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# Coastal Shipping vs. Pipeline for Petroleum Product Transport in the Cameroon

by Peter D. Cook\*

## ABSTRACT

Petroleum product shipments from refinery to centers of consumption frequently involve a choice of transportation modes. This is particularly the case where a refinery is situated in a relatively isolated coastal area close to offshore oil deposits, as in the Cameroon. This paper analyses the choice between pipeline alternatives and coastal shipping in a benefit-cost framework, and concludes that the pipeline alternative is most feasible in the case of the Cameroon.

The extension of the analysis to other countries is also discussed with respect to five parameters that could vary from the Cameroon case: distance, topology, uncertainty, secondary benefits and port investments. The paper concludes that for distances under 150 km, the pipeline alternative enjoys a distinct advantage, and in most cases there is an advantage over even greater distances.

## I. INTRODUCTION

Due to the presence of offshore oil deposits, the Cameroon produces more than enough oil to supply her needs, as well as part of the needs of inland countries (Chad and the Central African Republic). This oil is refined into petroleum products in a refinery at Pointe Limboh, which is on the coast about 75 km west of Douala, the largest city in the Cameroon.

The 1985 production of this refinery was 2.1 million metric tons, of which 60% was white products (gasoline, kerosene and automotive diesel fuel) and 40% black products (industrial diesel fuel, fuel oil and bunker fuel). All these products, except 18% of the white products, are shipped by a small coastal vessel (10000 DWT) from Pointe Limboh to Douala port for storage and distribution to the rest of the country. The remainder are transferred to tank trucks at the refinery for distribution to the Western regions of the country.

At present Pointe Limboh is strictly a service port for the refinery, with a dock capable of serving ships up to 20,000 DWT and a single point mooring buoy with an underwater pipeline for transferring crude oil between refinery storage and large tankers in deep water. Douala port is a major port on the West African coast, with all the facilities of a large port.

Since the present vessel is reaching its capacity at 11 trips per month, the question was posed as part of a National Transport Study in the Cameroon (Berger, 1986) whether or not another means of transport would provide lower cost petroleum service to Douala.

## II. LOCATION OF ALTERNATIVE TRANSPORT ROUTES

From the SONARA refinery at Pointe Limboh, there are four alternative potential transport links to Douala. One is the present coastal shipping route. A paved road also connects Douala to Pointe Limboh and the Western regions of the country. A third alternative would be to extend the existing railroad from Douala to Pointe Limboh. A fourth alternative is to construct a pipeline linking Pointe Limboh directly to Douala. The road, railroad and pipeline distances are approximately equal, and comparable to the sea route length from the SONARA pier at Pointe Limboh to the Port of Douala on the banks of the Wouri River (75-80 km). The present railway extends half the distance from Douala to Pointe Limboh before turning north to serve the Western regions. A railroad extension to Pointe Limboh is being considered as part of a port expansion plan.

The proposed pipeline would start from the refinery and pass through a very hilly zone near Mount Cameroon for about 30 km, following the existing road alignment. Then it would cross a relatively flat plain on its way to Douala. The highest rise is to 228 m from a starting altitude of 40 m at Pointe Limboh.

Since the proposed pipeline would parallel the existing road, the pipeline alternative also includes provision for construction of a storage point with truck transfer facilities for the products now transferred to trucks at the SONARA refinery and delivered to the Western regions of the Cameroon. The use of the pipeline rather than trucks over this hilly terrain results in substantial savings in trucking costs, as described below. The storage point will supplement the present SONARA storage which is near the industry minimum of 10 days production in a period of growing demand.

## III. INTER-MODAL COMPARISON

Before proceeding to a pre-feasibility analysis, a series of more general intermodal cost comparisons were made in order to identify the most interesting options. The options considered were:

- 1) increasing coastal shipping capacity by acquiring a second 10,000 DWT vessel,
- 2) replacing the present vessel by a 20,000 DWT ship,
- 3) building a single 10" pipeline from Pointe Limboh to Douala,
- 4) building a double 10" pipeline,
- 5) using the proposed rail line from Douala to the new port at Pointe Limboh, and
- 6) using truck transport on the existing road.

