BENEFIT

Business Models for Enhancing Funding
& Enabling Financing for Infrastructure in Transport

Deliverable: D 3.2 – The Decision Matching Framework Policy Guiding Tool, Project Rating Methodology and Methodological Framework to increase business model creditworthiness

European Commission

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BENEFIT Business Models for Enhancing Funding & Enabling Financing for Infrastructure in Transport

The Partnership

University of the Aegean,
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Project Coordinator

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Glossary

Within BENEFIT certain terms are used throughout. These are described here.

Collective BENEFIT database: This is the BENEFIT database consisting, at the start of the project, of seventy-five case studies of funding transport infrastructure and twenty-four country profiles. These are published data from COST Action TU1001 and the OMEGA Centre megaprojects. During the course of the project, the database will be supplemented with at least twenty-eight more cases of funding/financing infrastructure (in particular public funding/financing, which are less represented).

Funding Scheme: A funding scheme is considered to be any combination of private and public income generated by or towards the infrastructure over its life cycle. These may include any combination of user contribution (tolls, fees, fares etc.) or public contributions based on direct and indirect taxation etc. Public funding may also take on the form of availability fees, shadow tolls etc.

Financing Scheme: A Financing scheme is considered to be any combination of public and/or private financial investments required by the infrastructure over its life cycle.

Business model: The business model describes the business case of the overall investment in the project. Depending on the context, it may be narrowed, including strictly the infrastructure projects considered, or it may be widened, including other planned and commonly designed activities in order to capture other "planning gains" (and other value-added services) and even exploiting synergies across the sectors (e.g. transport, energy, ICT). The latter incorporates the notion of innovative procurement and other approaches to infrastructure delivery, now in the pilot phase.

Key Elements: Elements are groups of variable project dimensions of the same context, which influence the performance of the funding scheme and financing scheme. Elements, as noted in Figure 1.1.1 [of the proposal/contract], are the implementation environment (socio-political, micro and macroeconomic, institutional, regulatory, etc.); the transport mode (functionality; natural and contractual exclusivity, etc.); business model structure; funding scheme; financing scheme and governance and institutional arrangement (risk allocation; decision making processes; ownership rights, etc.).

Typology: A typology concerns groups of factors describing a project that contribute in demonstrating a particular behaviour. Example: Negative Private investment environment type in the implementation context typology. The group of factors leading to the demonstration of this behaviour may be: poor growth forecast, lack of enabling legal framework etc. Typologies for every element (context) will be generated during the project using the collective BENEFIT database (country profiles and case studies) as field examples and desk research. Quantitative and qualitative analysis are the analytical tools that may be used.

Decision Matching Framework: This is the Analysis and Decision Framework to be developed by the BENEFIT project. The framework will contain typologies influencing the overall performance of the investment. It will initially be developed using hypotheses of optimum matching between types, which are confirmed as Matching Principles (rules describing how optimum performance may be achieved) during the course of the project. As such, it could be used as an analysis tool (e.g. identification of "mismatches") or decision tool (e.g. given the types of elements, which funding scheme type or project rating framework (expressed as the risk to match a specific financing scheme) or project rating enhancing framework (which types may be changed and in which direction to improve project rating) is most appropriate).

Snapshots: These describe the project case study at various points in its life cycle through the typology indicator values at the particular point in time.

Transport Infrastructure Resilience Indicator: The ability of a Transport Infrastructure project to withstand and recover from changes within its structural elements with respect to its ability to deliver specific outcomes (such as cost and time to completion, expected traffic and expected revenue targets). The Transport Infrastructure Resilience Indicator has an underlying rating system whose categories reflect the likelihood of achieving pre-specified outcomes targets and expressing the level of vulnerability of the project to external adverse implementation conditions.

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Indicators

The Financial Economic Indicator measures more than just the macro-economic and macro-financial context of a country, but more broadly the *business environment* and can be seen as a proxy of *the level of productivity of a country*. The Global Competitiveness Index of the World Economic Forum was selected to describe this indicator.

The Institutional Indicator encompasses factors ranging from political stability to government efficiency as described by the respective score of the global competitiveness index.

The Cost Saving Indicator is a composite indicator including: Ability to construct (Level of civil works/ technical difficulty; Capability to construct; Construction risk allocation as per contractual agreement; Assessment of optimal construction risk allocation based solely on the capability to construct); Ability to monitor/control/plan and provide political support of the respective (public) contracting authority; Adoption of Innovation and its successful application; Life Cycle Planning and operation (Life cycle planning verification; Capability to operate; Operation risk allocation as per contractual agreement; Assessment of optimal operational risk allocation based solely on the capability to operate).

The Revenue Support Indicator is a measure of the project's ability to generate revenues. It is a composite indicator that includes: The level of Coopetition of the new (greenfield) and existing (brownfield) parts of the project; revenue transport and non-transport sources managerial assessment.

The Reliability/Availability Indicator represents the level of physical and operational reliability and availability of the transport service

The Governance indicator refers to factors setting the governance scene within a project. In this respect, it is defined by the contractual conditions and the process leading to them.

The Remuneration Attractiveness Indicator represents the various income sources with their assessed risk and potential cost coverage.

The Revenue Robustness Indicator represents the various revenue sources with their assessed risk and potential cost coverage.

The Financing Scheme Indicator reflects an expanded version of the cost of capital included in the project both from public and private sources (1-$WACC^{ad}$).

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Executive Summary

The BENEFIT project takes an alternative approach in analysing financing and funding schemes in transport infrastructure delivery within an inter-related system. This "System" is represented by indicators describing key elements of the transport infrastructure implementation context.

Following the development of the BENEFIT Matching Framework (MF) during the previous stages of the BENEFIT project, as well as the ex-post analysis of existing experience conducted qualitatively on the case studies and quantitatively through their indicator representation, the analysis conducted within this present report aims at capitalising on and synthesizing the findings of the above tasks in order to identify the combinations of BENEFIT Matching Framework indicators required to increase the likelihood of achieving target performance outcomes per mode. The outcomes selected at the start of the BENEFIT project have been: cost–to- (construction) completion; time–to- (construction) completion; actual vs forecast traffic; and actual vs forecast revenues. In other words, the BENEFIT Matching Framework is further adjusted and refined with respect to its functioning as a Policy Guiding Tool. More specifically, the objectives of the present analysis are to develop the following elements:

- The Decision Matching Framework Policy Guiding Tool;
- The Project Rating Methodology; and
- The Methodological Framework to increase business model creditworthiness.

The Decision Matching Framework Policy Guiding Tool is founded on the use of a new indicator, entitled **Transport Infrastructure Resilience Indicator (TIRI)**. Project resilience is defined herein as "*the ability of a transport infrastructure project to withstand and recover from changes within its structural elements with respect to its ability to deliver specific outcomes (such as cost and time to completion, expected traffic and expected revenue targets)*" (see Chapter 2).

The TIRI is a natural next step following the synthesis of findings from various previous parallel streams of analysis undertaken within BENEFIT (Tasks 4.1 stage 2, 4.2 and 4.3 and 5.2 on BENEFIT Policy Dialogues). These findings were merged and assessed in a comparative and complementary manner in order to map the conditions of resilience with respect to achieving key target outcomes per infrastructure mode (Chapter 3).

The above synthesis of findings of the quantitative indicator analyses (fsQCA, Importance Analysis and Econometrics Analysis) and the qualitative analysis per mode distinguished the BENEFIT Matching Framework indicators into two categories, with the second being further divided into two sub-categories. This categorisation corresponds to the degree of influence a decision-maker may have on the project's outcomes over time and include:

- **Exogenous Indicators:** These include the Financial-Economic indicator (FEI) and the Institutional Indicator (InI), describing the project's implementation context. The decision maker has no influence over these indicators and their values.

- **Endogenous Indicators:** All other indicators fall under this category. This category is further divided into the following two groups:
    - **Structural Indicators**: These are the Reliability-Availability indicator (IRA), the Cost Savings indicator (CSI), the Revenue Support indicator (RSI) and the Governance indicator (GI). Structural indicators describe the business model and the contractual conditions of implementation. Notably, following project award, the flexibility and, therefore, the range of possible available "structural" decisions gradually becomes limited.
    - **Policy Tool Indicators:** These are the Remuneration Attractiveness indicator (RAI), the Revenue Robustness indicator (RRI), and the Financing Scheme indicator (FSI). The

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values of these indicators may be changed throughout the life cycle of the project) based on corresponding decisions. These indicators, in combination with other indicators, and for specific values of their combination(s), have the ability to drive particular aspects of project performance. Also, the structure of the FSI allows for new financing instruments to be tested.

Regarding the exogenous indicators, the Financial-Economic indicator (FEI) is an important indicator but does not have the same impact on all modes, with road projects being particularly sensitive to it. On the other hand, the **Institutional indicator (InI) has been identified as potentially the most important external indicator across all modes and for all outcomes**. In many cases it was identified to be able to offset the impact of a low or decreasing FEI.

With respect to the endogenous ones, the Governance indicator may compensate and/or enhance the Institutional Indicator. Most importantly, the **Cost Saving indicator was found to contribute to all outcomes** and, in the majority of cases, works in combination with GI, whereby a low value of the CSI could be often offset by a higher value of GI and vice versa. The Revenue Support indicator could only have a positive role, while the Remuneration Attractiveness Indicator (RAI) can act as a policy tool. Demand-based remuneration schemes (low value of RAI) work well under positive exogenous conditions. The Revenue Robustness Indicator (RRI) expresses the riskiness of the project revenue streams, as well as the estimated level of cost coverage.

In summary, certain indicators are more prominent than others, while neither single indicators nor specific combinations of these are able to secure the successful attainment of single outcomes, let alone of all four outcomes simultaneously. What is noticeable is the **importance of the overall Business Model and Governance indicators across all modes and outcomes** (with the exception of revenues for roads, where the influence of the implementation context is far more prominent). The role of the **Financing Scheme indicator in developing strategic trade-offs between cost and time outcomes** is also evident. Finally, **Remuneration Attractiveness, Revenue Robustness and Financing Scheme** indicators are considered to act as "policy indicators" as they **drive project outcomes differently according to their values**.

The fact that the analysis indicated that each transport infrastructure mode is influenced differently by the implementation context and that different indicators contribute in each case to achieving the respective outcomes inevitably **guides the assessment of resilience towards an infrastructure mode-specific process**, which also includes a different specification of high and low values of the indicators for each mode under consideration. Moreover, while the outcomes of transport infrastructure projects are influenced by factors outside the managerial ability of the parties involved, there are many other internal project factors that may be addressed to improve their potential of achieving expected outcome targets. This also constitutes an important input for the development of the resilience assessment methodology, as it suggests that **project resilience could be improved by managing internal project parameters, since external factors are not within the influence of project stakeholders.**

In light of the above, the methodological framework of the Transport Infrastructure Resilience Indicator developed in the present report adopted separate approaches per mode of transport, covering roads, special structures (tunnels, bridges), airports, and public transit projects. The methodology followed aims to assign values to the TIRI in the form of ratings, which reflect the likelihood of attaining the respective targets for each outcome considered within the BENEFIT project. For each of these modes the respective TIRI rating system has been provided (Chapter 4). It is also acknowledged that the TIRI contains a time dimension which may cause it to **change over time**. Therefore, both a Static Transport Infrastructure Resilience Indicator (S-TIRI) and a Dynamic one (D-TIRI) are introduced. This approach also leads to the development of an **Overall Transport Infrastructure Resilience Indicator (O-TIRI)**. With respect to the latter, the BENEFIT project has consistently maintained a **stakeholder-agnostic or neutral approach** throughout its research effort.

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Assessing the overall likelihood of project success is clearly stakeholder-dependent. To this end, potential approaches outlined for the estimation of the O-TIRI may be adopted and adjusted to each stakeholder's value system.

The TIRI comprises **three rating categories** that describe the likelihood of reaching the figure-of-merit target values (four goals/ figure-of-merit target values with respect to system performance: Cost-to-Completion; Time-to-Completion; Actual vs Forecast Traffic; and Actual vs Forecast Revenue). These are:

- Rating A: projects have a high likelihood of reaching a specific outcome target as they demonstrate a well-structured business model (indicators IRA, CSI, RSI and GI), and policy decisions (indicators RAI, RRI and FSI) are supportive within a positive implementation context (FEI and InI).
- Rating B: Under this category projects may be characterised as B_{EX} or B_{EN} depending on the source of vulnerability. More specifically:
    - Rating B_{EX}: projects have an average likelihood of reaching a specific outcome target as they demonstrate a well-structured business model (indicators IRA, CSI, RSI and GI), and policy decisions (indicators RAI, RRI and FSI) are supportive **but** in a marginally positive implementation context (FEI and InI).
    - Rating B_{EN}: projects have an average likelihood of reaching a specific outcome target as they are implemented in a positive implementation context (FEI and InI) but lack a well-structured business model (indicators IRA, CSI, RSI and GI) and supportive policy decisions (indicators RAI, RRI and FSI).
- Rating C: projects have a poor likelihood of reaching a specific outcome target as they are implemented in a poor implementation context (FEI and InI) **and** lack a well-structured business model (indicators IRA, CSI, RSI and GI) as well as supportive policy decisions (indicators RAI, RRI and FSI).

A slightly better or worse likelihood per rating is noted with a (+) or (-) notch. Additionally, the dynamic indicator (D-TIRI) is assessed on top of the Static one (S-TIRI) to determine the percentage change needed in the key implementation context indicator (FEI or InI) for S-TIRI to move down or up a rating category. The D-TIRI values represent the vulnerability or stability of the rating with respect to the outcome target under consideration.

Based on the above, a **TIRI rating was assigned to each figure-of-merit (outcome) per mode**, taking as a starting point the typical indicator thresholds that distinguish "high" from "low" values from the results of the previous comparative analysis (see Chapter 3) and the definition of indicator threshold values.

The TIRI rating system was subsequently applied to the **entire set** of BENEFIT case studies (Chapter 5) for which indicator values could be obtained and/or estimated. This set consisted of **57 cases**, with results presented per figure-of-merit and infrastructure mode (Annex 1). For each case, the Static Transport Infrastructure Resilience Indicator (S-TIRI) was compared to the Dynamic (D-TIRI).

The rating system's application aimed to serve as a calibration of the proposed methodology through the use of the BENEFIT case sample and provided **encouraging findings** with respect to its **ability to predict project performance**. It should, however, be noted that the **suggested TIRI ratings** are **not** a comprehensive assessment of a project. They present a forward-looking estimation of a project's potential to achieve certain outcome targets.

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The TIRI can, therefore, be **used as a Policy Guiding Tool** (Chapter 6). Both exogenous and endogenous indicators may change over the life time of a project. While there may be little influence both decision makers and managers can exert over exogenous indicators, endogenous indicators are clearly within their sphere of influence. Accordingly, the **potential actions that may be taken over the project life cycle together with the timeframe to improve the resilience of a transport infrastructure project to unexpected changes of its exogenous indicators through the enhancement of its endogenous indicators** were highlighted**.** The framework for achieving at least a B_{EX}+ rating for each project outcome is considered, since this increases the likelihood of a project to achieve a specific outcome target under adverse external implementation conditions. This framework constitutes **the Methodological Framework to increase business model creditworthiness**. In essence, the key indicators to be improved are those describing the business model which needs to be determined at the front end of the project, while the indicators that may be manipulated throughout the life cycle of the project, i.e. the indicators related to the Funding and Financing Scheme typologies, are more appropriately used as policy tools.

The proposed approach entails a number of limitations, which also impact the current ability to structure the rating system for all figures-of-merit (outcomes) for all modes. These limitations concern Airports, Ports and Rail projects. Key considerations with respect to adjustments needed have been identified and constitute the basis for further research. Furthermore, sample size and accuracy limitations need to be addressed through the consideration of additional case studies across all modes of transport. Furthermore, the TIRI methodology and its accuracy can also be substantially improved through a more extensive application to a larger and more detailed sample of cases and also extended to modes that were currently insufficiently covered in the BENEFIT database. In this way, the adoption of this methodology by the industry could ultimately lead to the development of time-series data of the attainment of project outcome targets, which can vastly improve the prediction capabilities of the methodology and further enhance the state-of-the-practice with respect to the assessment of a project to deliver on its expected outcomes.

Finally, through the research conducted herewith, a number of **lessons** may be concluded.

The results demonstrated that a poor implementation context will most likely influence traffic and revenue outcomes, but may equally have a negative impact on the potential to achieve cost and time-to-completion targets. Moreover, although the financial-economic conditions have a significant impact on project outcomes, a strong institutional context may limit or even cancel the effect of poor financial-economic conditions. Therefore, countries with strong institutions are more capable of “surviving” a financial-economic crisis. Finally, an effective and flexible transport infrastructure contract may compensate for relatively low institutional context conditions and in future may limit the impact of poor financial-economic conditions.

With regard to project structure, the combination of the Governance, Cost Saving and Revenue Support Indicators appears to influence the likelihood of attainment of most project outcome targets. Findings demonstrate that the capability to manage a specific risk should be the guiding principle for risk allocation. The Governance indicator is associated with the achievement of outcome targets, and hence, any renegotiation will, by default, reduce the effectiveness of governance. The only way to address this weakness is by including contractual flexibility, which places additional emphasis on procurement. Finally, well-planned and justified projects have a greater likelihood of reaching pre-defined outcome targets and withstand financial-economic downturns, while innovation and the integration of non-transport services and corresponding revenues during the project’s lifetime, available for further manipulation, require a capable (experienced) contracting authority.

As the project life cycle progresses, fewer alternatives for taking action remain at the disposal of decision makers. These include project elements that are included in the Remuneration Attractiveness (RAI) indicator, the Revenue Robustness (RRI) indicator and the Financing Scheme (FSI) indicator. As the need to support public budgets continues, the need to identify and structure low

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cost financing instruments becomes even greater. Projects with larger values of the FSI (publicly financed or heavily supported by the public sector) tend to favour the achievement of cost over time targets, while the opposite was observed for projects with lower FSI values. In addition, the BENEFIT analysis has shown that demand-based remuneration schemes may be sustained during the crisis by projects that present high exclusivity in combination with other contributing indicators. Finally, a high value of the RRI along with other contributing indicators will improve the ability of reaching revenue targets. If revenues sources are not increased, then the only alternative to increase the RRI is to adjust the cost to be covered by these sources. Ultimately this means reduction of operation/maintenance costs or reduction of project scope. In any case, **the effects of factors included in the Policy Tools Indicators on project performance should be carefully considered, especially during renegotiations.**

In conclusion, the BENEFIT Matching Framework, is well-positioned to function as a Decision and Policy Guiding Tool. In effect, it can serve as a monitoring and ex-ante scenario building tool which may predict the likelihood of reaching specific targets related to the four main performance outcomes. Through this process, it may also allow for the identification of adverse factors and the specification of corresponding mitigation and other performance-enhancing actions.

The above will be further tested and applied in Task 5.1, while BENEFIT final conclusions and guidelines on how to improve on performance delivered through Task 5.3.

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Abbreviations

MF	:	Matching Framework
TIRI	:	Transport Infrastructure Resilience Indicator
S-TIRI	:	Static Transport Infrastructure Resilience Indicator
D-TIRI	:	Dynamic Transport Infrastructure Resilience Indicator
O-TIRI	:	Overall Transport Infrastructure Resilience Indicator
FEI	:	Financial – Economic Indicator
InI	:	Institutional Indicator
GI	:	Governance Indicator
CSI	:	Cost Saving Indicator
RSI	:	Revenue Support Indicator
RAI	:	Remuneration Attractiveness Indicator
RRI	:	Revenue Robustness Indicator
MEAI	:	Market Efficiency & Acceptability Indicator
FSI	:	Financing Scheme Indicator
fsQCA	:	Fuzzy-Set Qualitative Comparative Analysis
IA	:	Importance Analysis

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1 Introduction

1.1 Introduction to the BENEFIT Project

BENEFIT seeks to take an innovative approach by analysing funding schemes within an inter-related system. Funding schemes are deemed to be "successful" (or not) depending on the Business Model that generates them as well as their stakeholders and policy contexts. The performance of the Business Model is affected by the implementation typology and the transport mode context – together with other contextual changes over time and space, including changes in overarching policy frameworks. It is matched successfully (or not) by a financing scheme. Relations between actors are partially described by a governance model (contracting arrangements). These are key elements in Transport Infrastructure Provision, Operation and Maintenance, as illustrated by Figure 1.1.1.

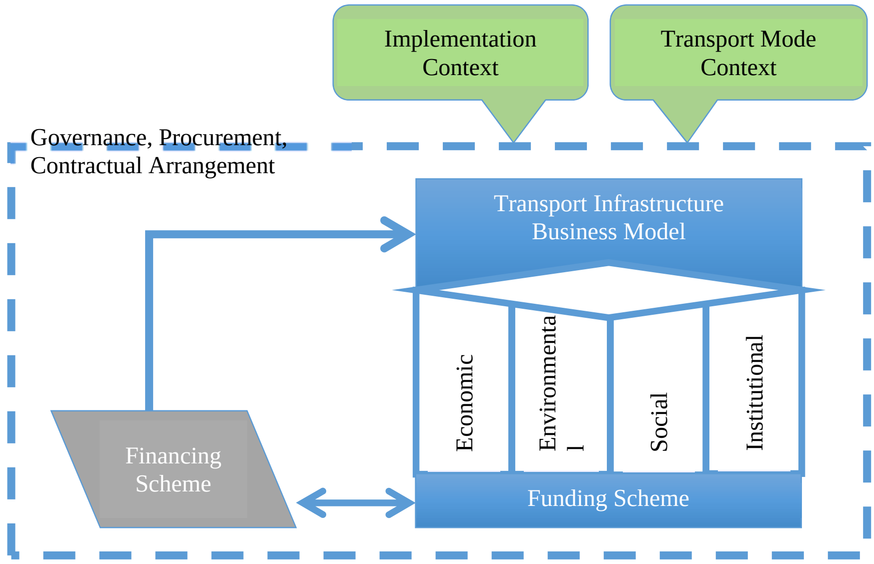

Figure 1.1.1: BENEFIT Key Elements in Transport Infrastructure Production, Operation and Maintenance

Success in relation to the application of a particular business model is seen here as an assessment of the appropriate matching of elements. Within BENEFIT funding and financing schemes are analysed in this respect. Describing these key elements proposed through their characteristics and attributes and clustering each of them into typologies is the basis of, first, developing a generic input/output model. Identifying best matches and their inter-relations (matching principles) leads to move from a generic model to a Decision Matching Framework that is developed to provide policy makers and providers of funding (and financing) extensive comparative information on the advantages and limitations of different funding schemes for transport infrastructure projects and improve the awareness of policy makers on the needs of projects serving an efficient and performing transport network within the Horizon 2050. Moreover, the model allows policy makers to identify changes that may be undertaken in order to improve the potential of success, such as improving the value proposition of the business model.

In developing this model, BENEFIT takes stock of project profiles known to its partners in combination with a meta-analysis of relevant EC funded research and other studies carried out with respect to funding schemes for transport (and other) infrastructure and direct contact with key stakeholder groups.

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More specifically, BENEFIT uses the published project profile descriptions of seventy-five transport infrastructure projects funded and financed by public and private resources from nineteen European and four non–European Countries covering all modes of transport. It also exploits twenty-four European country profiles with respect to contextual issues (institutions, regulations, macroeconomic and other settings) influencing funding and financing of transport infrastructure. This data has been produced within the framework of activities undertaken by the OMEGA Centre for Mega Projects in Transport and Development and the COST Action TU1001 on Public Private Partnerships in Transport: Trends and Theory. In addition, BENEFIT, through its partnership and respective experts, consolidates almost twenty years of successful European Commission research with respect to issues related to transport infrastructure and planning, assessment and pricing of transport services. In this sense the approach is supported by the tacit knowledge and insights of the BENEFIT partnership with respect to infrastructure projects in transport.

By applying the Decision Matching Framework, BENEFIT undertakes:

- An ex-post analysis and assessment of alternative funding schemes (such as public, PPP and other) based on existing experiences in different transport sectors and geographical areas and their assessment with respect to economic development, value for public money, user benefits, life-cycle investment, efficiency, governance and procurement modalities, etc.; and, provides lessons learned, identification of the limitations of the various schemes and the impact of the economic and financial crisis.
- An ex-ante (forward) analysis and assessment of the potential of transport investments and the related funding schemes, including innovative procurement schemes still in a pilot phase, to contribute to economic recovery, growth and employment, in view of future infrastructure needs with a 2050 horizon for modern infrastructure, smart pricing and funding.

BENEFIT is concluded within twenty one[2] months and bears the following stakeholder focus and policy scenarios:

- Transport infrastructure business models and their project rating: Improved value propositions lead to funding schemes with enhanced creditworthiness enabling viable financing, balancing of project financing and funding risks, increasing the value basis of stakeholders and highlighting the potential of transport investments.
- Transferability of findings with respect to lessons learned, limitations and the impact of the economic and financial crisis through the introduction of typologies for particular sets of stakeholder under different scenarios.
- Open-access case study database in a wiki format, allowing for continuous updates and providing a knowledge base serving both practitioners and researchers.

[2] Twenty –two months following the last BENEFIT project grant agreement amendment.

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1.2 Contribution of this Report to the BENEFIT Project

1.2.1 Contribution

The work undertaken under Task 3.2 aims to deliver against the following objectives, as stated in the BENEFIT proposal:

"Task 3.2 forms part of the Decision Matching Framework and is conducted after the ex-post analysis of existing experience where the matching principles (hypotheses) will be applied and tested. Feedback from this qualitative and quantitative process will be used to finalise the Decision Matching Framework in its function as a policy guiding tool. In addition, viewing the framework from a different perspective allows for the development of a methodology by which the transport business model and overall project may be rated. It will also allow the identification of means by which to increase creditworthiness so as to achieve improved terms of project financing. This will be compared to rating methodology reports issued by leading rating agencies. The enhancing business model approach will be compared to various common measures employed to strengthen infrastructure projects against risks such as Government credit guarantees; forfeiting of part of future revenues; introducing the option of prolongation of the toll period (in case of tolls) and others."

The research objective that this report aims to deliver against pertains to the development of the following elements:

- The Decision Matching Framework Policy Guiding Tool;
- The Project Rating Methodology; and
- The Methodological Framework to increase business model creditworthiness.

To this end Task 3.2 capitalises on all findings reported from all previous tasks and combines them to identify the combinations of BENEFIT Matching Framework indicators required to increase the likelihood of achieving respective outcomes per mode and more specifically: cost–to- completion; time–to-completion; actual vs forecast traffic; and actual vs forecast revenues.

Following on the BENEFIT concept, by which the delivery system is expressed through indicators, the Decision Matching Framework Policy Guiding Tool is founded on the use of a new indicator, entitled Transport Infrastructure Resilience Indicator (TIRI). In the context of BENEFIT, resilience is defined as "the ability of a transport infrastructure project to withstand and recover from changes within its structural elements with respect to its ability to deliver specific outcomes (such as cost and time to completion, expected traffic and expected revenue targets)".

The Transport Infrastructure Resilience Indicator *yields rating categories which correspond to the likelihood of achieving pre-specified outcomes and express the level of vulnerability of the project to adverse external implementation conditions.*

More specifically, for each pre-specified outcome and for every mode, the rating system supporting the Transport Infrastructure Resilience Indicator describes the combination of indicators and their respective values according to which the project may be characterised as:

- Having a high likelihood of reaching the pre-specified outcome target
- Having a high likelihood of *not* reaching the pre-specified outcome target
- Being resilient to adverse exogenous conditions
- Being vulnerable to adverse exogenous conditions

Notably, through this process the BENEFIT indicators are initially distinguished into two categories:

- Exogenous, i.e. indicators related to the implementation context and upon which the decision maker has no influence and can take no action to improve them, i.e. the Financial-Economic and the Institutional Indicators, and

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- Endogenous, i.e. the indicators that are connected directly to the structure of the project and are influenced by decisions made throughout the life cycle of the project.

Further to this categorisation, the endogenous indicators are characterised by their ultimate function which may be:

- Structural, as they may correspond to the project initial set up and business model (IRA, CSI, RSI and GI). Their key characteristic is the fact that their appropriate combination always leads to improved likelihood of achieving outcomes.
- Policy-related, as they may drive towards specific targets by taking low or high values depending on the outcome and mode under consideration (RAI, RRI and FSI).

By considering the above, a framework by which project performance can be enhanced is elaborated upon.

1.2.2 Limitations of Original Planning

The present report does not provide the assessment of the Transport Infrastructure Resilience Indicator for rail infrastructure projects. The reason is that the BENEFIT case database does not include adequate cases for which enough information was available to construct the BENEFIT indicators and, through the respective analyses of which a reliable rating system could be adopted.

The report, also, does not provide the assessment for the traffic and revenue outcomes for Airports and Ports. Through the consideration of findings from previous analysis streams, it was identified that in order to address Airports and Ports the BENEFIT indicators need to be adjusted to the particularities of these modes, especially with respect to their wider implementation context.

Finally, the Transport Infrastructure Resilience Indicator was not compared to actual commercial project credit ratings, as such ratings were not available for any of the projects in the BENEFIT database.

1.2.3 Extensions to Original Planning

The report contains a substantial extension with respect to the originally planned scope of work. This extension corresponds to the application of the developed Transport infrastructure Resilience Indicator methodology and its underlying rating to all BENEFIT case studies that could support it. Therefore, instead of providing one application per mode, all cases of road, urban transit, bridge and tunnel and airport projects[3] have been assessed. The results have provided a richer calibration of the methodology and have led to the identification of relevant conclusions and limitation which are presented at the end of this report.

[3] Only for cost- and time-to-completion outcome targets.

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1.3 Report Structure

This section provides a guide to the contents of this report. After discussing how this deliverable fits in the wider context of the BENEFIT project, (**Chapter 1**), this report aims to present a new indicator, the **Transport Infrastructure Resilience Indicator**, whose purpose is to assess the resilience of infrastructure projects towards the accomplishment of their expected outcomes against changes in their structuring elements.

Chapter 2 sets the methodological background of this deliverable by reviewing and reporting on relevant literature. The chapter starts with a discussion of project assessment methodologies used by various organisations and agencies. The concept of resilience is then explored together with methods of its measurement, with a focus on approaches that bear similarities to the BENEFIT context and structure. Particular focus is placed on credit assessment methodologies as they present the biggest similarity with the methodology that this task puts forward for the assessment of project resilience. In addition, this chapter presents methodological considerations that have affected and guided the development of the BENEFIT Transport Infrastructure Resilience Indicator. The different focus that BENEFIT has taken when assessing project resilience, i.e. the management and not just the bearing of risk, is also prominently highlighted.

Chapter 3 reviews results from previous BENEFIT analyses that have been obtained under tasks 4.1 stage 2, 4.2 and 4.3 and also task 5.2 which concerns the BENEFIT Policy Dialogues. The scope is to merge and leverage information and findings that can support the development of the Transport Infrastructure Resilience Indicator and the accompanying TIRI rating system. This is a crucial chapter as all findings are pulled together and assessed with respect to achieving key outcomes per infrastructure mode.

Chapter 4 presents the methodological framework of the Transport Infrastructure Resilience Indicator (TIRI) together with all its underlying assumptions. The methodology takes separate approaches per mode of transport covering roads, special structures (tunnels, bridges), airports and public transit projects providing the respective TIRI rating system. Rail projects are not covered as the rail sample of cases studies in the BENEFIT database was very limited and respective findings could not be used to develop the respective assessment system. Potentially, the urban transit assessment system could be adjusted to suit rail projects. Also, ports projects are not covered since it was identified in chapter 3 that the BENEFIT indicators would need, first to be adjusted to the particularities of port project delivery.

In Chapter 5 the application of the Transport Infrastructure Resilience Indicator (static and dynamic) is tested on the entire set of BENEFIT cases studies for which indicator values are currently available. The chapter constitutes an initial validation/calibration of the assessment methodology. The assessments are presented per mode in **Annex 1** and discussed in the chapter.

Chapter 6 maps the potential applications of the Transport Infrastructure Resilience Indicator with respect to ex-ante and on-going monitoring and even ex-post assessment of the project. In this chapter the Transport Infrastructure Resilience Indicator is used as a Policy Guiding Tool. As such, the process by which the project may be enhanced so as to improve its likelihood of achieving its goals is presented. The Transport Infrastructure Resilience Indicator is compared to creditworthiness ratings and the respective complementarities are identified. The present chapter, also, paves the way for Task 5.1.

Finally, **Chapter 7** concludes this report by discussing conclusions from the development and application of the Transport Infrastructure Resilience Indicator as well as highlighting topics for further research.

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2 Methodological background

2.1 Assessing infrastructure projects

Infrastructure projects are assessed under various contexts and for different purposes. Assessments can take place at the front end, especially during the appraisal phase, where they aim to determine whether projects should go forward with their implementation as well as how they should be structured. They can also be undertaken at the back end, usually aiming to evaluate whether initial expected outputs and outcomes have been met. In that sense, project assessments can be ex ante or ex post, depending on their timing with respect to the project's lifecycle. Furthermore, projects are usually monitored during their life cycle in an attempt to improve the prospect of achieving positive outcomes and avoiding/mitigating negative ones.

With respect to ex ante assessments, a fundamental initial assessment for every project to go forward is the determination of its overall rationale, a key component of which is economic viability or value for money, established by calculating and comparing its generated economic benefits and costs. Cost-Benefit Analysis (CBA) is the most well-known methodology for this type of assessment and is the one used by most agencies and organisations involved in the delivery of infrastructure projects (Carbonara *et al* 2016). Similarly, projects undergo financial assessment in order for their financial viability to be determined. For this type of assessment Discounted Cash-Flow (DCF) analysis is the most commonly used methodology through the development and elaboration of bespoke financial models and the computation of specific financial metrics such as the Net Present Value (NPV), the Internal Rate of Return (IRR) among others (Finnerty 2013). Environmental and social impact assessments also take place at the front end of infrastructure projects aiming to determine whether they have positive or negative impacts to the surrounding environment, both natural and man-made, within which they are developed. Very importantly these assessments also look at how these impacts can be enhanced or mitigated, depending on their positive or negative influence, respectively. For these types of analysis standardised methodological frameworks exist that are usually supported and/or promoted government ministries, typically of economics & finance or specific infrastructure (e.g Department for Transport in the UK) or by major organisations involved in infrastructure project development such as the World Bank (e.g. www.ifc.org/BiodiversityGuide), the European Investment Bank (EIB 2013) and others. Overall, ex ante project assessments are highly standardised depending on the methodology used and the subject of focus.

On the contrary, with respect to ex post assessments, little standardisation exists when it comes to evaluating whether projects have met their expected outputs and outcomes. Procedures may be published by ministries or parliamentary bodies, but these are not widespread. In most cases this is not undertaken at all, a fact that is corroborated by the lack of detailed records for most projects delivered around the world, whereas in cases ex post assessments are commissioned, the methodologies used are usually ad hoc and aim to monitor and record specific attributes of specific projects with little scope for generalisation.

Very importantly, in all above types of assessment the metrics that are determined through the various methodologies applied do not have the same meaning for all project stakeholders. In effect, stakeholders in infrastructure projects come with differing perspectives and many times competing objectives. It is therefore standard practice to customise these methodologies and/or interpret their results based on each stakeholder's own value system which reflects their unique point of view.

Although ex ante methodologies that treat the aforementioned economic, financial, environmental and social concerns of project stakeholders have been investigated and analysed extensively (Kwak 2009), the literature is currently lacking a methodology or a systematic process that considers the

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impact of institutional, strategic or managerial decisions on the likelihood of a project to achieve its expected outcomes. Managerial flexibility is treated to a certain extent and in an ex ante manner by the theory and applications of Real Options, where the focus is predominantly on the valuation of this flexibility and its impact on project selection and/or investment decisions (cfr. Copeland and Antikarov 2001). At the same time once it has been decided to go forward with a project, and its structuring negotiated and agreed upon by the relevant stakeholders few comprehensive methodologies are currently available that can be used to assess ex post whether these projects have met their expected objectives, let alone to investigate ex ante in a consistent and systematic way their sensitivity to changes in their structuring parameters and how such changes can ultimately impact project outcomes.

As described in Deliverable D3.1, the BENEFIT Matching Framework considers transport infrastructure projects as a system with inputs and outputs. Project selection as well as certain procurement decisions, are part of its input while project outcomes are its output. The Matching Framework itself is concerned with the interrelations of a number of additional structural elements (typologies) that affect the initial set-up of a project and aims to capture how their variation can affect the attainment of expected outcomes. In that sense, the development of an assessment methodology that measures or "rates" how likely infrastructure projects are to meet their expected outcomes, i.e., how "resilient" their structuring is in order to deliver these outcomes in the face of their ever-changing external as well as internal characteristics, is something that currently does not exist neither in the academic literature nor in industry practice. BENEFIT aims to contribute towards the bridging of this gap by leveraging information from its previous research findings and proposing a new Transport Infrastructure Resilience Indicator (TIRI).

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2.2 Resilience

2.2.1 Definitions

The term resilience (or resiliency) has received a lot of attention lately in the academic and professional literature. The term has its origin in the Latin term “resilire” which means “to leap/ spring/bounce back; to recoil” (Merriam-Webster n.d; Oxford Dictionaries n.d.). Resilience has been of interest to a number of disciplines such as ecology, sociology, psychology, organisational theory, engineering (e.g. networks, safety management, infrastructure systems) and economics (Francis and Bekera 2014). The general consensus is that there is currently no consistent treatment of the underlying concept with a tendency to use it as a “buzzword” for various purposes and assessments (Rose 2015).

Resilience has been associated with the following concepts: robustness, fault-tolerance, flexibility, reliability, survivability, agility, redundancy, resourcefulness, rapidity, adaptability, absorptivity, and recoverability, among others (cfr. Bruneau *et al* 2003; Fisher *et al* 2010; Henry and Ramirez-Marquez 2012; Rose and Krausmann 2013; Filippini and Silva 2014; Francis and Bekera 2014; Rose 2015). In certain cases resilience is also treated as the flip side of vulnerability although some researchers consider this as an arbitrary assumption (Rose and Krausmann 2013).

Research on resilience tends to fall within two major groups. The first group views resilience as any or all possible actions that can be put in place in order to reduce loss from a disruptive event (e.g. a disaster), ranging from pre-event mitigation to post-event recovery. The other group views resilience as actions following the materialisation of a disruptive event. Whereas the focus of the first group lies mostly on pre-event mitigation and is dominated by engineers, the second group acknowledges resilience as a process through which steps can be taken to enhance resilience even though some of them cannot be implemented until after the event has happened (Rose 2015).

Resilience is recognised to be a time-dependent function related to the system’s delivery function, i.e. the ability of the system to deliver its intended service (Henry and Ramirez-Marquez 2012). This attribute of resilience makes necessary the consideration of its time-path with respect to the recovery of the system as well as creates the need to distinguish between short-term and long-term recovery (Rose and Krausmann 2013).

Rose and Krausmann (2013) offer a few additional useful definitions. According to their work, (economic) resilience is applicable at three distinct levels with respect to its impact and assessment:

- Micro-economic: pertaining to individual businesses or households
- Meso-economic: pertaining to individual industries or markets
- Macro-economic: pertaining to the combination or all economic entities

Resilience is also distinguished into static and dynamic. Static resilience is defined as the ability of a system to maintain its intended function when shocked. Dynamic resilience is defined as the ability of a system to expedite its recovery after experiencing a shock (Rose and Krausmann 2013).

Finally resilience can also be distinguished in inherent and adaptive. Inherent resilience corresponds to aspects of recovery that are already built into the system. Adaptive resilience corresponds to actions and decisions undertaken under “stress” that enhance the ability of the system to recover (Rose and Krausmann 2013).

Resilience does not come for free and always has a cost associated with it. The cost of resilience actions should always be assessed with respect to their corresponding effectiveness (Rose 2015). At the same time the total cost of the system is a combination of the cost from the implementation of

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resilience actions as well as the cost incurred due to the system's inability to deliver its intended function because of the disruptive event (Henry and Ramirez-Marquez 2012).

2.2.2 Measures of resilience

Various measures of resilience currently exist in the literature and there is no consistent quantitative approach for its assessment. These measures differ depending on the underlying definition of resilience used as well as the system under consideration. From this plethora of different approaches, the focus of this section is on certain measures that appear to bear the maximum usefulness with respect to the intent of this deliverable.

Rose and Krausmann (2013) propose a framework for the development of a resilience index for business recovery in the face of a disaster. They investigate various existing frameworks of assessment and offer extensive critique on them. They put forward two measures of relative resilience, namely Direct Static Economic Resilience (DSER) and Total Static Economic Resilience (TSER). Both measures are concerned with the percentage avoidance of the maximum economic disruption that the system could experience as a result of a disruptive event, with DSER representing a partial economic equilibrium analysis while TSER pertains to a general equilibrium analysis. They identify various components of resilience that can affect business recovery and conclude that these cannot be combined but rather should be treated separately at the micro-, meso- and macro- levels of consideration. At the same time, they recognise the necessity for introducing weights to the various components that could be tied to specific policy initiatives.

Henry and Ramirez-Marquez (2012) propose a general framework for the quantification of resilience. They consider that any system to which resilience is of interest can experience three different states: (1) an original state; (2) a disrupted state; and (3) a recovered state. They also define two transitions that cause the system to move from state (1) to state (2) and from state (2) to state (3), which are a disruptive event and a resilience action, respectively. System disruption can be caused by both external and internal events thereby placing a strong emphasis on the identification of the system boundaries. The quantification of resilience takes place with the use of a "figure-of-merit" which is a time-dependent measure of the level of delivery of the system with respect to its intended service. The figure-of-merit is then used in order to quantify the effect of both the disruptive event(s) that may affect the system, as well as the resilience action(s) that will aim to restore it to a recovered state.

Filippini and Silva (2014) propose a modelling framework for the analysis of resilience in networked systems-of-systems. Their work focuses on the functional relationship between system components and their analysis is systemic in nature. The authors distinguish between structural analysis, which aims to assess the criticality, vulnerability and interdependency of each network node, and dynamic analysis (i.e. resilience analysis) which deals with the ability of the network to resist disturbances and recover from failure. The dynamic resilience analysis is further divided into qualitative and quantitative investigating the network's internal buffering and recovery characteristics. The modelling framework is, however, applied through a particular modelling language (IRML) which makes its usability rather limited.

Fisher *et al* (2010) propose a methodology for a resilience index for the protection of critical infrastructure. The work aims to complement previous research that assessed protective measures and infrastructure vulnerabilities (PMI/VI) by considering their respective components and focusing on the "weakest link". In effect the focus of the methodology behind their resilience index is three-fold:

1) to prevent incidents from happening;
2) to mitigate their effects when they happen; and
3) to increase the effectiveness of the recovery process.

Their approach is multi-level, aggregating a number of parameters into three main pillars of resilience, namely Robustness, Resourcefulness and Recovery. The aggregation takes place through a

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weighting process at each level. Weights are determined through surveys and indicate the relative importance attributed to each parameter considered. It is also worth noting that their index was eventually developed into a web-based tool.

Finally, and although not directly branded as such, another category of methodologies that aims to treat a very specific aspect of infrastructure project resilience is credit assessment methodologies. These methodologies serve a very specific objective and concern a very specific group of project stakeholders: they evaluate the likelihood of a project to repay its debt obligations against debt financing received from capital market financiers. In essence, these methodologies assess the resilience of a project towards meeting its debt obligations through the consideration of a number of relevant internal and external parameters. As identified extensively in the literature and corroborated by professional practice, credit assessment methodologies are becoming increasingly important in the financing of infrastructure projects especially as the project finance market is still feeling the repercussions of a series of ongoing financial crises that started from the sub-prime mortgage loan crisis in the USA and has continued through the world-wide credit crisis and the European sovereign debt crisis (Roumboutsos *et al*, 2016). For this reason, credit assessment methodologies are explored in a separate section and in more depth than the other assessments of resilience.

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2.3 Credit assessment methodologies

2.3.1 Principles and characteristics

Credit assessments concern the evaluation of the likelihood of default on obligations or delayed payment of debt. In the context of PPP projects, they are directly connected to project risks and their evolution over the life-cycle of the contractual agreement. Credit assessments are delivered by specialised firms that offer this type of service and which are called Credit Rating Agencies (CRAs).

CRAs are conducting project credit assessments in order to provide an opinion on the likelihood of default on obligations or delayed payment of debt. These assessments also give an indication of the relative credit risk of project financial obligations through an evaluation of general and project-specific credit factors. They also aim at providing a view on the relative performance capability of the project concerned and could serve as an input in pricing and credit decisions of investors, by giving a perspective on credit risk. Apart from the investors' viewpoint and in particular for PPP projects, project credit assessments could potentially facilitate the access to global capital markets for the necessary project financing. At the same time, this would imply that they have an effect on the ability of projects to raise initial debt or issue new debt and on the project renegotiation and refinancing phases. As the revenue streams of on-going and new PPPs - especially in the transport sector - are influenced by the changes in the macro-economic environment, project credit assessments have become an important indicator of their likelihood of default. Consequently, as such assessments are evolving to become metrics of crucial importance to the determination of the financing profile of a project, they are given increased attention.

CRAs publish their own methodology documents applied for infrastructure projects in order to explain to the public their framework but also because of EU regulatory requirements (European Commission, 2009). These methodologies have been developed over the last years and have been continuously evolving, following what seems to be a trend of increasing interest of investing in this particular asset class. The fact that there are various CRAs which rate infrastructure projects indicates that the definitions, methodologies and processes vary from agency to agency, as each one of them applies its own approach. CRAs follow different methodologies and incorporate different quantitative and qualitative elements in their assessments, which could also lead, on occasion, to differences in their assigned ratings. Such differences could explain the variations in the credit risk profile that a project might have. Small differences among CRAs highlight minor variations in the credit risk profiles of projects, while large differences signal significant variations.

CRAs initially define the entity or instrument they intend to rate. They might formulate credit assessments to project finance debt obligations/instruments (i.e. senior secured or subordinated debt), to project finance issuers, or to PPP schemes. Despite the methodological differences, we have also identified common elements in CRAs' approaches to rate projects. The following presents the basic features of CRAs' rating processes and methodologies, with the caveat that some of them might not be present in all CRAs which issue project ratings.

Initially, all CRAs use an established and defined ranking system of rating categories - a rating scale - through which they express their opinions on the creditworthiness of the projects they rate. The scale could also be used to reflect the project's timely debt repayment capability and / or to compare the relative credit risk profiles of different projects. At the same time, CRAs do not have harmonized rating scales. Different rating scales could be used for different types of issuers and instruments. The scales might differ as well with respect to the nomenclature and the number of rating categories and, in essence, the granularity of creditworthiness assessments. Most CRAs differentiate further within a rating category by including notches as illustrated in Table 2.3.1 below (CEREP 2016).

All CRAs should publish verifiable and quantifiable information concerning the historical default rates of the rating categories that they use (European Commission 2009). The reason is that, in this way,

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CRAs provide a basis for rating users to:

- Understand the historical performance of each rating category and if / how rating categories have changed; and
- Assist investors in drawing performance comparisons between CRAs. In particular, CRAs calculate default rates and produce transition studies to measure ratings performance. Default rates can be calculated across asset classes, for different rating levels and over multiple periods. Transition studies display the relative stability and volatility of ratings by measuring the rating changes along different rating categories within a certain period of time.

Table 2.3.1: The concept of "notching" in credit rating methodologies

Rating category	Notch
A	A+
	A
	A-
B	B+
	B
	B-
C	C+
	C
	C-

Source: Authors' own

The rating process that CRAs apply when assessing project finance creditworthiness involves different steps. The credit analysis of the issuer or debt obligation is conducted by an analyst who is assigned a portfolio of ratings (rating assignment) for which they are responsible.. Analysts base their assessment on the relevant methodologies. They would initially check whether a particular issue or issuer to be rated is eligible to be assessed through the project finance methodology, for example, if a project or a PPP is defined as such according to the methodology (applicability of methodology). Further, analysts would gather information which is necessary for them to conduct the analysis (information gathering). They would undertake a step-by step approach, review the various factors that determine creditworthiness and employ specific approaches / sequencing when addressing each factor as foreseen in the methodology (analysis of credit factors). For example, an analyst might start the assessment from reviewing either the operational or the construction elements of the project, or any other factor deemed appropriate. During the last steps of the analysis, analysts might apply necessary adjustments (for example, in terms of notching or capping) after evaluating other supplementary elements in order to finalise their rating recommendation (consideration of adjustment features). Typically, the analysts would present their analysis and rating recommendation to a collegial body – namely a rating committee - that would make a collective decision (usually through voting) on a potential rating change (the rating committee decision). The rating is subject to periodic ongoing surveillance which aims at identifying issues that could potentially lead to a rating change (monitoring of the rating). The different steps in the rating process are portrayed in the Figure 2.3.1 below.

