in national economy with GDP growth rate during the period of 4.8% per annum. This relative high growth is attributed to good showing of mining and tourism industries. South Africa, the economic giant in the region, has shown a subtle economic growth rate during the period.

Despite the low performance of economic activities in the last decade, SADC holds brilliant prospects for the future economy. According to the "Transport and Communications Integration - the catalyst for economic development in South Africa", prepared by SATCC in 1998, export from SADC is forecast to increase at about 4% per annum.

Economic growth rates for each member state of SADC have been estimated for this study in consideration of national plans, development scenario proposed in the SATCC study and analysis of existing data. In parallel with the national level analysis, project of regional development has been analysed on the basis of existing data, development plan of key industries specific to the regions.

As the result, future economic increasing rate as SADC total for this study is 3.11% (Botswana: 4.30%, Zambia: 3.80%) for pessimistic and 3.31% (Botswana: 5.10%, Zambia: 8.30%) for optimistic, which are smaller than that by SATCC. The future economic growth rates forecasted by Study Team is shown in Figure 3.1.

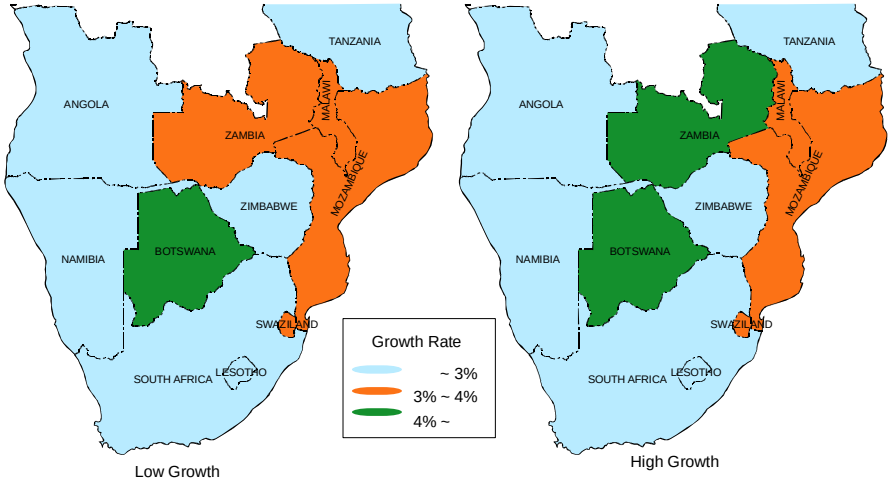


Figure 3.1 Future Economic Growth Rates in SADC Nations

(2) Prospect of Regional Economic Development in the Nearby Areas of the Project

It is expect that Project will affect development schemes in the surrounding regions. Major development schemes likely to be affected by Project are:

- Okavango Delta/Chobe National Development Project
- Resort Hotel Development at Livingstone in Zambia

According to the estimate by the Study Team, one-fourth of the tourists who will visit with Okavango Delta and Chobe National Park are to be chain tourist of Botswana – Zimbabwe (the Victoria Falls) – Zambia (Livingstone). Total numbers of these chain-tourists in 2010 and 2015 are estimated 55,000 and 77,000 per annum, respectively.

3.2 Future Traffic Level

Traffic across the Zambezi River will grow in future in response to increased economic activities in SADC region and greater vehicle ownership and use. The economy of South Africa will continue to dominate the region, but significant economic growth is forecast for the Democratic Republic of Congo and Copperbelt in Zambia. By the year 2015 traffic crossing the Zambezi is forecast to have grown by between 1.75 times (low growth scenario) and 2.56 times (high growth scenario).

Table 3.1 Traffic Forecasts in the year 2015

	Low Traffic Growth		High Traffic Growth	
	Case1	Case2	Case1	Case2
	Improved Ferry Operation	Bridge at Kazungula	Improved Ferry Operation	Bridge at Kazungula
Katima Mulilo	65.9	32.3	78.7	40.0
Kazungula	276.0	349.1	387.9	475.0
Victoria Falls	72.2	68.8	84.4	78.4
Chirundu	322.9	299.5	432.6	412.9
Kalongola	15.0	2.3	119.2	96.5
Total	752.0	752.0	1102.8	1102.8

Source JICA STRADA Traffic Model

Figure 3.2 shows the forecast traffic growth profile at Kazungula in the case of bridge construction. It is expected that traffic shall increase at 8.56% per annum in the high growth scenario and at 6.36% per annum in low growth scenario, respectively, during the period 2000-2015.

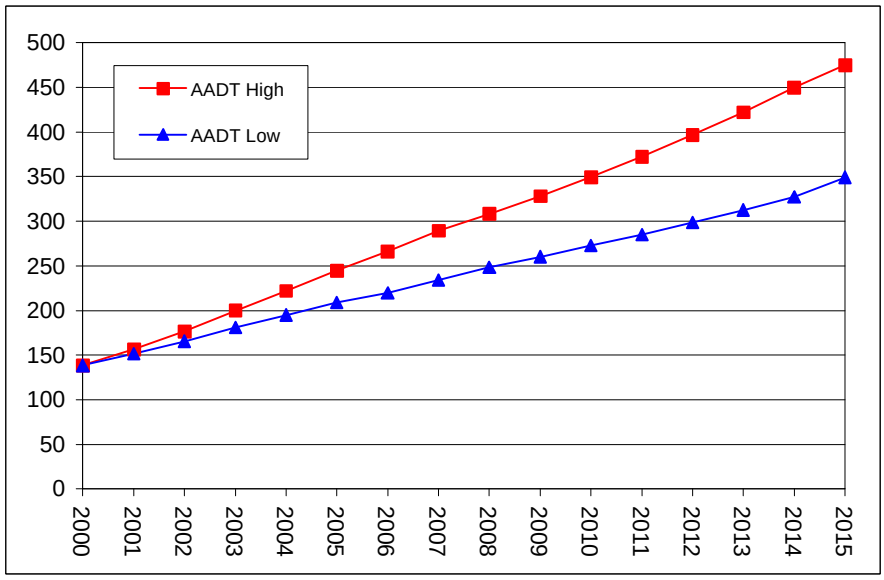


Figure 3.2 Traffic Growth at Kazungula

From the above, the following conclusion can be obtained.

- Improvements to ferry operations are probably only capable of meeting the low growth traffic demand,
- A bridge at Kazungula would attract a great number of the traffic that would otherwise use the proposed bridge at Katima Mulilo, and
- A bridge at Kazungula would carry similar traffic volumes to the new crossing at Chirundu.

4. Development Concept of Kazungula Crossing

4.1 Basic Policy of Development Plan and Methodology

(1) Basic Stance

It is expected that the improvement of Kazungula crossing shall produce a great benefit to transportation, socio-economies, and tourism development in the whole SADC region.

With this recognition, the development plan is to be formulated standing on the following concepts:

Socio-economic and political aspects

- Role and effects on the socio-economic and political integration of SADC countries,
- Role and effects on regional development in the surrounding areas of the project site.
- Recognition of international boundaries and sovereignties of concerned nations, as the project site is situated within the narrow and intermingled border areas of Botswana, Zambia, Zimbabwe and Namibia.

Transportation aspects

- Measures for enhancing river crossing capacities,
- Measures of prompt river crossing for international traffic,
- Measures of promoting border clearance procedures for international traffic, and
- Securing of operation schedule and safety of ferry operation

Technical aspects

- Constraints in the route alignment and bridge location as the site is situated at narrow and short interface of Botswana-Zambia border,
- Introduction of construction method that minimises the negative effects on existing ferry operation,
- Special consideration on bridge type and structure, as the bridge location is limited to a nearby point of confluence of Zambezi and Chobe rivers.
- Environmental consideration as the project site is situated in the midst of wild life preservation areas of Zambezi River,
- Consideration on minimising the project cost, and
- Tendency of future traffic growth and characteristics of regional traffic behaviours in the formation of development plans of the crossing.

