THE UNITED REPUBLIC OF TANZANIA

SUMMARY AND RECOMMENDATIONS OF INTERIM REPORT ON FEASIBILITY STUDY AND PRELIMINARY DESIGN OF SOUTHERN COASTAL LINK ROAD PROJECT

August, 1976

JAPAN INTERNATIONAL COOPERATION AGENCY

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SUMMARY AND RECOMMENDATION

CONTENTS

1. Preface

This report prescribes the Summary and Recommendation as abstracted from the contents of an interim report on the Feasibility Study and Preliminary Design of Southern Coastal Link Road so that outline and scope of this project study can easily be grasped by refering this report.

Therefore detailed contents shall be refered to an Interim Report.

2. Subject Plans for the Evaluation of Proposed Road

For the proposed Southern Coastal Link Road, the study team has, as a result of preliminary discussion with the Government of Tanzania, adopted a plan to complete the entire routs as two(2) lanes paved road from initial stage as an original plan (or plan No.1).

However, considering present daily traffic volume of the Southern Coastal Link Road that is around 40 to 95 vehicles/day, more economical construction plans are considered available. Then the study was also made for other three types of stage construction plans, although setting a higher priority value in the original plan, to be completed ultimately in the form of original plan for the purpose of reducing the initial investment as much as possible.

Consequently the plans subjected to the evaluation were finaly proposed as shown in Table-1, an original plan and other three types of stage construction plans basing on the studies on administrative, technical and economic aspect of the project.

Further, for these 4 alternate plans, entire route was divided into five construction sections as shown in Table-1.

3. Premise for the Economic Evaluation

The economic evaluation was carried out for the five (5) construction sections in the total extension of 330.5km between Kibiti and Lindi excluding 12kms section around Rufiji Bridge construction site assuming that the Rufiji Bridge is already constructed.

When the bridge will be constructed across the Ruvuma River running along the boundary with Mozambique, the traffic volume of the Southern Coastal Link Road is considered to increase at a rapid rate as this road will become an international trunk road.

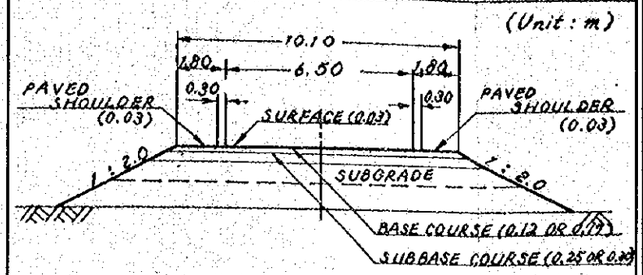
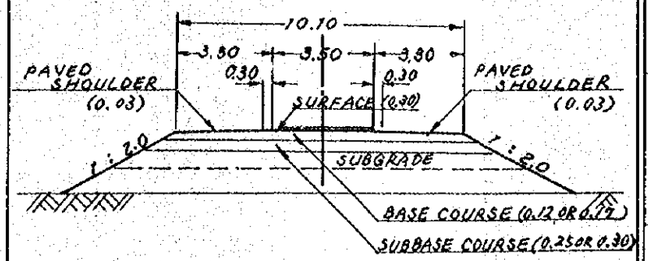
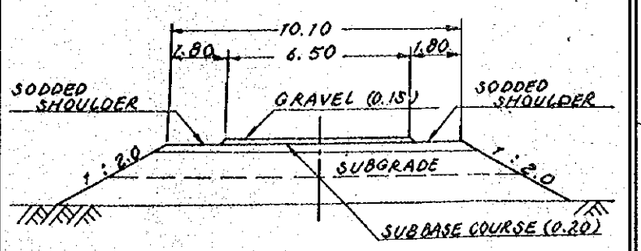
Therefore economic evaluations were made for four alternate plans as shown in Table-1, in both Cases of assuming the completion of Ruvuma river bridge in 1981 as Case-2 in which annual growth rate of traffic volume is estimated to be 7% and Case-1 in which said bridge will not be constructed with an assumption of 5% annual growth rate of traffic volume, whereas for plan No.2 and 3, economic evaluation was made for each construction section.

4. Soil and Aggregate Investigations

1) The soils distributed along the proposed route are classified into four grade, i.e., Grade I to IV as shown in Table-2.

   The pavement structure of proposed road and earth work planning were studied in accordance with this classification.

