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UNITED NATIONS ECONOMIC COMMISSION FOR AFRICA
THE REPUBLIC OF ZAIRE

TRANSAFRICAN HIGHWAY
FEASIBILITY STUDY
KISANGANI-BANGASSOU
FINAL REPORT

Comments on Draft Final Report
and Affiliated Answers

NOVEMBER 1976

JAPAN INTERNATIONAL COOPERATION AGENCY

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October 1976

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Comments on Draft Final Report and Affiliated Answers

(a) On Economic Analysis (UN-ECA)

1. "Regarding Table 2.2.6 of Volume 2, the distribution of passenger cars by capacity should be included and the number of vehicles counted in the O-D survey should be checked again."

The Tables 2.2.3 and 2.2.6 of Vol. 2 were corrected.

2. "In the tables and figures throughout the report, the number of traffic zones should be clearly presented."

The index of the number and the name of traffic zones are presented in related tables and plates.

3. "The formula used in calculating the depreciation cost per unit travel distance, which was missing in the relevant paragraph, should be included. (Vol. 2, Page 2-32)"

The missing formula was added. (Refer to 2.3.1(3) of Vol. 2.)

4. "Formula and data used in the calculation process of vehicles operating cost should be clearly presented to enable the reader to check the calculation."

Refer to 2.3.1(3) and Tables 2.3.3 to 2.3.7 which were rewritten.

5. "Supplemental explanation should be added regarding the changes in production of self consumption of food products due to the improvement of the TAH. (See Table 2.4.26 of Volume 2.)

Supplemental explanation is added on 2.4.2(3).

6. "Tables 2.4.40 and 2.4.41 of Volume 2, showing passenger traffic by year and by section of the TAH should be deleted because the passenger traffic was not analysed as accurate as that for freight traffic. Furthermore, such detailed tables for the number of passengers on the TAH were not necessary for the study and therefore, they should be replaced by other simplified tables."

Tables 2.4.40 and 2.4.41 of Vol. 2 were replaced with the simplified ones.

7. "Benefits due to the increase of loading factor should be analysed separately from user's benefit accrued from savings in operating cost."

Refer to 4.2.1 of Vol. 2 which was completely rewritten.

8. "The basis on calculating the vehicle operating cost for the purpose of economic analysis should be clarified. (Table 4.2.1 to 4.2.3)"

They were revised.

9. "With regard to the savings in travel cost by type of vehicle and by section, savings on improved laterite road against existing road and those on paved road against improved laterite road should be presented separately."

The savings in travel cost are presented in Table 4.2.3 of Vol. 2 by improvement alternative and by phase.

10. "For the purpose of economic analysis, 10-20k for the opportunity cost of agricultural laborers was assumed considering that the inhabitants in the project area were in semi-unemployment situation but this seems extremely low."

The opportunity cost of agricultural laborers appearing in Table 4.2.4 of Vol. 2 should be contrasted with the minimum official wage of 25 makutas for the average agricultural laborer including women and children. The net increase of living cost due to obtaining the agricultural job was considered here as the opportunity cost. Strictly speaking, such opportunity cost would be still less than 10 to 20 makutas because their employment term is not continuous but short.

11. "The Bureau requested for more clarification about the benefit accruing from developed traffic for which full amount of saving of operating cost was adopted as was done for the normal traffic. After exchange of views, it was agreed that although the final decision was to be made by the mission, it was felt desirable to present clearly the theory on which it was based so that the final report will be accepted by financing agencies, etc."

The mission adopted half amount of the savings of operating cost of normal traffic as the benefit accruing from developed traffic, and the case of the full amount of such savings for developed traffic was also analyzed in the comparative evaluations. (Refer to 4.2.1. of Vol. 2.)

12. "With regard to the commodity flow from Bondo to Aketi and Bumba, described in section 2.2.1 of Vol. 2, the freight rates of the alternative modes of transport should also be given."

Such freight rates were additionally presented in 2.2.1(2) of Vol. 2

13. "It should be reconsidered whether it is appropriate to compare Japan and Zaire with regard to the time value used in the economic analysis of the project."

It was impossible to calculate the reliable time values because affiliated reliable data were not available in Zaire. Consequently the mission calculated them approximately by contrasting the situation in Zaire to that of Japan accompanied with some modification, and regarded them as one of varying conditions in comparative evaluation. (Refer to 2.3.1(4) and 4.4.1(3) of Vol. 2.)

14. "As the study was not fully based on the O-D Survey, it should be clearly stated how far the results of the survey were reflected in the analysis and the relevant sections should be rephrased accordingly."

