European Rail Traffic Management System (ERTMS) across the Israeli rail network – a comprehensive economic feasibility study

VLADIMIR SIMON
Director, Transport Economic Planning and Research
Contents

• Economic and Transport Indicators

• Israel’s Transport Projects Appraisal (TPA) procedure

• ERTMS – Economic & Transport Evaluation.
Economic and Transport Indicators
ISRAEL - OVERVIEW

Total Area – 22,145 km²
2018:
Population – 8.9 million;
GDP - $ 374B, GDP per capita - $ 42 K
ISRAEL - OVERVIEW

8.9 million residents in 2018
Forecast 11.2 Million in 2030

Young population - about 50% is under the age of 30

The birth rate is the highest among the OECD countries

Life expectancy is ranked 11th among the OECD countries

Fertility rates in OECD countries

The birth rate in Israel is 3.1, compared with 1.75 on average in OECD countries

Source: OECD (2018), Fertility rates
## Inhabitants per km² in Selected Countries 2016

<table>
<thead>
<tr>
<th>Country</th>
<th>Population (000)</th>
<th>Inhabitants per km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>8,679</td>
<td>103</td>
</tr>
<tr>
<td>Belgium</td>
<td>11,288</td>
<td>370</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>7,177</td>
<td>65</td>
</tr>
<tr>
<td>Czech</td>
<td>10,604</td>
<td>134</td>
</tr>
<tr>
<td>Greece</td>
<td>11,218</td>
<td>85</td>
</tr>
<tr>
<td>Hungary</td>
<td>9,784</td>
<td>105</td>
</tr>
<tr>
<td>Slovakia</td>
<td>9,764</td>
<td>22</td>
</tr>
<tr>
<td>Switzerland</td>
<td>8,320</td>
<td>202</td>
</tr>
<tr>
<td>Netherlands</td>
<td>16,938</td>
<td>408</td>
</tr>
<tr>
<td>France</td>
<td>64,457</td>
<td>117</td>
</tr>
<tr>
<td>Germany</td>
<td>81,708</td>
<td>229</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>65,397</td>
<td>269</td>
</tr>
<tr>
<td><strong>Israel</strong></td>
<td><strong>8,629</strong></td>
<td><strong>391</strong></td>
</tr>
</tbody>
</table>

# Economic and Transport Indicators in Israel 1990-2018 and Forecast for 2020

<table>
<thead>
<tr>
<th>Economic Indicators</th>
<th>1990</th>
<th>2018</th>
<th>2020 Forecast</th>
<th>Average Annual Growth Rate (1990-2020)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population (Millions)</td>
<td>4.8</td>
<td>8.9</td>
<td>9.3</td>
<td>2.2%</td>
</tr>
<tr>
<td>Real GDP (Billion NIS, 2018 prices)</td>
<td>357</td>
<td>1,370</td>
<td>1,455</td>
<td>4.7%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Transport Indicators</th>
<th>1990</th>
<th>2018</th>
<th>2020 Forecast</th>
<th>Average Annual Growth Rate (1990-2020)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicles (Millions)</td>
<td>1.0</td>
<td>3.4</td>
<td>4.1</td>
<td>4.7%</td>
</tr>
<tr>
<td>Cargo at Sea Ports ( Millions of Tons)</td>
<td>22</td>
<td>53.6</td>
<td>58.2</td>
<td>3.3%</td>
</tr>
<tr>
<td>International Passenger Flow at Airports (Millions)</td>
<td>3.7</td>
<td>22.9</td>
<td>26.9</td>
<td>6.8%</td>
</tr>
<tr>
<td>Container Flow (Millions of TEUs)</td>
<td>0.5</td>
<td>2.9</td>
<td>3.4</td>
<td>6.5%</td>
</tr>
<tr>
<td>Rail Passenger Flow (Millions)</td>
<td>2.5</td>
<td>64.6</td>
<td>70</td>
<td>11.8%</td>
</tr>
</tbody>
</table>
Rate of Motorization of Passenger cars in Israel and Selected Countries 2002, 2015

(1) Number of vehicles per 1,000 residents, including: private cars, taxis and minibuses that are designed to transport up to 9 persons (including the driver).
(2) Data from 2014.

