An Economic Analysis of the Provision of Rural Access Roads in Papua New Guinea

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Abstract:

In Papua New Guinea all road improvements, upgrading and new construction are subjected to economic analysis to quantify benefits and costs, before commitment of funds This is the Government's road investment policy and a requirement of donor agencies such as the World Bank The paper presents one such analysis for a 37 kilometre new road The project construction had begun without the formal cost-benefits analysis. Cost was escalating far in excess of what had been estimated. The project was suspended to allow for detailed costing and estimate of benefits The paper illustrates how the various costs and benefits components were estimated for the project life cycle Three cases were considered, Base Case (present situation), Test Case 1, where it was assumed the project had not started and Test Case 2 sensitivity test with variation in cost and benefit parameters

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INTRODUCTION

A properly extended and reliable road network is a prerequisite for development. A network connecting isolated areas to markets and sources of supply does help to provide a platform to transform subsistence agriculture to commercial activity. Also, a well planned and reliable road network helps to reduce transport cost by assisting in the efficient movement of production inputs and finished goods to markets. With this in mind, the Government of Papua New Guinea has assigned a high priority to transport infrastructure development particularly roads, and in recent years, has been allocating about 18% of its annual Public Investment Program to the transport infrastructure sector; most of this allocation (72%) goes to the road subsector

The road network totals about 23,000km, of which only about 9% is paved. About 21% of the network is the responsibility of the National Government. A substantial part of the provincial network is not trafficable for most of the year particularly during rainy seasons. Registered vehicles in the country total about 52,000 with utility (*pickup*) vehicles dominating. The vehicle fleet is mainly Japanese made.

The road network in PNG is still rudimentary. There is very little inter-regional connectivity and several major urban centres, including the national capital, are not inter-linked by road, and hence the need to extend the road network.

Background

In Papua New Guinea all road improvements, upgrading and new construction are subjected to economic analysis to quantify benefits and costs, before commitment of funds. This is the Government's road investment policy and a requirement of donor agencies such as the World Bank.

This paper presents one such analysis for a new gravel road that was commenced in 1990. The main purpose of constructing the road is to provide an all weather road to service a large spice plantation that was under development in the catchment area and also to service the local population. The project construction had begun without formal cost-benefit analysis. Planners had assumed that the road assessment was an integral part of the development of the spice (cardamom) plantation. Construction cost was escalating far in excess of the estimated cost of K1.6m (A$2.2m). The project was suspended to allow for a re-examination of the assumptions and of the economic viability of the project in view of the substantial increases in the construction cost. Goods and services in the area are delivered mainly by air transport; this was seen as a major constraint to the early expansion of the spice plantation

Project Description

The project is a 37km new gravel road from Braham, a small mission station, to Bundi, also a small mission station. Both ends of the road are in Madang Province. Braham can be reached by road from Madang, turning off the Ramu Highway at the 75km marker and then continuing for another 22kms. Bundi can be reached by road from

Kundiawa, Simbu Province. ***See location Map***. Although there is a track linking the two stations, it is only useable by 4 wheel drive vehicles and grades on the tract range between 15-22%. Because of the narrowness of the track on hill crest and mountain ridges, some vehicles have been lost by falling off mountain ridges into deep valleys. Constructing bridges and reducing grades were discounted outright both on engineering and cost grounds. Also, the road alignment was not suitable to be upgraded to highway standard, even when future traffic demands such a standard.

Study Method

The evaluation was based on a spread sheet analysis using quatro-pro software. The input parameters were estimated, first the project cost and then the benefits.

Costs were considered for engineering design, construction, supervision and maintenance.

After one year of construction K1.7 million was spent on only 10.7km of road, much of the cost having been absorbed by an unforeseen rock excavation. This cost was treated as sunk cost.

A detailed survey of the route was carried out and, based on the results, the cost estimate was revised upward from the original K1.6m to K2.5m. The project was scheduled for completion in 1991.