The costs of each option considered in the analysis included the costs of transport equipment, any special facilities required, and the cost of wear and tear on the infrastructure due to petroleum product transport.

The first and simplest comparison was made between road and rail on the basis of cost per ton-km for liquified bulk transport in the 50-100 km range. Since road transport was approximately 3 times as expensive as rail transport, the road alternative was quickly discarded.

Further cost comparisons were more complicated, as shown in graphic form in Figure 1. This figure shows the total marginal transport cost per metric ton of petroleum products as a function of annual tonnage shipped between Pointe Limboh and Douala for all the above options except for road. This cost is calculated by adding operating costs, annual fixed costs, and a capital recovery cost for allocated investment costs at a twelve percent discount rate, then dividing the sum by the annual flow or shipment level.

In the case of coastal shipping, all vessel-related costs, plus the port service costs at Pointe Limboh have been included, but no port infrastructure costs for Douala are included, since this infrastructure would be used for other purposes in any case. Use of the present vessel also has an opportunity cost, since it could be sold on the international market if another alternative were chosen. For the railroad, a portion of the infrastructure costs was counted, cor-

responding to the petroleum share of total traffic. For the pipeline, all infrastructure costs are included, since it is dedicated to petroleum transportation.

As can be seen from Figure 1, the pipeline solutions produce the lowest costs per metric ton of any mode. It can also be seen that two 10" pipelines would be required to handle the forecast volumes (up to 4.2 million m per year by the year 2000) of SONARA production to satisfy demand for 20 years into the future.

Based on this inter-modal cost comparison, it is clear that the most pertinent pre-feasibility analysis would compare the best option: the 2 x 10" pipeline, with the second best option: the 20,000 DWT coastal ship. An additional sensitivity analysis using two 10,000 DWT vessels is also provided.

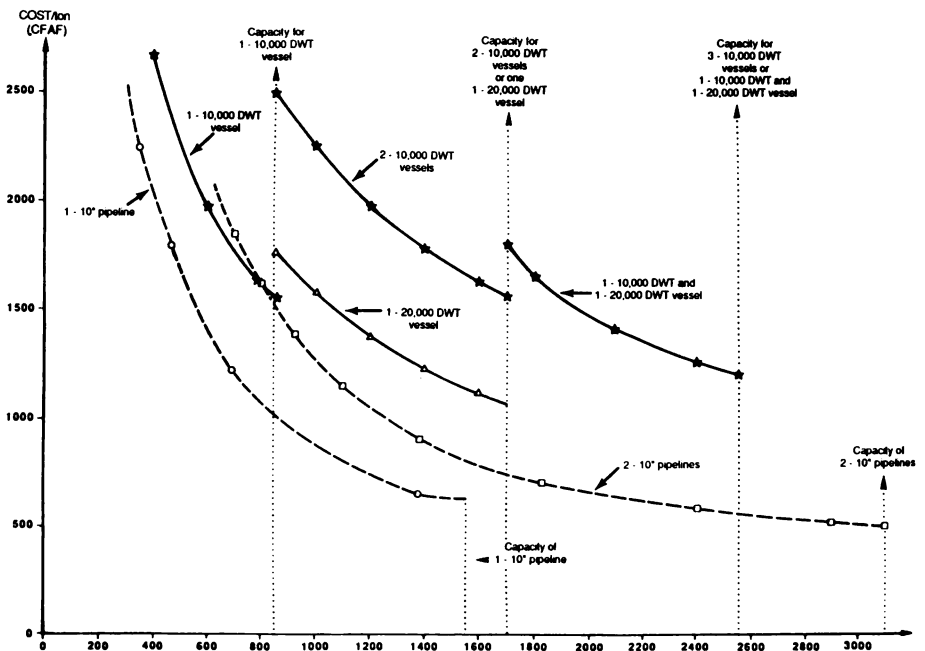
**IV. PIPELINE COSTS**

As noted above, two types of pipeline are analyzed for the proposed alignment between the SONARA refinery and Douala:

- a single 10" pipeline, and
- a double 10" pipeline.

