Investment Evaluation of a Suburban Coastal Transport System

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2002

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OF A SUBURBAN COASTAL TRANSPORT SYSTEM

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Summary
This paper aims at determining the optimum viable solution of an investment on a suburban coastal shipping system in the area of Athens. More specifically it refers to the development of a sea transport system, alternative to the existing road one, that would connect Piraeus with the southern suburban coastal area of Athens. The best viable solution of such an undertaking is considered to be the one, which under the existing constraints maximises the total profit that derives from this investment. The variables used for the formation of the constraints are the number of vessels used, the routing and the price of the services. The article after presenting the methodology of the market analysis, focuses on the financing alternatives of the project and their impact on its economic efficiency and concludes with the best viable scenarios and optimum solution.

1. Introduction

The paper's main objective is to determine the optimum solution of an investment undertaking that includes an alternative transportation system, that is a suburban coastal transport system in the south region of Athens. Such a system is believed that can offer a possible solution to the transport problems of congestion, which characterise the existing overloaded road network of Athens.
Suburban coastal shipping has a special character. First there are not many examples of cities that use an analogous transport system. Secondly, the main competitor of sea transport is road transport or fixed track systems (train, tram). It should be mentioned that the current transportation system despite its deficiencies in terms of time, cost as well as externalities remains a strong travel alternative and consequently a constraint for the development of the proposed seaborne transport. This is due to the several advantages it offers to its users like door to door services, flexibility and speed. City of Athens disposes a road system as the main one satisfying the transport demand to and from the suburban areas.

The best economic solution for an investment of this kind is determined as the one that maximises the profit of the investor, under the constraints that the current transport system sets. In this context, in order to format the constrains of the system, a market analysis has been conducted taking all the above into consideration in order to examine the possible demand for such a system versus the existing road transport one (Greek Bank of Industrial Development, 1995). However, the question is whether an enterprise in this field would be economically viable and which would be the required demand of that service, in order to be able to equalise the marginal costs with the marginal revenue.

2. A methodology for the development of a suburban coastal transportation system in Athens urban area

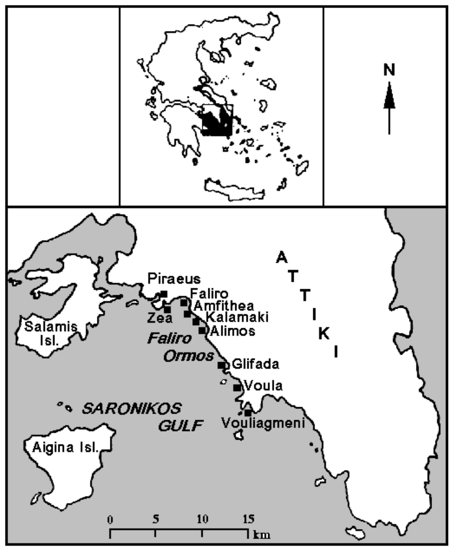
2.1 The survey

It is obvious that the greatest part of the demand for sea transportation would come from the coastal suburbs that lie mostly in the eastern and southern part of Piraeus and their most important feature is that they constitute areas of permanent residence.

These suburbs include Alimos, Voula, Vouliagmeni, Glyfada, Elliniko, Kalithea, Moschato, Piraeus and P. Faliro. They constitute the districts of direct interest for this analysis (see figure 1). The case of the nearby districts that are situated northern than the coastal ones is also examined (Ag. Dimitrios, Argyroupolis, Vari, Ilioupolis, Koukaki, N. Smirni etc). This case obviously refers to the current car owners who can drive their cars up to the terminal station and then embark on the sea vessels after parking their cars (park and ride).

The first step in estimating the potential demand for a suburban coastal transportation system was to proceed to the determination of the total movements in the above mentioned area. This led to the development of the analogous Trip Distribution Model (Sambracos 2001) that shows the movements between the examined suburbs by private car and by bus. Data for the creation of the model was gathered by several origin – destination surveys that have taken place over the last years in addition with the records of the National Statistics Services on the population of the suburbs.