Location Map:

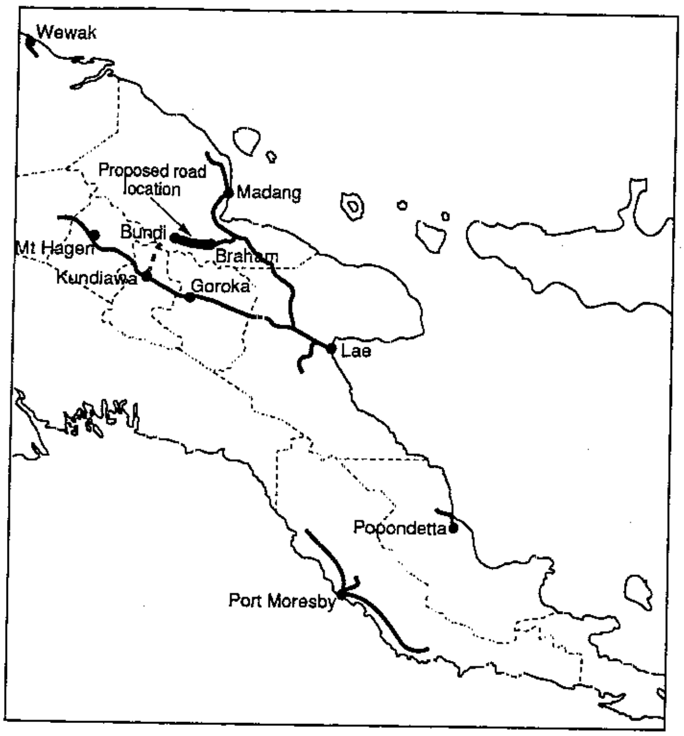

Table 1 below shows the revised cost estimate to complete the project and maintain the road. The cost of maintaining the road was based on current budget allocations for similar types of roads. The assumed high maintenance cost of K3,000 per km per year was due to the high probability of rock and soil slippage and their associated high clearing cost. It was assumed that this level of maintenance will be maintained for the first 4 years and there after K4000 per km per year till the 10th year when the road is expected to be upgraded at a cost of K600,000, there after maintenance cost is estimated to be K3500 per km per year until the end of the 20 year evaluation period. The maintenance cost for year four onward was calculated using the World bank HDMIII model. It estimates the rate of gravel loss, grading and regravelling cycles based on gravel type, road geometry and surface characteristics and traffic volume, inputs. Unit rates for hire of Grader, trucks and labour are then applied. To the results is added the cost of routine maintenance, ie clearing of grass, culverts and pot hole filling.

BREAKDOWN OF ESTIMATED COST

(Kina 000)

Table 1

ACTIVITY	ORGANISATION			MATERIAL				TOTAL COST
	Duration-month	Rate-Kina/m	Cost-	Type-material	Qty	Rate-K	Cost-K	
FORMATION Gang 1 Gang 2	12 12	53.3 53 3	640, 640.					1.280.
CULVERTS	16	12.5	200.	0 600 0 900 01 800	1890m 240m 152m	60 85 140	113.4 20 4 21.2	355
MIN. BRIDGE AND DRGE SPT.	16	12.5	200,	Gabion Bailey B. Conc. Etc....	400 5x18m	50 2.2	20 198 457	465
PAVEMENT	6	51 7	310,					310
CONST. L/SLIDES	Intermittent							100
MAINTENANCE	per year							111
TOTAL FUTURE WORK								K2,621

A Gang is made of Excavator, Dozer 24, Lt truck Supervisor. and 10 x Labourers.

Air Traffic

There are three airstrips in the study area, viz., Brahman airstrip, Kobum airstrip (location of spice plantation and plant) and Bundi airstrip. There are no regularly scheduled flights, all flights being charter on demand. On average, there are about two passenger flights a week, with an average passenger load of about 20 at a cost of K40.00 per person and three cargo charter flights per week. The spice company charters twice per week for fuel and general material supplies. The trade store owners charter once per week for store supplies. Cost per charter is K350.00 discounted for regular users to K330.00 (aircraft capacity is constrained to a weight of 700kg). Fertilisers are airlifted from Brahman at K110.00 per charter. Chartering is a normally on a return trip.

