6. Conclusions and Recommendations for Further Research
CONCLUSIONS

Public Transport financing represents an important challenge in the development and improvement of quality of life of cities in the XXI century. The tremendous growth that modern cities are experiencing, with each time more buildings, more inhabitants, and therefore, a greater mobility complexity, forces to seek sustainable and effective transport solutions in order to allow to making displacements in a more efficient, comfortable and secure way.

The feasibility\(^\text{12}\) of a new project is given by some parameters that, once assessed, produce some relevant indicators of the project’s economical, financial, social and operational characteristics, which can thereafter be compared with those of other similar projects previously financed (i.e. considered satisfactory). As a result of the analysis carried out along this research, these parameters are:

- The Supply (project scope, production, capacity)
- The Demand (expected)
- The Investment Costs
- The Operation and Maintenance Costs
- Social Benefits and Time Savings
- Economical and Financial Indicators

Using the existing database of projects financed by the EIB during the last decade, an “acceptable” range of variation was obtained for each variable. The main utility of these ranges is to compare projects of the same kind to determine the viability of the new one respect to those others already evaluated and financed.

The next table summarizes the results obtained from the analysis of single variables of the existing projects database:

\(^{12}\) The Encarta Encyclopedia defines the word “feasible” as something reasonable enough to be believed or accepted. A project is considered feasible whenever its main characteristics are in the range with others already accepted.
Ranges of Values

<table>
<thead>
<tr>
<th>Variables</th>
<th>Unit</th>
<th>Tramways and LRT</th>
<th>Metros</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum - Maximum</td>
<td>Minimum - Maximum</td>
<td></td>
</tr>
<tr>
<td>Demand</td>
<td>M Pax/Year</td>
<td>10 - 26</td>
<td>30 - 100</td>
</tr>
<tr>
<td>Train/Car Capacity*</td>
<td>Pax/(Train/Car)</td>
<td>205 - 360</td>
<td>160 - 225</td>
</tr>
<tr>
<td>Peak Hour Capacity</td>
<td>Pax/Hour/Dir</td>
<td>2,300 - 3,850</td>
<td>13,000 - 26,000</td>
</tr>
<tr>
<td>Project Unitary cost</td>
<td>M EUR/Km</td>
<td>9.0 - 21.0</td>
<td>32.0 - 80.0</td>
</tr>
<tr>
<td>RS Unitary Cost*</td>
<td>M EUR/(Train/Car)</td>
<td>1.5 - 2.4</td>
<td>1.0 - 1.9</td>
</tr>
<tr>
<td>RS Place Cost</td>
<td>EUR/Place</td>
<td>6,300 - 8,500</td>
<td>6,000 - 8,600</td>
</tr>
<tr>
<td>O&amp;M Costs*</td>
<td>EUR/(Train/Car)-Km</td>
<td>3.5 - 5.7</td>
<td>1.7 - 2.8</td>
</tr>
<tr>
<td>Cover Ratio</td>
<td>%</td>
<td>40 - 78</td>
<td>41 - 79</td>
</tr>
<tr>
<td>Avg. Revenue</td>
<td>EUR/Pax-Journey</td>
<td>0.35 - 0.77</td>
<td>0.30 - 0.70</td>
</tr>
<tr>
<td>ERR</td>
<td>%</td>
<td>3.6 - 8.8</td>
<td>3.9 - 8.1</td>
</tr>
<tr>
<td>Time Savings vs. Car</td>
<td>Minutes/Journey</td>
<td>5 - 11</td>
<td>7 - 17</td>
</tr>
<tr>
<td>Time Savings vs. Bus</td>
<td>Minutes/Journey</td>
<td>7 - 15</td>
<td>7 - 17</td>
</tr>
</tbody>
</table>

* In these variables the unit "Train" is used for Tramways and LRT and "Car" for Metro Projects.

In addition to these parameters, the determination of several Comparative Ratios that somehow measure the performance of the project under appraisal, play an important role in the global analysis, and thus the final acceptance of the project for its financing.

The Comparative Ratios that were found to be relevant to the aims of this work are the following:

- Ru = Demand/Capacity
- Investment/Benefits
- Demand/Investment
- Ru/O&M Costs
- Passenger Profit = Rp (Benefits/Demand) - Average Revenue

The most useful way to present the results of the ratios is by means of regression curves or clouds of points. Such obtained graphics were included as a part of the Decision Support System:
a) Tramways and LRT ratios results:

Ru = Demand/Capacity

\[ y = 1.1385x + 14.356 \]
\[ R^2 = 0.9088 \]

Benefits - Investment

\[ y = 0.8157x + 88.0707 \]
\[ R^2 = 0.8255 \]

Demand - Investment

\[ y = -0.0019x^2 + 0.6737x + 1.5619 \]
\[ R^2 = 0.8869 \]

Ru/M & O Costs

Passenger's Profits (Rp - Avg. Rev.)