A single 10-inch pipe can carry up to 2,100,000 m per year before the maximum practical speed of 2 m/sec is obtained with 24 hours of pumping. Given the variety of SONARA products and the expected growth of demand, a two-pipe system was also ex-

**FIGURE 1**  
**Comparison of Transport Costs of Petroleum Products from Pointe Limboh to Douala**



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aminated. For each of these pipeline types the construction, operation and maintenance costs are estimated below.

**Construction Costs.** Pipeline construction costs include the costs of supplying, preparing and burying the pipe; construction and equipping of the pump station; and construction of storage tanks and related facilities. River crossings are assumed to be made by suspended pipe, using cable suspension or attached to existing bridges. (There are one large and nine small river crossings along the alignment.)

The size of the pumping facilities required for a pipeline depends on the length of the line, the maximum height reached, the viscosity of the liquids pumped, and the diameter of the pipe. The unit cost estimate provided below is based on two pumps of 200 HP each for the single pipe system, and for four pumps in the two pipe system. Storage cost is calculated on the basis of storage tanks for 48,000 m<sup>3</sup>. The cost includes road access and loading areas, tank discharge systems, a small pump house, offices, fire and spill protection, and communications.

The unit equipment and construction costs for the two pipeline systems are given in Table 1. To calculate total project costs, a 6.5% engineering and construction supervision cost must be added, as well as a 15% contingency allowance.

**Pipeline Operation and Maintenance Costs.** In order to operate and maintain a pipeline and pumping station, it is necessary to have a certain number of personnel, including both administrative and technical staff. There is no significant difference in staff size requirements for pipelines of different sizes. A table of indicative staffing levels is provided below (Table 2). The actual staffing levels for a

particular project will depend on the personnel policies of the organization in charge and on the number of sites involved. (The personnel for security and fire fighting are assumed to be shared with nearby facilities, such as the SONARA refinery, but they may have to be provided in addition.)

Another major element is the maintenance and repair of equipment. This includes primarily the purchase of spare parts, and costs for repairs that cannot be handled by the on-site staff. These costs are estimated at 1.5% of the initial cost of pipes, fittings and pumphouse equipment per year (i.e. 45% of the initial cost over a 30 year life).

The third major cost component is the energy cost of pumping. This cost is related to the annual volume pumped, the size of the pipe, and the viscosity of the liquid being pumped. Table 3 provides an estimate of these costs for three pipe systems and four volume levels. In these ranges, the relationship between the power required, the flow rate, and the pipe diameter can be approximated by:

$$P1/P0 = (Q1/Q0)^{1.75}(D0/D1)^5$$

The total operation and maintenance costs are the sum of the three components described above.

**Mixing Costs.** In order to send several petroleum products with very different characteristics through the same pipeline (especially both light products and heavy products), some additional costs are incurred. These costs include equipment to minimize contamination, additional tankage, valves and meters, and costs due to slowdown in operations. All these extra costs are called mixing costs. The estimated additional investment and operating costs for a single

**TABLE 1**  
**Unit Construction Costs for Pipelines**  
**(1985 US\$)**

	Unit	10" pipeline	2 × 10" pipeline
1. Pipe Cost	1.m.	36.50	73.00
2. Preparation and delivery (35km)	1.m.	4.60	9.20
3. Installation	1.m.	40.00	65.00
4. Small River Crossings (30-100m)	#	225,000	450,000
5. Large River Crossings (150-300m)	#	500,000	800,000
6. Fittings 5% of pipeline costs			
7. Pump station			
2 pumps	1.s.	1,100,000	
4 pumps	1.s.	2,200,000	2,200,000
8. Storage area (48,000 m <sup>2</sup> )	1.s.	4,750,000	5,000,000

Notes: 1.m. = linear meter, 1.s. = lump sum, # = number

Source: Berger 1986, based on supplier quotations and engineering estimates.