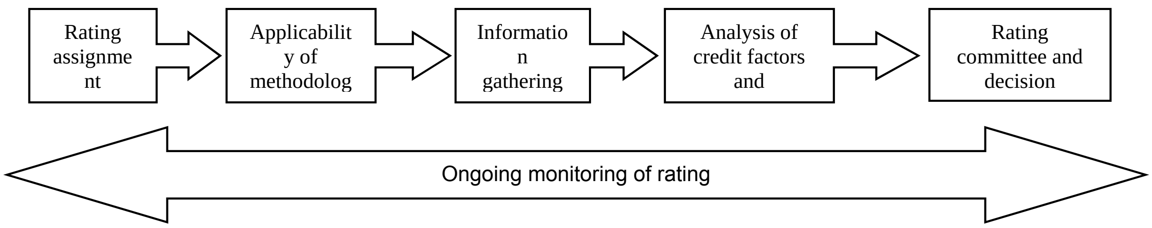

Figure 2.3.1: Steps in Rating Process (*Source: Authors' own*)

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Further, the methodologies used to conduct project credit assessments among CRAs appear to have similarities in some instances. For example, some of these methodologies are based on other methodologies that CRAs use to rate corporate issuers and issues. With respect to the framework and the rating factors, some CRAs would distinguish between the construction and the operation elements of a project. They may assess construction risks and other features relevant to the construction phase, such as the project/budget timeliness, the complexity of the project, the contractors' previous track records, the technology, the funding provisions and the project flexibility. As regards the operations phase and the operational risk, CRAs would potentially look at performance, financials and relevant counterparties.

CRAs would also incorporate in their evaluations elements attributed to pure financial analysis. A non-exhaustive list includes the revenues and cost structure, the capital structure, cash flow analysis, debt metrics (including interest rates and payment maturity), financial flexibility, liquidity and refinancing. CRAs would also assess the various parties who may be involved in project finance transactions such as, the sponsors, the investors, the lenders, the contractors, the consultants/advisors, the operators, the off-takers or other relevant actors. With reference to these parties, CRAs conduct their analysis in various ways, for example by undertaking counterparty risk assessments, reviewing previous track records of counterparties, and analysing contracts (construction, supply, purchase or PPP contracts). CRAs also look at project-specific features such as managerial and organizational changes, support from either the sovereign or parent affiliates and guarantee levels. Additionally, an analysis of the external environment is usually factored within the assessment of creditworthiness, through country/sovereign risk evaluations (derived from sovereign ratings), market and competition risk analysis and risk analysis of external events (such as regulatory reforms, institutional establishments, tax regimes etc.). Finally, in accordance with their methodology, CRAs could consider the aforementioned factors either as core elements of their credit assessment or as adjustment features.

2.3.2 Recent developments

As explained in the previous section, CRA's methodologies are focused on the ability of projects to service their debt obligations and in that sense the emphasis is placed on bearing the financial consequences of risks. Recent work by Pantelias and Roumboutsos (2015) as well as Roumboutsos et al (2016) has suggested a complimentary consideration to the credit assessment of infrastructure projects. In effect research undertaken in the context of PPP projects has shown that credit assessments are directly connected to project risks and their evolution over the life-cycle of the underlying contractual agreement. Managing risks, through the various stages of risk management (identification, assessment, allocation, mitigation, monitoring) is many times at the heart of PPP agreements and of paramount importance to the successful implementation of such projects. In effect, there is a fundamental difference between managing risks and bearing risks, as it is many times the case that the respective capability (i.e. management and/or coping), may not be found within the party to which the risk has been initially allocated. Based on this assumption a conceptual methodological framework was proposed by Pantelias and Roumboutsos (2015) that aims to put risk management and the characteristics of the contractual arrangements of PPP projects at the centre of the discussion regarding project credit assessments. This conceptual framework has been further extended by the work of Roumboutsos *et al* (2016) and transformed into a step-wise process that can be used to elicit project credit assessments. The proposed framework has six consecutive levels (steps) of analysis and has been based predominantly on the dual assessment of the management of risks over the project's life-cycle and of the underlying PPP business model, on top of other relevant factors.

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2.4 Methodological considerations and application to BENEFIT

In the context of BENEFIT, resilience is going to be defined as "the ability of a Transport Infrastructure project to withstand and recover from changes within its structural elements with respect to its ability to deliver specific outcomes (such as cost and time to completion, expected traffic and expected revenue)". This definition is based on the methodological background presented in previous sections. It does not present a conflict with existing definitions while it is specific enough to support the development of the Transport Infrastructure Resilience Indicator.

Furthermore, in order for this new indicator to be scientifically rigorous various elements from other relevant methodological approaches presented previously have been leveraged. These elements pertain to modelling principles as well as identified good practices and are presented hereafter as methodological considerations for application within BENEFIT.

The first consideration is the need to clearly identify the system of interest (Henry and Ramirez-Marquez 2012). Drawing the system boundary may not be a trivial task, especially in complex systems, and at the same time this boundary will help distinguish between internal and external disruptive events that may affect the system.

The second consideration is the specification of the system's figure-of-merit (Henry and Ramirez-Marquez 2012). This will help the quantification of resilience as a function of the system's ability to deliver its intended service. At the same time it is possible that a system may have multiple figures-of-merit as well as that the system may exhibit resilience for one figure-of-merit but not for another.

The third consideration is that constructing a resilience index should not just aim to study the recovery process but also to improve it (Rose and Krausmann 2013). In that respect it needs to distinguish between actionable variables and background conditions. The first are the ones that can be tied to decision making while the second ones can be considered as non-crucial for the recovery process as they can't be influenced.

The fourth consideration is that in the face of a disruptive event the recovery of the system will be dictated by the nature of the system as well as pre-determined policies and available facilities for recovery (Henry and Ramirez-Marquez 2012). This matches the concept of inherent resilience as described in Rose and Krausmann (2013) but underplays the significance of adaptive resilience as it puts the emphasis on the system. Adaptive resilience appears to be more related to the capabilities of decision makers and in that respect should also have an important role to play as their decisions "under stress" could influence profoundly the way and rapidity by which the system will bounce back from its disrupted state.

The fifth and final consideration is that any resilience index needs to be based on information that is accurate and transparent (Fisher et al 2010). Of particular significance is also the reproducibility of the index as its value and usefulness is closely related to being able to compare it and interpret it in a consistent way.

The development of the Transport Infrastructure Resilience Indicator has also aimed to leverage various methodological elements from credit assessment methodologies. The reason is simple: credit assessment methodologies for infrastructure are rigorous, comprehensive and have been in use for quite some time, having been continuously scrutinised by their developers in order to gain the trust of capital market financiers. At the same time, these methodologies serve a particular purpose which is a lot more limited than what the BENEFIT TIRI aims to accomplish and in that sense can serve as a useful stepping stone towards this goal. Furthermore, as mentioned previously, credit assessment methodologies are concerned with the ability of a project to service its debt obligations and therefore their focus is on risk bearing, i.e., on the entity which will be liable to honour (pay) these obligations when they fall due. The BENEFIT TIRI places its focus on risk management which comes a step

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earlier than the ability to bear risk, under the logic that various circumstances that can jeopardise the ability of a project to deliver on its expected outcomes (and to repay its debt obligations as a sub-set of them) can be anticipated and potentially mitigated through managerial actions/decisions before the need exists for one of the project stakeholders to bear the financial consequences of a risk that has eventuated. Finally, credit rating methodologies are concerned with infrastructure projects that are privately co-financed, i.e. projects where part of the financing originates from the private sector, such as projects procured as Public Private Partnerships. The Transport Infrastructure Resilience Indicator aims to be more comprehensive considering, as the Matching Framework also does, both privately co-financed as well as purely publicly financed infrastructure projects. In that sense and considering these fundamental differences in their scope, the Transport Infrastructure Resilience Indicator aims to act in a complimentary way to these existing methodologies rather than as a replacement.

In summary the Transport Infrastructure Resilience Indicator capitalises on existing scientific work as well as professional practice while leveraging findings that have been produced and published in previous BENEFIT deliverables. The discussion on the methodological framework for this new indicator, together with its underlying assumptions, is presented in Chapter 4 of this deliverable.

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3 Capitalising on BENEFIT Analyses Findings

3.1 Introduction

The BENEFIT Matching Framework makes use of indicators initially identified in BENEFIT Deliverables D2.2, D2.3 and D2.4; elaborated and initially validated in D4.2; and revised to their final configuration in D4.4. Key findings were identified with respect to the influence indicators have on the four specific outcomes considered within the BENEFIT Matching Framework, i.e. Cost to Completion, Time to Completion, Actual versus Forecast Traffic and Actual versus Forecast Revenues. Of course, the latter two are time related as traffic and revenue performance may change over time depending on the context. Task 4.3 considered this context under the economic crisis.

In the present chapter, findings attained through the various parallel streams of analysis undertaken within BENEFIT are considered in a comparative and complementary manner in order to map the conditions of resilience with respect to the aforementioned outcomes. These streams of analysis correspond to the qualitative analysis per mode (see D4.2 and D4.4) as well as the analyses of indicators (see D4.2 and D4.4). These streams are also complemented by the investigation of indicator interrelations as identified in D4.3 as well as practitioner perceptions as these were captured during the two Policy Dialogues events (task 5.2).

The qualitative analysis (see D4.2 and D4.4) identified differences amongst the various modes of transport infrastructure. With respect to the quantitative indicator analyses, these were not conducted as fully and extensively as originally intended due to dataset size and methodological limitations pertaining to the theoretical background of each analysis stream. The fullest analyses were conducted for the road mode which has the richest information from all modes captured in the BENEFIT database. Additionally, the quantitative indicator analyses considered PPP (privately co-financed) projects. The results of these analyses are presented in a comparative manner in the first section of the present chapter and are grouped per outcome. These findings are then combined with the results of the qualitative analysis, especially the ones pertaining to pre- and post-crisis conditions, to identify the particular considerations applied for each mode.

3.2 Comparative Summary of Indicator Analyses Findings

As described in Chapter 9 of D4.2, each of the quantitative analysis methodologies that have been undertaken within BENEFIT has its own theoretical background and limitations. Consequently, findings should be interpreted with respect to the methodology applied and in light of the corresponding limitations.

In spite of the overall richness of the BENEFIT project database, not all indicators could be investigated in the analyses undertaken. The Fuzzy-Set Qualitative Comparative Analysis (fsQCA) does not include the Reliability/Availability and the **Revenue Support indicators**, the latter being of high importance as it includes the “Level of Coopetition” or the control over traffic the project may have. The Econometrics analysis does not include the Institutional indicator as it was found to be highly correlated to the Financial-Economic indicator. Finally, the Importance analysis includes only the factor “Level of Coopetition” from the constituents of the Revenue Support indicator.

Considering the above, Tables 3.2.1 to 3.2.4 summarise findings per outcome broken down by analysis sample: the entire BENEFIT sample; a PPP-only project sample; and a sample considering projects completed before and after the 2008 year-mark, which is assumed to be the starting year of the financial crisis. Findings are discussed per outcome and in combination.

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3.2.1 Cost to Completion

The importance of the Governance Indicator (GI) in achieving cost to completion targets is evident as it appears in all sample analyses. This is followed by the Cost Saving Indicator (CSI) and the Revenue Support Indicator (RSI). Based on results from all samples it is concluded that the key factor of the RSI is the Level of Coopetition (LoC).

Table 3.2.1: Cost to Completion Summary of Findings

Method / Sample	**fsQCA**[4]	**Importance Analysis**	**Econometrics Analysis**
Entire Sample	Institutional+ Governance + Cost Saving+ Revenue Robustness+ Market Efficiency & Acceptability Financing Scheme+ *Cases explained: 4 of 51*	Level of Coopetition (Revenue Support) Institutional Governance Cost Saving	Financial Economic (Institutional) Revenue Support Cost Saving Governance
PPP Sample	Institutional+ Cost Saving+ Governance+ Financing Scheme+ Cases explained: 18 of 35 Institutional+ Financial Economic + Financing Scheme+ Cases explained: 16 of 35 Cost Saving+ Institutional+ Cases explained: 20 of 35	Institutional Level of Coopetition (Revenue Support) Governance Cost Saving	
Sample analysed for Crisis	**Completion Before Crisis** Financing Scheme* Institutional+ Governance + Financial Economic- Cases Explained: 5 of 22 Financing Scheme* Institutional+ Governance + Cases Explained: 11 of 22 **Completion After Crisis** Institutional+ Financial Economic+ Financing Scheme+ Cases Explained: 9 of 25 Institutional+ Financial Economic+ Cases Explained: 9 of 25	**Completion Before Crisis** Institutional Governance Level of Coopetition (Revenue Support) Cost Saving **Completion After Crisis** Institutional Level of Coopetition (Revenue Support) Governance Cost Saving	Financial Economic (Institutional) Revenue Support Cost Saving Governance

Legend: "+ "and " –" depict high or low values of an indicator, respectively

The Econometrics analysis identified that the crisis had a definite negative impact on the potential of projects to reach cost to completion targets. A marginal increase in the Financial-Economic Indicator (FEI) significantly improves the probability of achievement of these targets significantly (bivariate

[4] fsQCA provides findings based on pre-selected "paths" that include combinations of indicators. In the summary Tables only paths and combinations of indicators that may explain a considerable number of cases are considered. The number of cases explained are provided.

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model gave 56% and the logistic model 54.2%). This is reinforced by the fact that the fsQCA produced only one (1) path which included a low FEI and applied to only five (5) cases successfully with respect to the cost to completion outcome. The other paths with positive results included a high FEI whether before or after the 2008 year-mark.

The other indicator identified as important is the Institutional Indicator (InI). Notably, this indicator was not included in the Econometrics analysis, due to issues mentioned previously. However, the high value of InI is present in all combinations of the fsQCA and ranks high in the results of the Importance Analysis. The InI is also found in the path combination including the low value of the FEI.

In addition, the fsQCA provides repetitively one additional indicator with a positive impact: a high value of the Financing Scheme Indicator (FSI), referring to projects which are either delivered by the public sector or that have been heavily supported by it. One remarks the presence of a high FSI in the PPP sample results. Here, also, the combination of high values of the CSI and InI are supporting the ability to achieve cost to completion targets. In the Econometrics Analysis the FSI was not found to be significant. However, the indicator carried a “positive sign” indicating a trend towards higher values in order to achieve cost to completion targets. The Importance analysis found the FSI to be independent of the results in all sample cases.

In conclusion, the comparative analysis highlights the combined importance of high values of the Governance, Cost Saving and Revenue Support Indicators and the significant negative impact of the Financial-Economic Indicator, which may be counter-balanced by high values of the Institutional and Financing Scheme Indicators.

3.2.2 Time to Completion

The Econometrics Analysis identified that higher values of the GI and lower values of the Remuneration Attractiveness Indicator (RAI) improve the possibility of delivering projects “on-time”. As in the case of “cost-to-completion”, lower values of the FEI have a negative impact. Notably, the effect was found to be comparatively less significant (24.4%). A counter-balancing effect is provided by the GI as a marginal increase in the GI increases the probability of being “on-time” by 18.3%.

Further to the above, all analyses found that a low value of RAI increases the probability of achieving time targets. Notably, a low value of the RAI corresponds to high demand risk remuneration schemes, **which provide an incentive to start operation “on-time”.** For Importance analysis the incentive (RAI) is more pronounced after the crisis and in the PPP sample. The fsQCA has found that a low value of RAI in combination with positive implementation conditions (FEI), high values of GI and CSI lead to achieving time targets with a high value of the FSI.

Confirming the above, the Importance analysis found GI, RAI and InI to be influencing the potential to achieve time to completion targets”. The factor LoC was also identified as important in all cases.

There is agreement in all three analyses that the Governance indicator is important in achieving “time to completion”. A low Remuneration Attractiveness indicator will drive a project to be completed on time according to the Econometrics analysis, while structures featuring a high Level of Coopetition (such as bridges and tunnels) will most likely be completed on time according to the Importance analysis. Low Market Efficiency and Acceptability, low Governance and low Cost Savings indicator values will impact negatively the potential to achieve time targets according to the fsQCA.

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Table 3.2.2: Time to Completion Summary of Findings

Method / Sample	**fsQCA**[5]	**Importance Analysis**	**Econometrics Analysis**
Entire Sample	*Non-Achievement* Governance- Remuneration Attractiveness+ Cases explained: 5 of 51 Governance- Market Efficiency & Acceptability- Cost saving- Revenue Robustness- Remuneration Attractiveness+ Cases explained: 3 of 51 Institutional- Financial-economic- Governance- Market Efficiency & Acceptability- Remuneration Attractiveness+ Cases explained: 3 of 51	Governance Remuneration Attractiveness Level of Coopetition (Revenue Support)	Financial Economic Governance Remuneration Attractiveness- Reliability /Availability
PPP sample	Institutional+ Financial – Economic+ Cost Saving+ Governance+ Remuneration Attractiveness- Financing Schemes+ Cases explained: 5 of 35 Financial - Economic+ Cost Saving+ Case explained: 10 of 35	Governance Institutional Remuneration Attractiveness Level of Coopetition (Revenue Support)	
Sample analysed for Crisis	**Completion Before Crisis** Financing Scheme+ Governance+ Cases Explained: 15 of 22 Institutional+ Financial Economic+ Governance+ Cases Explained: 8 of 22 **Completion After Crisis** *Non- Achievement* Institutional- Market Efficiency & Acceptability- Cases explained: 4 of 25 Institutional- Cases explained: 6 of 25 Governance- Cases explained: 6 of 25	**Completion Before Crisis** Institutional Governance **Completion After Crisis** Governance Remuneration Attractiveness Institutional Level of Coopetition (Revenue Support)	Financial Economic Governance Revenue Scheme- Reliability /Availability

Legend: "+ "and " –" depict high or low values of an indicator, respectively

[5] FsQCA provides findings based on pre-selected "paths" including combinations of indicators. In the summary tables only paths and combinations of indicators that may explain a considerable number of cases are considered. The number of cases explained is provided.

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3.2.3 Actual vs Forecast Traffic

Importance analysis was not able to provide significant results for traffic goals.

Both the fsQCA and Econometrics analyses agree that a high Remuneration Attractiveness indicator value and a high Cost Saving indicator value are important in achieving traffic goals. A Positive Implementation context (InI and FEI) is also important. However, the Econometrics analysis highlights the importance of the FEI in achieving traffic targets, as a marginal increase in FEI improves the probability of achieving traffic goals by 72.6%, while the RAI by only 14%.

Similar are the findings of the fsQCA. The importance of low Remuneration Attractiveness and Cost Saving indicator values are reinforced by the fsQCA as factors for ***not*** achieving traffic goals when in a poor implementation context. A high value of the GI and InI, as per the fsQCA, is found in combinations of the above indicators.

With respect to the impact of the crisis, the value of the Remuneration Attractiveness indicator seems to be important in achieving traffic goals, as well as the Cost Saving indicator (econometrics analysis). While the contribution of an high RAI (example availability fees) may be, almost, self-evident, the importance of the CSI requires further consideration. More specifically, it should be noted that the CSI does not only include factors connected to construction but also factors connected to the capability to operate and the marurity of the contracting authority. In addition, factors related to construction are omitted following the project inauguration. A low Remuneration Attractiveness indicator (RAI) value combined with low Governance indicator and a high value of the Financing Scheme indicator are reasons for ***not*** achieving traffic goals according to fsQCA.

The same factors as above are important in the case of PPPs, according to fsQCA, while econometrics highlights the significance of availability (reliability/availability indicator (IRA)), especially in combination with a high value of the RAI. This is to be expected, since higher values of the RAI signify availability fee type remuneration schemes.

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Table 3.2.3: Actual vs Forecast Traffic Summary of Findings

Method / Sample	fsQCA[6]		Econometrics Analysis
	Achievement	Non- Achievement	
Entire Sample	Institutional+ Governance+ Cost Saving+ Remuneration Attractiveness+ Financing Scheme+ Case explained: 6 of 43 Cost Saving+ Remuneration Attractiveness+ Case explained: 7 of 43 Institutional+ Financial –economic+ Governance+ Remuneration Attractiveness+ Financing Scheme+ Cases explained: 4 of 43 Financial –economic+ Remuneration Attractiveness+ Cases explained: 4 of 43	Institutional- Financial Economic- Cost Saving- Cases Explained: 8 of 43 Institutional- Remuneration Attractiveness- Financial-economic- Cases explained: 6 of 43 Institutional- Remuneration Attractiveness- Governance+ Cases explained: 4 of 43	Financial Economic (institutional) Remuneration Attractiveness Cost Saving Reliability/Availability
PPP Sample	Cost Saving+ Remuneration Attractiveness+ Institutional+ Governance+ Financing Scheme+ Cases explained: 6 of 36 Cost Saving+ Remuneration Attractiveness+ Revenue Robustness- Cases explained: 5 of 36	Institutional- Financial Economic- Remuneration Attractiveness- Cases explained: 5 of 36 Cost Saving- Revenue Robustness- Cases explained: 5 of 36 Institutional- Financial Economic- Cases explained: 5 of 36	
Sample analysed for Crisis	**Completed Before Crisis** - **Completed After Crisis** Institutional+ Governance+ Remuneration attractiveness+ Cases explained: 10 of 21 Institutional+ Governance+ Remuneration attractiveness+ Financing Scheme+ Cases explained: 9 of 21	**Completed Before Crisis** Institutional- Financial – Economic- Remuneration Attractiveness- Cases explained: 4 of 22 **Completed After Crisis** Financial Economic- Remuneration Attractiveness- Financing Scheme + Cases explained: 4 of 21	Financial Economic Remuneration Attractiveness- Cost Saving Reliability/Availability

Legend: "+ "and " –" depict high or low values of an indicator, respectively

3.2.4 Actual vs Forecast Revenues

The Remuneration Attractiveness indicator (RAI) is key in achieving revenue targets. Econometrics and fsQCA also propose the Revenue Robustness indicator (RRI) but the indicator includes cost coverage and, therefore, on its own reflects the level of achieving revenues.

[6] FsQCA provides findings based on pre-selected "paths" including combinations of indicators. In the summary tables only paths and combinations of indicators that may explain a considerable number of cases are considered. The number of cases explained is provided.

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Other indicators found in the positive combinations of fsQCA are Governance (GI), Cost Saving (CSI) and the Institutional Indicator. Also, the financing Scheme indicator seems to provide a positive contribution. Finally, importance analysis identified the importance of the LoC (factor of the Revenue Support Indicator) as significant with respect to the crisis.

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Table 3.2.4: Actual vs Forecast Revenue Summary of Findings

Method / Sample	fsQCA[7]	Importance Analysis	Econometrics Analysis
Entire Sample	Governance+ Financing Scheme – Institutional + Revenue Robustness+ Cases explained: 4 of 43	Remuneration Attractiveness	Revenue Robustness Remuneration Attractiveness Reliability /Availability
PPP Sample	Institutional+ Revenue Robustness+ Cases explained: 18 of 36 Institutional+ Cost Saving+ Governance+ Remuneration Attractiveness+ Financing Scheme+ Cases explained: 6 of 36 Institutional+ Revenue Robustness+ Cases explained: 19 of 36	Remuneration Attractiveness	
Sample analysed for Crisis	**Completed Before Crisis** Revenue Robustness+ Financing Scheme+ Cases explained: 12 of 22 Governance+ Revenue Robustness+ Cases explained: 10 of 22 Governance+ Cost Saving+ Financing Scheme+ Cases explained: 8 of 22 Revenue Robustness+ Cases explained: 15 of 22 Cost Saving+ Cases explained: 9 of 22 **Completed After Crisis** Institutional+ Governance+ Financing Scheme+ Cases explained: 13 of 21 Institutional+ Governance+ Cases explained: 16 of 21	Level of Coopetition (Revenue Support) Remuneration Attractiveness	Revenue Robustness Remuneration Attractiveness Reliability /Availability

Legend: "+ "and " –" depict high or low values of an indicator, respectively

3.2.5 Discussion

All three streams of analysis are based on the sample of BENEFIT cases which is by no means perfect or unbiased. A different number of cases exists per mode of transport, while different modes have borne dissimilar impact with respect to the crisis.

[7] FsQCA provides findings based on pre-selected "paths" including combinations of indicators. In the summary tables only paths and combinations of indicators that may explain a considerable number of cases are considered. The number of cases explained is provided.

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In order to study the influence of the crisis during the construction phase, the analysis considered projects whose construction phase was completed before or after the crisis. However, this consideration is not entirely straightforward. In effect, the implementation context of projects was different before and after the crisis; before the crisis some projects were delivered under poor implementation context conditions while after the crisis, not all projects were implemented in countries presenting the same drop in their implementation context indicators. Therefore, findings need to be considered carefully, especially with respect to the corresponding Financial-Economic and Institutional indicators. Notably, in the qualitative analysis on roads (see Deliverable D4.4), the sample size allowed a full investigation of these differences.

The choice of defining pre- and post-crisis samples is supported by the evident agreement between findings from all analysis streams: Cost to completion presents the greatest level of agreement between all analyses findings. Findings about time to completion are also quite uniform but also slightly different. More specifically, meeting time to completion targets seems to be driven by a low RAI value. In other words, projects with demand-based remuneration schemes tend to be completed "on-time" with their financial –economic implementation context being less important than in the case of meeting cost targets. The FEI has a greater impact on cost to completion but is also very much dependent on the institutional context and governance. The factor LoC of the RSI appears significant. Notably, greater values of this indicator are consistent with bridge and tunnel projects.

For traffic and revenue outcomes, the findings were less clear. Starting with traffic, as discussed previously as well as subsequently, the effect of the crisis, i.e. low values of the Institutional and Financial-Economic indicators, have affected the various modes differently. In addition, for those modes which are negatively influenced, the crisis may have a different impact on traffic and/or revenues depending on the length of time the infrastructure was in operation prior to the crisis. Finally, meeting traffic targets is also influenced by the presence (or not) of **optimism bias** at award. However, all three analysis streams identified the Remuneration Attractiveness indicator as a dominant indicator in achieving both traffic and revenue targets. This finding is further supported by observing the dominant approach towards remuneration schemes implemented after the crisis. This can be seen in Figures 3.2.1 and 3.2.2 which show the results of an analysis of trends in remuneration schemes undertaken under task 4.3 (Deliverable D4.4). The analysis is based on a project list provided by the OECD[8].

Under the above considerations, the findings of the indicator analyses are carefully scrutinised when considering the qualitative analysis per mode. The importance of indicators in the achievement of the respective outcomes is assessed for each mode. Differentiation in indicator analyses findings are then meaningful as these describe the differentiation between modes. fsQCA analysis is in particular helpful in this case, as apart from the importance of the combination of indicators to achieve particular findings, it also provides the cases that may be explained, guiding further the understanding per mode.

[8] The inspiration for this analysis was provided by the Advisory Group Member Dr. Dejan Makovsek.

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Source: *Authors' compilation*

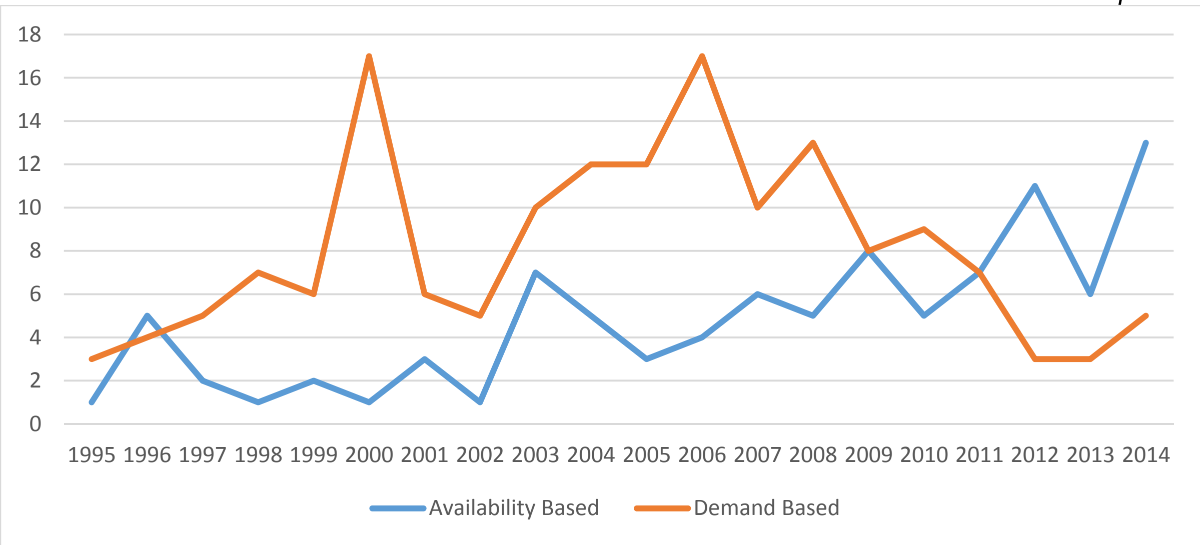

Figure 3.2.1: Availability vs Demand Based Remuneration Schemes over time (PPP Financial Close)

Source: *Authors' compilation*

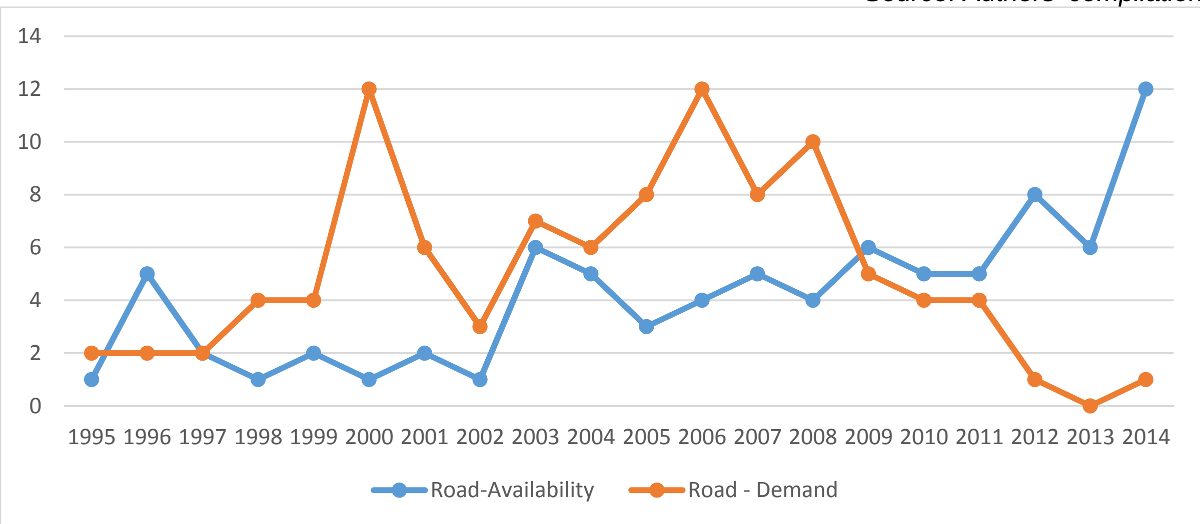

Figure 3.2.2: Availability vs Demand Based Remuneration Schemes over time (PPP Financial Close) of road projects

Table 3.2.5 presents a summary of key findings following the comparative study of the indicator analyses per outcome. One key finding is that it is not one single indicator that is dominant in driving the attainment of different outcomes but rather combinations of indicators. The implementation context indicators (FEI and InI), which are external to the project, are always significant.

Table 3.2.5 points to the dominance of three (3) indicators, namely the Institutional; Governance and Cost Saving indicators, as all three appear to influence all four project outcomes. Therefore, it is not surprising that the same three indicators were identified by Task 4.2 as the ones that need to be addressed properly in order to improve the potential of achieving outcomes.

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However, there are also indicators which are particular to each project that may influence the attainment of an outcome and, therefore, may be used to provide guidance towards the use of managerial tools that can improve the probability of reaching outcomes successfully.

Some key findings:

- Governance (GI) has a positive influence on outcomes and justifies the efforts placed in conducting a transparent and competitive procurement process but, also, highlights the significance of contractual flexibility.
- A high value of the InI also has a positive contribution for all outcomes, suggesting that governments need to strengthen their institutions, especially considering their limited control over the financial-economic context. This finding also justifies efforts placed in strengthening EU institutions. Further evidence in support of this finding is the high value of the Institutional Indicator of new entrants in the PPP market following the crisis (see D4.4).
- The CSI contributes positively to all outcomes apart from “time to completion”, where trade-offs between time and cost to completion are pronounced.
- The RAI is behind time and cost trade-offs. Demand-based and user-paid remuneration schemes drive time to completion, while availability and government-paid remuneration schemes provide more secure traffic and revenues to the project.
- RRI, as expected, is characteristic of expectations with respect to meeting revenue targets, as it expresses a project’s cost coverage and expected risk. More specifically, high values of RRI suggest greater potential of reaching revenue targets.

Market Efficiency & Acceptability (MEAI) does not feature at all in the results of any of the analysis streams. However, this may be related to the specific sample used and should not be generalised as a finding.

Finally, it is worthwhile commenting on the contribution of the Financing Scheme indicator (FSI). High values of the FSI correspond to projects financed by the public sector or private projects with a high contribution (or support) from the public sector. All three analysis streams showed that positive outcomes were always related to high values of the FSI. However, the Econometrics analysis showed a positive probability of meeting time to completion and revenue targets connected to a low FSI, albeit with low significance. It is also interesting to note that the achievement of the revenue target is not dependent on the Financial-Economic indicator (FEI). However, it should be pointed out that revenues in all cases are dependent on traffic and traffic has been identified to be influenced by the FEI. Furthermore, governments tend to secure revenues required for the operation of transport infrastructure or adjust maintenance schedules to fit available budgets. Recent reports on the level of infrastructure maintenance tend to support this assumption.

In addition, considering the indicators that contribute to the attainment of specific outcomes highlights the difficulty in ultimately achieving all project outcomes. A typical example is the RAI indicator: a low value will drive successful “on-time” delivery, while a high value will tend to support more secure traffic. Demand-based remuneration schemes (low RAI) do not support the potential of reaching forecast traffic, especially in an adverse implementation context. However, the presence of the other indicators in achieving revenue targets should not be neglected, as in combination they may be able to “balance” lower values of RAI. Furthermore, the strategy of selecting a remuneration scheme with a high RAI value to improve asset utilisation (i.e. traffic) can only be achieved under positive government budgetary conditions. This is also evident by the wide variety of countries seen to be adopting a high RAI value policy, i.e. availability-based remuneration schemes (see Deliverable D4.4).

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Table 3.2.5: Summary of findings per outcome

Indicators \ Outcomes	Cost to Completion	Time to Completion	Actual vs Forecast Traffic	Actual vs Forecast Revenue
Financial Economic (FEI)	***	*	***	
Institutional (InI)	**	**	**	**
Governance (GI)	**	**	**	**
Cost Saving (CSI)	**	**	**	**
Revenue Support (RSI)	**1	*1		*
Remuneration Attractiveness (RAI)		***3	***4	***4
Revenue Robustness (RRI)				**
Market Efficiency & Acceptability (MEAI)				
Financing Scheme (FSI)	*2	(*)		*5
Reliability/Availability (IRA)			***	***

Legend
[1]*RSI or LoC may be appearing in the analyses findings as high values are typical of bridge and tunnel projects, which in the BENEFIT sample are nationally driven and well-designed (see respective chapter in D4.2 and D4.4).*
[2]*High values of the FSI were found to support cost to completion. These are projects with public financing or heavily supported by the public sector in terms of financing.*
[3]*Low values of RAI, which are typical of demand-based and user-paid remuneration schemes*
[4]*High values of RAI, which are typical of availability and government-paid remuneration schemes*
[5]*High values of the FSI appear in the fsQCA for positive outcomes*

Finally, it is interesting to compare these findings with the perceptions of experts as registered during the 2nd Policy Dialogue event (see D5.2). Table 3.2.6 shows where indicators analyses findings coincide with expert perceptions. What is noticeable is the considerable overlap, especially given the fact that each expert comes from a different background and expresses his/her personal views with respect to particular infrastructure sector and country experience. However, expert perceptions should also be treated with caution as their full understanding of the BENEFIT indicators cannot be guaranteed. As an example, the Financing Scheme was not identified as a contributing indicator for any outcome which is rather surprising.

Nevertheless, what has been made evident through the Policy Dialogues and the qualitative analysis is the existence of differentiations between modes and the fact that some findings may be sample-specific. This is addressed in the following sections of this Chapter, where findings are presented by transport mode and an effort is made to reduce sample-specific effects.

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Table 3.2.6: Agreement Experts' Perceptions with Indicator Analyses Findings

Indicators \ Outcomes	Cost to Completion	Time to Completion	Actual vs Forecast Traffic	Actual vs Forecast Revenue
Financial Economic (FEI)	YES	YES	YES	Only PD
Institutional (InI)	YES	YES	YES	YES
Governance (GI)	YES	YES	YES	Not Considered
Cost Saving (CSI)	YES	YES	Not Considered	Not Considered
Revenue Support (RSI)	Not considered[1]	YES[1]		YES
Remuneration Attractiveness (RAI)		YES[3]	YES[4]	Not Considered [4]
Revenue Robustness (RRI)				Not Considered
Market Efficiency & Acceptability (MEAI)				Only PD
Financing Scheme (FSI)	Not considered[2]	(Not Considered)		Not Considered[5]
Reliability/Availability (IRA)			YES	YES

Legend
PD: Policy Dialogue
[1]*RSI or LoC may be appearing in the analyses findings as high values are typical of bridge and tunnel projects, which in the BENEFIT sample are nationally driven and well-designed (see respective chapter in D4.2 and D4.4).*
[2]*High values of the FSI were found to support cost to completion. These are projects with public financing or heavily supported by the public sector in terms of financing.*
[3]*Low values of RAI, which are typical of demand-based and user-paid remuneration schemes*
[4]*High values of RAI, which are typical of availability and government-paid remuneration schemes*
[5]*High values of the FSI appear in the fsQCA for positive outcomes*

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3.3 Roads

Road projects constitute a significant share of the BENEFIT database (see D4.2 – Annex 1), allowing for the **fsQCA** and **Importance analysis** to examine this sample of projects separately. Table 3.3.1 summarises findings with respect to all outcomes. As in the case of the full sample analysis, findings with respect to cost to completion present greater consistency. The **Econometrics analysis** presented in the previous section needs to be considered when assessing these results, which are compared and complemented by the qualitative analysis of the road cases sample in this section.

Table 3.3.1: Summary of Indicator Analyses Findings – Road cases

Analysis / Outcomes	**fsQCA**[9]	**Importance Analysis**
Cost to Completion	Institutional+ Governance+ Financing Scheme+ Cases explained: 12 of 22	Institutional Governance Cost Saving Level of Coopetition (Revenue Support)
Time to Completion	*Non-Achievement* Institutional- Governance- Market Efficiency & Acceptability- Cases explained: 3 of 22	Governance Institutional Remuneration attractiveness Level of Coopetition (Revenue Support)
Actual vs Forecasted Traffic	Institutional+ Financial Economic+ Governance+ Financing Scheme+ Cases explained: 3 *Non-Achievement* Financial Economic - Remuneration Attractiveness - Cases explained: 5 of 22	-
Actual vs Forecasted Revenues	Financing Scheme- Revenue Robustness+ Governance+ Cases explained: 2 of 20 Financial Economic+ Revenue Robustness+ Governance+ Cases explained: 3 of 20 Financial Economic+ Revenue Robustness+ Governance- Remuneration Attractiveness + Cases explained: 2 of 20 Revenue Robustness[10] Cases explained: 12	-

Legend: "+ "and " –" depict high or low values of an indicator, respectively

[9] fsQCA provides findings based on pre-selected "paths" including combinations of indicators. In the summary tables only paths and combinations of indicators that may explain a considerable number of cases are considered. The number of cases explained is provided.

[10] The indicator revenue robustness describes the cost coverage through revenues and in this context the result validates the indicator rather than provides a significant finding.

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3.3.1 Cost to Completion

As summarised in Deliverable D4.2, a very common reason leading to cost overruns is typically related to scope changes as well as other technical problems. These may be traced back to either less than adequate design and planning as well unforeseen problems impacting time to completion such as archaeological findings and problems with right-of-way land expropriation.

PPP projects in the BENEFIT case database dated before 2003 have demonstrated cost overruns. However, these seem to be recurrent predominantly within Spain, as is demonstrated in Table 3.3.2. There is also no obvious direct relation with the level of the Financing Scheme indicator, or otherwise the cost of capital identified for each project. The same applies for the country's Institutional and Financial-Economic indicators, which show a stable and strong implementation context. However, it should be noted that within a 7-year period (1996-2003) Spain awarded at least 24 road projects (see D4.4). Such a high volume of projects may have placed pressure on planning and project design during the first years of this 7-year period compensated later by increased capability due to acquired experience (improving the Cost Saving Indicator). The projects awarded during the latter years of the same period may have suffered from the limited ability of the market to respond to the respective call for tenders (declining Governance indicator). While, this cannot be fully validated, the Cost Saving and Governance indicator values seem to support the hypothesis (CSI values improve and GI values decrease over time). In addition, all Spanish cases awarded before 2003 demonstrated lower values of both the Cost Saving and the Governance Indicators in comparison with other road PPP cases awarded before 2003.

A positive (or negative) change in the Financial-Economic Indicator (FEI) seems to bring about the respective impacts with respect to cost overrun. Negative impacts in particular may be mitigated by higher values of the Cost Saving (CSI) and Governance (GI) indicators. Notably, in many cases changes in the FEI are followed by changes in the Institutional indicator (InI).

The **qualitative analysis** identified a substantial difference in performance between projects in northern and western European countries and projects in southern European countries. Most projects that experienced cost overruns were located in southern countries reflecting on the lower InI and FEI values (see Table 3.3.3).

Table 3.3.2: Cost overruns in PPP projects awarded prior to 2003

Project Title	Country	Year of Award	CSI	GI	FSI	InI	FEI	Cost Performance
A-19 Dishforth	UK	1998	0,411	0,688	0,525	0,830	0,635	In line
BNRR (M6 Toll)	UK	1992	0,172	0,813	0,640	0,820	0,635	In line
E4	Finland	1997	0,489	0,875	0,679	0,81	0,637	In line
E39	Norway	2003	0,556	0,563	0,719	0,81	0,738	In line
A23	Portugal	1999	0,318	0,625	0,779	0,690	0,540	In line
A22 Motorway	Portugal	2000	0,464	0,625	0,779	0,690	0,540	In line
Athens Ring Road	Greece	1996	0,230	0,688	0,561	0,590	0,543	In line
C-16 Terrasa Manresa toll motorway	Spain	1987	0,133	0,563	0,406	0,70	0,637	Overrun
M-45	Spain	1998	0,533	0,563	0,703	0,72	0,637	Overrun
Radial 2 Toll Motorway	Spain	2000	0,244	0,500	0,640	0,74	0,638	Overrun
Eje Aeropuerto (M-12) Motorway	Spain	2002	0,541	0,500	0,640	0,76	0,617	Overrun

The **fsQCA** analysis showed that high values of the GI and InI combined with a high value of the FSI in the particular case of road projects could explain the positive performance of 12 over 22 road

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cases. In addition, the analysis for PPPs identified that a high CSI value combined with a high InI value as well as a high value of GI could explain 9 of the 9 road PPP cases which were "on-budget". These projects also include a high FSI. Notably, under PPP, a high Financing Scheme indicator (FSI) represents cases with high public sector involvement through guarantees and/or subsidies or other form of publicly supported financing. Being on cost in this case, represents an effort to restrict further escalation of cost by the public sector.

Importance analysis also emphasised the same indicators in achieving cost to completion targets for roads. Here, however, an additional indicator was identified as significant: the factor "Level of Coopetition" of the Revenue Support Indicator (RSI) describing the position of the infrastructure in the network (Roumboutsos and Pantelias 2015). However, this factor has usually little importance for roads which tend to demonstrate a weak "Level of Coopetition" within the transport network. Exceptions to this rule of thumb pertain to exclusivity rights included in the contractual agreement or being in a unique position to serve a particular node of the network (as in the case of the Athens Ring Road serving Athens International Airport).

Similarly**,** the **Econometrics analysis** for the entire sample presented similar findings with the Revenue Support indicator (RSI) included as a significant indicator in place of Level of Coopetition. Again, this indicator is not of much relevance to cost performance for road projects. However, the qualitative analysis identified that road projects with brownfield sections performed better with respect to cost to completion, suggesting fewer technical difficulties as conditions could be foreseen with greater certainty. The Financial-Economic indicator (FEI) was also identified as important[11]. According to the Econometrics analysis a marginal increase in the FEI could increase the probability of being "on-budget" by 56%.

In conclusion, it seems that road projects (public and private) have a greater potential to achieve cost performance targets when they are structured with a higher Cost Saving (CSI) and Governance (GI) indicator, while a poor and mostly a declining Financial–Economic (FEI) and Institutional (InI) indicator may have a negative impact. A higher Revenue Support (RSI) indicator may have a positive impact. Also projects with a higher Financing Scheme indicator (FSI) value tend to achieve cost to completion.

Indicator values relevant to cost performance for roads are presented in Table 3.3.3. Shaded cells correspond to projects that do not follow the identified general trends such as the Spanish projects, as discussed above. It is worth noticing that high values of the Cost Saving, Governance, and Revenue Support indicators are capable of overcoming drops in the Financial-Economic and Institutional indicators such as in the cases of the Koper-Izola express way and the M-25 Orbital. There are also cases where the outcome cannot be justified or explained such as the A5 Maribor Pince motorway, the Belgrade By-pass Project, Section A: Batajnica-Dobanovci and the Moreas. It should be noted that the Moreas was the only one out of the five road PPPs awarded in Greece in 2007 that did not suffer from lengthy re-negotiations and suspension of construction work.

Box 1: Key Indicators Contributing to Cost–to-Completion for Road Projects

Institutional Indicator (InI)	Pre-requisite of being "on-budget"
Financial – Economic Indicator (FEI)	Strong positive or negative influence depending on high or low value
Governance Indicator (GI)	Needed for "on budget"
Cost Saving Indicator (CSI)	Needed for "on-budget"
Revenue Support Indicator (RSI)	Support for "on-budget"
High values of Financing Scheme Indicator (FSI)	Drive to "on-budget"

[11] The econometrics analysis did not include the InI as the indicator was found to be correlated to the FEI. Therefore, FEI, in this analysis, also includes the effect of the InI.

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Table 3.3.3: Road project indicators related to cost performance

Project Title	Country	Year of Award	CSI	GI	RSI	FSI	Δ FEI - Construction	Δ Inl – Construction	Cost Performance
Via-Invest Zaventem	Belgium	2007	0,449	0,688	0,216	0,740	-0,09	0,01	Below Budget
A5 Maribor Pince motorway	Slovenia	2005	-0,070	0,563	0,151	1,000	0,09	0,04	Below Budget
Koper - Izola Expressway	Slovenia	2008	0,279	0,500	0,152	1,000	-0,25	-0,02	Below Budget
BNRR (M6 Toll)	United Kingdom	1992	0,172	0,813	0,045	0,640	0,03	-0,01	In line
A-19 Dishforth	United Kingdom	1998	0,411	0,688	0,075	0,525	0,00	0,01	In line
M-25 Orbital	United Kingdom	2009	0,656	0,688	0,270	0,668	-0,03	0,01	In line
M-80 (Haggs)	United Kingdom	2009	0,564	0,688	0,148	0,529	-0,01	0,01	In line
E18 Muurla-Lohja	Finland	2005	0,133	0,750	0,121	0,773	0,01	0,00	In line
E4 Helsinki-Lahti	Finland	1997	0,489	0,750	0,145	0,679	0,00	0,02	In line
E39 Orkdalsvegen Public Road	Norway	2003	0,556	0,563	0,200	0,719	0,07	0,01	In line
A2 Motorway	Poland	2008	0,719	0,688	0,216	0,752	-0,02	0,03	In line
A22 motorway	Portugal	2000	0,000	0,813	0,267	0,779	-0,10	0,01	In line
A23 motorway	Portugal	1999	0,000	0,813	0,222	0,779	-0,10	0,01	In line
Belgrade By-pass Project, Section A: Batajnica-Dobanovci	Serbia	2010	-0,031	0,313	0,211	0,850	-0,02	0,00	In line
Athens Ring Road	Greece	1996	0,313	0,688	0,229	0,561	0,04	0,03	In line
Elefsina Korinthos Patra Pyrgos Tsakona Motorway	Greece	2007	-0,021	0,625	0,222	0,644	-0,25	-0,04	Overrun
Ionia Odos Motorway	Greece	2007	0,226	0,750	0,257	0,612	-0,25	-0,04	Overrun
Central Greece (E65) Motorway	Greece	2007	0,237	0,750	0,186	0,938	-0,25	-0,04	Overrun
Moreas Motorway	Greece	2007	0,750	0,750	0,301	0,816	-0,25	-0,04	Overrun
Motorway E-75, Section Donji Neradovac - Srpska kuca	Serbia	2009	0,000	0,188	0,193	1,000	-0,13	0,03	Overrun
Motorway E-75, Section Horgos-Novi Sad (2nd phase)	Serbia	2011	-0,030	0,188	0,257	1,000	0,03	0,01	Overrun
C-16 Terrasa Manresa toll motorway	Spain	1987	0,133	0,563	0,201	0,300	0,00	0,00	Overrun
M-45	Spain	1998	0,583	0,563	0,089	0,703	0,00	0,02	Overrun
Eje Aeropuerto (M-12) Motorway	Spain	2002	0,541	0,500	0,040	0,640	0,06	-0,03	Overrun
Radial 2 Toll Motorway	Spain	2000	0,244	0,500	0,089	0,640	0,00	-0,05	Overrun

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3.3.2 Time to Completion

The qualitative analysis identified that with respect to road cases in the BENEFIT database, the most typical reasons for delays were land expropriation problems, design changes, technical and archaeology issues, but also bankruptcy of the contractor (Koper-Izola Motorway). All the above issues are related to the Cost Saving Indicator, which was also found to be important by the fsQCA.