Table - 1 Subject Plans for the Evaluation of the Proposed Route and Division of Construction Section

Plan	Explanation of the Plan	Road Section
1	Construction of a two-lane paved road for the entire route.	
2	Construction of a two-lane road in Kibiti-Nyamwage section which has greater traffic volume than other sections, and a one-lane road in Sections 2-5 where the traffic volume is relatively small. Thereafter, with the growth of traffic volume two-lane paved roads are to be constructed in these sections to be completed in 15 years as in the form of original plan.	
3	Same as Plan 2, except that no shoulder pavement is planned for the first stage construction in Sections 2-5.	
4	Construction of a two-lane gravel road for the entire route, then improved to a paved road in 15 years as in the form of original plan.	

Construction Section	Section	Extension of proposed route (Km)
1	Kibiti ∿ Nyamwage	36.00
2	Nyamwage ∿ Nangurukuru	101.15
3	Nangurukuru ∿ Kiranjerange	86.70
4	Kiranjerange ∿ Lindi	76.23
5	Nangurukuru ∿ Kilwa Masoko	30.38
Total	Kibiti ∿ Lindi Nangurukuru ∿ Kilwa Masoko	330.46

Notes: 1) Indicated road extension excludes 12 km section of Rufiji bridge site.
2) These plans presuppose the completion of Rufiji river bridge.

Table-2 Soil Classification

Grade	Description
Grade I	Belongs to A-1-6, A-3 and A-2-4 according to AASHO classification system. Good to acceptable as the subbase course materials. Also acceptable as base course materials after grading adjustment and stabilization with cement or bituminous materials.
Grade II	Belongs to A-3, A-2-4 and A-2-6. Acceptable as subbase course materials. Also acceptable as base course materials if stabilized with cement. The soils of A-3 and A-2-4 of low plasticity are, if stabilized with bituminous materials mixing around 40% of aggregate, also acceptable as the materials of base course. Laterite soils belong to this grade.
Grade III	Unacceptable as subbase course materials. Should not to be used as subgrade materials. Better to use Grade I or II soils to form subgrade.
Grade IV	Having no trouble in dry condition but strength extremely goes down when absorbing water in the rainy season. Shall not be used as embankment materials. Black cotton clay and yellowish kaolin clay also belong to this grade.

2) Since soils that can be used for base materials are not available in the project area, crushed stones or locally available good soils of Grade I or II shall inevitably be used after stabilization.

For the subbase course materials, it was determined to use the said locally available good soils or the admixture of such soils and crushed stones after stabilizing them with asphalt, because in the northern half section of the proposed route, the transportation of materials takes long time thus it is more economical to use locally available soil, and to minimize the stripping between the subbase course and the surface course.

For the southern half section of the proposed route, admixture of locally available good soil and crushed stones to be stabilized with asphalt is planned to be used for base course.

3) Between Nangurukuru and Lindi, there exists promising quarry sites at the interval of an appropriate distance, therefore the supply of course aggregate of crushed stones are readily available, while from Nangurukuru to Kibiti, there are few quarry sites that can produce plently of aggregates with high quality.

Regarding fine aggregate, however, river sand and other sand with relatively good quality are easily obtainable at the area from Nangurukuru to Kibiti. But from Nangurukuru to Lindi, the distribution of good quality sand are limited.

4) For the area in a section from Nangurukuru to Kibiti, where the supply of course aggregate are not economically available, it is necessary for base course materials to reduce the amount of coarse aggregate used by devising the method to stabilize locally available good quality soil.

In the section from Nangurukuru to Lindi, the sand available at certain limited area (near Mpara) shall be used as much as possible. And for the material of which quality can be lowered by the use of concrete, the sand containing much fine particles is considered inevitable to be used.

5. Road Planning

1) The design of road was conducted by adopting design criteria prepared by Tanzania Government, major design criteria are as follows:

Table -3 Road Design Criteria

	Design Speed	Min.Radius of Hor'tl Curve	Maximum Grades
Flat Area	100 km/hr.	300m	5%
Hilly Area	80 km/hr.	300m	6%
Mountainous Area	60 km/hr.	230m	8%

Component of Road Width :

8.9m - 10.1m (Carriage way width : 6.5m
Shoulder width : 1.2m - 1.8m)

Widening section to be served as bus bay at villages :
3m x 2 = 6m

Bridge Width : 7.50m (Carriage Way) + 0.5m x 2 (shoulders)

2) The horizontal alignment was located, in principle, along the existing road. However, in the section where the existing road is located in low land thus likely to be affected by the flood in rainy season, the section in which existing alignment is unnecessarily detoured and the section of bad alignment, the existing alignment was improved.