(2) Methodology of the Study

The total study flow is described as below:

Fact Findings	:	Fact findings and problem articulation on the basis of Natural condition survey, IEE, Traffic Survey, Socio-economic survey and Construction condition survey.
↓		
Establishment of Planning Targets	:	Formulation of planning concept and goals
↓		
Preparation of Development Alternatives	:	Preparation of alternatives of development plans on bridge location, route alignment, ferry operation plans and one-stop border post.
↓		
Forecast	:	Preparation of socio-economic framework, traffic demand forecast and evaluation of projects in terms of future traffic volume.
↓		
Formulation of optimal Development Plan	:	Proposals preparation for optimal development plans of bridge, ferry operation and one-stop border post.
↓		
Evaluation	:	Evaluation of project proposals in terms of economic and financial aspect.
↓		
Conclusion and Recommendation	:	Conclusion and recommendation as the result of the study.

4.2 Improvement Plan of Ferry Operation

The preliminary design for ferry facilities had to be examined in two cases, i.e. “with bridge” case and “without bridge” case in order to execute the ideal ferry operation.

In case of “with bridge” case, improvement work should be contained to a minimum level in consideration of its effect on bridge construction work and discontinuation of the ferry operation in future. On the other hand, in case of “without bridge” case, suitable ferry facilities have to be proposed in order to reduce traffic congestion in future. Planning components of ferry improvement are as follows:

(1) With Bridge Case : Replacement of onshore ramp, dredging work of basin

(2) Without Bridge Case : Reconstruction of onshore ramp, reconstruction and expansion of parking lot, construction of storage facility, replacement of engine, improvement of upper deck, replacement of propeller

4.3 Construction Plan of Bridge and Approach Roads

The construction of the bridge and approach roads for the Kazungula Crossing is as follows:

(1) Bridge Construction Plan

1) Crossing Route

The following criteria were used in selection of the bridge route:

- Minimising construction cost, especially that for within the river channel,
- Minimising influence on both existing ferry operation and procedures at customs and immigration,
- Minimising disturbance to the existing facilities including military barracks, market square and transmission line,
- Avoiding serious hydraulic issues in the river, especially those associated with the confluence of the two rivers; Zambezi and Chobe,
- Selecting a suitable location in terms of geotechnical conditions (depth to resistant basalt rock), and
- Selecting a suitable location in the constraint of international boundaries.

Based on the above condition, “Route C” along with the power transmission line and connecting the existing onshore ramp was selected for the reasons of cost minimum, less hydraulic issues, easier relocation of the existing onshore ramps.

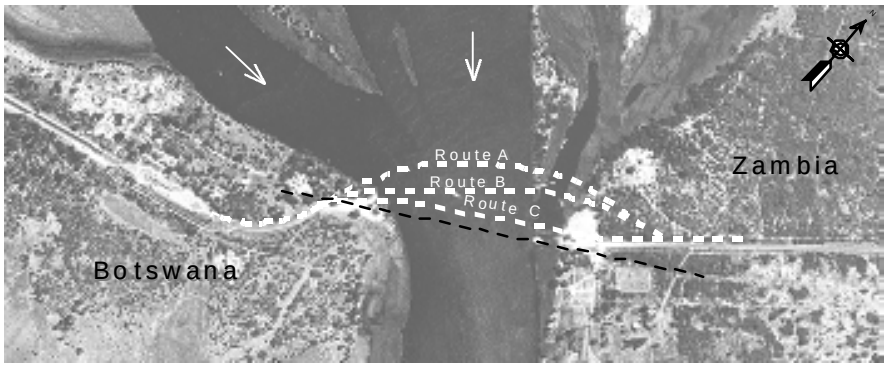


Figure 4.1 Alternative Routes

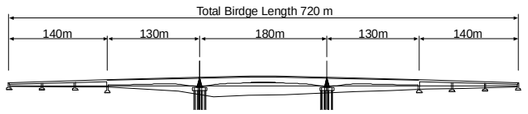
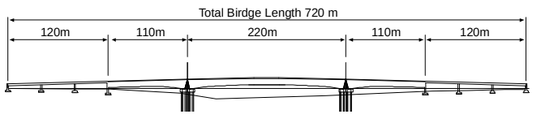
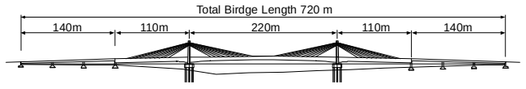
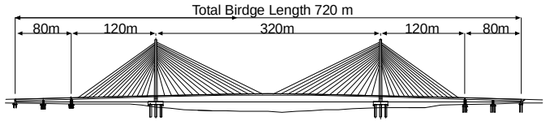
2) Bridge Type

As the main bridge, PC Extra-dosed type was selected for the reasons that it has superior points in construction costs, concrete works, economical design and environmental impact, compared with PC Box Girder and PC Cable-stayed bridge types.

3) Technical Standards and Specifications

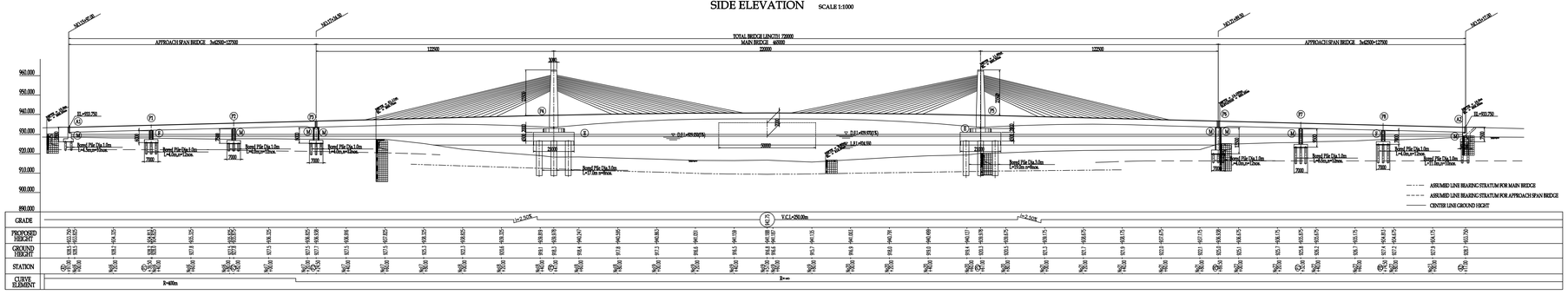
Design vehicle live loads in accordance with BS5400 was adopted for the structural design of bridge, and 37.5 unit of HB loading was considered. The existing standards available in Botswana and Zambia for bridge design were also considered.

