"Cost-Benefit Analysis of a Bridge at Tadoussac"

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Freeman Fox and Partners: Standard p40
— Justification économique: ajouter les touristique à chaque année
+ les industriel prévisible raisonnablement

p24 p26 - hospective.
p22: Vérifier 1PE bridge...
+25% autrefois après

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2- DESCRIPTION OF THE PROBLEM

The North Shore of the St. Lawrence River from Tadoussac to Seven Islands (see location map in Appendix E) is a region rich in natural resources with a considerable structure of resource-based industries - especially in the general area of hydroelectric power, and the exploitation and processing of raw materails, such as iron ore, aluminum and pulp and paper. In 1971, Seven Islands had the highest per capita income of any town in Canada and large new projects such as the Rayonier Plant are either planned or under construction. This region may be expected to continue its development, given the scarcity of natural resources.

Route 138 is the main land link between this region and central Quebec. The importance of this link can be judged in comparison to alternative modes of transportation. Air transport is expensive and has limited capacity. There is no railroad link, although the Government is now considering a railroad-ferry system between the terminal of the Quebec North Shore railroad at Seven Islands and Matane on the main railroad route to Maritime Provinces. The slowness of maritime transport as well as seasonal factors make this mode suitable only for bulk cargoes, such as iron ore and wood pulp.[2]

Another road exists between Quebec City and the North Shore, passing through Lake St. John and crossing the Saguenay at

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2- Data supplied verbally by the Ministry of Transport of Quebec.

Chicoutimi. This road is secondary and stretches the travelling distance between Quebec and the North Shore by 65 miles. It will be shown later that such a distance is considerably more costly in time, gasoline and wear on vehicles than the present cost of crossing at Tadoussac.

Between Chicoutimi and Tadoussac, the Saguenay is a deep fjord where a bridge would be more costly to construct than at Tadoussac. Also since the greatest activity of the North Shore is near the St. Lawrence River it is natural that Route 138 should cross the Saguenay at Tadoussac, being nearest the St. Lawrence.

At present, this crossing is serviced by a system of ferries. These ferries are highly overloaded in the Summer and subject to ice interference in the Winter. The ferry crossing is a major bottleneck to the flow of land traffic, and, with the continual growth of the region, this bottleneck will become more and more severe.

Route 138 is a two-lane roadway over very hilly terrain. This road is now being improved by widening in some stretches and by the addition of extra lanes on hills to allow the passing of heavy and slow vehicles. It is expected that in a few years it will be able to carry 1,000 vehicles per hour, the normal peak load for a two-lane roadway on flat terrain.[3]

The wharves for the ferries at Tadoussac are squeezed between a deep river and its steep rocky banks. There are now two loading facilities, hence improvements in facilities needed to accomodate increases in traffic would be very costly.

3- Traffic Engineering Handbook, Institute of Traffic Engineers, 1950, p. 340.

5- COST OF BRIDGE

A major physical problem exists in building a bridge at Tadoussac. The Saguenay River has very steep rocky banks. This steepness continues into the river, where the depth of water reaches 1,000 feet. The width of the river, at the narrowest point, is 4,000 feet. As it would be difficult to build piers in great depths of water, it was concluded that a suspension bridge with a central span of 3,800 feet would be most suitable. This would make it the longest suspension bridge in Canada, and one of the longest in the world.

The firm of Freeman, Fox and Partners of London, England designed, among others, the Istanbul bridge, which is similar to that which is required at Tadoussac. They prepared a preliminary design in collaboration with Letendre, Monti, Nadon, Gagnon, Consulting Engineers, of Montreal. The estimated cost prepared in collaboration with Janin Construction of Montreal, General Contractors, is $52,500,000. Illustrations of the bridge and its location may be found at the end of this report. As shown, the bridge has four lanes. There are two reasons for this design feature.

First, with such a large span, the problems of lateral stability in wind requires a width of bridge such that four lanes can be fitted on the deck. Secondly, even if two lanes were possible, the saving in cost would be relatively small and the bridge would reach capacity after 25 years. A second two lane bridge would be very costly

6- COST OF FERRY

One of the benefits of building a bridge is the saving of the cost of the ferry which, of course, the bridge would eliminate.

The subsidy to the ferry according to Mr Jacques Charland of the Ministry of Transport of Quebec was $1,300,000 in 1974 and the yearly cost of the wharves including maintenance and depreciation is evaluated at $100,000 in 1974 for a total yearly cost of $1,400,000 for the ferries.

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Since the traffic at this date is 450,000 vehicles per year, the per vehicle cost, the saving of which is considered a benefit, is:

11 200 000

$$\text{Benefit} = B = \frac{1,400,000}{450,000} = \$3.10$$

Consideration can be given to the possibility that future increases in traffic and a corresponding expansion of the ferry service could lower this cost. However, as already explained, the physical conditions at the ferry site would render any possible expansion difficult, and consequently more expensive.