Particularly, in selecting Mohoro district bypass, a comparative study was made on another route which stretches straight from Nyamwage into the mountainous area and takes a shortcut through Mohoro to make a detour around the flood area.

However, this alternative route was disregarded because of its high construction cost, and the originally selected route of which alignment was designed to make a minimum required detour around the flood area was adopted.

Also Kilwa Kivinje bypass runs through Kilwa Kivinje making a long detour of the existing road. In the alignment design, therefore, a route which takes a direct shortcut from the site of the former airport and descends along the hillside in the direction of Kilwa Masoko was selected.

3) Longitudinal alignment was so planned as to secure the function of an all wheather road and to reduce the construction cost by keeping amount of earth work at minimum.

4) For the plan of cross section, minimum cross slope was set at 3% to improve the drainage condition of road surface.

As a means of slope protection, grass planting method is planned. However, as the slopes at both ends of the bridge structures tend to be damaged by the flood flow, special slope is planned by means of precast concrete block or masonry work.

5) At the embankment section, naked ditch was planned to be installed at the point 3m away from toe of slope and at the cutting section, concrete faced side ditch and corrugate pipes are to be installed in the necessary spot for drainage purpose to make assurance in the drainage planning.

6) For the pavement structure, the surface course of the entire road shall be paved with penetration macadum in the thickness of 3cm and shall be overlaid every 5 years interval.

The base course shall be stabilized with bituminous materials due to its enough adhesiveness against surface course and local soils of grade I or II are to be used for subbase course.

In the area of Grade IV, good quality soils of 50-70cm thickness are used to form upper part of subgrade.

6. Proposed Factors of the Bridges at Major 3 Rivers

The each of Matandu, Mavuji and Mbwenkuru river is extremely meandering with unimproved channel, and the river channels are narrow as compared with the scale of drainage basin, forming vast flood plains.

Therefore in the bridge planning, it is necessary to study not only for the bridge at river channel but also for the flood opening bridge.

Then the study was made on the sufficient bridge length to safely let the design discharge by sifting up H.W.L. above the observed flood stage. The results are shown below.

Table-4 Factors of Major Three Rivers

Item / River	Catchment Area (km^2)	Discharge (m^3/s)		Planned H.W.L. (m)	Bridge Length (m)		
		Design	Max.		Main Stream	Flood Opening	Total
Matandu	15,210	2,000	4,530	10.5	80	Right Bank 100 Left Bank 500	680
Mavuji	3,030	1,000	1,980	35.0	80	Left Bank 100	180
Mbwemkuru	16,460	2,000	4,810	24.5	120	Right Bank 120 Right Bank 60	300

Note: 1) The designed discharge is referred from "Feasibility Report on Dar es Salaam/Lindi Coastal Link Road Project, Overseas Technical Cooperation Agency, 1971".

2) Clearance under girder is set at 1.2m.

7. Study on the Medium and Small Rivers

The structures across small rivers are, basically, by means of bridge. However if the amount of designed discharge is less than 50 $m^3/sec.$ and the flood can be scattered due to plain topography, corrugated pipes shall be installed.

As a results, among 77 small and medium rivers 49 places were designed as bridge and 28 places were designed as corrugated pipes.

The bridge length and number of corrugated pipes required are calculated based on the required cross sectional area to be obtained where v =3.0 - 3.5m of design flow velocity. The outline of the plan is shown in the Table below:

Table-5 Plan of Medium and Small Rivers

	Places	Scale of Plan	Remarks
Bridge	49	10 years return period	Clearance under Girder 1.0m
Corrugated Pipes	28	3 years return period	Diam. of pipe 1.8m

8. Bridge Planning

1) For the waterways, crossing the proposed route, the location of bridge construction was determined by studying hydrological data as shown in Table-6.

Table-6 Bridge Plan

Construction Section	Description	Number of Bridge Site	Extension (km)	Remarks
No.1	Medium to Small Bridge 2)	2	31	
No.2	Main Bridge	1	82	Matandu River
	Flood Opening Bridge 1)	2	630	"
	Medium to Small Bridge 2)	19	297	
No.3	Main Bridge	1	82	Mavuji River
	Flood Opening Bridge 1)	1	112	"
	Medium to Small Bridge 2)	14	259	
No.4	Main Bridge	1	122	Mbwemkuru River
	Flood Opening Bridge 1)	3	198	"
	Medium to Small Bridge 2)	15	336	
No.5	Medium to Small Bridge 2)	2		
Total		61	2,177	

Note: 1) The bridges other than main bridge required for designed discharge of major 3 rivers.