Figure 1: Suburban coastal shipping operation in the south region of Athens



The second step was to proceed to a Modal Split Model (Abacoumcin 1990, Giannopoulos 1981) and to determine the alternative means of transport that could satisfy the transport demand in and between the suburbs in question. In order to create such a model, the 'stated preference' method was used, a technique that uses and analyses the alternative scenarios, the questioned passengers state that they would prefer (Pearmain et.al, 1990, Bristow et.al, 2000). The questioned person is asked to choose between alternative situations/solutions, some of which may not yet be known to him, such as the proposed coastal transport system. The reason for using this method is mainly the fact that it can show results based on small samples (Koppelman et al, 1983). Thus the classic revealed preference method show disadvantages since it cannot be used in demand forecasting under existing conditions and cannot use qualitative criteria (such as the comfort of a transport means).

The survey was conducted with the use of questionnaires on June 1994 in the two main centres of interest, Piraeus and Glyfada. The questionnaire included 13 questions that had to do with:

- the used transport means,
- the origin and destination of the trip,
- the purpose of the trip,
- the frequency of the movement,

- the preference towards sea transport,
- the ability to use a car,
- the minimum and maximum time for the users of private cars and buses,
- the parking fees,
- the walking distance between the parking area or the bus station and the final destination.

Besides the questions there were six different scenarios, that referred to combinations of four main factors that determine the choice of a transport means. These are:
- the time of the trip (from door to door),
- the price of the ticket,
- the possible delays in the arrival of the vessel,
- the sea/weather condition.

Additionally, data regarding the sex, age and other demographic characteristics were taken into consideration.
In order to determine the demand allocation between the alternative transport means the Logit analysis was conducted (Ortuzar et. al., 1990) using as inputs the mentioned six scenarios and as variables the time of the trip (by bus/car and ship), the cost of the trip (by bus/car and ship), the delays (by ship), and the weather conditions of the coastal shipping alternative as well as the characteristics of the users (age, sex, purpose of the trip etc). Above them the time, cost of the trip and the weather conditions were statistically the most important variables.

2.2. Designing the system

In order to design the suburban coastal shipping system there are several factors of both quantitative and qualitative character to consider, using as data the outputs of the origin-destination model and the conducted survey (stated preferences).
The first factor was the ports that should be used to format the system, the number of stops between the main ports of Piraeus and Glyfada in combination with several levels of ticket prices. Three scenarios were examined:

1. Piraeus port – P. Faliro – Glyfada
2. Piraeus port – Zea port – P. Faliro – Glyfada and
3. Piraeus - Glyfada

The results from the survey showed that more mid stops would make the system unattractive and inefficient compared to the existing road one since they would increase the travel time. Additionally, more vessels would be required increasing therefore the cost of the system.

The price levels examined for each scenario referred to a sea fare of 300, 400, 500, 600 and 700 GRDrh respectively. The results of the stated preference model for a 12 hour and a peak hour transport work showed that the higher the number of mid stops the higher the demand for travelling. Based in that conclusion the third alternative was abandoned.

The second factor was the vessels type and the necessary number of vessels to cover the two and three mid stops alternatives. The number of vessels depends on the demand for each alternative on a 12h and peak hour (PD) basis, the time of the trip and consequently the maximum number of trips the vessel can perform (FB), the frequency of embarkations (FL), the capacity of the vessel (C = PD/FL) and equals to the ratio:

$$n = \frac{\mathrm{FL}}{\mathrm{FB}}$$

As for the type of the vessels, the choice was based on four factors:

- the purchase and operational cost
- the operational reliability, speed and flexibility
- the friendliness towards the environment
- the safety and comfort for the passenger

The proposed type of the vessel based on the above factors was the flying dolphin type. Its characteristics on speed (33knots/h) and capacity (110 pas.) prove that for the one mid stop scenario two vessels are requested and for the two mid stop scenario three vessels.

3. Defining the optimum solution

The best viable solution of such an undertaking is determined as the solution that maximises the Profit (P) of the undertaker. According to the economic theory maximising the Profit means maximising the difference between Revenues (R) and the Cost (C) that derive form the operation of the company. In other words it is:

$$P = R - C$$
$$\max(P) = \max(R - C)$$

The constraints of the above profit maximisation consist of the existing alternative solutions, which derive from the market analysis on demand patterns towards the undertaking.