EUR
b) Metro ratios results

**Demand - Capacity**

\[ y = 1.9046x + 16.398 \]

\[ R^2 = 0.9652 \]

**Ru = Demand/Capacity**

**Investment - Benefits**

\[ y = 0.785x + 41.822 \]

\[ R^2 = 0.966 \]

**Investment - Benefits**

**Demand - Investment**

\[ y = -0.0024x^2 + 0.9303x - 8.3521 \]

\[ R^2 = 0.7927 \]

**Ru/O&M Costs**

**Passenger's Profits (RP - Avg. Rev.)**

- Athens B
- Barcelona L9
- Barcelona RS
- Bilbao II
- Bucharest II
- Budapest
- Budapest L4
- Cairo L2
- Lisboa V
- Madrid II
- Prague
- Prague II
- Sur - Madrid
- Toulousse II
- Valencia II

EUR
In addition of the numeric values and graphical results, some other considerations were determined as well. Sometimes, values do not reflect all the specific characteristic of a certain project and, therefore the following considerations arise:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand</td>
<td>As an example, the demand for a LRT project is not suppose to be the same in Seville than in Bursa due to the huge difference in the population density of these two cities. In addition of setting a range value to classify projects with similar characteristics, it has to be taken in consideration the properties of each city evaluated.</td>
</tr>
<tr>
<td>Project Cost</td>
<td>The unit cost of projects varies significantly according the geographical zone. The explanation to this affirmation is clear, the GDP per capita is greater in countries of the west of Europe than the one in the East. According to the results revealed by the analysis, projects in countries of Eastern Europe and in countries as Turkey, Egypt and Tunisia are less expensive, approximately 1/5 for Metro Project and 1/4 for Tramways and LRT, than projects in Western Europe.</td>
</tr>
<tr>
<td>Rolling Stock</td>
<td>As the fabrication of Rolling Stock is very limited, the cost is approximately the same everywhere; therefore, the unitary cost of a Tram unit or a Metro wagon would be similar in Barcelona and in Bucharest, provided the characteristics of both Rolling Stocks are the same.</td>
</tr>
<tr>
<td>O&amp;M Costs</td>
<td>The Cost of Operation and Maintenance strongly depends on Administrator policy and the country. Some Administrations make provisions in their O&amp;M Costs renewals of rolling (according to the technical life of the equipment), others do not. The country’s GDP per capita affects the manual labor costs of Operation &amp; Maintenance; aid in many cases staff is over dimensioned.</td>
</tr>
<tr>
<td>Fares</td>
<td>Fares are greatly affected by the GDP per capita of each country and authorities policy, and the difference between fares of cities is well marked; the Average Revenue per passenger per trip in Western Europe countries is almost four time that of Eastern Europe, Turkey, Egypt, and Tunisia.</td>
</tr>
</tbody>
</table>

In summary, the final judgment about the actual quality of a project can only be established on case-by-case basis. However, if an analytical tool (such as the one developed in this research) supports it, the appraisal is tremendously simplified. In this sense the final result of all of these analyses is the *Decision Support System*, which is a tool conceived to determine analytically and graphically the acceptability of a certain project for its financing. Two versions of DSS were prepared (one for Tramways and LRT Projects and the other for Metro Projects).
RECOMMENDATIONS

The main recommendations made consequently to the conclusions of this research are the following:

- It is necessary to carry out a continuous updating of the Project’s Data Base and the DSS as well, in order to evaluate new projects each time with more accuracy.

- It is very important to make an Ex – post evaluation of every financed project when completed, with the purpose of comparing the variations that arises during construction, and therefore be able to set contingences costs according to the situation or characteristics of the project.

- In order to simplify the evaluation of projects related to other areas, such as Rails, Roads or Bus Systems, applying a similar analysis of parameters and then elaborating a Decision Support System seems to be an accurate decision.

- As this analysis was carried out after the ramp up of projects, the suggestions of making studies to determinate the time in which urban public transportation projects get a stable behavior represents an adequate recommendation, to know the optimum period to evaluate projects.

- Some variables of the projects are directly affected by the GDP per capita of each country and other economical and social parameters; it is very important to develop a research to determinate which social and economical parameters affect these variables, and the percentage of it that is directly affected.

It is the hope of the author of the present research that, on the one hand, it has been demonstrated the viability of developing a decision support tool for helping the appraisal process of urban public transport projects and, on the other hand, this tool would somehow simplify the tasks of people involved in the finance of this kind of projects.