Figure 4.2 Assessment for Optimum Bridge Type

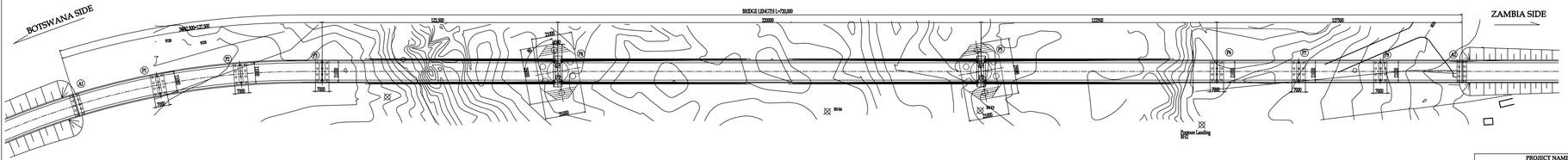
Features of Bridge	Technical description	Economic Interpretation	Environmental Impact
(A) PC- Box Girder (Ls =185m)  	• The main girder is concrete box and its depth is 9m at supporting point, • The pier in the river is 2 locations. • Total bridge length is 720m including 440m long of the main bridge. • The approach span bridges with 47m span length are provided on both sides of the main bridge. • The shorter central span length require more treble and longer period of works in the river.	(A)-1 Longest jetties (130m x 2) shall require additional construction cost compared with that in other 3 cases. Total construction cost shall be of medium size among the cases. (A)-2 The height of the carriageway is at medium level which requires moderate amount of vehicle operating cost at the approach road. (A)-3 Preliminary cost per one square meter (cost ratio): 6,360US$/$m^2$ (1.00) (A)-4 Vehicle operation cost is smaller than that of case (B).	(During the construction) (1) Since, for the construction of piers, cofferdam will be constructed, drilling noise is such that it might annoy both people and animals in the area. (2) Unless otherwise the water that will be used for the construction will be properly managed, it might contaminate the river water. (3) Dust that will be caused by construction activity might worse air quality of the area. (After completion) (1) Since the gradient of the bridge is 3%, which is relatively steep compared with the Type C and D, traffic noise and emission might cause more noise and air pollution. (2) Since two piers are relatively thicker than Type C and D, they might disturb the movement of fish and animals such as hippopotamus and crocodiles.
(B) PC-Box Girder (Ls = 220m)  	• The main girder is concrete box and its depth is 14m • The pier in the river is 2 locations. • Total bridge length is 720m including 440m long of the main bridge. • The approach span bridges with 47m span length are provided on both sides of the main bridge. • The construction period is normal.	(B)-1 Longer center span (220m) shall require additional construction cost on this segment compared with that in case (A). However, reduced jetty length (110.0m x 2) shall reduce the cost on this segment. (B)-2 Deepest girder (14.0m) among the four cases requires sharp slope at the approach road which shall result in higher vehicle operation cost and lower vehicle speed. (B)-3 Preliminary cost per one square meter (cost ratio): 6,741US$/$m^2$ (1.06) (B)-4 Highest vehicle operation cost is expended.	(During the construction) (1) Since, for the construction of piers, cofferdam will be constructed, drilling noise is such that it might annoy both people and animals in the area. (2) Unless otherwise the water that will be used for the construction will be properly managed, it might contaminate the river water. (3) Dust that will be caused by construction activity might worse air quality of the area. (After completion) (1) Since the gradient of the bridge is 3%, which is relatively steep compared with the Type C and D, traffic noise and emission might cause more noise and air pollution. (2) Since two piers are relatively thicker than Type C and D, they might disturb the movement of fish and animals such as hippopotamus and crocodiles. (3) Since the space between the two piers is wider than the Type A, impact on aquatic life is relatively smaller than that of Type A.
(C) PC- Extra –dosed (Ls = 220m)  	• The main girder is concrete shallow box and its depth is 6m at supporting point. • The height of pylon is 22m above the bridge deck. • The pier in the river is 2 locations. • Total bridge length is 720m including 440m long of the main bridge. • The approach span bridges with 47m span length are provided on both sides of the main bridge. • The construction period is normal.	(C)-1 Lower construction costs on jetties and main girder are expected of due to shorter length of jetties and shallow depth of main girder. 22.0m high pylon requires additional construction cost and resultant large expenditure for its maintenance. (C)-2 Lower level of carriageway shall reduce the magnitude of vehicle operation cost compared with those in former 2 cases. (C)-3 Preliminary cost per one square meter (cost ratio): 5,724US$/$m^2$ (0.90) (C)-4 Second smallest vehicle operation cost among the 4 cases is expended.	(During the construction) (1) Since, for the construction of piers, cofferdam will be constructed, drilling noise is such that it might annoy both people and animals in the area. (2) Unless otherwise the water that will be used for the construction will be properly managed, it might contaminate the river water. (3) Dust that will be caused by construction activity might worse air quality of the area. (After completion) (1) Since the gradient of the bridge is 2%, which is relatively gentle compared with the Type A and B, traffic noise and emission might cause less noise and air pollution than Type A and B. (2) Though two piers are relatively thinner than Type A and B, they still might disturb the movement of fish and animals such as hippopotamus and crocodiles. (3) Since the height of pylon is 22m above the bridge deck, it might affect aesthetic view of the area. However, there are divided opinions on it. There are those who think this bridge type is aesthetically favorable and, on the other hand, there are others who think this type of bridge might cause aesthetic pollution. Accordingly through public consultation in terms of selection of bridge type will be essential.
(D) PC – Cable – Stayed (Ls = 320m)  	• The main girder is shallow concrete box and its depth is 4m at supporting point. • The height of pylon is 55m above the bridge deck. • The pier in the river is 2 locations at the low velocity area of the river flow. • Total bridge length is 720m including 560m long of the main bridge. • The approach span bridges with 40m span length are provided on both sides of the main bridge. • The construction period is longer due to the installation and adjustment of prestressing of stay cables.	(D)-1 Greatest construction cost is expected of due to great magnitude of construction cost of stayed cables and their maintenance works, although the shallow depth of girder require less cost. (D)-2 Shallow depth of girder reduce vehicle operating cost due to small gradient at approach road. (D)-3 Preliminary cost per one square meter (cost ratio): 8,268US$/$m^2$ (1.30) (D)-4 Smallest vehicle operation cost among the 4 cases is expended.	(During the construction) (1) Since, for the construction of piers, cofferdam will be constructed, drilling noise is such that it might annoy both people and animals in the area. (2) Unless otherwise the water that will be used for the construction will be properly managed, it might contaminate the river water. (3) Dust that will be caused by construction activity might worse air quality of the area. (After completion) (1) Since the gradient of the bridge is 2%, which is relatively gentle compared with the Type A and B, traffic noise and emission might cause less noise and air pollution than Type A and B. (2) Though two piers are relatively thinner than Type A and B, they still might disturb the movement of fish and animals such as hippopotamus and crocodiles. (3) Since the height of pylon is 55m above the bridge deck, it might significantly affect aesthetic view of the area. (4) Since the space between the two piers is wider than the Type C, impact on aquatic life is relatively smaller than that of the Type C.

GENERAL VIEW OF MAIN BRIDGE

SIDE ELEVATION SCALE 1:1000

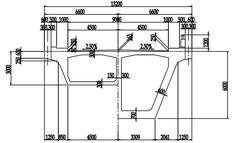


PLAN SCALE 1:1000

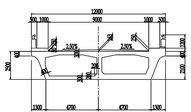


TYPICAL SECTION SCALE 1:200

MAIN BRIDGE



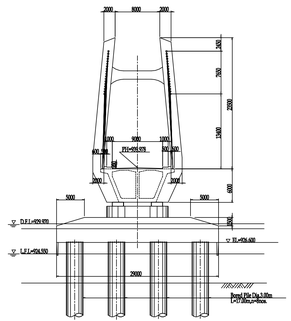
APPROACH BRIDGE



DESIGN CRITERIA

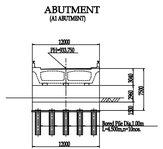
TYPE	MAIN BRIDGE	EXTRA-DOSED BOX GIRDER
	APPROACH BRIDGE	CONTINUOUS PC BOX GIRDER
BRIDGE LENGTH	MAIN BRIDGE	L=460.00m
	APPROACH BRIDGE	L= 2x127.50+255.00m
SPAN LENGTH	MAIN BRIDGE	132.50m+195m+132.50m
	APPROACH BRIDGE	5m@2.50m
WIDTH	CARRIAGEWAY	9.50m+0.50m+9.00m
	SIDEWALK	0.5 m+0.5m+1.00m
DESIGN LOAD	B.S. 5400-2:83	
RADIUS OF CURVATURE	R=∞	
LONGITUDINAL SLOPE	2.5% ⟷ 2.5%	V.C.L=250m(R=9000m)

P4 PIER,PYLON

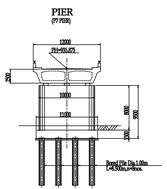


SUB-STRUCTURE SCALE 1:400

ABUTMENT
(A1 ABUTMENT)



PIER
(P7 PIER)