3.1 Cost of the suburban coastal transport system

The total cost, that such a transport company will face is a function of (Karvounis 2000:

- the investment cost (i),
- the operating cost (o)
- the financial cost (m)
- the depreciation cost (d)

Therefore we have,

$$C = f(i, o, m, d)$$

The total cost depends on the number of stops the vessels make. The more the stops the bigger the roundtrip time and consequently a bigger number of vessels is required in order to maintain a high level of service. This increases the investment cost since more capital is required to cover not only the acquisition of the vessels but also their operating expenses. Therefore, it is essential to determine the level up to which we must invest. There are different alternative scenarios that are based on the market analysis on origin – destination in order to determine the best alternatives for this system. The market survey already indicated two main alternatives using as a variable (i) the number of stops and the number of vessels to be employed:

- Scenario 1: one stop between the ports of origin and destination, using two vessels on pick hours
- Scenario 2: two stops between the ports of origin and destination, using three vessels on pick hours

That is ***Si,*** where i= 1,2 stops

Considering these scenarios, the main cost elements are estimated as following:

a. Investment and operating costs

The estimation of the investment and operating costs is presented in the table 1 below.
The investment cost consists of Founding & Organisation cost, Fixed investments (facilities etc), Working Capital, Unforseen expenses
The operating cost consists of Fuels, lubricans etc, Personnel, Office expenses, Maintenance Expenses, Port duties, Insurance, Advertisement

Table: 1 Investment and operating cost for the two scenarios (in 000GRDrh)*

Costs	Scenario 1	Scenario 2
a. Total investment costs	**1.150.000**	**1.500.000**
Founding - Organization	10.000	10.000
Fixed investments	940.000	1.240.000
Starting Capital	187.367	243.100
Unforeseen expenses	12.633	6.900
b. Total Annual Operating Cost	**562.100**	**729.300**
Fuels	281.000	337.000
Personnel	130.000	182.000
Office expenses	3.000	3.000
Maintenance Expenses	13.500	18.000
Port duties	45.000	80.000
Insurance	13.500	18.000
Advertisement	25.000	25.000
Unforeseen	51.100	66.300

*The estimation of the costs is based on market prices as of 1995

b. Depreciation cost

The cost of depreciation is estimated for both scenarios, using the depreciation rates, 4% for building and offices, 10% for the vessels and 20% for the rest equipment, as following:

- Scenario 1: annual depreciation for the first five years is 93,2mil.GRDrh and for the other five 91,2 mil.GRDrh.
- Scenario 2: annual depreciation for the first five years is 123,2mil.GRDrh and for the other five 121,2mil.GRDrh.

c. Financial cost

The financial cost for the development of this transport system deals with the financing of the investment costs for its development. Several scenarios of financing are proposed that include:

- different % of loaning and own capital
- several levels of loaning interest

3.2 Revenues of a suburban coastal transport system

The revenues from the operation of this system are a function of the demand (q) and the price of the ticket (p).

$$R = f\,(p, q)$$

The level of demand and the possible ticket price levels were examined during the market research. Although all price levels are possible the research showed that a range between 500GRDrh and 700GRDrh is the most viable one. Above this level the demand is low in favour of road transport and below it is economically unprofitable for the company. The two scenarios therefore are:
Sj, *w*here j= 700GRDrh, 500GRDrh

It is assumed that for the working days the total revenues are:

$$2 \times N \times P$$

where, P is the price of the ticket and
N the corresponding total daily number of passengers.

For the weekends (2 X 52=104 days per year) the passenger traffic is estimated to be 70% of the traffic during working days. Therefore the total annual income is:

$$(261+0{,}7 \times 104) \times 2 \times N \times P = 667{,}6 \times N \times P$$

Using the above mentioned scenarios *Si* and *Sj*, four cases result:
-Case A: $S_{1,700}$ (1 mid-stop & price of the ticket 700GRDrh)
-Case B: $S_{2,700}$ (2 mid-stops & price of the ticket 700GRDrh)
-Case C: $S_{1,500}$ (1 mid-stop & price of the ticket 500GRDrh)
-Case D: $S_{2,500}$ (2 mid-stops & price of the ticket 500GRDrh)

Taking the above into consideration the total annual revenues are for each case:

- $S_{1,700}$: 913 mil. GRDrh.
- $S_{2,700}$: 961 mil. GRDrh.
- $S_{1,500}$: 828 mil. GRDrh.
- $S_{2,500}$: 875 mil. GRDrh.