Also, performance varied between countries depending on their institutional and financial-economic context (e.g. northern vs southern countries). This was expressed through the Institutional and Financial-Economic indicators also illustrating the effects of the financial crisis. According to this analysis, public and private projects awarded during and after the economic crisis suffered from time overruns, with private projects doing relatively better. At the same time, most private projects in the BENEFIT database present a low Remuneration Attractiveness Indicator (RAI). The last point is also a dominant finding of the quantitative analysis.

Comparing the important indicators for achieving cost performance with the ones for time performance, interesting differences and trade-offs can be observed. More specifically, PPP projects with low Financing Scheme indicator values seem to favour time over cost, while PPP projects with high Financing Scheme indicator values as well as public projects (Financing Scheme indicator = 1) seem to favour cost over time. Seemingly, a road project with a high cost of capital (low Financing Scheme indicator) gives priority to the need to start operations and therefore generate income streams as soon as possible. Additionally, as mentioned previously, all analyses identified the significance of the Remuneration Attractiveness Indicator and the fact that low values of it (i.e. demand-based and user-paid remuneration schemes) favour a project being “on-time”.

The quantitative analysis placed emphasis on high values of the Governance and Institutional Indicators in achieving “time to completion”. According to fsQCA (table 3.3.1**)**, low values of the Institutional indicator were enough to explain time overruns insix cases. The same was found for the Governance Indicator for four cases that concerned roads. High values of the Cost Saving indicator were also found to be important in achieving time to completion in road projects. Typical examples are the A2 Motorway in Poland, the E-4 in Finland, Via-Invest in Belgium, the A-19 and M-80 in the UK, the E-39 in Norway or the M-45 in Spain (see Table 4.3.4). As identified in the quantitative analysis, the Governance indicator is by far the most important for this outcome as projects that have been on-time have typically higher values of the Governance indicator than projects which have had time overruns. However, lower values of the Governance indicator may be counter-balanced by a higher Cost Saving indicator as in the case of the M-45 in Spain. The impact of the implementation context is also evident. Outliers are indicated with shaded cells.

In conclusion, while time overruns may be triggered by factors included in the Cost Saving Indicator, there is a definite trade-off in favour of time by managers (high Governance indicator) especially in the case of riskier remuneration and revenue schemes. This approach is further pronounced when a high cost of capital is involved (low Financing Scheme indicator).

Box 2: Key Indicators Contributing to Time–to-Completion for Road Projects

Institutional Indicator (InI)	Pre-requisite for being “on-time”	Acts in combination with GI
Governance Indicator (GI)	Pre-requisite for being “on time”	Acts in combination with InI
Financial – Economic Indicator (FEI)	Positive or negative influence depending on high or low value	May be off-set by GI and InI
Cost Saving Indicator (CSI)	Needed for “on-time”	
Low values of Remuneration Attractiveness Indicator (RAI)	Drive to “on-time”	Risk acts as incentive
Low Value of Revenue Robustness Indicator (RRI)	Drive to “on-time”	Risk acts as incentive

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Table 3.3.4: Road project indicators related to time to completion performance

Project Title	Country	Year of Award	CSI	GI	FSI	RAI	Δ FEI - Construction	Δ InI - Construction	Time Performance
A2 Motorway	Poland	2008	0,719	0,688	0,752	1,000	-0,02	0,03	Ahead
E4 Helsinki-Lahti	Finland	1997	0,489	0,750	0,679	0,333	0,00	0,02	Ahead
E18 Muurla-Lohja	Finland	2005	0,133	0,750	0,773	0,667	0,01	0,00	In line
Via-Invest Zaventem	Belgium	2007	0,449	0,688	0,740	0,667	-0,09	0,01	Ahead
A-19 Dishforth	United Kingdom	1998	0,411	0,688	0,525	0,667	0,00	0,01	In line
BNRR (M6 Toll)	United Kingdom	1992	0,172	0,813	0,640	0,347	0,03	-0,01	In line
M-80 (Haggs)	United Kingdom	2009	0,564	0,688	0,529	0,667	-0,01	0,01	In line
E39 Orkdalsvegen Public Road	Norway	2003	0,556	0,563	0,719	0,333	0,07	0,01	In line
A22 motorway	Portugal	2000	0,000	0,813	0,779	0,667	-0,10	0,01	In line
A23 motorway	Portugal	1999	0,000	0,813	0,779	0,667	-0,10	0,01	In line
C-16 Terrasa Manresa toll motorway	Spain	1987	0,133	0,563	0,300	0,333	0,00	0,00	In line
M-45	Spain	1998	0,583	0,563	0,703	0,667	0,00	0,02	In line
Athens Ring Road	Greece	1996	0,313	0,688	0,561	0,333	0,04	0,03	In line
M-25 Orbital	United Kingdom	2009	0,656	0,688	0,668	0,667	-0,03	0,01	Late
Combiplan Nijverdal	The Nether-lands	2006	0,245	0,479	1,000	1,000	-0,10	0,01	Late
Central Greece (E65) Motorway	Greece	2007	0,237	0,750	0,938	0,333	-0,25	-0,04	Late
Elefsina Korinthos Patra Pyrgos Tsakona Motorway	Greece	2007	-0,021	0,625	0,644	0,400	-0,25	-0,04	Late
Ionia Odos Motorway	Greece	2007	0,226	0,750	0,612	0,433	-0,25	-0,04	Late
Moreas Motorway	Greece	2007	0,750	0,750	0,816	0,400	-0,25	-0,04	Late
A5 Maribor Pince motorway	Slovenia	2005	-0,070	0,563	1,000	1,000	0,09	0,04	Late
Koper - Izola Expressway	Slovenia	2008	0,279	0,500	1,000	1,000	-0,25	-0,02	Late
Eje Aeropuerto (M-12) Motorway	Spain	2002	0,541	0,500	0,640	0,333	0,06	-0,03	Late
Radial 2 Toll Motorway	Spain	2000	0,244	0,500	0,640	0,333	0,00	-0,05	Late
Belgrade By-pass Project, Section A: Batajnica-Dobanovci	Serbia	2010	-0,031	0,313	0,850	1,000	-0,02	0,00	Late
Motorway E-75, Section	Serbia	2009	0,000	0,188	1,000	1,000	-0,13	0,03	Late

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Project Title	Country	Year of Award	CSI	GI	FSI	RAI	Δ FEI - Construction	Δ InI - Construction	Time Performance
Donji Neradovac - Srpska kuca									
Motorway E-75, Section Horgos-Novi Sad (2nd phase)	Serbia	2011	-0,030	0,188	1,000	1,000	0,03	0,01	Late

3.3.3 Actual vs Forecast Traffic

Road projects are typically influenced by the financial-economic context with respect to traffic. They are also **vulnerable to optimism bias** making it difficult to distinguish the real reasons behind less-than-expected performance.

According to the **qualitative analysis,** well-planned projects seem to be able to perform better and, depending on the allocation of demand risk, PPP projects may also perform better (see D4.2). However, there seems to be a trade-off between traffic levels and revenues, especially in PPP projects with demand-based remuneration schemes, as the objective of the operator is to cover operating and maintenance costs and address financial obligations rather than achieve public traffic goals. A typical example is the BNRR - M6 Toll road, with traffic below forecast and positive revenues achieved through higher toll prices.

The same ambiguity features in the **fsQCA** results. While strong paths could not be identified, a low risk remuneration scheme (high RAI) accompanied by high Governance (GI) and Institutional (InI) indicators seem to lead to better outcomes in the period following the crisis. This trend (for low risk remuneration schemes) was also confirmed through an investigation of the award of projects following the crisis. In effect, countries with high values of the Institutional indicator are emerging as the new dominant PPP actors (see D4.4). The Cost Saving Indicator (CSI) in combination with a high value of the RAI indicator is found to contribute to a positive outcome.

In a similar way, **the Econometrics analysis** concluded that the Financial-Economic indicator and a remuneration scheme with low risk (high value of RAI) increased the potential of reaching forecast traffic. The Cost Saving indicator was also considered to increase the probability of meeting targets instead of a high Governance indicator. Notably, the Cost Saving indicator includes a factor corresponding to the capability of the operator (cfr. D4.2 and D4.4).

The **Importance analysis** was not able to provide significant indicators with respect to this outcome possibly due to the “noise” of optimism bias within the sample.

Box 3: Key Indicators Contributing to Actual vs Forecast Traffic for Road Projects

Financial – Economic Indicator (FEI)	Very strong Positive or negative influence depending on high or low value
May be limited by:	
Institutional Indicator (InI)	High Value
Governance Indicator (GI)	High Value
Cost Saving Indicator (CSI)	High Value
Remuneration Attractiveness Indicator (RAI)	High Value

In conclusion, road projects appear to perform better with respect to traffic goals under a positive implementation context when they are also characterised by high Cost Saving and Governance

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indicators. Under an adverse implementation context, a high Remuneration Attractiveness indicator (low risk remuneration schemes) supports the achievement of traffic goals. A high value of the Institutional indicator is important in all cases.

Considering that projects usually require a few years to reach nominal traffic levels, the BENEFIT road sample has been split into two groups, before and after the economic crisis, but allowing for traffic volumes to develop. Table 3.3.5 describes projects whose operation started before 2005 allowing for a least 2-3 years of operation before the crisis. Projects achieving traffic goals demonstrate high values of both Cost Saving and Governance indicators. Four of the projects not achieving traffic targets have very low Cost Saving indicators. The shaded ones may be attributed to overestimated initial traffic forecasts (i.e. optimism bias). Notably, none of these projects were influenced by adverse implementation context conditions.

Table 3.3.5: Road project indicators related to traffic performance **before crisis**

Project Title	Country	Year of Award	CSI	GI	FSI	RAI	Δ FEI - Award – before Crisis	Δ InI - Award – before Crisis	Traffic Performance before Crisis
Athens Ring Road	Greece	1996	0,313	0,688	0,561	0,333	0,04	0,03	Above forecast
E4 Helsinki-Lahti	Finland	1997	0,489	0,750	0,679	0,333	0,00	0,02	In line
M-45	Spain	1998	0,583	0,563	0,703	0,667	0,00	0,02	Above forecast
A-19 Dishforth	United Kingdom	1998	0,411	0,688	0,525	0,667	0,00	0,01	In line
E39 Orkdalsvegen Public Road	Norway	2003	0,556	0,563	0,719	0,333	0,07	0,01	In line
C-16 Terrasa Manresa toll motorway	Spain	1987	0,133	0,563	0,300	0,333	0,00	0,00	Below forecast
BNRR (M6 Toll)	United Kingdom	1992	0,172	0,813	0,640	0,347	0,03	-0,01	Below forecast
A23 motorway	Portugal	1999	0,000	0,813	0,779	0,667	-0,10	0,01	Far below forecast
A22 motorway	Portugal	2000	0,000	0,813	0,779	0,667	-0,10	0,01	Far below forecast
Radial 2 Toll Motorway	Spain	2000	0,244	0,500	0,640	0,333	0,00	-0,05	Below forecast
Eje Aeropuerto (M-12) Motorway	Spain	2002	0,541	0,500	0,640	0,333	0,06	-0,03	Below forecast

Table 3.3.6 lists projects whose operation may have been influenced by the crisis. For two, the A5 in Slovenia and E18 in Finland, no adverse implementation context exists. Both projects have low Cost Saving indicators and their performance may be attributed to the high value of the Remuneration Attractiveness indicator (low risk remuneration scheme). The other projects in the list with positive traffic outcomes share relatively high Governance and Remuneration Attractiveness Indicators, even though they are operating in poor financial-economic environments. The Greek cases all have low Remuneration Attractiveness Indicators leading to below expectations results given their poor implementation context conditions. The two Serbian cases demonstrated low values of the Cost Saving and Governance indicators. The list also includes one shaded project, which cannot be explained and could represent a case of overestimated traffic forecasts.

Table 3.3.7 lists the projects that were in operation before the crisis and shows their performance after the crisis. With the exception of the Athens Ring Road, where the absolute value of the Financial-Economic indicator is the lowest overall (0.308), no other project showed a change in

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performance. This also applies to the M-45 in Spain with a similar drop in its FEI value but for which the absolute value of the indicator is still 0.467. The three highlighted cases could not be explained.

Table 3.3.6: Road project indicators related to traffic performance **after crisis**

Project Title	Country	Year of Award	CSI	GI	FSI	RAI	Δ FEI - before Crisis – reporting	Δ InI - before Crisis – reporting	Traffic Performance before Crisis
A5 Maribor Pince motorway	Slovenia	2005	-0,070	0,563	1,000	1,000	0,09	0,04	Above forecast
E18 Muurla-Lohja	Finland	2005	0,133	0,750	0,773	0,667	0,01	0,00	In line
Via-Invest Zaventem	Belgium	2007	0,499	0,688	0,740	0,667	-0,09	0,01	In line
A2 Motorway	Poland	2008	0,719	0,688	0,752	1,000	-0,02	0,03	Above forecast
Koper - Izola Expressway	Slovenia	2008	0,279	0,500	1,000	1,000	-0,25	-0,02	In line
M-25 Orbital	United Kingdom	2009	0,656	0,688	0,668	0,667	-0,03	0,01	In line
M-80 (Haggs)	United Kingdom	2009	0,564	0,688	0,529	0,667	-0,01	0,01	In line
Motorway E-75, Section Donji Neradovac - Srpska kuca	Serbia	2009	0,000	0,188	1,000	1,000	-0,13	0,03	In line
Elefsina Korinthos Patra Pyrgos Tsakona Motorway	Greece	2007	-0,021	0,625	0,644	0,400	-0,25	-0,04	Far below forecast
Ionia Odos Motorway	Greece	2007	0,226	0,750	0,612	0,433	-0,25	-0,04	Far below forecast
Central Greece (E65) Motorway	Greece	2007	0,237	0,750	0,938	0,333	-0,25	-0,04	Far below forecast
Moreas Motorway	Greece	2007	0,750	0,750	0,816	0,400	-0,25	-0,04	Below forecast
Combiplan Nijverdal	The Netherlands	2006	0,245	0,479	1,000	1,000	-0,10	0,01	Below forecast
Motorway E-75, Section Horgos-Novi Sad (2nd phase)	Serbia	2011	-0,030	0,188	1,000	1,000	0,03	0,01	Below forecast
Belgrade By-pass Project, Section A: Batajnica-Dobanovci	Serbia	2010	-0,031	0,313	0,850	1,000	-0,02	0,00	Far below forecast

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Table 3.3.7: Road project indicators related to traffic performance **after crisis for projects in operation before the crisis**

Project Title	Country	Year of Award	CSI	GI	FSI	RAI	Δ FEI – before Crisis – reporting	Δ InI – before Crisis – reporting	Traffic Performance before Crisis
E39 Orkdalsvegen Public Road	Norway	2003	0,556	0,563	0,719	0,333	0,06	0,02	Above Forecast
M-45	Spain	1998	0,583	0,563	0,703	0,667	-0,233	0,01	Above forecast
A-19 Dishforth	United Kingdom	1998	0,411	0,688	0,525	0,667	-0,03	0,01	In line
Athens Ring Road	Greece	1996	0,313	0,688	0,561	0,333	-0,250	-0,04	Below forecast
E4 Helsinki-Lahti	Finland	1997	0,489	0,750	0,679	0,333	-0,026	0,02	Above forecast
C-16 Terrasa Manresa toll motorway	Spain	1987	0,133	0,563	0,300	0,333	-0,233	0,01	Below forecast
BNRR (M6 Toll)	United Kingdom	1992	0,172	0,813	0,640	0,347	-0,03	0,01	Below forecast
A23 motorway	Portugal	1999	0,000	0,813	0,779	0,667	-0,10	0,01	Far below forecast
A22 motorway	Portugal	2000	0,000	0,813	0,779	0,667	-0,10	0,01	Far below forecast
Radial 2 Toll Motorway	Spain	2000	0,244	0,500	0,640	0,333	-0,233	0,01	Below forecast
Eje Aeropuerto (M-12) Motorway	Spain	2002	0,541	0,500	0,640	0,333	-0,233	0,01	Below forecast

3.3.4 Actual vs Forecast Revenues

Revenues are related to traffic but also include a relative trade-off based on price elasticity especially when involving user charges. The **qualitative analysis** identified that private projects were more likely to reach expected revenues. However, this finding may be misleading as in cases where revenues were not achievable renegotiations took place.

The **fsQCA** analysis identified that projects with higher values of the Financing Scheme indicator were more capable of reaching revenue goals and so were cases with higher Institutional indicators. In essence, these are projects with high government financial support and, therefore, a lower cost of capital. Public projects very often do not face the need to recover construction costs but only to be operationally self-sustained thus reducing overall the level of revenues targeted. This is also expressed in the Revenue Robustness Indicator (RRI) which was also identified as an important indicator by the Econometrics analysis. Finally, the Governance and the Cost Saving Indicators appear in a number of indicator combinations leading to the attainment of forecast revenues.

The Remuneration Attractiveness indicator (RAI) was equally important in achieving revenue targets (both before as well as during the crisis) according to the findings of the **Importance analysis**. This finding is in line with post-crisis prevailing trends in PPP remuneration schemes (availability payments in lieu of tolls) for newly awarded road projects. The factor Level of Coopetition was found significant but as noted previously this is not always relevant to road projects.

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Finally, the **Econometrics analysis** identified both the Remuneration Attractiveness and the Revenue Robustness indicators as significant for achieving revenue targets. High values of the Reliability/Availability indicator were also significant which is reasonable considering that remuneration schemes with high values of the respective indicator (such as availability payments) are entirely dependent on the asset's availability and reliability in order for unitary payments to be made.

It is interesting to note that no analysis identified the Financial-Economic indicator as significant. Moreover, the Econometrics analysis did not identify the crisis as significant overall.

Box 4: Key Indicators Contributing to Actual vs Forecast Revenues for Road Projects

Revenue Robustness Indicator (RRI)	
May be supported by:	
Remuneration Attractiveness Indicator (RAI)	High Value
Governance Indicator (GI)	High Value
Cost Saving Indicator (CSI)	High Value
Expected when	
Financing Scheme Indicator (FSI)	High Value
Revenue Support Indicator (RSI)	High Value

Table 3.3.8 presents the list of road projects which were operational before the crisis. Revenues were below forecast in only two cases and these demonstrated a low Revenue Robustness indicator. It is also interesting that these cases also exhibit a low Remuneration Attractiveness indicator. In addition, these were projects with established traffic volumes before the crisis suggesting optimism of initial design.

For projects operating after the crisis (Table 3.3.9), a high Revenue Robustness indicator aligns with a positive revenue outcome. The shaded cells indicate projects that cannot be explained. However, most of the PPP projects in this group have been renegotiated with the principle aim of securing revenues. In many cases their outcome consisted of an increase in toll tariffs. While, the increase was not always welcome by the users, leading to a reduction in the value of the Market Efficiency and Acceptability indicator (MEAI), this indicator was not identified as important by any analysis.

Table 3.3.8: Road project indicators related to revenue performance **before crisis**

Project Title	Country	Year of Award	IRA	FSI	RAI	RRI	Traffic Performance before Crisis	Revenue Performance before Crisis
Athens Ring Road	Greece	1996	1,00	0,561	0,333	0,667	Above forecast	Above forecast
M-45	Spain	1998	1,00	0,703	0,667	0,063	Above forecast	Above forecast
E39 Orkdalsvegen Public Road	Norway	2003	1,00	0,719	0,333	0,667	In line	In line
E4 Helsinki-Lahti	Finland	1997	1,00	0,679	0,333	1,000	In line	In line
A-19 Dishforth	United Kingdom	1998	1,00	0,525	0,667	0,063	In line	In line
C-16 Terrasa Manresa toll motorway	Spain	1987	1,00	0,300	0,333	0,667	Below forecast	In line
BNRR (M6 Toll)	United Kingdom	1992	1,00	0,640	0,347	0,673	Below forecast	In line
Radial 2 Toll Motorway	Spain	2000	1,00	0,640	0,333	0,667	Below forecast	In line
Eje Aeropuerto (M-12) Motorway	Spain	2002	1,00	0,640	0,333	0,667	Below forecast	In line
A23 motorway	Portugal	1999	1,00	0,779	0,667	0,293	Far below forecast	Below forecast
A22 motorway	Portugal	2000	1,00	0,779	0,667	0,293	Far below forecast	Below forecast

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Table 3.3.9: Road project indicators related to revenue performance **after crisis**

Project Title	Country	Year of Award	IRA	FSI	RAI	RRI	Traffic Performance after Crisis	Revenue Performance after Crisis
A2 Motorway	Poland	2008	1,00	0,752	1,000	0,444	Above forecast	Above forecast
A5 Maribor Pince motorway	Slovenia	2005	1,00	1,000	1,000	1,000	Above forecast	Above forecast
Elefsina Korinthos Patra Pyrgos Tsakona Motorway	Greece	2007	0,56	0,644	0,400	0,667	Below forecast	In line
Ionia Odos Motorway	Greece	2007	0,56	0,612	0,433	0,667	Below forecast	In line
Central Greece (E65) Motorway	Greece	2007	0,56	0,938	0,333	0,667	Below forecast	In line
Koper - Izola Expressway	Slovenia	2008	1,00	1,000	1,000	1,000	In line	In line
Motorway E-75, Section Donji Neradovac - Srpska kuca	Serbia	2009	1,00	1,000	1,000	0,667	In line	In line
Motorway E-75, Section Horgos-Novi Sad (2nd phase)	Serbia	2011	1,00	1,000	1,000	0,667	Below forecast	In line
E18 Muurla-Lohja	Finland	2005	1,00	0,773	0,667	0,824	In line	In line
Belgrade By-pass Project, Section A: Batajnica-Dobanovci	Serbia	2010	1,00	0,850	1,000	0,203	Below forecast	Below forecast
Moreas Motorway	Greece	2007	1,00	0,816	0,400	0,679	Below forecast	Below forecast
Via-Invest Zaventem	Belgium	2007	1,00	0,740	0,667	0,000	In line	In line
M-25 Orbital	United Kingdom	2009	1,00	0,668	0,667	0,121	In Line	In line
M-80 (Haggs)	United Kingdom	2009	1,00	0,529	0,667	0,063	In line	In line
Combiplan Nijverdal	The Netherlands	2006	1,00	1,000	1,000	0,000	Below forecast	In line

3.3.5 Summary of Indicators influencing Road Infrastructure Project Performance

Table 3.3.10 summarises indicators influencing road project outcomes. Across all projects the Financial-Economic indicator is influential more with respect to traffic outcomes but also with an impact on cost and time targets. A high Institutional indicator may limit the impact of a low Financial-Economic indicator. In this context, countries with high Institutional indicators are more capable of weathering a financial/economic crisis.

With respect to time to completion, while the Governance indicator is the one dominating the potential to achieve this outcome, a high Cost Saving indicator may compensate smaller GI values. Trade-offs between cost and time to completion have been found to take place. In PPPs there is also a trade off with respect to revenues and traffic, especially if high-risk remuneration schemes are in place.

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Table 3.3.10: Summary table of indicators influencing outcomes in Road projects

Outcomes Indicators	Cost to Completion	Time to Completion	Actual vs Forecast Traffic	Actual vs Forecast Revenue
Financial – Economic Indicator (FEI)	Strong positive or negative influence depending on high or low value	Positive or negative influence depending on high or low value (May be off-set by GI and InI)	Very strong Positive or negative influence depending on high or low value	
Institutional Indicator (InI)	Pre-requisite	Pre-requisite (Acts in combination with GI)	High value may limit effect of FEI	
Governance Indicator (GI)	Needed (compensates for low CSI)	Pre-requisite (Acts in combination with InI)	High value may limit effect of FEI	Support: High Value
Cost Saving Indicator (CSI)	Needed (compensates for low GI)	Needed	High value may limit effect of FEI	Support: High Value
Revenue Support Indicator (RSI)	Support			Expected for High Value
Remuneration Attractiveness Indicator (RAI)		Driver: Low values	High value may limit effect of FEI	Support: High Value
Revenue Robustness Indicator (RRI)		Driver: Low values		Key Indicator
Financing Scheme Indicator (FSI)	Driver: High values			Expected for High Value

Key Findings may be summarised as follows:

Indicators Exogenous to the project

- The Financial-Economic indicator (FEI) plays a significant role in road projects. An increase or decrease in the value of this indicator may have a respective impact on the probability of achieving Time to completion, Cost to completion and Traffic targets. The influence is greater with respect to traffic and lesser with respect to time to completion. A high value of the Institutional Indicator may off-set the impact of a low FEI on time targets. The FEI is not a determining indicator with respect to the revenue target.
- The institutional indicator (InI) may be the most important. While exogenous to the project, it is not affected by economic cycles and, therefore, describes a measure of resilience to financial shocks. It is a pre-requisite in achieving cost and time to completion targets, while a high value may also limit the impact of a low FEI on traffic. Once again, the InI is not a determining indicator with respect to the revenue target.

Indicators Endogenous to the project

- The Governance indicator reflects in many ways the level of institutional maturity in the country where the project is procured. In this respect, it may compensate and/or enhance the

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Institutional Indicator. As it describes the institutional arrangements within the project it practically influences all project outcomes.

- The Cost Saving indicator describes the project's technical difficulty and also the capabilities of key project actors: the constructor's to construct, the operator's to operate, and the monitoring authority's to monitor the project in consideration. In addition, it assesses whether capabilities are aligned with the risk allocation among these actors. All these attributes were found to be important throughout the project life cycle. A high CSI may compensate for a lower value of GI with respect to cost to completion and may also contribute to off-setting the impact of a low FEI on traffic.
- The importance of the Revenue Support indicator is limited in road projects and depends on the criticality and exclusivity of the project in the network. A high value of the factor "Level of Coopetition" may have a positive impact on cost to completion and revenue targets.
- The Remuneration Attractiveness Indicator practically acts as a policy tool. Low values of the indicator will drive the attainment of time to completion targets. High values of the indicator will limit the effect of FEI on traffic and also support revenue targets.
- The Revenue Robustness Indicator expresses the riskiness of the project revenue streams as well as the estimated level of cost coverage. Therefore, it becomes a key indicator in assessing the potential of achieving revenue targets and also drives the project towards being "on-time".
- The Financing Scheme Indicator is also a policy tool as it becomes a response to adverse exogenous indicators. Low values of the FEI and InI dictate the need for higher values of the FSI. In other words, countries with low FEI and InI values are forced to increase public contributions to project financing structures or opt out of the PPP model for project delivery altogether.

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3.4 Urban Transit

The part of the qualitative analysis in Deliverable D4.4 that investigated the effect of the crisis on urban transit projects identified that the influence of the Financial-Economic indicator (FEI) is limited, except in cases of countries severely hit by the crisis. Under such circumstances projects are also exposed to institutional structural weaknesses. To this end the analysis in this section tries to identify combinations of indicators and their respective values that affect the various outcome targets using as the key indicator of change the **Institutional Indicator (InI).**

3.4.1 Cost to Completion

The **qualitative analysis** identified competence on the contractor as well as the respective public authority's side as important in achieving cost to completion in public transit projects (Cost Saving indicator). Additionally, the technical maturity of the project was one of the key problems identified leading to cost overruns. Competence and technical maturity are both captured in the Cost Saving Indicator.

The contractual arrangement was also identified to play an important role in achieving cost to completion targets during construction. These issues are related to the Governance Indicator.

Notably, urban transit is not directly influenced by the country's implementation context. The local and regional implementation context is far more important, especially, as it has often been seen that cost overruns are covered by the public sector. The country implementation context is significant in cases of projects driven by central government. **The institutional context** related to the project was identified as important by the qualitative analysis, as urban transit projects require a long maturing period over which political stability and transparent processes are important. Finally, the qualitative analysis identified the level of integration of the project into the urban transit network, as well as its position in the network, as important in managing construction and other related costs. These factors are considered in the **Revenue Support indicator** and its factor "Level of Coopetition".

With respect to the findings of the quantitative analyses, previously identified trends also appear to apply to urban transit: projects (public and private) have a greater potential to achieve cost performance targets when they are structured with a higher **Cost Saving and Governance indicator**, while a low and/or mostly declining Financial-Economic and Institutional indicator may have a negative impact.

However, for urban transit a high value of the Revenue Support indicator (as identified by the qualitative analysis) is also considered important by the **Econometric analysis**. It becomes of relevance in the case of projects that may be considered to have considerable Level of Coopetition within the network (e.g. metro lines) or cooperation with other urban networks and hence need to contain construction costs. The Level of Coopetition was also identified as influential by the **Importance analysis.**

Box 5: Key Indicators Contributing to Cost –to-Completion for Urban Transit Projects

High values of all listed indicators is important in achieving cost to completion	
Institutional Indicator (InI)	High Value
Governance Indicator (GI)	High Value
Cost Saving Indicator (CSI)	High Value
Revenue Support Indicator (RSI)	High Value

Table 3.4.1 lists urban transit projects for which indicator values could be calculated along with the identified significant indicators for achieving cost to completion. Projects demonstrating high values of the Institutional, Cost Saving, Governance, Revenue Support (including the factor Level of Coopetition) indicators achieved cost targets. Projects demonstrating lower values of any of these

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indicators and especially the Cost Saving indicator presented cost overruns. Low **values in this case are highlighted by the shaded cells**. Finally, the performance of the Metro do Porto could not be explained. An overestimated budget or a reduction in project scope may be possible reasons behind this observed performance.

Table 3.4.1: Urban Transit project indicators related to cost performance

Project Title	Country	Year of Award	CSI	GI	RSI	LoC	Inl Award	Inl Construction End	Cost Performance
Metrolink LRT, (Ph.1) Manchester	United Kingdom	1989	1,000	0,688	0,270	0,818	0,82	0,82	In line
Metrolink LRT, (Ph.2) Manchester	United Kingdom	1997	1,000	0,688	0,270	0,818	0,82	0,83	In line
Metrolink LRT, (Ph.3) Manchester	United Kingdom	2008	1,000	0,688	0,270	0,818	0,80	0,79	In line
MST-Metro Sul do Tejo	Portugal	2002	0,453	0,813	0,213	0,727	0,72	0,71	In line
Lyon's tramway T4	France	2004	0,178	0,688	0,109	0,545	0,75	0,73	In line
Athens Tramway	Greece	2001	-0,028	0,656	0,045	0,091	0,60	0,62	Overrun
Lyon's VeloV	France	2004	0,000	0,750	0,210	0,636	0,75	0,74	Overrun
Metro de Malaga	Spain	2004	0,065	0,688	0,227	0,727	0,72	0,69	Overrun
Reims tramway	France	2006	0,000	0,875	0,181	0,545	0,74	0,73	Overrun
Tram-Train Kombilösung Karlsruhe	Germany	2009	0,000	0,313	0,264	0,909	0,79	0,80	Overrun
Brabo 1	Belgium	2008	0,213	0,688	0,142	0,364	0,74	0,78	Overrun
Warsaw's Metro II-nd line	Poland	2009	0,691	0,625	0,181	0,636	0,63	0,62	Overrun
Metro do Porto	Portugal	2003	0,000	0,313	0,262	0,727	0,71	0,70	Below Budget

3.4.2 Time to Completion

As in the case of road projects, the **qualitative analysis** indicated that urban transit project delays originate from technical difficulties, poor planning and project maturation, as well as the (lack of) relevant competence from both private and public sector stakeholders involved to plan, construct, monitor and operate the project. These factors are captured by the **Cost Saving Indicator.**

As most urban transit projects are more often than not ultimately supported by the public authority, emphasis is usually placed on achieving cost rather than time targets. This is reflected in the **fsQCA** findings where higher values of the Financing Scheme indicator are connected to time overruns. Again, Level of Coopetition or the overall Revenue Support indicators were found to be important by the **Importance** and **Econometric analysis**. Governance, as well as the Institutional indicator, were both found to be significant.

The remuneration scheme is of little significance for urban transit as most operations (public and private) are subsidised.

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Table 3.4.2, listing urban transit projects in the BENEFIT database, demonstrates the above findings. Projects delivered on time carry high values of the Cost Saving, Governance, Level of Coopetition, Revenue Support and Institutional context indicators. Projects delivered with time overruns have low values of one or more of these indicators. Additionally, projects delivered late, while burdened by low values of the aforementioned indicators, also had a lower value of the Financing Scheme indicator.

Box 6: Key Indicators Contributing to Time–to-Completion for Urban Transit Projects

High values of all listed indicators is important in achieving time to completion		
Institutional Indicator (InI)	High Value	
Governance Indicator (GI)	High Value	May be combined with CSI
Cost Saving Indicator (CSI)	High Value	May be Combined with GI
Revenue Support Indicator (RSI)	High Value	

With respect to the Financing Scheme indicator, it is worth noting that for most urban transit projects (including those delivered as PPPs) the value of this indicator is high. This is a clear demonstration of the level of public financial support provided to these projects.

Finally, the performance of two projects (the Tram-Train Kombilösung Karlsruhe and Metro do Porto) could not be explained, as the values of the Cost Saving and Governance indicator would suggest a lower performance. In both cases the only indicator driving the positive outcome is the Revenue Support Indicator together with an improving implementation context.

Table 3.4.2: Urban Transit project indicators related to time to completion performance

Project Title	Country	Year of Award	CSI	GI	RSI	LoC	FSI	InI Award	InI Construction End	Time Performance
Metrolink LRT, (Ph.1) Manchester	United Kingdom	1989	1,000	0,688	0,270	0,818	0,981	0,82	0,82	In line
Metrolink LRT, (Ph.2) Manchester	United Kingdom	1997	1,000	0,688	0,270	0,818	0,995	0,82	0,83	In line
Metrolink LRT, (Ph.3) Manchester	United Kingdom	2008	1,000	0,688	0,270	0,818	0,960	0,80	0,79	In line
MST-Metro Sul do Tejo	Portugal	2002	0,453	0,813	0,213	0,727	0,959	0,72	0,71	In line
Lyon's tramway T4	France	2004	0,178	0,688	0,109	0,545	0,999	0,75	0,73	In line
Lyon's VeloV	France	2004	0,000	0,750	0,210	0,636	0,300	0,75	0,74	In line
Brabo 1	Belgium	2008	0,213	0,688	0,142	0,364	0,719	0,74	0,78	Ahead
Athens Tramway	Greece	2001	-0,028	0,656	0,045	0,091	0,982	0,60	0,62	Late
Metro de Malaga	Spain	2004	0,065	0,688	0,227	0,727	0,785	0,72	0,69	Late
Reims tramway	France	2006	0,000	0,875	0,162	0,545	0,868	0,74	0,73	Late
Warsaw's Metro II-nd line	Poland	2009	0,691	0,625	0,181	0,636	1,000	0,63	0,62	Late
Tram-Train Kombilösung Karlsruhe	Germany	2009	0,000	0,313	0,264	0,909	0,946	0,79	0,80	In line
Metro do Porto	Portugal	2003	0,000	0,313	0,262	0,727	0,887	0,71	0,70	In line

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3.4.3 Actual vs Forecast Traffic (ridership)

As identified by **the qualitative analysis**, **urban transit is often influenced by optimism bias** when new modes are introduced. In most cases, however, they constitute extensions of an existing network. Hence, similarly to brownfield road projects traffic may be reasonably estimated. In this sense, traffic for urban transit depends on planning and its integration within the urban transit network and the general mobility scheme, i.e. the Cost Saving and Revenue Support indicators respectively.

The **Econometrics analysis** identified the Cost Saving indicator as important in achieving ridership targets.

With respect to the implementation indicators (Institutional and Financial-Economic indicators), these are not always significant to urban transit as in other modes as two distinct and opposite forces may exist during a crisis depending on the prevailing behaviour of passengers. More specifically, while a reduction in the Financial-Economic indicator suggests a negative impact on employment and consequently on commuter travel, it may also have a positive effect on ridership as modal shift may take place in favour of urban transit.

Tables 3.4.3 and 3.4.4 list projects and relevant indicators for projects operating before and after the crisis. As concluded by the quantitative analyses, the Market Efficiency and Acceptability indicator does not seem to have an impact on the outcome. Traffic seems to be secured only when the majority of the following indicators have high values: **Cost Saving, Remuneration Attractiveness, Governance, Revenue Support and its factor Level of Coopetition.**

Table 3.4.3: Urban transit project indicators related to traffic performance **before crisis**

Project Title	Country	Year of Award	CSI	RAI	GI	RSI	LoC	MEAI	Δ FEI - Award – before Crisis	Δ Inl - Award – before Crisis	Traffic Performance before Crisis
Athens Tramway	Greece	2001	-0,028	0,333	0,667	0,045	0,091	0,389	0,02	0,02	Below
Metro do Porto	Portugal	2003	0,000	0,000	0,313	0,262	0,727	0,417	-0,01	-0,01	Far below
Lyon's tramway T4	France	2004	0,178	1,000	0,688	0,109	0,545	0,444	-0,02	-0,02	In line
Metro de Malaga	Spain	2004	0,065	0,333	0,563	0,227	0,727	0,167	-0,03	-0,03	In line
Metrolink LRT, (Ph.1) Mancheste r	United Kingdom	1989	1,000	0,333	0,688	0,270	0,818	0,167	0,00	0,00	In line
Metrolink LRT, (Ph.2) Mancheste r	United Kingdom	1997	1,000	0,333	0,688	0,270	0,818	0,167	0,01	0,01	In line
MST-Metro Sul do Tejo	Portugal	2002	0,453	0,467	0,813	0,213	0,727	0,444	-0,02	-0,02	In line
Lyon's VeloV	France	2004	0,000	0,500	0,750	0,210	0,636	0,333	-0,02	-0,02	Above

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Table 3.4.4: Urban transit project indicators related to traffic performance **after crisis**

Project Title	Country	Year of Award	CSI	RAI	GI	RSI	LoC	MEAI	Δ FEI - before Crisis – rep/ting	Δ InI - before Crisis – reporting	Traffic Performance after Crisis
Metrolink LRT, Manchester (Ph 3)	United Kingdom	2008	1,000	0,333	0,688	0,270	0,818	0,167	-0,01	-0,01	Above
Tram-Train Kombilösung Karlsruhe	Germany	2009	0,000	1,000	0,313	0,264	0,909	0,833	0,01	0,01	Above
Reims Tramway	France	2006	0,000	0,770	0,875	0,162	0,545	0,444	-0,03	-0,01	In line
Brabo 1	Belgium	2008	0,213	0,667	0,690	0,142	0,364	0,000	0,03	0,03	In line
Warsaw's Metro II-nd line	Poland	2009	0,691	0,870	0,625	0,181	0,636	0,167	0,06	-0,01	In line

Box 7: Key Indicators Contributing to Actual vs Forecast Traffic for Urban Transit Projects

A combination of all listed indicators is important in achieving ridership targets		
Institutional Indicator (InI)	High Value	
Governance Indicator (GI)	High Value	May be combined with CSI
Cost Saving Indicator (CSI)	High Value	May be Combined with GI
Revenue Support Indicator (RSI)	High Value	With emphasis on LoC
Remuneration Attractiveness Indicator (RAI)	High Value	Support

3.4.4 Actual vs Forecast Revenues

As noted in the **qualitative analysis**, the operation of urban transit projects is usually subsidised and is very **dependent on the demand risk allocation**. If the commercial risk is only borne by the contracting authority, revenues below forecast have to be regularly supplemented (e.g. Sul do Tejo). On the contrary, if commercial risk is only borne by the operator, financial imbalances are not compensated and renegotiations become inevitable (e.g. Reims project). Therefore, the **Revenue Support Indicator is very relevant.** This indicator also captures revenue generated by **commercial advertisements** which are very common in public transport.

Revenues in urban transit also depend on the ability of the operator to operate the system, which is reflected in the **Cost Saving indicator**. Both Cost Saving and Revenue Support indicators may, in turn, have an impact on the Revenue Robustness indicator, including the level of cost coverage. This revenue dependency may also be reflected in the Financing Scheme indicator through an increase in the value of the indicator over time as more public funding is needed. This time-dependent trend, however, was not registered in the respective cases of the BENEFIT database, probably because the corresponding values of the Financing Scheme indicator were high to begin with.

Furthermore, the Remuneration Attractiveness indicator is also relevant as it describes the capacity of the Funding Scheme of the project to cover the operating costs borne by the operator.

Finally, the financial crisis may have a severe impact on revenues, either through a drop in ridership, as described above, and/or through a drop in commercial advertisement revenue, which usually forms a significant part of the overall revenues. Also, the introduction of increased fares may influence the Market Efficiency and Acceptability Indicator.

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All parallel indicator quantitative analysis streams, either singularly or in combinations, confirmed the importance of most of the factors identified by the qualitative analysis. More specifically, the **Econometrics analysis** highlighted the significance of the Remuneration Attractiveness and Revenue Robustness indicators (as stemming from the Cost Saving and Revenue Support indicators) while the **fsQCA** emphasised the relevance of the Financing Scheme (even though not illustrated in the urban transit project values) and the Institutional indicator. The Remuneration Attractiveness indicator was identified as significant by the **Importance Analysis,** along with the Level of Coopetition for projects after the crisis. The **Econometrics** analysis also identified the Reliability/Availability indicator (IRA) as important.

Tables 3.4.5 and 3.4.6 list projects and their respective revenue performance before and after the crisis. What is noticeable is that the Financing Scheme indicator takes higher values following the crisis. It is also worth noticing that high values of the Revenue Support indicator are present when achieving revenue targets.

Table 3.4.5: Urban transit project indicators related to revenue performance **before crisis**

Project Title	Country	Year of Award	CSI	RSI	RRI	RAI	FSI	Δ FEI - Award – before Crisis	Δ Inl - Award – before Crisis	Revenue Performance before Crisis
Lyon's VeloV	France	2004	0,000	0,210	0,750	0,500	0,300	-0,02	-0,02	Above forecast
Athens Tramway	Greece	2001	-0,028	0,045	0,667	0,333	0,982	0,02	0,02	In line
Lyon's tramway T4	France	2004	0,178	0,109	0,258	1,000	0,999	-0,02	-0,02	In line
Metro de Malaga	Spain	2004	0,065	0,227	0,763	0,333	0,785	-0,03	-0,03	In line
Metro do Porto	Portugal	2003	0,000	0,262	0,371	0,000	0,887	-0,01	-0,01	In line
Metrolink LRT, (Ph.1) Manchester	United Kingdom	1989	1,000	0,270	0,667	0,333	0,981	0,00	0,00	In line
Metrolink LRT, (Ph.2) Manchester	United Kingdom	1997	1,000	0,270	0,667	0,333	0,995	0,01	0,01	In line
MST-Metro Sul do Tejo	Portugal	2002	0,453	0,213	0,593	0,467	0,959	-0,02	-0,02	In line

Table 3.4.6: Urban transit project indicators related to revenue performance **after crisis**

Project Title	Country	Year of Award	CSI	RSI	RRI	RAI	FSI	Δ FEI - before Crisis – reporting	Δ Inl - before Crisis – reporting	Revenue Performance after Crisis
Metrolink LRT, Manchester	United Kingdom	2008	1,000	0,270	0,667	0,333	0,960	-0,01	-0,01	Above forecast
Tram-Train Kombilösung Karlsruhe	Germany	2009	0,000	0,264	0,000	1,000	0,946	0,01	0,01	Above forecast
Brabo 1	Belgium	2008	0,213	0,142	0,462	0,667	0,719	0,03	0,03	In line
Warsaw's Metro II-nd line	Poland	2009	0,691	0,181	0,446	0,870	1,000	0,06	-0,01	In line

What is worth noting from the list of projects, is that **at least two of the considered indicators should have a high value for revenues to be "in line" with forecasts.**

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Box 8: Key Indicators Contributing to Actual vs Forecast Revenues for Urban Transit Projects

A combination of all listed indicators is important in achieving revenue targets. At least two indicators should have a high value for revenues to be secured.	
Institutional Indicator (InI)	High Value
Revenue Robustness Indicator (RRI)	High Value
Governance Indicator (GI)	High Value
Cost Saving Indicator (CSI)	High Value
Revenue Support Indicator (RSI)	High Value
Remuneration Attractiveness Indicator (RAI)	High Value
Reliability / Availability Indicator (IRA)	High Value

3.4.5 Summary of Indicators influencing Urban Transit Infrastructure Project Performance

Table 3.4.7 summarises indicators influencing urban transit project outcomes. What is noticeable is that in order to secure positive outcomes all indicators identified have to exhibit high values. This is particularly important in order to achieve the cost to completion target. Some flexibility was identified with respect to the combination of the influence of the Cost Saving and Governance Indicators.

Finally, the Econometrics analysis identified the Reliability/Availability indicator (IRA) as significant in achieving ridership and revenue targets. In Table 3.4.7 below, it is noted as a prerequisite.

Table 3.4.7: Summary table of indicators influencing outcomes in Urban Transit projects

Outcomes / Indicators	Cost to completion	Time to completion	Actual vs Forecasted Traffic	Actual vs Forecasted Revenues
Institutional	High Value	High Value	High Value	High Value
Financial Economic				Only with respect to advertisements
Governance	High Value	High Value (May be combined with CSI)	High Value (May be combined with CSI)	High Value
Cost Saving	High Value	High Value (May be Combined with GI)	High Value (May be Combined with GI)	High Value
Revenue Support	High Value	High Value	High Value (With emphasis on LoC)	High Value
Remuneration Attractiveness			Support	High Value
Revenue Robustness				High Value
Market Efficiency & Acceptability				
Reliability /Availability			Prerequisite	Prerequisite
Financing Scheme				
Comment	All indicator above should have high values			At least two of the above indicators should bear a high value.

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Key Findings may be summarised as follows:

Indicators Exogenous to the project

- The Financial-Economic indicator (FEI) whether describing the national context, as in the BENEFIT approach, or the local conditions, is not decisive for urban transit projects as the effect of a low or decreasing FEI (recession) may affect ridership positively or negatively (or both). The only definite negative effect FEI may have is on the amount of revenues from advertisements, which is a common income stream for urban transit.
- The Institutional indicator (InI) may be the most important. While exogenous to the project, it is not affected by economic cycles and, therefore, describes a measure of resilience to financial shocks and also transparency with respect to project maturity. It is a prerequisite in achieving all target outcomes.

Indicators Endogenous to the project

- The Governance indicator reflects in many ways the level of institutional maturity in the country of project procurement. In this effect, it may compensate and/or enhance the Institutional Indicator. A high value contributes to the "on-budget" and revenue targets. High values may also compensate for low values of the CSI for "on-time" and traffic targets.
- The Cost Saving indicator describes the project's technical difficulty and also the capabilities of key project actors: the constructor's to construct, the operator's to operate, and the monitoring authority's to monitor the project in consideration. In addition, it assesses whether capabilities are aligned with the risk allocation among these actors. All these attributes were found to be important through-out the project life cycle. A higher value of the CSI may compensate for a lower value of GI with respect to time to completion and traffic targets.
- The Revenue Support indicator is highly important in urban transit. It describes both the exclusivity of the project in the urban transit network as well as its ability to generate revenues from other sources. However, within urban transit the most important factor is "Level of Coopetition".
- The Remuneration Attractiveness Indicator is always relatively high in urban transit as most operations are subsidised. Higher values of the indicator correspond to greater public support and consequently less expensive fares driving both ridership and revenues for the project.
- The Revenue Robustness Indicator expresses the riskiness of the project revenue streams as well as the cost coverage level estimated. Therefore, it becomes a key indicator in assessing the potential of achieving revenue targets.
- The Financing Scheme Indicator was not found to have a particular impact on outcomes most probably because urban transit is usually heavily supported by the public sector. This support is mostly reflected in the Remuneration Attractiveness Indicator.
- Finally, while a high Reliability/Availability Indicator is important for all modes, it is a prerequisite for traffic and revenue targets in urban transit projects.

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3.5 Bridge & Tunnel Projects

3.5.1 Cost to Completion

Bridges and tunnels are cost-intensive structures requiring long planning and maturing periods. The **qualitative analysis** indicated that with one exception, all relevant cases in the BENEFIT database had long maturing periods. By studying cases available for qualitative assessment, it was observed that large transport projects related to special structures such as bridges and tunnels needed support on a governmental/national level, for both public and private cases. Seven cases out of nine analysed could be regarded as achieving outcomes. These happen to be nationally driven projects with political support on a central government level. Two projects in the BENEFIT database that were driven on a local/regional level did not achieve their cost to completion goal. This finding suggests the importance of the Institutional Indicator as well as the Cost Saving indicator with respect to planning.

In addition, the exclusive nature of these structures also placed additional emphasis on the necessary design and planning that can lead to improved construction conditions and help to achieve cost targets.

Of equal importance was the capability of contractors to deliver their part. Most projects in the BENEFIT database were undertaken by construction companies with a high level of competence and international activities.

Bridges and tunnels delivered through PPP schemes were planned prudently in terms of construction costs. Moreover, the private party optimised costs through changes in technology or in design, as was the case in Millau Viaduct (structural changes proposed by the contractor resulted in a 18% reduction of the original budget). Such diligent budgeting is not typically found in public cases, whose costs are usually underestimated, as in the case of the Blanka Tunnel (more than 100% difference).

All the above qualitative assessments correspond to the composite indicator Cost Savings, the Institutional indicator (with respect to central planning), the Governance indicator and the “Level of Coopetition” (factor of the Revenue Support indicator).

The **fsQCA** analysis identified high values of the Cost Saving, Institutional, Governance and Financing Scheme indicators as important in achieving cost to completion targets. The same findings were also identified for the PPP projects sample with emphasis on the Institutional and Cost Saving indicators. These findings are in agreement with the qualitative analysis.