**TABLE 2**  
**Indicative Staffing Requirements**  
**for a Pipeline Operation in the Cameroon**

	# Personnel	Annual Salary (1985 US\$)
<b>1. Pipeline and pump station</b>		
a) Pipeline Operations Supervisor	1	16,250
b) Assistant	4	4,500
c) Electrician	1	6,500
d) Mechanic	1	3,250
e) Maintenance men	10	3,250
<b>2. Storage area</b>		
a) Storage Area Supervisor	1	16,250
b) Assistant	1	4,500
c) Electrician	1	6,500
d) Mechanic	1	3,250
e) Maintenance men	4	3,250

Note: Watchmen may also be required in many locations.

Source: Berger 1986.

**TABLE 3**  
**Energy Costs of Pumping**  
**(76km pipeline—230m rise)**

Volume (BPD)	10" pipeline	2 × 10" pipeline
10,000	13,000	—
15,000	26,500	15,750
20,000	43,750	26,000
30,000	88,750	53,000

Note: Costs in 1985 US\$.

Source: Berger 1986.

**TABLE 4**  
**Extra Costs for Pumping a Mix of**  
**Petroleum Products**  
**(in 1985 US\$)**

<b>1. Additional Investment Costs*</b>	
a) Pig launchers and receivers	75,000
b) Extra Tankage and Piping	200,000
c) Extra Meters	60,000
<b>Total</b>	<b>\$335,000</b>
<b>2. Additional Operating Costs per Year</b>	
a) Pig costs	6,500
b) Other operating costs	3% of total oper. costs

\*not including design, construction supervision and contingencies.

Source: Berger 1986, based on suppliers' quotations.

pipeline carrying both light and heavy petroleum products are given in Table 4. These mixing costs must be added to the costs incurred by regular pipeline operations with one product or with products where contamination is not a problem. Mixing costs add approximately 3% to the capital cost of a single pipeline and 4-6% to operating costs.

*Total Pipeline Costs.* To evaluate the cost of building the different pipeline alternatives, the unit costs from Tables 1 and 2 were combined with quantities calculated from the plan and profile for the pipeline. The resulting costs are summarized in Table 5. The pipeline is assumed to have a lifetime of 30 years with a 5% salvage value at the end of this time. Pumping equipment is assumed to have a 15 year lifetime.

The operating costs were calculated from the assumptions given in Tables 2, 3, and 4. Personnel and maintenance costs are assumed to be constant in real terms over the life of the pipeline. Energy costs, on the other hand, increase exponentially with the amount of flow through the pipeline, as shown in Table 3. (Table 3 assumes constant unit costs of energy, but the results of the analysis are not sensitive to large variations in these unit costs.)

## V. COASTAL SHIPPING COST SAVINGS AND OTHER BENEFITS

The coastal shipping costs of the present petroleum operations are summarized in Table 6, along with the estimated costs of a 20,000 DWT vessel. As noted previously, these include ship investments, crew costs, maintenance and repair costs, insurance, and certain port fees at Pointe Limboh. Since this analysis is a marginal cost analysis, it does not include infrastructure costs which would be incurred with or without this coastal shipping service, such as Douala port costs.

**TABLE 5**  
**Pipeline Construction Cost Estimates**  
 (million 1985 US\$ without taxes)

	10" pipeline	2 × 10" pipeline
1. Pipe purchase	2.77	5.54
2. Prep. and delivery	0.35	0.70
3. Installation	3.06	4.94
4. Small river crossings	2.03	4.05
5. Wouri River crossing	0.50	0.80
6. Fittings	0.44	0.80
7. Pump station	<u>1.10</u>	<u>2.20</u>
Subtotal	10.25	19.03
8. Engineering Design and Supervision (6.5%)	0.66	1.24
9. Contingencies (15%)	<u>1.64</u>	<u>3.04</u>
Total Costs	\$12.55	\$23.31

Source: Table 1 and Figures 1 and 2.