The extent how far the results of the O-D Survey were reflected in the analysis was supplementarily explained in 2.4.1(3) of Vol. 2 and the main description of the O-D Survey was transferred from Vol. 2 to Vol. 3. (Refer to A.3.16 of Vol. 3.)

15. "It is requested to indicate in the final report the effect to the Highway Project the devaluation of Zaire currency which occurred after the preparation of the draft final report."

On the effect on the project evaluation of the revision of the official exchange rate of Zaire currency, refer to 4.4 of Vol. 2 which was supplementarily added to the Report.

(b) On Economic Analysis (Zaire Government)

1. Remarks of General Nature

"The economic analysis of the area affiliated with the project, and the forecasts of the development which would result from the improvement of the existing road, seem to have been carried out in purely technical manner in the form of a mathematical model. This procedure, which necessitates strict formulation of each economic phenomenon, is valuable because it generally gives coherent results. However, to be well understood, this procedure requires very precise explanations of each formulation, without which the study is of no value. Consequently, it is necessary that an effort be made in this respect and, in more general terms, it is necessary to show more clearly the methodology adopted in performance of the study. This methodology could constitute the subject of a very clear description in Volume 1 with, in particular, explanation of the way in which the surveys were made during the analysis of the data and the hypotheses adopted for evaluation of the future economic development of the zone of the project. Finally, for the sake of clarity it would be preferable to give in Volume 2 only the summarizing tables of major descriptive interest and to give the detailed tables in Volume 4."

The methodology of the economic analysis is presented in three modes in 4.1 of Vol. 2, namely the descriptions, flow charts and formulae, in order to enable readers understand clearly.

2. Agricultural Production

"The future production of foodstuffs is determined from the future consumption of the population in question. This procedure is quite correct and it is explained in pages 2-94 to 2-116 of Volume 2.

However, in these pages there is an abrupt transition from the population forecasts to the production forecasts, without any description of consumption. Consequently, it is necessary to include between the two types of forecasts a paragraph on consumption stating the consumption levels per product and per inhabitant. Moreover, it would be advantageous to insert in pages 2-117 to 2-129 of the volume, which concern future production of products other than foodstuffs, a description of the area of land cultivable for each product, the productivity levels and their future development. This procedure would result in clearer substantiation of the future production levels."

Refer to affiliated answer to No. 5 of comments by UN-ECA.

3. Industry

"The project for developing an iron mine near Banalia is mentioned but the effect of the project on the traffic volume is not considered. Although the project is still uncertain, it would be preferable to take into account in the calculations, with assumption of hypothetical annual production of 300,000 tonnes transported from Banalia to Kisangani by road."

The iron ore development plan near Banalia was mentioned in Vol. 2, 1.4.4 (2). It is still under study and its general outline of the plan, the economic feasibility, the development schedule and the quantity of production etc., are still unknown as described already. Accordingly, the prospective traffic to be generated by this iron ore development plan was not taken into consideration in estimating the future traffic on the project road in this feasibility study. When this development plan is realized, the economic study to determine whether the iron ore be transported by rail or by road should be carried out first.

4. Traffic

"The development of traffic volume is dealt with satisfactory. In effect, the so-called "normal" process could not be used in the report because of the unreliable and unrepresentative nature of the presently available data concerning the traffic. The process used, which is based on the forecasts of the flows of goods and passengers, is better suited to the local conditions. On the other hand, the international traffic has not been taken into consideration sufficiently. It is certain that there will be traffic between Kenya and the Central African Republic for which that of Zaire will constitute only a stage. Consequently, it is necessary to allow, by agreement with the other study offices, a certain significant value for this type of traffic."

The analysis of the international traffic is originally not included in Terms of Reference of this survey, but the Japanese Survey Team has been much concerned on this type of traffic from the beginning of this survey from the viewpoint of the nature of this international highway and revealed the findings on its part and the current international traffic in the Interim Report already. But it was found that estimating its future international traffic with the same accuracy as that of the domestic traffic will need an additional comprehensive survey over the whole Trans-African Highway system and the consensus by those countries concerned on the way of estimating benefits to be accrued by the international traffic and their shares. After discussing this problem with authorities concerned the international traffic was excluded in the traffic estimation and the its benefit calculation. (See Vol. 2, 4.2.3) The description of the past and the current international traffic which appeared already in the Interim Report was included in Vol. 3, A.3.7 as a reference.

(c) On Engineering Studies (UN-ECA)

1. "The minimum requirement of the laterite surface of the road between Buta and Ndu in Alternative II should be clearly presented."