In order to forecast the total revenues for the years to come there is the assumption that the traffic natural increase rate is 1,5% annually, therefore all the above amounts for the future year e should be multiplied by $1{,}015^{(e-1)}$ (e=1, the first year of evaluation).

4. Financial analysis of the system

4.1 Evaluation of the financial cost

The determination of the best financial solution that maximises the profit of the Coastal Transport Company is the next step of the investment evaluation of the system. The financial cost (m) of the undertaking is determined by two variables:

- **l**: the percentage (%) of a loan to cover the investment cost and
- **n**: the level of the interest rate

Therefore m is a function of l and n, or

$$m = f(l, n)$$

and so

$$C = f(i, o, l, n, d)$$

All cost components have been determined for all S_{ij}. Assuming that the variables in the above function are l and n, we will try to maximise it by using all possible combinations of l and n.

In order to evaluate the financial efficiency **(Goulielmos 1997)** based on the above variables of this initiative we use the method of the Net Present Value and the Internal Rate of Return. Using a discount factor of 4%, the target is to find the alternative S_{ij} that gives the higher Net Present Value (NPV) as well as IRR.

Using the above variables we proceed to a 10 years simulation in order to format the equation that proves the relationship between the percentage of loan for all possible levels of loan interest and the NPV, IRR results. The results for all cases and the final equations are included for each case in table 2. The general form of the derived equations, as resulted from the simulation, is a first degree one, with the following formation:

$$Y = a - bX$$

Where Y = NPV
X = the percentage of loan at different levels of interest rate
a, b = constants

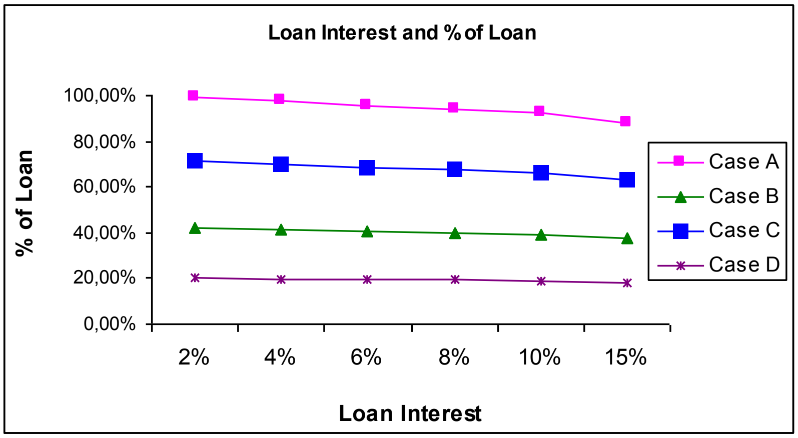
The main conclusion is that $S_{1,700}$ is the optimum solution, since it shows the greatest Net Present Value and Internal Rate of Return for all different levels of interest (Table 2). Regarding the financing of the project, it is concluded that in every level of the interest rate, the best solution is to self-finance the project.

Another important observation is that in $S_{1,700}$, the percentage of loan that makes the NPV equal or less than zero (which means that the project is economically a non viable solution) is the highest, in comparison with the other Cases. For example for $S_{1,700}$ (see table 2 and figure 2), in the case of a loan interest of 4% the company can take a loan that does not exceed 97,62% of the investment cost. In all other cases, this percentage is much lower, which means bigger financial risk and danger, in the case of inability to self-finance a significant proportion of the investment cost. The same conclusion can be derived for all levels of interest loan. Taking the above into consideration, the second viable solution is $S_{1,500}$, where for a 4% of loan interest, the total loan must not exceed 70,03% of the investment cost.