In addition to the coastal shipping costs that would be saved by constructing a pipeline, some trucking costs would not be incurred for the Western regions of the country which now truck fuel from the SONARA refinery. The trucks would save about 30 km of trucking distance in very hilly terrain. These savings amount to almost 40% of the total savings. Table 7 summarizes the benefits and costs over a 32-year period (including a 2-year construction period and a 30-year life).

## VI. ECONOMIC EVALUATION

The economic evaluation of the Pointe Limboh-Douala pipeline project given in Table 7 shows that the pipeline has a net present value of US \$18.14 million in 1985 dollars in comparison with coastal shipping by a 20,000 DWT vessel. The first year benefits would exceed 12% of investment costs if the pipeline were opened in 1985. Therefore, 1985 is the optimum opening year (although 1989 is proba-

**TABLE 6**  
**Coastal Shipping Costs**  
 (1985 US\$ without taxes)

	Vessel Type	
	10,000 DWT	20,000 DWT
1. Vessel Purchase (16 year life, 5% salvage value)	6,650,000	10,000,000
2. Fixed Costs per year		
a) Salaries (22 crew)	300,000	300,000
b) Maintenance	375,000	425,000
c) Insurance	40,000	50,000
d) Limboh port oper. costs	<u>450,000</u>	<u>450,000</u>
Total fixed costs	\$1,165,000	\$1,225,000
3. Variable Costs per trip		
a) Fuel cost at sea	3,023	3,780
b) Fuel cost in port	1,512	3,100
c) Douala port charges	<u>6,250</u>	<u>8,333</u>
Total variable costs	\$10,785	\$15,213
4. Tonnage Carried per trip	8,000	16,400
5. Variable Cost per metric ton	\$1.35	\$0.93

Source: Berger 1986, based on data from Petrosoulac Shipping Company.

bly the first year in which the pipeline can begin operations). The internal rate of return for a 1989 opening is 24%, a very high return.

An evaluation was also made of the economic return of the project compared to the situation of using two coastal vessels of 10,000 DWT each. As expected, this gives an even higher value for the pipeline alternative, with a net present value of US \$30 million in 1985 dollars, and an internal rate of return of 29%.

## VII. STAGING OF THE PROJECT

From observation of Figure 1, it is apparent that the cost of operating a single pipeline of 10" is less

than that for a double pipeline, up to the capacity of the single pipe (2,100,000 m/year). In this case it may be desirable to build the project in two stages, starting with one 10" pipe and adding a second pipe to complete the project when the single pipe capacity is reached.

To evaluate the staging of the project, the costs of a two-phased construction were compared with the costs of the original two-pipe project built in one stage. Based on a forecast 8% growth rate in fuel consumption, it can be expected that it will take six years after 1989 for the capacity of the first pipe to be reached. Therefore construction of the second pipe should start in 1992.

The additional construction costs of building in two stages were estimated at \$1,250,000, based on

TABLE 7

Pipeline vs. Coastal Shipping Economic Analysis (mil. US\$ w/o taxes)