PROJECT NAME	IMPLEMENTATION AGENCY	EXECUTING AGENCY	JICA STUDY TEAM	DRAWING TITLE	DWG NO.
THE FEASIBILITY STUDY ON THE PROPOSED KAZUNGULA BRIDGE OVER THE ZAMBEZI RIVER BETWEEN BOTSWANA AND ZAMBIA	JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	MINISTRY OF WORKS, TRANSPORT AND COMMUNICATIONS REPUBLIC OF BOTSWANA MINISTRY OF WORKS AND SUPPLY REPUBLIC OF ZAMBIA	NIPPON KOEI CO.,LTD. ORIENTAL CONSULTANTS CO.,LTD	GENERAL VIEW OF MAIN BRIDGE	BR/001

(2) Approach Roads Construction Plan

- Design Conditions

  - Design Speed : 80km/hr
  - Navigational Clearance : 7m (vertical) x 50m (horizontal)
  - Typical Cross Section : Bridge: Carriageway 2@3.5m, shoulder 1.0m, sidewalk 1.0m
    Road: Carriageway 2@3.5m, shoulder 2.0m, shoulder protection 0.5m

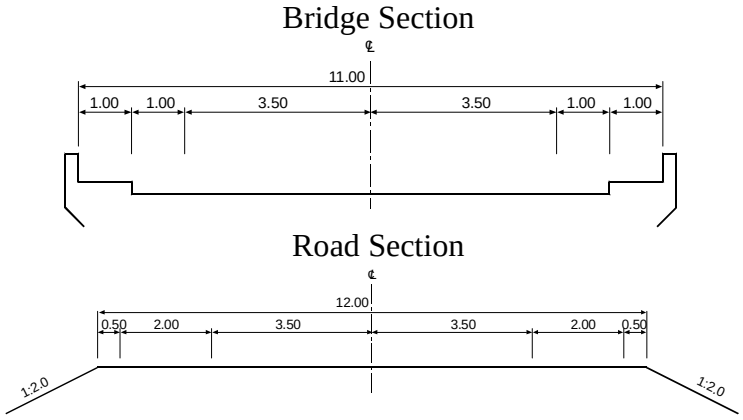


Figure 4.4 Proposed Typical Cross Sections

(3) Outline of Construction Plan of Bridge and Approach Roads

-	Total Bridge Length	:	720.0m
-	Main Bridge (PC Extra-dosed)	:	465.0m
-	Approach Span Bridge	: Zambia side:	127.5m (3@42.5m)
		: Botswana side:	127.5m (3@42.5m)
-	Approach Roads	: Zambia side:	1,383.0m
		: Botswana side:	1,597.0m

(4) Construction of Temporary works

a) Temporary Work for Main Bridge

The temporary bridges will be provided towards the main bridge pier, approx. 130m from both riversides of Botswana and Zambia, where the water depth around the piers are 8.0m. The foundations of temporary bridge will be constructed by using steel piles to be installed into the holes drilled in the weathered rock.

During the construction of temporary bridge and also the permanent bridge structures in the river, the existing ferry facilities will be shifted towards the upstream so that the ferry operation will not be affected by the bridge construction.

b) Temporary Work for Approach Span Bridge

The Construction locations of the approach span bridge is situated at the areas where the inundation during flooding does not appear often except the 100 year flood case.

4.4 Improvement Plan of Border Passing System

(1) One Stop Border Control System and Border Facilities

The Design has been based on the conclusion that the One-Stop system has been recommended for implementation for the three affected Border facilities. This is where all the exit and entry procedures for travelling between two countries are carried out at one location, situated in the departure-side country. Thus for this project there will be three separate Border Facilities.

(2) Construction Plan of New Border Facilities

The construction plan covers the following main buildings and facilities:

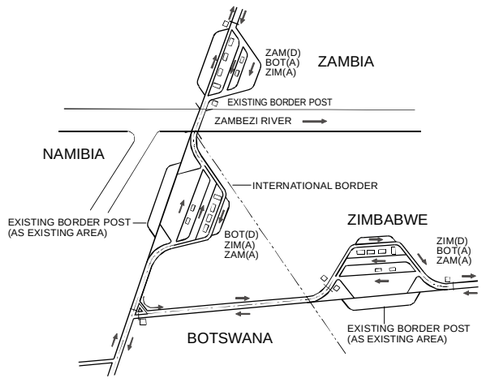
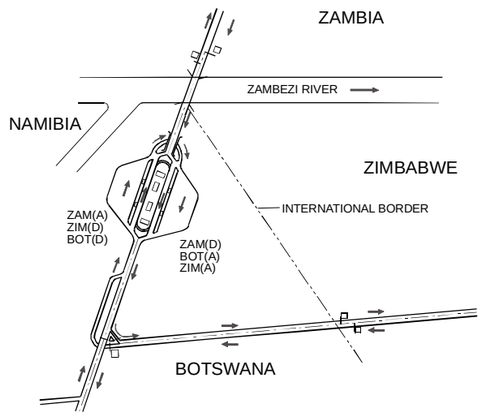
- Central 'Passenger Control' Building:
  Passenger Immigration & Customs Areas
  Immigration, Customs and Police Staff Offices (for 3 countries)
- Car and bus parking, and separate truck parking areas (with weigh bridge)
- Vehicle Inspection Canopies (with future provision of inspection booths)
- Freight Office Building (with offices for clearing agents)
- Integrated Truck Inspection and freight unloading building

(3) Outline of Construction Plan of Border Control Facilities

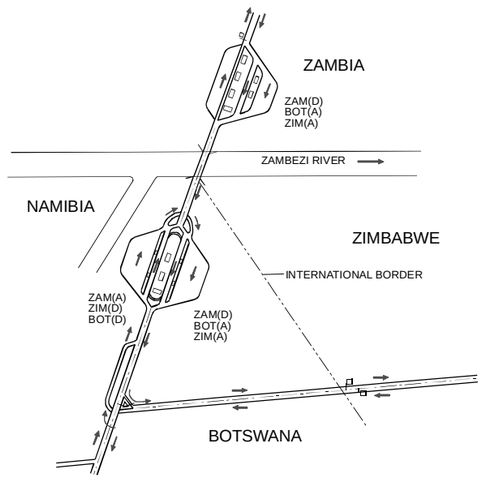
The Border Control Facilities with One Stop Border Control System, which will be built in individual country, has the following spaces enclosed with fences.

- Facility in Botswana : 17.1ha
- Facility in Zambia : 15.8ha
- Facility in Zimbabwe : 12.1ha

