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Evaluation Framework for Investments in Rail Infrastructure Projects

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***Abstract*—**Transport infrastructures are high-cost, long-term investments that serve as vital foundations for the operation of a region or nation and are essential to a country's or business's economic development and prosperity, by improving well-being and generating jobs and income. The development of appropriate financing options is of key importance in the decision making process in order develop viable transport infrastructures. The development of transport infrastructure has increasingly been shifting toward alternative methods of project financing such as Public Private Partnership (PPPs) and hybrid forms. In this paper, a methodological decision-making framework based on the evaluation of the financial viability of transportation infrastructure for different financial schemes is presented. The framework leads to an assessment of the financial viability which can be achieved by performing various financing scenarios analyses. To illustrate the application of the proposed methodology, a case study of rail transport infrastructure financing scenario analysis in Greece is developed.

***Keywords*—**Rail transport infrastructure; financial viability, scenario analysis, rail project feasibility.

I. Introduction

LARGE Transport Infrastructure projects are megaprojects in the transportation sector (e.g. high speed railways, airports and long bridges). They are often late, costly, and fail to provide the promised benefits to the society [1], [2]. Budget constraints always play a pivotal role, so decision-makers need information regarding the spending and benefits promoted by infrastructure development to prioritize investment [3].

Government agencies and stakeholders ask for accurate evaluations of the economic impact due to the development of new infrastructure projects. However, the evaluation framework may differ, and it's crucial to conduct a project feasibility analysis [16].

Time and especially cost forecasts are difficult to estimate, and often prove to be wrong as Locateli at al. [4] analyze. The risk of cost overrun should be incorporated in the project evaluation and decision-making Berechman et al. [5] emphasizes. Mishra et al. [6] analyzes that transport infrastructures are irreversible investments and require long-time commitment maintenance and operation.

II. Investments in Transport Infrastructure

Transport infrastructure and especially freight rail projects and services require significant capital investment as well as ongoing funding for operations and maintenance [7]. There are many different approaches in the way the passengers rail projects on one hand and the freight rail projects on the other are financed and then funded. For the case of freight rail projects [8] as for example in the United States generate sufficient operating revenues to cover their capital, operating, and maintenance costs and they are operated as profitable private businesses. Passenger rail projects and services, do not have sufficient operating revenues to cover their operating and maintenance costs, let alone capital costs [7].

From a financial point of view, these projects have a "funding gap" and require other sources of funding in order to be sustainable. Many of these projects can generate very large non-market public benefits, such as improved connectivity, mobility and accessibility, regional economic development, reduced congestion and reduced environmental impacts. Although these public benefits can create a strong incentive for investmetns in such projects, they do not on their own generate funding sources to pay for such projects [7].

III. Evaluation Framework for Financial Feasibility

The financial viability of a transport infrastructure project results from its ability to meet its financial commitments and guarantee that its recurrent costs will be covered by multiple stakeholders. Financial viability is evaluated combing, various analyses and multiple criteria:

- The liquid assets necessary for the operation: the financing plan is entirely oriented toward the viability of the transport infrastructure
- Break-even point: determination of the minimal production level at which the investment in transport infrastructure can meet all its expenses.
- The financial performance: the negative or positive amounts of the cash flow, net operating profit, benefits

Different industries have different expectations, key strategies and key challenges as analytically presented in Fig. 1.

A. Stakeholders Different Interests Management

Transport infrastructure projects are developed in a way that competing stakeholder interests and contributions have to be managed. Cascetta et al. [9] defines that the quality of the decision-making process is a key factor for the successful planning and delivery of transport infrastructure projects. In addition, the decision-making process, grouping three institutional elements (strategic ambiguity, redundancy and resilience) under the notion of strategic capacity as Giezen et al. analyzes [10]. Hensher et al. [11] review the role of how the emotional bias toward certain type of project can affect the

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decision process and ultimately the project performance. Stakeholders generally fall into three categories: such as governments, private sector enterprises, private equity) and providers (constructors and operators). Fig. 1 shows analytically a sample of the project environment featuring the different kinds of stakeholders involved on a typical rail transport project in the financing process.