Year	Flow (000 m3)	Pipeline Costs		Savings		Net Value	Net Present Value
		const.	oper. & maint.	Ship	Road		
1987		11.25				-11.25	-10.05
1988		12.06		10.00		-2.06	-1.65
1989	1292		0.25	2.07	1.02	2.84	2.02
1990	1395		0.26	2.13	1.10	2.98	1.90
1991	1507		0.27	2.21	1.19	3.13	1.78
1992	1627		0.28	2.28	1.29	3.29	1.68
1993	1757		0.29	2.37	1.39	3.47	1.58
1994	1898		0.30	2.46	1.50	3.66	1.49
1995	2050		0.31	2.56	1.67	3.92	1.43
1996	2214		0.32	2.67	1.86	4.21	1.37
1997	2391		0.33	2.78	2.07	4.53	1.31
1998	2789		0.34	3.04	2.31	5.01	1.30
1999	3010		0.35	3.18	2.57	5.40	1.25
2000	3251		0.36	3.34	2.71	5.68	1.18
2001	3511		0.38	3.51	2.85	5.98	1.11
2002	3792		0.38	3.69	3.00	6.32	1.05
2003	4095		0.38	13.89	3.15	16.67	2.47
2004	4200		0.38	3.96	3.32	6.90	0.91
2005	4200		0.38	3.96	3.32	6.90	0.82
2006	4200		0.38	3.96	3.32	6.90	0.73
2007	4200		0.38	3.96	3.32	6.90	0.65
2008	4200		0.38	3.96	3.32	6.90	0.58
2009	4200		0.38	3.96	3.32	6.90	0.52
2010	4200		0.38	3.96	3.32	6.90	0.46
2011	4200		0.38	3.96	3.32	6.90	0.42
2012	4200		0.38	3.96	3.32	6.90	0.37
2013	4200		0.38	3.96	3.32	6.90	0.33
2014	4200		0.38	3.96	3.32	6.90	0.30
2015	4200		0.38	3.96	3.32	6.90	0.26
2016	4200		0.38	3.96	3.32	6.90	0.24
2017	4200		0.38	3.96	3.32	6.90	0.21
2018	4200		0.38	3.96	3.32	6.90	0.19
2019		-1.13		-1.75		-0.63	-0.02
<b>Total</b>		<b>22.19</b>	<b>10.39</b>	<b>119.82</b>	<b>79.47</b>	<b>166.72</b>	<b>18.19</b>

IRR = 24%

Note: 1 m3 = 0.7 ton, discount rate = 12%

Source: Tables 1 to 6, and Berger 1986a.

an examination of each major cost item. Additional costs are incurred due to the mixing of light and heavy petroleum products during the period when only one pipeline is operated (see Table 3).

A comparative evaluation of construction in one stage and in two stages is shown in Table 8. The results show that the net present value for one-stage construction is \$2.5 million less than for two-stage construction, since the savings in initial investment costs are greater than the discounted value of the second stage costs plus the increased operating costs incurred between 1990 and 1995.

However, the cost advantage of a two-stage solution should be evaluated in more detail in order to come to a definitive conclusion. For example, there may be additional costs incurred if construction of the second stage would in any way interfere with operation of the first pipeline. Also, if the time

before the first stage capacity is reached is less than five years, the benefits of the staged solution would be much lower. However, on the basis of these calculations the staged solution appears to be preferable.

#### VIII. IMPLICATIONS FOR SIMILAR PROJECTS IN OTHER COUNTRIES

There are several general conclusions that can be drawn from the above analysis. However, it should be noted that specific characteristics of other locations may have a major effect on the costs and benefits which would determine the choice between pipeline and coastal shipping.

First, it is clear that pipeline costs are lower than coastal shipping costs over distances of less than 100

