- Private houses	2,570,000 m^2 x 20% x Z 2/m^2	= Z 771,000
- Survey cost for compensation	(Z 285,300 + Z 771,000) x 5%	= Z 52,815
	Total:	Z1,109,115

Alternative II:

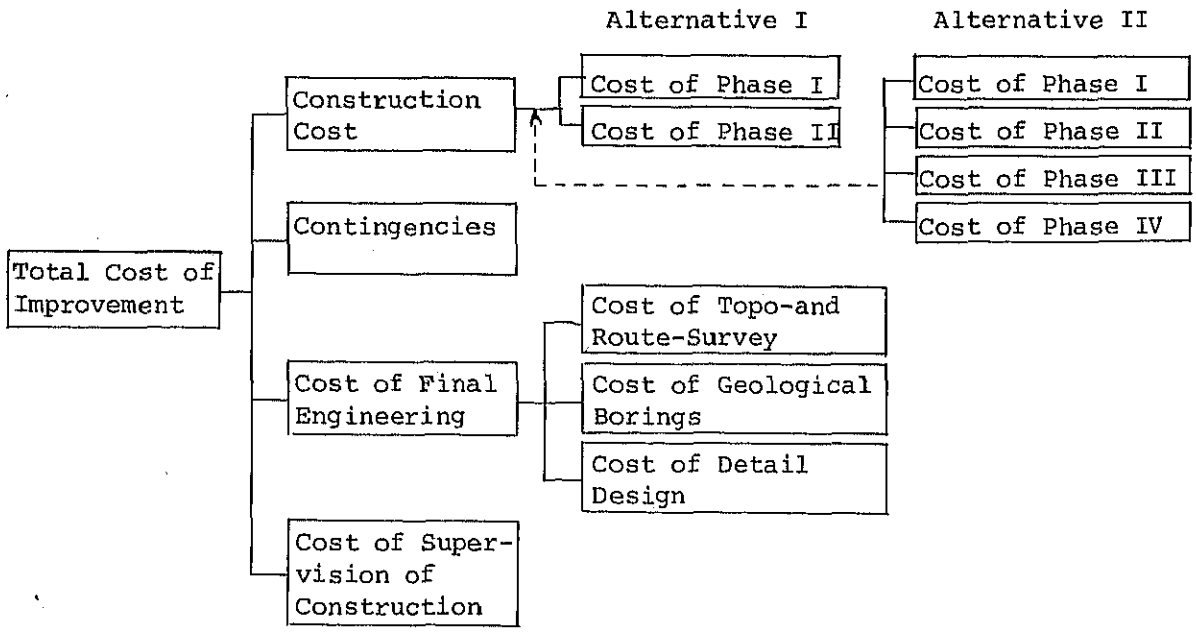
- Plantations	142,650 m^2 x Z 2/m^2	= Z 285,300
- Private house	1,726,700 m^2 x 20% x Z 2/m^2	= Z 518,010
- Survey cost for compensation	(Z 285,300 + Z 541,600) x 5%	= Z 40,166
	Total:	Z 843,476

The Percentage of the compensation cost to the net construction cost:

- Alternative I Z 1,109,115 ÷ Z 61,623,296 = 1.8%
- Alternative II Z 843,471 ÷ Z 42,173,671 = 2.0%

(6) Total Cost of Improvement of Project Road

The total construction cost is composed of the following:



As for the total cost of improvement of Alternative I is referred to Table 3.5.4 and for that of Alternative II is referred to Table 3.5.5.

As for the comprehensive chart showing the breakdown of the construction cost (work quantities, unit prices and costs), other expenses, and total construction cost, A.3.5.2 to A.3.5.9 are referred to.

Table 3.5.4 Total Costs of Improvement (Alternative-I)

Tableau 3.5.4 Coûts bruts d'amélioration

(Unit / Unite : Zaire)

DIVISION	SECTION	FROM – TO / DE – VERS	TOTAL LENGTH / LONGEUR TOTAL	NET COST : COUT NET									CONTINGENCY / EVENTUALITE	FINAL ENGINEERING AND SUPERVISION / L'INGENIEUR FINAL ET SURVEILLANCE	TOTAL COST / COUT TOTAL
				PHASE I							PHASE II				
				CLEARING / DEBOISEMENT	EARTHWORKS / TERRASEMENTS	SIDE SLOPES / TALUS	DRAINAGE / DRAINAGE	PAVEMENT / PAPAGE	BRIDGES / PONTS	FERRY / BAC	PAVEMENT / REVETUE	TOTAL / TOTAL			
		Kisangani	km												
IV	10		44 920	80,950	1,546,760	58,600	313,766	2,320,500	1,745,750		972,630	7,038,956	1,055,843	774,260	8,869,050
	9		77 690	129,720	3,674,730	99,300	982,134	4,039,200	263,500		2,019,960	11,208,544	1,681,296	1,232,950	14,122,790
		Banalia													
	TOTAL		122 610	210,670	5,221,490	157,900	1,295,900	6,359,700	2,009,250		2,992,590	18,247,500	2,737,130	2,007,210	22,991,840
		Banalia													
III	8		73 245	167,730	1,536,860	98,300	609,258	3,671,350	4,376,000		—	10,459,498	1,568,930	1,150,522	13,178,950
	7		28 190	59,010	340,750	37,500	240,433	1,149,700	189,000		—	2,016,393	302,460	221,787	2,540,640
	6		86 375	170,110	829,745	109,300	808,151	3,782,050	664,000		—	6,363,356	954,500	699,954	8,017,810
		Buta													
	TOTAL		187 810	396,850	2,707,355	245,100	1,657,842	8,603,100	5,229,000		—	18,839,247	2,825,890	2,072,263	23,737,400
		Buta													
	5		74 620	123,510	437,960	105,900	596,081	2,874,850	436,500		—	4,574,801	686,230	503,229	5,764,260
II	4		64 830	122,850	750,580	92,600	456,969	2,520,800	572,000		—	4,518,799	677,831	497,070	5,693,700
	3		58 465	103,650	673,440	83,000	391,624	2,372,050	450,000	18,000	—	4,091,764	613,776	450,110	5,155,650
		Bondo													
	TOTAL		197 915	350,010	1,861,980	281,500	1,447,674	7,767,700	1,458,500	18,000	—	13,185,364	1,977,837	1,450,409	16,613,610
		Bondo													
	2		122 335	234,650	965,390	174,000	1,045,108	4,380,050	108,000	7,000	—	6,914,198	1,037,130	760,552	8,711,880
I	1		68 285	128,800	1,401,065	98,300	601,122	2,191,700	—	16,000	—	4,436,987	665,540	488,053	5,590,580
		Ndu													
	TOTAL		190 620	363,450	2,366,455	272,300	1,646,230	6,571,750	108,000	23,000	—	11,351,985	1,702,670	1,248,605	14,302,460
GRAND TOTAL / TOTAL			698 995	1,320,980	12,157,280	956,800	6,047,646	29,302,250	8,804,000	41,000	2,992,590	61,623,296	9,243,527	6,778,489	77,645,310

Note: Contingency includes allowance for net cost and costs of final engineering and supervision, that means 90.4% is for net cost and 9.1% is for costs of final engineering and supervision.

Table 3.5.5 Total Costs of Improvement (Alternative-II)
Tableau Coûts bruts d'amélioration

(Unit : Zaire)
(Unite

DIVISION	SECTION	FROM - TO / DE - VERS	TOTAL LENGTH / LONGEUR TOTAL	NET COST : COUT NET																	TOTAL NET COST / COUT NET TOTAL	CONTINGENCY / EVENTUALITE	FINAL ENGINEERING AND SUPERVISION / L'INGENIEUR FINAL ET SURVEILLANCE	TOTAL COST / COUT TOTAL
				PHASE I								PHASE II			PHASE III				PHASE IV				
				CLEARING / DEBOISEMENT	EARTHWORKS / TERRASEMENTS	SIDE SLOPES / TALUS	DRAINAGE / DRAINAGE	PAVEMENT / PAPAGE	BRIDGES / PONTS	FERRIES / BACS	TOTAL	BRIDGES / PONTS	FERRIES / BACS	TOTAL	PAVEMENT / PEVETUE	BRIDGES / PONTS	FERRIES / BACS	TOTAL	FERRIES / BACS				
IV	10	Kisangani	km 44 920	64,950	1,344,860	43,100	298,499	2,320,500	--	--	4,071,909	1,745,750	--	1,745,750	972,630	--	--	972,630	--	6,790,289	1,018,560	746,951	8,555,800
	9		77 690	103,680	2,726,730	73,200	879,572	4,039,200	--	--	7,822,382	263,500	--	263,500	2,019,960	--	--	2,019,960	--	10,105,842	1,515,890	1,111,648	12,733,380
	TOTAL	Banalia	122 610	168,630	4,071,590	116,300	1,178,071	6,359,700	--	--	11,894,291	2,009,250	--	2,009,250	2,992,590	--	--	2,992,590	--	16,896,131	2,534,450	1,858,599	21,289,180
III	8	Banalia	73 245	117,250	730,160	60,100	705,386	625,250	--	16,800	2,254,946	--	119,800	119,800	3,372,800	192,000	119,800	3,684,600	119,800	6,179,146	926,870	679,694	7,785,710
	7		28 190	41,570	224,750	23,000	215,077	223,800	--	--	728,197	--	--	--	943,950	168,000	--	1,111,950	--	1,840,147	276,020	212,483	2,328,650
	6		86 375	120,750	387,445	68,700	626,776	522,400	--	--	1,726,071	550,000	--	550,000	3,850,200	56,000	--	3,906,200	--	6,182,271	927,340	680,039	7,789,650
	TOTAL	Buta	187 810	279,570	1,342,355	151,800	1,547,239	1,371,450	--	16,800	4,709,214	550,000	119,800	669,800	8,166,950	416,000	119,800	8,702,750	119,800	14,201,564	2,130,230	1,572,216	17,904,010
II	5	Buta	74 620	90,670	426,760	63,000	524,920	582,900	283,500	--	1,971,750	--	--	--	--	100,000	--	100,000	--	2,071,750	310,770	227,900	2,610,420
	4		64 830	79,290	443,980	34,900	369,789	666,300	59,500	--	1,653,759	--	--	--	--	462,000	--	462,000	--	2,115,759	317,371	232,730	2,665,860
	3		58 465	67,370	166,590	31,800	330,791	588,900	--	18,000	1,203,451	--	--	--	--	412,500	--	412,500	--	1,615,951	242,370	177,749	2,036,070
	TOTAL	Bondo	197 915	237,330	1,037,330	129,700	1,225,500	1,838,100	343,000	18,000	4,828,960	--	--	--	--	974,500	--	974,500	--	5,803,460	870,511	638,379	7,312,350
I	2	Bondo	122 335	146,370	486,590	66,800	850,719	1,158,700	96,000	7,000	2,812,179	--	--	--	--	--	--	--	--	2,812,179	421,831	309,330	3,543,340
	1		68 285	81,520	1,179,115	36,500	515,002	632,200	--	16,000	2,460,337	--	--	--	--	--	--	--	--	2,460,337	369,030	270,643	3,100,010
	TOTAL	Ndu	190 620	227,890	1,665,705	103,300	1,365,721	1,790,900	96,000	23,000	5,272,516	--	--	--	--	--	--	--	--	5,272,516	790,861	579,973	6,643,350
GRAND TOTAL TOTAL			698 955	913,420	8,116,980	501,100	5,316,531	11,360,150	439,000	57,800	26,704,981	2,559,250	119,800	2,679,050	11,159,540	1,390,500	119,800	12,669,840	119,800	42,173,671	6,326,052	4,649,167	53,148,890

Note: Contingency includes allowance for net cost and costs of final engineering and supervision, that means 90.4% is for net cost and 9.1% is for costs of final engineering and supervision.

(7) Currency Components of Total Costs of Improvement

The currency components of the total costs of improvement of the project road are worked out from unit prices and are accumulated into the total cost of improvement. However, they vary with each unit price and unit item of cost and even in the total improvement cost of each route section they vary with local physical conditions such as changes in haul distance.

In this paragraph the approximate integrated proportion of currency components are shown for the main items in the following:

	Foreign Currency	Taxes	Domestic Currency
Construction Cost	48%	18%	34%
Contingencies	48%	18%	34%
Cost of Final Engineering	85%	10%	5%
Cost of Supervision of Construction	55%	12%	33%
Total Cost of Improvement	50%	17%	33%

The primary item in the component of foreign currency is the purchase cost of equipment which are assumed to be completely depreciated during the construction period, particularly those to be used in Phase I. The secondary items are those materials such as corrugated steel pipes, reinforcement bars, structural steel, asphalt, fuel and oils, spare parts and tools of equipment, and also a part of cement. The rest of the items are a part of the final engineering cost and the cost of supervision by foreign consultants, and also the personnel cost of foreign staff, the general administration cost and profits of the contractor. (See A.3.5.19 - A.3.5.22(4))

3.5.2 Estimate of Road Maintenance Cost

(1) General Description

The road maintenance costs are estimated for the following types of roads and facilities:

(a) Existing Road
(b) Improved Laterite Road
(c) Paved Road
(d) Steel Bridges
(e) Ferries

Regarding types (a), (b) and (c), the annual maintenance cost per kilometer of road is calculated, according to the estimated traffic volume in order to arrive at annual maintenance cost of each section of the road.

As for types (d) and (e), the annual maintenance cost of each structure and facility is separately calculated; this amount is added to the annual maintenance cost of the section of road, to which each structure or facility belongs.

The sources of funds for the above maintenance cost are foreign currency, domestic currency and taxes.

The details of calculation are described in the following. (The summary of the maintenance costs by alternative improvement and year are as shown in Table 3.5.7 and their details in A.3.5.10 to A.3.5.22.(4))

The level of road maintenance by type of road, aims at maintaining the following average operating speeds:

- Existing earthroad	18 to 20 km/hr in wet season
	36 to 40 km/hr in dry season
- Improved laterite road	55 to 60 km/hr throughout a year
- Paved road	70 to 75 km/hr throughout a year

(2) Road Maintenance Cost

(a) Maintenance cost of existing road

As of November, 1974, Office of Roads of Haut-Zaire Region has the following

budget for the maintenance of the Kisangani - Ndu section of the project road.(1)

Year	Kisangani - Buta Section (314 km)	Buta - Dulia Section (74 km)	Dulia - Monga Section (250 km)	Monga - Ndu Section (72 km)
1974	95 Z/km	-	200 Z/km	-
1975	200	1,000 Z/km	190	-
1976	200	500	900	200 Z/km
1977	200	200	500	900

For the stretch of 314 km from Kisangani to Buta, the section where the rehabilitation work with the aid of IBRD is now underway, the annual budget of 200 Z/km is to be given for the maintenance after this rehabilitation work has been completed.

For the road north of Buta, no rehabilitation program exists at the present, but plans are to repair it by section with an annual budget of 1,000 Z/km in the initial year and 200 - 500 Z/km for the remaining years.

Such maintenance work, including the heavy maintenance during the year, is scheduled to be completed as far as Ndu, by 1977.

The weighted average of the above maintenance costs for 1974 - 1977 all in all is 304 Z/km per year which is converted into approximately to 350 Z/km per year with the current 1975 price level. However since the normal traffic will increase somewhat in the future even without any improvement of the project road and this price is not sufficient to maintain the road at the all-weather level, it is considered necessary to increase the maintenance cost to approximately 800 Z/km per year when the cost is calculated as shown in A.3.5.10 ∿ A.3.5.13. This unit price is made up of foreign currency, taxes and domestic currency - 30%, 13% and 57% respectively.

(b) Maintenance cost of improved laterite road

(i) Maintenance cost of shoulders, side-slopes, side-ditches and cleared zone (See Table 3.5.11)

Note (1): Source: Office des Routes Régional, Kisangani, Nov. 1974.