The **Importance analysis** also identified the influential nature of the Cost Saving, Institutional, and Governance indicators along with “Level of Coopetition” (factor of the Revenue Support Indicator). This factor, which describes the position of the infrastructure in the network (Roumboutsos and Pantelias 2015), is of exceptional importance for bridges and tunnels and in many cases it is also enhanced contractually by limiting direct competition. Again, these findings are in agreement with the qualitative analysis.

Similarly**, the Econometrics analysis** for the entire sample presented the same findings as before with Revenue Support included as a significant indicator in place of Level of Coopetition. It is also noted that the Econometrics analysis identified the Financial–Economic indicator as important. This analysis stream, however, did not consider the Institutional indicator as the implementation context indicators were identified to be closely correlated and could not use both in the analysis.

Finally, **bridge and tunnel projects due to their cost intensity** are usually highly supported by the public sector with low cost financing and, therefore, demonstrated a relatively high value of the Financing Scheme indicator. This was found to be important in achieving cost to completion goals by the **fsQCA**.

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Table 3.5.1 lists the bridge and tunnel projects of the BENEFIT database for which indicators could be calculated. The low Cost Saving and Governance indicators explain the cost overrun in the case of Blanca Tunnel, while the same indicators may explain the performance of the Herrentunnel despite the low Level of Coopetition (Revenue Support) indicator.

Table 3.5.1: Bridges/tunnels project indicators related to cost performance

Project Title	Country	Year of Award	CSI	GI	FSI	RSI	LoC	Δ FEI – Construction	Δ InI - Construction	Cost Performance
Blanka Tunnel	Czech Republic	2006	0,000	0,188	1,000	0,222	0,818	0,01	0,00	Overrun
Herrentunnel Lübeck	Germany	1999	0,528	0,563	0,848	0,107	0,455	0,03	-0,02	In line
Lusoponte Vasco da Gama Bridge	Portugal	1994	0,582	0,875	0,796	0,416	1,000	-0,10	0,01	In line
Rion-Antirion Bridge	Greece	1996	0,698	0,688	0,873	0,256	0,909	0,04	0,03	In line

Box 9: Key Indicators Contributing to Cost –to-Completion for Bridge & Tunnel Projects

A strict combination of the following indicators may support the cost to completion target.		
Institutional Indicator (InI)	High Value	
Financing Scheme Indicator (FSI)	High Value	
Governance Indicator (GI)	High Value	
Cost Saving Indicator (CSI)	High Value	
Revenue Support Indicator (RSI)	High Value	High LoC Important

3.5.2 Time to Completion

The **qualitative analysis** identified that nationally driven bridge and tunnel projects appeared more likely to reach time to completion targets. All projects in the BENEFIT sample were completed before the crisis, while there is evidence in the literature of the negative impact that a crisis can have on time to completion for such projects. This impact is basically due to the size of the investment (large) but also to the impact of the crisis on international and experienced construction companies, which are the common contractors for such projects. These factors are captured by the Cost Saving indicator.

The **fsQCA,** while not providing overall significant results, did consider the negative impact of the Institutional and Financial-Economic context on time targets throughout the sample. PPPs perform better for a combination of high Institutional, Financial-Economic, Cost Saving, and Governance indicators with a low value of the Remuneration Attractiveness and a high Financing Scheme Indicator. These are typical levels of the indicator values of bridge and tunnel projects.

The **Importance analysis** identified Governance, Remuneration Attractiveness and Level of Coopetition as significant indicators in achieving time to completion targets. As in the case of cost to completion, Level of Coopetition is considered influential for bridge and tunnel projects. The same indicators with the inclusion of the Institutional indicator were considered significant for achieving time to completion during the economic crisis.

The **Econometrics analysis** concluded on similar findings considering the entire sample. However, findings suggested that the lower the attractiveness of the Remuneration Scheme the greater the potential for reaching time targets. Furthermore, there was a definite negative impact of the crisis on achieving time to completion targets. Findings indicate that the riskier the Revenue Scheme the

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greater the potential of achieving time targets. Most probably the need to initiate operation and, therefore, income generation becomes more important the riskier the Remuneration and Revenue Schemes.

Table 3.5.2 lists bridge and tunnel projects with respect to time to completion performance. Low Cost Saving and Governance indicators in combination with a high Remuneration Attractiveness indicator seem to explain the late delivery of the Blanka tunnel. High Cost Saving, Governance indicators and a low Remuneration Attractiveness indicator are able to explain the achievement of the time target for the Lusoponte and Rio-Antirion projects. The Herrentunnel, while demonstrating a high Cost Saving indicator, has a rather low Governance indicator as well as low Level of Coopetition. The Hurrentunnel, however, does have an extremely low Remuneration Attractiveness indicator which may counter-balance the relatively low Governance indicator.

Table 3.5.2: Bridges/tunnels project indicators related to time to completion performance

Project Title	Country	Year of Award	CSI	GI	RSI	LoC	RAI	Δ FEI – Construction	Δ InI - Construction	Time Performance
Blanka Tunnel	Czech Republic	2006	0,000	0,188	0,222	0,818	1,000	0,01	0,00	Late
Herrentunnel Lübeck	Germany	1999	0,528	0,563	0,107	0,455	0,000	0,03	-0,02	In line
Lusoponte Vasco da Gama Bridge	Portugal	1994	0,582	0,875	0,416	1,000	0,433	-0,10	0,01	In line
Rion-Antirion Bridge	Greece	1996	0,698	0,688	0,256	0,909	0,333	0,04	0,03	Ahead

Box 10: Key Indicators Contributing to Time –to-Completion for Bridge & Tunnel Projects

A combination of the following indicators may support the time to completion target.		
Institutional Indicator (InI)	High Value	
Financing Scheme Indicator (FSI)	High Value	
Governance Indicator (GI)	High Value	
Cost Saving Indicator (CSI)	High Value	
Revenue Support Indicator (RSI)	High Value	High LoC Important
Remuneration Attractiveness Indicator (RAI)	Low Value	May compensate for RRI
Revenue Scheme Robustness Indicator (RRI)	Low Value	May compensate for RAI

3.5.3 Actual vs Forecast Traffic

The **qualitative analysis** indicated that projects planned and financed by a private party (PPP model) are planned more realistically. In many cases traffic estimates were prepared conservatively leading to actual traffic that was greater than expected (also see D4.2). Adopting conservative traffic forecasts clearly reduces the risk for concessionaires particularly with regard to the Remuneration Scheme. The Level of Coopetition, which is typically high in bridge and tunnel projects due to their position in the network, also supports higher traffic levels and allows the public sector to pass demand risk to the operator (Roumboutsos and Pantelias 2015).

Notably, projects that include road traffic are typically overestimated with respect to vehicle forecast traffic. However, when demand risk is passed over to the concessioner then projects are planned more conservatively. This is generally consistent with international trends observed (Flyvbjerg, Holm and Buhl 2006). This was also confirmed by the analysis on demand risk allocation of D4.2.

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The economic crisis affects bridge and tunnel projects negatively as it does to road traffic. However, as previously noted, bridges and tunnels are inherently exclusive assets, monopolistic in nature, facilitating the crossing of natural barriers. In this context, they are able to secure traffic due to their high Level of Coopetition.

The quantitative analysis has limited explanatory power for the case of bridge and tunnel projects, as only four cases were included in the analysis. Interpretation of findings is, therefore, based on the qualitative analysis. Furthermore, bridges and tunnels usually hold an exclusive position in the network, favouring demand risk allocation to the private party and demand-based remuneration schemes. However, high values of the Governance and the Institutional indicators are important.

Notably, the **fsQCA** suggested that traffic forecasts are not achievable for low values of Remuneration Attractiveness. For PPPs, which encompass most cases in this group, a combination of high Cost Saving, Remuneration Attractiveness, Institutional, Governance and Financing Scheme indicators produce favourable conditions for achieving traffic targets. Notably, for all sample groups analysed, the fsQCA highlights the negative impact of combining low Remuneration Attractiveness with low values of Cost Saving, and/or Governance, and/or the Institutional Indicator. Such combinations should clearly be avoided for bridge and tunnel projects.

In a similar way, the **Econometrics analysis** concluded that high values of the Financial-Economic indicator and a low risk remuneration scheme (high value of RAI) increased the potential of reaching the forecast traffic. The Cost Saving indicator was also considered to increase the probability of meeting traffic targets instead of high values of Governance.

Lastly, and in addition to the above, for the particular case of bridge and tunnel projects the Level of Coopetition should also be considered as identified by the qualitative analysis.

Table 3.5.3 presents the bridge and tunnel projects of the BENEFIT database for which indicators have been calculated. Notably, the low values of the Governance and Level of Coopetition indicators may be considered the reason of low performance of the Herrentunnel. Table 3.5.4 shows traffic performance following the crisis. Notably, the Herrentunnel is a clear case of traffic overestimation. The Rio-Antirio Bridge faces the impact of the great drop in the financial-economic context although the impact is not as severe as would have been expected.

Box 11: Key Indicators Contributing to Actual vs Forecast Traffic for Bridge & Tunnel Projects

A combination of the following indicators may support the traffic targets		
Institutional Indicator (InI)	High Value	Should exist if Low RAI
Financing Scheme Indicator (FSI)	High Value	
Governance Indicator (GI)	High Value	Should exist if Low RAI
Cost Saving Indicator (CSI)	High Value	Should exist if Low RAI
Revenue Support Indicator (RSI)	High Value	High LoC Important

Table 3.5.3: Bridges/tunnels project indicators related to traffic performance **before crisis**

Project Title	Country	Year of Award	CSI	GI	LoC	RAI	Δ FEI - Award – before Crisis	Δ InI - Award – before Crisis	Traffic Performance before Crisis
Herrentunnel Lübeck	Germany	1999	0,528	0,563	0,455	0,000	0,03	-0,02	Below Forecast
Lusoponte Vasco da Gama Bridge	Portugal	1994	0,582	0,875	1,000	0,433	-0,10	0,01	In line
Rion-Antirion Bridge	Greece	1996	0,698	0,688	0,909	0,333	0,04	0,03	In line

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Table 3.5.4: Bridges/tunnels project indicators related to traffic performance **after crisis**

Project Title	Country	Year of Award	CSI	GI	LoC	RAI	Δ FEI - Award – before Crisis	Δ InI - Award – before Crisis	Traffic Performance before Crisis
Herrentunnel Lübeck	Germany	1999	0,333	0,563	0,455	0,000	0,082	0,01	Far Below Forecast
Rion-Antirion Bridge	Greece	1996	0,578	0,688	0,909	0,333	-0,250	-0,03	Below Forecast
Blanka Tunnel	Czech Republic	2006	0,000	0,188	0,818	1,000	0,01	0,00	In line

3.5.4 Actual vs Forecast Revenue

The **qualitative analysis** identified that private projects were more able to reach expected revenues. Notably, in the case of bridge and tunnel projects, the Level of Coopetition allows user charges to be increased which can, up to a certain extent, offset the loss of revenues caused by the drop in traffic.

The **fsQCA** analysis identified that projects with higher levels of the Financing Scheme indicator were more capable of reaching revenue goals and so were cases with high values of the Institutional indicator. This applies to cases completed before and after the crisis as well as PPP projects.

The Remuneration Attractiveness Indicator was also important in achieving revenue targets (also during the crisis) according to the findings of the **Importance analysis**. However, this is not directly applicable to bridge and tunnel projects for which remuneration is usually achieved through user charges.

Finally, the **Econometrics analysis** identified both the Remuneration Attractiveness and the Revenue Robustness indicators as significant for achieving revenue targets. This was identified in combination with a high value of the Reliability/Availability indicator as in the case of roads. Again, this is not directly applicable to bridges and tunnels.

Finally, it should be noted that revenues are related to traffic, hence, the key indicators for achieving traffic should also be considered.

Box 12: Key Indicators Contributing to Actual vs Forecast Revenues for Bridge & Tunnel Projects

A combination of the following indicators may support the revenues targets (provisional due to small sample)		
Institutional Indicator (InI)	High Value	Should exist if Low RAI
Financing Scheme Indicator (FSI)	High Value	
Governance Indicator (GI)	High Value	Should exist if Low RAI
Cost Saving Indicator (CSI)	High Value	Should exist if Low RAI
Revenue Support Indicator (RSI)	High Value	High LoC Important
Revenue Robustness Indicator (RRI)	High Value	

Table 3.5.5 lists the bridge and tunnel projects in the BENEFIT database with respect to revenue performance prior to the crisis. All projects have a high Financing Scheme indicator value. However, the Herrentunnel case cannot be explained.

Table 3.5.6 lists projects after the crisis. Despite the significant drop in the Financial-Economic indicator value revenues continue to be acceptable for the Rio-Antirion bridge. The Blanka Tunnel is also in line with expectations as is its traffic. The Herrentunnel cannot be explained.

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Table 3.5.5: Bridges/tunnels project indicators related to revenue performance **before crisis**

Project Title	Country	Year of Award	RRI	RAI	IRA	LoC	FSI	Δ FEI - Award – before Crisis	Δ InI - Award – before Crisis	Revenue Performance before Crisis
Herrentunnel Lübeck	Germany	1999	0,444	0,000	1,00	0,455	0,848	0,03	-0,02	In line
Lusoponte Vasco da Gama Bridge	Portugal	1994	0,659	0,433	1,00	1,000	0,796	-0,10	0,01	In line
Rion-Antirion Bridge	Greece	1996	0,667	0,333	1,00	0,909	0,873	0,04	0,03	In line

Table 3.5.6: Bridges/tunnels project indicators related to revenue performance **after crisis**

Project Title	Country	Year of Award	RRI	RAI	IRA	LoC	FSI	Δ FEI - Award – before Crisis	Δ InI - Award – before Crisis	Revenue Performance after Crisis
Herrentunnel Lübeck	Germany	1999	0,444	0,000	1,00	0,455	0,848	0,082	0,01	In line
Rion-Antirion Bridge	Greece	1996	0,667	0,333	1,00	0,909	0,873	-0,250	-0,03	In line
Blanka Tunnel	Czech Republic	2006	0,000	1,000	1,00	0,818	1,000	0,01	0,00	In line

3.5.5 Summary of Indicators influencing Bridge and Tunnel Infrastructure Project Performance

Table 3.5.7 summarises indicators influencing bridge and tunnel project outcomes. The Financial-Economic Indicator influences traffic and revenues as expected but to a lower extent than roads due to the **high Level of Coopetition that characterises these structures**. The influence of the crisis on cost and time to completion could not be assessed, as all projects in the BENEFIT database were completed before the crisis. It is reasonable to assume that indicators applicable to road projects are of equal importance during the construction phase for bridge and tunnel projects.

Once again, the Cost Saving, Governance and Revenue Support indicators are important for all outcomes, with greater emphasis on the Revenue Support (including the Level of Coopetition) indicator as bridge and tunnel projects are usually designed with a low value of the Remuneration Attractiveness indicator.

Finally, the findings with respect to bridge and tunnel projects should be considered purely indicative given their small sample size in the BENEFIT database. In addition, the performance of one project – the Hurrentunnel – could not be explained based on the explanatory framework used by BENEFIT.

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Table 3.5.7: Summary table of indicators influencing outcomes in Bridge and Tunnel projects

Outcomes / Indicators	Cost to completion	Time to completion	Actual vs Forecasted Traffic	Actual vs Forecasted Revenues
Institutional	High Value	High Value	High Value (prerequisite for Low RAI)	High Value (prerequisite for Low RAI)
Financial Economic	High Value important. Low Values may be off-set by high values of the other indicators			
Governance	High Value	High Value	High Value (prerequisite for Low RAI)	High Value (prerequisite for Low RAI)
Cost Saving	High Value	High Value	High Value (prerequisite for Low RAI)	High Value (prerequisite for Low RAI)
Revenue Support	High Value (High LoC Important)	High Value (High LoC Important)	High Value (High LoC Important)	High Value (High LoC Important)
Remuneration Attractiveness		Low Value (May compensate for RRI)		
Revenue Robustness		Low Value (May compensate for RAI)		High Value
Market Efficiency & Acceptability				
Reliability /Availability				
Financing Scheme	High Value	High Value	High Value	High Value

Key Findings may be summarised as follows:

Indicators Exogenous to the project

- The Financial-Economic indicator (FEI) is an important indicator, as in the case of road projects. FEI will affect cost and time to completion targets and a high FEI is important in the case of a low Remuneration Attractiveness Indicator which is common in bridge and tunnel projects. However, in the case of bridge and tunnel projects the negative impact of a low and/or decreasing FEI may be offset by high values of other indicators (e.g. GI, CSI and RSI).
- The Institutional indicator (InI) may be, once again, the most important. While exogenous to the project, it is not affected by economic cycles and, therefore, describes a measure of resilience to financial shocks. It is a prerequisite in achieving traffic and revenue targets in the case of a low RAI.

Indicators Endogenous to the project

- **The Governance indicator reflects in many ways the level of institutional maturity in the country of project procurement.** In this effect, it may compensate and/or enhance the Institutional Indicator. A high value contributes to the “on-budget” and “on-time” targets. High values are a prerequisite in achieving traffic and revenue targets in the case of a low RAI.
- The Cost Saving indicator describes the project’s technical difficulty and also the capabilities of key project actors: the constructor’s to construct, the operator’s to operate, and the monitoring authority’s to monitor the project in consideration. In addition, it assesses whether

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capabilities are aligned with the risk allocation among these actors. All these attributes were found to be important through-out the project life cycle. A high value contributes to the successful attainment of “on-budget” and “on-time” targets. High values are a prerequisite in achieving traffic and revenue targets in the case of a low RAI.

- The Revenue Support indicator is highly important for bridge and tunnel projects, especially its factor “Level of Coopetition”. It describes the exclusivity of the project in the network and a high value has a positive impact on all outcomes.
- The Remuneration Attractiveness Indicator is typically low in bridge and tunnel projects as the relative high “Level of Coopetition” allows the public sector to pass demand risk to the operator. A low RAI is a driver towards achieving time to completion. The Revenue Robustness indicator has the same effect with respect to achieving time targets. A low RAI may counterbalance a high RRI and vice versa.
- The Revenue Robustness Indicator expresses the riskiness of the project revenue streams as well as the estimated level of cost coverage. For bridge and tunnel projects it has the same effect as RAI, i.e. it drives time to completion.
- The Financing Scheme Indicator was typically found to be high in all bridge and tunnel cases of the BENEFIT database. A high value of the FSI contributes to achieving project outcome targets.

In conclusion, as it was also identified by the qualitative analysis, Bridges and Tunnels could be considered as special cases of road projects with much higher exclusivity which allows them to attain low RAI values (high risk remuneration schemes such as tolls). As these are usually projects of high technical difficulty, their ability to reach construction phase objectives is dependent, in addition to design maturity, on the expertise of the contractors/concessioners.

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3.6 Airport Projects

3.6.1 Cost to Completion

The **qualitative analysis** for the airport cases presented a differentiation between PPP cases which were delivered on budget as opposed to public cases which presented budget overruns. Typical reasons for overruns were related to planning issues such as obtaining permits and relative authorisations, all of which are captured by the Cost Saving indicator.

Similar to the analysis of bridge and tunnel projects, the quantitative analysis for airport has limited explanatory power as only four cases were available in the BENEFIT database. The interpretation of findings is, therefore, based on the qualitative analysis.

The **fsQCA** analysis indicated the importance of a high Cost Saving indicator combined with a high Institutional indicator as well as high values of the Governance indicator in attaining cost to completion targets. The indicators of importance also include a high Financing Scheme indicator.

The **Importance analysis** also placed emphasis on the same indicators in achieving cost to completion targets. Here, however, an additional indicator was also identified as significant: the factor "Level of Coopetition" of the Revenue Support Indicator (RSI) describing the position of the infrastructure in the network (Roumboutsos and Pantelias 2015). This factor may be considered important in a number of cases such as the Athens Airport, and the Larnaca and Paphos Airports.

Similarly**,** the **econometrics analysis** for the entire sample presented the same findings as before with the Revenue Support Indicator included as a significant indicator in place of Level of Coopetition.

Table 3.6.1: Airports project indicators related to cost performance

Project Title	Country	Year of Award	CSI	GI	FSI	RSI	LoC	Δ FEI - Construction	Δ InI - Construction	Cost Performance
Berlin Brandenburg Airport (BER)	Germany	2004	-0,300	0,375	0,963	0,290	0,909	0,290	0,02	Overrun
Modlin Regional Airport - Reopening	Poland	2010	0,000	0,438	0,906	0,000	0,000	0,000	0,02	Overrun
Athens International Airport	Greece	1995	0,433	0,750	0,702	0,402	1,000	0,402	0,01	In line
Larnaca and Paphos International Airports	Cyprus	2005	0,748	0,688	0,678	0,364	1,000	0,364	0,03	In line

Table 3.6.1 lists the projects for which indicators have been calculated. The low values of the Cost Saving and Governance indicators may explain the cost overrun of the Berlin and Modlin airport projects. Notably, the Modlin airport is further burdened by a low Revenue Support indicator.

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Box 13: Key Indicators Contributing to Cost- to- Completion for Airport Projects

A strict combination of the following indicators may support the cost to completion target.		
Institutional Indicator (InI)	High Value	
Financing Scheme Indicator (FSI)	High Value	
Governance Indicator (GI)	High Value	
Cost Saving Indicator (CSI)	High Value	
Revenue Support Indicator (RSI)	High Value	High LoC Important

3.6.2 Time to Completion

According to the **qualitative analysis**, **the main reasons for delays** in airports are **construction failures** as well as **issues related to planning**. Both are typically captured by the Cost Saving indicator along with the competence of the constructor and the public authority, to construct and monitor the project, respectively. These represented the major reasons of delay in the airport cases of the BENEFIT database.

With respect to the findings of the quantitative analysis, the **fsQCA** indicated the negative impact of the Institutional and Financial-Economic context on attaining time targets for the entire sample, but also specifically for PPPs.

The **Importance analysis** identified Governance, Remuneration Scheme Attractiveness and Level of Control as significant indicators in achieving time to completion targets. As in the case of cost to completion, Level of Coopetition can be considered influential for airports. The same indicators with the inclusion of the Institutional indicator were considered significant for achieving time to completion during the economic crisis.

The **Econometrics analysis** concluded on similar findings considering the entire sample. However, findings suggested that the lower the attractiveness of the Remuneration Scheme the greater the potential of reaching time targets. Furthermore, there was a definite negative impact of the crisis on achieving time to completion.

Table 3.6.2 lists the projects for which indicators were calculated. The low values of the Cost Saving and Governance indicators may explain the time overrun of both the Modlin and Berlin Airport projects. Notably, under positive implementation context conditions the low Remuneration Attractiveness was not an incentive to achieve time to completion in the case of the Modlin Airport project.

Table 3.6.2: Airports project indicators related to time to completion performance

Project Title	Country	Year of Award	CS	GI	LoC	RAI	FSI	Δ FEI - Construction	Δ InI - Construction	Time Performance
Modlin Regional Airport - Reopening	Poland	2010	0,000	0,438	0,000	0,000	0,906	0,00	0,02	Late
Berlin Brandenburg Airport (BER)	Germany	2004	-0,300	0,375	0,909	0,450	0,963	0,09	0,02	Late
Athens International Airport	Greece	1995	0,433	0,750	1,000	0,410	0,702	0,00	0,01	In line
Larnaca and Paphos International Airports	Cyprus	2005	0,748	0,688	1,000	0,333	0,678	0,13	0,03	In line

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Box 13: Key Indicators Contributing to Time- to- Completion for Airport Projects

A combination of the following indicators may support the time to completion target.		
Institutional Indicator (InI)	High Value	
Financing Scheme Indicator (FSI)	High Value	
Governance Indicator (GI)	High Value	
Cost Saving Indicator (CSI)	High Value	
Revenue Support Indicator (RSI)	High Value	High LoC Important
Remuneration Attractiveness Indicator (RAI)	Low Value	May compensate for RRI
Revenue Scheme Robustness Indicator (RRI)	Low Value	May compensate for RAI

3.6.3 Actual vs Forecasted Traffic

Within the BENEFIT database two airport cases have presented demand in line with or above the forecast of the project planning phase. Independently from their contractual structure, the Sá Carneiro[12] and Athens airports have been presenting outstanding and satisfactory traffic since their inauguration (see D4.4.). Despite the effects of the 2008 financial crisis and other project delays, both projects have met their expected traffic estimations. This positive outcome may be associated with the added value created by those airports in their influence area. Both airports have been constructed to address accessibility bottlenecks at regions that combine strong tourism and other economic activities with already implemented intermodal connections. These factors are associated with the Revenue Support indicator.

The **qualitative analysis** concluded that traffic outcomes may be associated with the necessary connectivity of the airport infrastructure to the rest of the local economy and the wider transport network. Again this contributing factor describes the Level of Coopetition, a factor of the Revenue Support indicator. The incentives of the airport business scope were also identified as important during the crisis. This refers to other business activities that are developed within the scope of the airport project. This incentive impacts airports differently depending on their size (passenger capacity) and overall scope.

The **fsQCA** suggested that traffic forecasts are achievable with a low risk Remuneration Scheme accompanied by high Governance and Institutional indicators. While the latter are important, a low risk Remuneration Scheme (high Remuneration Attractiveness indicator) is not typically encountered in airports.

In a similar way, the **Econometrics analysis** concluded that the Financial-Economic indicator and a low risk Remuneration Scheme increased the potential of reaching the forecast traffic. The Cost Saving indicator was also found to increase this probability of achieving traffic goals instead of a high Governance indicator value. These two indicators are both very relevant to airports.

However, in addition to the above, for the particular case of airports, the Revenue Support indicator (which includes the Level of Coopetition) as well as the demand risk allocation (incentives) should also be considered as identified through the qualitative analysis.

Table 3.6.3 presents traffic before the crisis for the two operating projects. The traffic outcome of the Larnaca and Cyprus airports cannot be explained based on the indicators. The opening of this airport coincided with the start of the international economic crisis but the Cypriot national economy had apparently still not been influenced despite the international impact.

[12] For this case full information to construct indicators was not available.

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Table 3.6.4 lists the projects operating after the crisis. Apart from the drop in the Financial-Economic Indicator, it is also worth highlighting the drop in the Cost Saving Indicator for both the Athens International Airport and the Larnaca & Paphos Airport projects. The low values of the respective indicators explain the low performance of the Modlin Airport.

Table 3.6.3: Airports project indicators related to traffic performance **before crisis**

Project Title	Country	Year of Award	CSI	GI	RSI	LoC	RAI	Δ FEI - Award – before Crisis	Δ InI - Award – before Crisis	Traffic Performance
Athens International Airport	Greece	1995	0,433	0,750	0,402	1,000	0,410	0,00	0,01	In line
Larnaca and Paphos International Airports	Cyprus	2005	0,655	0,688	0,364	1,000	0,333	0,13	0,03	Below forecast

Table 3.6.4: Airports project indicators related to traffic performance **after crisis**

Project Title	Country	Year of Award	CSI	GI	RSI	LoC	RAI	Δ FEI – 2014 - Before Crisis	Δ InI - 2014– before Crisis	Traffic Performance
Athens International Airport	Greece	1995	0,000	0,750	0,400	1,000	0,407	-0,250	-0,03	Below Forecast
Larnaca and Paphos International Airports	Cyprus	2005	0,437	0,688	0,363	1,000	0,333	-0,030	0,01	Below forecast
Modlin Regional Airport – Reopening	Poland	2010	0,000	0,438	0,000	0,000	0,000	0,00	0,02	Far below forecast

Box 15: Key Indicators Contributing to Actual vs Forecast Traffic for Airport Projects

A combination of the following indicators may support the traffic target.		
Institutional Indicator (InI)	High Value	
Financial – Economic Indicator (FEI)	High Value	Connected to international Financial – Economic conditions
Governance Indicator (GI)	High Value	
Cost Saving Indicator (CSI)	High Value	
Revenue Support Indicator (RSI)	High Value	High LoC Important

3.6.4 Actual vs Forecast Revenues

Stemming from the achievement of traffic goals, airports have the potential of generating revenues from other non-aeronautical activities. These additional revenue streams are enhanced by the Level of Coopetition of the infrastructure. Hence, the revenues of an airport are strongly related to the Revenue Support indicator. The national or local implementation context as described in the qualitative analysis of task 4.3 (see D4.4) does not have a direct impact as international conditions may have a stronger influence. For example, as passenger traffic is related to the trip purpose between origin and destination a decrease in an airport's country FEI may reflect a drop in business trips but may not affect leisure trips. The latter may also be related to the conditions in the country of trip origin, the positioning of the airport's country in the leisure market and also the positioning of the airport in the international air travel market as a hub.

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As presented in Table 3.6.4, the general findings of the quantitative analysis do not directly apply to airport projects. This is expected given the small number of airport cases in the BENEFIT case database. Indicators that may influence the ability to reach expected revenues are the Cost Saving, Governance, Revenue Support, Revenue Robustness as well as the Financial-Economic Indicators.

Tables 3.6.5 and 3.6.6 present the relevant indicator values before and after the crisis. The influence of the Revenue Robustness indicator value is evident in the Athens and Larnaca & Paphos Airports supporting revenues also after the crisis. The value of the Revenue Support indicator is also worth noticing in both cases.

Box 16: Key Indicators Contributing to Actual vs Forecast Revenues for Airport Projects

A combination of the following indicators may support the traffic target.		
Institutional Indicator (InI)	High Value	
Financial – Economic Indicator (FEI)	High Value	Also connected to international Financial – Economic conditions
Governance Indicator (GI)	High Value	
Cost Saving Indicator (CSI)	High Value	
Revenue Support Indicator (RSI)	High Value	Alternative revenues
Revenue Robustness Indicator (RRI)	High Value	

Table 3.6.4: Airports project indicators related to revenue performance **before crisis**

Project Title	Year of Award	CSI	GI	RSI	LoC	RAI	RRI	Δ FEI - Award – before Crisis	Δ InI - Award – before Crisis	Revenue Performance
Athens International Airport	1995	0,433	0,750	0,402	1,000	0,410	0,705	0,00	0,01	In line
Larnaca and Paphos International Airports	2005	0,748	0,688	0,364	1,000	0,333	0,667	0,13	0,03	In line

Table 3.6.5: Airports project indicators related to revenue performance **after crisis**

Project Title	Year of Award	CSI	GI	RSI	LoC	RAI	RRI	Δ FEI - Award – before Crisis	Δ InI - Award – before Crisis	Revenue Performance
Athens International Airport	1995	0,000	0,750	0,400	1,000	0,407	0,703	-0,250	-0,03	In line
Larnaca and Paphos International Airports	2005	0,437	0,688	0,363	1,000	0,333	0,667	-0,030	0,01	In line
Modlin Regional Airport – Reopening	2010	0,000	0,438	0,000	0,000	0,000	0,500	0,00	0,02	Below forecast

3.6.5 Summary of Indicators influencing Airport Infrastructure Project Performance

The small sample of airport projects included in the BENEFIT database limits the explanatory power of the analysis as well as the ability to generalise conclusions**.** Findings from the quantitative analyses were compared to the qualitative analysis as well as the existing literature.

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As in the case of other transport infrastructure, the Cost Saving and Governance Indicators are important in achieving cost to completion targets. Revenue Support also seems to be contributing positively. The same indicators are also important in order to achieve time to completion targets. Traffic is influenced by the implementation context but also by the way the airport is connected to the local/regional or national economy. Incentives connected to demand risk allocation are also important.

Contrary to the findings of the quantitative analysis, revenue targets are not directly impacted by the Financial-Economic indicator. For this outcome Revenue Support, Revenue Robustness, Cost Saving and Governance are the indicators that drive positive results. Notably, the Remuneration Attractiveness indicator is typically low in airport projects.

Table 3.6.7: Summary table of indicators influencing outcomes in Airport projects

Outcomes / Indicators	Cost to completion	Time to completion	Actual vs Forecasted Traffic	Actual vs Forecasted Revenues
Institutional	High Value	High Value	High Value	High Value
Financial Economic	High Value important	High Value important	High Value - Connected to international Financial – Economic conditions	High Value - Connected to international Financial – Economic conditions
Governance	High Value	High Value	High Value	High Value
Cost Saving	High Value	High Value	High Value	High Value
Revenue Support	High Value (High LoC Important)	High Value (High LoC Important)	High Value (High LoC Important)	High Value (also alternative revenues)
Remuneration Attractiveness		Low Value (May compensate for RRI)		
Revenue Robustness		Low Value (May compensate for RAI)	High Value	High Value
Market Efficiency & Acceptability				
Reliability /Availability				
Financing Scheme	High Value	High Value		

Key Findings are presented below However, due to the small sample size, they should be handled with care.

Indicators Exogenous to the project

- The Financial-Economic indicator (FEI) is an important indicator. For airport projects, a high value of the indicator will have a positive impact on cost and time to completion. However, when it comes to traffic and revenue targets, the wider financial-economic context should be considered depending on the business scope of the airport.
- The Institutional indicator (InI) may be the most important. While exogenous to the project, it is not affected by economic cycles and, therefore, describes a measure of resilience to financial shocks.

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Indicators Endogenous to the project

- The Governance indicator reflects in many ways the level of institutional maturity in the country of project procurement. In this effect, it may compensate and/or enhance the Institutional Indicator.
- The Cost Saving indicator describes the project's technical difficulty and also the capabilities of key project actors: the constructor's to construct, the operator's to operate, and the monitoring authority's to monitor the project in consideration. In addition, it assesses whether capabilities are aligned with the risk allocation among these actors. All these attributes were found to be important through-out the project life cycle. The Revenue Support indicator is highly important for airport projects both with respect to its factor "Level of Coopetition" as well as the consideration of alternative sources of revenue. A high value of the indicator contributes to all four outcomes.
- The Remuneration Attractiveness Indicator is typically low in airport projects as the relative high values of "Level of Coopetition" allow the public sector to pass demand risk to the operator. A low RAI is a driver in achieving time to completion. The Revenue Robustness indicator has the same effect with respect to achieving time targets. A low RAI may counterbalance a high RRI and vice versa.
- The Revenue Robustness Indicator expresses the riskiness of the project revenue streams as well as the estimated level of cost coverage. For airport projects it has the same effect as the RAI, i.e. it drives time to completion. Additionally, it is important in assessing the ability to achieve traffic and revenue targets.
- A high Financing Scheme indicator was found to contribute positively to cost and time to completion targets.

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3.7 Port Projects

3.7.1 Cost to Completion

Based on the **qualitative analysis**, port projects are typically awarded to private parties with experience and competence in port management and operation rather than simple construction expertise (Suarez et al, 2015). Hence, the Cost Saving Indicator is typically low in port projects with respect to factors concerning construction. Emphasis is placed on operation rather than construction with budgets relatively smaller than for other infrastructure projects.

The quantitative analysis arrived at similar findings. Table 3.7.1 illustrates the predominant small values of the Cost Saving Indicator for most BENEFIT port cases. Notably projects with higher CSI values seem to perform well (Ports of Sines, Leixoes and the Deurganckdock Lock).

The Governance indicator was also identified as important by the quantitative analyses. However, since the respective market is small, the Governance Indicator also takes relatively lower values. Again, higher values of the Governance Indicator lead to positive performance (see the Port of Leixoes and the Deurganckdock Lock).

The Revenue Support Indicator (reduced to the factor Level of Coopetition in the case of Importance Analysis) was identified as important. However, ports due to their nodal position in the logistics chain commonly have high values of the Level of Coopetition factor.

Moreover, the **fsQCA** conducted specifically on the port sample (see Annex 2) could not identify a combination of indicators leading to successful attainment of cost to completion targets. It did identify, however, that high Cost Saving, high Institutional and low Revenue Robustness indicator values appeared frequently in the sample.

Based on the above, no particular trend may be identified. More specifically, while high values of the Cost Saving, Governance, Revenue Support and Institutional indicators seem to lead to positive performance, low values of the proposed indicators do not necessarily lead to worse outcomes nor is there a prevailing combination of the abovementioned indicators that drives particular performance. Furthermore, values of the Revenue Robustness indicator are typically low in the port sector.

Table 3.7.1: Seaports project indicators related to cost to completion performance

Project Title	Country	Year of Award	CSI	GI	RSI	LoC	FSI	InI	Cost Performance
Port of Agaete	Spain	1982	0,000	0,500	0,255	0,818	1,000	0,70	In line
Port of Sines Terminal XXI	Portugal	1999	0,222	0,375	0,293	0,727	0,835	0,68	Below Budget
Port of Leixoes	Portugal	2000	0,533	0,750	0,228	0,636	1,000	0,70	In line
Barcelona Europe South Terminal	Spain	2006	-0,033	0,438	0,237	0,727	0,438	0,69	Overrun
Piraeus Container Terminal	Greece	2008	0,083	0,563	0,271	0,727	0,300	0,57	In line
Deurganckdock Lock	Belgium	2011	0,467	0,625	0,245	0,818	0,655	0,77	In line
Muelle Costa Terminal Barcelona	Spain	2011	-0,078	0,438	0,360	0,727	0,300	0,69	In line

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Box 17: Key Indicators Contributing to Cost-to-Completion for Port Projects

Important BUT not necessary to achieve cost to completion targets		
Institutional Indicator (InI)	High Value	
Governance Indicator (GI)	High Value	
Cost Saving Indicator (CSI)	High Value	
Revenue Support Indicator (RSI)	High Value	High LoC Important
Revenue Scheme Robustness (RRI)	Low Value	Typical in the case of ports

3.7.2 Time to Completion

The **Importance** and **Econometrics** analyses identified the implementation context (Institutional and Financial-Economic), Revenue Support (Level of Coopetition), Governance and Cost Saving Indicators as important in achieving time to completion targets. In effect, the two projects in Table 3.7.2 that exhibit high values of these indicators do achieve time targets.

The fsQCA carried out for the particular case of ports was inconclusive. Governance, Remuneration Attractiveness and Financing Scheme indicators seemed important.

Checking against all findings, a particular trend that applies for port projects could not be identified. Reasons may be traced back to actors' strategies, especially in the case of low values of the Financing Scheme indicator, where significant private involvement may be identified.

Table 3.7.2: Seaports project indicators related to time to completion performance

Project Title	Year of Award	CSI	GI	RSI	LoC	FSI	RAI	FEI at Completion/ Δ FEI - Construction	InI at Completion/ Δ InI – Construction	Time Performance
Port of Agaete	1982	0,000	0,500	0,255	0,818	1,000	0,333	0,637/ 0,00	0,70/ 0,00	In line
Port of Sines Terminal XXI	1999	0,222	0,375	0,293	0,727	0,835	0,333	0,57/ 0,10	0,71/ -0,01	Overrun
Port of Leixoes	2000	0,533	0,750	0,228	0,636	1,000	0,333	0,642/ -0,10	0,68/ 0,01	In line
Barcelona Europe South Terminal	2006	-0,033	0,438	0,237	0,727	0,438	0,333	0,508/ -0,19	0,69/ 0,02	Overrun
Piraeus Container Terminal	2008	0,083	0,563	0,271	0,727	0,300	0,333	0,500/ -0,06	0,59/ -0,01	Overrun
Deurganckdock Lock	2011	0,467	0,625	0,245	0,818	0,655	0,667	0,600/ -0,04	0,77/ -0,01	In line
Muelle Costa Terminal Barcelona	2011	-0,078	0,438	0,360	0,727	0,300	0,333	0,475/ -0,08	0,69/ 0,00	In line

3.7.3 Actual vs Forecast Traffic

Once again when considering the successful attainment of traffic goals, ports represent a particular case with no apparent combination of indicators capable of explaining traffic performance. Instead, their business scope and position within the logistics supply chains have better explanatory power. The **fsQCA** for the particular case of ports, while overall inconclusive, identified the Institutional and Cost Saving Indicators to be relevant (the CSI includes the capability of the concessioner)

Further investigation, combined with an effort to consider the port cases within the overall framework of findings, points towards the importance of the Revenue Support Indicator. The caveat is that the

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Level of Coopetition is referring to the networks each port is addressing commercially. In this context, only the RSI and LoC values of the port of Agaete could be considered to have explanatory power. The values pertaining to the terminal of Muelle Costa Terminal Barcelona may also be considered relevant as it serves specific origin-destinations.

The same lens should be used when considering the Institutional and Financial-Economic indicators for ports. Again, the values of these indicators seem to be able to explain the case of the Port of Agaete (service within the same country) and the Muelle Costa Terminal Barcelona as the origin – destination (OD) countries share similar institutional and Financial-Economic implementation conditions (see Deliverable D3.1).

Table 3.7.3: Seaports project indicators related to traffic performance **before crisis**

Project Title	Country	Year of Award	CSI	GI	RSI	LoC	RAI	FSI	Δ FEI - Award – before Crisis	Δ Inl - Award – before Crisis	Traffic Performance before crisis
Port of Agaete	Spain	1982	0,000	0,500	0,255	0,818	0,333	1,000	0,00	0,00	Above forecast
Port of Leixoes	Portugal	2000	0,533	0,750	0,228		0,333	1,000	-0,10	0,01	In line
Port of Sines Terminal XXI	Portugal	1999	0,222	0,375	0,293		0,333	0,835	0,10	-0,01	Far below forecast
Barcelona Europe South Terminal	Spain	2006	-0,033	0,438	0,237		0,333	0,438	-0,19	0,02	Below forecast

Table 3.7.4: Seaports project indicators related to traffic performance **after crisis**

Project Title	Country	Year of Award	CSI	GI	RSI	LoC	RAI	FSI	Δ FEI - before Crisis – reporting	Δ Inl - before Crisis – reporting	Traffic Performance after Crisis
Deurganck-dock Lock	Belgium	2011	0,467	0,625	0,245		0,667	0,655	-0,04	-0,01	In line
Muelle Costa Terminal Barcelona	Spain	2011	-0,078	0,438	0,360	0,727	0,333	0,300	-0,08	0,00	In line
Piraeus Container Terminal	Greece	2008	0,083	0,563	0,271		0,333	0,300	-0,06	-0,01	In line

3.7.4 Actual vs Forecast Revenues

As in the case of the other outcomes, the quantitative analyses findings fall short of explaining port revenue performance. The **fsQCA** conducted for ports concluded on similar findings. An important indicator in achieving revenue targets seemed to be the Cost Saving indicator.

However, stemming from the observation that ports typically follow demand-based remuneration schemes, it can be concluded that revenues are dependent on traffic and therefore, observations for traffic may also typically apply for revenue. If the project is remunerated through an availability scheme (e.g. Deurganckdock Lock) the findings of the **Econometrics analysis** (i.e. that high RAI and RRI values and low FSI values improve probability to achieving targets) typically apply.

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Table 3.7.5: Seaports project indicators related to revenue performance **before crisis**

Project Title	Country	Year of Award	CSI	RAI	RRI	FSI	Δ FEI - Award – before Crisis	Δ Inl - Award – before Crisis	Revenue Performance before crisis
Port of Agaete	Spain	1982	0,000	0,333	0,667	1,000	0,00	0,00	Above forecast
Port of Leixoes	Portugal	2000	0,533	0,333	0,667	1,000	-0,10	0,01	In line
Port of Sines Terminal XXI	Portugal	1999	0,222	0,333	0,346	0,835	0,10	-0,01	Below forecast
Barcelona Europe South Terminal	Spain	2006	-0,033	0,333	0,667	0,438	-0,19	0,02	In line

Table 3.7.6: Seaports project indicators related to revenue performance **after crisis**

Project Title	Country	Year of Award	GI	RAI	RRI	FSI	Δ FEI - before Crisis – reporting	Δ Inl - before Crisis – reporting	Revenue Performance after Crisis
Deurganckdock Lock	Belgium	2011	0,467	0,667	0,750	0,655	-0,04	-0,01	In line
Muelle Costa Terminal Barcelona	Spain	2011	-0,078	0,333	0,667	0,300	-0,08	0,00	In line
Piraeus Container Terminal	Greece	2008	0,083	0,333	0,667	0,300	-0,06	-0,01	In line

3.7.5 Summary of Indicators influencing Port Infrastructure Project Performance

The prominent feature of the port cases is their uniqueness with respect to outcomes. A dominant condition in achieving cost and time to completion, in accordance with the quantitative analyses findings, are high values of the Cost Saving, Governance, Revenue Support and Institutional indicators. However, very importantly, positive outcomes may be reached even if these conditions are not met. Notably, these BENEFIT indicators need to be adjusted for the port sector. For example, the CSI with respect to construction is now assessing SPV competence. A future adjustment may involve the assessment of the sub-contractor builder.

Considering the above, it is possible that the BENEFIT Matching Framework cannot be applied to port infrastructure as trade-offs between cost and time to completion are affected by strategic behaviour.

Strategic behaviour seems to also influence traffic and revenue outcomes (see Deliverables D4.2 and D4.4). In effect, port traffic is dependent on the international strategies of shipping lines and hinterland connections (logistic supply chains), which in order to be captured by the BENEFIT framework would need to have the Level of Coopetition factor expressing the uniqueness of the port in the internal logistic networks that it serves.

Finally, the financial–economic context continues to be important. However, once again, it should not refer to the national context of the country where the port is positioned but to the logistic chains it serves.

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3.8 Rail Infrastructure Projects

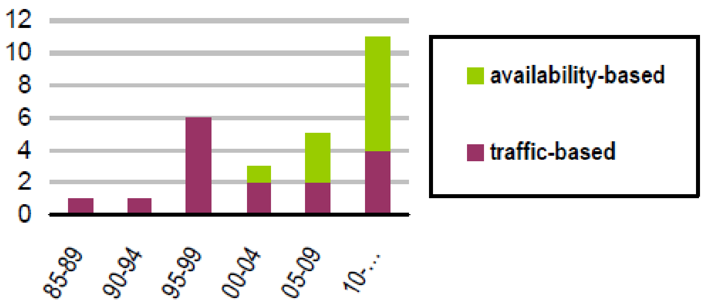
The BENEFIT case study database only included a limited number of rail projects that hampers the opportunity to carry out a qualitative analysis with respect to rail infrastructure projects.

Instead, an overview of Rail PPPs was undertaken in view of identifying key BENEFIT indicators that may contribute or may be limiting the potential of achieving outcomes in the case of rail infrastructure projects. Notably, as further use of this section is not foreseen, a full assessment has not been considered.

3.8.1 Railway PPPs

Railway PPP projects are challenging because of their technical complexity and capital intensity. Particularly the wide array of requisite infrastructures (land structures, bridges, tunnels, control & command & safety systems, etc.) make PPP projects for rail more demanding than road projects for example, in many respects. This remark relates to the Cost Saving Indicator in particular.

The recent decade has seen a global shift from traffic-based rail PPPs towards asset-only and availability -based projects (i.e values of the Remuneration Attractiveness indicator shifting from low to high) . This is an expected trend, as the availability based remuneration schemes offer much less volatility than traffic based ones. Therefore, the investor risks are lower too.



	integrated	asset-only[3]	total
1985 – 2005	9	2	**11**
2005 – 2012	4	12	**16**

Figure 3.8.1: Trends in Remuneration Schemes (Dehornoy, 2012)

Often failures in rail PPPs relate to political issues, as the projects are highly politicised, complex, often with significant spatial, safety and interoperability requirements and substantial cash flows to cover capital investments.

Table 3.8.1: Main sources of failure in rail PPPs (Painvin, 2010)

politics	complexity	commercial
- lengthy decisions processes may cause scope deviations - failure to execute / interference by public authority - "political entrepreneur syndrome" - public and market acceptance - involvement in incumbent train operating company - quality of legal and institutional framework	- long and complex completion phase - technical intensity: proven technologies but complex integration: ↳ structures and ground conditions ↳ interaction of a variety of systems ↳ safety ↳ technical interfaces ↳ functional interfaces	- revenue structure - demand forecast

Failures due to politics or complexity are harder to manage than commercial risks. Within the BENEFIT Matching Framework, these correspond to the Institutional Indicator, especially with respect

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to nationally driven projects and/or the capability of the contracting authority to manage both stakeholders and the project, which formulates part of the Cost Saving Indicator.

A rail project can capture value also from land use and the consumption power of large masses of travellers, in addition to revenues related to transport services and infrastructure charging. From the logistics side, terminals, warehousing and other logistics services may provide improved business cases when connected to the rail project. It is the bundling of business cases that can make a non-viable, purely rail transport focused project, into a viable multiple-revenue-source project. Railways are such an elemental part of urban and inter-urban infrastructures that their isolation from the wider built environment context is always a mistake – politically, technically, financially and socio-economically. Hence, the Revenue Support indicator is of high importance for rail infrastructure and may take relatively high values.

3.8.2 Revenues in Railway PPPs: Value Capturing Rationale

The Japanese railways can make a substantial share of their revenues from stations and the businesses the stations are capable of facilitating. For example, in 2013 JR East had a revenue share of 9% from shopping centres and office buildings, and 15% station space utilisation (JR East 2013). Combining these type of revenues to prospective government subsidies, which could well be justified by safety and environmental arguments, have the potential of making rail PPP equation work for all relevant parties.