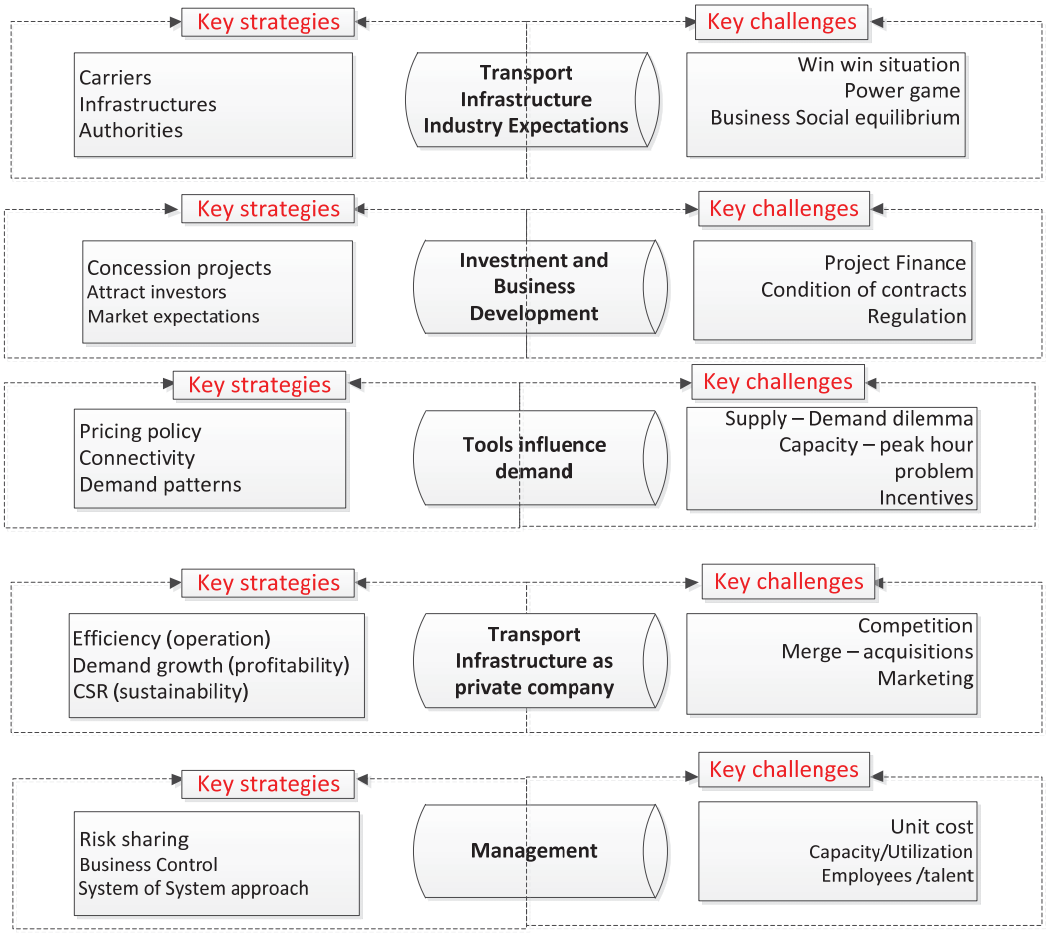

Fig. 1 Transport industry expectations for investing in infrastructure projects

Several different determinants of transport infrastructure projects conceptually represent how those determinants can improve efficiency and performance [14]. The different determinants that play the most key role to cross border rail investmetns are evaluated.The aim is to define the objectives and key different aspects that stakeholders have to deal with worldwide by a top down overal approach framework [14].