This cost is considered constant regardless of the traffic volume and is calculated and shown A.3.5.11. 15% of the 471 Z/km/year will be met by foreign currency, 11% by taxes and 74% by domestic currency.

(ii) Maintenance cost of road surface

The maintenance cost of the improved laterite road varies with the traffic volume. As shown in A.3.5.12, the cost will be 340 Z/km/year for ADT of 100, which will be broken down into 49% from foreign currency, 18% from taxes, and 33% from domestic currency.

(iii) Total maintenance cost

The total of the above items (i) and (ii) is as follows:

$$C = 430 + 3.4 \times ADT \ (Z/km/year)$$

The percentages of foreign currency, taxes and domestic currency calculated according to various traffic volumes is as follows:

ADT	Foreign Currency	Taxes	Domestic Currency	Total
less than 50	25%	13%	62%	100%
50 - 100	30	14	56	100
100 - 150	34	14	52	100
150 - 200	36	15	49	100
more than 200	38	15	47	100

(c) Maintenance cost of paved road

(i) Maintenance cost of shoulders, side-slopes, side-ditches and cleared zone

This cost is assumed constant regardless of traffic volume and as same as the case of the improved laterite road. The cost is 471 Z/km/year, which will be broken down into 15% from foreign currency, 11% from taxes and 73% from domestic currency. (See A. 3.5.11.)

(ii) Maintenance cost of road surface

Assuming that the maintenance cost of the paved road remains constant while traffic volume is small, the cost, as shown in A.3.5.13 has been calculated

to be 600 Z/km/year per 1,500 in ADT, which will be broken down into 39% from foreign currency, 14% from taxes and 47% from domestic currency.

When the ADT exceeds 1,500, the maintenance cost of 600 Z/km/year for an excess traffic volume of 1,500 in ADT is to be added.

(iii) Total maintenance cost

The total of items (i) and (ii) above is as follows:

ADT $\leqq$ 1,500	C = 430 + 600 = 1,030	Z/km/year
1,500 $<$ ADT	C = 1,030 + 0.4 (ADT - 1,500)	Z/km/year

The results of calculating the proportion of foreign currency, taxes and domestic currency according to traffic volume have been estimated as follows:

	Foreign Currency	Taxes	Domestic Currency	Total
less than 1,500	29%	13%	58%	100%
1,500 - 1,800	30	13	57	100
more than 1,800	31	13	56	100

(d) Maintenance cost of bridges

(i) Existing bridges

It has been assumed that steel members will be painted once every 5 years and wooden path boards will be replaced once every 4 years.

Painting cost = (metal tonnage) x 40 Z/t x 1/5(per year)

Cost of path board = (bridge length in meter) x (width in meter) x 0.08 m x 70 Z/m^3 x 1/4(per year)

(ii) New bridge

Steel members will be painted once every 5 years and the pavement surface will be overlayed once every 6 years.

Painting cost = (metal tonnage) x 40 Z/t x 1/5(per year)

Cost of pavement = (bridge length in meter) x (width in meter) x 5 Z/m^2 x 1/6 (per year)

The proportion among foreign currency, taxes and domestic currency is estimated to be 50%, 15% and 35% respectively.

(e) Operating and maintenance cost of ferry

Calculation of maintenance cost of a ferry is shown in A.3.5.14 - A.3.5.18 and the results are as shown in Table 3.5.6.

(f) Road maintenance cost per year

The maintenance costs discussed under (a) to (e) above have been applied to each section of the project road and accumulated by construction division as shown in Table 3.5.7 and their details in A.3.5.19 to A.3.5.22.

Table 3.5.6 Annual Operating and Maintenance Cost of Ferry

(Z/ferry/year)

	Name of River	Type of Ferry	Annual Operating and Maintenance Cost	Currency Components			
				Foreign Currency	Taxes	Domestic Currency	Total
With the improvement of project road	Aruwimi	35 tons	28,600 Z/year	49%	15%	36%	100%
	Uélé	30 tons	24,800	48	14	38	100
	Bili	8 tons (Hand-rowing)	6,200	40	11	49	100
	Bomu	12 tons	14,500	47	14	39	100
Without the improvement of project road	Aruwimi	35 tons	26,800	48	15	37	100
	Uélé	30 tons	23,000	47	14	39	100
	Bili	12 tons	5,500	38	11	51	100
	Bomu	12 tons	12,900	45	14	41	100

Note: Costs in the Table are calculated on the cost level of April 1975.

Table 3.5.7 Summary of Financial Maintenance Cost of Road by Year

(Unit: 1,000 Zaires)

Year		Alternative I					Alternative II					Existing Road				
Alternative / Division		IV	III	II	I	Total	IV	III	II	I	Total	IV	III	II	I	Total
1	1983	133	211	231	217	792	132	136	117	104	489	105	185	186	176	654
2	4	"	"	"	"	"	"	148	119	"	503	"	"	"	"	"
3	5	"	"	"	"	"	"	162	122	105	520	"	"	"	"	"
4	6	"	"	"	"	"	133	203	126	"	567	"	"	"	"	"
5	7	"	"	"	"	"	"	218	130	"	586	"	"	"	"	"
6	8	"	"	"	"	"	"	234	134	"	607	"	"	"	"	"
7	9	"	"	"	"	"	"	248	137	106	624	"	"	"	"	"
8	1990	"	"	"	"	"	"	262	139	"	641	"	"	"	"	"
9	1	"	"	"	"	"	"	306	142	107	688	"	"	"	"	"
10	2	"	"	"	"	"	"	321	144	"	705	"	"	"	"	"
11	3	"	"	"	"	"	"	280	146	108	668	"	"	"	"	"
12	4	"	"	"	"	"	"	"	147	"	669	"	"	"	"	"
13	5	136	"	"	"	794	136	"	148	"	672	"	"	"	"	"
14	6	141	"	"	"	799	141	"	149	"	678	"	"	"	"	"
15	7	146	"	"	"	804	146	309	150	"	713	"	"	"	"	"
16	8	151	"	"	"	810	151	"	151	"	719	"	"	"	"	"
17	9	156	"	"	"	818	156	"	152	"	725	"	"	"	"	"
18	2000	162	"	"	"	820	162	"	153	"	731	"	"	"	"	"
19	1	167	"	"	"	825	167	"	153	"	737	"	"	"	"	"
20	2	172	"	"	"	831	172	"	154	"	743	"	"	"	"	"
21	3	177	"	"	"	836	177	"	155	"	750	"	"	"	"	"
22	4	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
23	5	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
24	6	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
25	7	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
26	8	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
27	9	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
Total		4,071	5,689	6,224	5,864	21,848	4,065	7,378	3,901	2,890	18,234	2,839	5,007	5,023	4,761	17,649
Average (Z/Km-Year)		1,230	1,118	1,165	1,139	1,157	1,228	1,455	730	561	966	839	949	928	893	910

Note: Costs in the Table are calculated on the cost level of April, 1974.

3.5.3 Financial Project Cost by Year

(See A.3.5.19, A.3.5.20, A.3.5.21 & A.3.5.22.)

4. EVALUATION OF PROJECT

4. EVALUATION OF PROJECT

4.1 Method of Evaluation

4.1.1 Method of Cost-Benefit Analysis

(1) Main Formulae to be used

(i) Maximum Possible Investment

The maximum possible investment (Table 4.3.1) is obtained by the following formula:

$$K = \sum_{t=1}^{n} \left\{ \frac{1}{(1+r)^t} \cdot (Bt - AEt) \right\} \quad \cdots\cdots\cdots\cdots \quad (4.1)$$

Where:

K = Maximum possible investment

n = Number of years of analysis period = 30

r = Discount rate = 0.12

Bt = Benefit in the year t

AEt = Shadow-Priced Maintenance cost of the project road in the year t (Table 4.1.1-Table 4.1.3)

(ii) Internal Rate of Return

The internal rate of return (Table 4.3.1) is R that makes both sides of the following formula equal.

$$\sum_{t=1}^{n} \frac{Bt}{(1+R)^t} = \sum_{t=1}^{n} \left\{ \frac{Ct}{(1+R)^t} + \frac{AEt}{(1+R)^t} \right\} - \frac{S}{(1+R)^n} \quad \cdots \quad (4.2)$$

Where:

R = Internal rate of return (Table 4.3.1)

Ct = Shadow-Priced Improvement cost of the project road in the year t (Table 4.1.4 - Table 4.1.5)

S = Residual value of the project road, which is assumed to be zero when n = 30

(iii) Benefits

The benefit Bt used in the formulae (4.1) and (4.2) is obtained by the following formula:

$$Bt = NADt + BRt + KWt + SMt \quad \ldots\ldots\ldots\ldots\ldots \quad (4.3)$$

Where:

Bt = Total benefits in the year t (Table 4.3.9 - Table 4.3.10)

NADt = Net increase in the added value of products in the year t (Table 4.3.9)

BRt = User Benefits in the year t (Table 4.3.9 - Table 4.3.10)

KWt = Net increase in the income of local unskilled laborers to be employed in the improvement of the project road in the year t (Table 4.3.9 - Table 4.3.10)

SMt = Savings in the maintenance cost of the project road in the year t (Table 4.3.9 - Table 4.3.10)

(iv) Cost-Benefit Ratio

The cost-benefit ratio is obtained by the following formula:

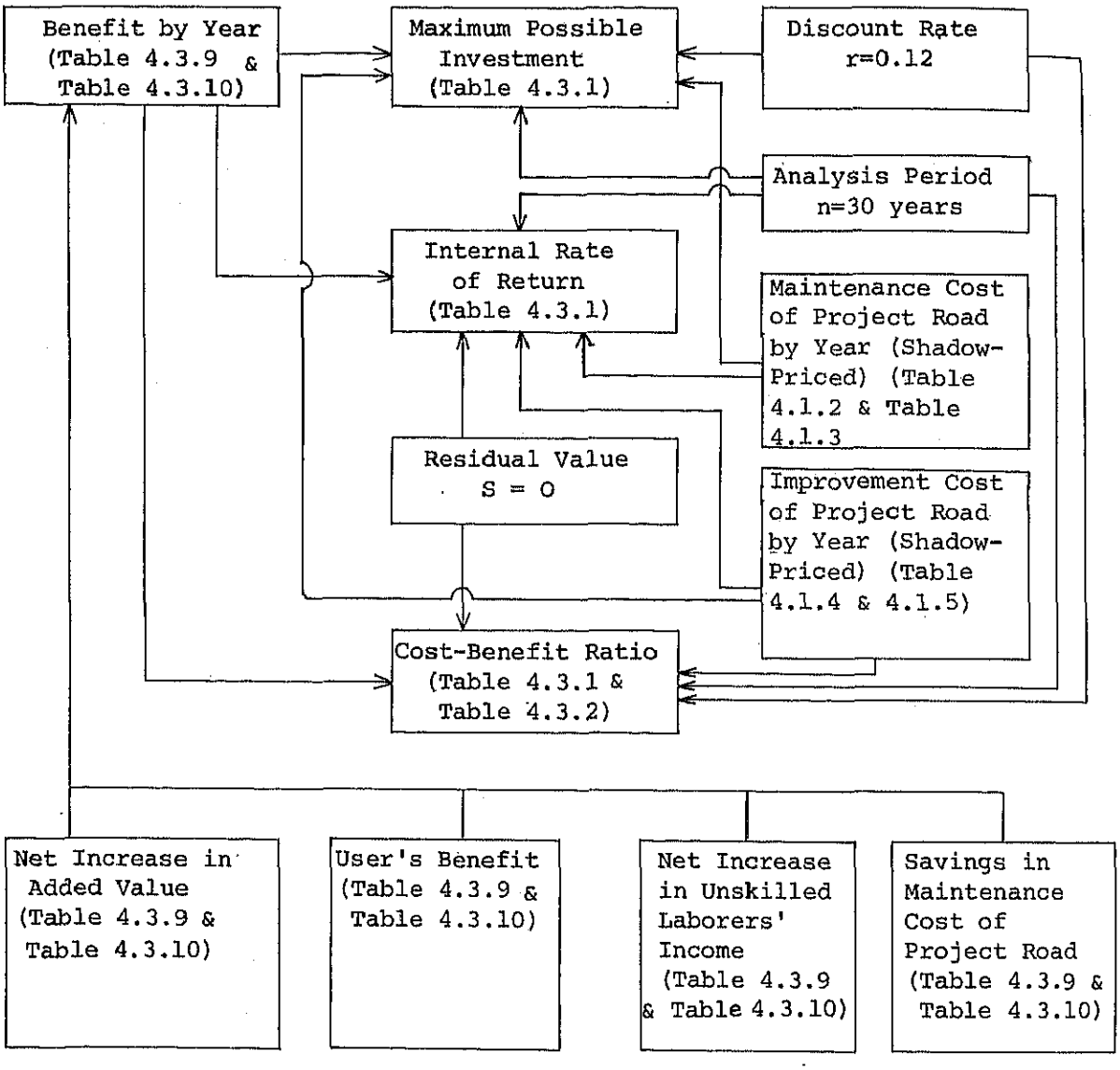
$$R' = \frac{\sum_{t=1}^{n} \left\{ \frac{Bt}{(1+r)^t} \right\}}{\sum_{t=1}^{n} \left\{ \frac{Ct + AEt}{(1+r)^t} \right\} - \frac{S}{(1+r)^n}} \quad \ldots\ldots\ldots\ldots \quad (4.4)$$

Where:

R' = Cost - benefit ratio

Plate 4.1.1 shows the process of cost-benefit analysis using the formula (4.1) to the formula (4.4).

Plate 4.1.1 Process of Cost - Benefit Analysis



4.1.2 Basic Concept on Condition of Analysis

(1) Analysis Period

An analysis period of economic evaluation of 30 years was adopted because of the following reasons:

(i) It is required to adopt a long analysis period in order to measure the economic impact due to the additional investment which will take place nearly 15 years after commencement of the original improvement.

(ii) If the analysis period is long enough, the residual value becomes almost negligibly small as viewed from a discount rate of 12%. Therefore, the residual value may be considered to be zero.

(2) Discount Rate

The discount rate must be theoretically equal to the opportunity cost of capital in Republic of Zaire. However, it is extremely difficult to estimate this correctly from the view point of the current financial and economic conditions of the country. Therefore, 12%, which is reasonable as the current international level, was adopted.

(3) Shadow Price

The official rate of one zaire is two U.S. dollar. However, this does not mean that an economic value of one zaire is equal to two U.S. dollar. The value of one zaire to be used in the economic evaluation must not be an official rate nor black market rate, but must exactly be an economic value of one zaire. However, it is a task of extreme difficulty to measure this economic value.

We assumed that the economic value of one zaire is 1/1.5 of an official rate. This assumption will be reasonable also as viewed from an example of the feasibility study of Bukavu-Kindu Road[1/]. However, as seen from Table 4.1.4, whether to use an official rate or not was dealt as the objective of the sensitivity analysis.

Note 1/ Source: TAMS - Technical and Economic Feasibility Study for the Bukavu-Kindu Road, Final Report, March 1974, P.X.-3

A problem of the economic value arises also in the wages of laborers. The wage of laborers to be employed in construction was assumed to be 1.2 zaire a day for an unskilled laborer taking into consideration the minimum legal wage. But the effective wage in the locality is mostly more or less 0.7 zaire per day. Therefore, the difference of 0.5 zaire may be subtracted from the wage, but we dealt this as the benefit due to a net increase of the income because the legal wage cannot be neglected after all. If this 0.5 zaire is subtracted from the wage or it is dealt as the benefit, there is no change in the internal rate of return, but a slight change occurs in the benefit/cost ratio. But this change is negligible since the net increase of income of laborers is extremely small as described later. Concerning laborers who are to be employed in the maintainance work of the road, the problem of the legal and effective wages also arises. Therefore, labor costs are multiplied by 0.5 in the maintenance cost in Tables 4.1.1 to 4.1.3.