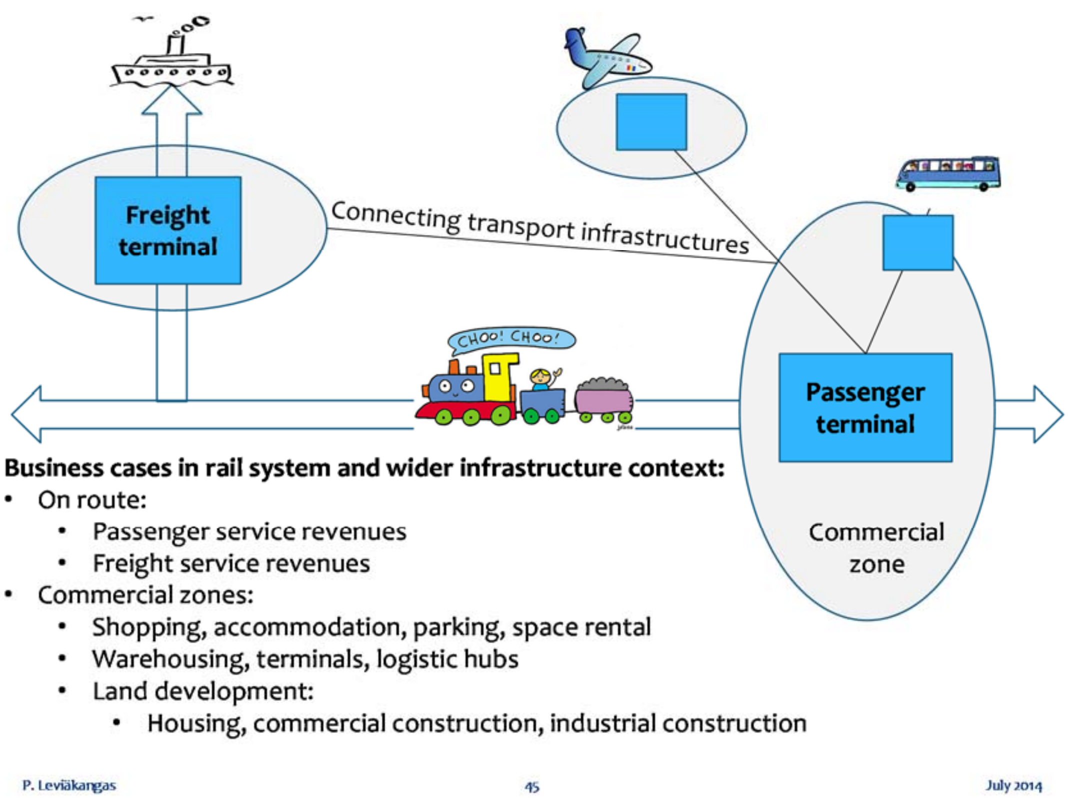

Figure 3.8.2: Value Capture Structure of Rail Infrastructure Projects

The possible combinations of working formulas are numerous and therefore there is not a single-solution model for rail PPPs. Also the often mentioned competition on or for tracks, although surely

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relevant, might not be the only crucial factor for railway PPPs when considering the business models that could work.

Industry structure constraints

Particularly in the European context, the EU rail policy implementation that is adopted in a country dictates some of the manoeuvring space that is available for bundling. Two main types of railway industry structures are present:

- *The authority model*, where the infrastructure and operations are fully separated and the infrastructure is owned and managed by a national infrastructure authority, as is with roads in most cases in Europe.
- *The subsidiary model*, where the infrastructure is owned by the national railway holding company and the separation of infrastructure and operations is done at financial accounts level. This structure is e.g. in Germany, where DB Netz is the infrastructure company within DB corporation.

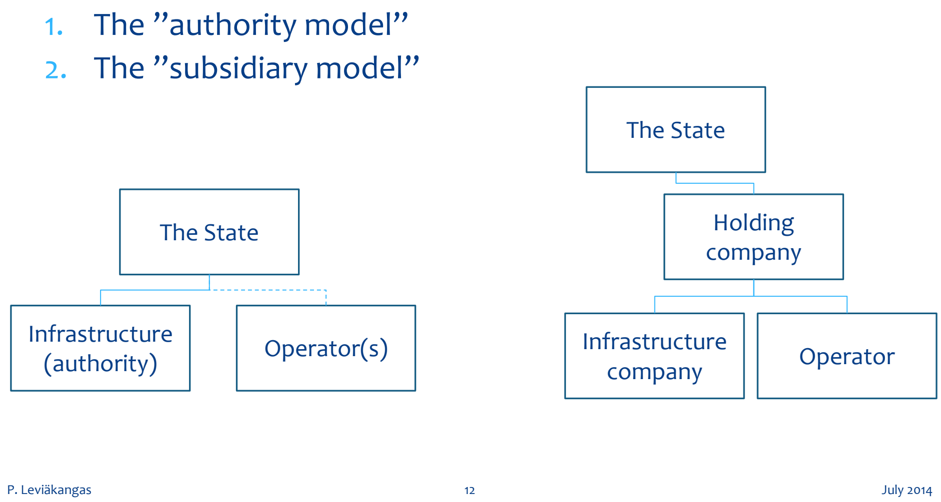

Figure 3.8.2: Industry Structure of Rail Projects

It is obvious that bundling of infrastructure related businesses (commercial zones) is easier for more integrated railway corporations. These are in general also financially much stronger and take up on endeavours that require substantial cash inlays. By splitting railways into small entities, the EU has in fact somewhat made it more difficult for European railways to take on PPPs. This applies to new market entrants too, since the fully infrastructure-operations separated industry structure makes the investment environment more complex in bundling of business cases is in the target.

For urban rails the abovementioned challenges are not so serious. Within a city or metropolitan region, urban rail network development can more easily be connected to land use planning and compilation of business cases from both transport operations and commercial zone potential is made available (see e.g. Newman et al. 2016). However, urban rail systems are passenger oriented and the possibility to link logistics business is not there whereas for heavier inter-urban railways the option exists. Of there are considerable exceptions, such as the Monoprix in Paris.

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BENEFIT indicators related to Value Capture and Revenues
BENEFIT indicators can be linked with some typical business cases and challenges faced in rail PPPs. This is shown in the below table. The impact of financial crisis is not assessable due to the limited number of railway PPP cases included in BENEFIT database. However, some impacts are quite logical. First, the shift from traffic-based projects towards availability-based ones will increase the financial and economic resilience of projects. In their purest form, availability payment revenues should be nearly zero-risk in terms of covariance with the market movements and economic context. Second, the bundling of business cases and diversifying revenue base will reduce base case business risks, but might not reduce exposure to market and economic situation. In fact, the bundling could in some cases increase the risks.

The institutional context risks are enhanced in the bundling of business cases. Land use plans, building rights, etc. are politicised processes where local public (and private) interests can collide with private business interests. Economic/financial crises affect the political processes that are necessary for business case bundling and hence the resilience of bundled business models is not necessarily any better than single-case models – in fact in some cases this can be vice versa. Also rent levels, property values and interest rates in general affect these models significantly.

Table 3.8.2: Rail Business Cases vs BENEFIT Indicators

Business cases / value capture	**Challenge type and ranking**	**BENEFIT indicators explicitly related to no. 1 challenge**	**Notes & elaborations**	**Resilience against crises**
On-route business	1. Commercial (cash flow from operations) 2. Political (competition) 3. Technical complexity	• Financial-economic context • Revenue support	The highest risk relates to customer demand for passenger and freight services. If these can be bundled, it may diversify some of the risk.	Availability payments increase resilience practically against all risks
Commercial zone business Land development	1. Political (land use planning) 2. Commercial (investment pay-back) 3. Technical complexity	• Institutional context	The highest risk relates to political decision-making on land use and building rights. The actual demand risk is lower, since consumption patterns of travellers is fairly well understood.	Bundling zone and land development business cases increase exposure to crises

3.8.3 Key Issues

With respect to their construction Rail projects have the high profile and technical risks equal or even greater than those observed in special structures (bridge and tunnel Projects). Simultaneously, as opposed to special structures they are not characterised by exclusivity and, therefore, they cannot take advantage of their position in the network to employ the project structure characteristics of bridge & tunnels, i.e. low value Remuneration attractiveness indicator. They do, however, employ high values of the Financing Scheme Indicator.

In addition, while their Revenue Support Indicator with respect to position in the network is relatively low (low exclusivity) other features can provide a high Revenue Scheme indicator such as business

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orientation, other transport related and non- related services. Notably, the bundling of services while positive for revenue prospects places pressure on both the governance indicator and the Cost Saving Indicator with respect to the capability of the contracting authority. In addition, the institutional indicator is important, also, in this context.

Stemming from the above, while the initial tendency would be to approximate rail infrastructure projects to other linear infrastructures, the behaviour with respect to indicators points research to urban transit projects.

The present assessment does not allow for further consideration of rail infrastructure projects but the guidelines for future research are well set.

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3.9 Overall Conclusions and Trade-offs

A key finding of Chapter 3 has been the fact that each transport infrastructure mode is influenced differently by the implementation context and that different indicators contribute in each case to achieving the respective outcomes.

This finding guides the assessment of resilience towards an infrastructure mode-specific process, which also includes a different specification of high and low values of the indicators for each mode under consideration.

It is also noticeable that some indicators are more prominent than others while neither single indicators nor specific combinations of them are able to secure the successful attainment of single outcomes, **let alone of all four outcomes simultaneously**. However, there are findings that may be generalized both across modes as well as outcome targets. Tables 3.91 to 3.9.2 summarise all findings per outcome.

Indicators Exogenous to the project

- The Financial-Economic indicator (FEI) is an important indicator, but does not have the same impact on all modes. Road projects are particularly sensitive to the FEI as it was found to influence all outcomes apart from revenues. For urban transit projects the FEI could have a varying affect which may be offset by other indicators. In bridge and tunnel projects the negative impact of a low and/or decreasing FEI may also be offset by high values of other indicators (GI, CSI and RSI). For airports the FEI influenced cost and time targets but traffic and revenues should consider an extended FEI.
- The Institutional indicator (InI) has been identified as potentially the most important external indicator across all modes and for all outcomes. In many cases it was identified to be able to offset the impact of a low or decreasing FEI.

Indicators Endogenous to the project

- The Governance indicator reflects in many ways the level of institutional maturity in the country of project procurement. In this effect, it may compensate and/or enhance the Institutional Indicator.
- The Cost Saving indicator describes the project's technical difficulty and also the capabilities of key project actors: the constructor's to construct, the operator's to operate, and the monitoring authority's to monitor the project in consideration. This indicator was found to contribute to all outcomes and, in most cases, works in combination with GI. More specifically, it was found in many cases that a low value of the CSI could be offset by a higher value of GI and vice versa.
- The Revenue Support indicator could only have a positive role. However, it is not always possible to have a high value and/or in many cases the projects are not designed for a high value of the RSI.
- The Remuneration Attractiveness Indicator can act as a policy tool. Demand-based remuneration schemes (low value of RAI) work well under positive exogenous conditions. In an adverse context a low value of RAI needs to be supported by other indicators.
- The Revenue Robustness Indicator expresses the riskiness of the project revenue streams as well as the estimated level of cost coverage.

What is noticeable is the importance of the overall Business Model and Governance indicators across all modes and outcomes with the exception of revenues for roads, where the influence of the implementation context is far more prominent. The same indicators are also important for ports, although positive outcomes may be achieved under poor conditions for these specific projects. It should also be noted that while the Governance indicator is based on the contractual setup and

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reflects the tendering procedure, both Business Model indicators (CSI and RSI) are composite and for each mode particular aspects of them may be of greater importance. Stemming from this remark it is also reasonable to expect that the thresholds that define low and high values for the various indicators are different per mode, as each mode relies on different factors of the overall composite indicator. These particularities are considered in Chapter 4.

Another point of interest is the Financing Scheme indicator and its role in developing strategic trade-offs between cost and time outcomes. It was observed that projects with a high contributions of public sector (high value of FSI) support seek to complete “on-budget”, while when private financing is dominant (low FSI), there is an effort to complete “on-time”. In addition, supporting project revenues leads to higher values of the FSI.

It is also worth remarking on the small role of the implementation context indicators with respect to achieving revenue targets. Notably, their influence is implicit as it affects in most cases the attainment of traffic targets, which clearly impact revenues. However, the determining factors for meeting revenue expectations are captured by the Remuneration Attractiveness and the Revenue Robustness indicators.

In conclusion, while the outcomes of transport infrastructure projects are influenced by factors outside the managerial ability of the parties involved, there are many other internal project factors that may be addressed to improve their potential of achieving expected outcome targets. This is an important input for the development of the resilience assessment methodology as it suggests that project resilience could be improved by managing internal project parameters since external factors are not within the influence of project stakeholders. Further to this remark, it also interesting to note that three of the endogenous indicators namely, Remuneration Attractiveness, Revenue Robustness and Financing Scheme Indicator, may be considered “policy indicators” as they drive project outcomes differently according to their values. This is in contrast to the other internal indicators for which, when important, low values are typically associated with negative outcomes.

Table 3.9.1: Cost to completion Indicator Combinations Across Modes

Modes / **Indicators**	**Road Infrastructure**	**Urban Transit**	**Bridge & Tunnel**	**Airports**
Financial – Economic Indicator (FEI)	Strong positive or negative influence depending on high or low value	-	High Value important but may be off-set by high values of the other indicators	High Value important
Institutional Indicator (InI)	Pre-requisite	High Value	High Value	High Value
Governance Indicator (GI)	Needed (compensates for low CSI)	High Value	High Value	High Value
Cost Saving Indicator (CSI)	Needed (compensates for low GI)	High Value	High Value	High Value
Revenue Support Indicator (RSI)	Support	High Value	High Value (High LoC Important)	High Value (High LoC Important)
Remuneration Attractiveness Indicator (RAI)				
Revenue Robustness Indicator (RRI)				
Financing Scheme Indicator (FSI)	Driver: High values			
Comments		All indicators above should have high values		

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Table 3.9.2: Time to completion Indicator Combinations across Modes

Modes / Indicators	Road Infrastructure	Urban Transit	Bridge & Tunnel	Airports
Financial – Economic Indicator (FEI)	Positive or negative influence depending on high or low value (May be off-set by GI and InI)		High Value important but may be off-set by high values of the other indicators	High Value important
Institutional Indicator (InI)	Pre-requisite (Acts in combination with GI)	High Value	High Value	High Value
Governance Indicator (GI)	Pre-requisite (Acts in combination with InI)	High Value (May be combined with CSI)	High Value	High Value
Cost Saving Indicator (CSI)	Needed	High Value (May be Combined with GI)	High Value (High LoC Important)	High Value
Revenue Support Indicator (RSI)		High Value	Low Value (May compensate for RRI)	High Value (High LoC Important)
Remuneration Attractiveness Indicator (RAI)	Driver: Low values		Low Value (May compensate for RAI)	Low Value (May compensate for RRI)
Revenue Robustness Indicator (RRI)	Driver: Low values		Low Value (May compensate for RAI)	Low Value (May compensate for RAI)
Financing Scheme Indicator (FSI)			High Value	High Value

Table 3.9.3: Actual vs Forecast Traffic Indicator Combinations across Modes

Modes / Indicators	Road Infrastructure	Urban Transit	Bridge & Tunnel	Airports
Financial – Economic Indicator (FEI)	Very strong Positive or negative influence depending on high or low value		High Value important but may be off-set by high values of the other indicators	High Value - Connected to international Financial – Economic conditions
Institutional Indicator (InI)	High value may limit effect of FEI	High Value	High Value (prerequisite for Low RAI)	
Governance Indicator (GI)	High value may limit effect of FEI	High Value (May be combined with CSI)	High Value (prerequisite for Low RAI)	High Value
Cost Saving Indicator (CSI)	High value may limit effect of FEI	High Value (May be Combined with GI)	High Value (prerequisite for Low RAI)	High Value
Revenue Support Indicator (RSI)		High Value (With emphasis on LoC)	High Value (High LoC Important)	High Value (High LoC Important)
Remuneration Attractiveness Indicator (RAI)	High value may limit effect of FEI	Support		
Revenue Robustness Indicator (RRI)				High Value
Financing Scheme Indicator (FSI)		High Value	High Value	

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Table 3.9.4: Actual vs Forecast Traffic Indicator Combinations across Modes

Modes Indicators	Road Infrastructure	Urban Transit	Bridge & Tunnel	Airports
Financial – Economic Indicator (FEI)		Only with respect to advertisements	High Value important but may be off-set by high values of the other indicators	High Value - Connected to international Financial – Economic conditions
Institutional Indicator (InI)		High Value	High Value (prerequisite for Low RAI)	High Value
Governance Indicator (GI)	Support: High Value	High Value	High Value (prerequisite for Low RAI)	High Value
Cost Saving Indicator (CSI)	Support: High Value	High Value	High Value (prerequisite for Low RAI)	High Value
Revenue Support Indicator (RSI)	Expected for High Value	High Value	High Value (High LoC Important)	High Value (also alternative revenues)
Remuneration Attractiveness Indicator (RAI)	Support: High Value	High Value		
Revenue Robustness Indicator (RRI)	Key Indicator	High Value	High Value	High Value
Financing Scheme Indicator (FSI)	Expected for High Value		High Value	
Comments		At least two of the above indicators should bear a high value.		

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4 Transport Infrastructure Resilience Indicator

4.1 Introduction

In the context of BENEFIT, resilience is defined as “the ability of a Transport Infrastructure project to recover from changes within its structural elements with respect to its ability to deliver specific outcomes (such as cost and time to completion, expected traffic and expected revenue targets)”.

The present Chapter describes the methodology behind the assessment of the Transport Infrastructure Resilience Indicator (TIRI). Stemming from the analysis of Chapter 3, an assessment is identified per transport infrastructure mode. Port projects have been identified to be dependent on factors and strategies that lie outside the BENEFIT Matching Framework. For rail projects, the information (i.e. number of cases) that was collected within the BENEFIT project was insufficient to support any relevant analysis. Under a similar rationale Airport projects are only partially addressed.

The proposed methodology considers:

- Resilience methodologies already reported in the literature (see Chapter 2 of this deliverable)
- The BENEFIT Matching Framework architecture and system nature (see Deliverable D3.1)
- The particularities of each mode of transport infrastructure as assessed with respect to the achievement of project outcomes (see Chapter 3 of this deliverable)

The next section of this Chapter places the development of the Transport Infrastructure Resilience Indicator (TIRI) under the methodological considerations defined in section 2.4 of this report. These constitute the outline and formulate the application area of the methodology. The detailed description of the indicator is accompanied by the specification of its proposed rating categories. It is also acknowledged that the Transport Infrastructure Resilience Indicator (TIRI) contains a time dimension which may cause it to **change over time**. Therefore, both a Static Transport Infrastructure Resilience Indicator (S-TIRI) and a Dynamic one (D-TIRI) are introduced.

The BENEFIT Matching Framework employs various typologies and their respective indicators. The analyses findings presented earlier make reference to “high” or “low” values of the indicators without always specifying the **thresholds they refer to**. In section 4.3, the “typical” thresholds are defined for each indicator. However, these constitute only the starting point for subsequently setting the respective thresholds per mode and outcome in section 4.4.

Furthermore, the BENEFIT project has identified that different combinations of indicators (see Chapter 3) may contribute to the achievement of particular outcomes with respect to cost –to-completion; time-to-completion; and actual vs forecast traffic or revenues. In this context, both the Static and the Dynamic Transport Infrastructure Resilience Indicator (S-TIRI and D-TIRI) are estimated for all outcomes and modes in section 4.3.

This approach also leads to the development of an Overall Transport Infrastructure Resilience Indicator (O-TIRI). In the present Chapter potential approaches are presented for the calculation of the O-TIRI that may be suitably endorsed or **adjusted by stakeholders** depending on their value systems and respective interests. Within BENEFIT, following on the **stakeholder-agnostic/ neutral approach** adopted throughout this research, the O-TIRI takes the form of a serial representation of the respective TIRI ratings per outcome.

Finally, the assessment of the overall applicability of the TIRI for the BENEFIT cases is carried out in Chapter 5. This part also aims to serve as a first validation of the TIRI methodology.

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4.2 Transport Infrastructure Resilience Methodology

4.2.1 Methodological Considerations

The proposed methodology aims to assign values to the Transport Infrastructure Resilience Indicator in the form of ratings, which reflect the likelihood of attaining the respective targets for each outcome considered within the BENEFIT project. The specification of the rating categories is based largely on previous BENEFIT analysis results that have been summarised in Chapter 3. This section starts with addressing the methodological considerations.

System Boundaries

The first consideration is the need to clearly identify the boundaries of the system of interest (Henry and Ramirez-Marquez 2012). The methodology, as in Filippini and Silva (2014), considers the systemic nature of the BENEFIT Matching Framework (see Deliverable D3.1), which communicates with the wider universe of infrastructure delivery through its inputs, i.e. all decisions made concerning the project prior to project award.

These also include the project budget, the expected construction duration, as well as forecast traffic and revenues.

The implementation, which is the focus of the BENEFIT Matching Framework, is represented through indicators. Amongst these indicators two, the Financial Economic Indicator (FEI) and the Institutional Indicator (InI) are considered exogenous to the project as they affect the project but cannot be influenced by project stakeholders. All other indicators are considered endogenous as, while they also affect project performance, actions may be taken in order to influence the sign of their impact. Moreover, they may also be used to address negative effects from the exogenous indicators.

Figure-of-Merit

A system's resilience is measured against its ability to reach specific goals (Henry and Ramirez-Marquez 2012). Within BENEFIT four goals with respect to system performance have been studied: Cost-to-Completion; Time-to-Completion; Actual vs Forecast Traffic; and Actual vs Forecast Revenue. These four elements were chosen to represent key project goals (see D4.1). Hence, the TIRI addresses four different Figures-of-Merit. As expected, the system may exhibit simultaneous resilience for one or more figures-of-merit but not necessarily for all.

Actionable Variables and Background Conditions

The TIRI rating is structured by carefully considering the distinct nature and impact of the endogenous and the exogenous indicators. In the developed rating system it becomes immediately obvious which indicators need to be addressed in order to improve resilience (Rose and Krausmann 2013).

System Stability

It is acknowledged that the system – the BENEFIT Matching Framework – will change over time, especially as a response to involuntary changes in the exogenous indicators. In this context, it is not enough to provide a TIRI rating reflecting current conditions (Static Transport Infrastructure Resilience Indicator, S-TIRI). This indicator needs to be accompanied by an indication of potential resilience to change. To this end, the methodology also includes a Dynamic Transport Infrastructure Resilience Indicator (D-TIRI).

Accuracy and Transparency

The TIRI needs to be based on information that is accurate and transparent (Fisher et al 2010). The rating methodology proposed is systematic, consistent and does not require a qualitative assessment or interpretations. Therefore, the resulting TIRI ratings (Static and Dynamic) are both reproducible and easy to verify.

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4.2.2 Transport Infrastructure Resilience Indicator Rating System

The Transport Infrastructure Resilience Indicator comprises three basic rating categories, namely A, B and C. These are specified as follows:

- A: Describing very high likelihood of reaching the figure-of-merit target value (achievement of outcome).
  Projects assigned an A rating exhibit high values for both exogenous (Financial-Economic (FEI) and Institutional (InI)) and endogenous (all other) indicators. The threshold values that determine the required high indicator values for each infrastructure mode are specified separately based on the analysis of findings conducted in Chapter 3.

- B: Describing average likelihood of reaching the figure-of-merit target value (achievement of outcome).
  A project assigned a B rating exhibits potential vulnerability that may be due to either exogenous (Financial Economic Indicator (FEI) and Institutional Indicator (InI)) or endogenous (all other indicators) conditions. Because of these two different sources of vulnerability, this rating category is further divided into B_{EX} and B_{EN}, corresponding to:
  - B_{EX}: A rating describing a fairly robust internal project structure but subject to exogenous vulnerability, and
  - B_{EN}: A rating describing a project implemented under largely positive exogenous conditions but with internal structure vulnerabilities.

- C: Describing low likelihood of reaching the figure-of-merit target value (achievement of outcome).
  Projects assigned a C rating are **vulnerable to both** exogenous and endogenous conditions.

Furthermore, due to the many indicators involved in determining each rating for each figure-of-merit and mode, slightly better or worse conditions may exist. These are presented with additional rating notches, (+) or (-) shown next to the basic rating, A, B or C. Table 4.2.1 summarises the range of potential values of the proposed rating system.

Table 4.2.1: BENEFIT Transport Infrastructure Resilience Indicator

Exogenous Vulnerability	Rating Category	Endogenous Vulnerability
None	A	None
None	A-	Some
Some	B_{EX}	Limited
Endogenous structure reduces vulnerability	B_{EX}+	Limited
Endogenous structure increases vulnerability	B_{EX}-	Limited
Limited	B_{EN}	Some
Limited	B_{EN}+	The combination of endogenous and exogenous conditions reduces vulnerability
Limited	B_{EN}-	The combination of endogenous and exogenous conditions increases vulnerability
Existing: The combination of endogenous and exogenous conditions reduces vulnerability	C+	Existing: The combination of endogenous and exogenous conditions reduces vulnerability
Existing	C	Existing

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4.2.3 Static Transport Infrastructure Resilience Indicator

The Static Transport Infrastructure Resilience Indicator (S-TIRI) reflects the potential of reaching a specific outcome target (figure-of-merit) at a particular point in time and+ is estimated based on the indicator values which are relevant to the respective outcome (cost to completion; time to completion; actual vs forecast traffic; and actual vs forecast revenue).

The assessment of the Static Transport Infrastructure Resilience Indicator **constitutes the core of the methodology** and is described per outcome (figure-of-merit) and infrastructure mode in section 4.4.

Based on the general TIRI rating system described in the previous section, both exogenous and endogenous conditions are considered in the assessment of the rating, with the exogenous primarily setting the rating categories (A, B or C). Amongst the two implementation context indicators (Financial-Economic (FEI) and Institutional (InI)) describing the exogenous conditions of a project**, FEI is taken as the starting point in the assessment of rating categories.**

The systematic study of findings in Chapter 3, identifies two very important threshold values for FEI:

- FEI=0.60
  Above this value, for all modes and all figures-of-merit (outcomes), the project implementation context conditions are favourable. The Institutional indicator, also an important indicator of the implementation context, bears a strong correlation (see Deliverable D4.4, Econometrics analysis findings) with the FEI and is also supported (i.e. low values are compensated) by the Governance indicator (GI). In other words, above this threshold, the potential to reach any figure-of-merit (outcome) target for all modes is dependent on the internal structure of the project. In turn, the resilience of the project internal structure depends on the values of a combination of indicators which are significant for each outcome and infrastructure mode.

- FEI=0.50
  When FEI $\in$ [0.50, 0.60], then **in order to reach the respective figure-of-merit (outcome) targets, a project needs to be structured (designed) with endogenous resilience**. This means that depending on the infrastructure mode the combination of other indicators (specific to each mode) define the potential resilience of the project. Their range of values, once again, depends on the particular mode.

  Below FEI=0.50 the potential to reach the figure of merit target is low, especially when combined with low values of some or all other indicators which are important for the respective infrastructure mode and figure-of-merit. This potential may be improved depending on the structure of the project.

This rationale is followed in all rating assessment Tables presented in section 4.4.

4.2.4 Dynamic Transport Infrastructure Resilience Indicator & Stability of Assessment

The Dynamic Transport Infrastructure Resilience Indicator is assessed based on the Static considering various scenarios whose impact on the project cannot be influenced or actioned by project stakeholders.

The key scenarios considered reflect change in the *exogenous conditions* during project implementation. The key condition change considered corresponds to the improvement or

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deterioration of the financial-economic context, i.e. the increase or decrease of the value of the Financial-Economic Indicator. Notably, various scenarios may be built, including:

- Improvement (deterioration) during **the construction phase,** which may influence the potential of reaching cost to completion and time to completion but also the subsequent traffic and revenue goals.
- Improvement (deterioration) during the **operation phase**, which may influence the potential of reaching traffic and revenue goals.

An issue when estimating the Dynamic Transport Infrastructure Resilience Indicator is the percentage (%) of change in the FEI that needs to be considered. Various approaches may be applicable:

Percent Change in the Financial Economic Indicator (FEI)
This would require defining the median change in FEI observed over the years in various countries. Figure 4.2.1 illustrates **maximum annual changes in FEI values** between 2001 and 2014. Notably, significant changes have been witnessed since 2001, making the assignment of a particular percentage change in FEI challenging and of questionable validity.

Rating for Financial Economic Indicator (FEI) Threshold Values
As FEI is directly linked to rating thresholds, another approach would be to assess the ratings corresponding to below (above) the identified threshold values, i.e. FEI=0.60 and FEI=0.50. However, these ratings are significant when accompanied by the percentage drop (or increase) in the project's FEI indicator value to reach these critical threshold values. More specifically, the drop below FEI = 0.60 is important in order to assess projects that belong in the range FEI $\in$ [0.50, 0.60],and the drop below FEI=0.50 is of interest in order to assess projects that have a FEI<0.50. **Such an assessment provides a comprehensive picture of a project's potential to reach the corresponding outcome target**. The key limitation in this approach is that this assessment cannot be reported in a simple and comprehensive way thus increasing the complexity of the representation. Table 4.2.2 presents examples of this approach.

Table 4.2.2: Dynamic Transport Infrastructure Resilience Indicator based on FEI Threshold Values

Project Title	**Figure of Merit**	**Static* Rating**	**Dynamic Rating***					
			50↓%	Rating-50-	60↓%	Rating-60-	60↑%	Rating-60+
BNRR (M6 Toll)	Cost to Completion	B_{EN}+	21,3	C	5,5	B_{EX}-	0	B_{EN}+
	Time to Completion	A	21,3	B_{EX}-	5,5	A	0	A
	Actual vs Forecast Traffic	B_{EN}-	32,6	B_{EX}-	19,1	B_{EN}-	0	B_{EN}-
	Actual vs Forecast Revenues	A-	32,6	B_{EX}-	19,1	B_{EN}-	0	A-

**Assessments are made based on the rating assessment tables presented in the next section*

As may be observed in Table 4.2.2 above, ratings for FEI threshold values might not necessarily lead to a change in the rating level. Additionally, a large percentage drop or increase may be needed for the project's FEI value to reach the critical threshold values. These features provide evidence of project **static rating stability**. More specifically, **a project's rating stability may be considered as high** when:

- A <u>project's rating remains positive</u> (A, B_{EN}, B_{EX}+)
- The percentage change in FEI is considered high as a big drop or increase of the FEI would be needed to reach the threshold values. This assessment, however, depends on the country's level of fluctuations of the FEI values and, also contains an element of subjectivity as it is related to the stakeholder's (decision maker's) risk appetite. A sample of annual fluctuation of the FEI values for countries whose projects are included in the BENEFIT database is presented in Figure 4.2.1.

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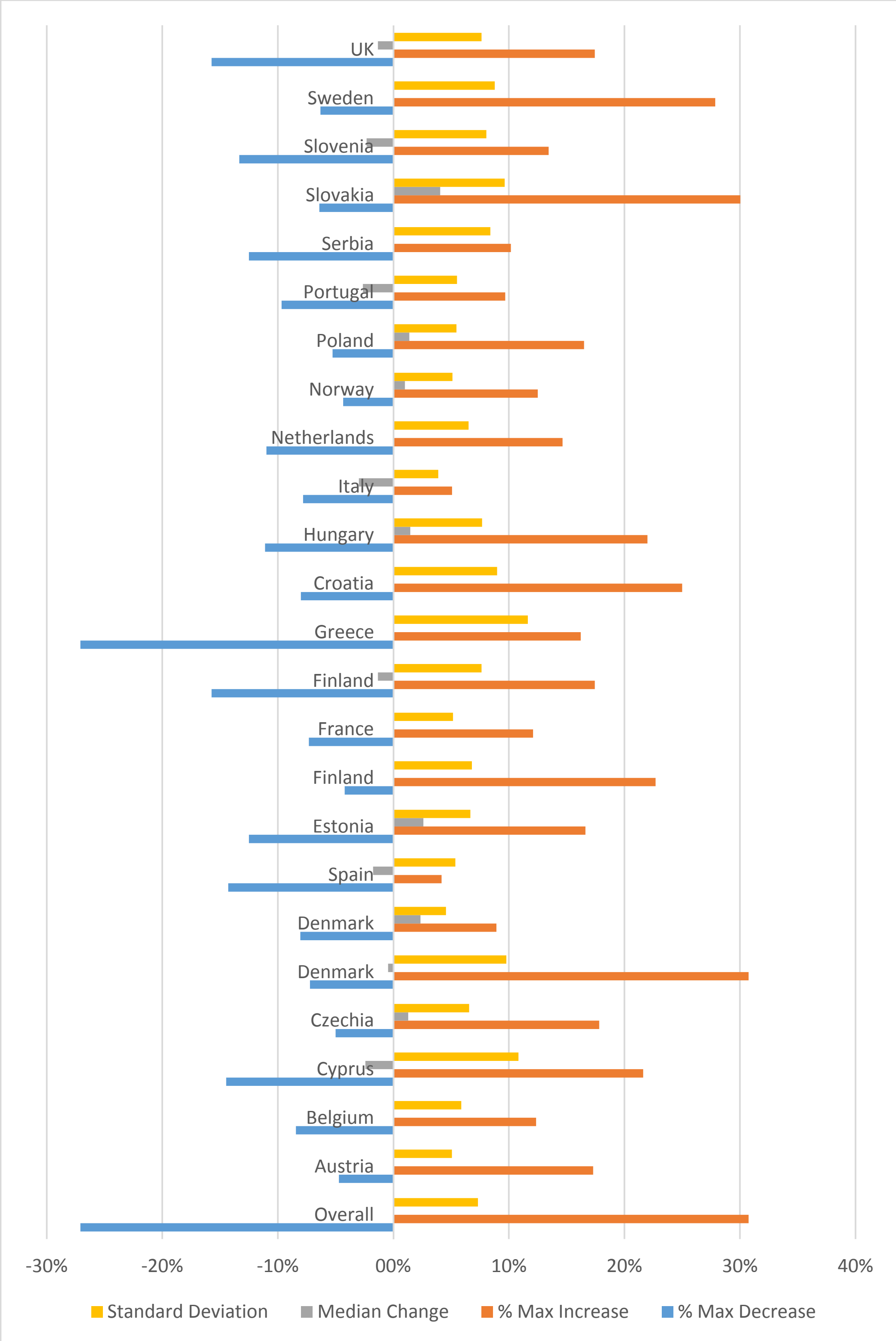

Figure 4.2.1: Annual changes in FEI values between 2001-2014 for various BENEFIT countries

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Change in the Financial Economic Indicator Value leading to Change in S-TIRI Rating
A final, alternative approach is to identify the percentage change in the value of the FEI needed to change the rating level (A, B or C) upwards or downwards. In this case, the Dynamic Transport Infrastructure Resilience Indicator is expressed by two values:

- the first describing the percentile decrease needed to drop to the next lower rating category, i.e. from A to B or from B to C, and
- the second describing the percentile increase needed to move up a rating category, i.e. from C to B or from B to A.

Table 4.2.3 illustrates the estimation of the Dynamic Transport Infrastructure Resilience Indicator assessment for “cost to completion” on a number of projects, as an example. The full assessment may be found in Annex 1. S-TIRI and D-TIRI Ratings are calculated in accordance to the rating assessment Tables of section 4.4.

Table 4.2.3.: D-TIRI calculation Examples for the Rating Category Change Approach

Project Title	FEI at Award	Inl at Award	GI	CSI	RSI	FSI	**Static Rating**	**Dynamic Rating**		Cost Performance
	Δ FEI – Construction	Δ Inl – Construction						**Below Category**	**Above Category**	
Via-Invest Zaventem	0,690	0,76	0,688	0,449	0,216	0,740	A	13,0%	0	Below Budget
	-0,09	0,01								
M-25 Orbital	0,625	0,78	0,688	0,656	0,270	0,668	A	4,0%	0	In line
	-0,03	0,01								
E18 Muurla-Lohja	0,753	0,86	0,750	0,133	0,121	0,773	B_{EN}+	20,3%	n.p.	In line
	0,01	0,00								
Athens Ring Road	0,543	0,59	0,688	0,313	0,229	0,561	B_{EX}+	7,9%	10,5%	In line
	0,04	0,03								
Moreas Motorway	0,558	0,61	0,750	0,750	0,301	0,816	B_{EN}+	10,4%	7,5%	Overrun
	-0,250	-0,04								
A22 motorway	0,540	0,69	0,813	0,000	0,267	0,779	B_{EX}-	7,4%	n.p.	In line
	-0,10	0,01								
	-0,13	0,03								
Motorway E-75, Section Horgos-Novi Sad (2nd phase)	0,483	0,47	0,188	-0,030	0,257	1,000	C	0	3,5%	Overrun
	0,03	0,01								
	0,06	-0,03								
Radial 2 Toll Motorway	0,63	0,74	0,500	0,244	0,089	0,640	B_{EN}-	20,6%	n.p.	Overrun
	0,00	-0,05								

Notably, if a project already belongs to rating category “C”, the first value will be equal to 0 (e.g. Motorway E-75, Section Horgos-Novi Sad, 2nd phase). Similarly, if a project already belongs to rating category “A”, the second value will be equal to 0 (e.g. Via-Invest Zaventem and M-25 Orbital). **There are also cases, for which the increase in rating category is not possible (n.p.).** This is due to the internal structure of the project which has been identified to have problems that would prevent it from achieving a better resilience rating. In effect, projects with internal vulnerability (B_{EN} rating) will not be able to improve their rating category in most cases (e.g. E18 Muurla-Lohja and A22 motorway).

This approach presents the advantage of providing valuable information with just two additional figures. For example:

- Large values of percentage change indicate the stability of the static rating.

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- Small values of the first figure (distance from downgrading) suggest potential risk, while small values of the second figure (distance from upgrading) suggest potential opportunity.
- An "n.p." indication suggests the project is not capable of withstanding fluctuations in the implementation context due to its internal structure.

Utilising this approach is more convenient with respect to capitalising on the findings of Chapter 3, as the **FEI does not influence certain outcomes** (e.g. Revenue for roads) **and is not particularly influential for urban transit projects.** In **such cases, the ruling concept continues to be the change in category rating. However, the measure in these cases is the Institutional indicator**.

Notably, by employing the Institutional indicator the limitations of the other approaches towards the assessment of the Dynamic Transport Infrastructure Resilience Indicator may be remedied. Therefore, any of the suggested approaches may be followed. **In the present report, the "change in rating category" approach is followed** although both other proposed approaches may be of equal merit and the rating assessment Tables of section 4.4 allow for their uninhibited consideration.

4.2.5 Overall Transport Infrastructure Resilience Indicator

The assessment of an Overall Transport Infrastructure Resilience Indicator (O-TIRI) is mostly an expression of a particular stakeholder's point of view, as it would reflect their own value system with respect to the relevant importance attached to achieving the different project outcomes. In this context, the **proposed methodology can be tailored to a particular stakeholder's needs.**

Notably, **there is merit in assessing the potential to achieve each outcome target, through the proposed TIRI ratings**. **These ratings can assist the various project stakeholders in determining the nature and extent of their involvement in the various project phases.** For private parties this assessment may be related to corresponding investment decisions whereas for the public party it can help to better allocate risks or assess the influence project structure decisions may have on the project's potential of reaching specific outcome targets under various implementation context conditions.

Furthermore, providing an Overall Transport Infrastructure Resilience Indicator may be useful to less knowledgeable stakeholders as it may guide their project-related decisions.

In order to construct the Overall Transport Infrastructure Resilience Indicator two basic approaches are possible:

- The Overall Transport Infrastructure Resilience Indicator is equal to its "weakest link", i.e. it is equal to the minimum of the ratings describing the four figures-of-merit (outcomes) considered in BENEFIT. However, in this approach the potential importance or ability of the "strongest link" to compensate for shortcomings is overlooked.

- The Overall Transport Infrastructure Resilience Indicator is equal to a weighted average of the four figures-of-merit considered in BENEFIT. This approach is based on a mapping of the various rating categories against values indicating the "likelihood" of reaching the expected outcome targets. The demonstration of this approach is based on assumed likelihood values that have not been validated and should be treated as a simple proof-of-concept. Furthermore, this approach also needs to be tailored to the needs of each stakeholder as the respective weighting applied would reflect the particular stakeholder's risk perceptions and interests.

Both approaches bear advantages and disadvantages and may be equally applied using either the Static or the Dynamic Transport Infrastructure Resilience Indicator. Combinations of the two approaches may also be considered while either of them may be applied per project phase.

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Notably, if all figures-of-merit (outcomes) have obtained an equal rating then the process is further simplified. If the TIRI rating, however, varies between outcomes, then the Overall Transport Infrastructure Resilience Indicator would need to express the decision maker's interests and viewpoints.

As stated throughout the BENEFIT project, **BENEFIT is stakeholder-agnostic, i.e. it is not assuming the point of view of any stakeholder**. Therefore, the construction of the Overall Transport Infrastructure Resilience Indicator is left to the **particular stakeholder to consider** based on the suggested methodologies and approaches. Consequently, different stakeholders may end up with different overall assessment for the same project based on their own value system.

Within this deliverable the O-TIRI will be presented as a four letter rating composed sequentially from all four individual ratings that have been obtained for each considered figure-of-merit (outcome). The **sequence of the ratings** will be in the form of O-TIRI = {Cost to completion, Time to Completion, Actual vs Expected Traffic, Actual vs Expected Revenue}.

Table 4.2.4 is an illustration of how the Overall Transport Infrastructure Resilience Indicator (O-TIRI) may be structured and the potential rating outcome for all aforementioned approaches.

Table 4.2.4: Examples of the Transport Infrastructure Resilience Indicator Assessment (O-TIRI)

Project	Cost-to-Completion	Time-to-Completion	Actual vs Forecast Traffic	Actual vs Forecast Revenue	O-TIRI
Approach: Weakest Link					
Via – Invest Zaventem	A	A	A	A	A
Koper-Izola Expressway	A	C	A	A	C
Approach: Weighted Average					
Stakeholder's Weighting	20%	10%	40%	30%	
Via – Invest Zaventem*	A	A	A	A	5=A
	Very High Likelihood (5)	Very High Likelihood (5)	Very High Likelihood (5)	Very High Likelihood (5)	
	0,2*5	0,1*5	0,4*5	0,3*5	
Koper-Izola Expressway	A	C	A	A	4,6=A-
	Very High Likelihood (5)	Low Likelihood (1)	Very High Likelihood (5)	Very High Likelihood(5)	
	0,2*5	0,1*1	0,4*5	0,3*5	
Approach: BENEFIT					
Via – Invest Zaventem	A	A	A	A	AAAA
Koper-Izola Expressway	A	C	A	A	ACAA

***See table 5.2.1 for probability assignment*

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4.3 Typical Indicator Threshold Values

In the comparative study of previous BENEFIT analysis results undertaken in Chapter 3, reference is made to the “high” or “low” value of indicators. As explained in various instances the reference to “high” or “low” values correspond to different thresholds for each indicator, mode and outcome (figure-of-merit). In the present section, the typical thresholds that distinguish “high” from “low” values are set. These values are merely considered a starting point for setting the respective mode-specific values in section 4.4. Three approaches are considered which are subsequently combined.

4.3.1 Fuzzy-Set Qualitative Analysis Calibration

A calibration method should be based on theory or empirical studies, not just mathematical operation (Ragin 2008; Rihoux & Ragi 2009; Schneider & Wagemann 2010; Schneider & Wagemann 2012). As known, all typology indicators within BENEFIT include different sub indicators, for example: Institutional setting (7 sub-indicators), governance (12 sub indicators), etc. Consequently, no theoretical framework or empirical studies within the available literature could be used as a reference. In this context, direct calibration is employed for assigning specific values into sets of memberships either “fully in/more in than out” or “fully out/more out than in”. According to Ragin (2008), the direct method uses estimates of the log of the odds of full membership with the following formula:

Odds of membership = (degree of membership)/(1- (degree of membership)).

The calculation of values using direct calibration is provided by the fsQCA software 2.5. Three important qualitative anchors to structure calibration are initially defined (Ragin, 2000):

- the threshold for full membership,
- the threshold for full non-membership and
- the crossover point.

According to Ragin (2008), the qualitative anchors are set up as: the threshold for full membership (0.95); the crossover point (0.5) and the threshold for full non-membership (0.05). In this context, careful consideration is required in setting the threshold, since it differs in terms of the method of calculation.

First, Institutional setting and financial economic setting are composed by different sub indicators, whose raw values are provided by specific sources such as: the World Bank Governance Indicators (WGI), Liberalization of transport market from OECD, World Economic Forum (WEF), called ‘type 1’. Secondly, the indices (i.e. governance, cost saving, revenue support, remuneration attractiveness, revenue robustness, transport market efficiency & acceptability, and financing scheme) are calculated by aggregating a number of sub indicators from several data collection sources such as: secondary data, questionnaires, interviews, and other sources, called ‘type 2’.

The direct calibration ‘type 1’ encompasses institutional setting and financial economic setting. First, the institutional setting is reviewed for 26 European countries from 1996 to 2013. Due to the somewhat incomplete data[13], the average value is 0.69 and the average maximum and minimum values are 0.85 (Denmark) and 0.39 (Serbia), respectively. However, when looking at values in specific countries as well as years, the minimum value occurred for Serbia-2001 (0.29), while Denmark-2004 (0.88) held the maximum value. Therefore, the following thresholds are set: for full membership, cross over point and non-full memberships as 5% percentile or threshold for non-membership= 0.40; 50% percentile or cross over point = 0.65 and 95% percentile or threshold for full

[13] Such countries have some missed values, for example: 4 countries with no liberalization of transport market index, Montenegro was only available for 2006-2013.

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membership= 0.90. Likewise, based on the review of the financial economic setting index for 26 European countries from 2001 to 2014, albeit containing incomplete data[14], the average value was found to be 0.61, while the average maximum and minimum value 0.78 (Norway) and 0.39 (Serbia), respectively. Subsequently, the threshold is specified as: 5% percentile or threshold for non-membership = 0.40; 50% percentile or cross over point = 0.60; and 95% percentile or threshold for full membership = 0.80.

The direct calibration 'type 2' includes 7 typology indicators such as: Governance, Cost Saving, Revenue Support, Remuneration Attractiveness, Revenue Robustness, Transport Market Efficiency & Acceptability, and Financing Scheme. One might consider that all indicators do not have a specific reference, however, the theoretical maximum and minimum values can be used as reference. Out of 7 indicators, with the exception of cost saving, the theoretical values of all indicators range between 0 (lowest) to 1 (highest). Accordingly, the threshold is specified as: 5% percentile or threshold for non-membership = 0.05; 50% percentile or cross over point = 0.50 and 95% percentile or threshold for full membership = 0.95. Unlike the other 6 typology indicators, the Cost Saving indicator has the theoretical minimum and maximum values of -0.333 (lowest) and 1 (highest), respectively. In this case, the threshold is set up as: 5% percentile or threshold for non-membership = -0.2665; 50% percentile or cross over point = 0.333; and 95% percentile or threshold for full membership = 0.9335. Finally, as Rihoux & Ragin (2009) revealed, a condition/variable must vary across cases[15], so the final check for the calibrated values should be carried out. As a result, all indicators can be considered since they satisfy the criterion of having 'more variation', except the one of revenue support.

Table 4.3.1 Indicator Threshold Values

Indicators	Indicator Value Range		BENEFIT Cases Indicator Range		Threshold Values
	Min	Max	Min	Max	
Institutional	0,000	1,000	0,380	0,860	0,650
Financial Economic	0,000	1,000	0,305	0,842	0,600
Governance	0,000	1,000	0,188	0,875	0,600
Cost Saving	-0,333	1,000	-0,300	1,000	0,333
Revenue Support	0,000	1,000	0,000	0,416	0,500
Remuneration Attractiveness	0,000	1,000	0,000	1,000	0,500
Revenue Robustness	0,000	1,000	0,000	1,000	0,500
Market Efficiency & Acceptability	0,000	1,000	0,000	0,813	0,400
Reliability /Availability	0,000	1,000	0,250	1,000	1,000
Financing Scheme	0,000	1,000	0,000	1,000	0, 650

4.3.2 Estimation of the Revenue Support Indicator Threshold

For the composite indicator Revenue Support, it is important to note that the maximum value cannot be achieved by all transport modes and, **therefore the maximum and threshold values are different per mode.** Figure 4.3.1 illustrates the components of the Revenue Support indicator. The component (v) is not included in the calculation of the indicator used in the BENEFIT Analysis (see more information in Deliverable D3.1). The other five (5) components are included with an equal weight. Table 4.3.2 presents qualitatively the maximum values of each component depending on the

[14] There were some missing values for such countries: Serbia, Albania, Cyprus, Croatia, Denmark and Montenegro.
[15] As a general rule, variation might be designated by at least 30% cases, which are in either below 0,5 set of membership or above 0,5 set of membership.

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transport infrastructure mode. **Considering a qualitative scale of 1 to 3 a**nd assigning respective values the maximum value of the Revenue Support indicator for each infrastructure mode is estimated. Threshold values of the Revenue Support Indicator are estimated per mode using the same approach as described in the previous approach. The threshold values per mode are presented in Table 4.3.3.