2) Bridges other than main bridge and flood opening bridge of major 3 rivers.

Among medium to small bridges 15 reinforced concrete bridge were planned, making a total extension of approx. 170m.

2) The design criteria for the bridges are as follows:

a) Live Road : British Standard 153, Part 3-2, H.A. Loading

b) Width of Carriage Way : 2 lanes : 7.50m

c) Width of Foot Way : 3 Major Bridges: Install Footway with 1.5m width at one side.

Medium to Small Bridge : 1.0m width at one side for the bridges more than 30m length

3) The study was made on the case of utilizing as 2 lanes bridges by improving existing bridges of relatively good condition.

As a result, revealed is the fact that almost equal amount of repaire cost is necessitated as in the case of re-erecting new bridge with 2 lanes of both super and substructure, and it is difficult to plan the bridges having complete safety through the project life in view of hydrological and structural consideration. Therefore in this project, every bridges were planned to entirely be re-erected instead of utilizing existing bridges.

4) For the road construction work, beside the original plan staged construction were considered such as to serve as one lane road at the first stage. However in studying the bridge construction work, its execution in stages was concluded to be undesirable for the following reasons and it was determined to design the cross section for construction of a two-lane bridge.

(a) The stage construction of the bridge incurs a higher total cost than the construction of a complete two-lane bridge.

(b) The economic advantage of the stage construction is only slighly higher than the construction of a complete two-lane bridge.

(c) The stage construction not only invites structural complexity but also makes the execution of the second stage work extremely difficult.

5) For the main bridges at major 3 rivers, the pony truss bridge with 40m span lengths was planned. For the flood opening bridges and medium to small bridges, several types of H-beam standard girder was planned for the purpose of reducing material, fabrication, transportation and erection costs by adoping appropriate types according to their bridge lengths.

For the bridges across small waterways, reinforced concrete bridges were planned principally.

6) Bridges across 3 major rivers, the Matandu, Mavuji and Mbwemkuru are to be supported by comparatively long piles. Other medium to small bridges can be appropriately supported by relatively short piles of less than 10m except some bridges.

7) Abutment shall be of reinforced concrete structure and for the foundation work, H-beam of 400 x 400 in size was adopted as a pile.

The piers of main bridge at major three rivers are designed as wall type and as a foundation pile steel pipes with 500mm in diam. of around 10 to 20 length are adopted. At the Mbwemkuru Bridge site, however, the piles of more than 20m length shall be required in some part.

500mm in diam. steel pipe 4 pile bent of several to 20m length are planned to be used for the piers of flood opening bridges and bridges of more than 2 spans considering constructive merit and soil conditions.

9. Construction Cost

The construction work is planned to be completed in five years. The work schedule was determined based on the assumption that approx. four months (from January to the end of April) are the wet season of the year, and no other works than preparation works are possible during the season.

The economic construction cost for each plan which does not include tax and disregarding the effect of inflation after October, 1975 is shown in Table-7. The percentage of bridge construction cost occupied in the total amount of direct construction cost are, although it varies depending on the condition of each construction section, around 16.8 to 18.5%.

Table-7 Construction Cost by Respective Plan and Section

(Unit: 1,000 Shs.)

	Section	1st Stage	2nd Stage	Total	Cost/Km (1000 Shs./km.)
Plan 1	1	56,351	0	56,351	1,565
	2	248,189	0	248,189	2,457
	3	203,757	0	203,757	2,342
	4	193,270	0	193,270	2,543
	5	49,054	0	49,054	1,635
	Total	750,621	0	750,621	2,275
Plan 2	1	56,351	0	56,351	1,565
	2	228,358	31,912	260,270	2,577
	3	186,539	27,488	214,027	2,460
	4	178,636	24,013	202,649	2,666
	5	42,575	9,479	57,054	1,735
	Total	692,459	92,892	785,351	2,380
Plan 3	1	56,351	0	56,351	1,565
	2	221,075	33,898	254,973	2,525
	3	180,259	29,200	209,459	2,408
	4	173,114	25,508	198,622	2,613
	5	39,336	10,069	49,405	1,647
	Total	670,135	98,675	768,810	2,330
Plan 4	1	42,588	22,493	65,081	1,808
	2	208,434	63,107	271,541	2,689
	3	170,235	54,360	224,595	2,582
	4	163,460	47,486	210,946	2,776
	5	37,526	18,744	56,270	1,876
	Total	622,243	206,190	828,433	2,510

The above construction cost is estimated according to the following prerequisites:

(1) The respective unit price shall be based on the one at October 1975.