Figure 4.5 Assessment for Optimum Type of Border Post

Type of Border Post	Technical Description	Economic Interpretation	Environmental Impact
(A) SEPARATED BORDER POST  	(1) The site area of each border post is required normal size. (2) Border facilities will be simple. (3) Road alignment is plane and not crossing and so economic. (4) Formality for custom and immigration could be done at one time at one border post (minimizing time). (5) Need mutual agreement about legislative matters. (6) Existing border could be operational while new borders are being constructed.	(A)-1 One-stop border facilities at each country shall streamline the border traffic stream due to simple and clear-cut series of procedure to be realized by this system. (A)-2 Traffic signs/boards to conduct the Zambia–Zimbabwe traffic to proper lane is inevitable to be introduced. (A)-3 Smallest construction cost, due to small scale of facilities for each country, is expected of.	(1) Zambian side (During the construction) - Some tribal land, should be acquired and certain amount of trees must be removed. Though there is no regulation in Zambia to compensate tree cutting, the project must seek some measures of compensation. - There is no resettlement involved - Water, air, noise pollution can be expected unless appropriate measures should otherwise be taken (During the operation) - The existing border control facility is a “sentimental monument” for Kazungula people. Accordingly, it should remain as it is and should be used for other purposes. - New border facility might generate employment opportunities for local people. (2) Botswana side (During the construction) - Some tribal land, should be acquired and certain amount of trees must be cut off. Though there is no regulation in Botswana to compensate tree cuttings, the project must seek some measures of compensation. - There is no resettlement involved - Water, air, noise pollution can be expected unless appropriate measures should otherwise be taken - Though this area is not a part of national park, animals such as elephants, buffalos and lions are straying to fetch water. During the construction, unless construction camps site are properly planned, these animals can attack workers. At the same time, construction work hour should be restricted from 6 am to 5 pm to avoid the disturbance of animal movement. (During the operation) - New border facility might generate employment opportunities for local people. - Certain protection measures will be necessary against the damage by animals. - Local people are worried about the transmission of HIV (AIDS) and other sexually transmitted diseases (STD) by truck drivers, who stay at the facility or its surrounding area (3) Zimbabwe side (During the construction) - Some national park land, should be acquired and certain amount of trees must be removed. The project must follow necessary measures to do development activities in national park according to legislations and regulations of national parks in Zimbabwe. - There is no resettlement involved - Water, air, noise pollution can be expected unless appropriate measures should otherwise be taken - Since this is a part of national park, animals such as elephants, buffalos and lions are straying. During the construction, unless construction camps site are properly planned, these animals can attack workers. At the same time, construction work hour should be restricted according to the movement of animals. (During the operation) - Certain protection measures will be necessary against the damage by animals. - Life and traffic noise might cause adverse impact on animals.
(B) INTEGRATED BORDER POST  	(1) All borders are integrated at one place. (2) Huge site area is needed. (3) Legislative agreement is needed. (3) 2-Underpass will be needed which may entail cost increase. (4) User’s convenience is high since all formalities could be done at one time. (5) During construction, it may need some arrangement for maintaining existing border post.	(B)-1 One but large scale facility has to be constructed which requires large extent of land and its preparation. Large construction cost is expected of, among the 3 systems described herein. (B)-2 Notice, traffic signs and signboards to conduct users to proper direction also have to be introduced. (B)-3 Grade-separated pass way to conduct cross border vehicles to proper direction is inevitable to be constructed. Construction of this kind of pass way requires considerable amount of cost.	(During the construction) - Large scale of land than Type A and C, which is tribal land, should be acquired and certain amount of trees must be cut off. Though there is no regulation in Botswana to compensate tree cuttings, the project must seek some measures of compensation. - There is no resettlement involved - Water, air, noise pollution can be expected unless appropriate measures should otherwise be taken - Though this area is not a part of national park, animals such as elephants, buffalos and lions are straying to fetch water. During the construction, unless otherwise construction camps site will not be properly planned, these animals can attack workers. At the same time, construction work hour should be restricted from 6 am to 5 pm to avoid the disturbance of animal movement. - Since underpasses will be constructed, drainage should be appropriately planned. (During the operation) - New border facility might generate employment opportunities for local people. - Certain protection measures will be necessary against the vandalism of animals. - Local people are worried about the transmission of HIV (AIDS) and other sexually transmitted diseases (STD) by trackers, who stay at the facility or its surrounding area

(Continued)

Type of Border Post	Technical Description	Economic Interpretation	Environmental Impact
(C) SEMI-INTEGRATED BORDER POST  	(1) One separate type border post combining with semi-integrated border post. (2) 2-Underpass will be needed which may increase construction cost. (3) Legislative agreement is needed (4) During construction, some arrangement on the semi-integrated post is needed.	(C)-1 Relatively large scale facility on Botswana side has to be constructed to perform the formalities for Botswana and Zimbabwe at one time. (C)-2 Large construction cost than that of case (A), but smaller cost than case (B), is expected.	(1) Zambian side: (During the construction) - Some tribal land, should be acquired and certain amount of trees must be removed. Though there is no regulation in Zambia to compensate tree cuttings, the project must seek some measures of compensation. - There is no resettlement involved - Water, air, noise pollution can be expected unless appropriate measures should otherwise be taken (During the operation) - The existing border control facility is a “sentimental monument” for Kazungula people. Accordingly, it should remain as it is and should be used for other purposes. - New border facility might generate employment opportunities for local people. (2) Botswana side: (During the construction) - Some tribal land, should be acquired and certain amount of trees must be cut off. Though there is no regulation in Botswana to compensate tree cuttings, the project must seek some measures of compensation. - There is no resettlement involved - Water, air, noise pollution can be expected unless appropriate measures should otherwise be taken - Though this area is not a part of national park, animals such as elephants, buffalos and lions are straying to fetch water. During the construction, unless otherwise construction camps site will not be properly planned, these animals can attack workers. At the same time, construction work hour should be restricted from 6 am to 5 pm to avoid the disturbance of animal movement. - Since underpasses will be constructed, drainage should be appropriately planned. (During the operation) - New border facility might generate employment opportunities for local people. - Certain protection measures will be necessary against the vandalism of animals. - Local people are worried about the transmission of HIV (AIDS) and other sexually transmitted diseases (STD) by truck drivers, who stay at the facility or its surrounding area. (3) Zimbabwe side (During the demolition) - Water, air, noise pollution can be expected unless appropriate measures should otherwise be taken - Demolished materials should be appropriately dealt with

4.5 Preliminary Cost Estimate

(1) Construction Cost and Project Cost

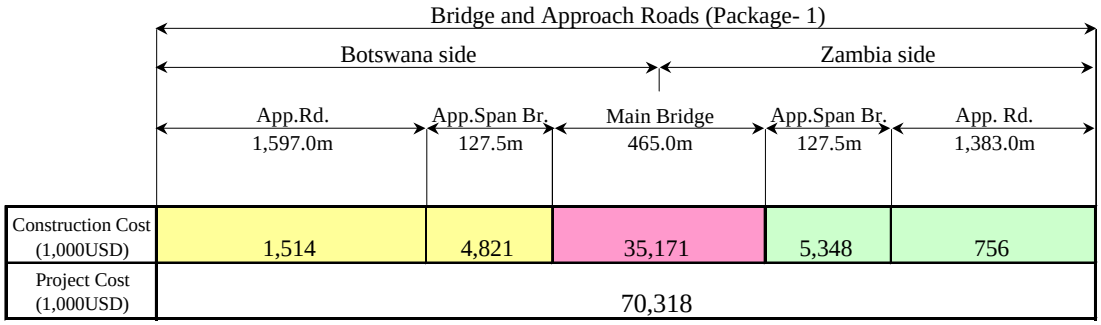
Unit : 1,000USD

Description	Botswana	Zambia	Zimbabwe	Total
1. Bridge and Approach Roads (Package - 1)				
1.1 Construction Cost				
1) Approach Road (Botswana side)	1,514	----	----	1,514
2) Approach Span Bridge (Botswana side)	4,821	----	----	4,821
3) Main Bridge	*17,585	*17,585	----	35,171
4) Approach Span Bridge (Zambia side)	----	5,348	----	5,348
5) Approach Road (Zambia side)	----	756	----	756
6) Ferry Facility	----	58	----	58
Total of Construction Cost	23,921	23,748	----	**47,668**
1.2 Project Cost	35,286	35,031	----	**70,318**
2. Boder Control Facilities (Package - 2)				
2.1 Construction Cost				
1) Botswana side	7,513	----	----	7,513
2) Zambia side	----	4,972	----	4,972
3) Zimbabwe side	----	----	2,952	2,952
Total of Construction Cost	7,513	4,972	2,952	**15,437**
2.2 Project Cost	14,868	9,839	5,842	**30,550**

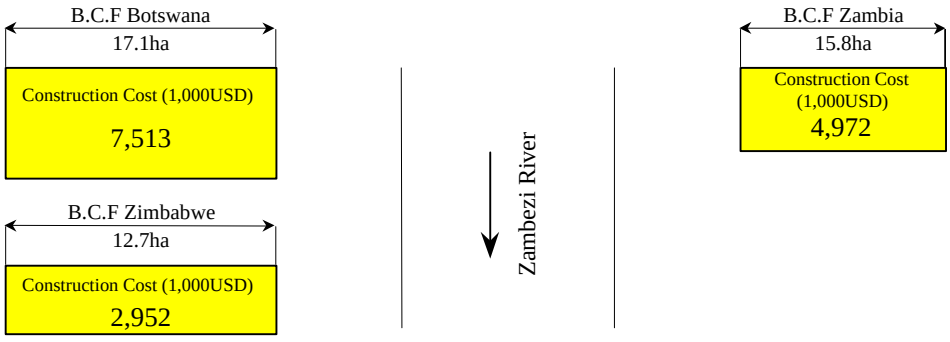
Note : * The divided cost in case that if the international boundary is located at the middle of the main bridge.