Source: Central Bureau of Statistics, Israel, Motor Vehicles 2016 (publication no. 1688)
Rail Passengers 1996 – 2018 and Forecast for 2022 (millions)
Israel’s Transport Projects Appraisal (TPA) procedure – “Nohal Prat”
Investment in transport infrastructure improves mobility and is considered to have a major affect on economic activity and growth.

In Israel, the Ministry of Transport and Road Safety is in charge of:

- transport policy,
- infrastructure financing
- and strategic planning,

while governmental companies and local authorities are in charge of project planning, building and maintenance.
The main aims of TPA are:

- Select alternatives for proposed projects
- Correct design for each alternative and finally the chosen alternative
- Determination of the timing of investment in each project
- Selecting a "basket" of projects that maximizes the benefit of resources that can be addressed.

- The first official project appraisal guide published in 1996.
- The next official versions were published in 2006 and 2012.
- The new 2019 version is being prepared and supposed to be published on January 2020.
Introduction to TPA ("Nohal Prat") - General Methodology

Transport Network
- Without project
- With project

Transport Network
- With project

Origin-Destination matrices

Savings in vehicle operating costs

Value of time savings

Other benefits:
- Safety
- Environmental
- Induced traffic
- Agglomeration

Project investment, operating and maintenance costs

Economic Indicators (NPV, IRR, B/C, FYBC)
ERTMS – Economic & Transport Evaluation
Haifa and Northern Districts
2.4 million people, 27%

Central district
2.2 million people, 25%

Tel Aviv district
1.4 million people, 16%

Jerusalem district and surrounding area
1.5 million people, 17%

Southern district
1.3 million people, 15%
The length of Israel's rail network is approximately 1300 km of single track. The Ayalon Corridor in the center of the Tel Aviv metropolitan area is the heart of the national railway system. This corridor has almost reached the peak of its capacity.
ERTMS - SWOT Analysis

Strengths
- Increased reliability and safety of rail.
- Increased capacity
- Reduced passenger travel times

Opportunities
- Increasing the competitiveness of rail.
- Postponement of several investments in rail.

Weaknesses
- A major investment
- In the short run, adjustments in existing infrastructure/rolling stock

Threats
- Future technology application may depend on ERTMS.
- Cyber risk exposure
ERTMS - Introduction

- ERTMS will allow:
  - Significant increase in train traffic safety, prevention of human error.
  - Increase of 30% in the number of trains during peak-hours - a total Ayalon Corridor capacity increase from 14 trains today to 17 trains.
  - Potential increase of maximum train speed from 160 to 250 km/h.
  - Up to 5% energy savings.
  - Replacing the MIRS public communications system with GSM-R.
• Upgrade of the public transport system such as the ERTMS project, affects all passengers on both road and rail.

• Investment in public transport generates two types of benefits arising from savings in travel time:
  ✓ direct benefits
  ✓ indirect benefits

• Therefore, the ERTMS project will lead to two major outcomes:
  ✓ Increased level of service - Increased frequency, improved safety and better train reliability.
  ✓ Encourage public transport use.
Transport analysis of the ERTMS was performed on the basis of Israel's National Transport Model (NTM, mode choice, traffic and transit assignment software). NTM is based on wide-scale surveys and updated data from various sources, such as nation-wide cellular phone surveys, an innovative approach at that time.

The main purpose of the transport analysis was to forecast rail passengers for the years 2020, 2030 and 2040 under different scenarios. For this purpose, the transport model was applied numerous times, with and without the ERTMS.
The Israeli national travel demand model is updating to describe the national trip distribution in present, and as a platform for forecast the years 2030/40/50.

This travel demand are estimate in 3 dimensions: geography, day periods and transport mode.

The new model is based on a huge cellphones survey -more than 5.5 million people (60% of the all population in Israel) for 2 years. The main output will be trips origin-destination matrices for every month from-to 2,630 zones by hour, characteristics of the passengers and even the mean of traveling.