(2) The effect of inflation after 1975 is not considered.

(3) The rate of exchange between Tanzanian Shillings and U.S. Dollar is made as follows:

One U.S.Dollar = 8.1 Tanzanian Shillings

(4) Machineries and plant facilities for use in the construction work shall be provided from Japan and the residual value of these machineries and plant facilities after completion of the construction work shall be zero.

(5) The above construction cost include direct and indirect construction cost as well as supervision fee for the preparately, earth work, small structure, pavement and bridge construction works.

The maintenance costs were estimated, in principle, under the condition that overlay for road pavement will be done once in every 5 years and re-painting work will be done once in every 10 years.

Table-8 Maintenance Cost and Management Expenses by Each Plan

(Unit: 1,000 Shs.)

Plan / Year	Plan 1		Plan 2		Plan 3		Plan 4	
	Road	Bridge	Road	Bridge	Road	Bridge	Road	Bridge
1982	2,297	30	2,297	30	2,297	30	2,297	30
1983	4,594	"	4,594	"	4,594	"	4,594	"
1984	"	"	"	"	"	"	"	"
1985	"	"	"	"	"	"	"	"
1986	39,054	"	26,757	"	26,757	"	18,379	"
1987	39,054	"	26,757	"	26 757	"	18,379	"
1988	4,594	"	4,594	"	4,594	"	4,594	"
1989	"	"	"	"	"	"	"	"
1990	"	"	"	"	"	"	"	"
1991	39,054	"	26,757	"	26,757	"	18,379	"
1992	39,054	3,597	26,757	3,597	26,757	3,597	18,379	3,597
1993	4,594	30	4,594	30	4,594	30	4,594	30
1994	"	"	"	"	"	"	"	"
1995	"	"	"	"	"	"	"	"
1996	39,054	"	26,757	"	26,757	"	"	"
1997	39,054	"	26,757	"	26,757	"	"	"
1998	4,595	"	4,594	"	4,594	"	"	"
1999	"	"	"	"	"	"	"	"
2000	"	"	"	"	"	"	"	"
2001	39,054	"	39,054	"	39,054	"	"	"
2002	39,054	3,597	39,054	3,597	39,054	3,597	39,054	3,597
2003	4,594	30	4,594	30	4,594	30	39,054	30
2004	"	"	"	"	"	"	4,594	"
2005	"	"	"	"	"	"	"	"
2006	39,054	"	39,054	"	39,054	"	"	"
2007	39,054	"	39,054	"	39,054	"	39,054	"
2008	4,594	"	4,595	"	4,594	"	39,054	"
2009	"	"	4,594	"	4,594	"	4,594	"
2010	"	"	"	"	"	"	"	"
2011	39,054	"	39,054	"	39,054	"	"	"

10. Survey of Transport Economy

(1) In the survey of transport economy the study was made on the present traffic condition of road and coastal shipping line on and in the vicinity of the proposed Southern Coastal Road after grasping present and past pattern of transport condition in the whole of Tanzania.

The major study items for the road transport consist of the secular change of traffic volume, distribution of Origin-Destination of traffic volume, traffic variation by dry and rainy season, condition of traffic crossing the Rufiji River and condition of bus transport along the coastal road. As regards the coastal shipping line, number of passengers, commodity movement, transportation cost, time required for transportation and operation schedule were studied between major ports in the coastal region.

After analysing national and regional transport condition mentioned above, the inter-relation among these transport condition with industries and economy of Tanzania was analysed. As a result, close co-relation was revealed between the traffic volume and G.D.P.

Then the future traffic volume was estimated using macroscopic method by correlating with G.D.P., and based on these traffic volume, future traffic volume by respective vehicle types are estimated using the correlation between already analysed traffic volume related to southern coastal road and vehicle type classification.

Also future traffic volume was estimated respectively for normal traffic, generated traffic and diverted traffic.

The vehicle operating cost was surveyed for the cost of fuel, lubricant oil, tyres and vehicle as at October 1975 by respective items such as retail price, sales tax, import and export duties etc. using "Quantification of Road User Savings, Jan de Weille", issued by International Bank for Reconstruction and Development.