(2) Construction Components and Costs

1) Bridge and Approach Roads (Package - 1)



2) Border Control Facilities (Package - 2)



5. Evaluation of Development Plans of Kazungula Crossing

5.1 Economic Evaluation

(1) Preposition of Evaluation

For the evaluation of the viability of the projects the following assumptions were adopted in the Study:

1) Construction work timing

- Bridge: 4 years after the preceding engineering studies
- One-Stop Border Post: 4 years after the preceding engineering and administrative studies
- Ferry Facilities: Facility improvement works shall begin in 2001.

2) Project life: 30 years after the completion of initial construction works.

3) Monetary unit for the evaluation

US$ was adopted taking international nature of the projects into consideration. The following exchange rates (as of November 1, 2000) were adopted:

US$1=5.5 Botswana Pula
US$1=3600.0 Zambia Kwacha
US$1=55.0 Zimbabwe dollar
US$1=110.0 Japanese Yen

4) Standard conversion factor

Standard conversion factor of 0.85 for the conversion of financial cost into economic one was applied in consideration of the tax rates and duties in Botswana and Zambia.

5) Discount Rate

A 12% discount rate, for the calculation of B/C and NPV, was applied taking the opportunity costs of Botswana and Zambia into consideration. In addition, the above were calculated indicators under a 10% of discount rate for reference.

6) Future Traffic Levels

Two of the future traffic growth scenarios presented: high growth and low growth were adopted as the basis of evaluation. Annual traffic growth rates adopted in the evaluation of individual projects were as follows:

Bridge and One-Stop Border Post
High Growth Scenario: 8.56%
Low Growth Scenario: 6.36%

Improved Ferry
High Growth Scenario: 7.11%
Low Growth Scenario: 4.70%

7) Vehicle Mode

Throughout the economic evaluation, following vehicle classification was adopted:

Mode1: Car
Mode2: Bus, Medium Truck
Mode3: Heavy Truck

8) Traffic Classification

Throughout the evaluation, two of the traffic classification, i.e. (i) normal traffic and (ii) developed traffic, were handled separately. Definitions of these traffic are as follows.

- Normal traffic : Traffic due to natural increase of economic activities, including those traffic which may divert from the other routes.

- Developed traffic : Traffic due to development effects of the project, includes induced traffic by the project.

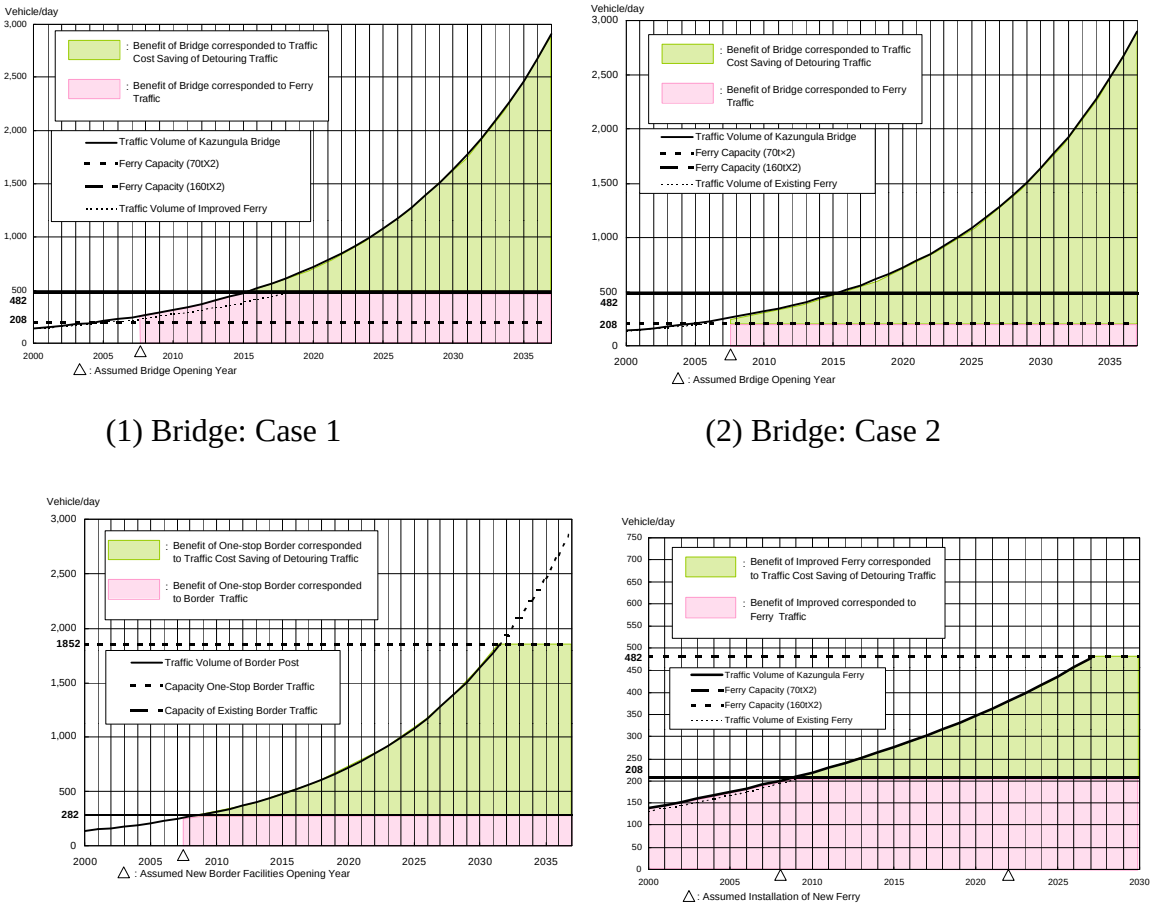
9) Assumption of “without” or “do nothing” Cases

The cases of “without” or “do nothing” as the basis of benefit estimation were assumed as follows:

- Evaluation of Bridge: Case 1: Improved ferry
  Case 2: Existing ferry
- Evaluation of One-Stop Border Post: Existing border posts
- Evaluation of Ferry Improvement: Existing ferry

10) Capacities of Facilities and Detouring

Traffic volumes in the “Without Project Case” were obtained in relation to the capacities of each facility. Traffic levels above the capacities was reckoned as detouring traffic to other routes. The concept of benefit calculation is illustrated in Figure 5.1.



(1) Bridge: Case 1 (2) Bridge: Case 2

(3) One-Stop Border Post (4) Ferry Improvement

Figure 5.1 Concept of Benefit Calculation

(2) Conclusion

1) Calculated Evaluation Indicators

The results of calculated indicators are shown in Table 5.1.

Table 5.1 Results of Calculated Evaluating Indicators

	Project	Case	IRR	B/C		NPV (US$ mil.)	
				Discount rate: 10%	Discount rate: 12%	Discount rate: 10%	Discount rate: 12%
Bridge	Bridge (Case 1) (without case: Improved Ferry)	High Growth	0.1370	1.8931	1.3193	23.0674	7.9723
		Low Growth	0.0943	0.8990	0.6371	-2.6583	-9.1780
	Bridge (Case 2) (without case: Existing Ferry)	High Growth	0.1569	2.0095	1.5349	31.4575	15.4818
		Low Growth	0.1106	1.1541	0.8862	4.8040	-3.2941
One stop Border Post	One Stop Border Post	High Growth	0.1846	2.7258	2.0894	22.0636	12.7053
		Low Growth	0.1144	1.1730	0.8909	2.1814	-1.2566
Ferry	Ferry Improvement	High Growth	0.2483	3.2372	2.7388	4.1557	2.7624
		Low Growth	0.1542	2.2306	1.7763	1.7526	0.9427

2) Sensitivity Test

Sensitivity test was conducted for the IRR of the bridge construction project to confirm the robustness of the above evaluation. The results are as shown in Table 5.2 where variations of ±20% of cost and benefit are assumed.