Road Traffic

A traffic survey carried out at two locations in the project area indicated an average of 24 vehicles per day (ADT); only two vehicle types were encountered, viz, small commercial and medium commercial. No vehicle was observed proceeding to Bundi. It was observed that over half of the vehicles had cargoes bound for the spice plantation. However because of lack of accessible road, the cargoes were off-loaded at Brahman station to be airlifted to the plantation. Passengers with destination beyond Brahman had to walk for a minimum of 4 hours

There is a considerable amount of walking in the study area, particularly plantation workers walking to and from their surrounding villages. However, it is not expected that the road will change the pattern for most walkers

The population in the catchment area was estimated to be 2100 persons. However the spice plantation at full production is expected to employ 2000 people. At the time of the study the work force was 200.

It is assumed that, with such a low population, most of future employees will come from areas outside the catchment area, most likely the Madang urban area. It was estimated that at least 1000 will be recruited from Madang.

Using an average occupancy rate of 8 (as obtained from the survey), passenger traffic per year will reach about 386 vehicles by 1995 excluding Madang-Kundiawa through traffic. This figure is based on the assumption that one air trip per employee would be made in the absence of a road, and that with a road these trips will divert to vehicles. With a road, however, trip frequency will be much greater and these increased trips will represent generated benefits (about 5 trips per employee per year).

The spice plantation will require an annual shipment of fertiliser of 80 tonnes. This will increase to about 4000 tonnes per year from 1995. Spice production at the time of the study was at a level of 70 tonnes per year increasing to 400 tonnes in 1995. It has been assumed that about 50% of the cardamom export from the plantation will be transported as back-loads for vehicles that haul supplies such as fertiliser to the plantation. Thus only half of the cardamom crop will generate additional traffic. General store good (trade store) accounts for 36.4 tonnes per annum increasing to about

70 tonnes as the plantation peaks at 2000 employees, around 1995 Assuming an average freight truck of 20-24 tonnes, freight traffic generated will be about 190 vehicles one way (280 total) per year excluding Madang-Highlands through traffic. It has been assumed that other products such as vegetables and coffee will be absorbed by excess capacity in back-loading on other freight traffic as outlined above.

The above scenario assumes that there will be 100% freight diversion from existing mode.

An employee level of 2000 will represent a population of perhaps 7000 persons Trade store goods per capita consumption are about 10kg per year Recent studies (Duncan, Agogo and others 1990) have indicated that per capita consumption is likely to be significantly higher, thus the estimate of 70 tonnes of general store goods may be regarded as conservative.

EVALUATION

For the purpose of the economic evaluation transport and construction costs are required in terms of resources costs, reflecting the cost of resources used in providing the particular transport service. This eliminates taxes and subsidies that are transfer payments within the economy, and distributions such as excessive profit margins perhaps resulting from a transport operator's monopoly position. Construction costs were factored by 0.9 whilst maintenance was by 0.85. Air traffic rates were factored by 0.85. This factor was used to remove excessive profit margins and other transferable costs in the rates.

For fertilisers and cardamom, there was evidence of rates discounting indicating a wider profit margin The factoring rates were the averages of rates used in several studies in PNG In the case of road travel, economic vehicle operating costs were used as the basis for estimating resources cost

The traffic survey revealed that about 80% of the traffic were in the small commercial group The VOC for this group was assumed to be 30.8 toea (Australian 42.35 cent) per km and this was used to estimate the travel cost for vehicles carrying passengers. The World Bank VOC model was used in the estimation Road and vehicle characteristics plus cost associated with the vehicle are input into the model The model then computes VOC per Km

To convert the VOC per vehicle to costs per passenger an average occupancy of 8 passengers per vehicle was used. These costs were compared to existing passenger fares, to establish variation and causes

Analysis

In the 'do nothing' situation, air travel cost,(passenger) was calculated by the product of airfare discounted to reflect resource cost and estimated annual trips. The annual freight transport cost was calculated on the same basis. The assumption was made that the 2 weeks' charter will be scheduled in such a way that the 80 tonnes' fertiliser and 70 tonne's cardamom per year were carried.