(4) Import Duty

Duty on imported construction equipment and materials was subtracted from the construction costs in Tables 4.1.4 and 4.1.5. Of course, there is another way that this is added to the benefit instead of substracting this from the costs. However, the former method was adopted here. Even if either method is adopted, there is no change in the internal rate of return, while a slight change will occur in the benefit/cost ratio.

(5) Content of Benefit

As seen from the formula (4-3), the benefit consists of four factors; i.e. user benefit, net increase of an added value due to the increase of agricultural production, savings in the road maintenance cost, net increase of the income of local unskilled laborers.
For the net increase of an added value due to the increase of agricultural production, the following measures were taken to prevent double counting when it is added to the benefit.

(i) When an added value is calculated, producers' price, was used instead of consumers' price.
(ii) A net increase of an added value was calculated subtracting opportunity cost of increased farm workers from the increase of an added value.

But, whether to add the net increase of an added value to the benefit was dealt finally as an objective of the sensitivity analysis.

(6) Ceiling of Traffic Volume

The forecast of a traffic volume is usually limited to approximately 20 years. However, a traffic volume after 21st year to 30th year was assumed constant since the analysis period of 30 years was adopted in the present study.

Table 4.1.1 Maintenance Cost of Existing Road (Shadow Priced)

(Unit: Zaire)

Year \ Section	1	2	3	4	5	6	7	8	9	10
1 1980										
2 1										
3 2										
4 3	63,540	92,980	65,550	47,490	53,080	64,250	21,500	81,320	55,420	37,550
5 4	"	"	"	"	"	"	"	"	"	"
6 5	"	"	"	"	"	"	"	"	"	"
7 6	"	"	"	"	"	"	"	"	"	"
8 7	"	"	"	"	"	"	"	"	"	"
9 8	"	"	"	"	"	"	"	"	"	"
10 9	"	"	"	"	"	"	"	"	"	"
11 90	"	"	"	"	"	"	"	"	"	"
12 1	"	"	"	"	"	"	"	"	"	"
13 2	"	"	"	"	"	"	"	"	"	"
14 3	"	"	"	"	"	"	"	"	"	"
15 4	"	"	"	"	"	"	"	"	"	"
16 5	"	"	"	"	"	"	"	"	"	"
17 6	"	"	"	"	"	"	"	"	"	"
18 7	"	"	"	"	"	"	"	"	"	"
19 8	"	"	"	"	"	"	"	"	"	"
20 9	"	"	"	"	"	"	"	"	"	"
21 2000	"	"	"	"	"	"	"	"	"	"
22 01	"	"	"	"	"	"	"	"	"	"
23 02	"	"	"	"	"	"	"	"	"	"
24 03	"	"	"	"	"	"	"	"	"	"
25 04	"	"	"	"	"	"	"	"	"	"
26 05	"	"	"	"	"	"	"	"	"	"
27 06	"	"	"	"	"	"	"	"	"	"
28 07	"	"	"	"	"	"	"	"	"	"
29 08	"	"	"	"	"	"	"	"	"	"
30 09	"	"	"	"	"	"	"	"	"	"

Note: Foreign currency component is multiplied by 1.5 and labor cost of domestic currency component is multiplied by 0.5.

Costs in the Table are on the basis of the cost level of April 1975.

Table 4.1.2 Maintenance Cost of Improved Road (Alternative-I)
(Shadow Priced US$ 1.33 = Z 1.00)

(Unit: Zaire)

Year	Route section	1	2	3	4	5	6	7	8	9	10
1	1980										
2	1										
3	2										
4	3	75,650	115,740	77,770	58,830	67,510	78,460	25,500	81,840	69,960	47,050
5	4	"	"	"	"	"	"	"	"	"	"
6	5	"	"	"	"	"	"	"	"	"	"
7	6	"	"	"	"	"	"	"	"	"	"
8	7	"	"	"	"	"	"	"	"	"	"
9	8	"	"	"	"	"	"	"	"	"	"
10	9	"	"	"	"	"	"	"	"	"	"
11	90	"	"	"	"	"	"	"	"	"	"
12	1	"	"	"	"	"	"	"	"	"	"
13	2	"	"	"	"	"	"	"	"	71,230	48,130
14	3	"	"	"	"	"	"	"	"	74,100	49,790
15	4	"	"	"	"	"	"	"	"	76,980	51,460
16	5	"	"	"	"	"	"	"	"	79,870	53,530
17	6	"	"	"	"	"	"	"	"	82,740	55,200
18	7	"	"	"	"	"	"	"	"	85,630	56,890
19	8	"	"	"	"	"	"	"	"	88,510	58,570
20	9	"	"	"	"	"	"	"	"	91,400	60,270
21	2000	"	"	"	"	"	"	"	"	94,270	61,940
22	1	"	"	"	"	"	"	"	"	"	"
23	2	"	"	"	"	"	"	"	"	"	"
24	3	"	"	"	"	"	"	"	"	"	"
25	4	"	"	"	"	"	"	"	"	"	"
26	5	"	"	"	"	"	"	"	"	"	"
27	6	"	"	"	"	"	"	"	"	"	"
28	7	"	"	"	"	"	"	"	"	"	"
29	8	"	"	"	"	"	"	"	"	"	"
30	9	"	"	"	"	"	"	"	"	"	"

Table 4.1.3 Maintenance Cost of Improved Road (Alternative-II)
(Shadow Priced US$ 1.33 = Z 1.00)

(Unit: Zaire)

Year	Route section	1	2	3	4	5	6	7	8	9	10
1	1980										
2	1										
3	2										
4	3	39,500	51,000	43,320	26,150	29,180	42,500	13,730	63,420	69,960	45,250
5	4	"	"	43,820	26,700	30,030	47,490	15,250	67,390	"	"
6	5	39,700	51,350	44,320	27,250	31,300	54,460	17,520	73,300	"	"
7	6	"	"	44,980	27,990	32,790	58,440	19,350	106,860	"	47,050
8	7	"	"	45,820	38,920	34,500	66,760	22,060	113,920	"	"
9	8	39,890	51,700	46,650	29,840	36,200	73,370	24,210	119,520	"	"
10	9	40,090	52,050	47,320	30,580	37,030	79,830	26,310	125,000	"	"
11	90	"	"	47,990	31,320	37,900	85,690	28,220	129,970	"	"
12	1	40,280	52,400	48,650	32,060	40,330	93,310	30,700	165,240	"	"
13	2	40,480	52,750	49,110	31,870	41,090	100,010	32,580	170,890	"	"
14	3	40,670	53,100	49,780	32,610	41,970	78,150	25,460	152,350	"	"
15	4	"	"	49,940	32,800	42,190	"	"	"	"	"
16	5	"	"	50,110	32,980	42,630	"	"	"	71,230	48,130
17	6	"	"	50,280	33,170	43,670	"	"	"	74,100	49,790
18	7	"	"	51,500	34,520	43,296	"	"	181,150	76,980	51,460
19	8	"	"	51,840	34,900	43,730	"	"	"	79,870	53,530
20	9	"	"	52,010	35,090	43,960	"	"	"	82,740	55,200
21	2000	"	"	52,190	35,280	44,400	"	"	"	85,630	56,890
22	1	"	"	52,360	35,470	44,240	"	"	"	88,510	58,570
23	2	"	"	52,530	35,660	45,060	"	"	"	91,400	60,270
24	3	"	"	52,880	36,050	45,500	"	"	"	94,270	61,940
25	4	"	"	"	"	"	"	"	"	"	"
26	5	"	"	"	"	"	"	"	"	"	"
27	6	"	"	"	"	"	"	"	"	"	"
28	7	"	"	"	"	"	"	"	"	"	"
29	8	"	"	"	"	"	"	"	"	"	"
30	9	"	"	"	"	"	"	"	"	"	"

Table 4.1.4 Financial and Economic Costs of Improvement (Alternative I)

Tableau Coûts économqiues et financiers de l'amélioration (Alternative I)

(unit unité: 1,000 Zaire)

Section Tronçon		1 Monga - Ndu		2 Bondo - Monga		3 Likati - Bondo		4 Dulia - Likati		5 Buta - Dulia		6 Tele - Buta		7 Kole - Tele		8 Banalia - Kole		9 Bengamisa - Banalia		10 Kisangani - Bengamisa	
Shadow Rate Taux économique		With Avec	With-out Sans	With Avec	With-out Sans	With Avec	With-out Sans	With Avec	With-out Sans	With Avec	With-out Sans	With Avec	With-out Sans	With Avec	With-out Sans	With Avec	With-out Sans	With Avec	With-out Sans	With Avec	With-out Sans
T.	Year Année																				
1	1980	1,949	1,479	3,037	2,305	1,797	1,364	1,945	1,507	2,009	1,525	2,795	2,122	886	672	4,594	3,484	4,036	3,063	2,665	2,922
2	81	1,699	1,313	2,648	2,047	1,567	1,211	1,730	1,338	1,752	1,354	2,437	1,884	772	597	4,006	3,096	3,519	2,720	2,323	1,796
3	82	1,699	1,313	2,648	2,047	1,567	1,211	1,730	1,338	1,752	1,354	2,437	1,884	772	597	4,006	3,096	3,519	2,720	2,323	1,796
4	83	688	532	1,072	830	634	491	700	542	709	549	986	764	313	242	1,621	1,255	1,424	1,103	940	728
5	84																				
6	85																				
7	86																				
8	87																				
9	88																				
12	91																	912	700	1,318	1,012
13	92																	1,825	1,401		
16	95																				
17	96																				
18	97																				

Note: (1) With and without mean "with shadow rate" and "without shadow rate" respectively.
"Avec" ou "sans" veulent expliquer "avec prix fictifs et sans "prix fictifs" respectivement.

(2) The final engineering costs between 1976 and 1979 are added up with interest to 1980.
Le coût technique final entre 1976 et 1977 est ajouté avec intérets jusqu'en 1980.

(3) The calculation of the economic cost of improvement with shadow rate is based on the exchange rate of Z1.00 equals to US$1.33.
Le calcul de coût economique de l'amélioration avec prix fictif est basée sur le taux d'échange de 1,00 Zaïres équivalent un dollar trente-trois US$1,33.

(4) Import tax is excluded.
Drois à l'importation est exclu.

(5) Costs in the Table are on the basis of the cost level of April 1975.
Coûts dans le Tableau sont à la base de niveau du coût d'Avril 1975.

Table 4.1.5 Financial and Economic Costs of Improvement (Alternative II)

Tableau Coûts économiques et financiers de l'amélioration (Alternative II)

(unit unité: 1,000 Zaire)

Section Tronçon		1		2		3		4		5		6		7		8		9		10	
Shadow Rate Taux économique		With Avec	Without Sans	With Avec	Without Sans	With Avec	Without Sans	With Avec	Without Sans	With Avec	Without Sans	With Avec	Without Sans	With Avec	Without Sans	With Avec	Without Sans	With Avec	Without Sans	With Avec	Without Sans
T.	Year Année																				
1	1980	1,081	820	1,235	938	529	401	726	551	866	657	758	575	320	243	990	752	3,436	2,608	1,789	1,358
2	81	942	728	1,077	832	461	356	633	490	755	584	661	511	279	216	864	667	2,996	2,315	1,560	1,205
3	82	942	728	1,077	832	461	356	633	490	755	584	661	511	279	216	864	667	2,996	2,315	1,560	1,205
4	83	381	295	436	337	187	144	256	198	306	237	268	207	113	87	350	271	1,212	939	631	489
5	84											44		30				21	14	139	94
6	85											351	271					325	258	1,109	855
7	86											351	271			162	125			1,109	855
8	87																				
11	90							37	25	8	5			13	9	15	10	161	109	77	52
12	91					208	158	391	302	127	98	76	58	228	175	409	316	1,283	990	618	477
13	92					351	271	196	151									1,283	990	618	477
14	93											2,608	2,002	640	491	2,302	1,771				
15	94											2,608	2,002	640	491	2,302	1,771				
16	95																				
17	96																				
18	97															162	125				

Note: Same as those of Table 4.1.4.

Même que Tableau 4.1.4.

4.2 Benefits

4.2.1 User Benefit

Generally, the user benefit in the case of considering the increase of the average tonnage to be carried by a vehicle is calculated in the following formula:

$$BR = AQ.BRN.UCRB - AQ.ARN.UCRA \quad \ldots\ldots\ldots\ldots\ldots \quad (4.5.1)$$

Where:

BR = User benifit

AQ = Tonnage to be transported after the project road is improved.

BRN = Conversion factor from a ton of freight into a number of vehicle without the project road improvement.

ARN = Conversion factor from a ton of freight into a number of vehicle with the project road improvement.

UCRB = Operating cost per vehicle without the project road improvement (at the conversion factor of BRN).

UCRA = Operating cost per vehicle with the project road improvement (at the conversion factor of ARN).

There is a possibility that the benefit is over-estimated unless UCRB is clearly for BRN and UCRA is clearly for BRN. The formula (4.5.2.) would represent the most severe case if the loading conditions of UCRB and UCRA are not clearly defined.

$$BR = AQ.\ (\ ARN.UCRB - ARN.UCRA\ ) \quad \ldots\ldots\ldots\ldots\ldots \quad (4.5.2.)$$

But there is a possibility that the benefit is less-estimated if the benefit is calculated by using the formula (4.5.2.). Therefore, the most appropriate benefit would be represented by the formula (4.5.3.) which is the intermediate one between the formula (4.5.1.) and (4.5.2.).

$$BR = AQ.ARN.(UCRB - UCRA) \cdot \frac{BRN}{ARN} \quad \ldots\ldots\ldots\ldots \quad (4.5.3)$$

While,

$$AQ.ARN = DA \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (4.5.4)$$

where:

DA = Number of vehicles after the project road was improved.

Then,

$$BR = DA.\ (UCRB - UCRA) \cdot \frac{BRN}{ARN} \quad \ldots\ldots\ldots\ldots\ldots \quad (4.5.5)$$

Thus, the formula (4.5) is induced.

$$BRt = \sum_{m} \sum_{k} \left\{ DAtmk \cdot (UCRBmk - UCRAmk) \cdot \frac{BRNtk}{ARNtk} \right\} \ldots \quad (4.5)$$

Where:

BRt = User benefit in the year t (Table 4.3.9 - Table 4.3.10)

DAtmk = Traffic of the vehicle of type k in the section m in the year t with the project road improvement (Table 2.4.36)

UCRBmk = Operating cost of the vehicle of type k in the section m in the year t without the project road (Table 4.2.2)

UCRAmk = Operating cost of the vehicle of type k in the section m in the year t with the project road improvement (Table 4.2.1)

BRNtk = Conversion factor to convert a ton of freight into the number of the vehicles of type k without the project road improvement (Table 2.4.7)

ARNtk = Conversion factor to convert a ton of freight into the number of the vehicles of type k with the project road (Table 2.4.7)

The user costs UCRBmk and UCRAmk used in the formula (4.5) are calculated respectively as follows:

$$UCRBmk = UFRBmk + UDRBmk + UTRBmk \cdot MRk \quad \ldots\ldots\ldots\ldots \quad (4.6)$$

Where:

UFRBmk = Fuel cost of the vehicle of type k in the section m without the project road improvement (Table 2.3.10)

UDRBmk = Depreciation cost of the vehicle of type k in the section m without the project road improvement (Table 2.3.10)

UTRBmk = Necessary travel time of the vehicle of type k in the section m without the project road improvement (Table 2.3.8)

MRk = Time value of the vehicle of type k (See 2.3.1.(4)).

$$UCRAmk = UFRAmk + UDARmk + UTRAmk.MRk \quad \ldots\ldots\ldots\ldots \quad (4.7)$$

Where:

UFRAmk = Fuel cost of the vehicle of type k in the section m with the project road (Table 2.3.10)

UDARmk = Depreciation cost of the vehicle of type k in the section m with the project road (Table 2.3.10)

UTRAmk = Necessary travel time of the vehicle of type k in the section m with the project road (Table 2.3.8)

The operating costs to be used in the formulae (4.6) and (4.7) are referred to 2.3. (See Table 2.3.3)

The operating benefit per trip due to the induced traffic is regarded theoretically as well as approximately as 50% of that of the normal traffic, and also the developed traffic according to a conservative opinion is regarded as a part of the induced traffic and its benefit is regarded as 50% of that of the normal traffic.