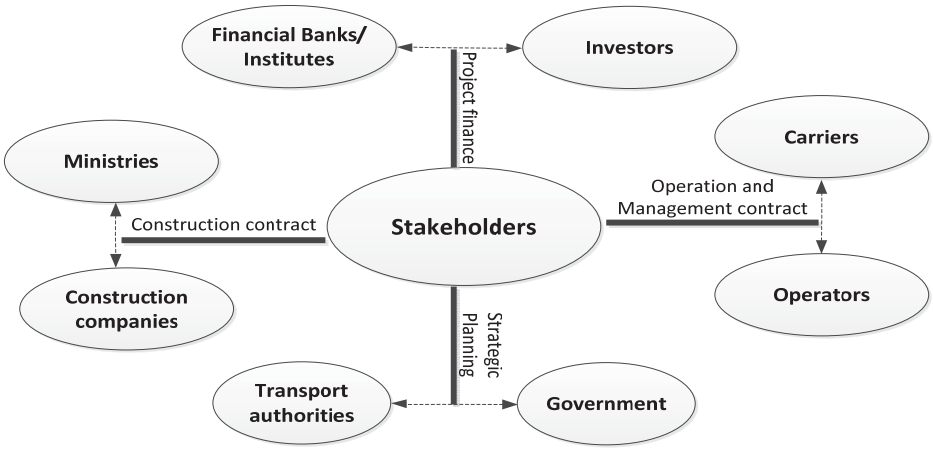

Fig. 2 Different stakeholders in the financial vialability evaluation process

B. Developing Best Cases Financing Scenarios

Whether driven by revenue growth, better performance, more efficient cost management, it is critical for viable transport infrastructure to identifying both the long-term benefits and impact on the overall business, services and strategy and develop different financing scenarios.

OECD 2014 analytically defines. There are many aspects , including the overall macroeconomic environment, and the ristrict financial rules in countries suffering from recessions have led to a reallocation of flows from the banking institutions to various private investing institutions.

There are many of ways to finance transport infrastructure development. The public sectors role can vary and there are a number of hybrid forms. The literature on private provision of infrastructure has proved many different aspects why social welfare under public provision and PPPs may be different. First, since the same investor constructs and operates the project under a PPP, it has incentives to consider life cycle cost considerations during the construction phase, and on the other side service quality provide a good argument in favor of PPPs. The reason is that the investor has an incentive to define the life cycle costs and, at the same time, cannot reduce on the quality of service [12].

Pellegrino et al [13] proposed a new "dynamic" risk management approach for PPP financing schemes based on aspects that improves the traditional risk management scheme by supporting the stakeholders with a cost-effective combination of forms based on PPP investment in order to control risk and optimize the economic value of the investment [13].

C. Alternative Financing Scenario Development

1.Public Funding

Direct public funding includes State budget money invested in the project. The budgetary funds owners may be local governments, subdivisions of ministries, public organizations, or other institutions. The Central Government gives finances according to the state budget to the budgetary funds owner, who uses it to finance transport and logistics infrastructure projects. The objects of investments will be owned by the State.

2.Funding from Investment Bank and Financial Institutions

Domestic Bank financing may be difficult with financial restrictions due to the narrow, concentrated and illiquid nature of the domestic banking sectors. The tightening of banking regulations in the aftermath of the financial crisis could also impede international financing of infrastructure projects. Once the projects proved to be viable, large international banks such as European Investment Bank will be another scenario for finance.

3.Public-Private Partnership

A public–private partnership (PPP) is a cooperative arrangement between one or more public and private sectors, typically of a long term nature. In recent decades a huge trend towards the use of PPP fianncing schemes due to global financing restricting times has taken place.