Table 5.2 Result of Sensitivity Analysis of the Bridge Construction Project

1) High Growth Scenario: Case 1 (=Assumed without case: Improved Ferry)

	Benefit 20% down	Benefit Constant	Benefit 20% up
Cost 20% down	0.1370	0.1520	0.1652
Cost Constant	0.1232	0.1370	0.1492
Cost 20% up	0.1126	0.1257	0.1370

2) High Growth Scenario: Case 2 (= Assumed without case: Existing Ferry)

	Benefit 20% down	Benefit Constant	Benefit 20% up
Cost 20% down	0.1569	0.1793	0.1996
Cost Constant	0.1368	0.1569	0.1750
Cost 20% up	0.1218	0.1403	0.1569

3) Low Growth Scenario: Case 1 (=Assumed without case: Improved Ferry)

	Benefit 20% down	Benefit Constant	Benefit 20% up
Cost 20% down	0.0943	0.1065	0.1172
Cost Constant	0.0829	0.0943	0.1042
Cost 20% up	0.0742	0.0849	0.0943

4) Low Growth Scenario: Case 2 (= Assumed without case: Existing Ferry)

	Benefit 20% down	Benefit Constant	Benefit 20% up
Cost 20% down	0.1106	0.0832	0.1441
Cost Constant	0.0943	0.1106	0.1250
Cost 20% up	0.0820	0.0972	0.1106

(3) Case Study of the Opening Year of the Bridge

For the purpose of finding out the optimal year for opening the bridge, case study that assumes different opening year was conducted as shown below:

1) Assumption of Evaluation

- Evaluation Period : 30 years until 2037 due to conform to the original case
- Residual Value : Residual value of bridge was reckoned at the last year of the evaluation period.
- Traffic Volume : Two traffic scenarios: High growth scenario and low growth scenario
- Evaluation Indicator: IRR and NPVs under 12 % of official discount rate

2) Case Study

Case study for opening year is shown in Table 5.3.

Table 5.3 Case Study for Opening Year

Case	Assumed Opening Year	Benefit Estimation Case	Background of Case Study
Case A	2007	Case 1 (Improved Ferry)	Saturation year of Existing ferry capacity (208vehicles/day)
Case B	2007	Case 2 (Existing Ferry)	Saturation year of Existing ferry capacity (208vehicles/day)
Case C	2013	Case 1 (Improved Ferry)	Opening year of bridge is delayed by 5 years.
Case D	2013	Case 2 (Existing Ferry)	Opening year of bridge is delayed by 5 years.
Case E	2018	Case 1 (Improved Ferry)	Opening year of bridge is delayed by 10 years.
Case F	2027	Case 1 (Improved Ferry)	Saturation year of Existing ferry capacity (482vehicles/day)

3) Results of Benefit Calculation

Result of benefit calculation is shown in Table 5.4.

Table 5.4 Result of Benefit Calculation

	High Growth Scenario		Low Growth Scenario	
	IRR	NPV (mil. US$)	IRR	NPV (mil. US$)
Case A	0.1370	7.9723	0.0946	-9.1780
Case B	0.1569	15.4818	0.1106	-3.2941
Case C	0.1723	13.8263	0.1122	-1.6062
Case D	0.1856	15.7839	0.1310	2.1480
Case E	0.2267	14.9167	0.1419	2.4605
Case F	-	-	0.1022	-2.0538

4) Consideration of Evaluation Indicators

Bridge

- It can be concluded from that the bridge construction project is economically feasible in the case of high traffic growth scenario in 2007.
- Maximum of NPVs in high growth scenario appears around year 2013, that is 5 years of postponement from original schedule. This fact suggests that opening the bridge in 2013 is more feasible in terms of national economics than that in 2007.
- It can be judged that the optimal opening year in low growth scenario may lie in somewhere around year 2018.
- The results of sensitivity test suggest that IRRs are insensitive to the variation of cost and benefit. In the low growth scenario, IRRs in 20% of benefit increase with 20% of cost down of original level in the case 2 come up with values that are higher than discount rate of 12%. This fact suggests the project is apt to be feasible even in the low growth scenario if conditions meet.

One-Stop-Border Post

- One-stop border post construction project was proved to be feasible in high traffic growth scenario.

Improvement Ferry

- Investment cost of ferry improvement is US$6.3 million, which is equivalent to about 15% of bridge construction cost of US$40.47 million in terms of economic price. This small investment cost is major reason of high economic returns obtained.
- Ferry improvement project is proved to be feasible both in high growth and low growth scenarios.
- Because of relatively low capacity of improved ferry which is 478 vehicles/day, NPVs are small (high growth scenario: US$2.76

million, low growth scenario: US$0.94 million) as against that of the bridge.

5.2 Financial Consideration

(1) Possibility of Toll Bridge System

1) Study on Optimal Toll Rate

The optimal level of toll rates for the bridge was analysed on "willing to pay" principle. The optimal toll rates were thus set at US$10 for passenger car, US$20 for medium sized truck, and US$30 for heavy truck.

2) Financial Internal Rate of Return

Financial Internal Rates of Return (FIRR) was calculated for the optimal toll rates under two different traffic scenarios: High growth scenario and low growth scenario. Conditions set for the evaluation were as follows:

- Redemption Period: 30 years
- No cost escalation and price hike is assumed.

FIRR of 0.1444 for high growth scenario and 0.1145 for low growth scenario were obtained for the base case, respectively as shown in Table 5.5.

Table 5.5 Calculated FIRRs for Toll Bridge

	Base Case	Alternative of Base Case	Optimal Toll Rate
High Growth Scenario	0.1444	0.1196	0.0839
Low Growth Scenario	0.1145	0.0910	0.0571

- Base Case : Mode1: US$20, Mode2: US$55, Mode3: US$70
- Alternative of Base Case : Mode1: US$15, Mode2: US$40, Mode3: US$50
- Optimal Toll Rate : Mode 1: US$10, Mode2: US$20, Mode3: US$30

(2) Consideration of Financial Viability of Implementation Agencies

The total project costs by component of sub project are as follows:

Bridge and Access Road

- Engineering Cost: US$ 4.77 million
- Construction Cost: US$47.67 million (of which maximum disbursement per annum is US$ 23.01 million in 2005)
- Maintenance Cost: US$4.08 million

One-Stop Border post

- Engineering Cost: US$ 2.32 million
- Construction Cost: US$15.44 million (of which maximum disbursement per annum is US$ 8.53 million in 2004)
- Maintenance Cost: US$13.23 million

Ferry Improvement

(High Growth Scenario)

- Improvement Cost: US$ 7.45 million

(Low Growth Scenario)

- Improvement Cost: US$ 5.79 million

The recent budgets of would-be implementing agencies, Zambian Ministry of Public Works and Supply (MOPS) and Botswanan Ministry Works and Transportation and Communication (MWTC) are not sufficient to cater to all the above project cost and are at the level of catering to only annual maintenance cost. This fact suggests that the project fund is to be procured by off shore basis, including ODA and/or None-ODA from foreign governments, international financial organisations, or private financing.

Table 5.6 (1) Budget of Implementation Agency (Zambian MOWS)

Unit: Mil. Kwacha

	1994/5	1995/6	1996/7	1998/9
Total Government	964,569	1,266,026	1,625,562	1,818,339
MOWS	56,755	64,114	81,193	119,845
Road Department	57,714	70,461	112,919	221,407
Maintenance	50,173	58,579	71,071	113,455

US$1=3,600 Kwacha (Nov, 2000)

Table 5.6 (2) Budget of Implementation Agency (Botswana MWTC)

Unit: Mil.Pula (97price)

		1996/7	1998/9	1999/2000
Development Budget of MWTC	Development Budget	386.7	349.9	279.3
	Road/Bridge	204.8	212.2	151.1
Recurrent Budget of MWTC	Recurrent Budget	459.8	483.7	508.9
	Road/Bridge	108.9	111.7	114.6
Total MWTC Budget	MWTC Budget	846.5	833.6	788.2
	Road/Bridge	313.7	323.9	265.7

US$1=5.5 Pula

5.3 Indirect Effects of the Project

The Project will not only create an economic effect, but will have influence on the technical improvement, including mitigation of environmental impact.