But there exist such cases in developing countries where the main portion of the generated traffic consists of the developed traffic and it is necessary in such cases to confirm whether it is appropriate to follow such conventional principle. The definitions of the induced traffic and the developed traffic here are as follows; the former means the latent traffic already exists and induced instantly when the project is carried out, while the latter means the increased portion of the latent traffic to be induced by the development of the local economic activities. The traffic of a given zone-pair is represented by the following formula:

$$Qb = Sb \cdot \int_{Cb}^{\infty} f(u)\,du \qquad \text{..... (4.8)}$$

where:

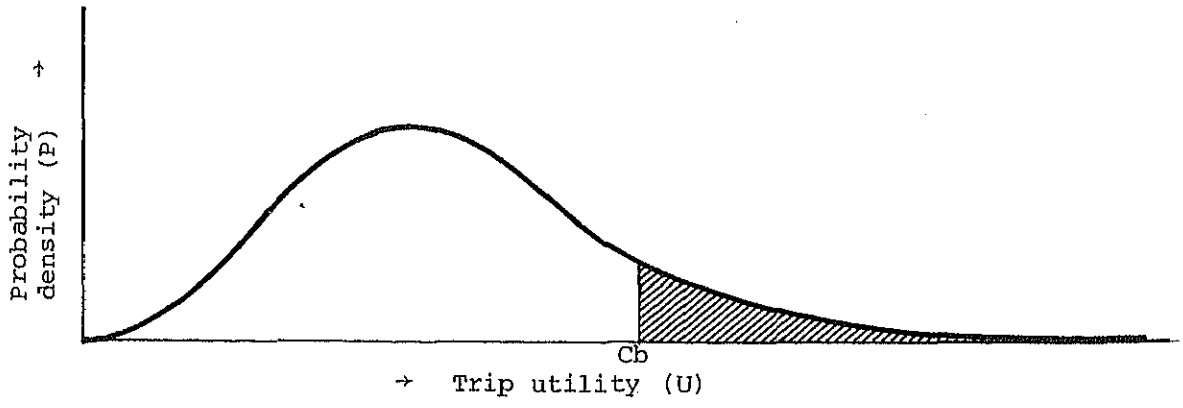
Qb = The existing traffic of a given zone-pair without the road improvement

Sb = Latent traffic of a given zone-pair without road improvement

f(u) = Probability density function of the trip utility of a given zone-pair without road improvement

Cb = Operating cost per trip of a given zone-pair without the road improvement.

Plate 4.2.1 Distribution of Probability Density Function of the Trip Utility of a Given Zone-Pair without Road Improvement



$\int_{Cb}^{\infty} f(u)du$ in the formula (4.8) represents the shaded area in Plate 4.2.1; in other words, this portion manifests those trips having trip utility which exceed the average operating cost Cb per trip. In the formula (4.8) Qb and Sb represent the existing traffic and the latent traffic respectively and such integration means the manifesting rate.

Because the road improvement is considered not only reduces the vehicular operating cost but also affects on the distribution of the trip utility as well as on the latent traffic, the traffic with the road improvement is represented by the following formula:

$$Qa = Sa. \int_{Ca}^{\infty} g(u)du \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (4.9)$$

where:

Qa = Traffic of a given zone-pair with the road improvement

Sa = Latent traffic of a given zone-pair with the road improvement

g(u) = Probability density function of the trip utilization of a a given zone-pair with the road improvement

Ca = Operating cost per trip of a given zone-pair with the road improvement

Formula (4.8) and Formula (4.9) are also indicated by using demand curves as shown in Plate 4.2.2 which are merely the accumulation of the trip-utilization distribution; and consequently the induced traffic is represented by the following formula:

$$\begin{aligned} Qy &= Q' - Qb \\ &= Sb. \int_{Ca}^{\infty} f(u)du - Sb. \int_{Cb}^{\infty} f(u)du \\ &= Sb. \left[\int_{Ca}^{\infty} f(u)du - \int_{Cb}^{\infty} f(u)du \right] \quad \ldots\ldots\ldots\ldots\ldots \quad (4.10) \end{aligned}$$

where;

Qy = Induced traffic due to the road improvement.

Q' = Traffic with the road improvement where operating cost is affected by the demand curve remains unchanged.(See Plate 4.2.2)

On the other hand, the developed traffic is represented by the following formula:

$$Qd = Qa - Q'$$

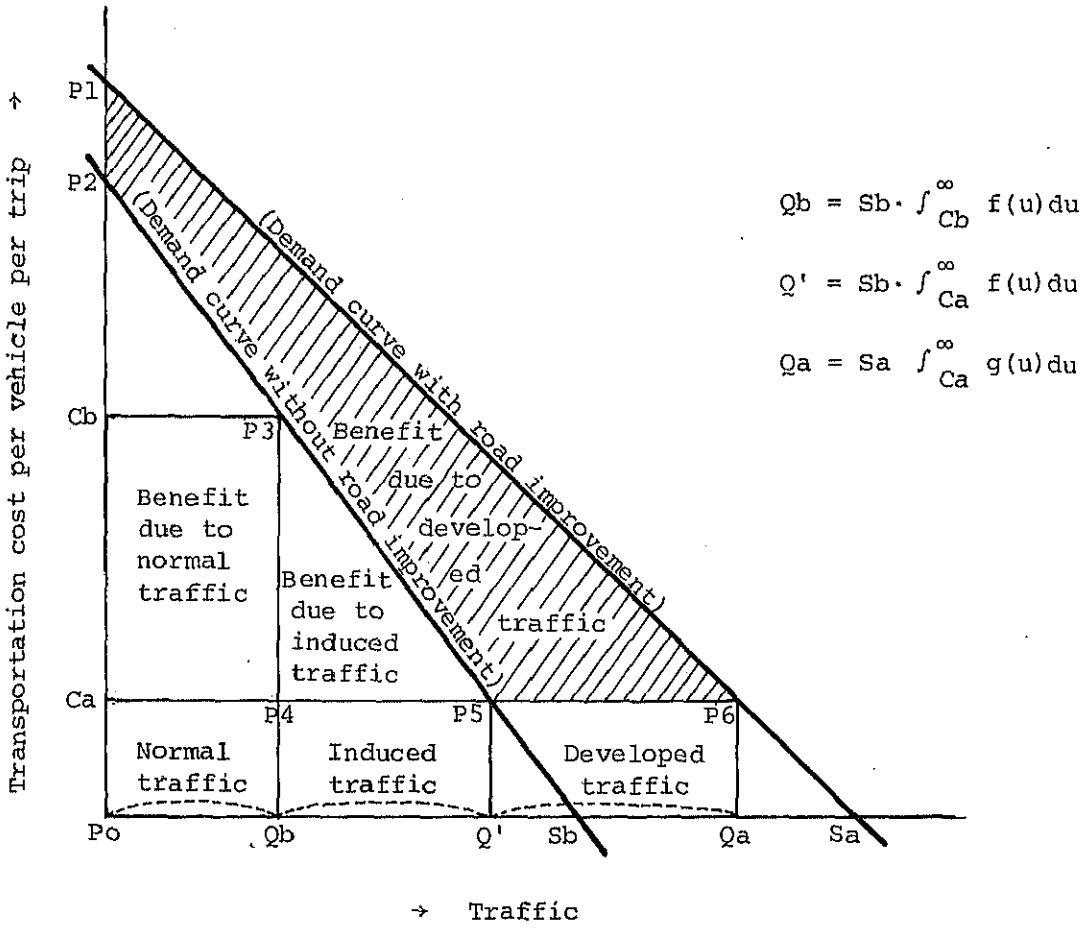
$$= Sa. \int_{Ca}^{\infty} g(u)du - Sb. \int_{Ca}^{\infty} f(u)du \quad \cdots\cdots\cdots\cdots \quad (4.11)$$

where:

Qd = Developed traffic due to the road improvement.

Qa = Traffic with the road improvement when the operating cost and the demand curve are both affected by the road improvement (See Plate 4.2.2)

Plate 4.2.2 Increase of Traffic due to Road Improvement



The user's surplus with the road improvement is represented by the following formula:

$$Yb = \sum_{u=Cb}^{\infty} \{Sb. \int_{u-1}^{u} f(u)du.(u - Cb)\} \quad \ldots\ldots\ldots\ldots \quad (4.12)$$

where:

Yb = User's surplus without the road improvement

u = Trip utilization

This user's surplus is represented by the triangle of P2-Cb-P3 in Plate 4.2.2.

On the other hand, the user's surplus with the road improvement is represented by the following formula:

$$Ya = \sum_{u=Ca}^{\infty} \{ Sa. \int_{u-1}^{u} g(u)du.(u - Ca)\} \quad \ldots\ldots\ldots\ldots \quad (4.13)$$

This surplus is represented by a triangle P1-Ca-Pb in Plate 4.2.2.

The benifit due to the road improvement equals to the net increase in the user's surplus; and consequently it is represented by the following formula:

$$BF = Ya - Yb$$

$$= \sum_{u=Ca}^{\infty} \{ Sa. \int_{u-1}^{u} g(u)du.(u - Ca)\} - \sum_{u=Cb}^{\infty} \{Sb. \int_{u-1}^{u} f(u)du.(u - Cb)\}$$

$$\ldots\ldots\ldots\ldots \quad (4.14)$$

Therefore, the benifit due to the road improvement is represented by remaining portion of the triangle P1-Ca-P6 after substracting the triangle P2-Cb-P3 from it (See Plate 4.2.2), and the portion of its benefit due to the normal traffic is represented by the following formula:

$$BFN = Qb.(Cb - Ca) \quad \ldots\ldots\ldots\ldots \quad (4.15)$$

where:

BFN = Benefit due to the normal traffic, which is represented by the rectangle Cb-Ca-P4-P3 in Plate 4.2.2.

The benefit due to the induced traffic is represented by the following formula and also by the triangle P3-P4-P5 in Plate 4.2.2.

$$BFI = \sum_{u=Ca}^{Cb} \{Sb. \int_{u-1}^{u} f(u)du.(u - Ca)\}$$

$$= (Q' - Qb). \frac{Cb - Ca}{2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (4.16)$$

where:

BFI = Benifit due to the induced traffic.

Here exists the reason why the benifit due to the induced traffic per trip is approximately 1/2 of that of the normal traffic, although it varies slightly larger or smaller than this value depending upon the linear shape of the demand curve.

In the benifit due to the road improvement the rectangle Cb-Ca-P4-P3 in Plate 4.2.2. is the benefit due to the normal traffic and the triangle P3-P4-P5 is the benefit due to the induced traffic and the remaining portion surrounded by P1-P2-P5-P6 corresponds to the benefit due to the developed traffic.

If the average benefit per trip of the developed traffic is assumed to be approximately equal to that of the normal traffic, then the benefit due to the developed traffic is represented by the following formula:

$$BFD = Qd. (Cb - Ca)$$

$$= (Qa - Q'). (Cb - Ca) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (4.17)$$

where:

BFD = Benefit due to the developed traffic.

When the area surrounded by P1-P2-P3-P5-P6 which corresponds to the genuine benefit due to the developed traffic is compared to the area formed by (Qa - Q') x (Cb - Ca) which corresponds to the induced traffic when the benefit per trip due to the developed traffic is assumed to be equal to that of the normal traffic, the former will be larger or smaller than the latter depending upon the linear shape of the demand curves

and in most cases the former will be larger than the later. If the conservative opinion is taken, the both are assumed to be equal; in other words, the average benefit per trip of the developed traffic is considered to be equal to that of the normal traffic.

However, this opinion has not been also accepted widely and it would be appropriate to regard the benefit due to developed traffic per trip as 1/2 of the benefit due to normal traffic per trip. Therefore, both cases were calculated in the economic analysis; the one is the case that the benefit due to the developed traffic per trip is assumed to be a half of that due to the normal traffic, and the other is the case that the former benefit is assumed equal to the later benefit.

Plate 4.2.3 Estimating Process of Road User Benefit

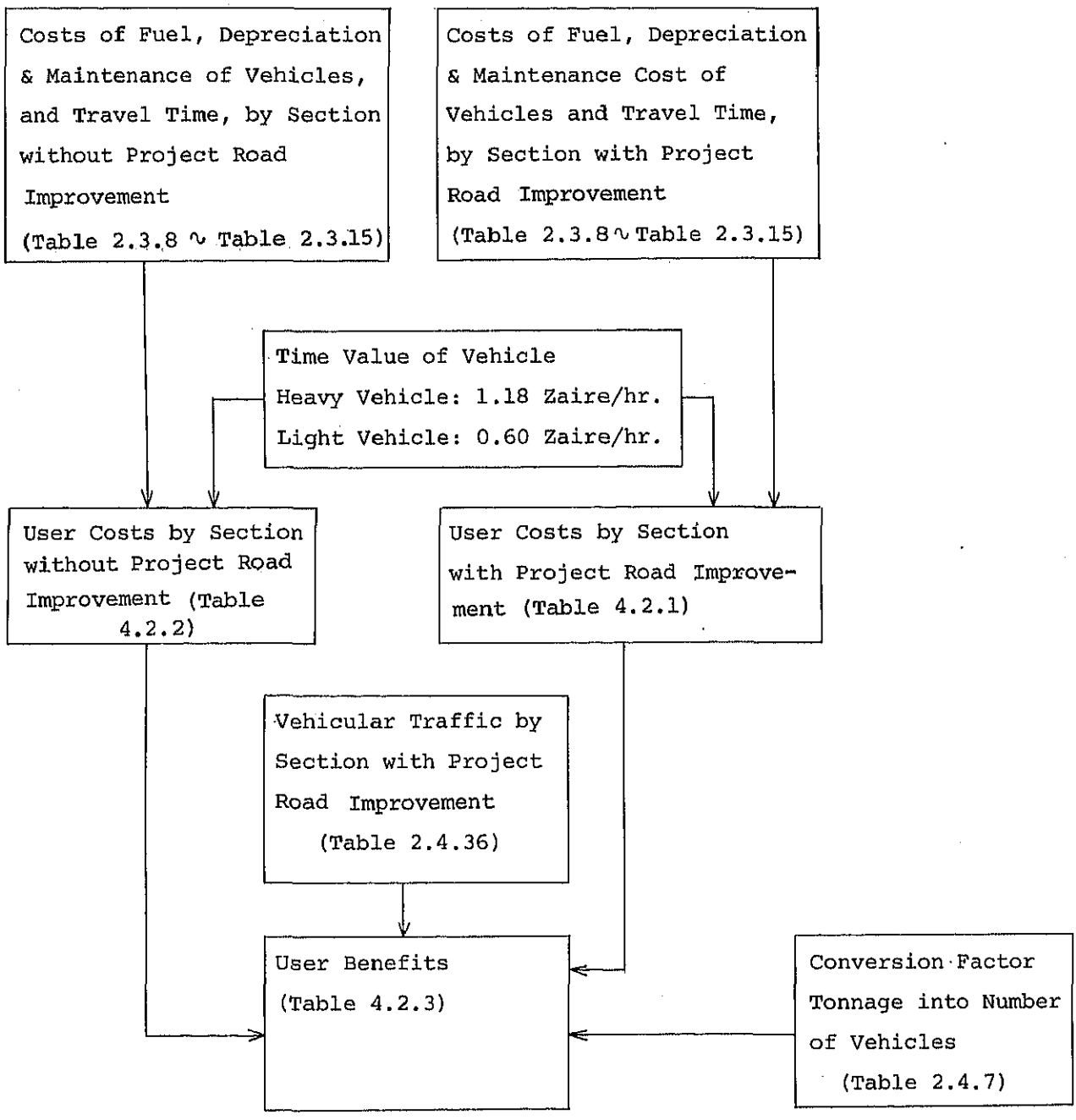


Table 4.2.1 Travelling Costs on Improved Road

(including time cost) (Unit: Z/vehicle)

Alternative	Type of Vehicle	Road Section 1 Monga - Ndu	2 Bondo - Monga	3 Likati - Bondo	4 Dulia - Likati	5 Buta - Dulia	6 Tele - Buta	7 Kole - Tele	8 Banalia - Kole	9 Bengamisa - Banalia	10 Kisangani - Bengamisa	Total Kisangani - Ndu
I	Heavy vehicle	10.4	17.9	8.7	9.1	10.6	12.1	4.0	10.3	11.0	6.3	100.3
(T=4∿30)	Light vehicle	7.3	12.8	6.3	6.7	7.6	8.8	2.9	7.5	7.9	4.7	72.5
II	Heavy vehicle	13.3	23.4	11.5	12.0	13.9	16.0	5.2	14.1	11.0	6.3	126.7
(T=4∿14)	Light vehicle	9.1	16.1	7.9	8.4	9.6	11.1	3.7	9.8	7.9	4.7	88.3
III	Heavy vehicle	13.3	23.4	11.5	12.0	13.9	12.1	4.0	11.0	11.0	6.3	118.5
(T=15∿30)	Light vehicle	9.1	16.1	7.9	8.4	9.6	8.8	2.9	7.8	7.9	4.7	83.2

Note: In Alternative II only south of Banalia is paved in the year T=3 and the section between Banalia and Buta is paved in the year T=14. At Aruwimi River the existing ferry is replaced with bridge in Alternative I, while the ferry is still in service in Alternative II.