In the improvement Alternative II the road north of Banalia, which is 576.35 km long, is to be built as a laterite road in Phase I, where the section between Banalia and Buta which is 187.82 km long is paved later in Phase II. In such section the improved road is opened for traffic after placing a laterite layer of 40 to 50 cm in thickness on the existing earth road and in the latter section only the sub-base course of laterite is placed in Phase I. Then it is recommended, from the viewpoint of maintenance of earth road, to use such soils possessing the following characteristics as the materials of wearing course of at least 25 to 30 cm in thickness, if available:

Soil Classification: A-2-6 (AASHO designation M 145-49
CASAGRANDE, designation SC)

Characteristics of granometric curves:

Granules smaller than

5 micron	15 - 25%
0.5 mm	18 - 37%
2.0 mm	40 - 70%
10.0 mm	67 - 100%
Liquid limit:	Less than 40
Plasticity index:	15 - 25

2. "The TAH Bureau was of the opinion that the improvement cost of the two Alternatives were comparatively high particularly for the section between Kisangani and Banalia whose rehabilitation work was now well underway. Therefore, the cost estimates should be reviewed based on the latest cost information provided by the Office des Routes during the Mission's meeting in Kinshasa between 20th May and 7th June

1976, Supplemental explanation would also be required to clarify and summarize the basis of cost estimates.

Refer to the answer for (4) Various Problem commented by the Zaire Government.

3. "The rehabilitation programme currently being executed by IBRD on the Kisangani-Buta section should be presented in more detail, including the total cost, typical cross section, and other improvement features of the programme."

The supplementary description was added to the original one in 3.2.4 of Vol. 2.

(d) On Engineering Studies (Zaire Government)

1. Coordination and Standardization

"It is desirable that the two study offices, the Japanese Mission and the company SODECOTRA-TRACTIONEL, which are in charge of the Trans-African Highway section in the Territory of the Republic of Zaire, collaborating in especially close manner in the preparation of the plans. These study offices must adopt, in their plans the standards recommended by UN-ECA for the Trans-African Highway."

The Japanese Survey Team was not able to coordinate with the Belgian Team in the preparation of the plans because the latter commenced the field survey much later than the Japanese Team. On the standardization, it was clarified in the Japanese Team's Interim Report that the design standards suggested by UN-ECA are not economically justified by the estimated traffic in the future on the Trans-African

Highway section between Kisangani and Bangassou. Accordingly, the design standards of national roads of the Republic of Zaire were adopted to the project road after consulting with UN-ECA and the Zaire Governemnt and also conducting the Team's own sutdy to check them by item whether they fit for the project road or not.

2. Dimensioning of the Roads

"A safety factor must be applied in the determination of the thickness of the base layer, with due consideration for the natural location and the climate. The CBR is rather optimistic in its assessment of the properties of the ground. Moreover, it is realistic to expect a high percentage of overloaded vehicles, some of which could be very damaging to a cement-stabilized base course of insufficient thickness, although the equivalent traffic would not be damaging to the roadway. It must be confirmed that there is a sufficient supply of lateritic materials, particularly in certain sections of the road. This factor must be taken into account in a comparative study of the costs for the purpose of determining the relative thickness of the sub-base course (composed of laterite) and of the cement-stabilized base course (using laterite)."

Confirmation of Soil Type

In the stage of feasibility study the confirmation of soil types was performed through the observation from the ground surface and also by the results of the auger boring which was carried out at every 15 km on the project road and the soil samples were tested at the National Laboratory in Kinshasa. Therefore, the soil type by spot should be confirmed more in details by conducting additional auger borings in the stage of the final engineering.

The CBR Values

The CBR values are based on the results of the field CBR tests conducted by the Japanese Team during the reconnaissance in the latter

part of the wet season in 1976; and the CBR values used in the design of the pavement structure are not considered optimistic due to the facts that the ground water level will get relatively lower from the road surface than the existing road because the road surface is raised about 50 cm from the existing surface by the improvement and that the side ditches get 60 cm deeper than those rehabilitated in the section Kisangani and Buta in 1974 - 1975.

Influence of Overloaded Vehicles

As for overloaded vehicles, the weight limiting of passing vehicles on existing bridges are being enforced even at present because of their insufficient strength. In the Alternative II those weak bridges are to be replaced with those of the design load of BS-153 in 10 years after the road is opened for traffic. Consequently, the weight limiting of vehicles should be kept on until all those weak bridges are replaced, and the 20 ton-type trailers for transporting logs and lumber should not be introduced until then. Such an legislative measure will also surely protect the pavement from being damaged by overloaded vehicles or forbidding heavy vehicles. In the section between Kisangani and Banalia the pavement is overlaid with asphalt concrete just in time when weak bridges are completely replaced with stronger ones.