In the calculation of vehicle operating cost, the data of vehicle operating cost obtained in the past survey in Tanzania are also taken into account.

(2) Estimated future traffic volume are shown in the following table.

Table-9 Future Traffic Volume by Respective Section, Plan and Case

(Unit: Vehicle/day)

Const. Section	Section	Plan, Case	1973	1982	1992	2002	2011
1	Kibiti S Nyamwaga	Plan 1.2.3. Case 1	95	192	295	454	677
		" Case 2	95	209	377	695	1,232
		Plan 4 Case 1	95	182	304	457	680
		" Case 2	95	199	410	700	1,237
2	Nyamwage S Nangurukuru	Plan 1.2.3. Case 1	50	91	164	249	368
		" Case 2	50	98	207	376	659
		Plan 4 Case 1	50	86	169	263	382
		" Case 2	50	93	231	403	686
3	Nangurukuru S Kiranjerange	Plan 1.2.3. Case 1	40	74	133	202	297
		" Case 2	40	79	168	304	531
		Plan 4 Case 1	40	69	137	214	309
		" Case 2	40	74	167	294	521
4	Kirangerange S Lindi	Plan 1.2.3. Case 1	40	87	132	201	296
		" Case 2	40	93	167	303	530
		Plan 4 Case 1	40	71	123	190	285
		" Case 2	40	84	179	307	534
5	Nangurukuru S Kilwa Masoko	Plan 1.2.3. Case 1	30	53	82	126	189
		" Case 2	30	57	105	195	348
		Plan 4 Case 1	30	44	97	118	181
		" Case 2	30	51	119	206	359

11. Economic Evaluation

1) As shown in Table-10, the internal rate of return of the project varies by plan. It ranges from 4.0% to 7.3% if the project life is taken for 30 years. If the project life is taken for 20 years, the upper limit of the internal rate of return goes down to as low as 3.5%.

   If judged from the economic point of view alone, Plan 3 is most advantageous, followed by Plan 2,4 and 1. Nevertheless, the difference in the internal rate of return between Plan 3 and Plan 1 is as small as 0.8% (Case 2) and 0.7% (Case 1) for the project life of 30 years.

   An engineering study of Plan 3 discloses the following facts.

   a) Vehicles are forced to run on shoulders when passing by each other, so that the wear of shoulders is liable to be accelerated.

   b) Rainwater is prone to percolate through unpaved shoulders into the subbase course and subgrade.

   c) Intrusion of rainwater, coupled by repetitive surface load, is prone to lead to heavy deterioration of the cross-section.

   Therefore since the difference in the internal rate of return between Plan 3 and Plan 2 is negligible, it is recommended that Plan 2 shall be adopted as the most optimal plan.

2) When the project is reviewed by section, the internal rate of return for the project are 15.4% and 15.5% under Plan 2 and Plan 3 respectively in section 1 for the project life of 30 years. The internal rate of return in other sections at the same project life ranges from 6.2% to 1.8% under the two plans. The economic advantage of section 1 is thus considerably large.