**TABLE 8**  
Pipeline Phasing Economic Analysis (mil. US\$ w/o taxes)

Year	Flow (000 m3)	1 Stage Pipeline const.	oper. & maint.	2 Stage Pipeline const.	oper. & maint.	1 Stage Net Value	Net Present Value
1987		11.25		7.50		-3.75	-3.35
1988		12.06		7.80		-4.26	-3.40
1989	1292		0.25		0.24	-0.01	-0.01
1990	1395		0.26		0.26	0.00	0.00
1991	1507		0.27		0.28	0.01	0.01
1992	1627		0.28	4.60	0.30	4.62	2.35
1993	1757		0.29	4.66	0.31	4.69	2.13
1994	1898		0.30		0.30	0.00	0.00
1995	2050		0.31		0.31	0.00	0.00
1996	2214		0.32		0.32	0.00	0.00
1997	2391		0.33		0.33	0.00	0.00
1998	2789		0.34		0.34	0.00	0.00
1999	3010		0.35		0.35	0.00	0.00
2000	3251		0.36		0.36	0.00	0.00
2001	3511		0.38		0.38	0.00	0.00
2002	3792		0.38		0.38	0.00	0.00
2003	4095		0.38		0.38	0.00	0.00
2004	4200		0.38		0.38	0.00	0.00
2005	4200		0.38		0.38	0.00	0.00
2006	4200		0.38		0.38	0.00	0.00
2007	4200		0.38		0.38	0.00	0.00
2008	4200		0.38		0.38	0.00	0.00
2009	4200		0.38		0.38	0.00	0.00
2010	4200		0.38		0.38	0.00	0.00
2011	4200		0.38		0.38	0.00	0.00
2012	4200		0.38		0.38	0.00	0.00
2013	4200		0.38		0.38	0.00	0.00
2014	4200		0.38		0.38	0.00	0.00
2015	4200		0.38		0.38	0.00	0.00
2016	4200		0.38		0.38	0.00	0.00
2017	4200		0.38		0.38	0.00	0.00
2018	4200		0.38		0.38	0.00	0.00
2019		-1.13		-2.46		-1.34	-0.03
Total		22.19	10.39	22.10	10.44	-0.04	-2.30

Note: 1 m3 = 0.7 ton, discount rate = 12%

Source: Tables 1 to 6, and Berger 1986a.

km., even if all pipeline construction costs and no port infrastructure costs are included in the analysis. In most cases, however, use of coastal shipping will require some additional port investments. The main drawback to the pipeline alternative is that the initial investment is approximately twice as high for a 75 km. pipeline as the purchase of a vessel with similar capacity (as in the case of a double 10" pipeline compared to a 20,000 DWT vessel).

In a different situation, there are five main parameters that would affect the choice of mode:

1. Distance of shipping
2. Topology of the land route
3. Uncertainty of demand level
4. Amount of secondary benefits
5. Port investments required.

The distance of shipping affects pipeline costs per ton more than coastal vessel operation costs per ton. Almost three quarters of pipeline costs (which are dominated by construction costs) vary directly with distance of shipment. Vessel operating costs vary with distance only in terms of the time spent at sea and costs associated with the number of round trips that can be made over a given time period. The combined effect is the equivalent of a 25-30% cost variation with distance. This means that at some distance (in this case about 200 km), the costs are equal, and beyond that distance the cost comparison changes and coastal shipping becomes the least cost alternative.

The topology of the land route affects the comparison in several ways. First, if the length is substantially different for the pipeline alignment compared with coastal shipping, this will affect relative costs. Second, if the terrain through which the pipeline must pass is mountainous, or crosses many rivers, this raises the relative cost of the pipeline.

The actual amount of products shipped has virtually no effect on this comparison since both vessel and pipeline size can be adjusted. However, the uncertainty of demand creates a risk of oversizing,

which is more serious in the case of a pipeline than for a vessel which can be traded in for a vessel of smaller size with little effort or cost. A higher degree of uncertainty favors coastal shipping, the option with lower investment costs and greater flexibility. A pipeline can always be built later when future levels of demand are known with greater certainty.

The amount of secondary benefits can be very important in a benefit-cost analysis. In the Cameroon case, the trucking cost savings amounted to 39% of the total cost savings, and favored the pipeline alternative. If there were similar benefits for coastal shipping (such as backhaul traffic as deck cargo), this could affect the decision as some shipping costs could be covered by backhaul revenues.

Finally, port costs and related secondary benefits can be very important. In the Cameroon case, the port installations were already in place, and would be used anyway (with the exception of some short pipelines), so no port costs were considered. If port facilities need to be built, this cost would favor the pipeline alternative. If there are other benefits to having the port facilities, these should be added in favor of coastal shipping.

The final decision in a given location hinges on all of the above considerations. However, it is evident that the pipeline alternative enjoys a clear cost advantage over coastal shipping for distances under 150 km, and for much greater distances if port construction is involved.

## REFERENCES

1986 Louis Berger International Inc., Cameroon National Transport Plan Study, Phase II.

## ENDNOTE

\*Arlington, Virginia