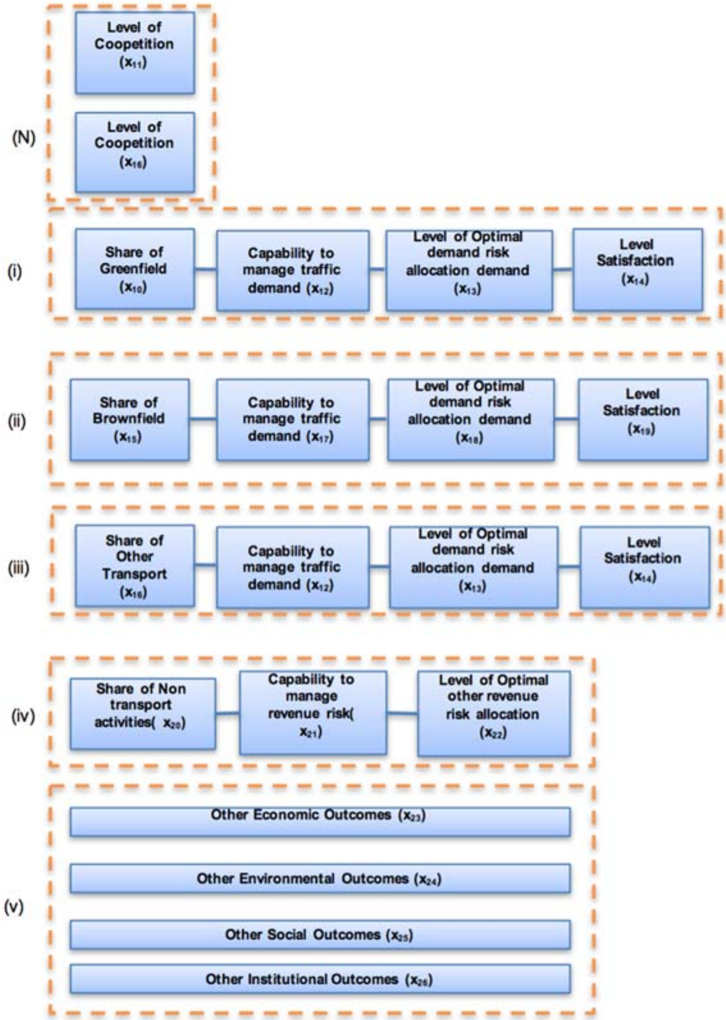

Figure 4.3.1: Structure of the Revenue Support Indicator

Table 4.3.2.: Qualitative Estimation of maximum values per component and infrastructure mode

Component / Mode	Level of Control / Coopetition	Greenfield & Demand allocation	Brownfield & Demand Allocation	Other Transport Mode & Demand Allocation	Other Non-Transport Revenues & Demand Allocation	Total	Normalised to the Unit.
Road	2	1	1	1	1	6	0,400
Urban Transit	3	2	3	3	3	14	0,933
Bridge & Tunnel	3	1	1	2	1	8	0,533
Airport	3	2	3	3	3	14	0,933
Ports	3	2	3	3	1	12	0,800

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Table 4.3.3: Revenue Support Indicator range and threshold values per mode

Mode	Indicator Value Range		BENEFIT Cases Indicator Range		Threshold Values
	Min	Max	Min	Max	
Roads	0,000	0,400	0,042	0,301	0,150
Urban Transit	0,000	0,933	0,045	0,274	0,400
Bridges& Tunnels	0,000	0,533	0,107	0,416	0,250
Airports	0,000	0,933	0,000	0,402	0,400
Ports	0,000	0,800	0,210	0,400	0,350

4.3.3 Financial-Economic Indicator: Second Lower Threshold

The Financial-Economic context is known to **influence demand in transport**. Indicator analysis also highlighted the importance of the indicator in achieving outcomes. Especially, the Econometrics analysis (see D4.4.) indicated that **marginal changes in the Financial-Economic Indicator (FEI) increase (or reduce) the probability of achieving outcomes** by a significant probability (e.g. 58% and 72% for cost to completion and actual vs forecasted traffic, respectively).

Observations of the value of FEI associated with lower performance indicated that for FEI<0.50 projects across all modes and outcomes had a lower probability of reaching their respective goal. Table 4.3.4 below shows the number of cases that did not reach their respective goals when FEI <0.50 with respect to the cases (snapshot representation) of the BENEFIT database.

Table 4.3.4: Occurrence of Non Achievement of Outcomes for FEI<0,50

FEI value	Total Number of Snapshots	Cost to Completion	Time to Completion	Actual vs Forecast Traffic	Actual vs Forecast Traffic
FEI<0,50	41	43,90%	53,66%	58,54%	26,83%
FEI>0,50	87	27,59%	31,03%	31,03%	13,79%

Considering that the outcome in all cases is defined by a combination of indicators, the presence of FEI with values lower than **FEI = 0.50 in negative outcomes justifies the use of this value as a second lower threshold value.**

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4.4 Transport Infrastructure Resilience Rating System per Mode

The system of assigning a Transport Infrastructure Resilience Indicator rating to each figure-of-merit (outcome) per mode is presented in this section. **The rating "A" is assigned in each case to projects with indicator values equal or greater than those presented in the respective Tables. The rating "C" is assigned to cases with respective indicator values below the values shown in the respective Tables. The rating "B" (either B_{EN} or B_{EX}) describes in-between values of the indicators influencing performance.**

The accuracy of the proposed system of assignment of TIRI ratings is dependent on the data that were available per mode in the BENEFIT database. The proposed system is applied to all available cases in the BENEFIT database for which enough information was available in order to structure the respective BENEFIT indicators.

4.4.1 Road Infrastructure

The following Tables 4.4.1 to 4.4.4 present the system of Transport Infrastructure Resilience Indicator rating per figure-of-merit (outcome) for road infrastructure projects. They are based on the combined findings of section 3.3 using the typical indicator threshold values presented in section 4.3 as a reference point and adjusted to the characteristics identified.

Table 4.4.1: Transport Infrastructure Resilience Indicator Rating Cost-to-Completion for Road infrastructure Projects

	FEI	InI	GI	CSI	RSI	FSI
Max Resilience Rating: A A- for InI $\in$ [0,61, 0,65] and FSI>0,60	$\geq$ 0,60	$\geq$ 0,65	$\geq$ 0,500	$\geq$ 0,333	$\geq$ 0,150*	
Endogenous Vulnerability Rating: B_{EN} B_{EN}+ for larger values of GI, CSI & RSI B_{EN}- for smaller values of GI B_{EN}- for InI $\in$ [0,61, 0,65] and FSI>0,60	$\geq$ 0,60	$\geq$ 0,65	$\geq$ 0,700	[0,333, 0,000]	[0,150, 0,000]	
Exogenous Vulnerability Rating: B_{EX} B_{EX}+ for larger values of GI, CSI & RSI B_{EX}- for smaller values of CSI & RSI B_{EX}- for InI $\in$ [0,61, 0,65] and FSI>0,60 B_{EX}- when C+ and FSI >0,666	[0,50, 0,60]	$\geq$0,65	$\geq$0,500	$\geq$0,333	$\geq$0,150	$\geq$0,600
Poor Resilience Rating: C C+ For larger values of GI	<0,50	<0,65	<0,500	<0,333	<0,150	<0,60
Rating: C	$\forall$	$\forall$	$\forall$	$\forall$	$\forall$	$\rightarrow$0,00

* *For road projects RSI$\leq$0.400*

Notably, lower values of the Cost Saving and Revenue Support indicators may be compensated by higher values of the Governance indicator along with higher values of the Institutional indicator.

Lower values of the Institutional indicator (but not lower than 0.60) may be compensated by a Financing Scheme indicator with a value greater than 0.60.

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If the Financing Scheme indicator is very small (<.333), then the prevailing strategy is to trade-off cost to completion for time to completion and a cost overrun is to be expected. Hence the rating “C”.

With respect to time to completion the InI and GI are of greater importance. They also drive time to completion in case of low RAI (riskier Remuneration Scheme).

Table 4.4.2: Transport Infrastructure Resilience Indicator Rating Time-to-Completion for Road infrastructure Projects

	FEI	InI	GI	CSI	RAI	FSI
Max Resilience Rating: A A- for InI $\in$ [0,61, 0,65] and FSI<0,60 or GI>0,600	≥0,60	≥0,65	≥0,500	≥0,000		
Endogenous Vulnerability Rating: B_{EN} B_{EN}+ for larger values of GI B_{EN}- for smaller values of GI	≥0,60	≥0,65	≥0,500	[0,000, 0,200]	<0,500	
Exogenous Vulnerability Rating: B_{EX} B_{EX}+ for larger values of GI B_{EX}- for InI $\in$ [0,61, 0,65] and GI>0,500	[0,50, 0,60]	≥0,65	≥0,500	[0,000, 0,200]	<0,500	
Poor Resilience Rating: C C+ for larger values of GI or InI	<0,50	<0,65	<0,500	<0,00	>0,500	>0,600

As per the analysis in section 3.3, the Financial-Economic Indicator is the most important for the achievement of a project’s traffic goals, combined with the Institutional, Governance and Cost Saving Indicators, while a high Remuneration Attractiveness indicator also supports traffic performance.

Table 4.4.3: Transport Infrastructure Resilience Indicator Rating Actual vs Forecast Traffic for Road infrastructure Projects

	FEI	InI	GI	CSI	RSI	RAI
Max Resilience Rating: A A- for InI $\in$ [0,61, 0,65] and GI>0,600 A- for RAI<0,500	≥0,60	≥0,65	≥0,500	≥0,333	≥0,150*	
Endogenous Vulnerability Rating: B_{EN} B_{EN}+ for larger values of GI and/or CSI and/or RSI B_{EN}+ for RAI>0,500 B_{EN}- for smaller values of GI B_{EN}- for RAI <0,500	≥0,60	≥0,65	≥0,500	[0,000, 0,333]	[0,000, 0,150]	
Exogenous Vulnerability Rating: B_{EX} B_{EX}+ for larger values of GI or CSI or RSI B_{EX}- for RAI <0,500 B_{EX}- for InI $\in$ [0,61, 0,65] and GI>0,500	[0,50, 0,60]	≥0,65	≥0,500	≥0,333	≥0,150	>0,500
Poor Resilience Rating: C C+ for larger values of GI or InI C+ for RAI>0,500	<0,50	<0,65	<0,500	<0,00	<0,150	<0,500

* *For road projects RSI≤0.400*

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The analysis in section 3.3 outlined the Remuneration Attractiveness Indicator as the most important for achieving the revenue goals, supported by the Revenue Robustness Indicator. The Governance and Cost Saving Indicators also influence the revenues, as well as high values of the Financing Scheme and the Revenue Support Indicators. When rating the revenue outcome, the rating of the traffic outcome is also taken into account.

Table 4.4.4.: Transport Infrastructure Resilience Indicator Rating Actual vs Forecast Revenue for Road infrastructure Projects

	RRI	**RAI**	**GI**	**CSI**	**RSI**	**FSI**
Max Resilience **Rating: A** If Traffic Rating A, then Revenue Rating A And Figure-of-Merit for Traffic outcome B A- for any RRI RAI, GI, CSI, FSI smaller	≥0,666	≥0,666	≥0,500	≥0,333	≥0,150*	≥0,666
Endogenous Vulnerability **Rating: B_{EN}** And Figure-of-Merit for Traffic outcome A, B or C B_{EN}+ for larger values of RAI and/or GI and/or CSI and/or RSI and/or FSI B_{EN}- for smaller values of RAI and/or GI and/or CSI and/or RSI and/or FSI	<0,666	[0,500, 0,600]	≥0,500	[0,000, 0,333]	≥0,150	≥0,500
Exogenous Vulnerability **Rating: B_{EX}** And Figure-of-Merit for Traffic outcome B or C B_{EX}+ for larger values of RAI and/or GI and/or CSI and/or RSI and/or FSI B_{EX}- for smaller values of RAI and/or RRI and/or GI and/or CSI and/or RSI and/or FSI	≥0,666	≥0,500	≥0,500	≥0,333	≥0150	≥0,500
Poor Resilience **Rating: C** And Figure-of-Merit for Traffic outcome C C+ for larger values of RRI or RAI and/or GI and/or CSI and/or RSI and/or FSI	<0,666	<0,500	<0,500	<0,000	<0150	<0,500

* *For road projects RSI≤0.400*

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4.4.2 Urban Transit

A key characteristic in the Transport Infrastructure Resilience Indicator rating of Urban Transit projects is the **emphasis placed on the institutional (InI) and Governance (GI) indicators and the absence of the Financial-Economic (FEI) indicator.** Also noticeable in the rating of Urban Transit are the relatively large values of the Revenue Support Indicator that need to be attained. Tables 4.4.5 to 4.4.8 present the rating system per outcome and are based on the composite findings of section 3.4 and the typical threshold values estimated in section 4.3 as a reference point and adjusted accordingly.

Table 4.4.5: Transport Infrastructure Resilience Indicator Rating Cost-to-Completion for Urban Transit infrastructure Projects

	InI	**GI**	**CSI**	**RSI**
Max Resilience Rating: A A- for RSI $\in$ [0,200, 0,400] A- for InI $\in$ [0,61, 0,65] and all other with values as indicated A- for smaller values of CSI or RSI	$\geq$0,65	$\geq$0,500	$\geq$0,333	$\geq$0,400*
Endogenous Vulnerability Rating: B_{EN} B_{EN}+ for larger values of GI, CSI & RSI B_{EN} - for GI $\in$ [0,500, 0,700]; if GI< 0,500 then C+ B_{EN} - for smaller values of CSI or RSI	$\geq$0,65	$\geq$0,700	[0,200, 0,333]	[0,200, 0,400]
Exogenous Vulnerability Rating: B_{EX}	FEI does not have a specific direct impact on Urban transit and InI has to have a value InI>0,65 in all conditions leading to positive outcomes			
Poor Resilience Rating: C C+ For larger values of GI and/or CSI and/or RSI	<0,65	<0,500	<0,333	<0,150

* *For urban transit projects RSI$\leq$0.933*

Table 4.4.6: Transport Infrastructure Resilience Indicator Rating Time-to-Completion for Urban Transit infrastructure Projects

	InI	**GI**	**CSI**	**RSI**
Max Resilience Rating: A A- for RSI $\in$ [0,200, 0,400]	$\geq$0,65	$\geq$0,500	$\geq$0,333	$\geq$0,400*
Endogenous Vulnerability Rating: B_{EN} B_{EN}+ for larger values of GI, CSI & RSI B_{EN} - for GI $\in$ [0,500, 0,700]; if GI< 0,500 then C+ B_{EN} - for smaller values of CSI or RSI	$\geq$0,65	$\geq$0,700	[0,200, 0,333]	[0,200, 0,400]
Exogenous Vulnerability Rating: B_{EX}	FEI does not have a specific direct impact on Urban transit and InI has to have a value InI>0,65 in all conditions leading to positive outcomes			
Poor Resilience Rating: C C+ For larger values of GI and/or CSI and/or RSI	<0,65	<0,500	<0,333	<0,150

* *For urban transit projects RSI$\leq$0.933*

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Table 4.4.7: Transport Infrastructure Resilience Indicator Rating Actual vs Forecast Traffic for Urban Transit infrastructure Projects

	InI	**GI**	**CSI**	**RSI**	**LoC**	**RAI**
Max Resilience Rating: A A- for RSI $\in$ [0,200, 0,400] A- for InI $\in$ [0,61, 0,65] and all other with values as indicated A- for smaller values of CSI or RSI	≥ 0,65	≥ 0,500	≥ 0,333	≥ 0,400*	≥ 0,500	
Endogenous Vulnerability Rating: B_{EN} B_{EN}+ for larger values of GI, CSI & RSI B_{EN} - for GI $\in$ [0,500, 0,700] or CSI or RSI $\in$ [0,000, 0,200] RAI > 0,500 supports	≥ 0,65	≥ 0,700	[0,200, 0,333]	[0,200, 0,400]	≥ 0,500	≥ 0,500
Exogenous Vulnerability Rating: B_{EX}	FEI does not have a specific direct impact on Urban transit and InI has to have a value InI>0,65 in all conditions leading to positive outcomes					
Poor Resilience Rating: C C+ For larger values of GI and/or CSI and/or RSI	<0,65	<0,500	<0,333	<0,150	<0,500	<0,500

* *For urban transit projects RSI$\leq$0.933*

Table 4.4.8: Transport Infrastructure Resilience Indicator Rating Actual vs Forecast Revenue for Urban Transit infrastructure Projects

	InI	**GI**	**CSI**	**RSI**	**LoC**	**RAI**	**RRI**
Max Resilience Rating: A If traffic rating A, then Revenue Rating A A- for RSI $\in$ [0,200, 0,400] A- for InI $\in$ [0,61, 0,65] and all other with values as indicated A- for smaller values of CSI or RSI	≥ 0,65	≥ 0,500	≥ 0,333	≥ 0,400*	≥ 0,500	≥ 0,500	≥ 0,500
Endogenous Vulnerability Rating: B_{EN} If traffic rating B_{EN}, then Revenue Rating B_{EN} Or **At least two indicators with values greater than indicated** B_{EN}+ If more than two indicators with values greater than indicated InI >0,65 always	≥0,65	0,500	0,333	0,400	0,500	0,500	0,500
Exogenous Vulnerability Rating: B_{EX}	FEI does not have a specific direct impact on Urban transit and InI has to have a value InI>0,65 in all conditions leading to positive outcomes						
Poor Resilience Rating: C C+ For larger values of GI and/or CSI and/or RSI or RRI	<0,65	<0,500	<0,333	<0,150	<0,500	<0,500	<0,500

* *For urban transit projects RSI$\leq$0.933*

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4.4.3 Bridge & Tunnel Projects

Bridge and Tunnel projects may be considered as special cases of road projects. Their key characteristics focus around their exclusivity in the network, the preferred remuneration scheme, which is usually demand-based, and the high public sector contribution to their financing. Hence, bridge and tunnel projects are based on the Transport Infrastructure Resilience Indicator rating approach applied to roads with the consideration of high Revenue Support (especially the factor Level of Coopetition), low Remuneration Attractiveness and high Financing Scheme Indicator values.

Table 4.4.9: Transport Infrastructure Resilience Indicator Rating Cost-to-Completion for Bridge & Tunnel infrastructure Projects

	FEI	InI	GI	CSI	RSI	LoC	FSI
Max Resilience Rating: A A- for InI $\in$ [0,61, 0,65] and LoC>0,500	≥ 0,60	≥ 0,65	≥ 0,500	≥ 0,333	≥ 0,250*	≥ 0,500	
Endogenous Vulnerability Rating: B_{EN} B_{EN}+ for larger values of GI, CSI & RSI B_{EN} - for smaller values of GI, CSI & RSI B_{EN} - for InI $\in$ [0,61, 0,65] and LoC>0,500 If GI< 0,400 then C+	≥0,60	≥0,65	≥0,500	[0,000, 0,333]	[0,150, o,250]	≥ 0,500	
Exogenous Vulnerability Rating: B_{EX} B_{EX} + for larger values of GI, CSI & RSI B_{EX} - for smaller values of CSI & RSI B_{EX} - for InI $\in$ [0,61, 0,65] and LoC>0,500 B_{EX}- when C+ and FSI > 0,666 or LoC>0,700	[0,50, 0,60]	≥0,65	≥ 0,500	≥ 0,333	≥ 0,150	≥ 0,700	≥ 0,600
Poor Resilience Rating: C C+ For larger values of GI	<0,50	<0,65	<0,500	<0,333	<0,150	<0,500	<0,60

* *For bridge & tunnel projects RSI≤ 0.533*

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Table 4.4.10: Transport Infrastructure Resilience Indicator Rating Time-to-Completion for Bridge & Tunnel infrastructure Projects

	FEI	InI	GI	CSI	RSI	LoC	RAI	RRI	FSI
Max Resilience Rating: A A- for InI $\in$ [0,61, 0,65] and LoC>0,700 or GI>0,600	≥ 0,60	≥ 0,65	≥ 0,500	≥ 0,250	≥ 0,250*	≥ 0,500	RAI <0,500 Or/and RRI <0,500		≥ 0,500
Endogenous Vulnerability Rating: B_{EN} B_{EN}+ for larger values of GI or LoC B_{EN}- for smaller values of GI C+ for GI <<0,500 & RAI >0,500	≥ 0,60	≥ 0,65	≥ 0,500	[0,000, 0,250]	≥ 0,250	≥ 0,500	RAI <0,500 Or RRI <0,500		≥ 0,500
Exogenous Vulnerability Rating: B_{EX} B_{EX}+ for larger values of GI B_{EX}- for InI $\in$ [0,61, 0,65] and GI>>0,500 or LoC>>0,500	[0,50, 0,60]	≥ 0,65	≥ 0,500	≥ 0,000	≥ 0,250	≥ 0,500	RAI <0,500 Or RRI <0,500		>0,500
Poor Resilience Rating: C C+ For larger values of GI or InI or LoC	<0,50	<0,65	<0,500	<0,00	<0,250	0,500	RAI <0,500 Or RRI <0,500		>0,600

* *For bridge & tunnel projects RSI≤0.533*

Table 4.4.11: Transport Infrastructure Resilience Indicator Rating Actual vs Forecast Traffic for Bridge & Tunnel infrastructure Projects

	FEI	InI	GI	CSI	RSI	LoC	RAI	FSI
Max Resilience Rating: A A- for InI $\in$ [0,61, 0,65] and GI>0,600 A- for RAI<0,500	≥ 0,60	≥ 0,65	≥ 0,500	≥ 0,333	≥ 0,250*	≥ 0,500	<0,500	>0,500
Endogenous Vulnerability Rating: B_{EN} B_{EN}+ for larger values of GI and/or CSI and/or RSI B_{EN}- for smaller values of GI B_{EN}- for InI $\in$ [0,61, 0,65] and GI>0,500 & LoC>>0,500 C+ if RSI<0,150 & LoC<0,500 & RAI<0,500	≥ 0,60	≥ 0,65	≥ 0,500	[0,000, 0,333]	[0,150, 0,250]	≥0,500	<0,500	>0,500
Exogenous Vulnerability Rating: B_{EX} B_{EX}+ for larger values of GI or CSI or RSI B_{EX}- for InI $\in$ [0,61, 0,65] and GI>0,500	[0,50, 0,60]	≥ 0,65	≥ 0,500	≥ 0,333	≥ 0,250	≥ 0,500	<0,500	>0,500
Poor Resilience Rating: C C+ For larger values of GI or InI or LoC	<0,50	<0,65	<0,500	<0,00	<0,150	0,500	<0,500	>0,500

* *For bridge & tunnel projects RSI≤0.533*

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Due to limited information and data, the B rating cannot be assessed for revenue. However, the respective assessment for roads could be applied for the characteristics (indicator values) of bridge and tunnel projects. Notably, the Institutional indicator is also important for these projects. As in the case of roads, the Transport Infrastructure Resilience Indicator rating with respect to the figure-of-merit Actual vs Forecast Traffic is also important and should be taken into account in the revenue rating.

Table 4.4.12: Transport Infrastructure Resilience Indicator Rating Actual vs Forecast Revenue for Bridge & Tunnel infrastructure Projects

	InI	RRI	RAI	GI	CSI	RSI	FSI
Max Resilience **Rating: A** If Traffic Rating A, then Revenue Rating A And Figure-of-Merit for Traffic outcome B A- for any RAI, GI, CSI, FSI smaller	≥ 0,65	≥0,666	<0,500	≥ 0,500	≥ 0,333	≥ 0,250*	≥ 0,666
Poor Resilience **Rating: C** And Figure-of-Merit for Traffic outcome C C+ for larger values of RAI and/or GI and/or CSI and/or RSI and/or FSI	<0,65	<0,500	<0,500	<0,500	<0,000	<0,150	<0,500

* *For bridge & tunnel projects RSI≤0.533*

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4.4.4 Airport Projects

The comparative analysis of Chapter 3 identified the limitations of the BENEFIT Matching Framework and, more specifically, the structure of the Financial–Economic Indicator to address airport projects as their operation takes place within a wider implementation environment. In this context, it is possible to customise the Transport Infrastructure Resilience Indicator rating system for the Cost-to-Completion and Time-to-Completion outcomes but not for Actual vs Forecast Traffic and Revenue.

Table 4.4.13: Transport Infrastructure Resilience Indicator Rating Cost-to-Completion for Airport infrastructure Projects

	FEI	InI	GI	CSI	RSI	LoC	FSI
Max Resilience Rating: A A- for InI $\in$ [0,61, 0,65] and LoC>0,500	≥ 0,60	≥ 0,65	≥ 0,500	≥ 0,333	≥ 0,400*	≥ 0,500	≥ 0,500
Endogenous Vulnerability Rating: B_{EN} B_{EN}+ for larger values of GI, CSI & RSI B_{EN} - for smaller values of GI, CSI & RSI B_{EN} - for InI $\in$ [0,61, 0,65] and LoC>0,500 If GI< 0,400 then C+	≥ 0,60	≥ 0,65	≥ 0,500	[0,000, 0,333]	[0,200, 0,400]	≥ 0,500	≥ 0,500
Exogenous Vulnerability Rating: B_{EX} B_{EX} + for larger values of GI, CSI & RSI B_{EX} - for smaller values of CSI B_{EX} - for InI $\in$ [0,61, 0,65] and LoC>0,500 B_{EX}- when C+ and FSI > 0,666 or LoC>0,700	[0,50, 0,60]	≥0,65	≥0,500	≥0,333	≥0,400	≥0,700	≥0,600
Poor Resilience Rating: C C+ For larger values of GI	<0,50	<0,65	<0,500	<0,333	<0,150	<0,500	<0,60

* *For airport projects RSI≤ 0.933*

Table 4.4.14: Transport Infrastructure Resilience Indicator Rating Time-to-Completion for Airport infrastructure Projects

	FEI	InI	GI	CSI	RSI	LoC	RAI	RRI	FSI
Max Resilience Rating: A A- for InI $\in$ [0,61, 0,65] and LoC>0,700 or GI>0,600	≥ 0,60	≥ 0,65	≥ 0,500	≥ 0,250	≥ 0,400*	≥ 0,500	RAI <0,500 Or/and RRI <0,500		≥ 0,500
Endogenous Vulnerability Rating: B_{EN} B_{EN}+ for larger values of GI or LoC B_{EN}- for smaller values of GI C+ for GI <<0,500 & RAI >0,500	≥0,60	≥0,65	≥ 0,500	[0,000, 0,250]	[0,200, 0,400]	≥ 0,500	RAI <0,500 Or RRI <0,500		≥ 0,500
Exogenous Vulnerability Rating: B_{EX} B_{EX}+ for larger values of GI B_{EX}- for InI $\in$ [0,61, 0,65] and GI>>0,500 or LoC>>0,500	[0,50, 0,60]	≥0,65	≥0,500	[0,000, 0,250]	≥ 0,400	≥ 0,500	RAI <0,500 Or RRI <0,500		>0,500
Poor Resilience Rating: C C+ For larger values of GI or InI or LoC	<0,50	<0,65	<0,500	<0,00	<0,250	0,500	RAI <0,500 Or RRI <0,500		>0,60

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4.4.5 Port Projects

The comparative analysis of findings on Chapter 3 identified that the BENEFIT Matching Framework, in its current configuration and structure, is unable to explain the performance of port projects. Stemming from this conclusion the customisation of the Transport Infrastructure Resilience Indicator rating methodology for ports is not possible.

4.4.6 Rail Projects

The BENEFIT case database included a very small sample of cases, for which furthermore there was limited information. Due to this limitation, the Rail project performance could not be studied.

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4.5 Limitations

The proposed methodological approach is based on the qualitative analysis of the case studies and the quantitative analysis of their indicators and as captured in the BENEFIT database. All analyses are carried out on the same data set and are limited by the accuracy (or inaccuracy) of the original data. This is reflected in all previous BENEFIT analysis results and deliverables. The methodological approach and system of Transport Infrastructure Resilience Indicator rating is developed based on these results. The comparative and complementary analysis and synthesis of findings from the various methods used to analyse the BENEFIT case study data (fsQCA, Importance Analysis, Econometrics Analysis, Qualitative Analysis) reduces inaccuracies and increases the level of confidence in the findings.

Furthermore, the data collected for most cases is publically available and, in many instances, less than perfect information approximations, assumptions and interpretations had to be made. This is especially true for the outcome “actual vs forecast revenue” as information for revenue was usually not publicly available. In addition, many indicator values are aggregate, lack detail, or had to be estimated based on qualitative assessments. This was the case with all project outcome values which, as a result, had to ultimately be captured in a qualitative format.

Finally, the BENEFIT Matching Framework has been developed based on the fundamental assumption that all decisions prior to project procurement and implementation are rational, correct and unbiased. This assumption may not hold true in many cases. These cases, which ultimately could not be explained by the proposed methodological approaches, were identified as outliers (see Chapter 3 of the present Deliverable).

Considering the above, the proposed BENEFIT Transport Infrastructure Resilience Indicator rating system has the following limitations:

- Lacks the ability to cover all figures-of-merit (outcomes) for all infrastructure modes due to the current configuration of some indicators
- Bears different levels of accuracy depending on the figure-of-merit (outcome) and infrastructure mode under investigation. The accuracy of figures-of-merit may be hampered by the existing bias in the information that was used to capture them while different modes were populated by a different number of cases available in the BENEFIT database and consequently not all mode-specific analysis were of equal strength.

Based on the above, the expected accuracy for each figure-of-merit and mode is ranked with the use of a qualitative relative scale of 1 (= low) to 3 (=high) and is presented in Table 4.5.1. The qualitative assessment was based on the number of cases available per mode in combination to the accuracy of information per outcomes.

Table 4.5.1.: Estimated Level of TIRI Rating Accuracy per Figure-of –Merit and Infrastructure Mode.

Figure-of-Merit / Infrastructure Mode	Cost-to-Completion	Time-to-Completion	Actual vs Forecast Traffic	Actual vs Forecast Revenue
Road Projects	3	3	2	1
Urban Transit Projects	2	2	2	1
Bridge & Tunnel Projects	3	3	2	1
Airport Projects	2	2	-	-
Ports	-	-	-	-

The proposed Transport Infrastructure Resilience Indicator rating system is applied to the entire set of BENEFIT cases for which there was enough information collected to construct the BENEFIT indicators. The ratings per figure-of-merit (outcome) and infrastructure mode are included in Annex 1 of the present report along with the actual observed outcome. The results of the application of the

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BENEFIT Transport Infrastructure Resilience Indicator rating system are presented and discussed in Chapter 5.

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5 Transport Infrastructure Resilience Indicator Rating of BENEFIT Cases

5.1 Introduction

The Transport Infrastructure Resilience Indicator rating system described in Chapter 4 was applied to the **entire set** of BENEFIT case studies for which indicator values could be obtained and/or estimated. This set consisted of **57 cases**. The complete results are presented per figure-of-merit and infrastructure mode in Annex 1. In the present chapter, the accuracy of the assigned ratings is discussed.

For each case the Static Transport Infrastructure Resilience Indicator (S-TIRI) is compared to the Dynamic (D-TIRI).

The present Chapter aims to serve as a calibration of the proposed methodology through the use of the BENEFIT case sample. This is a crucial step in the overall development of the Transport Infrastructure Resilience Indicator which needs, however, to be followed by the **necessary validation**. The validation cannot be undertaken through the use of the same dataset (for reasons of bias) and in that respect new cases will need to be introduced towards this end. The validation of the methodology will be undertaken under Task 5.1.

5.2 Rating the BENEFIT Case Studies

Table 4.2.1 of the previous Chapter presented the possible Transport Infrastructure Resilience Indicator ratings per figure-of-merit a project may be assigned. These ratings reflect the expected likelihood of achieving the respective outcome target.

Table 5.2.1 assigns quantitative values to each rating category that aim to reflect the likelihood of achievement of the rated figure-of-merit targets (Likelihood Score). These values range from 1 (low likelihood) to 5 (very high likelihood) and have been assigned qualitatively for demonstrative purposes only. The mapping between the rating categories and the proposed likelihood values **has not been developed scientifically** but **only aims to serve as a proof of concept**. In effect, **this initial assignment guides the assessment of the accuracy of the TIRI rating predictions as these are compared to the actual observed outcomes.** It should be noted, however, that the probabilistic elicitation of such values of likelihood, in the form of a % probability of achieving a specific figure-of-merit target, is something that can happen in the future if this methodology is adopted in practice and the necessary project information is captured routinely and accurately.

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Table 5.2.1: Expected Likelihood of achievement of figure-of-merit per Transport Infrastructure Resilience Indicator rating category

Rating Index	Expected probability of achievement	Likelihood Score	Qualitative Description
A	Very high	5	Almost all cases rated A will achieve the figure-of-merit target
A-	High	4,5	Only few cases rated A- will not achieve the figure-of-merit target
B_{EN}+	Rather High	4	B_{EN}+ rated cases have a slightly improved likelihood of reaching the figure-of-merit target.
B_{EX}+	Rather High	4	B_{EX}+ rated cases have a slightly improved likelihood of reaching the figure-of-merit target.
B_{EN}	Average	3	Many cases rated B_{EN} will achieve the figure-of-merit target. The result is highly dependent on the exogenous indicators. If implementation conditions remain fairly stable, the potential is positive. A decrease in the exogenous indicators will highly increase the likelihood of underachievement.
B_{EX}	Average	3	Many cases rated B_{EX} will achieve the figure-of-merit target. The result is highly dependent on the exogenous indicators. If implementation conditions remain fairly stable, the potential is positive.
B_{EN}-	Rather Low	2	B_{EN}- rated cases have a rather low likelihood of reaching the figure-of-merit target. These cases are more sensitive to exogenous indicators and rely more on the stability of the implementation context.
B_{EX}-	Rather Low	2	B_{EX}- rated cases have a rather low likelihood of reaching the figure-of-merit target. These cases are more sensitive to exogenous indicators and rely more on the stability of the implementation context.
C+	Rather Low	2	C+ rated cases, while bearing poor likelihood of reaching their figure-of-merit target, they do hold potential of achievement.
C	Low	1	C rated cases have a poor likelihood of reaching their figure-of-merit target.

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5.2.1 Road Projects

Table 5.2.2 presents the number of cases per rating and figure-of-merit and compares with the respective observed outcomes.

Table 5.2.2: Road Project **Static** Rating Assessment of Predictions

Likelihood of Achievement	Corresponding Rating	Number of cases per corresponding rating	Number of cases with positive outcomes	Likelihood of Achieving Figure of Merit	% Achieving Figure of Merit
Cost to Completion S-TIRI Assessment					
Very High	A	5	5	5	100%
High	A-	2	2	4.5	100%
Rather High	BEX+, BEN+	5	3	4	60%
Average	BEX, BEN	-	-	3	-
Rather Low	BEX-, BEN-, C+	3	2	2	66,6%
Low	C	2	0	1	0%
Time to Completion S-TIRI Assessment					
Very High	A	12	11	5	91,7%
High	A-	1	1	4.5	100,0%
Rather High	BEX+, BEN+	5	1	4	20,0%
Average	BEX, BEN	0	-	3	-
Rather Low	BEX-, BEN-, C+	1		2	0,0%
Low	C	3		1	0,0%
Actual vs Forecast Traffic S-TIRI Assessment					
Very High	A	7	7	5	100%
High	A-	3	3	4.5	100%
Rather High	BEX+, BEN+	10	5	4	50%
Average	BEX, BEN			3	-
Rather Low	BEX-, BEN-, C+	8	2	2	25%
Low	C	5		1	0%
Actual vs Forecast Revenue S-TIRI Assessment					
Very High	A	2	2	5	100%
High	A-	6	6	4.5	100%
Rather High	BEX+, BEN+	2	2	4	100%
Average	BEX, BEN			3	-
Rather Low	BEX-, BEN-, C+	11	8	2	73,7%
Low	C			1	

As seen from the results in Table 5.2.2 The **Static Transport Infrastructure Resilience Indicator provided acceptable accuracy of prediction.** By Studying the Dynamic version (D-TIRI) of the indicator for the projects not performing in accordance with their rating the following observations are put forward:

Cost to Completion:

- The two BEX+ rated cases both had a D-TIRI {10.4%, 7.5%}. The rating meant that an increase in the FEI by 7.5% would upgrade the projects into the A category, while a drop of 10,4% would downgrade the projects into C+. During the construction phase the FEI dropped from FEI = 0,558 to FEI = 0,308 (a decrease of 44,8%).
- **The two BEX- rated cases which performed better than expected had a rating-TIRI {7,4%, n.p.}. This meant that the rating category could not be improved due to the**

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projects' internal structure and that a 7,4% drop in the FEI would downgrade them. In fact, the FEI did drop by 18,1%. However, during the same period the Institutional indicator increased to InI=0,70. The analyses have indicated that a high InI may compensate for a drop in FEI. **These cases need further investigation.**

Time to Completion:

- One project rated A did not meet time targets. The D-TIRI was {12,2%,**0},** meaning that no further rating improvement is possible, while a 12,2% drop in the FEI would downgrade the project's rating. During construction the FEI dropped from FEI=0,683 to FEI=0,483 (-29,3%). Hence, the D-TIRI provided a good measure of the project's vulnerability.
- With respect to the four B_{EX}+, all presented a drop in the FEI greater than the limit shown in the D-TIRI.

Actual vs Forecast Traffic

- The D-TIRI may explain the poor performance of the 5 B_{EX}+ rated projects.
- The D-TIRI could not explain why the two B_{EN}- projects were performing better in terms of actual traffic. These cases need further investigation.

Actual vs Forecast Revenue

- **The D-TIRI was not able to provide guidance with respect to the better than expected performance of 8 projects**. However, the assessment of the revenue outcome is considered the one with the least accuracy and needs further investigation.

The BENEFIT cases also included a number of projects (see Annex 1), which could not be explained by the analysis presented in Chapter 4. The reasons could vary from the existence of decision biases prior to project implementation to poor data and/or errors during the construction of the BENEFIT indicators. **These cases were purposely excluded from Table 5.2.2.** However, when assessing the resilience of a project, these issues are not known to the estimator. It is still interesting to see whether the resilience indicator value was giving a prediction of performance that corresponded to the actual outcome. In this context, the projects were rated per figure-of-merit. The comparison with their final observed outcomes produces the following results:

- Cost to Completion: Amongst the seven (7) projects excluded, the S-TIRI of the five (5) was justified by the outcome. The remaining two (2) could still not be explained.
- Time to Completion: Amongst the four (4) projects excluded, the S-TIRI of one (1) was justified by the outcome. The D-TIRI could explain the performance of yet one more case. The remaining two could still not be explained.
- Actual vs Forecast Traffic: Amongst the five (5) projects excluded, the S-TIRI of the two (2) was justified by the outcome. The remaining three could still not be explained.
- Actual vs Forecast Revenues: Amongst the four (4) projects excluded, the S-TIRI of all four (4) was justified by the outcome.

Following the above results, the overall assessment of the accuracy of prediction of the BENEFIT Transport Infrastructure Resilience Indicator for roads is presented in Table 5.2.3.

Table 5.2.3: Summary of Accuracy of TIRI rating for roads

	Number of cases matching Static Rating predictions	Number of cases explained through the Dynamic Rating	Number of "excluded" cases matching predictions	Total number of Cases rated	% of Cases explained
Cost to Completion	13	2	5	24	**83,33%**
Time to Completion	17	5	2	26	**92,31%**
Actual vs Forecast Traffic	26	5	2	38	**86,84%**
Actual vs Forecast Revenue	13	0	4	25	**68,00%**

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5.2.2 Urban Transit Projects

As in the case of road projects, Table 5.2.4 presents the number of cases per rating and figure-of-merit and compares with the respective observed outcomes.

Table 5.2.4: Urban Transit Project Static Rating Assessment of Predictions

Likelihood of Achievement	Corresponding Rating	Number of cases per corresponding rating	Number of cases with positive outcomes	Likelihood of Achieving Figure of Merit	% Achieving Figure of Merit
Cost to Completion S-TIRI Assessment					
Very High	A	-	-	5	-
High	A-	4	4	4.5	100%
Rather High	B_{EX}+, B_{EN}+	-	-	4	-
Average	B_{EX}, B_{EN}	-	-	3	-
Rather Low	B_{EX}-, B_{EN}-, C+	6	1	2	16,6%
Low	C	2		1	0%
Time to Completion S-TIRI Assessment					
Very High	A	-	-	5	-
High	A-	4	4	4.5	100%
Rather High	B_{EX}+, B_{EN}+	1		4	0%
Average	B_{EX}, B_{EN}	1	1	3	100%
Rather Low	B_{EX}-, B_{EN}-, C+	5	1	2	20%
Low	C			1	
Actual vs Forecast Traffic S-TIRI Assessment					
Very High	A	-	-	5	-
High	A-	4	4	4.5	100%
Rather High	B_{EX}+, B_{EN}+			4	-
Average	B_{EX}, B_{EN}	1	1	3	100%
Rather Low	B_{EX}-, B_{EN}-, C+	6	5	2	83,3%
Low	C	1		1	100%
Actual vs Forecast Revenue S-TIRI Assessment					
Very High	A	2	2	5	100%
High	A-	3	3	4.5	100%
Rather High	B_{EX}+, B_{EN}+	-	-	4	-
Average	B_{EX}, B_{EN}	4	4	3	100%
Rather Low	B_{EX}-, B_{EN}-, C+	1	1	2	100%
Low	C	2	2	1	100%

As anticipated, the accuracy of the predictions for all outcomes is reduced for urban transit projects in comparison to road projects.

Investigating further the cases whose rating category for S-TIRI did not correspond to the observed outcomes, through the D-TIRI, the following is observed:

Cost to Completion:
- The D-TIRI cannot explain the B_{EN}- case whose performance was better than anticipated.

Time to Completion:
- The D-TIRI cannot explain any of the cases whose rating does not match their observed performance.

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Actual vs Forecast Traffic

- The D-TIRI could not explain why the five (5) B_{EN}- projects were performing better in terms of actual traffic. However, it was noted that four (4) of the five (5) had very high values of RAI and GI. This is an issue for further investigation.

Actual vs Forecast Revenue

- The D-TIRI was not able to provide guidance with respect to the better than expected performance of three (3) projects. However, the assessment of the revenue outcome is considered the one with the least accuracy and further investigations are warranted.

The BENEFIT cases also included a number of urban transit projects (see Annex 1), which could not be explained by the analysis presented in Chapter 4. These cases were purposely excluded from **table 6.2.4** but have been further investigated. The comparison with final outcomes produces the following results:

- Cost to Completion: The performance of the one case still remains unexplained.
- Time to Completion: The two cases included could still not be explained.

Following the above results, the overall assessment of the accuracy of prediction of the BENEFIT Transport Infrastructure Resilience Indicator for urban transit projects is presented in Table 5.2.5.

Table 5.2.5: Summary of Accuracy of TIRI for Urban Transit Projects

	Number of cases matching Static Rating predictions	Number of cases explained through the Dynamic Rating	Number of “excluded” cases matching predictions	Total number of Cases rated	% of Cases explained
Cost to Completion	11	0	0	13	**84,6%**
Time to Completion	9	0	0	13	**69,2%**
Actual vs Forecast Traffic	7	0	-	12	**58,3%**
Actual vs Forecast Revenue	9	0	-	12	**75,0%**

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5.2.3 Bridge and Tunnel Projects

As in the case of previous modes, Table 5.2.6 presents the number of cases per rating and figure-of-merit and compares with the respective observed outcomes. Notably, the sample of Bridge & Tunnel projects in the BENEFIT database is rather small and, therefore, findings, should be considered with caution.

Table 5.2.6: Bridge & Tunnel Static Rating Assessment of Predictions

Likelihood of Achievement	Corresponding Rating	Number of cases per corresponding rating	Number of cases with positive outcomes	Likelihood of Achieving Figure of Merit	% Achieving Figure of Merit
Cost to Completion S-TIRI Assessment					
Very High	A	-	-	5	-
High	A-	-	-	4.5	-
Rather High	B_{EX}+, B_{EN}+	2	2	4	100%
Average	B_{EX}, B_{EN}	-	-	3	-
Rather Low	B_{EX}-, B_{EN}-, C+	1		2	0%
Low	C			1	
Time to Completion S-TIRI Assessment					
Very High	A	-	-	5	-
High	A-	-	-	4.5	-
Rather High	B_{EX}+, B_{EN}+	2	2	4	100%
Average	B_{EX}, B_{EN}	-	-	3	-
Rather Low	B_{EX}-, B_{EN}-, C+	1		2	0%
Low	C			1	
Actual vs Forecast Traffic S-TIRI Assessment					
Very High	A	-	-	5	-
High	A-	-	-	4.5	-
Rather High	B_{EX}+, B_{EN}+	1	1	4	100%
Average	B_{EX}, B_{EN}			3	-
Rather Low	B_{EX}-, B_{EN}-, C+	5	3	2	60%
Low	C			1	
Actual vs Forecast Revenue S-TIRI Assessment					
Very High	A	1	1	5	100%
High	A-	3	3	4.5	100%
Rather High	B_{EX}+, B_{EN}+			4	
Average	B_{EX}, B_{EN}			3	
Rather Low	B_{EX}-, B_{EN}-, C+			2	
Low	C	2	2	1	100%

Investigating further the cases whose rating predictions did not correspond to observed outcomes it was observed that the D-TIRI was not able to provide a better justification of project performance.

The BENEFIT cases also included a project (see Annex 1), which could not be explained by the analysis presented in Chapter 3. The case was excluded from Table 5.2.6 but has been investigated further. The comparison with final outcomes produces the following results:

- Cost to Completion: The performance of the case still remains unexplained.
- Time to Completion: The performance of the case still remains unexplained.

Following the above results, the overall assessment of the accuracy of prediction of the BENEFIT Transport Infrastructure Resilience Indicator for bridge and tunnel projects is presented in Table 5.2.7.

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Table 5.2.7: Summary of Accuracy of rating for Bridge and Tunnel Projects

	Number of cases matching Static Rating predictions	Number of cases explained through the Dynamic Rating	Number of "excluded" cases matching predictions	Total number of Cases rated	% of Cases explained
Cost to Completion	3	0	0	4	**75%**
Time to Completion	3	0	0	4	**75%**
Actual vs Forecast Traffic	4	0	-	6	**66,7%**
Actual vs Forecast Revenue	4	0	-	6	**66,7%**

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5.2.4 Airport Projects

The BENEFIT Matching Framework in its present configuration of indicators was found not to be able to address traffic and revenue outcomes for airports. Hence, Table 5.2.8 presents the number of cases per rating for cost and time to completion and compares with the respective observed outcomes. Notably, the sample of airport projects in the BENEFIT database is rather small and, therefore, findings should be considered with caution.

Table 5.2.8: Airport Projects Static Rating Assessment of Predictions

Likelihood of Achievement	Corresponding Rating	Number of cases per corresponding rating	Number of cases with positive outcomes	Likelihood of Achieving Figure of Merit	% Achieving Figure of Merit
Cost to Completion S-TIRI Assessment					
Very High	A	-	-	5	-
High	A-	-	-	4.5	-
Rather High	B_{EX}+, B_{EN}+	-	-	4	-
Average	B_{EX}, B_{EN}	1	1	3	100%
Rather Low	B_{EX}-, B_{EN}-, C+	3	1	2	33,3%
Low	C			1	
	Time to Completion S-TIRI Assessment				
Very High	A	-	-	5	-
High	A-	-	-	4.5	-
Rather High	B_{EX}+, B_{EN}+	2	2	4	100%
Average	B_{EX}, B_{EN}	-	-	3	-
Rather Low	B_{EX}-, B_{EN}-, C+	2		2	0%
Low	C			1	

Investigating further the case whose rating prediction did not correspond to the observed outcome, it was noted that during the construction period there was an improvement in the Institutional indicator (InI).

5.3 Overall Assessment

Applying the Transport Infrastructure Resilience Indicator to the entire set of cases in the BENEFIT database provided encouraging findings with respect to the ability of the proposed Transport Infrastructure Resilience rating system to predict project performance.

The entire assessment process was faced with limitations emanating both from the various streams of analysis that have supported the development of the methodology as well as from the BENEFIT case sample in terms of the accuracy of the collected information and the sample sizes per mode. Notably, for some modes where very few cases are rated, the assessment of the accuracy of the proposed rating system is not representative of the potential to predict outcomes.

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6 The BENEFIT Matching Framework Policy Guiding Tool: Applications

6.1 Introduction

In the present report previous BENEFIT findings are summarised leading to the development of the BENEFIT Transport Infrastructure Resilience Indicator (TIRI) and its underlying rating system.

The **suggested TIRI ratings** are **not** a comprehensive assessment of a project. They present a forward-looking estimation of a project's potential to achieve certain outcome targets. As shown in the relevant section 4.4 of this report, the assessment for each outcome (figure-of-merit) and mode is dependent on both exogenous and endogenous indicators to the project. Furthermore, the values of the endogenous indicators, contributing to positive outcomes, may vary from mode to mode and from outcome to outcome.

Both exogenous and endogenous indicators may change over the life time of a project. While there may be little influence both decision makers and managers can exert over exogenous indicators, endogenous indicators are clearly within their sphere of influence. However, it is commonly known (cfr. Polydoropoulou and Roumboutsos, 2009) that the ability to influence endogenous indicators is reduced as the project development progresses. This places increased emphasis on the quality of decision-making at the front end of projects.

This Chapter highlights the **potential actions that may be taken over the project life cycle to improve the resilience of a transport infrastructure project to unexpected changes in its exogenous indicators through the enhancement of its endogenous indicators.**

In this context, this Chapter looks into the factors included in each BENEFIT Matching Framework indicator and highlights those that may be potentially improved **together with the timeframe** within which respective activities may need to take place. The potential benefit of the proposed activities should be considered with respect to the combination of indicators and respective threshold values required to achieve the respective outcomes per mode. **Therefore, this Chapter should be considered in combination with section 4.4.**

Overall, this Chapter presents the range of applications the BENEFIT Matching Framework may have through its TIRI rating tool as well as its complementarity with other related decision tools, including commercially supplied project credit ratings. These are presented at the end of this Chapter in lieu of conclusions.