Quantity of Laterite

The possible quantity of laterite to be available should be confirmed in details at every possible borrow pit by conducting additional borings in the stage of the final engineering, particularly in the section between Kisangani and Banalia where such material resources is scarce.

3. Drainage

"The estimated total cost of the drainage (8.2% of the final cost of phase I and 7.8% of the final cost of phase II) seems low for a road in this region. Improvement of the drainage can be effected without increase of costs by constructing anti-erosion weirs reinforced with wicker-work.

The problem of capillary rising of water must be investigated."

(a) In the Alternative II the drainage works, as shown in Table A.3.5.6 in the Volume 3, is completed in the Phase I at the cost of Z 5,316,531 excluding contingency. The drainage work occupies the following percentage in the gross cost of improvement including contingency but not the costs of final engineering and supervision and involving from Phase I to Phase IV (See Table A.3.5.9):

Drainage works	Z 6,114,010 (12.6%)
Gross cost of improvement	Z 48,499,723 (100%)

The costs of shaping and sodding of side slopes of ditches are included not in the item of drainage but in the item of side slope; and if those costs are added to the item of drainage the total amount of drainage cost will reach Z 6,817,631 including contingency and corresponds to 14.05% of the gross cost of improvement including contingency. The cost of replacing the subgrade in the Division II because of its ill-drainage is included in the item of earth work.

(b) On the number of culverts, in addition to the improvement of existing 167 locations additional culverts are provided in the improvement at 406 locations, whereby the total number of culverts amounts to 573 which corresponds to the rate of 0.8 culvert per average 1.0 km of the road maintaining the minimum rate of culvert per km of road in such flat or slightly rolling terrain.

(c) Open side ditches are lined with stone in portions where the profile exceeds 4.0 percent in grade, covering not over the whole steep stretch but only over the lower two third length of the steep portions

where the flowing water gets velocity.

Providing weirs of wooden piles with wicker-work and masonry water cushion in side ditches is a useful method to keep the flowing velocity lower by maintaining slope flatter than 4% which results in protecting them from erosion. But wood and wicker-work decay very quickly in such a tropical territory and if the profile is too steep, the masonry water cushion of the weir will be almost continuous and its construction cost will be almost as same as that of the ditch lined with stone. The type of ditch should be carefully selected site by site at the time of final engineering, but the type to be lined with stone was adopted temporarily for the purpose of cost estimate in this feasibility study.

4. Various Problems

"The cost per kilometer, which was estimated at 111,100.00 Z in April 1975, seems high. The price estimated at the present time is approximately 90,000 Z/km. The 50% in foreign exchange is low in relation to actual needs and a substantial difference must be observed between alternative I and II. The purchase of bitumen, fuel and lubricant must be regarded as a foreign-exchange cost. The problem of installation of a ferry boat on the Aruwimi River must be examined in greater detail on the basis of the data concerning this river."

Average Costs of Improvement per km of Road

The average cost of the improvement per km of the improved road including contingency but not the costs of the final engineering and supervision are shown by alternative as follows:

Division (Sections)	Cost (Z/km)		Average Earth Haul Distance	Average Aggregates Haul Distance
	Alternative I	Alternative II		
IV (#10 & #9)	171,149 (144,471)	160,921 (134,240)	7.4-12.5 km	23-40 km
III (#8, #7 & #6)	115,356	86,959	0.8-2.9	45-78
II (#5, #4 & #3)	76,616	33,722	0.8-2.2	5-45
I (#2 & #1)	68,477	31,808	1.0-1.3	6-39
Weighted Average	101,388	69,388		

- Note: (1) The costs surrounded by a thick frame are of the paved sections.
- (2) The costs of the Division IV include the cost of overlaying which is to be carried out in Phase II, and the costs in parentheses show those costs excluding the cost of overlaying.

Viewing the entire divisions the polarization in distribution of and the long haul distance of aggregate materials and also the raising the road surface by 50 cm from the existing road surface are considered to be the reasons of high costs of the road improvement per km. The scarcity in aggregate material distribution resulted in overwhelming adoption of steel corrugated pipes in culverts, steel girders in bridges and cement stabilized base course in pavement in selecting materials in the improvement.