Table 4.2.2 Travelling Costs on Existing Road

(including time cost) (Unit: Z/vehicle)

Type of vehicle	Road Section 1 Monga - Ndu	2 Bondo - Monga	3 Likati - Bondo	4 Dulia - Likati	5 Buta - Dulia	6 Tele - Buta	7 Kole - Tele	8 Banalia - Kole	9 Bengamisa - Banalia	10 Kisangani - Bengamisa	Total Kisangani - Ndu
Heavy vehicle	22.7	38.9	18.8	20.0	23.1	27.0	9.1	24.0	24.3	14.1	221.9
Light vehicle	14.0	23.8	11.5	12.4	14.2	16.7	5.5	14.7	15.0	8.8	136.6

Notes on Table 4.2.1 and Table 4.2.2
(1) Heavy vehicle means large truck and bus.
(2) Light vehicle means pick-up truck and passenger car.
(3) Costs in the table are based on the basis of the cost level of November 1974.

Table 4.2.3 Savings in Operating Cost Including Time Cost by Type of Vehicle and by Section

(Unit: Zaire)

Alternative	Type of Vehicle	1 Monga - Ndu	2 Bondo - Monga	3 Likati - Bondo	4 Dulia - Likati	5 Buta - Dulia	6 Tele - Buta	7 Kole - Tele	8 Banalia - Kole	9 Bengamisa - Banalia	10 Kisangani - Bengamisa	Total Kisangani - Ndu
I	Heavy vehicle	12.3	21.0	10.1	10.9	12.5	14.9	5.1	13.7	13.3	7.8	121.6
(T= 4∿30)	Light vehicle	6.7	11.0	5.2	5.7	6.6	7.9	2.6	7.2	7.1	4.1	64.1
II	Heavy vehicle	9.4	15.5	7.3	8.0	9.2	11.0	3.9	9.1	13.3	7.8	95.2
(T= 4∿14)	Light vehicle	4.9	7.7	3.6	4.0	4.6	5.6	1.8	4.9	7.1	4.1	48.3
III	Heavy vehicle	9.4	15.5	7.3	8.0	9.2	14.9	5.1	13.0	13.3	7.8	103.4
(T=15∿30)	Light vehicle	4.9	7.7	3.6	4.0	4.6	7.9	2.6	6.9	7.1	4.1	53.4

4.2.2 Net Increase of Added Value of Agricultural Products

The net increase of added value NADt (Table 4.3.9 - Table 4.3.10) used in the formula (4.3) is calculated as follows:

$$NADt = \sum_i \sum_j NADtij \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (4.18)$$

Where;

NADt = Net increase of added value in the year t (Table 4.3.9 - Table 4.3.10)

NADtij = Net increase of added value of the product type j in the zone i in the year t (Table 4.2.7)

$$NADtij = AADtij - BADtij - \bar{O}Ctij \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (4.19)$$

Where:

AADtij = Added value of the product type j in the zone i in the year t with project road (Table 4.2.5)

BADtij = Added value of the product type j in the zone i in the year t without the project road (Table 4.2.6)

$\bar{O}Ctij$ = Opportunity cost of the increased agricultural laborers of the product of type j in the zone i in the year t (Table 4.2.4)

$$AADtij = AQtij \cdot (Pj - UCOSj) \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (4.20)$$

Where:

AQtij = Production in the zone i in the year t without project road (Table 2.4.26)

Pj = Price of the product of type j (Table 4.2.4)

UCOSj = Production cost of the product of type j including the capital reward but not that of laborers (Table 4.2.4)

Since the price Pj used here is the producer price and a double counting of the benefit does not take place. If the consumer price is used here, the benefit is doubled because the consumer price includes the cost of transportation.

$$BADtij = BQtij \cdot (Pj - UCOSj) \quad \text{.....} \quad (4.21)$$

Where:

BQtij = Production of the product type j in the zone i without project road improvement (Table 2.4.22)

Then, the opportunity cost OCtij of the increased laborers in the formula (4.13) is calculated as follows:

$$\bar{O}Ctij = UWj \cdot (AQtij - BQtij) \cdot U\bar{O}Cj \quad \text{.....} \quad (4.22)$$

Where:

UWj = Necessary number of laborers per ton of the product of type j (Table 4.2.4)

AQtij = Production of the product of type j in the zone i in the year t with project road (Table 2.4.26)

BQtij = Production of the product of type j in the zone i in the year t without project road (Table 2.4.22)

$U\bar{O}Cj$ = Opportunity cost of agricultural laborers who are engaged in the production of the product of type j (Table 4.2.4)

The process mentioned here, after all, means the following:

(Net increase of added value) = (Increase of added value)
- (Opportunity cost of increase of capital)
- (Opportunity cost of increase of laborers)

But there is such an opinion that if the number of farmers increase then the number of local schools and hospitals will also need to be increased, and such additional costs for schools and hospitals ought to be subtracted from the increase of added value; but this is wrong because, if such an opinion is admitted the benefit caused by the additional investment in schools and hospitals ought to be added to the benefit of investment in the road. The calculating process from the formula (4.18) to the formula (4.22) is shown as a flow chart in Plate 4.2.4.

Plate 4.2.4 Calculating Process of Net Increase of Added Value

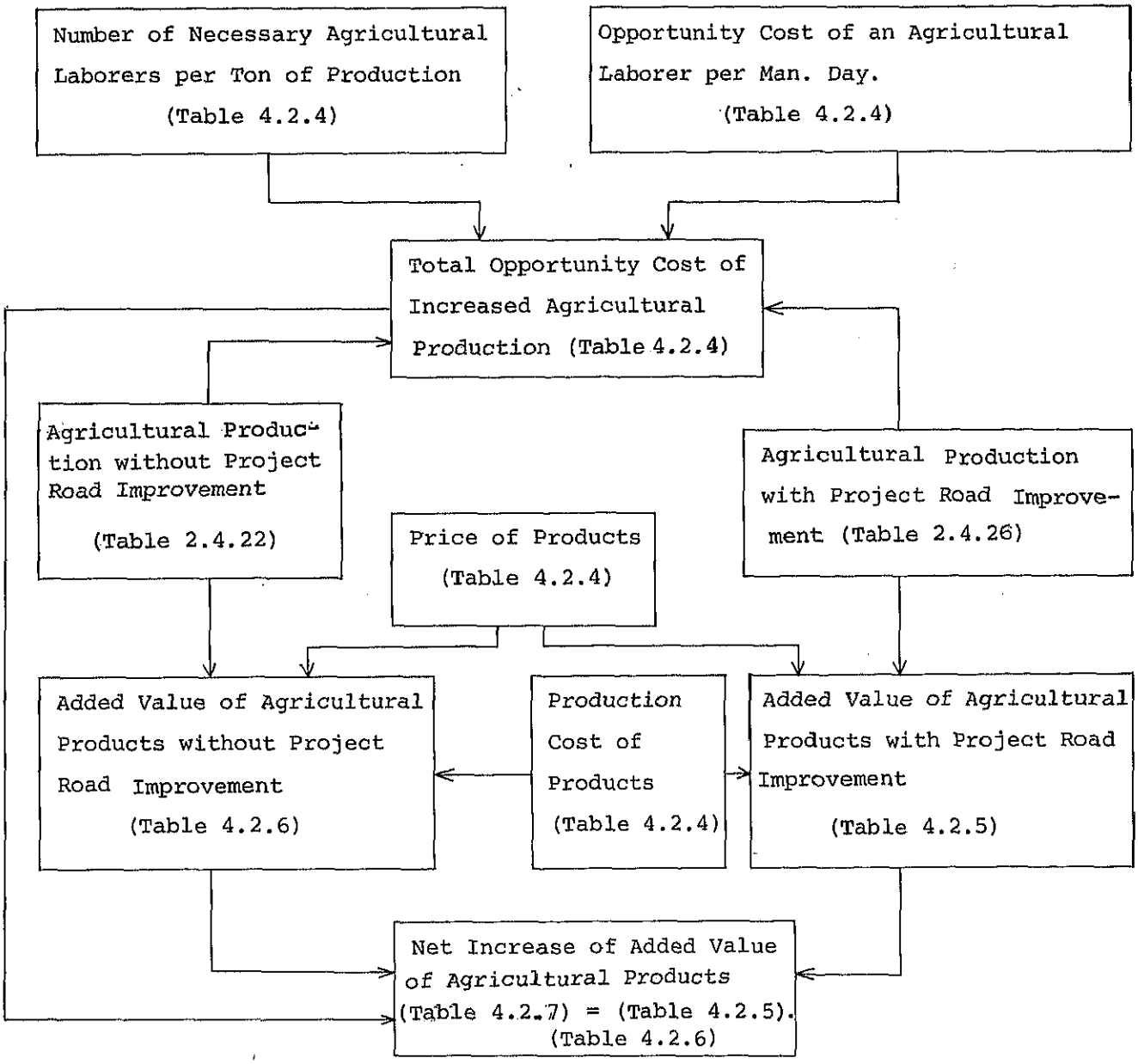


Table 4.2.4 Price and Cost of Production of Agricultural Products

	Official Price Pj (Zaires/ton)	Necessary Number of Laborers per Ton of Product UWj (man-days/ton)	Production Cost $UC\bar{O}Sj$ (Zaires/ton)	Opportunity Cost of a Laborer $U\bar{O}Cj$ (Zaires/man-day)
1. Rice	40	113	6	0.1
2. Corn	30	83	5	0.1
3. Groundnuts	40	106	8	0.1
4. Cassava	20	30	4	0.1
5. Cotton	60	160	12	0.1
6. Sweet Potato	20	30	4	0.1
7. Banana	20	18	2	0.1
8. Coffee	90	90	45	0.1
9. Palm Oil	90	90	45	0.1
10. Rubber	40	40	20	0.1
11. Cocoa	200	133	160	0.1
12. Cabbage Palm	90	60	72	0.1
13. Lumber	40	80	8	0.2

Note: Pj = Price maintained in 1969.

UWj = Data were collected through hearings at Office des Agricole Regionale at Kisangani and also plantations located along the project road.

$U\bar{O}Cj$ = The official minimum wage is 25 makutas per man-day for agricultural laborers but their average daily income under 10 makutas because the semi-unemployment situation prevails.

$UC\bar{O}Sj$ = Data were collected through hearings at Office de Agricole Regionale at Kisangani and also plantations located along the project road. Data include the capital reward but not the labor cost.

Opportunity cost of a laborer is an increase in daily living cost when he gets the job in agricultural work.

Table 4.2.5 / Tableau
Yearly Added Value in 1989 with Project Road Improvement
Valeur brute annuelle en 1989 avec l'amélioration de la Route de Projet

(unit / unité: Zaire)

Type of Commodity / Type de artirle	Zone						
	Bondo(2)	Buta(3)	Banalia(4)	Aketi(7)	Bambesa(9)	Ango(10)	Poko(12)
1. Rice / Riz	55,454	104,040	406,674	72,522			
2. Maize / Mais	101,050	54,675	89,700	53,325			
3. Peanuts / Arachides	65,248	55,968	38,272	34,144			
4. Cassava / Manioc	293,616	314,800	1,263,120	191,968			
5. Cotton / Coton	164,112	78,432	95,184	109,824	210,720	173,952	163,824
6. Sweet Potato / Potates douce							
7. Banana / Banane	264,258	306,936	430,614	167,976			
8. Coffee / Café	5,940	54,045	75,150	87,120	99,495	4,635	473,895
9. Palm Oil / Huil de palme	45,675	31,456	26,955	29,430	79,380	8,460	82,170
10. Rubber / Caoutchouc			22,500	9,220			
11. Cacao / Cacao							
12. Palmist / Palmiste							
13. Lumber / Bois de charpente							

Table 4.2.6
Tableau

Yearly Added Value in 1989 without Project Road Improvement

Valeur brute annuelle en 1989 sans l'amélioration de la Route de Projet

(unit / unité : Zaire)

Type of Commodity / Type de article	Zone						
	Bondo(2)	Buta(3)	Banalia(4)	Aketi(7)	Bambesa(9)	Ango(10)	Poko(12)
1. Rice / Riz	36,788	73,338	330,582	49,232			
2. Maize / Mais	67,625	38,525	72,925	36,200			
3. Peanuts / Arachides	43,264	39,456	31,136	23,160			
4. Cassava / Manioc	194,720	221,856	1,026,768	130,256			
5. Cotton / Coton	94,368	34,368	56,016	62,352	119,472	153,936	82,272
6. Sweet Potato / Potates douce							
7. Banana / Banane	175,248	216,324	350,028	113,994			
8. Coffee / Café	5,445	2,520	9,540	79,650	91,035	4,230	433,395
9. Palm Oil / Huil de Palme	900	16,110	18,180	675	54,675		3,915
10. Rubber / Caoutchouc			4,980				
11. Cacao / Cacao							
12. Palmist / Palmiste							
13. Lumber / Bois de charpente			270,624				

Table 4.2.7 Net Increase of Added Value in 1989 by Zone by Commodity

Tableau Augmentation nette de la valeur brute par zone par article en 1989

(unit / unité : Zaire)

Type of Commodity / Type de article	Zone						
	Bondo(2)	Buta(3)	Banalia(4)	Aketi(7)	Bambesa(9)	Ango(10)	Poko(12)
1. Rice / Riz	12,462	20,498	50,803	15,549			
2. Maize / Mais	22,929	10,788	11,206	11,439			
3. Peanuts / Arachides	14,702	11,042	4,772	7,340			
4. Cassava / Manioc	80,353	75,517	192,036	50,141			
5. Cotton / Coton	46,496	29,376	26,112	31,648	60,832	13,344	54,368
6. Sweet Potato / Potates douces							
7. Banana / Banane	80,109	81,551	75,527	48,584			
8. Coffee / Café	396	41,220	52,488	5,976	6,768	324	32,400
9. Palm Oil / Huil de palme	35,820	12,276	7,020	23,004	19,764	6,768	
10. Rubber / Caoutchouc			14,016	7,376			
11. Cacao / Cacao							
12. Palmist / Palmiste							
13. Lumber / Bois de charpente		269,312	1,372,784				

4.2.3 Other Benefits

The net increase of income of local unskilled laborers to be employed in the improvement of the project road included in the formula (4.3) is obtained by the following formula;

$$KWt = KLt \cdot UKW \cdot \alpha \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (4.23)$$

Where:

KLt = Number of local unskilled laborers to be employed in the improvement of the project road in the year of t (man-days) (Table 4.2.8)

UKW = Daily wage of an unskilled laborer to be employed in the locality = 1.20 Zaire/day

α = Coefficient to obtain the net increase of income from wages excluding the opportunity cost = 0.5 (This value was obtained from hearings with local contractors)

In the same way, the benefit of savings in the maintenance cost of the project road (SMt) used in the fomula (4.3) is obtained as follow (Table 4.3.9 - Table 4.3.10);

$$SMt = BEt - AEt \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (4.24)$$

Where:

BEt = Maintenance cost of the road without the project road improvement (Table 4.1.1)

AEt = Maintenance cost of the road with the project road improvement (Table 4.1.2 - Table 4.1.3)

The benefit from international traffic is neglected in the calculation of benefits in this report because of the following reasons;

(i) International through traffic is generally well influenced by the policies regarding diplomacy, international trade and transportation of each of member countries of the project road and therefore it is really difficult to estimate it definitely at the present stage;

(ii) The benefit of international through traffic on the project road by foreign vehicles through the territory of Zaire is not considered to belong to Zaire. On the contrary, it is anticipated that Zaire must bear the increase of the maintenance cost of the project road; and

(iii) International tourism traffic on the project road will certainly bring forth a fair amount of foreign currencies to the localities along the project road, but the completion of the improvement of the project road alone is not enough for the purpose of gaining foreign currencies; investments in such facilities as hotels, gasoline stations, vehicle repair shops and various stores are necessary. In consideration of such conditions, it is really difficult to calculate the net increase of the local income to be caused by international through traffic.