The financial crisis of 2008 onwards brought high interest in PPPs. Financing constraints on public resources due to recession, while highlighting the importance of new infrastrucutre investments in order to boost regional and economic development are increasingly interest and financing mechanisms to the private sector as an alternative additional source of funding in order to meet all the funding gap. While recent interest has been increased on fiscal risk, governments focus on the private sector involvemnet for many reasons:

- Improve operational efficiency
- Give incentives to the private sector to deliver projects on time and during time constraints
- Increase levels of private sector participation in a way so as to transfer of snew and innovative skills
- Make the country more competitive in terms of transport infrastructure and accesibility
- Meet future growing demand for transport infrastructure development

4.Private Investment

Private investment is the financial model where a private investor will finance the project. Such private investors may be private companies and enterprises or individuals. In this model, the private investor uses his own money or borrows it from the financial market and invests it in his/her own infrastructure object.

The target for each financing scenario is to reach the desired socioeconomic effects. The likelihood balance between the financing scenarios described above and the socioeconomic effects are depicted in Fig. 3.

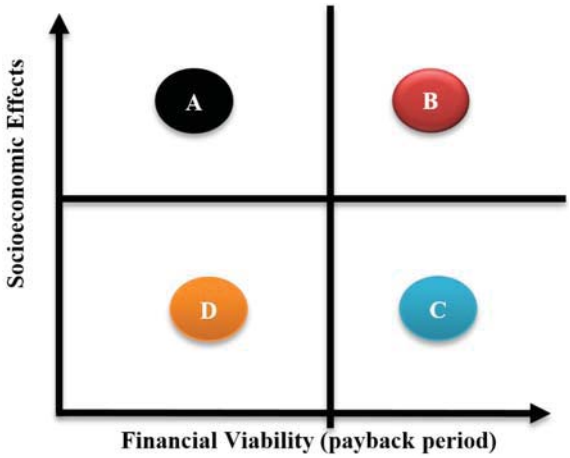

Fig. 3 Balance between financial viability and socioeconomic effects for the financing scenarios

IV. Case Study

The project involves the renovation of infrastructure – trackwork in located stretches of the rail line and the installation of electrification – signalling – ETCS Level 1 along the entire Alexandroupolis – Ormenio – Bulgarian borders line [15]. The 180km rail line between Alexandroupoli

and Ormenio/Bulgarian line has been recently reconstructued with modern superstructure materials [16]. According to OSE,2014 the line includes 70 bridges and 13 stations serving passenger transportation [14].

There is lack of electrification infrastructure and advanced signalling equipment and this affects the efficiency of the corridor. The upgrading of the signalling systems can improve the sustainability of the corridor, its capacity and safety [16].

Improvement of the level of service in terms of distance, comfort, and quality and increase of rail safety –reduction and rail accidents will:

- Improve Intermodality
- Improve connectivity with the EU Rail Network
- Improveconnectivity with East freight market
- Support the improvement of the strategic location of the country
- Become an international freight hub for Central and Eastern Europe
- Improve rail connectivity with ports and industrial areas in the region of Thrace and in Bulgaria (Burgas) and (Varnas) [16].

The great importance of the upgrade of the Alexandroupolis-Ormenio rail line is the potential to connect Alexandropoulis with the two ports in Bulgaria (Burgas and Varna), which could increase intermodal transport and enable the operation of the three ports as transit centers for the commercially fast-growing Black Sea area, bypassing the Bosporus which is saturated with shipping [14].

The first step towards the connection of the Ports of Bulgaria with Alexandroupolis is the upgrade of the line Alexandroupolis- Ormenio(A-O), then the construction of the rail and road network from Ormenio to port of Burgas and then to the port of Varnas. The stimulation of the trade demand growth is divided in three phases as analytically described below.

The analytical specification of alternative financing scenarios is analytically depicted in Table I for scenarios A, B, C, and D. The risk for each scenario is demonstrated in Fig. 5. Scenarios A1,A2,A3B1,C3,D1,D2,D3 are in the high risk area, the scenarios B2,B3,C1,C2 are in the medium risk area.