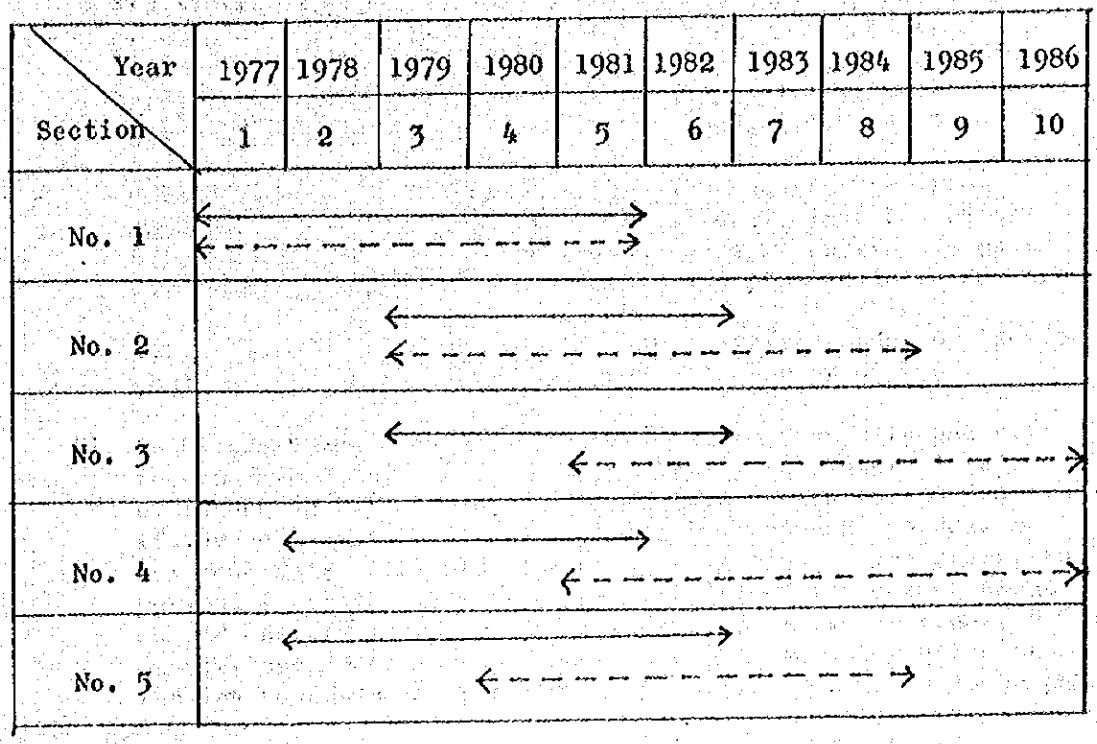
Table-10 Internal Rate of Return and Cost/Benefit Ratio by Respective Plan, Case and Section

I.R.R. or B/C	Project Life	Cost Benefit or Discount Rate	Case	Plan 1	Plan 2	Plan 3	Plan 4
I.R.R. (%)	30 years	*C=100(%)	Case-1	4.0	4.4	4.7	4.2
		B=100(%)	Case-2	6.5	7.0	7.3	6.9
	20 years	C=100(%)	Case-1	-	0.2	0.4	-
		B=100(%)	Case-2	2.6	3.2	3.5	2.3
B/C	30 years	4 (%)	Case-1	1.00	1.05	1.08	1.03
		7 (%)		0.69	0.74	0.76	0.72
		10 (%)		0.50	0.53	0.55	0.51
		4 (%)	Case-2	1.39	1.47	1.51	1.46
		7 (%)		0.94	1.00	1.04	0.99
		10 (%)		0.66	0.70	0.73	0.68

I.R.R.	Project Life	Case	Section	Plan 2	Plan 3
I.R.R. (%)	30 years	Case-1	1	15.4	15.5
			2	6.0	6.2
			3	1.8	2.0
			4	2.2	2.6
			5	2.5	2.8
			Average	4.4	4.7

Note: *C=100%, B=100% means the case in which no increase and reduction are made in the cost and benefit.

Fig. - 1 Investment Program for Each Section



Notes: ——— Original Plan

– – – – – Plan A (Alternate plan to put off construction period of plan No.2 in later years)

3) It is therefore desirable that the construction work shall be started in section 1. If consideration is given to the economic aspects alone, it is advisable to proceed from section 1 to sections 2,5,4, and 3 in that order. From the engineering point of view, however, top priority should be given to section 1, followed by sections, 4,5,2 and 3.

Considering the need for landing sea-borne construction machinery and for minimizing the difficulty involved in the construction work, it is advisable to start working in port area such as Lindi and Kilwa Masoko and proceed to inland area.

It is therefore recommended that the priority order of sections shall be determined from the engineering point of view.

4) In Plan A formulated as an alternative to Plan 2 to put off the investment period as shown in Fig.-1 the internal rate of return is 6.6% if the project life is taken for 30 years. If the investment period is not put off, Plan 2 produces an internal rate of return of 4.4%. In section 1, therefore, the period of construction work and the time of its commencement should conform to the original plan. For other sections, however, studies should be made on the validity of an alternative construction schedule in which the construction period is to be put off.