In the Alternative I the entire length of the road is paved in Phase I in which the average costs of the improvement per km deviate largely such as from 68,477 to 171,149 Zaire. The main reasons why the Division IV needs noticeable higher cost when it is compared to other divisions are as follows:

- (a) The route section # 10 is designed at the design speed of 100 km/h while other sections are designed at 80 km/h.
- (b) In the Division IV there exist those silty sections whose accumulated length reaches to 64% of the total length of the division. In silty sections all excavated soils are estimated to be disposed and the lateritic soils are hauled in despite the long average haul distance which is 12.45 km in the Section # 10 while it is 7.4 km in the Section # 9.
- (c) The polarization in the distribution of aggregate materials necessitates the average haul distance of aggregates of 23 km in the Section # 10 while 40 km in the section #9.
- (4) In the Division IV the future estimated traffic is noticeably larger than in other divisions and it is necessary to provide the stronger types of pavement under the unfavorable subgrade soil conditions

In the Division III the main reasons of the large deviation between the costs of improvement of Alternatives I & II are regarded as follows:

- (a) The decrease in the clearing and grubbing width, quantity of earth work and the length of culverts due to the difference of the rate of side slope of earth work.
- (b) The decrease in earth work due to the decrease in shoulder width.
- (c) The crushed stone is assumed possible to be much utilized in construction after Phase II because the aggregate resources is anticipated to be more developed until then due to the local demand.

- (d) The sub-base course is constructed in Phase I and the base course and the surface course are constructed in the 10th and the 11th years after the opening of the road and the sub-base course of lateritic soil is anticipated to increase its design CBR value by being compacted by traffic during the period; consequently, the pavement type V can be used and delayed 10 years in paving instead of constructing the pavement types I to III in Phase I.
- (e) At Aruwimi River, a 2-laned highway bridge of 640 m long is constructed in Phase I in the Alternative I, while the number of ferry is increased instead of constructing a highway bridge in the Alternative II.

As mentioned above the Division IV is the highest in the average cost of improvement per km due to the handicapped conditions in the transportation of filling materials and aggregates. But the endeavour should be expected in the stage of final engineering in finding borrow pits and quarry sites which are more advantageous even in forests to economize the costs of improvement in the Division IV. Such economy can be easily understood from the costs of improvement of the Alternative I in divisions II and I where the improvement of the road into a 2-laned paved road costs less than Z 80,000 per km where such handicaps do not exist.

Therefore, units prices adopted in this project are not expensive but rather cheaper when compared to the revised unit prices used in the rehabilitation work of the section Kisangani-Buta. The prices used in this study are considered appropriate and well reflect the local conditions by section. (See the calculation of the average haul distances of filling materials in the volume 3 and the average haul distances of aggregates in 3.5.1 in the Volume 2.)

Proportion of Foreign Currency in Gross Improvement Cost

Fuel oils, according to the statistics of 1973^{1/} were mainly refined in Zaire importing the crude oil from abroad and 80% of refined fuel oils were exported again. In this study particularly in the cost estimates fuel oils to be consumed in the improvement work was estimated to be refined domestically as mentioned above. In such case the proportion of foreign currency portion in the gross improvement cost was estimated as 50% of the gross improvement cost of project. In this study.

Here, a comparison of such proportion of the foreign currency portion of the following two cases for the Alternative II are shown as reference:

Case (A) – Fuel Oils are produced domestically by refining the imported crude oil.

(Unit: Zaire)

Items	Total	Foreign Currency	Taxes	Local Currency
Net Improvement Cost	42,173,631	20,243,360	7,591,260	14,339,051
Contingency	6,326,052	3,036,505	1,138,689	2,150,858
Costs of Final Engineering & Supervision	4,649,167	3,296,135	537,881	815,151
Gross Improvement Cost	53,148,890 (100%)	26,576,000 (50%)	9,267,830 (18%)	17,305,060 (32%)

Source: 1/ Departement de l'Economie Nationale Conjoncture Economique
(No. 14), 1974 pp. 136-137

Case (B) — Refined fuel oils are imported

(Unit: Zaire)

Items	Total	Foreign Currency	Taxes	Local Currency
Net Improve- ment Cost	42,173,631	23,407,200	7,749,356	11,272,115
Contingency	6,326,052	3,479,329	1,138,689	1,708,034
Costs of Final Engineering & Supervision	4,649,167	3,317,815	507,182	824,170
Gross Improve- ment Cost	53,148,890 (100%)	30,204,344 (57%)	9,140,227 (17%)	13,804,319 (26%)

The Aruwimi River

In the wet season of 1975 it is said that an unprecedented flood took place along the area of the Aruwimi River but the measured flood data and the affiliated submerged area at Banalia were not available to the Japanese survey team.

In the stage of final engineering the flood data of 1975 should be confirmed in order to take them into account in selecting the height of the road surface of the portion of the road on both banks of the river, and additional ferry sites should be carefully studied by locating the existing reefs in the river which would endanger the ferry navigation in dry season.