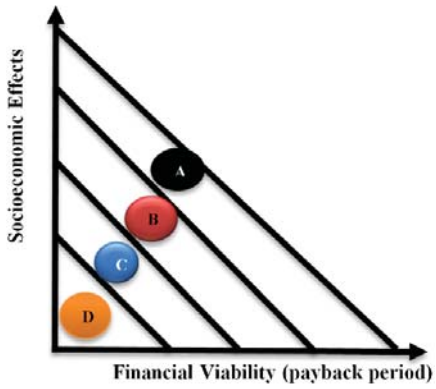

Fig. 4 Payback period for the likelihood financing scenarios

TABLE I
PROJECT FINANCING SCENARIOS

Scenario	Interest rate (%)	Financing Conditions	Investing Conditions	Impact to project budget
Acronym	*30 years average*	*Capital and Equity*	*Scheme and nature*	*Cost and Time*
A1 **A2** **A3**	1.5-2.5	-- National budget -- National funds supported by ECB -- National average loan rate > 1% -- All investing risks to public sector	-- Public financing schemes -- Implemented by Governmental entities -- Minimum earnings ratio	-- Construction offer rate (reduction) 30% -- Potential impact on implementation time (additional 1 year)
B1 **B2** **B3**	3.0-4.0	-- Supported by investing bank/funds (EIB, EBRD etc) -- National funds contribution up to 50% -- National funds average loan rate > 1% -- risks to public sector	-- Public financing schemes -- Implemented by Governmental entities -- Investing Banks earnings ratio	--Construction offer rate (reduction) 30% -- Potential impact on implementation time (additional 1 year)
C1 **C2** **C3**	4.5-5.0	-- Supported by investing bank/funds (EIB, EBRD etc) up to 70% -- National funds contribution up to 50% -- Public funds average loan rate > 1% -- National 25years bonds > 4% -- risk sharing mechanism between private and public	-- PPP financing schemes -- Implemented by Concessioner's entities -- Investing Banks earnings ratio -- private sector earrings: 5 < IRR < 8	-- Maintenance included in PPP -- Minimum implementation time (2 year) -- Project control and management cost 3% of the total budget
D1 **D2** **D3**	6.0-7.0	-- Minimum supporting by investing bank/funds <25% -- Non-national funds -- All investing risks to private sector	-- PPP financing schemes -- Implemented by Concessioner's entities -- Capital resources: equity and bank loans -- private sector earrings: 5 < IRR < 12	-- Maintenance included in PPP -- Minimum implementation time (2 year) -- Project control and management cost 3% of the total budget