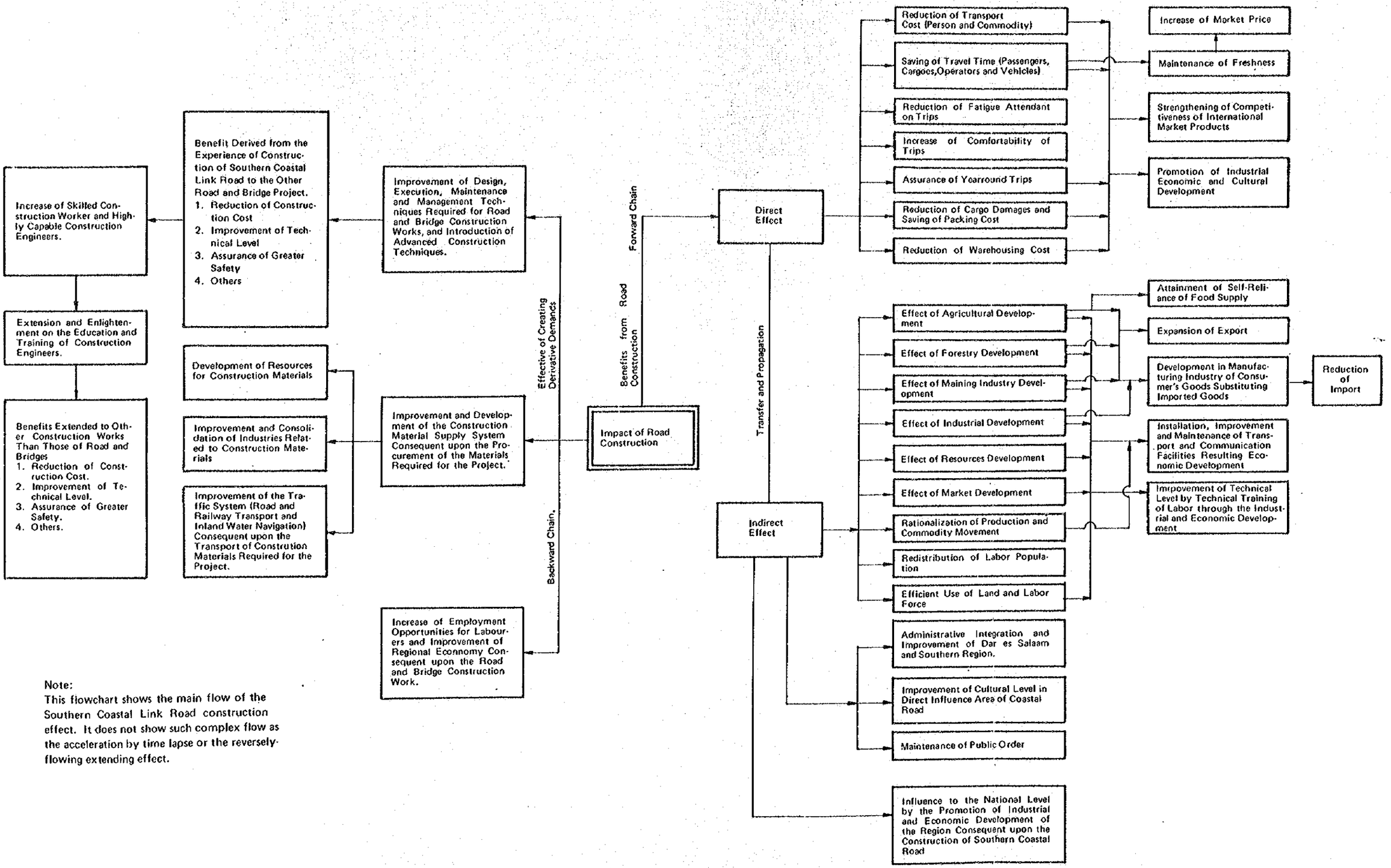
If the duration of the construction schedule is extended, a number of benefits can be expected such as the smoother procurement of equipment and materials, effective utilization of labour force, distribution and reduction of the initial capital input for construction machinery. The internal rate of return attainable by extending the construction schedule was therefore calculated assuming that the construction cost would be reduced to about 95% of the initially estimated value.

5) The proposals made in Items 1) to 4) above are based chiefly on the economic evaluation in which direct benefits were subjected to an econometric analysis as well as on the studies made from the engineering point of view.

As shown in Fig.-2, the project is expected to produce a diversity of other important and intangible effects, such as administrative integration and improvement of Dar es Salaam and southern regions, and promotion of regional industrial and economic development.

It cannot therefore be justified to judge the validity of the project only on the basis of its economic evaluation. The significance of the project should be studied and grasped from a broad, comprehensive and long-range point of view.

Fig.-2 Impact Effect of Southern Coastal Link Road Project



Note:
This flowchart shows the main flow of the Southern Coastal Link Road construction effect. It does not show such complex flow as the acceleration by time lapse or the reversely-flowing extending effect.