Examples and further recommendations with respect to improving the resilience of transport infrastructure projects is the focus of BENEFIT Task 5.1.

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6.2 Ability to influence indicators

6.2.1 Indicators Exogenous to the Project

Amongst the BENEFIT Matching Framework typology indicators, those exogenous to the project are the ones describing its implementation context: the Financial-Economic (FEI) and the Institutional (InI) indicators (see Deliverables D2.2; D3.1; and D4.2). Notably, these indicators encompass more than their title may suggest. Furthermore, they are built based on international indices published by prominent international institutions. More specifically:

- The Institutional indicator shows the extent to which the political, legal and regulatory, and administrative context in a country is stable and of a high quality. It includes three dimensions:
  - The “political” sub-dimension “political capacity, support and policies” which is composed by three main governance indicators of the World Bank:
    - Political stability and absence of violence,
    - Control of corruption and
    - Voice & accountability.

    When combined these three indicators give a good overview of the general political situation in a country. In short, the political stability and absence of violence basically captures the likelihood of political instability and/or politically-motivated violence, where the voice and accountability reflects a country’s citizens’ ability to participate in selecting their government. Also, the control of corruption index delineates the extent to which public power is exercised for private gain.

  - The “regulatory” sub-dimension “legal and regulatory framework” which is also composed by the World Bank Indicators:
    - Rule of law and
    - Regulatory quality

    combined with the inverse of the aggregated OECD indicators of:
    - Regulation in energy, transport and communications (ETCR) on the regulatory restrictiveness of markets.

    The ECTR index of the OECD in reverse represents the extent of liberalization of these markets. Again, these three elements paint a rather comprehensive picture of the judicial and regulatory context of a country. Whilst the rule of law index represents the extent to which agents have confidence in and abide the rule of society, the regulatory quality index captures the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.

  - The “administrative” sub-dimension “public sector capacity” has only one indicator, namely
    - the government effectiveness developed by the World Bank.

    This index mainly reflects the level of effectiveness of government in terms of the quality of public service, the quality of civil service, the quality of policy formulation and implementation and the credibility of the government’s commitment to such policies.

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- The Financial-Economic indicator, despite its name, measures more than just the macro-economic and macro-financial context of a country, but more broadly the *business environment* and can be seen as a proxy of *the level of productivity of a country*. As described in the Deliverable D3.1, the Global Competitiveness Index of the World Economic Forum, was selected to describe this dimension of the implementation context. The overall "competitiveness index" of the World Economic Forum aims to measure *the capacity of the national economy to achieve sustained economic growth over the medium term, controlling for the current level of economic development*. It includes predominantly:
    - A macro-economic dimension, capturing the government budget balance, gross national savings, inflation, general government debt and the country credit rating,
    - A financial market development pillar (measuring among others the availability and affordability of financial services, ease of access to loans, soundness of banks, and venture capital availability).

But also:

- Information on supporting contextual elements and policies, including the goods market efficiency, labour market efficiency, technological readiness, market size, business sophistication and innovation in a country.
- The availability of some basic requirements in terms of education, health of the population and overall infrastructure, as well as
- Limited business-oriented aspects of the institutional environment (like property rights, intellectual property protection, efficiency of legal framework in settling disputes, strength of auditing and reporting standards)[16].

In this context, a high value of the FEI is supportive of a high Revenue Support Indicator, as implementation context conditions would allow for business initiatives.

The Institutional Indicator (InI) encompasses factors ranging from political stability to government efficiency as described by the respective score of the global competitiveness index. This has two ramifications:

- On the one hand, both InI and FEI include the notion of competitiveness since they both stem from the same global competitiveness index and bear a degree of correlation as identified by the econometrics analysis.
- On the other hand, the InI includes many features supporting project governance and minimizing stakeholder strategic behavior.

Therefore, a high value of FEI suggests high global competitiveness in terms of macro-economic conditions and financial market development, while a high value of the InI suggests support to project governance, political stability, political support for competitiveness and transparency in stakeholder strategies.

Notably, the two indicators, and especially the Institutional one, address key concerns raised at both Policy Dialogue sessions with respect to strategic behaviour and political support (see Deliverable D5.2).

Finally, it is evident that while financial-economic shocks will influence the FEI, a high InI still provides positive conditions for project development.

[16] There is some limited overlap with the institutional indicator we use, particularly in the sub-dimension of legal and regulatory framework, as the 'global competitiveness index' captures some institutional aspects with direct bearing on the business environment in a country.

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6.2.2 Indicators Endogenous to the Project

Indicators endogenous to the project could be categorised as those related to the project structure and those that are commonly used as policy tools. This distinction is based on the fact that once the project has progressed in its life cycle, there are few indicators decision-makers may still act upon. In this context the indicators that could be categorised as "policy tools" are:

- the Remuneration Attractiveness
- the Revenue Robustness
- the Financing Scheme Indicators

6.2.2.1 Business Model

Core in the development and successful implementation of a project is its business model. In the BENEFIT Matching Framework it is described by two composite indicators: the Cost Saving (CSI) and the Revenue Support Indicator (RSI) (see Deliverables D2.2.; D3.1; D4.2; and D4.4). The former (CSI) represents a project's ability to be efficient both in construction and in operation/maintenance. The latter (RSI) represents its ability to generate revenues and create demand (attract traffic).

Cost Saving Indicator

The Cost Saving Indicator is a composite indicator including:

- Ability to construct
    - Level of civil works/ technical difficulty;
    - Capability to construct based on the market position of the contractor with respect to construction or respective project delivery capability (example for rolling stock);
    - Construction risk allocation as per contractual agreement;
    - Assessment of optimal construction risk allocation based solely on the capability to construct.
- Ability to monitor/control/plan and provide political support of the respective (public) contracting authority
- Adoption of Innovation and its successful application
- Life Cycle Planning and operation
    - Life cycle planning verification;
    - Capability to operate based on the market position of the operator;
    - Operation risk allocation as per contractual agreement;
    - **Assessment of optimal operational risk allocation** based solely on the capability to operate.

It is evident, based on the above description, that the CSI, in all practical terms, illustrates a *measure of a project's efficiency* during construction and operation. In addition, many of its constituent factors are specified before and/or during project award and include all directly involved actors: the constructor; the operator; and the contracting authority. If the project is promoted and implemented on a national level, the Institutional indicator and the Cost Saving Indicator bear limited overlap with reference to the contracting authority, as both indicators address institutional maturity. However, the assessment is based on a different approach and for CSI concerns the ability of the contracting authority to monitor the project and provide the respective political support.

Table 6.2.1 illustrates the relevant project phase within which the factors that constitute CSI are originally set. The Table also suggests **whether and how the value of each factor may be improved**.

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Table 6.2.1: Origin of the Cost Saving Indicator Factors

Key Factor	**Origin Relevant Project Phase**	**Mitigation / Improvement Measures**
Level of civil works/ technical difficulty	Project planning phase	Systematic review during construction
Capability to construct[17]	Procurement & Award Phase	
Construction risk allocation	Contract design & negotiation	Through contract re-negotiation
Ability of the contracting authority[18]	Exogenous to project	May be improved through training throughout the project life cycle and continuous support to the project
Adoption of Innovation	All project phases	Continuously
Life cycle planning	Project planning phase	
Capability to operate & maintain[19]	Procurement & Award Phase	
Operation risk allocation	Contract design & negotiation	Through contract re-negotiation

The above analysis also shows how closely related the Cost Saving Indicator is to the Governance indicator, as well as the importance of the procurement process in achieving a high value of the CSI.

Revenue Support Indicator

The Revenue Support Indicator is also a composite indicator that includes:

- **The level of Coopetition of the new (greenfield) and existing (brownfield) parts of the project.** This indicator reflects:
    - The level of business development scope, designed to attract demand (e.g. airports etc.);
    - The level of project exclusivity with respect to its position in the transport network (e.g. metros, bridge and tunnel projects, ports airports under certain conditions). Notably, exclusivity may also be contractually induced;
    - The level at which a transport network supports the project's exclusivity

- **Revenue sources from:**
    - Traffic from new and brownfield operation in relation to:
        - Capability to manage demand
        - Demand risk allocation
        - Assessment of demand risk allocation based on the capability to manage demand
        - Quality of service
    - Traffic from other transport infrastructure bundled in the project in relation to:
        - Capability to manage demand
        - Demand risk allocation
        - Assessment of demand risk allocation based on the capability to manage demand

[17] *Please look up D3.1 and D4.2 on the definition and formulation of the sub-indicator*

[18] *Following indicator revision (see Deliverable D4.4). Please see D4.4. on the construction of the contracting authority's capability sub-indicator*

[19] *Please look up D3.1 and D4.2 on the definition and formulation of the sub-indicator*

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    - Quality of service
  - Other non-transport related activities in relation to:
    - Capability to manage the other activities
    - Risk allocation
    - Assessment of demand risk allocation based on the capability to manage demand
    - Quality of service

Overall, it can be appreciated that, **the Revenue Support Indicator (RSI) is a *measure of the project's ability to generate revenues*.** Table 6.2.2 indicates the project phase within which the above factors are set and suggests potential mitigation/improvement measures.

Table 6.2.2: Origin of the Revenue Support Indicator Factors

Key Factor	Origin Relevant Project Phase	Mitigation / Improvement Measures
Business development scope	Project planning phase	May be bounded by the type of infrastructure but may also be developed during the life cycle of the project depending on social and other evolution.
Exclusive position in the transport network	Project planning phase	May be bounded by the type of infrastructure but may be also **contractually induced.**
Transport network supporting project's exclusivity	Project planning phase	May be: ▪ Bounded by the type of infrastructure; ▪ Contractually induced; ▪ Changed over time due to network development.
Capability to manage demand[20] (prime infrastructure & brownfield)	Procurement & Award Phase	
Demand risk allocation (prime infrastructure & brownfield)	Contract design & negotiation	Through contract re-negotiation
Quality of service of prime infrastructure & brownfield	Operation phase	Continuously
Capability to manage demand[21] (other transport infrastructure)	Procurement & Award Phase	
Demand risk allocation (other transport infrastructure)	Contract design & negotiation	Through contract re-negotiation
Quality of service of other transport infrastructure	Operation phase	Continuously
Capability to manage demand of other non-transport activities[22]	Procurement & Award Phase	
Demand risk allocation (other non-transport activities)	Contract design & negotiation	Through contract re-negotiation
Quality of service of other non-transport activities	Operation phase	Continuously

[20] *Please look up D3.1 and D4.2 on the definition and formulation of the sub-indicator*
[21] *Please look up D3.1 and D4.2 on the definition and formulation of the sub-indicator*
[22] *Please look up D3.1 and D4.2 on the definition and formulation of the sub-indicator*

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It is worth noting that Task 4.2 identified that a common result of renegotiation has been the granting of additional sources of revenues, i.e. the government grants additional revenue rights, such as new service areas or business lines.

The Table also shows how closely related the Revenue Support Indicator (RSI) is to the Governance indicator, as well as the importance of the procurement process in achieving a high value of the RSI. In addition, Table 6.2.2 indicates the potential importance of the "perceived" quality of service.

Finally, the above indicator apart from being a measure of the project's ability to generate revenues, it is also a *measure of the project's efficiency in exploiting the potential sources of revenue*. Notably, the **low values of the RSI of the projects in the BENEFIT sample illustrate the poor use of other potential sources of revenue.**

6.2.2.2 Reliability/Availability Indicator

The Reliability/Availability Indicator represents the level of physical and operational reliability and availability of the transport service (see D2.4; D3.1; and D4.2). The quantitative analysis streams identified it as important in reaching traffic and revenue goals. However, the indicator has not been included in the development of the Transport Infrastructure Resilience Indicator because it is always considered to take its maximum possible values.

Other factors connected to this indicator are: infrastructure type; size (of investment) and location. All of them are considered as decisions taken prior to project award as are the project's outcome targets.

6.2.2.3 Governance Indicator

The Governance indicator refers to factors setting the governance scene within a project (see Deliverables D2.2.; D3.1; D4.2; and D4.4). In this respect, it is defined by the contractual conditions and the process leading to them. Table 6.2.3 lists the parameters included in the Governance indicator. These are determined during the tendering and contract award stage. However, this does not necessarily mean that the GI value remains constant through the contract duration.

As shown in Table 6.2.3, many parameters of the Governance Indicator (GI) are subject to the level of enforcement and monitoring exercised by the contracting authority. Hence, the value of the GI risks is decreasing if proper contract management is not enforced by the contracting authority.

In addition, the value of Governance indicator may change through re-negotiations, with ramifications on other indicators (e.g. CSI and RSI). It should be noted that a renegotiation process will reduce by default the value of some parameters. For example, the parameter "competition between bidders" will be "null" following renegotiations as the process only takes place with the one party that has been awarded the contract.

Table 6.2.3 shows the relative support between the Institutional Indicator and the Governance Indicator (GI), as a high value of the Institutional Indicator may compensate for a lower value of the Governance Indicator**.** Also, the ability to enforce crucial factors of the Governance Indicator is captured by certain factors included in the Cost Saving Indicator. In addition, if Governance Indicator parameter values related for example to risk allocation, are not respected during project implementation, the values of the Cost Saving and Revenue Support Indicator will change respectively.

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Table 6.2.3: Governance Indicator Factors and Conditions of Change

Key Factor	**Tendering Stage**	**Implementation**	**Re-negotiations**
Governance Efficiency and Effectiveness			
The client selected only one service provider [bidder] to participate in the pricing stage	√	Changes are justified and agreed upon	√
The client and the key service providers [bidders] collectively estimated the expected project cost	√	Changes are justified and agreed upon	Changes are justified and agreed upon
Encouragement of competition between bidders	Minimum number of bidders should be set based on market conditions.		**No competition at re-negotiation.** The Governance Indicator value reduces with respect to this component.
Integration of design and construction	√	Subject to contract monitoring by contracting authority	Depends on the stage re-negotiations take place
The key service providers [contractor] to pay a penalty if completion dates were not met	√	Subject to contract enforcement by contracting authority	
The key service providers [contractor] solely carried the risk of rising costs	√	Subject to contract enforcement by contracting authority	√
The client and key service providers [contractor] [to share] shared equal proportions of profit due to cost under-runs	√	Subject to contract monitoring by contracting authority	√
Incentives[23]	√	Subject to contract monitoring by contracting authority	√
Bonding requirements	√	Subject to contract monitoring by contracting authority	√
Commercial/revenue & financial risks are not concentrated	√	Subject to contract monitoring by contracting authority	√
Contractual Flexibility			
Clauses enable updating of service and/or price changes	√	Subject to contract monitoring by contracting authority	√
Clauses indicate that client has an option to terminate the agreement without cause	√	Subject to contract enforcement by contracting authority	√

[23] *Following indicator revision (see Deliverable D4.4)*

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6.2.2.4 Funding Scheme

The Funding Scheme includes three (3) indicators (see D2.4; D3.1; D4.2 and D4.4):

- The Remuneration Attractiveness Indicator;
- The Revenue Robustness Indicator; and
- The Market Efficiency and Acceptability Indicator

The analysis carried out in D4.4 did not identify the impact of the Market Efficiency and Acceptability Indicator and, consequently, this indicator has not been considered any further. This is not conforming to common knowledge and may be due to the level of detail of the indicator.

As before, Tables 6.2.4 and 6.2.5 present the factors included in the indicators, the project phase within which these factors are set and the conditions of change. The Table highlights how volatile both project income and revenues may be. It also shows the importance of including alternative streams of both income and revenues. It is evident that the two sub-indicators could be conditioned as well as that they may potentially be correlated or independent. Chapter 3 of the present report describes how they can be used as a driver towards reaching specific project outcomes.

Table 6.2.4[24]: Origin of the Remuneration Attractiveness Factors

Key Factor	Origin Relevant Project Phase	Mitigation / Improvement Measures
Expected income as % of full project costs;	Project planning phase Procurement & Award Phase	May be bounded by the type of infrastructure. May change throughout the operation phase
Share of each income stream on total income;	Procurement & Award Phase	May be: ▪ Bounded by the type of infrastructure; ▪ Contractually induced; ▪ Changed over time due to mobility and other social behaviour. May change overtime Restricted if only one income stream.
Risk of each income source	Operation Phase	Influenced by Acceptability of price: Low acceptability reflects in high risk associated to the income source. Adjust pricing policy

As shown in Deliverable D4.3, these are the indicators commonly adjusted as a result of a renegotiation process. More specifically, Task 4.2 identified that most common actions taken following renegotiations amongst the cases in the BENEFIT database of projects were:

- Government payments to cover cost overruns: The government agrees to pay some or the whole amount of the cost overruns.
- O&M duty releases: The grantor releases some obligations to the concessionaire which will eventually reduce the O&M expenses.
- Government funding support (MRG or operating subsidies): The grantor agrees to fund the project with minimum revenues guarantees, for a limited period or for the whole period.
- Extension of the concession period: The grantor agrees to extend the concession period to compensate for time overruns and/or provide additional funding to the project.
- Toll/Tariffs increase that will eventually increase project revenues.
- Change of the operator's remuneration sources: e.g from toll charges to availability payments.

[24] *Following indicator revision (see Deliverable D4.4)*

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All, apart from the last action, have a direct effect (increase) on cost coverage and, consequently, all else being kept equal, lead to an increase in the values of both the Remuneration Attractiveness and Revenue Robustness Indicators. The latter, apart from possibly changing the mix of streams of sources of income increases the level of risk associated with one or both aforementioned indicators depending on the structure of the funding scheme. Notably, while the above actions may not have a direct effect on the revenue streams per se, the reduce the overall cost and, therefore, improve cost coverage.

Other actions which may have a positive effect are:
- Earmarking other revenues (e.g. fuel tax)
- Bundling infrastructure/services
- Increase infrastructure use price

Table 6.2.5[25]: Origin of the Revenue Robustness Indicator Factors

Key Factor	**Origin Relevant Project Phase**	**Mitigation / Improvement Measures**
Expected revenues as % of full project costs	Project planning phase Procurement & Award Phase	May be bounded by the type of infrastructure. May change throughout the operation phase.
Share of each revenue stream on total revenues	Procurement & Award Phase	May be: ▪ Bounded by the type of infrastructure; ▪ Contractually induced; ▪ Changed over time due to mobility and other social behaviour. May change overtime Restricted if only one revenue stream.
Risk of each revenue source	Operation Phase	May change throughout the operation phase.

6.2.2.5 Financing Scheme Indicator[26]

The Financing Scheme Indicator (FSI) reflects an expanded version of the cost of capital included in the project both from public and private sources (see D2.4; D3.1; D4.2; and D4.4).

It is originally set at the project's financial close in the case of private involvement or prior to project procurement in the case of a publicly financed project. However, the indicator's value may change overtime reflecting changes in both the financing structure as well as the cost of capital per source of financing.

The analysis in Chapter 3 identified the role of the Financing Scheme in achieving specific project outcomes in combination with other indicators. Implicitly, this latter observation may also be used to identify whether and under which conditions, a project with specific indicator values could be delivered through the PPP model and with which capital structure (FSI) in order to achieve the respective outcome targets.

Following on input from task 4.2 (see Deliverable D4.3), key actions taken in re-negotiations processes amongst the BENEFIT cases were directly connected to the Financing Scheme indicator. More specifically, these included:

1. Use of financing facilities that are available for special situations (e.g. renegotiations)

[25] *Following indicator revision (see Deliverable D4.4)*
[26] *Following indicator revision (see Deliverable D4.4)*

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2. New financing arrangements agreed with creditors for special situations (e.g. renegotiations).
3. Sponsors' financial support: Shareholder contributions usually in the form of capital or participative loans.
4. Financial support by the Government, through loans or subventions: The grantor provides capital grants and/or loans. This could be refunded at the end of the concession period, if possible.
5. Government funding support (MRG or operating subsidies): The grantor agrees to fund the project with minimum revenues guarantees, for a limited period or for the whole period.
6. Spontaneous additional revenues: Additional unexpected revenues from new commercial areas or non-core businesses.
7. Public/private contributions to pay off urgent debt

And also

1. Lower O&M expenses.
2. O&M duty releases: The grantor releases some obligations to the concessionaire which will eventually reduce the O&M expenses.
3. Government payments to cover cost overruns: The government agrees to pay some or the whole amount of the cost overruns.
4. Extension of the concession period: The grantor agrees to extend the concession period to compensate for time overruns and/or provide additional funding to the project.

The second group of actions have a dual effect:

5. A reduction in the overall contribution needed in terms of financing and therefore, making bounded sources of financing increase their respective share in the financing structure; and
6. They introduce less costly financing and, therefore, increase the value of the Financing Scheme Indicator.

Finally, it should be noted that the structure of the Financing Scheme Indicator allows for testing of new financing instruments and the impact these may have on project performance.

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6.3 Enhancing Project Performance: The MF Policy Guiding Tool

6.3.1 Introduction

The BENEFIT Matching Framework considers performance following project award. Many project conditions, at this point, have already been set. These include, for example, infrastructure type, size of investment, location as well as the delivery model (fully public or including private financing). Based on studies conducted before the tendering stage, the key outcomes of a project have also been set. With respect to the BENEFIT Matching Framework these include:

- Construction *budget*
- Construction *duration*
- Anticipated level of *traffic*
- Anticipated level of *revenues*

The synthesis of findings conducted within this report also highlights:

- The influence of the implementation context, with the Institutional Indicator also representing the level of implementation stability
- The impact of decisions made at the procurement phase on a project's ability to reach its targets.
- The limited ability to enhance performance after the procurement phase, which is mostly focused on innovation and business development opportunities
- The potential role that Funding and Financing Scheme indicators may play in driving a project's outcomes under the particular conditions already set.

Within this context, by applying the BENEFIT Transport Infrastructure Resilience Indicator and its underlying rating system in an ex ante approach, project structuring scenarios may be considered during all project phases. When addressing these scenarios, the target would be to accomplish a B_{EX}+ TIRI rating for all figures-of-merit of interest, if possible. As described previously, a B_{EX}+ rating would secure a rather high likelihood of achieving a specific figure-of-merit even under relatively adverse implementation conditions.

Assessing scenarios during the various project phases would include (in chronological order):

- **The planning phase**: where alternative decisions of project design and structure may be tested under different procurement options (PPP model or public financing), implementation conditions, as well as funding and financing schemes. At this point, new financing instruments can also be tested as well as the potential capital structure of the project. Notably, at this stage the decision maker also identifies the minimum procurement expectations.

- **The procurement phase:** by defining the minimum number of bidders per tender; the minimum requirements of bidder selection; the minimum contractual conditions and other issues related to the Governance, Cost Saving and Revenue Support Indicators.

- **Financial Close phase[27]:** where the expected value range of the Financial Scheme Indicator supporting the selected scenario may guide the specification of the capital structure of the project. The contribution of new and innovative financing instruments may be assessed with respect to the selected scenario of project implementation.

- **The implementation phase:** by investigating potential opportunities of including innovation and new business activities and also improving the monitoring and managerial capability of the contracting authority.

[27] In the case of a PPP model of infrastructure delivery

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- **Renegotiations:** given the project's structure and implementation context, potential future renegotiations may be guided so as to attain indicator values that will support the achievement of particular project outcome targets, especially with respect to the project's funding and financing scheme.

Finally, employed as a monitoring instrument, the BENEFIT Transport Infrastructure Resilience Indicator may assist in providing future predictions of the likelihood of achieving certain project performance targets and adopting measures during the project's life cycle that minimise adverse effects of the implementation context or capitalise on other relevant opportunities.

The demonstration of the above applications is foreseen to be carried out in Task 5.1 of Work Package 5, with respect to road, urban transit and bridge and tunnel projects. Rail, Airport and Port projects will not be investigated any further given:

- The limitations of the BENEFIT database with respect to the number of Rail and Airport cases, which hampered the ability to develop the respective TIRI rating system
- The need to adjust BENEFIT indicators to the particularities of Port projects before developing the respective TIRI rating system.

6.3.2 Planning Phase enhancements

The BENEFIT framework considers the project characteristics after the completion of all relevant preliminary studies as justifying the project's existence and defining its outcomes.

6.3.2.1 Exogenous Indicators: Implementation Context (FEI and InI)

The analysis identified that projects delivered in an implementation context characterised by a Financial-Economic indicator of FEI<0,50 should be treated with extreme caution, since their likelihood of reaching specified outcome targets is severely diminished.

However, if the Institutional Indicator has a high value (InI>> 0,65) then, a relative improvement of the odds is expected, especially if an increasing trend in the FEI is observed.

The conditions for FEI are not compulsory for urban transit projects, while a high InI is important in this case.

6.3.2.2 Endogenous Indicators: Project Structure (IRA, CSI, RSI, GI)

The design of the structure of the project together with input from all previous studies leads to the initial estimation of the corresponding indicators. Within this section, the Reliability/Availability (IRA), the Cost Saving (CSI), the Revenue Support (RSI) and the Governance (GI) indicators are considered.

IRA: This indicator is usually considered to be IRA=1 reflecting the reliability and availability of service. If, within the life cycle of the project, partial operation or staged inauguration has been planned, the IRA will take the respective values over time.

CSI: At the planning phase this indicator should reflect the actual conditions for its known parameters and assist in the investigation of plausible scenarios for those not known following the indicator estimation process (see D2.2, D3.1, D4.2, D4.4). More specifically, the CSI considers in principle the following parameters:

<u>Technical difficulty</u>: The technical difficulty of the project is assessed, including design maturity, land acquisition, permits etc.

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Constructor Capability: The minimum construction capability to address the project should be defined, also in relation to risks to be passed on to the constructor.

Operator Capability: The minimum operator capability to address the project should be defined, also in relation to risks to be passed on to the operator. In case the public sector is to operate the project then the public's sector capability to operate in relation to the risks to be borne is assessed.

Contracting Authority's Capability: The contracting authority's capability to plan, monitor, enforce contract, manage stakeholders and support the project is assessed. Also the existing track record is considered (see D4.4).

Innovation: Concerns the assessment if innovation is included in the project. At this stage, the successful application of innovation is considered.

Life cycle planning: The degree of life cycle planning is assessed.

RSI: The Revenue Support Indicator is assessed based on the project's configuration in the transport network and the revenue sources initially planned (see D2.2, D3.1, D4.2, D4.4). The indicator considers in principle the following parameters:

Level of Coopetition: The project's business scope (business development vs service provision), its exclusivity in the network, and the impact of the transport network on the project's exclusivity are assessed. A scenario could also be built concerning the project's induced exclusivity through relevant contractual terms.

Sources of revenues: The project's designed sources of revenues are initially considered in combination with the estimation of the ability to manage the respective demand risk of these sources (transport and non-transport). This is important with respect to the corresponding risk allocation.

Quality of service/ user satisfaction per source of revenue: At the planning stage this parameter may be considered to take the highest possible value. However, scenarios with respect to lower quality could be developed and considered.

GI: The Governance Indicator is composed of two sets of parameters (or sub-indicators) concerning governance effectiveness/efficiency and flexibility. It takes into account:

- The project's "needs" in capabilities as they are estimated in the construction of the CSI and RSI,
- The procurement laws and regulations applied in the contracting authority's respective level of government. At the planning stage the minimum values of the parameters are set.

6.3.2.3 Endogenous Indicators: Policy Tools (RAI, RRI, FSI)

This set of indicators reflects the contracting authority's (public sector) project implementation policy.

RAI: The Remuneration Attractiveness Indicator (see D4.4) reflects the decision with respect to the potential streams of project income or the remuneration scheme associated with the risks each source of income may present and the cost coverage ratio potentially achieved. Normally, 100% coverage should be estimated at this stage, but also respective scenarios of lower coverage may be developed.

RRI: The Revenue Robustness Indicator (see D4.4) reflects the various sources of project-generated revenues (connected to RSI) associated with their respective risk and the expected cost coverage

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that may be assumed. Again, 100% coverage should be estimated at this stage, but also respective scenarios of lower coverage may be developed.

FSI: The Financing Scheme Indicator reflects the model of project delivery (Public or with Private Financing) as well as the potential structure of the financing in terms of cost of capital. Notably, at this stage, key scenarios may be tested: 100% public financing (FSI=1); strictly or the majority of the financing coming from the private sector (usually FSI<0,300); private financing with significant public support through guarantees, public contribution of financing etc. (usually FSI>0,600). The effect on FSI of innovative financing instruments can also be tested at this point.

6.3.2.4 Transport Infrastructure Resilience indicator: Project rating

Based on the methodology presented previously, all BENEFIT indicators would be estimated allowing for the assessment of the Transport Infrastructure Resilience Indicator. **Should the resulting rating be at the B_{EX}+ level or above, then the planning could be considered successful for the desired outcomes.**

Notably, at this stage individual stakeholder views can be considered. Each stakeholder may assess the resulting rating per outcome as well as the overall one, depending on their prevailing interests. If the result is not acceptable, then improvements to the CSI, RSI or changes in policy (RAI, RRI and FSI) should be considered.

It is evident that at the planning stage a series of iterative investigations need to be undertaken to test for various scenarios of project structuring and implementation. To simplify the process, the decision-maker may start with the preferred scenario and then check for:

1. The values of the D-TIRI to identify the stability of the selected set-up
2. The worst and best case scenarios accompanied by their D-TIRI.

Figure 6.3.1 illustrates the suggested process as described in this section.

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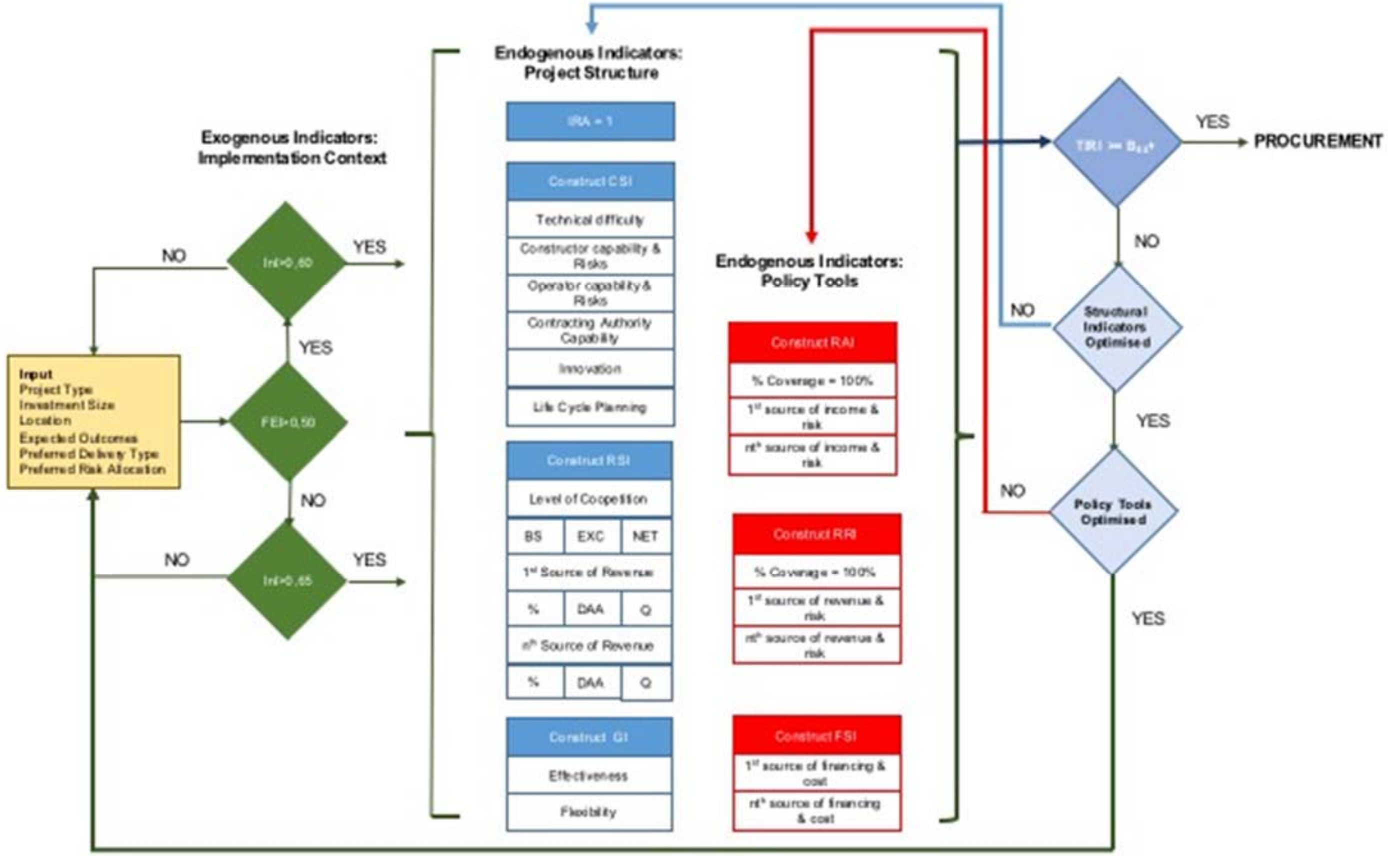

Figure 6.3.1: Schematic representation of iterative investigation process at the planning stage

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6.3.3 Procurement enhancements

The analysis at the planning stage will define the procurement process, tendering documents and other minimum requirements so that the Governance indicator can achieve a value greater or equal to the one identified in the planning process.

As corroborated by experience, all initial estimates generated during the planning stage will, more often than not, not materialise in practice. All endogenous indicators should then be re-calculated based on the contractual agreement terms and the capabilities of the actual actors involved (constructor, operator etc.).

The TIRI may once again be assessed. Depending on the resulting rating, both S-TIRI and D-TIRI, corresponding mitigations measures could be prepared considering the possibilities available by both Structural Indicators as well as those indicators functioning as Policy Tools.

Notably, from this stage onwards, the flexibility of the structural indicators is reduced.

6.3.4 Financial Close enhancements

Reaching financial close will finally define the Financing Scheme Indicator. At this point it is worth estimating the TIRI (S-TIRI and D-TIRI) rating of the project in order to identify the optimum synthesis of financing sources that would lead to an improved and stable rating.

Notably, the value of the FSI has a different influence on the various outcomes and the decision-maker would need to make an overall assessment based on their own interests and priorities.

6.3.5 Implementation Phase enhancements

During the implementation phase, both exogenous and endogenous indicators may vary over time. More specifically:

- The implementation context (FEI and InI) may become more or less favourable;
- Contractual terms, especially with respect to risk allocation may be honoured to a greater or lesser extent (GI, CSI, RSI);
- Coverage and risks related to the income and revenues may vary (RAI, RRI);
- Financing sources and respective cost of capital may vary (FSI)
- etc.

The S-TIRI and D-TIRI will provide a measure of the project's stability and likelihood of reaching outcomes allowing for corrective actions or mitigation measures to be introduced. As noted previously, following project award and financial close the project system becomes less flexible.

6.3.6 Renegotiations

The BENEFIT framework may be applied to assess improvements that can be brought about during potential renegotiations. Notably, renegotiations should result in an improved rating of the TIRI for individual outcomes of interest or all of them simultaneously. However, the anticipated challenge under a renegotiation setting is whether interests and priorities are aligned, as if this does not hold true each party would be seeking the optimal settlement of its own individual interests which may not necessarily coincide with an overall optimal restructuring of the project. The use of the TIRI methodology could help identify such imbalances or misalignments of interests and help craft renegotiation solutions that are as close to the overall optimum as reasonably possible.

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6.4 Comparing BENEFIT with Industry Practice

The successful development and implementation of the Transport Infrastructure Resilience Indicator depends on its ability to capture project characteristics in an unambiguous and realistic way. At the same time, it is important to determine whether its constituent parts bear similarities to the factors that are captured and considered by existing methodologies applied in the world of industry practice. Despite the fact that all existing methodologies, as discussed in Chapter 2, do not have the same objectives as the Transport Infrastructure Resilience Indicator, the relevance of their factors is important in order for this new indicator to be convincing and to merge as seamlessly as possible with existing practices, offering improvements where possible.

Because the Transport Infrastructure Resilience Indicator has used credit assessment methodologies as its underlying methodological template, a comparison with them is in order. Table 6.4.1 below contains a comprehensive list of parameters that are considered by CRAs in their assessment of project creditworthiness compared with relevant parameters captured in the BENEFIT Matching Framework through its various typologies and indicators.

As can be seen from this Table the thematic coverage of the parameters considered in CRAs' methodologies by the Matching Framework's Typology Indicators is full and comprehensive. Furthermore, in order to describe the Implementation context, BENEFIT also employs an Institutional Indicator on a country level.

Once again, it should be clarified that Credit Ratings have a totally different focus than the TIRI and its rating assessment system. The former assesses the ability of the respective parties to address project-related financial liabilities, while the TIRI considers the likelihood of achieving particular outcomes, allowing also for actions to be taken to mitigate downside risks. In combination, they may provide a far more comprehensive prediction of project performance. Towards this end, the consideration of the TIRI could provide important information which would contribute to the adjustment of a project's credit assessment either upwards or downwards. Such input would ultimately lead to more realistic ratings that would improve market confidence.

Finally, it needs to be mentioned that CRA methodologies frequently go to a more extensive level of detail in some of their fields of assessment that the BENEFIT indicators can go. This is due to data access and availability: while CRA's enjoy full information disclosure from the projects that have solicited their rating, BENEFIT collects and works with information that is only available in the public domain and/or obtained through individual research of its contributors. In the presence of more comprehensive information, with a level of detail that is comparable to what is enjoyed by CRAs, BENEFIT indicators can be suitably modified in order to increase the granularity of the analysis and thus improve the accuracy and precision of the corresponding assessments.

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Table 6.4.1: Comparison of factors considered by Credit Rating Methodologies and the BENEFIT Matching Framework (MF) typology indicators

Phase / Field of assessment	Rating factors	Specifics	MF Indicators
Construction Phase	Construction risk	Technology	Cost Saving
	Project/ budget timeliness	Funding provisions	Financing Scheme
	Complexity of project	Project flexibility	Cost Saving
	Contractors' track records		Cost Saving
Operation Phase	Operation Risk	Financials	Remuneration Scheme
			Revenue Robustness
	Performance	Counterparts	Cost Saving
			Revenue Support
			Reliability /Availability
			Market Efficiency & Acceptance
Financial Analysis	Revenues / cost structure	Financial flexibility	Remuneration Scheme
			Revenue Robustness
			Revenue Support
	Capital structure	Liquidity	Financing Scheme
	Cash flow analysis	Refinancing	
	Debt metrics		
Counterparties	Counterparty risk assessments	Analysis of Contracts	Governance
			Cost Saving
	Track records of counterparties		Cost Saving
Project -Specific features	Project companies	Support from sovereign / parent affiliates	Cost Saving
	Managerial / organizational changes	Guarantees	Financing Scheme
			Governance
External environment	Country / sovereign risk evaluations	Risk analysis of external events	Financial – Economic
	Market / competition risk		Market Efficiency & Acceptance
			Revenue Support

Sources: Fitch Ratings (2015), Moody's Investors Service (2010), Standard and Poor's (2014), Pantelias and Roumboutsos (2015), BENEFIT Deliverables D4.2 and D4.4.

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7 Conclusions

7.1 General considerations

The BENEFIT Matching Framework expresses the system of transport infrastructure delivery, comprising both construction and operation, through a number of indicators. The Matching Framework (see Deliverable D3.1) has as its starting point the award of a project under the explicit assumption that all studies conducted and decisions taken prior to or leading to this award are accurate and rational. Ultimately, this assumption is further reflected in the specification of realistic project outcome targets, with respect to:

- Construction Budget
- Construction Duration
- Traffic Forecast
- Revenue Forecast

Through the analyses undertaken in previous tasks within BENEFIT (see Deliverables D4.2, D4.3, D4.4 and also D5.2) for each infrastructure mode and project outcome and by constructively comparing and complementing their respective findings in the course of this report, specific conditions of project implementation that should exist for the attainment of outcome-specific targets have been identified.

The research objective that this report aims to deliver against pertains to the development of the following elements:

- The Decision Matching Framework Policy Guiding Tool;
- The Project Rating Methodology; and
- The Methodological Framework to increase business model creditworthiness.

The Decision Matching Framework Policy Guiding Tool is founded on the use of a new indicator, entitled Transport Infrastructure Resilience Indicator (TIRI). In the context of BENEFIT, resilience is defined as "the ability of a transport infrastructure project to recover from changes within its structural elements with respect to its ability to deliver specific outcomes (such as cost and time to completion, expected traffic and expected revenue targets)". The TIRI has three versions, namely a Static (S-TIRI), a Dynamic (D-TIRI) and an Overall (O-TIRI) version. Each version has a different role to play and its estimation refers to the following:

- The likelihood of reaching a specific outcome target at a particular time in the project's life cycle (S-TIRI),
- The dynamic variation of the S-TIRI with respect to external influences that could increase or diminish the likelihood of reaching a specific outcome target (D-TIRI) and
- The overall likelihood of attaining project outcome targets (either individually or in combination) as perceived by different project stakeholders (O-TIRI).

With respect to the overall version of the indicator (O-TIRI), the BENEFIT project has consistently maintained a **stakeholder-agnostic approach** throughout its research effort. Assessing the overall likelihood of project success is clearly stakeholder-dependent. To this end, potential approaches are outlined for the estimation of the O-TIRI that may be adopted and adjusted to each stakeholder's value system. Within BENEFIT, the O-TIRI is demonstrated as a sequential presentation of the S-TIRI of each outcome. Hence, an O-TIRI takes the form of a vector, for example, O-TIRI = {A,C,B_{EN},B_{EN}+}, which simply states that for a particular project the Transport Infrastructure Resilience Indicator has attained the following rating scores:

- A with respect to reaching "Cost-to-Completion" targets,
- C with respect to achieving "Time-to-Completion" targets,
- B_{EN} concerning the achievement of "Actual vs Forecast Traffic" targets

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- BEN+ concerning the achievement of “Actual vs Forecast Revenue” targets

The TIRI rating system is presented in Chapter 4 of the present report.

Following on from the Transport Infrastructure Resilience Indicator and the respective rating system, the framework for achieving at least a BEN+ rating for each project outcome is considered. Notably, a BEN+ rating increases the likelihood of a project to achieve a specific outcome target under adverse external implementation conditions. This framework constitutes the Methodological Framework to increase business model creditworthiness. In essence, the key indicators to be improved are those describing the business model which needs to be determined at the front end of the project, while the indicators that may be manipulated throughout the life cycle of the project, i.e. the indicators related to the Funding and Financing Scheme typologies, are more appropriately used as policy tools.

Conclusions with respect to the BENEFIT Matching Framework and its applicability are presented in the following section. In the process of developing the Transport Infrastructure Resilience Indicator and its underlying rating system, key findings with respect to infrastructure development and delivery were identified and harvested from previous analysis streams within BENEFIT. These are presented separately.

Finally, the chapter ends with recommendations for future research.

7.2 BENEFIT Matching Framework, Transport Infrastructure Resilience Indicator and Rating System

7.2.1 Domain of Application and Limitations

The BENEFIT Matching Framework is presented in this report in its final version. As explained in previous deliverables reaching this final version was an iterative process that entailed multiple rounds of validation. Through sequential analyses and revisions, the BENEFIT Matching Framework (MF) Typology Indicators have been refined to their present configuration.

From its original concept[28], the emphasis of the BENEFIT MF has been in modelling the implementation system of transport infrastructure. This modelling effort was initially presented in detail through the first configuration of the Typology Indicators in Deliverable D3.1 of Task 3.1. Under the proposed approach, the BENEFIT MF considers as input to its system all decisions taken before project award, while its outputs correspond to the level of achievement of pre-specified goals of various types of project outcomes (e.g. transport-related, project management, related, social, economic, environmental, institutional or other). In its final working version, the BENEFIT MF focused on four key outcomes:

- Two pertaining to project management criteria: cost- and time-to-(construction) completion, and
- Two to transport business model criteria: actual vs forecast traffic and revenues.

Consequently, as a Decision and Policy Guiding Tool, the BENEFIT MF is well-positioned to function as a monitoring and ex-ante scenario building tool, which may predict the likelihood of reaching specific targets related to the abovementioned outcomes. Through this process it may also allow for the identification of adverse factors and the specification of corresponding mitigation and other performance-enhancing actions. The process by which such an ex-ante assessment can be carried out is presented in section 6.3 and illustrated schematically in Figure 6.3.1.

[28] BENEFIT proposal to H2020 call H2020 MG 9.3

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As highlighted from the very beginning of the development of the BENEFIT MF, the proposed model is heuristic in nature. In effect it is built on and continuously learns from information captured from case study data and in this context:

- Bears the limitations of its original case study dataset in terms of accuracy, level of detail and breadth of infrastructure sectors covered. More specifically, the BENEFIT case study database has been built on case study information which is readily available in the public domain. This fact has two major ramifications:
  - The data the MF has been built upon lack of detail, which in many cases hampered the ability to conduct more advanced and detailed analyses. This limitation was addressed by conducting multiple parallel analyses through which different aspects and conditions could be identified.
  - The BENEFIT MF, in its present form, is capable of conducting ex-ante scenario analyses, and may therefore be combined with other existing methods used in the pre-award phase. Furthermore, it is set up in a way that it can include additional detail, should this be available, and, therefore, may be used as a monitoring tool during project implementation.
- Can be continuously improved over time through its application on more, varied and detailed case studies of transport infrastructure projects.

It should also be noted that while the model is capable of addressing multi-contract projects, the difficulty in accessing and obtaining information on multiple contracts limited the number of such cases in the dataset.

The analysis per mode of transport identified that although overarching conditions may be present which influence the performance of many or all of them, there are also significant differences between the combinations of indicators and their respective values that are needed to achieve specific outcomes per mode.

In this light, the aforementioned limitations of the BENEFIT case study dataset were clearly manifested and proved to be highly influential. The BENEFIT MF in its present state of development cannot provide a reliable rating system for the following modes of transport:

- Rail infrastructure, as the information made available was not sufficiently conclusive, despite the fact that the analysis of the literature suggests that the performance of rail infrastructure could be captured by the same indicators identified for urban transit projects but with the additional consideration of the FEI.
- Airport infrastructure with respect to the achieving actual vs forecast traffic and revenue outcome targets. The analysis presented within this report identified the limitations of the Financial-Economic indicator to fully represent the implementation environment for airport operation.
- Port infrastructure with respect to all project outcomes. Previous research undertaken within the BENEFIT project together with the analysis findings reported herewith concluded that the Financial-Economic (FEI), Cost Saving (CSI) and Revenue Support (RSI) indicators, in their current configuration are not representative of port operations and strategies with respect to construction. More specifically, it was concluded that the FEI represents a far narrower implementation context than what ports operate in; the Level of Coopetition factor included in the RSI should be tailored to assess the port's position in the international supply chains served by the specific port and, finally, the capability of the operator should be expanded to fit port considerations within the CSI configuration.

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Notably, the BENEFIT MF and TIRI with respect to road, bridge & tunnel, urban transit and airport[29] infrastructure projects has been delivered and calibrated successfully. All other limitations identified within this report are addressed in terms of proposed outline of corrective actions and future research in the last section of the Chapter.

7.2.2 Description and Initial Results

The rating system that supports the Transport Infrastructure Resilience Indicator is detailed and transparent based on considerations that facilitate the easy recognition of the likelihood of reaching pre-defined project outcomes as well as potential vulnerabilities of the project implementation system. More specifically project rating categories can be explained as follows:

- Rating A: projects have a high likelihood of reaching a specific target outcome as they demonstrate a well-structured business model (indicators IRA, CSI, RSI and GI), and policy decisions (indicators RAI, RRI and FSI) are supportive within a positive implementation context (FEI and InI).
- Rating B_{EX}: projects have an average likelihood of reaching a specific target outcome as they demonstrate a well-structured business model (indicators IRA, CSI, RSI and GI), and policy decisions (indicators RAI, RRI and FSI) are supportive but in a marginally positive implementation context (FEI and InI).
- Rating B_{EN}: projects have an average likelihood of reaching a specific target outcome as they are implemented in a positive implementation context (FEI and InI) but lack a well-structured business model (indicators IRA, CSI, RSI and GI) and supportive policy decisions (indicators RAI, RRI and FSI).
- Rating C: projects have a poor likelihood of reaching a specific target outcome as they are implemented in a poor implementation context (FEI and InI) and lack a well-structured business model (indicators IRA, CSI, RSI and GI) as well as supportive policy decisions (indicators RAI, RRI and FSI).

A slightly better or worse likelihood per rating is noted with a (+) or (-) notch. Additionally the dynamic indicator (D-TIRI) is assessed on top of the Static one (S-TIRI) to determine the percentage change needed in the key implementation context indicator (FEI or InI) for S-TIRI to move down or up a rating category. The D-TIRI values represent the vulnerability or stability of the rating with respect to the outcome target under consideration.

The TIRI methodology was applied to the entire sample of BENEFIT case studies for which sufficient information was available with very encouraging results (see Chapter 5 and Annex 1).

7.2.3 Final Formulation of the BENEFIT Matching Framework

Research undertaken within Task 3.2 concluded in adjusting and refining the BENEFIT Matching Framework with respect to its operationalisation. The synthesis of findings from the quantitative indicator analyses (fsQCA, Importance Analysis and Econometrics) and the qualitative analysis per mode (D4.2 and D4.4.) distinguished the BENEFIT Matching Framework indicators into two categories, with the second being further divided into two sub-categories. This categorisation corresponds to the degree of influence a decision-maker may have on the project's outcomes. More specifically, the BENEFIT MF indicators may be distinguished in the following categories:

- Exogenous Indicators: These include the Financial-Economic indicator (FEI) and the Institutional Indicator (InI). These indicators describe the implementation context. The decision maker has no influence over these indicators and their values.