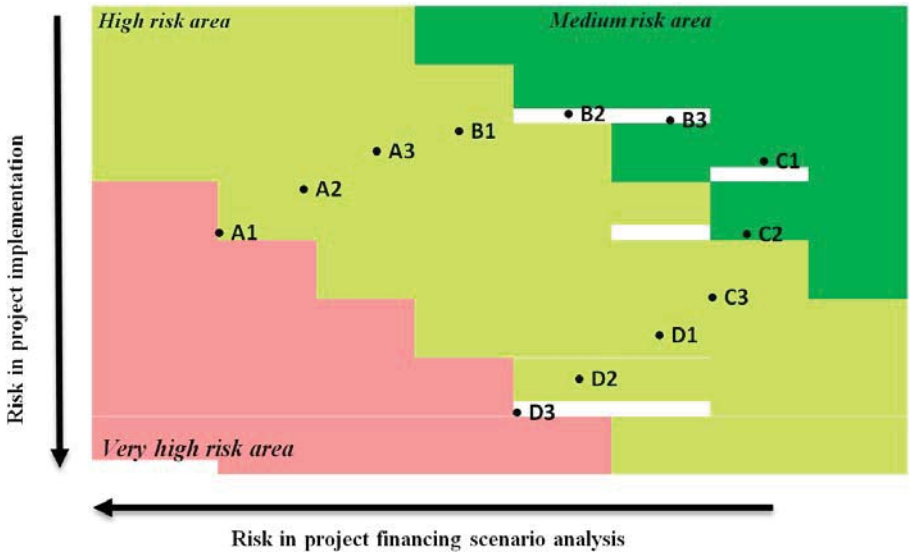

Fig. 5 Likelihood financing scenarios for the case study

V. Conclusions

From the point of view of the state if the capitals could be secured then the most suitable option for the project financing is option A and secondly B. The payback period could be only slightly above 20 years; however, the capital resources for this project is essential challenge. For the case that in the project funding should stimulate capitals driven from the Funds and Private the payback period ranges from 30 to 35 years and the concession period for the C and D scenarios should be extended for 35 years. The less attractive option is the D scenario, mainly because of the high capitals and financing cost. The most beneficial (in term of risk and cumulative investment capitals) seems to be the C project financing scenarios (PPP) including all the operational and the project financing costs.

References

[1] C.C. Cantarelli, et al. Cost overruns in large-scale transportation infrastructure projects: explanations and their theoretical embeddedness Euro. J. Transp. Infrastruct. Res., 10 (1) (2010), pp. 5–18
[2] B. Flyvbjerg, M.K. Skamris Holm, S.L. Buhl What causes cost overrun in transport infrastructure projects? Transp. Rev., 24 (1) (2004), pp. 3–18
[3] OECD, 2016. Transport Infrastructure investment. OECD Official Website (accessed 02/12/2016).
[4] Giorgio Locatelli, Diletta Colette Invernizzi , Naomi J. Brookes, Project characteristics and performance in Europe: An empirical analysis for large transport infrastructure project, Transportation Research Part A: Policy and Practice, Volume 98, April 2017, Pages 108–122,
[5] J. Berechman, L. Chen Incorporating risk of cost overruns into transportation capital projects decision-making J. Transp. Econ. Policy, 45 (January) (2011), pp. 83–104
[6] S. Mishra, S. Khasnabis, S. Swain Incorporating uncertainty and risk in transportation investment decision-makingTransport. Plan. Technol., 38 (7) (2015), pp. 738–760
[7] Alternative Funding and Financing Mechanisms for Passenger and Freight Rail Projects (NCCRRP) National Cooperative Railroad Research Program (NCRRP); Transportation Research Board,2015
[8] Pantelias A. and Zhang Z.(2010). Methodological Framework for Evaluation of Financial Viability of Public-Private Partnerships: Investment Risk Approach, Journal of Infrastructure Systems, Vol. 16, Issue 4 (December 2010)
[9] E. Cascetta, et al. A new look at planning and designing transportation systems: A decision-making model based on cognitive rationality, stakeholder engagement and quantitative methods Transp. Policy, 38 (2015), pp. 27–39
[10] M. Giezen, W. Salet, L. Bertolini Adding value to the decision-making process of mega projects: fostering strategic ambiguity, redundancy, and resilience Transp. Policy, 44 (2015), pp. 169–178
[11] D.a. Hensher, C. Ho, C. Mulley Identifying preferences for public transport investments under a constrained budget Transport. Res. Part A: Pol. Pract., 72 (2015), pp. 27–46
[12] Engel, E. M. R. A.; Fischer, R. D.; Galetovic, A. (2010) The economics of infrastructure finance: Public-private partnerships versus public provision, EIB Papers, ISSN 0257-7755, Vol. 15, Iss.1, pp. 40-69
[13] Pellegrino R., Vajdic, N., Carbonara, N. (2013) "Real option theory for risk mitigation in transport PPPs", Built Environment Project and Asset Management, Vol. 3 Iss: 2, pp 199-213
[14] Dimitriou D., Sartzetaki M. (2016). Decision Framework for Cross-Border Railway Infrastructure Projects, International Journal of Social, Behavioral, Educational, Economic, Business and Industrial Engineering, Vol.10 (11), pp 3531-3536.
[15] Ergose, http://www.ergose.gr/view, (assesed May 2017)
[16] Dimitrios J. Dimitriou,2017, Quantitive evaluation taxonomy for transport infrastructure project, International Journal of Rexearch Science and Management 4(3), ISSN: 2349-5197.