Feasibility Studies through Quantitative Methods: The Revamping of a Tourist Railway Line in Italy

Armando Carteni, Ilaria Henke

**Abstract**—Recently, the Italian government has approved a new law for public contracts and has been laying the groundwork for restarting a planning phase. The government has adopted the indications given by the European Commission regarding the estimation of the external costs within the Cost-Benefit Analysis, and has been approved the ‘Guidelines for assessment of Investment Projects’. In compliance with the new Italian law, the aim of this research was to perform a feasibility study applying quantitative methods regarding the revamping of an Italian tourist railway line. A Cost-Benefit Analysis was performed starting from the quantification of the passengers’ demand potentially interested in using the revamped rail services. The benefits due to the external costs reduction were also estimated (quantified) in terms of variations (with respect to the not project scenario): climate change, air pollution, noises, congestion, and accidents. Estimations results have been proposed in terms of the Measure of Effectiveness underlying a positive Net Present Value equal to about 27 million of Euros, an Internal Rate of Return much greater the discount rate, a benefit/cost ratio equal to 2 and a PayBack Period of 15 years.

**Keywords**—Cost-benefit analysis, evaluation analysis, demand management, external cost, transport planning, quality.

I. INTRODUCTION: THE BACKGROUND

RECENTLY, investments in transportation projects and infrastructures have progressively decreased. The Italian government has tried to change this trend, approving a new law for public contract laying the groundwork for a new look at planning and designing transportation systems restarting a sustainable and rational planning phase [1], [2]. In particular, the Government, after a long phase of sharing with institutional and non-institutional stakeholders, has decreed the “Guidelines for Assessment of Investment Projects”. The guidelines incentive the ex-ante evaluation for the new infrastructure and the ex-post evaluation for the project in progress and they are not completed. These analyses must be based on quantitative techniques. In particular, the Cost-Benefit Analysis is the tool proposed for assessing the economic viability (feasibility study) of the investments, in accordance with the Guidelines provided by the European Commission. In addition to the Economic Value, Economic Net Present Value (ENPV) and the benefit/cost analysis (B/C), to identify investment priorities, are nevertheless suggested other investment efficiency indicators. These indicators measure the degree of responsiveness of investment to achieve the strategic objectives identified in the general guidance document entitled "Connecting Italy" (annex on infrastructures to the Italian Economic and Financial Planning Document of the Italian Government April 2016).

According to this new law for public contract, in this research, a feasibility study has been carried out through quantitative methods regarding the revamping of a tourist railway line in Italy. A cost-benefit analysis based on external costs estimation and in compliance with the new law for public contracts was performed. Starting from the estimation of the commuters and tourists demand (along the years) within the study area directly influenced by the railway object of revamping (the Municipality of Formia and Gaeta) and potential demand attracted by the new rail service, it was being measured the external costs saved both for users (e.g. travel time saved) and for non-users (e.g. environmental impacts). The Measures of Effectiveness (MoE) estimated were the Internal Rate of Return (IRR), the Net Present Value (ENPV), the PayBack Period, and the Benefit/Cost ratio. Furthermore, a sensitivity analysis was also performed to evaluate the robustness of the results.

The paper is divided into three sections; in the first one, the case the study is described; in the second, the methodology for the Cost-Benefit analysis is reported, while in the last section the main results of the analysis in term of Measure of Effectiveness are discussed.

II. APPLICATION CASE STUDY

As said, the application case study is composed of the Formia and Gaeta municipalities, the area directly involved by the revamping of the railway line object of the study. Formia and Gaeta are two tourist coastal cities of the Lazio Region (Fig. 1), very popular during the summer period. These two municipalities have significant road congestion and pollutant problems. For this reason, the local municipalities have started to revamping the available railway line linking the two municipalities to reduce traffic congestion and environmental (external) impacts and improving the quality of life (welfare).

The tourist railway line object of the study is 9 km long and is part of the national Gaeta-Sparanise railway corridor, one of the most Italian historical line (Fig. 1). Opened in 1892, it was damaged during the Second World War and remained not in operation for many years. The services re-opened in 1954, but due to the boom of the automobile industry of that period, it soon became not used by the transport users until its final closure in 1981. Only in 2008, the revamping activities started, restoring 6 of the 9 km of the line, but before reopening the line, the works were stopped [4]. Actually, the line is not in operation.
This railway line represents an important opportunity for the requalification of these tourist territories. This railway service could potentially serve both the commuters (in the winter) and the domestic tourists (during the summer) from Lazio and Campania Regions (Italy).

Fig. 1 The railway line Formia-Gaeta (in red) within the national railway network [3]

III. THE CASE STUDY AND THE MOBILITY SURVEY

The positive impacts (benefits) produced by the revamped railways line Formia-Gaeta, was estimated as the change between the project scenario (the new line) and the Not Project (NP) scenario. They were evaluated according to different perspectives [5]:

- **benefits for users**: potential users of the revamped railway line and the whole transport system users;
- **benefits of non-users**: those who will not use the revamped railway line, but anyway have some benefits from the new construction (e.g. environmental impacts reduction).

Comparing the difference between the overall costs and benefits the economic feasibility of the revamped railway line was performed.