The implementation of the model to the long run (2030/40/50) will take into account different technology and behavioral scenarios.
• The original operational programmes of Israeli Railways were carried out with consideration to implementation of ERTMS. In order to evaluate ERTMS benefits, a scenario "without ERTMS" had to be created (for 2020/2030/2040).

• Modifications of the lines were defined and considered according to the following three options:

1. Modify or decrease frequency of lines with low average occupancy, replacing them with new lines.

2. Decrease proportionally the frequency of all lines which share the bottleneck segments of the rail network.

3. Sensitivity analysis no. 2 - decrease the frequencies of lines with high average occupancy and replace them with new lines in alternative corridors.
As to the transport analysis results: in the year 2040 the number of passengers that choose to travel by train during the morning average peak-hours, between 6:00 and 9:00 am, increases from 71,150 to 74,270 (an increase of 4.4%).

The transport analysis results show that the project's objectives were achieved.
ERTMS – Economic Evaluation Results

• The project cost, including VAT, is about €750 million. The study considers the renewal of technical equipment as well as rolling stock equipment every 20 years.

• Operating and maintenance costs of infrastructure and annual rolling stock were calculated based on data received from Israel Railways Company.

• The project was examined using 7% rate of interest, which is the rate posed by Israel's Ministry of Finance. The project's lifetime is determined to be 40 years.
ERTMS – Economic Evaluation Results

- Time savings: 41%
- Operating costs savings: 29%
- Freight benefits: 12%
- Rail accident savings: 12%
- Agglomeration benefits: 2%
- Environment costs savings: 1%
- Road accident cost savings: 3%
- Freight benefits: 12%

**Road accident cost savings:** 3%

**Operating costs savings:** 29%

**Time savings:** 41%

**Freight benefits:** 12%
# ERTMS – Economic Evaluation Results

<table>
<thead>
<tr>
<th>Test/alternatives</th>
<th>Net Present Value (millions of €), <strong>NPV</strong></th>
<th>Benefit-cost ratio, <strong>B/C</strong></th>
<th>Internal rate of return, <strong>IRR</strong></th>
<th>Investment coverage period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full network</td>
<td>87.2</td>
<td>1.24</td>
<td>8.33%</td>
<td>16</td>
</tr>
<tr>
<td><strong>Sensitivity Exams</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Investment cost increased by 50%</td>
<td>153-</td>
<td>0.72</td>
<td>5.21%</td>
<td>24</td>
</tr>
<tr>
<td>Modification option no.2</td>
<td>268</td>
<td>1.73</td>
<td>11.33%</td>
<td>12</td>
</tr>
<tr>
<td>Modification option no.3</td>
<td>316</td>
<td>1.86</td>
<td>11.57%</td>
<td>13</td>
</tr>
</tbody>
</table>
The project is expected to yield average daily savings (depending on the modification option) of 2,000-7,300 passenger hours in 2020, 6,100-9,600 hours in 2030 and 17,200-35,500 hours in 2040.

A full network project is economically viable;

Other benefits of the project, such as reliability improvement and train service quality improvement for users (passengers and cargo), were not quantified. These benefits would increase project feasibility.
The economic feasibility study found that the project is economically viable.

The study indicates the significance of passenger and driver time savings. In addition, the project provides other benefits such as vehicle operational cost savings, improved efficiency of freight transport and agglomeration.

Following the results and recommendations, the Ministry of Finance approved the inclusion of the project into Israel's Transport Work Plan. All components of the project are in different stages of implementation.
General Conclusions

• A transportation economy measures costs and benefits, and **enables rational decision-making** in the field of investment in, or management of, the transportation infrastructure.

• Economic examinations **require extensive information and research**, and sensitivity to developments in many areas: scope and deployment of housing and employment, technological changes, input prices, and more.

**Finally,**

**TPA is still only one of the tools used in the decision-making process.**
Thank you!

VLADIMIR SIMON
simonv@mot.gov.il