Similarly, the transport related cost in year five when the plantation was in full production was calculated.

In the project case, economic vehicle operating cost was the basis of deriving fares and freight rates by road. The project construction period was estimated to be 2 years and to be completed in mid-year. Benefits for such trips were regarded as half of the normal trips. The following are the cost and benefit streams:

	Cost				Benefits Kina	
					Generated	Normal
Passenger	1991	1995		1991	37230	14892.8
Rd	5578.4	10720		1992	74464.4	29785.6
Air	35360	68000		1995	143200	57280
Frght Rd	661.4	7267	Frght	1991		21548.5
Air	43758	702834		1992		43097
				1995		695567

Table 2 presents the results of the base case. The project produces 19.3% internal rate of return.

Table 2	BENEFITS PASSENGER Normal	Generated	FREIGHT	COSTS CONST	MAINT	NET BENEFITS K'000
1990				259		259
1991	14.9	37.2	21.5	2000	47.2	-2010.8
1992	29.8	74.5	43.1		94.4	52.9
1993	29.8	74.5	43.1		94.4	52.9
1994	29.8	74.5	43.1		94.4	52.9
1995	57.3	143.2	695.6		125.8	770.3
1996	57.3	143.2	695.6		125.8	770.3
1997	57.3	143.2	695.6		125.8	770.3
1998	57.3	143.2	695.6		125.8	770.3
1999	57.3	143.2	695.6		125.8	770.3
2000	57.3	143.2	695.6	540	0	356.1
2001	57.3	143.2	695.6		110.1	786
2002	57.3	143.2	695.6		110.1	786
2003	57.3	143.2	695.6		110.1	786
2004	57.3	143.2	695.6		110.1	786
2005	57.3	143.2	695.6		110.1	786
2006	57.3	143.2	695.6		110.1	786
2007	57.3	143.2	695.6		110.1	786
2008	57.3	143.2	695.6		110.1	786
2009	57.3	143.2	695.6		110.1	786
2010	57.3	143.2	695.6		110.1	786
ECONOMIC						
	1415.3	2408.7	10427.3	2799	1950.3	9502
DISCOUNTED ECONOMIC BENEFITS-COSTS AT:						
10% NPV	486.3	860.2	3341.9	2077.6	751.4	1859.4 IRR-18.9 %
12% NPV	406.7	725.7	2747.3	1980.9	644.3	1254.6

SENSITIVITY

Experienced has shown that during project implementation cost is the most significant variable that change, usually upwards. For this reason and for the fact that some potential benefits have been excluded, the sensitivity tests were centred on cost variations.

A number of sensitivity tests were carried out First, the assumption was made that the original estimated economic cost for construction was K3,798,000 that is the present estimated total cost ie sunk cost plus revised cost. The project showed an IRR of 11.3%.

The current estimated cost to complete the project was increased by 50% and benefits were reduced by 20%.
The project showed an IRR of 9.7% still within the government cut-off mark.

CONCLUSIONS

The study had generally adopted a very pessimistic approach in all assumptions used; some very obvious benefits such as Highlands-Madang diverted traffic and benefits growth rates have not been considered, yet the project's viability is not in doubt

The findings of the study conclusively demonstrate that the cost increases did not affect the economic viability of the project, and therefore the project should continue. The evaluation has cast doubts on the plantation developing to its projected capacity and generating employment of 2000 without the road. The impact of the road on economic development is clearly demonstrated through the study