* A. The Estimation of Demand Related to the Revamped Railway Line

Many of the activities relating to a cost-benefit analysis are...
variables, [7]) composed in:

- a multimodal supply model (for details see [8], [9]), explicitly considering the interaction among car, train and bus modes;
- an activity-based discrete choice model (for details see [10], [11]);
- both stochastic (for the car mode) and deterministic (for train and bus mode) assignment models (for details see [6]).

The main results of the demand estimation are reported in Table I.

### Table I

<table>
<thead>
<tr>
<th>Rail users/ year</th>
<th>Variations in car usage (Δcar*km/year)</th>
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</thead>
<tbody>
<tr>
<td>6,230</td>
<td>-5,404,617</td>
</tr>
</tbody>
</table>

**B. The Cost Estimation**

The costs considered in the analysis are:

- the investment cost (30 million of Euros), which is the realization cost supported during the construction and the first years of service;
- the maintenance and management costs (18 million of Euros), from the first year the line enters into operation and for the whole life period of 30 years considered in the analysis;
- the residual value of the investment (with a positive sign), taking into account that the value of the revamped railways line is higher than the life time period considered for the analysis (e.g. 100 years vs. 30 years).

To exclude taxes and subsidies, all the costs have been multiplied by specific correction coefficients as suggested in [12]. The total estimated investment cost (at 2016 price) is about 25 million of Euros, maintenance and management costs are about 18 million of Euros, and residual value of the investment was prudently fixed equal to 1 million of Euros (underestimating the real value).

**C. The Benefits Estimation for Users**

The revamped railway line will produce direct and non-direct benefits to users. The benefits directly perceived by the users include travel time savings, while the non-perceived benefits for the users include the savings associated with the reduction of the car maintenance costs.

The estimated benefits for the potential users of the revamped railway are quantified in about 3 million of Euros in the first year of services. Considering a life period of 30 years and a discount rate equal to 3%, at the end of the evaluation period (in 2048), the estimated overall benefits (perceived and not) for the users will be over 596 million of Euros (at
constant prices).

D. The Benefits Estimation for The Non-Users (External Cost Saved)

The benefits estimation for the non-users (external cost saved) in a cost-benefit evaluation regard the estimations of external impacts (externalities) produced by the project both with respect to the environment (e.g. climate change costs) and with respect to human health (e.g. air pollution and road safety).

The proposed design scenario (revamped railway line) will produce a reduction in the use of private car with significant positive benefits for the non-users in term of reduction in: climate change, air pollution, noises, traffic congestion, and car accidents.

<table>
<thead>
<tr>
<th>TABLE II</th>
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<tbody>
<tr>
<td><strong>THE BENEFITS ESTIMATION FOR THE NON-USERS</strong></td>
</tr>
<tr>
<td><strong>External costs saved</strong></td>
</tr>
<tr>
<td>Climate Change</td>
</tr>
<tr>
<td>Air Pollution</td>
</tr>
<tr>
<td>Noise</td>
</tr>
<tr>
<td>Congestion</td>
</tr>
<tr>
<td>Accident</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
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</table>

Overall, the average amount per year saved is about 360,000 Euro/year (at 2016 prices) with a cumulative monetary value for all the life period considered for the revamped railway line equal to 11 million Euro (at constant prices).

IV. MEASURE OF EFFECTIVENESS AND CONCLUSIONS

We defined and quantified (in monetary terms) the impacts related to the revamped railway line, the following performance indicators (Measure of Effectiveness - MoE) were estimated:

Net Present Value (NPV): compares the amount invested (costs) in the present value with the future cash receipts from the investment (benefits). It is calculated as:

\[
NPV (r) = \sum_{t=0}^{Tm} \left( \frac{\sum_j Ben_j^t - \sum_j Cost_j^t}{(1 + rate)^t} \right)
\]

where: \( rate \) is the rate of return (3% as suggested in the Guidelines for Assessment of Investment Projects); \( Tm \), is the life time period of the analysis (for this case study was considered 30 years); \( Ben_j \) are all the benefits (both for users and for non-users) that the revamped railway service will produce; \( Cost_j \) are all costs supported (investment, maintenance and management);

Internal Rate of Return (IRR) is the value of the rate of return that null the NPV:

\[
IRR = rate_o, \quad NPV(rate_o) = 0
\]

Benefit /Cost (Ben/Cost) is defined as the ratio between the total benefits and costs discounted at the initial year:

\[
Ben \sum_{t=0}^{Tm} \frac{\sum_j Ben_j^t}{(1 + rate)^t}
\]

Cost \( \sum_{t=0}^{Tm} \frac{\sum_j Cost_j^t}{(1 + rate)^t} \)

Pay Back Period (PBP) is the length of time necessary to recover all the costs supported (the NPV become positive):

\[
PBP = T_{min}; \quad NPV(rate) > 0
\]

The estimation of performance indicators (Measure of Effectiveness - MoE) shows that the revamped railway line is economically feasible for the following reasons:

- the NPV is positive and equal to about 27 million of Euros;
- the IRR is much greater in the discount rate (around 9% vs. 3%);
- the Ben/Cost ratio is approximately equal to 2; and
- the PBP is only 15 years.

REFERENCES