Table 4.2.8
Tableau

Labors to be Locally Employed in Construction
Employés pour la construction à recruter sur place

(man-days/year)
(homme-jours/année)

T	Year Année	Alternative I	Alternative II
1	1980	1,608,000	725,200
2	81	1,608,000	777,000
3	82	1,608,000	777,000
4	83	536,000	310,800
5	84		
6	85		71,000
7	86	270	71,000
12	91	8,680	164,000
13	92	8,680	164,000
14	93		233,000
15	94		233,000
16	95	17,720	180
17	96		
18	97		450

4.3 Results of Economic Analysis

In the economic analysis of the project the benefit/cost ratio method and the internal rate of return method were adopted, and five cases of analysis were carried out by alternative, varying evaluating conditions as follow as it is done in so-called sensitivity analysis:

(a) Shadow rate is applied to the cost of improvement or not;

(b) The net increase in added value of agricultural products is included in or excluded from the benefit;

(c) Savings in time cost is included in or excluded from the benefit; and,

(d) The benefit due to the developed traffic per trip is assumed to be a half or same as that due to the normal traffic.

It is understood from Table 4.3.1, that even Alternative II shows such low values as 0.531 in the benefit/cost ratio which is much smaller than 1.0 and 7.4% in the internal rate of return which is much smaller than the discount rate of 12% under the severet conditions; and Alternative I shows worse values than Alternative II under the same conditions. Consequently, both Alternatives are not economically justified under such conditions.

Viewing Alternatives by route section, the following facts are found from Table 4.3.2 that:

- In Alternative I the route section between Kisangani and Banalia is economically justified in all cases except the most severe one;

- In Alternative II the route section between Kisangani and Buta is economically justified in all cases except the most severe case.

Next, viewing overall the project, it is understood from the results of the economic evaluations that:

- In Alternative II the route section between Kisangani and Banalia is approximately economically justified under the most severe conditions because the benefit/cost ratio is nearly 1.0;

- In Alternative II, if it is viewed under the conditions except the most severe conditions, the benefit/cost ratio of the entire route shows a favorable value in each case as shown in from # 6 to # 9 and it is recommended to improve the entire route if the financial situation permits.

Tables 4.3.3 and 4.3.4 show the costs and the benefits of the project by alternative and by year. The benefits consist of such four factors as (1) the net increase in added value of agricultural products, (2) the users' benefit covering savings in operating cost including those due to the improvement of loading factor and those in time cost, (3) the net increase in unskilled laborers' income and (4) savings in maintenance cost of the road. The figures of users' benefit in those tables show the case that the benefit due to the developed traffic is assumed equal to that of the normal traffic. In those tables the users' benefit occupies 67% and the benefit due to the net increase of added value 30% of the total benefit. Consequently, the total of the rest benefit is not more than 3%.

In the most severe case the users' benefit occupies 90% and the net increase in added value zero % and the total of the rest benefit 10% of the total benefit.

Tables 4.3.7 and 4.3.8 show savings in the operating cost by section and by year, which are not discounted, for Alternative I and Alternative II respectively. The figures in the table include savings in time cost.

Tables 4.3.9 and 4.3.10 show also the cost of improvement by year for Alternative I and Alternative II respectively with shadow rate as well as without shadow rate, both of which are not discounted.

Benefits shown in Table 4.3.5 include not only the users' benefit but also all other benefits appearing in Tables 4.3.3 and 4.3.4 respectively. In this table the benefit due to the net added value is distributed to each route section according to the amount of savings of the operating cost of every route section under the assumption that the all route sections are improved and opened for traffic simultaneously.

Table 4.3.1 Results of Economic Analysis (Kisangani-Bangassou)

Case	Alter-native	Exchange rate for estimating improvement cost	Benefit due to net increase in added value	Benefit due to savings in time cost	Benefit due to developed traffic	Internal rate of return	Benefit/ cost ratio	Maximum possible investment (1,000 Zaires)	Total benefit (present value) (1,000 Zaires)	Total project cost (present value) (1,000 Zaires)
# 1	I	OR x 1.5	Yes	Yes	Normal	0.115	0.945	59,913	63,907	67,636
# 2	I	OR	Yes	Yes	Normal	0.138	1.209	59,917	63,907	52,865
# 3	I	OR x 1.5	No	Yes	Normal	0.085	0.668	41,185	45,176	67,636
# 4	I	OR	No	Yes	Normal	0.105	0.855	41,185	45,176	52,863
# 5	I	OR x 1.5	No	No	1/2 x Normal	0.051	0.305	18,834	20,659	67,636
# 6	II	OR x 1.5	Yes	Yes	Normal	0.176	1.662	58,478	61,969	37,026
# 7	II	OR	Yes	Yes	Normal	0.207	2.107	58,478	61,969	29,196
# 8	II	OR x 1.5	No	Yes	Normal	0.135	1.156	39,746	42,798	37,026
# 9	II	OR	No	Yes	Normal	0.163	1.466	39,746	42,798	29,133
#10	II	OR x 1.5	No	No	1/2 x Normal	0.074	0.531	18,283	19,687	37,026

Notes: 1) Yes means considered, and No means ignored.

2) OR means the original exchange rate of US$1.00 = Z 0.50.

3) Normal means the same amount as much as that due to the normal traffic; while 1/2 x Normal means the half amount of that due to the normal traffic.

4) The net increase in local unskilled laborers' income and savings in maintenance cost of the road occupy a small percentage in the total benefit and are not considered as items of changing condition in the analysis but their amounts are included in the total benefit.

Table 4.3.2 Results of Economic Analysis by Alternative and by Section

Case	Alter-native	Exchange rate for estimating improvement cost	Benefit due to net increase in added value	Benefit due to savings in time cost	Benefit due to developed traffic	B/C Ratio by Route Section										Entire route
						(1) Bangassou ~ Monga	(2) Monga ~ Bondo	(3) Bondo ~ Likati	(4) Likati ~ Dulia	(5) Dulia ~ Buta	(6) Buta ~ Tele	(7) Tele ~ Kole	(8) Kole ~ Banalia	(9) Banalia ~ Bengamisa	(10) Bengamisa ~ Kisangani	
# 1	I	OR x 1.5	Yes	Yes	Normal	0.056	0.056	0.164	0.169	0.241	0.879	0.935	0.530	2.639	2.367	0.945
# 2	I	OR	Yes	Yes	Normal	0.072	0.071	0.207	0.216	0.307	1.123	1.196	0.682	2.397	3.046	1.209
# 3	I	OR x 1.5	No	Yes	Normal	0.048	0.047	0.123	0.128	0.177	0.623	0.663	0.383	1.845	1.656	0.668
# 4	I	OR	No	Yes	Normal	0.062	0.060	0.156	0.163	0.225	0.797	0.848	0.493	2.375	2.131	0.855
# 5	I	OR x 1.5	No	No	1/2 x Normal	0.022	0.022	0.056	0.058	0.081	0.262	0.303	0.175	0.844	0.757	0.305
# 6	II	OR x 1.5	Yes	Yes	Normal	0.129	0.166	0.381	0.334	0.432	1.508	1.539	1.143	3.027	2.792	1.662
# 7	II	OR	Yes	Yes	Normal	0.164	0.206	0.473	0.425	0.549	1.902	1.944	1.417	3.893	3.519	2.107
# 8	II	OR x 1.5	No	Yes	Normal	0.117	0.151	0.294	0.258	0.324	1.045	1.069	0.780	2.088	1.926	1.156
# 9	II	OR	No	Yes	Normal	0.149	0.187	0.365	0.328	0.411	1.319	1.350	0.967	2.685	2.476	1.466
#10	II	OR x 1.5	No	No	1/2 x Normal	0.054	0.069	0.135	0.119	0.149	0.481	0.492	0.358	0.960	0.884	0.531

Notes: 1) Yes means considered, and No means ignored.

2) OR means the original exchange rate of US$ 1.00 = Z 0.50.

3) Normal means the same amount as much as that due to the normal traffic; while 1/2 x Normal means the half amount of that due to the normal traffic.

4) As for the benefit and the cost by route section, refer to Table 4.3.5 and Table 4.3.6 respectively.

Table 4.3.3 Costs and Benefits of Project by Year (Alternative-I)
Tableau (Present Value discounted at 12%)
Coût et bénéfices de projet en année (Alternative-I)
(Valeur escomptée actuelle à 12%)

[Indicated in present value discounted at 12% to the 0 th year (1979) which is immediately before the commencement of construction.
[Indiqué à valeur escomptée actuelle à 12% à 0(Zéro) année (1979) quelle est en avant le commencement immédiat de la construction.]

(Unit / Unité: 1,000 Zaires)

T	Year	Net Increase in Added Value	User Benefit	Net Increase in Unskilled Laborers' Income	Savings in Maintenance Cost	Total Benefit	Maintenance Cost of Propósed Road	Maintenance Cost of Existing Road	Improvement Cost (with shadow rate)	Improvement Cost (without shadow rate)
T	Année	Augmentation nette dans la valeur ajoutée	Bénéfice d'Usagers	Augmentation d'usagers dans main-d'ouvre non spécialisée	Economie dans le coût d'entretien	Bénéfice totale	Coût d'entretien de route proposée	Coût d'entretien de route existante	Coût d'amélioration (avec taux économique)	Coût d'amélioration (sans taux économique)
1	1980			1,005		1,005			22,994	17,453
2	1981			897		897			17,901	13,835
3	1982			801		801			15,983	12,353
4	1983	99	599	238	-73	863	444	370	5,775	4,471
5	1984	377	1,073		-66	1,384	396	331		
6	1985	593	1,493		-59	2,028	354	295		
7	1986	759	1,840		-52	2,547	316	264		
8	1987	883	2,131		-47	2,968	282	235		
9	1988	971	2,366		-42	3,295	252	210		
10	1989	1,000	2,377		-37	3,340	225	188		
11	1990	1,012	2,367		-33	3,346	201	168		
12	1991	1,009	2,340	2	-30	3,321	179	150	572	439
13	1992	996	2,298	1	-27	3,269	161	134	418	321
14	1993	974	2,204		-25	3,153	144	119		
15	1994	944	2,116		-23	3,036	130	106		
16	1995	909	2,021		-22	2,909	117	95		
17	1996	871	1,922		-20	2,773	105	85		
18	1997	831	1,821		-18	2,633	94	76		
19	1998	789	1,720		-17	2,492	84	68		
20	1999	747	1,619		-16	2,350	76	60		
21	2000	705	1,520		-14	2,211	68	54		
22	2001	663	1,424		-13	2,074	61	48		
23	2002	622	1,331		-11	1,942	54	43		
24	2003	582	1,242		-10	1,814	49	38		
25	2004	520	1,109		-9	1,619	43	34		
26	2005	464	990		-8	1,446	39	31		
27	2006	414	884		-7	1,291	35	27		
28	2007	370	789		-6	1,153	31	24		
29	2008	330	705		-6	1,029	28	22		
30	2009	295	629		-5	919	25	19		
TOTAL		18,731	42,928	2,945	-697	63,908	3,991	3,294	63,645	48,872

Note: In the table, even in the case of improvement cost without shadow rate the tax component is excluded.
Même dans le cas du coût de l'amélioration de la route sans prix fictif, les taxes sont exclues.

As for the case of being not discounted, see Table 4.3.9 in Vol. 2.
Se réferer au cas de non-décompte voir le Tableau 4.3.9 dans le Vol 2.

In the cost of improvement of 1980 the costs of final engineering between 1976 and 1979 with interest are added.
Dans le coût de l'amélioration de 1988, les coûts de l'étude technique finale entre 1976 et 1979 avec intérêts sont ajoutés.

Table 4.3.4 Costs and Benefits of Project by Year (Alternative-II)
Tableau (Present Value discounted at 12%)

Coût et bénéfices de projet en année (Alternative-II)
(Valeur escomptée actuelle à 12%)

[Indicated in present value discounted at 12% to the 0 th year (1979) which is immediately before the commencement of construction.]

[Indiqué à valeur escomptée actuelle à 12% à 0(Zéro) année (1979) quelle est en avant le commencement immédiat de la construction.]

(Unit / Unité : 1,000 Zaires)

T / T	Year / Année	Net Increase in Added Value / Augmentation nette dans la valeur ajoutée	User Benefit / Bénéfice d'usagers	Net Increase in Unskilled Laborers' Income / Augmentation d'usagers dans main-d'ouvre non spécialisée	Savings in Maintenance Cost / Economie dans le coût d'entretien	Total Benefit / Bénéfice totale	Maintenance Cost of Proposed Road / Coût d'entretien de route proposée	Maintenance Cost of Existing Road / Coût d'entretien de route existante	Improvement Cost (with shadow rate) / Coût d'amélioration (avec taux économique)	Improvement Cost (without shadow rate) / Coût d'amélioration (sans taux économique)
1	1980			453		453			10,473	7,949
2	1981			434		434			8,154	6,302
3	1982			387		387			7,280	5,626
4	1983	99	520	138	101	859	269	370	2,631	2,037
5	1984	872	968		83	1,428	248	336	115	78
6	1985	593	1,363	25	65	2,047	230	295	909	702
7	1986	759	1,691	22	38	2,511	225	264	734	566
8	1987	883	1,966		25	2,874	210	235		
9	1988	971	2,188		16	3,175	194	210		
10	1989	1,000	2,196		9	3,205	179	188		
11	1990	1,012	2,186		4	3,201	164	168	89	61
12	1991	1,009	2,159	29	-10	3,189	159	150	857	660
13	1992	996	2,120	26	-12	3,130	146	134	561	433
14	1993	974	2,032	33	-2	3,038	121	119	1,136	872
15	1994	944	2,086	30	-2	3,059	108	106	1,014	779
16	1995	909	1,994		-2	2,901	97	95		
17	1996	871	1,897		-3	2,766	87	85		
18	1997	831	1,799		-7	2,623	83	76	21	16
19	1998	789	1,699		-7	2,482	75	68		
20	1999	747	1,601		-7	2,202	67	60		
21	2000	705	1,503		-7	2,201	60	54		
22	2001	663	1,409		-6	2,065	54	48		
23	2002	622	1,317		-6	1,933	49	43		
24	2003	582	1,229		-6	1,805	44	38		
25	2004	520	1,097		-5	1,612	39	34		
26	2005	464	980		-4	1,439	35	31		
27	2006	414	875		-4	1,285	31	27		
28	2007	370	731		-4	1,147	28	24		
29	2008	331	697		-3	1,024	25	22		
30	2009	295	623		-3	915	22	19		
TOTAL		18,731	40,977	1,579	243	61,529	3,052	3,294	33,974	26,082

Note: In the table, the tax component is excluded even in the improvement cost without shadow rate.
Dans le tableau, les taxes sont exclues meme dans le coût de l'amélioration de la route sans les prix fictifis.