At this moment this creates a big problem since the service has reached a temporary limit.

Three boats are operating at Tadoussac loading and unloading at two boat slips, one at each shore of the Saguenay River. Since the crossing is of short duration and loading can take a good amount of time, there are occasions when the third

boat has to wait in the river until one of the other boats liberates a loading slip.

Since line-ups and waiting time are serious in the summer months, any increase of traffic will require adding wharf space and another ferry boat.

Because of space limitations this increase in wharfage should be quite costly and counterbalance any economies of scale that the expanded service may generate especially since these economies can only affect management of the operation.

It is therefore assumed that as the ferry system is expanded by the enlargement of wharves and addition of ferry boats, the costs will be proportional to the increase in traffic volume thus maintaining a constant cost per vehicle of $3.10.

Of course ferry service at peak periods cannot be increased proportionally to traffic. As traffic increases so does waiting time. When finally a new boat is put into service waiting time falls but because of the sudden increase in total costs, cost per automobile rises.

Therefore the cost per automobile is not constant but oscillates as service is increased in steps while traffic increases uniformly and taking $3.10 in 1978 is a simplification. As an example taking the 1973 subsidy of $907,000 and the traffic count of 430,000 vehicles and thereafter applying an inflation factor of 5.5% annually would give for the cost per automobile in 1978.

In the case where savings would not be passed on by the truckers then the benefits remain with them, as is the case with automobile drivers.

Another factor to be examined is the fact that induced traffic created by the bridge would require ancillary facilities such as gasoline sales and the supply of meals.

This in dollar volume would be very important but could only be considered if meals would otherwise not be eaten or if vehicles not travelling on the bridge would be left idle. This is very unlikely and therefore the bridge would not create a new activity but rather shift such an activity from one location to another.

This analysis has been based on present conditions. There is no doubt that the bridge would change these conditions over time, and a study undertaken a few years after the opening of a bridge would reflect the new reliance of the region built around an efficient link with central Quebec.

Of course, irrespective of the present economic conditions, the Government could still build a bridge as an investment if it could see that improved communications would increase considerably the activity of the North Shore region, one of the wealthiest of the province.

But this would require a rather long range forecasting and is beyond the scope of this work.

12- CONCLUSION

In this study a comparison was made over a period of 50 years between the cost of construction and maintenance of a bridge at Tadoussac over the Saguenay River, and the cost of the ferries and lost time at the same location.

At the beginning of the period, that is in 1978, the costs of the ferry and of the bridge are fairly well determined by data available. On the other hand as time goes by the traffic and cost projections for the ferry have to be somewhat conjectural.

The results indicate that the ferry system would cost about 2.5 times the bridge over the period herewith considered.

Although it is difficult to predict the future because of the discounting of distant benefits, errors in estimation have been shown to be of reduced effect.

As an example a traffic in 50 years 30% less than the expectation, diminishes the benefit/cost ratio from 2.4 to 1.95, a fall of only 19%.

In the same way increasing the net rate of discount from 3% to 4% or by 33%, diminishes the benefit/cost ratio from 2.4 to 1.93, that is 20%.

It therefore appears that the B/C ratio which varies from 2.4 to 3 depending on the basis of the study, remains close to 2 when the different paremeters are varied.

In greater detail:

a- If the ferry were to carry the expected traffic over the period, its cost in operations and lost time would be 2.4 times the cost of the bridge. Since the cost per vehicle is divided as $3.10 for the ferry and 3.30 for lost time the benefits of removing the ferry would compare to the cost of the bridge as follows:

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Cost of bridge (+ maintenance) = $71,000,000

Cost of ferry $\times \frac{71,000,000 \times 2.4 \times 3.10}{3.10 + 3.30} = \$83,000,000$

Cost of lost time $= \frac{71,000,000 \times 2.4 \times 3.3}{6.4} = \$88,000,000$

It appears therefore that the cost of the ferry is greater than the cost of the bridge, even forgetting the cost of lost time.

b- An hypothetical demand curve for a crossing at Tadoussac was created based on present conditions and alternative routes.

If a free bridge were built at the location, the evaluated consumer's surplus would be about three times the cost of the bridge.

On the other hand if a toll of $3.00 per vehicle was charged, a toll less than the $3.30 it now costs in lost time, the cost of the bridge would be covered over the years and a consumer's surplus of $2,900,000 would be created in 1978 which over the period, corresponds to $140,000,000 or double the cost of the bridge.

One can therefore conclude that the replacement of the ferries at Tadoussac by a bridge seems a viable economic solution.

As to whether the Government should proceed with this project depends on the priorities. There are other places needing government expenditures and only if the benefits are greater in this location could the project be considered above the others.