- Strengthening of regional integrity,
- Promotion of local industries.
- Enhancement of farm gate prices of agricultural production,
- Inducement of community area development,
- Contribution to enhancement of Basic Human Needs,
- Contribution to WID (Women in Development),
- Strengthening of smuggling control and security,
- Enhancement of traffic safety levels, and
- Contribution to mitigation of water contamination.

6. Conclusions and Recommendations

6.1 Implementation Program

(1) Packaging and Works

The Project package will be divided into two packages with different characteristics in administration and technical aspects. Package-1 consists of the bridge and approach roads. Package-2 consists of the three border control facilities. The project outlines are:

Package-1

-	Total project length of Bridge and Approach Roads	:	3,700 m
-	Total Bridge Length	:	720 m
-	Main Bridge Length	:	465 m
-	Approach Road (Zambia side)	:	1,383 m
-	Approach Road (Botswana side)	:	1,597 m
-	Total Approach Roads Length	:	2,980 m

Package-2

-	Border Control Facility (Zambia)	:	15.8 ha
-	Border Control Facility (Botswana)	:	17.1 ha
-	Border Control Facility (Zimbabwe)	:	12.7 ha
-	Passing Road (Zimbabwe)	:	600 m

(2) Project Cost

The project cost and its breakdown are (unit: 1,000 USD) described as below:

-	Construction Cost	:	47,668
-	Engineering Cost	:	4,766
-	Administration Cost	:	2,860
-	Land Acquisition and Compensation	:	7
-	Price Escalation & Physical Contingency, etc.	:	9,533
-	Duty Tax (VAT)	:	4,766
	Total Project Cost	:	70,317

(3) Tentative Implementation Schedule

The overall implementation program and tentative schedule are proposed as below:

-	Procurement of Consultant	:	6 months (July 2001 - Dec. 2001)
-	Detailed Design	:	12 months (Jan. 2002 - Dec. 2002)

- PQ & Tendering : 12 months (Jan. 2003 - Dec. 2003)
- Construction
  - Package-1 (Bridge Approach Roads) : 39 months (Jan. 2004 - March 2007)
  - Package-2 (Border Control Facilities) : 33 months (July 2004 - March 2007)

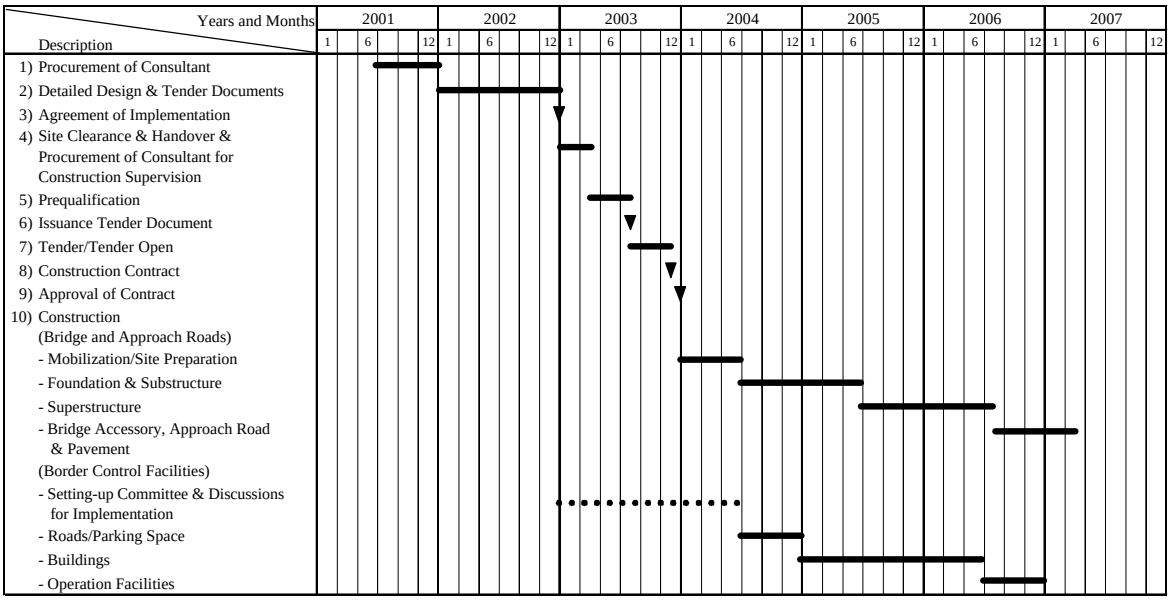


Figure 6.1 Tentative Project Implementation Schedule

6.2 Financial Procurement Plan

As far as economic evaluation is concerned, the project proposed in the study is mainly feasible. Furthermore, the simple cost/revenue analysis suggests that the revenues from the toll bridge can cover a great portion of project cost. Under these conditions, implementation of the project is a matter to be discussed among the concerned parties in line with the probable financing method to be adopted.

The international nature of the project entails many international arrangements need to be made before the initiation of the plan. These are closely related to the financial arrangements of the project.

With regard to international financing of this bilateral project, either of the following methods is probable:

Method 1: Separate financing to Botswana and Zambia

After the arrangement of legal matters (property ownership, international boundary, responsibility of maintenance, and toll levying right) the type and conditions of international financing, including the term of repayment, interest rate and so on, shall be discussed between the recipient governments and probable international financiers, independently.

Method 2: Financing to one of the governments that is a representative of the project implementation body

After the same discussion between Botswana and Zambia and agreement attained, method of international financing shall be discussed between the representative government selected and probable international financiers. The arrangement between Botswana and Zambia is subject to the two governments.

In either case, it is recommended that the governments of Botswana and Zambia should establish a joint committee for the project preparation at an early stage.

6.3 Formation of Project Implementation

(1) Settlement of International Borders in the River

The international boundaries on shore in and around the bridge crossing site are clearly identified by several concrete stakes, but it is difficult to identify the off shore boundaries due to missing documents related to the boundaries. Prior to the commencement the further stage, the international borders in the Zambezi River shall therefore be settled by a joint committee composed of Representatives from the Governments of Zambia, Botswana, Zimbabwe and Namibia.

(2) Formulation of Project Management Joint Committee

For smooth project implementation in the succeeding stage, it is requisite to formulate a project management joint committee (provisionally called) composing of high level Government officials from Zambia and Botswana, and also attended by Representatives from the Governments of Zimbabwe and Namibia as an observer. This Committee is mainly responsible for tasks such as seeking project financial source(s), determination of ownership of the bridge, project implementation and procurement method, formulation of regulations of usage and maintenance, and setting up of management policy and bridge maintenance strategy and other key issues related to the project implementation. After completion of the Project, this committee will be re-organised to function as **Kazungula Bridge Authority (KBA)** that will be responsible for operation and maintenance of the Bridge.

(3) Special Attention for Construction of Bridge Across the Border

Each country has its own legal system, regulations, guidelines, and different customs and culture. Consequently some conflicts and misunderstandings are likely to arise, especially concerning construction of a bridge across the border. One of the successful examples with similar features to the Project in SADC

region is New Chirundu Bridge Construction Project between Zambia and Zimbabwe, which is being implemented with Japan's Grant Aid Scheme. Some of the lessons from implementing Chirundu Project will be applicable to the Kazungula Bridge Construction Project, but some other possible issues derived from differences in site conditions and socio-economic situations between the two projects shall be taken into consideration. The issues from Chirundu Project applicable to the Kazungula Bridge Construction Project are as follows:

- Distinguished construction area as a neutral zone
- Issuance of border pass for free passage of the Project staff and vehicles
- Assignment of joint security force for unity
- Application of standardised wage rates for labour and technicians in the Project