As for the case of being not discounted, see Table 4.3.10 in Vol. 2.
Comme dans le cas de non-décompte, voir le tableau 4.3.10, Volume 2.

Table 4.3.5 Total Benefit by Alternative and by Section

Accumulated for 30 years of total benefits
and discounted at 12%

(Unit: 1,000 Zaires)

Case	Alter-native	Exchange rate for estimating improvement cost	Benefit due to net increase in added value	Benefit due to savings in time cost	Benefit due to developed traffic	B/C Ratio by Route Section										Entire route
						(1) Bangassou ∿ Monga	(2) Monga ∿ Bondo	(3) Bondo ∿ Likati	(4) Likati ∿ Dulia	(5) Dulia ∿ Buta	(6) Buta ∿ Tele	(7) Tele ∿ Kole	(8) Kole ∿ Banalia	(9) Banalia ∿ Bengamisa	(10) Bengamisa ∿ Kisangani	
# 1	I	OR x 1.5	Yes	Yes	Normal	291	449	788	873	1,269	6,364	2,151	6,165	28,745	16,813	63,908
# 2	I	OR	Yes	Yes	Normal	291	449	788	873	1,269	6,364	2,151	6,165	28,745	16,813	63,908
# 3	I	OR x 1.5	No	Yes	Normal	251	381	592	659	931	4,154	1,525	4,461	20,100	11,765	45,176
# 4	I	OR	No	Yes	Normal	251	381	592	659	931	4,154	1,525	4,461	20,100	11,765	45,176
# 5	I	OR x 1.5	No	No	1/2 x Normal	115	174	271	301	425	1,898	697	2,039	9,192	5,380	20,659
# 6	II	OR x 1.5	Yes	Yes	Normal	368	549	642	700	1,016	5,460	1,868	4,791	29,129	17,005	61,529
# 7	II	OR	Yes	Yes	Normal	368	549	642	700	1,016	5,460	1,868	4,791	29,129	17,005	61,529
# 8	II	OR x 1.5	No	Yes	Normal	335	497	496	541	761	3,786	1,297	3,268	20,090	11,727	42,798
# 9	II	OR	No	Yes	Normal	335	497	496	541	761	3,786	1,297	3,268	20,090	11,727	42,798
#10	II	OR x 1.5	No	No	1/2 x Normal	154	229	228	249	350	1,742	597	1,503	9,241	5,384	19,687

Notes: 1) Yes means considered, and No means ignored.

2) OR means the original exchange rate of US$ 1.00 = Z 0.50.

3) Normal means the same amount as much as that due to the normal traffic; while 1/2 x Normal means the half amount of that due to the normal traffic.

4) As for the total benefit, refer to Table 4.3.3 and Table 4.3.4.

Table 4.3.6 Total Project Costs by Alternative and by Section

Accumulated for 30 years of total project costs
discounted at 12%

(Unit: 1,000 Zaires)

Case	Alter-native	Exchange rate for estimating improvement cost	Benefit due to net increase in added value	Benefit due to savings in time cost	Benefit due to developed traffic	B/C Ratio by Route Section										Entire route
						(1) Bangassou ∿ Monga	(2) Monga ∿ Bondo	(3) Bondo ∿ Likati	(4) Likati ∿ Dulia	(5) Dulia ∿ Buta	(6) Buta ∿ Tele	(7) Tele ∿ Kole	(8) Kole ∿ Banalia	(9) Banalia ∿ Bengamisa	(10) Bengamisa ∿ Kisangani	
# 1	I	OR x 1.5	Yes	Yes	Normal	5,169	8,043	4,812	5,161	5,270	7,244	2,299	11,640	10,894	7,103	67,636
# 2	I	OR	Yes	Yes	Normal	4,069	6,238	3,797	4,041	4,136	5,665	1,799	9,046	8,463	5,520	52,863
# 3	I	OR x 1.5	No	Yes	Normal	5,169	8,043	4,812	5,161	5,270	7,244	2,299	11,640	10,894	7,103	67,636
# 4	I	OR	No	Yes	Normal	4,069	6,328	3,797	4,041	4,136	5,665	1,799	9,046	8,463	5,520	52,863
# 5	I	OR x 1.5	No	No	1/2 x Normal	5,169	8,043	4,812	5,161	5,270	7,244	2,299	11,640	10,894	7,103	67,636
# 6	II	OR x 1.5	Yes	Yes	Normal	2,856	3,299	1,687	2,094	2,349	3,622	1,214	4,193	9,622	6,089	37,026
# 7	II	OR	Yes	Yes	Normal	2,245	2,664	1,357	1,647	1,852	2,870	961	3,381	7,483	4,735	29,196
# 8	II	OR x 1.5	No	Yes	Normal	2,856	3,299	1,687	2,094	2,349	3,622	1,214	4,193	9,622	6,089	37,026
# 9	II	OR	No	Yes	Normal	2,245	2,664	1,357	1,647	1,852	2,870	961	3,381	7,483	4,735	29,196
#10	II	OR x 1.5	No	No	1/2 x Normal	2,856	3,299	1,687	2,094	2,349	3,622	1,214	4,193	9,622	6,089	37,026

Notes: 1) Yes means considered, and No means ignored.

2) OR means the original exchange rate of US$ 1.00 = Z 0.50.

3) Normal means the same amount as much as that due to the normal traffic, while 1/2 x Normal means the half amount of that due to the normal traffic.

4) Total project cost is the sum of the cost of improvement and the cost of maintenance of the road. (See Table 4.3.3)

Table 4.3.7 Savings in Operating Cost by Year and by Section
(Alternative I) Amounts are not discounted.

(Unit: 1,000 Zaires)

Year	T	Bangassou ~ Monga	Monga ~ Bondo	Bondo ~ Likati	Likati ~ Dulia	Dulia ~ Buta	Buta ~ Tele	Tele ~ Koke	Kole ~ Banalia	Banalia ~ Bengamisa	Bengamisa ~ Kisangami
1980	1										
81	2										
82	3										
83	4	7	12	17	18	24	158	54	146	320	187
84	5	8	14	25	27	41	239	81	221	780	455
85	6	10	16	35	39	62	329	111	303	1,290	753
86	7	11	18	47	51	85	421	142	388	1,834	1,071
87	8	12	20	60	66	112	519	176	478	2,422	1,414
88	9	13	22	75	81	141	620	210	572	3,047	1,779
89	10	16	27	85	92	155	707	239	652	3,415	1,994
1990	11	19	32	95	103	169	797	270	734	3,798	2,217
91	12	22	37	106	115	183	890	301	820	4,193	2,449
92	13	25	43	117	127	199	986	333	908	4,603	2,688
93	14	28	47	126	137	210	1,065	360	981	4,956	2,882
94	15	28	47	129	141	216	1,140	386	1,050	5,331	3,113
95	16	28	47	133	144	222	1,215	411	1,119	5,726	3,343
96	17	28	47	136	148	227	1,290	436	1,188	6,120	3,574
97	18	28	47	139	152	233	1,365	461	1,257	6,516	3,804
98	19	28	47	142	155	239	1,439	487	1,326	6,911	4,035
99	20	28	47	146	159	244	1,514	512	1,395	7,306	4,266
2000	21	28	47	149	162	250	1,589	537	1,464	7,701	4,496
01	22	28	47	152	166	256	1,664	563	1,533	8,096	4,727
02	23	28	47	156	170	261	1,739	588	1,602	8,491	4,958
03	24	28	47	159	173	267	1,814	613	1,671	8,886	5,188
04	25	28	47	159	173	267	1,814	613	1,671	8,886	5,188
05	26	28	47	159	173	267	1,814	613	1,671	8,886	5,188
06	27	28	47	159	173	267	1,814	613	1,671	8,886	5,188
07	28	28	47	159	173	267	1,814	613	1,671	8,886	5,188
08	29	28	47	159	173	267	1,814	613	1,671	8,886	5,188
09	30	28	47	159	173	267	1,814	613	1,671	8,886	5,188

Costs in the Table are on the basis of the cost level of April 1975.

Table 4.3.8 Savings in Operating Cost by Year and by Section
(Alternative II) Amounts are not discounted. (Unit: 1,000 Zaires)

Year	T	Bangassou ~ Monga	Monga ~ Bondo	Bondo ~ Likati	Likati ~ Dulia	Dulia ~ Buta	Buta ~ Tele	Tele ~ Koke	Kole ~ Banalia	Banalia ~ Bengamisa	Bengamisa ~ Kisangami
1980	1										
81	2										
82	3										
83	4	6	9	12	13	17	114	40	102	320	187
84	5	6	10	18	19	29	173	60	155	780	455
85	6	7	12	25	27	44	238	82	212	1,290	753
86	7	8	13	33	36	61	304	105	272	1,834	1,071
87	8	9	14	43	46	80	375	129	335	2,422	1,414
88	9	10	16	53	57	101	448	155	401	3,047	1,779
89	10	12	19	60	65	111	511	176	457	3,415	1,994
1990	11	14	23	67	73	121	576	199	514	3,798	2,217
91	12	17	27	75	81	132	643	222	574	4,193	2,449
92	13	19	31	83	90	143	712	245	636	4,603	2,688
93	14	21	34	89	97	151	769	265	687	4,936	2,882
94	15	21	34	92	99	155	1,140	386	1,050	5,331	3,113
95	16	21	34	94	102	159	1,215	411	1,119	5,726	3,343
96	17	21	34	96	105	163	1,290	436	1,188	6,120	3,574
97	18	21	34	99	107	167	1,365	461	1,257	6,561	3,804
98	19	21	34	101	110	171	1,439	487	1,326	6,911	4,035
99	20	21	34	103	112	175	1,514	512	1,395	7,306	4,266
2000	21	21	34	106	115	179	1,589	537	1,464	7,701	4,496
01	22	21	34	108	117	184	1,664	563	1,533	8,096	4,727
02	23	21	34	110	120	188	1,739	588	1,602	8,491	4,958
03	24	21	34	113	122	192	1,814	613	1,671	8,886	5,188
04	25	21	34	113	122	192	1,814	613	1,671	8,886	5,188
05	26	21	34	113	122	192	1,814	613	1,671	8,886	5,188
06	27	21	34	113	122	192	1,814	613	1,671	8,886	5,188
07	28	21	34	113	122	192	1,814	613	1,671	8,886	5,188
08	29	21	34	113	122	192	1,814	613	1,671	8,886	5,188
09	30	21	34	113	122	192	1,814	613	1,671	8,886	5,188

Costs in the Table are on the basis of the cost level of April 1975.

Table 4.3.9 Tableau

Costs and Benefits of Project by Year (Alternative-I)
(Amounts are not discounted)

Coût et bénéfices de projet en année (Alternative-I)
(Sommes n'ont pas escomptées)

(Unit : 1,000 Zaires)
(Unité : 1,000 Zaires)

T	Year	Net Increase in Added Value	User Benefit	Net Increase in Unskilled Laborers' Income	Savings in Maintenance Cost	Total Benefit	Maintenance Cost of Proposed Road	Maintenance Cost of Existing Road	Improvement Cost (with shadow rate)	Improvement Cost (without shadow rate)
T	Année	Augmentation nette dans la valeur ajoutée	Bénéfice d'usagers	Augmentation d'usagers dans main-d'ouvre non spécialisée	Economie dans le coût d'entretien	Bénéfice totale	Coût d'entretien de route proposée	Coût d'entretien de route existante	Coût d'amélioration (avec taux économique)	Coût d'amélioration (sans taux économique)
1	1980			1,126		1,126			28,040	21,085
2	1981			1,126		1,126			22,453	17,355
3	1982			1,126		1,126			22,453	17,355
4	1983	156	942	375	-116	1,358	698	583	9,087	7,036
5	1984	664	1,892		-116	2,440	698	583		
6	1985	1,171	2,947		-116	4,003	698	583		
7	1986	1,679	4,067		-116	5,630	698	583		
8	1987	2,186	5,277		-116	7,348	698	593		
9	1988	2,694	6,560		-116	9,138	698	583		
10	1989	3,107	7,382		-116	10,373	698	583		
11	1990	3,520	8,234		-116	11,638	698	583		
12	1991	3,933	9,116	6	-116	12,939	698	583	2,230	1,712
13	1992	4,346	10,029	6	-118	14,263	701	583	1,825	1,401
14	1993	4,759	10,773		-123	15,410	705	583		
15	1994	5,167	11,581		-127	16,620	710	583		
16	1995	5,574	12,388		-132	17,830	715	583		
17	1996	5,982	13,195		-137	19,040	719	583		
18	1997	6,890	14,003		-141	20,251	724	583		
19	1998	6,797	14,810		-146	21,461	728	583		
20	1999	7,205	15,617		-150	22,672	733	583		
21	2000	7,613	16,425		-155	23,883	738	583		
22	2001	8,021	17,232		-155	25,098	738	583		
23	2002	8,428	18,039		-155	26,313	738	583		
24	2003	8,836	18,846		-155	27,528	738	583		
25	2004	8,836	18,846		-155	27,758	738	583		
26	2005	8,836	18,846		-155	27,528	738	583		
27	2006	8,836	18,846		-155	27,528	738	583		
28	2007	8,836	18,466		-155	27,528	738	583		
29	2008	8,836	18,846		-155	27,528	738	593		
30	2009	8,836	18,846		-155	27,528	738	583		

Note: In the table the tax component is excluded even in the improvement cost without shadow price.
Dans le tableau, les taxes sont exclues même dans le coût de l'amélioration sans prix fictifs.

As for the case of being discounted, see Table 4.3.3 in this volume.
Comme pour le cas de non-décompte voir le Tableau 4.3.3 dans ce volume.

In the cost of improvement in 1980 the costs of final engineering between 1976 and 1979 with interest are added.
Dans le coût de l'amélioration en 1980 le coût final de l'étude entre 1976 et 1979 sans intérêt est ajouté.