Table 2: Financial viability of the project for S_{ij}

	$S_{1,700}$		$S_{2,700}$	
Loaning Interest Rate	Equation (y=a-bX)	% of Loan that makes NPV=0	Equation (y=a-bX)	% of Loan that makes NPV=0
2%	Y=2.352.749-2.363.779X	99,53%	y=1.299.424-3.083.191X	42,14%
4%	Y=2.352.749-2.410.128X	97,62%	y=1.299.424-3.143.645X	41,33%
6%	Y=2.352.749-2.456.477X	95,78%	y=1.299.424-3.204.100X	40,55%
8%	Y=2.352.749-2.502.825X	94,00%	y=1.299.424-3.264.555X	39,80%
10%	y=2.352.749-2.549.174X	92,29%	y=1.299.424-3.325.009X	39,08%
15%	y=2.352.749-2.665.045X	88,28%	y=1.299.424-3.476.146X	37,38%
	$S_{1,500}$		$S_{2,500}$	
Loaning Interest Rate	Equation (y=a-bX)	% of Loan that makes NPV=0	Equation (y=a-bX)	% of Loan that makes NPV=0
2%	y=1.687.936 - 2.363.780X	71,41%	y=626.789 - 3.083.191X	20,33%
4%	y=1.687.936 - 2.410.128X	70,03%	y=626.789 - 3.143.645X	19,9%
6%	y=1.687.936 - 2.456.477X	68,71%	y=626.789 - 3.204.100X	19,56%
8%	y=1.687.936 - 2.502.825X	67,44%	y=626.789 - 3.264.555X	19,20%
10%	y=1.687.936 - 2.549.174X	66,21%	y=626.789 - 3.325.009X	18,85%
15%	y=1.687.936 - 2.665.045X	63,34%	y=626.789 - 3.476.146X	18,03%

Figure 2: Financial viability of the project

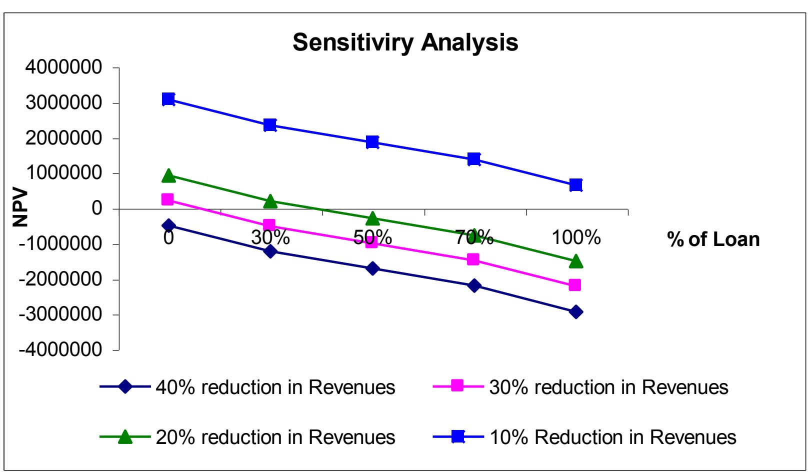


4.2 Sensitivity analysis

Another important relationship is observed between the level of the loan and the economic effectiveness of the project (Theofanides, 1985). It is also essential to recognise the risk of such an investment (we choose the optimum solution $S_{1,700}$). Since the calculation of the costs is based on real data, while the approach of the revenues is based on demand forecasts, a sensitivity analysis is performed, on different levels of demand. The results are presented in figure 3.

Figure 3 shows that, the lower the loan, the lower the danger for all different levels of demand, which we normally expected. A 10% reduction in revenues has no impact on the viability of the project. On the other hand a loan of 30% or more of the investment cost shows great sensitivity if the revenues reduce for 20% and higher.

Figure 3: Sensitivity analysis for $S_{1,700}$



5. Conclusion

From the above analysis it is concluded that the implementation of a suburban coastal transport system in the southern Athens area is economically viable. This can be achieved with one or two mid stops and different price ticket levels. The optimum though economic solution is accomplished when we apply the smallest number of mid stops and the higher ticket price level. In the examined case study, an one mid stop system with a 700GRDRh ticket ($S_{1,700}$), is the most efficient financial solution since it shows the higher NPV and IRR. That means that the investor has bigger profit by offering the minimum service (1 mid. stop) with the highest price of the range examined (500 - 700 GRDrh). If he increased the stops and offer more service, and if he reduced the ticket price, then he would attract more customers. But, according to the above analysis the best solution is $S_{1,700}$, that means less service, less passengers and higher ticket price.

Thus, the percentage of Loan that makes NPV=0 is higher in case $S_{1,700}$, in every level of loan interest. That means that offering lower service with the higher price holds minimum financial risk for the investor. Additionally, the sensitivity analysis shows that the higher the level of uncertainty in the total revenues (reduction in demand) the lower the percentage of the loan, that the investor should take. From that point of view the case $S_{1,700}$, proves to be the most secure one.

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