Table 4.3.10 Costs and Benefits of Project by Year (Alternative-II)
Tableau (Amounts are not discounted)

Coût et bénéfices de projet en année (Alternative-II)
(Sommes nëont pas escomptées)

(Unit / Unité: 1,000 Zaires)

T	Year	Net Increase in Added Value	User Benefit	Net Increase in Unskilled Laborers' Income	Savings in Maintenance Cost	Total Benefit	Maintenance Cost of Proposed Road	Maintenance Cost of Existing Road	Improvement Cost (with shadow rate)	Improvement Cost (without shadow rate)
T	Année	Augmentation nette dans la valeur ajoutée	Bénéfice d'usagers	Augmentation d'usagers dans main-d'ouvre non spécialisée	Economie dans le cout d'entretien	Bénéfice totale	Coût d'entretien de route proposée	Coût d'entretien de route existante	Coût d'amélioration (avec taux économique)	Coût d'amélioration (sans taux économique)
1	1980			508		508			11,730	8,903
2	1981			544		544			10,228	7,905
3	1982			544		544			10,228	7,905
4	1983	156	819	218	159	1,351	424	583	4,140	3,205
5	1984	664	1,706		146	2,516	436	583	204	138
6	1985	1,172	2,691	50	128	4,040	454	583	1,795	1,385
7	1986	1,679	3,738	50	84	5,550	498	583	1,622	1,251
8	1987	2,186	4,868		63	7,117	520	583		
9	1988	2,694	6,067		44	8,805	538	583		
10	1989	3,107	6,321		27	9,955	555	583		
11	1990	3,520	7,603		12	11,135	570	582	311	211
12	1991	3,933	8,412	115	-37	12,422	620	583	3,340	2,573
13	1992	4,346	9,249	115	-53	13,657	636	583	2,448	1,889
14	1993	4,759	9,932	163	-8	14,845	591	583	5,550	4,264
15	1994	5,167	11,421	163	-9	16,741	592	583	5,550	4,264
16	1995	5,574	12,224		-12	17,786	595	583		
17	1996	5,982	13,028		-17	18,992	600	583		
18	1997	6,390	13,832		-54	20,168	636	583	162	125
19	1998	6,707	14,635		-60	21,373	642	583		
20	1999	7,205	15,439		-65	22,579	648	583		
21	2000	7,613	16,243		-70	23,786	653	583		
22	2001	8,021	17,046		-76	24,991	658	583		
23	2002	8,428	17,850		-81	26,198	663	583		
24	2003	8,836	18,654		-86	27,403	669	583		
25	2004	8,836	18,654		-86	27,403	669	583		
26	2005	8,836	18,654		-86	27,403	669	583		
27	2006	8,836	18,654		-86	27,403	669	583		
28	2007	8,836	18,654		-86	27,403	669	583		
29	2008	8,836	18,654		-86	27,403	669	583		
30	2009	8,836	18,654		-86	27,403	669	583		

Note: In the table the tax component is excluded even in the improvement cost without shadow price.
Dans le tableau, les taxes sont exclues meme dans le coût de l'amélioration sans prix fictifs.

As for the case of being discounted, see Table 4.3.4 in this volume.
Comme pour le cas de non-décompte voir le Tableau 4.3.3 dans ce volume.

In the cost of improvement in 1980 the costs of final engineering between 1976 and 1977 with interest are added.
Dans le coût de l'amélioration en 1980 le coût final de l'étude entre 1976 et 1979 sans intérêt est ajouté.

4.4 Additional Comparative Evaluations under New Exchange Rate

4.4.1 Conditions in Additional Evaluations

Additional comparative economic evaluations were carried out because the official exchange rate of Zaire currency was revised when this report was completed. The rate was changed from US$ 1.00 = Z 0.50 to US$1.00 = Z 0.874. The case when the shadow rate of 1.50 was applied to the original rate, that is US$ 1.00 = Z 0.75, was already evaluated. But the case of the new rate which corresponds to the case of applying the shadow rate of 0.874/0.50 = 1.748 to the original rate and also the case of applying the shadow rate to the new rate which corresponds to the case of applying the shadow rate of 1.748 x 1.5 = 2.622 to the original rate are considered necessary to be evaluated. The conditions of evaluation are as follow:

(a) The operating cost and the cost of improvement are estimated under the new rate;

(b) The shadow rate is applied to the cost of improvement or not;

(c) The net increase in added value of agricultural products is included in or excluded from the benefit;

(d) Savings in time cost are included in or excluded from the benefit;

(e) The benefit due to the developed traffic per trip is assumed to be a half of or same as that due to the normal traffic.

Table 4.4.1 shows the summary of evaluating conditions for cases before the revision as well as after the revision of the exchange rate, and additional evaluations are shown in cases # 11 to # 14 for Alternative I and cases from # 15 to # 18 for Alternative II respectively.

Table 4.4.1 Summary of Conditions in Comparative Economic Evaluations

Case	Alter-native	Benefit due to net increase in added value	Exchange rate for estimating improvement cost				Cost level		Benefit due to developed traffic		Benefit due to saved time cost
			Original rate		New rate						
			OR	OR x 1.5	OR x 1.75	OR x 2.6	Before	After	Normal	Normal x 1/2	
# 1	I	Yes		X			X		X		Yes
# 2	I	Yes	X				X		X		Yes
# 3	I	No		X			X		X		Yes
# 4	I	No	X				X		X		Yes
# 5	I	No		X			X			X	No
# 6	II	Yes		X			X		X		Yes
# 7	II	Yes	X				X		X		Yes
# 8	II	No		X			X		X		Yes
# 9	II	No	X				X		X		Yes
#10	II	No		X			X			X	No
#11	I	Yes				X		X		X	No
#12	I	Yes				X		X	X		Yes
#13	I	Yes			X			X	X		Yes
#14	I	No				X		X		X	No
#15	II	Yes				X		X		X	No
#16	II	Yes				X		X	X		Yes
#17	II	Yes			X			X	X		Yes
#18	II	No				X		X		X	No

Notes: 1) Yes means included, while No means excluded.

2) OR means the original rate, then OR x 1.75 = New rate and OR x 2.6 = New rate x 1.5.

3) Normal means the same amount as much as that of the normal traffic per trip; and Normal x 1/2 means a half amount of that of the normal traffic per trip.

4) Before means the before the revision of the exchange rate, and After means after the revision of the exchange rate.

4.4.2 Modification of Operating Costs due to Revision of Exchange Rate

The basic concept of the modification is as follows:

a) The basic cost level to be modified is that of November 1974 and the costs were estimated by cost item under the assumption that the exchange rate be revised in November 1974.

b) Those cost items which consist mainly of foreign currency, such as vehicles, spare parts, gasoline and oils etc., were modified by the following formula;

New price in Zaire = Original price in Zaire x 1.745

c) Those cost items which consist mainly of local currency, such as cost of personnel and overhead cost, etc., are difficult to be accurately modified at this stage and were assumed to remain at the original cost.

d) Unit time costs by type of vehicles were assumed to remain as the original costs.

The results of the modification of operating costs are shown in Table 4.4.2-1 and Table 4.4.2-2 as costs in makuta per vehicle/kilometer by type of vehicle, by type of road surface and by class of profile grade.

Table 4.4.2-1 Operating Costs by Type of Road Surface and by Class of Profile Grade (Light Vehicle)

Unit: ₭/km/vehicle

Type of Road Surface	Paved Road				Improved Laterite Road				Existing Earth Road							
									Dry Season				Wet Season			
Class of Profile Grade	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
Operaing Speed (km/h)	75	70	60	50	60	55	50	40	40	35	30	25	20	20	20	20
Operating Costs																
1. Running costs																
(1) Fuel consumption	3.64	3.69	4.11	5.25	3.68	3.89	4.69	6.07	3.92	4.32	5.57	6.56	5.18	5.64	6.81	8.42
(2) Engine oil		0.12				0.18				0.21				0.25		
(3) Tire wear		0.32				0.61				1.14				1.72		
(4) Maintenance		3.16				4.37				6.72				6.72		
(5) Depreciation & Int.		3.06				4.06				5.41				5.41		
Sub-total	10.30	10.35	10.77	11.91	12.90	13.11	13.91	15.29	17.40 (18.18)	17.80 (18.61)	19.05 (19.83)	20.04 (21.07)	19.28	19.74	20.91	22.52
2. Fixed costs																
(1) Depreciation & Int.		3.06				4.06				5.41				5.41		
(2) Insurance		0.69				0.86				1.13				1.14		
(3) Driver's wage		2.59				3.23				3.42				6.83		
(4) Overhead	1.66	1.67	1.71	1.83	2.11	2.13	2.21	2.34	2.74	2.78	2.90	3.00	3.27	3.31	3.43	3.59
Sub-total	8.00	8.01	8.05	8.17	10.26	10.28	10.36	10.48	12.70 (14.35)	12.74 (14.39)	12.86 (14.51)	12.96 (14.63)	16.65	16.69	16.81	16.97
Total (1 + 2)	18.30	18.36	18.82	20.08	23.16	23.39	24.27	25.77	30.10 (32.53)	30.54 (33.00)	31.91 (34.33)	33.00 (35.71)	35.93	36.43	37.72	39.49

Note: Figure in parentheses are the weighted averages, taking into consideration the ratio of number of days of dry season against wet season as 0.583:0.417.

I: under 3% of grade, II: grade between 3% & 5%, III: grade between 5% & 7%, IV: grade steeper than 7%

Table 4.4.2-2 Operating Costs by Type of Road Surface and by Class of Profile Grade (Heavy Vehicle)

Unit: K/km/vehicle

Type of Road Surface	Paved Road				Improved Laterite Road				Existing Earth Road							
									Dry Season				Wet Season			
Class of Profile Grade	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
Operating Speed (km/h)	75	70	60	50	60	55	50	40	40	35	30	25	20	20	20	20
Operating Costs																
1. Running costs																
(1) Fuel consumption	7.65	8.86	9.77	12.67	8.79	10.57	12.79	16.17	10.75	12.46	15.75	21.40	16.00	16.00	19.51	25.11
(2) Engine oil		0.18				0.25				0.37				0.40		
(3) Tire wear		1.00				2.07				4.50				6.76		
(4) Maintenance		3.81				5.73				9.54				9.54		
(5) Depreciation & Int.		2.52				3.34				4.46				4.46		
Sub-total	15.16	16.37	17.28	20.18	20.18	21.96	24.18	27.56	29.62 (32.76)	31.33 (33.76)	34.62 (37.14)	40.27 (42.77)	37.16	37.16	40.67	46.27
2. Fixed costs																
(1) Depreciation & Int.		2.52				3.34				4.46				4.46		
(2) Insurance		0.60				0.74				0.99				0.99		
(3) Driver's wage		1.49				1.86				1.97				3.93		
(4) Overhead	1.98	2.10	2.19	2.48	2.61	2.79	3.01	3.35	3.70	3.88	4.20	4.77	4.65	4.65	5.01	5.57
Sub-total	6.59	6.71	6.80	7.09	8.55	8.73	8.95	9.29	11.12 (12.33)	11.30 (12.44)	11.62 (12.78)	12.19 (13.34)	14.03	14.03	14.39	14.95
Total (1 + 2)	21.75	23.08	24.08	27.27	28.73	30.69	33.13	36.85	40.74 (45.10)	42.63 (46.20)	46.24 (49.92)	52.46 (56.11)	51.19	51.19	55.06	61.22

Notes: Figure in parentheses are the weighted averages, taking into consideration the ratio of number of days of dry season against wet season as 0.583:0.417.

I: under 3% of grade, II: grade between 3% & 5%, III: grade between 5% & 7%, IV: grade steeper than 7%

4.4.3 Modification of Improvement Costs due to Revision of Exchange Rate

The basic concept of the modification is as follows:

a) The basic cost level to be modified is that of April 1975 and the costs were modified by annual gross cost of improvement under the assumption that the exchange rate be revised in April 1975.

b) The foreign currency portions were modified by the following formula:

New cost in Zaire = Original cost in Zaire x 1.745

c) The tax portions were modified as in the same way in the foreign currency portion as follow:

New cost in Zaire = Original cost in Zaire x 1.745

In calculating the economic cost of the project the tax portions are excluded.

d) The local currency portions are difficult to be accurately modified at this stage when it was immediately after the revision of the rate and its effect on the local currency portion has not pervaded. Consequently, the effect of the rate revision on the local currency portions was ignored in this feasibility study.

4.4.4 Modification of Maintenance Costs of Road due to Revision of Exchange Rate

The foreign currency portion of maintenance cost of the road after the improvement is theoretically affected by the revision of the exchange rate, but this effect was ignored in this study because of the following reasons:

a) In the project cost the maintenance cost of the road is much smaller in amount when it is compared with the cost of the improvement.

b) This is the type of the cost which becomes necessary in the future and the exchange rate then is unknown at present.

c) This item becomes smaller in amount in the economic cost of the project and does not affect noticeablly on the project evaluation because it is reduce at the rate of 12%.

d) The maintenance cost of the road was calculated in the original calculation not by the original exchange rate of US$ 1.00 = Z 0.50 but by the shadow rate of 1.5 to the original rate which corresponds to the rate of US$ 1.00 = Z 0.75.

4.4.5 Results of Additional Sensitivity Analysis

As shwon in Table 4.4.3 it was found that the revision of the exchange rate does not much affect on the benefit/cost ratio of the project. This is because that the devaluation of Zaire currency will increase the import prices of equipment and their spare-parts, fuel and oils and some construction materials to be imported which will result in the increase in the improvement cost of the project, but on the benefit side of the project the increase of the import prices of vehicles and their spare-parts, and fuel and oils will increase the operating costs of vehicle which will result in the increase of savings in operating cost and such increase in benefits will cover the increase in the improvement cost of the road.

In the severest conditions of evaluation which corresponds to the case # 14 in Alternative I and the case # 18 in Alternative II and B/C ratio shows 0.34 for Alternative I and 0.59 for Alternative II

respectively, in which the internal rate of return becomes the negative value in Alternative I, while only the Kisangani-Banalia section is hardly feasible in Alternative II.

Table 4.4.3 Summary of Additional Economic Evaluations

After Revision of Exchange Rate

Case	Alternative	Benefit due to net increase in added value	Exchange rate for estimating improvement cost	Benefit due to saved time cost	Benefit due to developed traffic	Present value (Rate of discount 12%) (Unit: 1,000 Zaires) Benefit	Present value (Rate of discount 12%) (Unit: 1,000 Zaires) Cost	Internal rate of return (%)	Benefit /cost ratio	Benefit/cost ratio by route section (1) Bangassou ∿ Monga	(2) Monga ∿ Bondo	(3) Bondo ∿ Likati	(4) Likati ∿ Dulia	(5) Dulia ∿ Buta	(6) Buta ∿ Tele	(7) Tele ∿ Kole	(8) Kole ∿ Banalia	(9) Banalia ∿ Bengamisa	(10) Bengamisa ∿ Kisangani
#11	I	Yes	NR x 1.5	No	Normal x 1/2	54,150	104,218	0.05	0.52	0.05	0.05	0.11	0.11	0.14	0.48	0.54	0.29	1.44	1.27
#12	I	Yes	NR x 1.5	Yes	Normal	93,428	104,218	0.11	0.89	0.05	0.05	0.15	0.15	0.22	0.82	0.91	0.48	2.55	2.25
#13	I	Yes	NR	Yes	Normal	93,428	77,260	0.13	1.21	0.06	0.06	0.20	0.20	0.30	1.10	1.22	0.65	3.45	3.05
#14	I	No	NR x 1.5	No	Normal x 1/2	35,419	104,218	0.00 >	0.34	0.03	0.03	0.07	0.07	0.09	0.31	0.35	0.19	0.94	0.83
#15	II	Yes	NR x 1.5	No	Normal x 1/2	52,198	56,422	0.10	0.92	0.11	0.14	0.23	0.22	0.27	0.81	0.89	0.61	1.65	1.53
#16	II	Yes	NR x 1.5	Yes	Normal	89,714	56,422	0.17	1.59	0.09	0.12	0.34	0.29	0.83	1.43	1.53	1.13	2.88	2.67
#17	II	Yes	NR	Yes	Normal	89,714	42,188	0.20	2.13	0.13	0.16	0.45	0.39	0.51	1.90	2.04	1.48	3.90	3.62
#18	II	No	NR x 1.5	No	Normal x 1/2	33,467	56,422	0.07	0.59	0.07	0.09	0.17	0.14	0.17	0.52	0.57	0.39	1.06	0.98

Notes: 1) Yes means included, while No means excluded.

2) NR means the new exchange rate, and NR x 1.5 = OR x 2.6.
OR means the original exchange rate.

3) Normal means the same amount as much as that of the normal traffic per trip; and Normal x 1/2 means a half amount of that of the normal traffic per trip.