[29] Only for project management outcome targets (cost to completion, time to completion)

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- Endogenous Indicators: All other indicators fall under this category. This category is also divided into the following two groups:
  - Structural Indicators: These describe the business model and the contractual conditions of implementation (IRA, CSI, RSI and GI). Notably, following project award, the flexibility and, therefore, the range of possible available decisions gradually becomes limited.
  - Policy Tool Indicators: The values of these indicators may be changed throughout the life cycle of the project (RAI, RRI and FSI) based on corresponding decisions. These indicators, in combination with other indicators and for specific values of the indicators combined, have the ability to drive particular aspects of project performance. Furthermore, the structure of the FSI allows for new financing instruments to be tested.

The general relation between these indicators is illustrated schematically in Figure 7.2.1. The combination(s) of indicators and their respective values per mode with respect to the likelihood of achieving a specific outcome are presented in detail in Chapter 4.

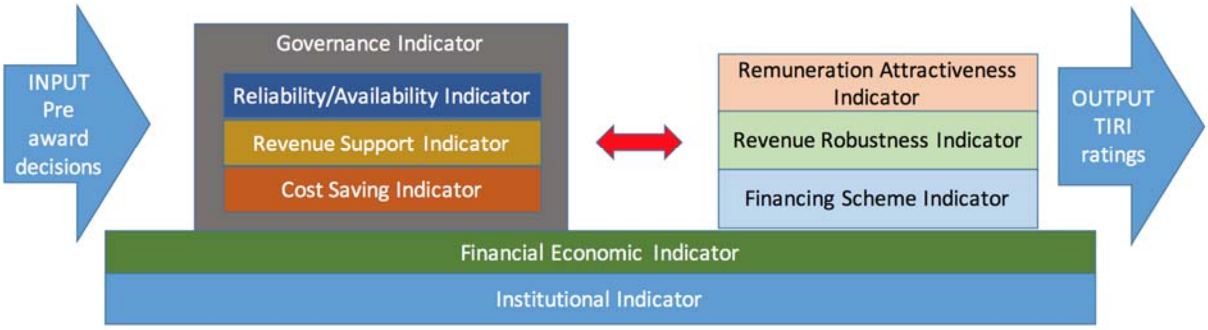

Figure 7.2.1: BENEFIT Matching Framework: Figurative relation between indicators

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7.3 Observations and lessons learned

The synthesis of analyses undertaken during the course of the BENEFIT project (see D2.2, D2.3, D2.4, D3.1, D4.2, D4.3, D4.4 and also D5.2) allowed a number of observations and lessons learned to be drawn. Key observations are that:

- There is no single element (indicator) of the project system that can define the likelihood of achieving an outcome target but rather combinations of them;
- There is no single combination of project elements (indicators) that can secure the successful attainment of all project outcomes simultaneously;
- Outcome targets are not achieved by the same set of elements (indicators) across all modes of transport.

General lessons learned are presented in the following with respect to Implementation context, project structure-related and policy tools-related indicators and their combinations.

7.3.1 Implementation Context

Lessons learned with respect to the implementation context are:

- The implementation context, and more so, the financial-economic conditions are known to influence traffic and revenue outcomes in transport infrastructure projects. Recent reports indicate that a poor implementation context may equally have a negative impact on the potential to achieve cost and time-to-completion targets.

- While the financial-economic conditions have a significant impact on transport infrastructure project outcomes, a strong institutional context may limit or even cancel the effect of poor financial-economic conditions. To this end, countries with strong institutions are more capable of "surviving" a financial-economic crisis. Strengthening, therefore, of institutions[30], as they are described in through the respective BENEFIT indicator, is highly recommended.

- For some modes and outcomes, low values of the Institutional indicator can be compensated by high values of the Governance indicator[31] while, oppositely, a high Institutional indicator value can compensate for a low Governance indicator. Therefore, an effective and flexible transport infrastructure contract may compensate for relatively low institutional context conditions and in extension may limit the impact of poor financial-economic conditions. Therefore, contractual effectiveness and flexibility are recommended, especially in marginal positive (or negative) implementation environments.

7.3.2 Project Structure

Stemming from the synthesis of findings and the formulation of the TIRI methodology, the combination of the Governance, Cost Saving and Revenue Support Indicators appears to influence the likelihood of attainment of most project outcome targets.

While outcomes for these indicators will be supported as their values tend to the higher end of the spectrum (Indicator value = 1), structural limitations may not always allow for this to happen. This is particularly true in the case of the Revenue Support indicator. More specifically:

- Not all infrastructure modes display the potential of increased exclusivity or of business development.

[30] See definition of Institutional Indicator
[31] Contractual governance effectiveness and flexibility

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- Not all infrastructure modes have the same potential of exploiting additional non-transport revenues or of being bundled with other development activities.

Despite this fact, it was noted that even for infrastructure projects which may benefit from their wider integration both in the transport network as well as the relevant urban environment (e.g. urban transit), little advantage was taken of this attribute. In this context, the Revenue Support Indicator may be used as a proxy of project integration.

However, the bundling of activities in infrastructure projects, while positive, may also be the source of reduced effectiveness, as contracting authorities have a poor record with respect to managing and monitoring such projects (reflected in a lower value of CSI). Consequently, bundling of activities can only take place when sufficient training and support is offered to the contracting authority.

The capability of contractors (concessionaires, constructors, and operators) is important. Within BENEFIT the assessment of their capability has been based on their market position (and therefore on their experience and financial strength). Larger (bundled) and integrated projects have higher complexity and usually require actors with high capabilities. However, these actors, as they are usually international businesses, are also vulnerable to global (but also remote) financial-economic fluctuations.

As repeatedly reported in the literature the allocation of risks between contractors and the public sector is of paramount importance. Within BENEFIT, the assessment of the suitability (and equity) of this allocation is made based on the capability of the party to which the risk has been allocated to manage it. Divergence from this rule reduces the value of the CSI and RSI indicators leading, in turn, to a reduced potential of achieving pre-specified outcome targets. According to BENEFIT findings, capability to manage a specific risk should be the guiding principle for risk allocation.

The Governance indicator (governance effectiveness and flexibility) has systematically been identified to be associated with the achievement of outcome targets. Each renegotiation will, by default, reduce the effectiveness of governance. The only way to address this weakness is by including contractual flexibility.

Moreover, most of the above elements are defined during the procurement process. This fact places additional emphasis on procurement.

Finally, the importance of a mature project design and preparation has also been consistently identified. Well-planned and well-justified projects have a greater likelihood of reaching pre-defined outcome targets and withstand financial-economic downturns.

As the project life cycle progresses, the only structural elements available for further manipulation are innovation and the integration of non-transport services and corresponding revenues. However, being able to harvest these element requires a capable (experienced) contracting authority.

7.3.3 Policy Tools

As the project life cycle progresses fewer alternatives for taking action remain at the disposal of decision makers. These include project elements that are included in the Remuneration Attractiveness (RAI) Indicator, the Revenue Robustness (RRI) Indicator and the Financing Scheme (FSI) Indicator.

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The analyses indicated that projects with FSI >0,60 had a greater potential of achieving project outcome targets[32]. Notably, this range of values for the indicator corresponds to one of the following possible options:

- publicly financed projects (FSI =1); or
- projects heavily supported by the public sector; or
- projects with access to low cost financing.

As the need to support public budgets continues, the need to identify and structure low cost financing instruments becomes even greater.

In addition, it was noted that projects with larger values of the FSI (publicly financed or heavily supported by the public sector) tend to favour the achievement of cost over time targets, while the opposite was observed for projects with lower values of the FSI.

As expected, during and after the crisis, demand-based remuneration schemes have not been favoured. In many ways, this undermines the drive for private financing. The BENEFIT research has shown that demand-based remuneration schemes may be sustained during the crisis by projects that present high exclusivity in combination with other contributing indicators.

Finally, a high value of the RRI along with other contributing indicators will improve the ability of reaching revenue targets. If revenues sources are not increased, then the only alternative to increase the RRI is to adjust the cost to be covered by the revenues (increase of the cost coverage factor of the indicator). Ultimately this means reduction of operation/maintenance costs or reduction of project scope.

The effects of factors included in the Policy Tools Indicators on project performance should be carefully considered, especially during renegotiations.

7.4 Recommendations for Future Research

The limitations of the BENEFIT Matching Framework that have been identified previously constitute the basis for future research.

Research conducted within Task 3.2 can provide the starting point in order to address limitations and broaden the domain of application of the proposed methodologies. Sample size and accuracy limitations need to be addressed through the consideration of additional case studies across all modes of transport. The methodology can be strengthened and improved considerably if implemented along the same lines of CRA methodologies, i.e. enjoying full information disclosure from all project stakeholders. Such an increase of information depth and breadth can lead to the reconsideration of the level of granularity of the BENEFIT MF indicators and, in turn, to a more detailed and reliable modelling of the transport infrastructure delivery system.

Furthermore, the TIRI methodology and its accuracy can also be substantially improved through a more extensive application to a larger and more detailed sample of cases. Such a wider application will not only benefit from the increase of modelling accuracy that will come from the recalibration of the BENEFIT MF indicators but will also allow a more quantitative, probabilistic consideration of the likelihood associated with the attainment of the various outcome targets within the various rating categories. It will also assist in the extension of the TIRI methodology to modes that were currently insufficiently covered in the BENEFIT database for their reliable consideration to take place.

[32] For the specific outcomes per mode that may be achieved for FSI>0, please refer to section 4.4.

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Ultimately, the adoption of this methodology by the industry can lead to the development of time-series data of the attainment of project outcome targets which can vastly improve the prediction capabilities of the methodology and further enhance the state-of-the-practice with respect to the assessment of a project to deliver on its expected outcomes.

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Annex 1: Case Applications

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A.1 Road Cases Applications

Rating Cost to Completion

The rating of road infrastructure projects in terms of cost to completion is presented in Table A.1.1 according to the rating system outlined in section 5.4. The rating score is estimated based on the values of the relevant BENEFIT indicators and is compared against the performance of the cost-to-completion outcome for each case.

The table, also, includes the rating of seven (7) projects for which the outcome could not be explained by the analysis conducted in chapter 4.

Table A.1.1 Figure of Merit: Cost to Completion

Project Title	FEi at Award / FEi at inaguration	InI at Award / InI at Inaguration	GI	CSI	RSI	FSI	Static Rating	Dynamic Rating: Below Category	Dynamic Rating: Above Category	Cost Performance
Via-Invest Zaventem	0,690	0,76	0,688	0,449	0,216	0,740	A	13,0%	0	Below Budget
	0,600	0,77								
M-25 Orbital	0,625	0,78	0,688	0,656	0,270	0,668	A	4,0%	0	In line
	0,600	0,79								
M-80 (Haggs)	0,625	0,78	0,688	0,564	0,148	0,529	A	4,0%	0	In line
	0,637	0,83								
E4 Helsinki-Lahti	0,637	0,81	0,750	0,489	0,145	0,679	A	5,8%	0	In line
	0,00	0,02								
E39 Orkdalsvegen Public Road	0,738	0,81	0,563	0,556	0,200	0,719	A	18,7%	0	In line
	0,808	0,82								
A2 Motorway	0,630	0,61	0,688	0,719	0,216	0,752	A-	4,8%	0	In line
	0,608	0,64								
E18 Muurla-Lohja	0,753	0,86	0,750	0,133	0,121	0,773	B_{EN}+	20,3%	n.p.	In line
	0.792	0.84								
Athens Ring Road	0,543	0,59	0,688	0,313	0,229	0,561	B_{EX}+	7,9%	10,5%	In line
	0,587	0,62								
Koper - Izola Expressway	0,683	0,68	0,500	0,279	0,152	1,000	A-	Max 12,2%	n.p.	Below Budget
	0,433	0,66								
BNRR (M6 Toll)	0,635	0,82	0,813	0,172	0,045	0,640	B_{EN}+	21,3%	n.p.	In line
	0,665	0,81								
A22 motorway	0,540	0,69	0,813	0,000	0,267	0,779	B_{EX}-	7,4%	n.p.	In line
	0,442	0,70								
A23 motorway	0,540	0,69	0,813	0,000	0,222	0,779	B_{EX}-	7,4%	n.p.	In line
	0,442	0,70								
Elefsina Korinthos Patra Pyrgos Tsakona Motorway	0,558	0,61	0,625	-0,021	0,222	0,644	B_{EX}-	10,4%	n.p.	Overrun
	0,308	0,57								
Ionia Odos Motorway	0,558	0,61	0,750	0,226	0,257	0,612	B_{EX+}	10,4%	n.p.	Overrun
	0,308	0,57								
Central Greece (E65) Motorway	0,558	0,61	0,750	0,237	0,186	0,938	B_{EX}+	10,4%	n.p.	Overrun
	0,308	0,57								

European Commission

This BENEFIT project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635973

BENEFIT Business Models for Enhancing Funding & Enabling Financing for Infrastructure in Transport

Project Title	FEI at Award FEi at inaguration	InI at Award InI at Inaguration	GI	CSI	RSI	FSI	Static Rating	Dynamic Rating: Below Category	Dynamic Rating: Above Category	Cost Performance
Motorway E-75, Section Donji Neradovac - Srpska kuca	0,550	0,45	0,188	0,000	0,193	1,000	C	9,1%	9,1%	Overrun
	0,417	0,48								
Motorway E-75, Section Horgos-Novi Sad (2nd phase)	0,483	0,47	0,188	-0,030	0,257	1,000	C	0	3,5%	Overrun
	0,517	0,48								
Not Explained in Chapter 4										
Moreas Motorway	0,558	0,61	0,750	0,750	0,301	0,816	B_{EN}+	10,4%	7,5%	Overrun
	0,308	0,57								
A5 Maribor Pince motorway	0,595	0,64	0,563	-0,070	0,151	1,000	B_{EX}-	16,0%	n.p.	Below Budget
	0,683	0,68								
Belgrade By-pass Project, Section A	0,483	0,47	0,313	-0,031	0,211	0,850	C	0	24,2%	In line
	0,467	0,47								
C-16 Terrasa Manresa toll motorway	<0,63	<0,70	0,563	0,133	0,201	0,300	C	0	n.p.	Overrun
	0,637	0,70								
M-45	<0,63	<0,72	0,563	0,583	0,089	0,703	B_{EN}-	?	n.p.	Overrun
	0,637	0,70								
Eje Aeropuerto (M-12) Motorway	0,616	0,76	0,500	0,541	0,040	0,640	B_{EN}-	18,8%	n.p.	Overrun
	0,678	0,73								
Radial 2 Toll Motorway	0,63	0,74	0,500	0,244	0,089	0,640	B_{EN}-	20,6%	n.p.	Overrun
	0,638	0,69								

European Commission | This BENEFIT project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635973

Rating Time to Completion

The rating of road infrastructure projects in terms of time to completion is presented in Table A.1.2. The rating index is estimated based on the values of the relevant BENEFIT indicators and is compared against the performance of the time outcome for each case.

The table, also, includes the rating of four (4) projects for which the outcome could not be explained by the analysis conducted in chapter 4.

Table A.1.2: Figure of Merit: Time to Completion for road projects

Project Title	FEI at Award FEI at Inaugu-ration	InI at Award InI at Inaugu-ration	GI	CSI	RAI	FSI	Static Rating	Dynamic Rating Category Below	 Ab Category Above	Time Perfor mance
A2 Motorway	0,630 0,608	0,61 0,64	0,688	0,719	1,000	0,752	A	4,7%	0	Ahead
E4 Helsinki-Lahti	0,637 0,637	0,81 0,83	0,750	0,489	0,333	0,679	A	5,8%	0	Ahead
E18 Muurla-Lohja	0,753 0,792	0,86 0,84	0,750	0,133	0,667	0,773	A	20,3.	0	In line
Via-Invest Zaventem	0,690 0,600	0,76 0,77	0,688	0,449	0,667	0,740	A	13%	0	Ahead
A-19 Dishforth	0,635 0,635	0,82 0,83	0,688	0,411	0,667	0,525	A	5,5%	0	In line
BNRR (M6 Toll)	0,635 0,665	0,82 0,81	0,813	0,172	0,347	0,640	A	5,5%	0	In line
M-80 (Haggs)	0,625 0,617	0,78 0,79	0,688	0,564	0,667	0,529	A	4%	0	In line
E39 Orkdalsvegen Public Road	0,738 0,808	0,81 0,82	0,563	0,556	0,333	0,719	A	18,7%	0	In line
A22 motorway	0,540 0,442	0,69 0,70	0,813	0,000	0,667	0,779	B_{EX}+	7,4%	n.p.	In line
A23 motorway	0,540 0,442	0,69 0,70	0,813	0,000	0,667	0,779	A	7,4%	n.p.	In line
C-16 Terrasa Manresa toll motorway	0,637 0,637	0,70 0,70	0,563	0,133	0,333	0,300	A	5,8%	n.p.	In line
M-45	0,637 0,637	0,72 0,74	0,563	0,583	0,667	0,703	A	,8%	0	In line
Athens Ring Road	0,543 0,587	0,59 0,62	0,688	0,313	0,333	0,561	A-	7,9%	0	In line
Combiplan Nijverdal	0,760 0,660	0,82 0,83	0,479	0,245	1,000	1,000	B_{EN}-	34,8%	n.p.	Late
Central Greece (E65) Motorway	0,558 0,308	0,61 0,57	0,750	0,237	0,333	0,938	B_{EX}+	10,4%	7,5%	Late
Elefsina Korinthos Patra Pyrgos Tsakona Motorway	0,558 0,308	0,61 0,57	0,625	-0,021	0,400	0,644	B_{EX}+	10,4%	n.p.	Late
Ionia Odos Motorway	0,558 0,308	0,61 0,57	0,750	0,226	0,433	0,612	B_{EX}+	10,4%	7,5%	Late
Moreas Motorway	0,558 0,308	0,61 0,57	0,750	0,750	0,400	0,816	B_{EX}+	10,4%	7,5%	Late

<table>
<tr><th rowspan="2">Project Title</th><th>FEI at Award</th><th>InI at Award</th><th rowspan="2">GI</th><th rowspan="2">CSI</th><th rowspan="2">RAI</th><th rowspan="2">FSI</th><th rowspan="2">Static Rating</th><th colspan="2">Dynamic Rating</th><th rowspan="2">Time Perfor mance</th></tr>
<tr><th>FEI at Inaugu-ration</th><th>InI at Inaugu -ration</th><th>Category Below</th><th>Ab Category Above</th></tr>
<tr><td rowspan="2">Koper - Izola Expressway</td><td>0,683</td><td>0,68</td><td rowspan="2">0,500</td><td rowspan="2">0,279</td><td rowspan="2">1,000</td><td rowspan="2">1,000</td><td rowspan="2">A</td><td rowspan="2">12,2%</td><td rowspan="2">0</td><td rowspan="2">Late</td></tr>
<tr><td>0,433</td><td>0,66</td></tr>
<tr><td rowspan="2">Belgrade By-pass Project, Section A: Batajnica-Dobanovci</td><td>0,483</td><td>0,47</td><td rowspan="2">0,313</td><td rowspan="2">-0,031</td><td rowspan="2">1,000</td><td rowspan="2">0,850</td><td rowspan="2">C</td><td rowspan="2">0</td><td rowspan="2">24,2%</td><td rowspan="2">Late</td></tr>
<tr><td>0,467</td><td>0,47</td></tr>
<tr><td rowspan="2">Motorway E-75, Section Donji Neradovac - Srpska kuca</td><td>0,550</td><td>0,45</td><td rowspan="2">0,188</td><td rowspan="2">0,000</td><td rowspan="2">1,000</td><td rowspan="2">1,000</td><td rowspan="2">C</td><td rowspan="2">0</td><td rowspan="2">n.p.</td><td rowspan="2">Late</td></tr>
<tr><td>0,417</td><td>0,48</td></tr>
<tr><td rowspan="2">Motorway E-75, Section Horgos-Novi Sad (2nd phase)</td><td>0,483</td><td>0,47</td><td rowspan="2">0,188</td><td rowspan="2">-0,030</td><td rowspan="2">1,000</td><td rowspan="2">1,000</td><td rowspan="2">C</td><td rowspan="2">0</td><td rowspan="2">n.p.</td><td rowspan="2">Late</td></tr>
<tr><td>0,517</td><td>0,48</td></tr>
<tr><td colspan="11">Not Explained in Chapter 4</td></tr>
<tr><td rowspan="2">A5 Maribor Pince motorway</td><td>0,595</td><td>0,64</td><td rowspan="2">0,563</td><td rowspan="2">-0,070</td><td rowspan="2">1,000</td><td rowspan="2">1,000</td><td rowspan="2">B_{EX}-</td><td rowspan="2">16%</td><td rowspan="2">n.p.</td><td rowspan="2">Late</td></tr>
<tr><td>0,683</td><td>0,68</td></tr>
<tr><td rowspan="2">M-25 Orbital</td><td>0,625</td><td>0,78</td><td rowspan="2">0,688</td><td rowspan="2">0,656</td><td rowspan="2">0,667</td><td rowspan="2">0,668</td><td rowspan="2">A</td><td rowspan="2">4%</td><td rowspan="2">0</td><td rowspan="2">Late</td></tr>
<tr><td>0,600</td><td>0,79</td></tr>
<tr><td rowspan="2">Eje Aeropuerto (M-12) Motorway</td><td>0,616</td><td>0,76</td><td rowspan="2">0,500</td><td rowspan="2">0,541</td><td rowspan="2">0,333</td><td rowspan="2">0,040</td><td rowspan="2">A</td><td rowspan="2">2,6%</td><td rowspan="2">0</td><td rowspan="2">Late</td></tr>
<tr><td>0,678</td><td>0,73</td></tr>
<tr><td rowspan="2">Radial 2 Toll Motorway</td><td>0,637</td><td>0,74</td><td rowspan="2">0,500</td><td rowspan="2">0,244</td><td rowspan="2">0,333</td><td rowspan="2">0,089</td><td rowspan="2">A</td><td rowspan="2">5,8%</td><td rowspan="2">0</td><td rowspan="2">Late</td></tr>
<tr><td>0,638</td><td>0,69</td></tr>
</table>

Rating Actual vs Forecast Traffic

The rating of road infrastructure projects in terms of actual vs forecast traffic is presented in the following tables. Table A.1.3 contains projects that started operation before the economic crisis, where the values for FEI and InI correspond to the award phase and the time before the crisis. Table A.1.4 presents the rating of cases that started operation after the beginning of the economic crisis, while Table A.1.5 refers to traffic performance after crisis for road projects that were in operation before the start of the economic recession.

The tables, also, include the rating of projects for which the outcome could not be explained by the analysis conducted in chapter 4. More specifically, table A.1.3 includes three (3); table A.1.5 includes two (2) and table A.1.4 does not include any.

Table A.1.3: Figure of Merit: Actual vs Forecast Traffic for road projects operating **before the crisis**

Project Title	FEI at Award	InI at Award	GI	CSI	RSI	RAI	Static Rating	Dynamic Rating		Traffic Performance before Crisis
	FEI Before Crisis	InI Before Crisis						Category Below	Category Above	
Athens Ring Road	0,543	0,59	0,688	0,313	0,229	0,333	B_{EX}-	7,9 %	10,5%	Above forecast
	0,500	0,59								
E4 Helsinki-Lahti	0,637	0,81	0,750	0,489	0,145	0,333	A-	5,8 %	0	In line
	0,792	0,84								
M-45	<0,637	<0,72	0,563	0,583	0,089	0,667	B_{EN}+	21,5 %	n.p.	Above forecast
	0,700	0,68								
A-19 Dishforth	0,635	0,82	0,688	0,411	0,075	0,667	B_{EN}+	5,5 %	n.p.	In line
	0,635	0,83								
E39 Orkdalsvegen Public Road	0,738	0,81	0,563	0,556	0,200	0,333	A	18,7 %	0	In line
	0,808	0,82								
BNRR (M6 Toll)	0,635	0,82	0,813	0,172	0,045	0,347	B_{EN}+	21,3 %	n.p.	Below forecast
	0,742	0,80								
A23 motorway	0,540	0,69	0,813	0,000	0,222	0,667	B_{EX}+	7,4 %	n.p.	Far below forecast
	0.517	0.68								
A22 motorway	0,540	0,69	0,813	0,000	0,267	0,667	B_{EX}+	7,4 %	n.p.	Far below forecast
	0.517	0.68								
Not Explained in Chapter 4										
Radial 2 Toll Motorway	0,637	0,74	0,500	0,244	0,089	0,333	B_{EN}	21,5 %	n.p.	Below forecast
	0,700	0,68								
Eje Aeropuerto (M-12) Motorway	0,616	0,76	0,500	0,541	0,040	0,333	B_{EN}	18,8 %	n.p.	Below forecast
	0,700	0,68								
C-16 Terrasa Manresa toll motorway	<0,637	<0,70	0,563	0,133	0,201	0,333	B_{EN}	5,8 %	0	Below forecast
	0,700	0,68								

Table A.1.4: Figure of Merit: Actual vs Forecast Traffic for roads' first operation **after the crisis**

Project Title	FEI at Award / FEI Reporting	InI at Award / InI Reporting	GI	CSI	RSI	RAI	Static Rating	Dynamic Rating: Category Below	Dynamic Rating: Category Above	Traffic Perform-ance after Crisis
A5 Maribor Pince motorway	0,595 0,433	0,64 0,66	0,563	-0,070	0,151	1,000	B_{EN}+	16%	n.p.	Above forecast
E18 Muurla-Lohja	0,753 0,758	0,86 0,86	0,750	0,133	0,121	0,667	B_{EN}+	33,6 %	n.p.	In line
Via-Invest Zaventem	0,690 0,600	0,76 0,77	0,688	0,499	0,216	0,667	A	13,0 %	0	In line
A2 Motorway	0,630 0,608	0,61 0,64	0,688	0,719	0,216	1,000	A-	4,8%	0	Above forecast
Koper - Izola Expressway	0,683 0,433	0,68 0,66	0,500	0,279	0,152	1,000	A-	12,2 %	0	In line
M-25 Orbital	0,625 0,600	0,78 0,79	0,688	0,656	0,270	0,667	A	4%	0	In line
M-80 (Haggs)	0,625 0,600	0,78 0,79	0,688	0,564	0,148	0,667	A	4%	0	In line
Motorway E-75, Section Donji Neradovac - Srpska kuca	0,550 0,417	0,45 0,48	0,188	0,000	0,193	1,000	B_{EX}-	9,1%	n.p.	In line
Elefsina Korinthos Patra Pyrgos Tsakona Motorway	0,558 0,308	0,61 0,57	0,625	-0,021	0,222	0,400	B_{EX}-	10,4 %	n.p.	Far below forecast
Ionia Odos Motorway	0,558 0,308	0,61 0,57	0,750	0,226	0,257	0,433	B_{EX}-	10,4 %	7,5 %	Far below forecast
Central Greece (E65) Motorway	0,558 0,308	0,61 0,57	0,750	0,237	0,186	0,333	B_{EX}-	10,4 %	7,5 %	Far below forecast
Moreas Motorway	0,558 0,308	0,61 0,57	0,750	0,750	0,301	0,400	B_{EX}+	10,4 %	7,5 %	Below forecast
Motorway E-75, Section Horgos-Novi Sad (2nd phase)	0,483 0,417	0,47 0,48	0,188	-0,030	0,257	1,000	C+	0	n.p.	Below forecast
Belgrade By-pass Project, Section A: Batajnica-Dobanovci	0,483 0,417	0,47 0,48	0,313	-0,031	0,211	1,000	C+	0	n.p.	Far below forecast

The Static Rating is estimated by adding a category, given the fact that traffic has already reach its nominal rate. While for tables A.1.1 and A.1.4, the rating was based on the values of Award, in table A.1.5 the rating takes into account the values of FEI and InI at the reporting time. In other words, tables A.1.1 and A.1.4, provide an ex-ante rating assessment, while table A.1.5 a current assessment. In addition, tables A.1.1 to A.1.4 include both the Static and Dynamic Rating and serve in validating the methodology.

Table A.1.5: Figure of Merit: Actual vs Forecast Traffic **after crisis for road projects in operation before the crisis**

Project Title	FEI before crisis / FEI Report-ing	InI before crisis / InI Report-ing	GI	CSI	RSI	RAI	Static Rating	Dynamic Rating: Category Below	Dynamic Rating: Category Above	Traffic Performance after Crisis
E39 Orkdalsvegen Public Road	0,808	0,82	0,563	0,556	0,200	0,333	A	25,7%	0	Above Forecast
	0,842	0,84								
M-45	0,700	0,68	0,563	0,583	0,089	0,667	(C+) B_{EX}+	0	28,5%	Above forecast
	0,467	0,69								
A-19 Dishforth	0,635	0,83	0,688	0,411	0,075	0,667	A	5,5%	0	In line
	0,600	0,79								
Athens Ring Road	0,500	0,59	0,688	0,313	0,229	0,333	(C+) B_{EX}+	0	67,6%	Below forecast
	0,358	0,57								
E4 Helsinki-Lahti	0,792	0,84	0,750	0,489	0,145	0,333	A	21,7%	0	Above forecast
	0,766	0,86								
C-16 Terrasa Manresa toll motorway	0,700	0,68	0,563	0,133	0,089	0,333	C	0	28,5$	Below forecast
	0,467	0,69								
BNRR (M6 Toll)	0,742	0,80	0,813	0,172	O,045	0,347	B_{EN}-	16,7%	n.p.	Below forecast
	0,600	0,79								
A23 motorway	0.517	0.68	0,813	0,000	0,222	0,667	C	0	35,7%	Far below forecast
	0,442	0,70								
A22 motorway	0.517	0.68	0,813	0,000	0,267	0,667	C	0	35,7%	Far below forecast
	0,442	0,70								
Not Explained in Chapter 4										
Radial 2 Toll Motorway	0,700	0,68	0,500	0,244	0,089	0,333	C	0	28,5%	Below forecast
	0,467	0,69								
Eje Aeropuerto (M-12) Motorway	0,700	0,68	0,500	0,541	0,040	0,333	C	0	28,5%	Below forecast
	0,467	0,69								

Rating Actual vs Forecast Revenue

The rating of road infrastructure projects in terms of actual vs forecast revenue level is presented in the following tables. Table A.1.6 presents the rating of projects that started operation before the economic crisis, while Table A.1.7 refers to cases that started operation after the beginning of the economic crisis. The estimated rating index for the revenue level is also based on the corresponding traffic rating index in both tables.

The Dynamic Rating, is based on the traffic rating category change, as FEI nor InI is included in the combination of indicators influencing revenue performance.

The table, A.1.7 also includes the rating of projects of four (4) for which the outcome could not be explained by the analysis conducted in chapter 4.

Table A.1.6: Figure of Merit: Actual vs Forecast Revenue for roads operating **before crisis**

Project Title	FEI Before Crisis	InI Before Crisis	RRI	RAI	GI	CSI	RSI	FSI	Static Traffic Rating	Static Revenue Rating	Dynamic Rating		Revenue Performance before Crisis
											Category Below	Category Above	
Athens Ring Road	0,500	0,59	0,667	0,333	0,688	0,313	0,229	0,561	B_{EX}-	B_{EX}-	n.p.	20%	Above
M-45	0,700	0,68	0,063	0,667	0,563	0,583	0,089	0,703	B_{EN}+	B_{EN}+	n.p.	n.p.	Above
E39 Orkdalsveg en Public Road	0,808	0,82	0,667	0,333	0,563	0,556	0,200	0,719	A	A	38,1 %	0	In line
E4 Helsinki-Lahti	0,792	0,84	1,000	0,333	0,750	0,489	0,145	0,679	A-	A-	36,9 %	0	In line
A-19 Dishforth	0,635	0,83	0,063	0,667	0,688	0,411	0,075	0,525	B_{EN}+	B_{EN}+	21,3 %	n.p.	In line
C-16 Terrasa Manresa toll motorway	0,700	0,68	0,667	0,333	0,563	0,133	0,201	0,300	A	A-	28,6 %	0	In line
BNRR (M6 Toll)	0,742	0,80	0,673	0,347	0,813	0,172	0,045	0,640	B_{EN}+	A-	32,6 %	0	In line
Radial 2 Toll Motorway	0,700	0,68	0,667	0,333	0,500	0,244	0,089	0,640	B_{EN}	A-	28,6 %	0	In line
Eje Aeropuerto (M-12) Motorway	0,700	0,68	0,667	0,333	0,500	0,541	0,040	0,640	B_{EN}	A-	28,6 %	0	In line
A23 motorway	0.517	0.68	0,293	0,667	0,813	0,000	0,222	0,779	B_{EX}+	B_{EN}-	3,3%	n.p.	Below
A22 motorway	0.517	0.68	0,293	0,667	0,813	0,000	0,267	0,779	B_{EX}+	B_{EN}-	3,3%	n.p.	Below

Table A.1.7: Figure of Merit: Actual vs Forecast Revenue for roads operating **after crisis**

Project Title	FEI reporting	InI reporting	RRI	RAI	FSI	GI	CSI	RSI	Static Traffic Rating	Static Revenue Rating	Dynamic		Revenue Performance after Crisis
											Category Below	Category Above	
A2 Motorway	0,608	0,64	0,444	1,000	0,752	0,688	0,719	0,216	A	A-	17,8%	0	Above
A5 Maribor Pince motorway	0,433	0,66	1,000	1,000	1,000	0,563	-0,070	0,151	C+	B_{EX}-	n.p.	n.p.	Above
Elefsina Korinthos Patra Pyrgos Tsakona Motorway	0,308	0,57	0,667	0,400	0,644	0,625	-0,021	0,222	C	C+	0	62,3 %	In line*
Ionia Odos Motorway	0,308	0,57	0,667	0,433	0,612	0,750	0,226	0,257	B_{EX}-	C+	0	62,3 %	In line*
Central Greece (E65) Motorway	0,308	0,57	0,667	0,333	0,938	0,750	0,237	0,186	C+	C+	0	62,3 %	In line*
Koper - Izola Express	0,433	0,66	1,000	1,000	1,000	0,500	0,279	0,152	C+	C+	0	15,5 %	In line
Motorway E-75, Section Donji Neradovac - Srpska kuca	0,417	0,48	0,667	1,000	1,000	0,188	0,000	0,193	C+	C+	0	19,9 %	In line
Motorway E-75, Section Horgos-Novi Sad (2nd phase)	0,417	0,48	0,667	1,000	1,000	0,188	-0,030	0,257	C+	C+	0	19,9 %	In line
E18 Muurla-Lohja	0,758	0,86	0,824	0,667	0,773	0,750	0,133	0,121	A	A	34,0%	0	In line
Belgrade By-pass Project, Section A: Batajnica-Dobanovci	0,417	0,48	0,203	1,000	0,850	0,313	-0,031	0,211	C+	C+	0	19,9 %	Below forecast
Not Explained in Chapter 4													
Moreas Motorway	0,308	0,57	0,679	0,400	0,816	0,750	0,750	0,301	C+	C+	0	62,3 %	Below forecast
Via-Invest Zaventem	0,600	0,77	0,000	0,667	0,740	0,688	0,499	0,216	A	A-	16,7%	0	In line
M-25 Orbital	0,600	0,79	0,121	0,667	0,668	0,688	0,656	0,270	A	A-	16,7%	0	In line
M-80 (Haggs)	0,600	0,79	0,063	0,667	0,529	0,688	0,564	0,148	A	A-	16,7%	0	In line

A.2 Urban Transit Cases

Rating Cost to Completion

The rating of urban transit infrastructure projects in terms of cost to completion is presented in Table A.2.1 according to the rating system outlined in section 5.4. The rating score is estimated based on the values of the relevant BENEFIT indicators and is compared against the cost outcome for each case.

Table includes one case that could not be explained by the analysis of Chapter 4.

Table A.2.1: Figure of Merit: Cost to Completion for urban transit projects

Project Title	InI Award	InI Inauguration	GI	CSI	RSI	LoC	Static Rating	Dynamic Rating: Category Below	Dynamic Rating: Category Above	Cost Performance
Metrolink LRT, (Ph.1) Manchester	0,82	0,82	0,688	1,000	0,270	0,818	A-	20,7 %	0	In line
Metrolink LRT, (Ph.2) Manchester	0,82	0,83	0,688	1,000	0,270	0,818	A-	20,7 %	0	In line
Metrolink LRT, (Ph.3) Manchester	0,80	0,79	0,688	1,000	0,270	0,818	A-	18,8 %	0	In line
MST-Metro Sul do Tejo	0,72	0,70	0,813	0,453	0,213	0,727	A-	9,7%	0	In line
Lyon's tramway T4	0,75	0,73	0,688	0,178	0,109	0,545	B_{EN}-	13,3 %	n.p.	In line
Athens Tramway	0,60	0,62	0,656	-0,028	0,045	0,091	C	0	n.p.	Overrun
Lyon's VeloV	0,75	0,73	0,750	0,000	0,210	0,636	B_{EN}-	13,3 %	n.p.	Overrun
Metro de Malaga	0,72	0,69	0,688	0,065	0,227	0,727	B_{EN}-	9,7%	n.p.	Overrun
Reims tramway	0,74	0,73	0,875	0,000	0,181	0,545	B_{EN}-	12,2 %	n.p.	Overrun
Tram-Train Kombilösung Karlsruhe	0,79	0,80	0,313	0,000	0,264	0,909	C	n.p.	3,2%	Overrun
Brabo 1	0,74	0,77	0,688	0,213	0,142	0,364	B_{EN}-	12,2 %	n.p.	Overrun
Warsaw's Metro II-nd line	0,63	0,62	0,625	0,691	0,181	0,636	B_{EN}-	n.p.	3,2%	Overrun
Excluded cases (not explained in Chapter 4)										
Metro do Porto	0,71	0,70	0,313	0,000	0,262	0,727	C	0	n.p.	Below Budget

Rating Time to Completion

The rating of urban transit projects in terms of time to completion is presented in Table A.2.2. The rating index is estimated based on the values of the relevant BENEFIT indicators and is compared against the performance of the time to completion outcome for each urban transit case.

The table includes two cases that could not be explained in the analysis of Chapter 4.

Table A.2.2: Figure of Merit: Time to Completion for urban transit projects

Project Title	InI Award InI Inauguration	GI	CSI	RSI	LoC	Static Rating	Dynamic Rating		Time Performance
							Category Below	Category Above	
Metrolink LRT, (Ph.1) Manchester	0,82 0,82	0,688	1,000	0,270	0,818	A-	20,7%	0	In line
Metrolink LRT, (Ph.2) Manchester	0,82 0,83	0,688	1,000	0,270	0,818	A-	20,7%	0	In line
Metrolink LRT, (Ph.3) Manchester	0,80 0,79	0,688	1,000	0,270	0,818	A-	18,8%	0	In line
MST-Metro Sul do Tejo	0,72 0,70	0,813	0,453	0,213	0,727	A-	9,7%	0	In line
Lyon's tramway T4	0,75 0,73	0,688	0,178	0,109	0,545	B_{EN}	13,3%	n.p.	In line
Lyon's VeloV	0,75 0,73	0,750	0,000	0,210	0,636	B_{EN}-	13,3%	n.p.	In line
Brabo 1	0,74 0,77	0,688	0,213	0,142	0,364	B_{EN}-	12,2%	n.p.	Ahead
Athens Tramway	0,60 0,62	0,656	-0,028	0,045	0,091	C+	0	n.p.	Late
Metro de Malaga	0,72 0,69	0,688	0,065	0,227	0,727	B_{EN}-	9,7%	n.p.	Late
Reims tramway	0,74 0,73	0,875	0,000	0,162	0,545	B_{EN}+	12,2%	n.p.	Late
Warsaw's Metro II-nd line	0,63 0,62	0,625	0,691	0,181	0,636	B_{EN}-	n.p.	3,2%	Late
Excluded cases (not explained in Chapter 4)									
Tram-Train Kombilösung Karlsruhe	0,79 0,80	0,313	0,000	0,264	0,909	C	0	n.p.	In line
Metro do Porto	0,71 0,70	0,313	0,000	0,262	0,727	C	0	n.p.	In line

Rating Actual vs Forecast Traffic

The rating of urban transit projects in terms of actual vs forecast traffic is presented in the following tables. Table A.2.3 contains projects that started operation before the economic crisis, where the values for InI correspond to the award phase, while Table A.2.4 presents the rating of cases that started operation after the beginning of the economic crisis.

Table A.2.3: Figure of Merit: Actual vs Forecast Traffic for urban transit projects operating **before the crisis**

Project Title	InI - Award	InI before crisis	GI	CSI	RSI	LoC	RAI	Static Rating	Dynamic Rating: Category Above	Dynamic Rating: Category Below	Traffic Performance before Crisis
Athens Tramway	0,60	0,59	0,667	-0,028	0,045	0,091	0,333	C+	0	n.p.	Below
Metro do Porto	0,71	0,70	0,313	0,000	0,262	0,727	0,000	C	0	n.p.	Far below
Lyon's tramway T4	0,75	0,73	0,688	0,178	0,109	0,545	1,000	B_{EN}-	13,3 %	n.p.	In line
Metro de Malaga	0,72	<0,69	0,563	0,065	0,227	0,727	0,333	B_{EN}-	9,7%	n.p.	In line
Metrolink LRT, (Ph.1) Manchester	0,82	0,80	0,688	1,000	0,270	0,818	0,333	A-	20,7 %	0	In line
Metrolink LRT, (Ph.2) Manchester	0,82	0,80	0,688	1,000	0,270	0,818	0,333	A-	20,7 %	0	In line
MST-Metro Sul do Tejo	0,72	0,70	0,813	0,453	0,213	0,727	0,467	A-	9,7%	0	In line
Lyon's VeloV	0,75	<0,73	0,750	0,000	0,210	0,636	0,500	B_{EN}-	13,3 %	n.p.	Above

Table A.2.4: Figure of Merit: Actual vs Forecast Traffic for urban transit projects' first operation **after crisis**

Project Title	InI - before Crisis	InI Report-ing	GI	CSI	RSI	LoC	RAI	Static Rating	Dynamic Rating: Category Below	Dynamic Rating: Category Above	Traffic Performance
Metrolink LRT, Manchester (Ph 3)	0,80	0,79	0,688	1,000	0,270	0,818	0,333	A-	18,8 %	0	Above
Tram-Train Kombilösung Karlsruhe	0,79	0,80	0,313	0,000	0,264	0,909	1,000	B_{EN}-	17,7 %	n.p.	Above
Reims Tramway	0,74	0,73	0,875	0,000	0,162	0,545	0,770	B_{EN}-	12,2 %	n.p.	In line
Brabo 1	0,74	0,77	0,690	0,213	0,142	0,364	0,667	B_{EN}	12,2 %	n.p.	In line
Warsaw's Metro II-nd line	0,63	0,62	0,625	0,691	0,181	0,636	0,870	C+	0	3,2%	In line

Rating Actual vs Forecast Revenues

The rating of urban transit projects in terms of actual vs forecast revenue level is presented in the following tables. Table A.2.5 presents the rating of projects that started operation before the economic crisis, while Table A.2.6 presents cases that started operation after the beginning of the economic crisis. The estimated rating index for the revenue level is also compared against the corresponding traffic rating in both tables.

Table A.2.5: Figure of Merit: Actual vs Forecast Revenue for urban transit projects operating **before crisis**

Project Title	InI Award	GI	CSI	RSI	RAI	RRI	Static Traffic Rating	Static Revenue Rating	Dynamic Rating		Revenue Performance before Crisis
	InI before crisis								Category Below	Category Above	
Lyon's VeloV	0,75 <0,73	0,750	0,000	0,210	0,500	0,750	B_{EN}-	A	13,3 %	0	Above
Athens Tramway	0,60 0,59	0,667	-0,028	0,045	0,333	0,667	C+	C+	0	8,3%	In line
Lyon's tramway T4	0,75 0,73	0,688	0,178	0,109	1,000	0,258	B_{EN}-	B_{EN}	13,3 %	n.p.	In line
Metro de Malaga	0,72 <0,69	0,563	0,065	0,227	0,333	0,763	B_{EN}-	B_{EN}	9,7%	n.p.	In line
Metro do Porto	0,71 0,70	0,313	0,000	0,262	0,000	0,371	C	C	0	n.p.	In line
Metrolink LRT, (Ph.1) Manchester	0,82 0,80	0,688	1,000	0,270	0,333	0,667	A-	A-	20,7 %	0	In line
Metrolink LRT, (Ph.2) Manchester	0,82 0,80	0,688	1,000	0,270	0,333	0,667	A-	A	20,7 %	0	In line
MST-Metro Sul do Tejo	0,72 0,70	0,813	0,453	0,213	0,467	0,593	A-	A-	9,7%	0	In line

Table A.2.6: Figure of Merit: Actual vs Forecast Revenue for urban transit projects operating **after the crisis**

Project Title	InI - before Crisis	GI	CSI	RSI	RAI	RRI	Static Traffic Rating	Static Revenue Rating	Dynamic Rating		Revenue Performance after Crisis
	InI Report-ing								Category Above	Category Below	
Metrolink LRT, Manchester (Ph 3)	0,80 0,79	0,688	1,000	0,270	0,333	0,667	A	A-	18,8 %	0	Above forecast
Tram-Train Kombilösung Karlsruhe	0,79 0,80	0,313	0,000	0,264	1,000	0,000	C	C	0	n.p.	Above forecast
Brabo 1	0,74 0,77	0,690	0,213	0,142	0,667	0,462	B_{EN}	B_{EN}	12,2 %	n.p.	In line
Warsaw's Metro II-nd line	0,63 0,62	0,625	0,691	0,181	0,870	0,446	C	B_{EN}		3,2%	In line

A.3 Bridge and Tunnel Cases

Rating Cost to Completion

The rating of special transport infrastructure projects (bridges and tunnels) in terms of cost to completion is presented in Table A.3.1 as per the rating system described in section 5.4. The rating is estimated based on the values of the relevant BENEFIT indicators and is compared against the cost to completion outcome for each case.

Table A.3.1: Figure of Merit: Cost to Completion for bridge/tunnel projects

Project Title	FEI Award / FEI Inauguration	InI Award / InI Inauguration	GI	CSI	RSI	LoC	FSI	Static Rating	Dynamic Rating: Category Below	Dynamic Rating: Category Above	Cost Performance
Blanka Tunnel	0,650	0,67	0,188	0,000	0,222	0,818	1,000	B_{EN} -	7,7%	n.p.	Overrun
	0,658	0,67									
Lusoponte Vasco da Gama Bridge	0,540	0,69	0,875	0,582	0,416	1,000	0,796	B_{EX} +	n.p.	11,1%	In line
	0,442	0,70									
Rion-Antirion Bridge	0,543	0,59	0,688	0,698	0,256	0,909	0,873	B_{EX} +	n.p.	10,5%	In line
	0,587	0,62									
Excluded cases (not explained in Chapter 4)											
Herrentunnel Lübeck	0,608	0,81	0,563	0,528	0,107	0,455	0,848	B_{EN} -	1,3%	n.p.	In line
	0,635	0,79									

Rating Time to Completion

The rating of bridge/tunnel projects in terms of time to completion is presented in Table A.3.2. The rating index is estimated based on the values of the relevant BENEFIT indicators and is compared against the performance of the time to completion outcome for each bridge/tunnel case.

Table A.3.2: Figure of Merit: Time to Completion for bridge/tunnel projects

Project Title	FEI Award / FEI Inaug/tion	InI Award / InI Inaug/tion	GI	CSI	RSI	LoC	RAI	RRI	FSI	Static Rating	Dynamic Rating: Category Below	Dynamic Rating: Category Above	Time Performance
Blanka Tunnel	0,650	0,67	0,188	0,000	0,222	0,818	1,000	0,00	1,000	B_{EN}-	231,%	n.p.	Late
	0,658	0,67											
Lusoponte Vasco da Gama Bridge	0,540	0,69	0,875	0,582	0,416	1,000	0,433	0,659	0,796	B_{EN}+	7,4%	11,1%	In line
	0,442	0,70											
Rion-Antirion Bridge	0,543	0,59	0,688	0,698	0,256	0,909	0,333	0,667	0,873	B_{EX}+	7,9%	10,5%	Ahead
	0,587	0,62											
Excluded cases (not explained in Chapter 4)													
Herrentunnel Lübeck	0,608	0,81	0,563	0,528	0,107	0,455	0,000	0,444	0,848	B_{EN}-	1,3%	n.p.	In line
	0,635	0,79											

Rating Actual vs Forecast Traffic

The rating of bridge/tunnel projects in terms of actual vs forecast traffic is presented in the following tables. Table A.3.3 contains projects that started operation before the economic crisis, while Table A.3.4 presents the rating of cases that started operation after the beginning of the economic crisis. Finally, Table A.3.5 shows the cases the operated before the crisis also after the crisis.

Table A.3.3: Figure of Merit: Actual vs Forecast Traffic for bridge/tunnel projects operating **before the crisis**

Project Title	FEI Award / FEI before crisis	InI Award / InI before crisis	GI	CSI	RSI	LoC	RAI	FSI	Static Rating	Dynamic Rating: Category Below	Dynamic Rating: Category Above	Traffic Performance before Crisis
Herrentunnel Lübeck	0,608 0,635	0,81 0,79	0,563	0,528	0,107	0,455	0,000	0,848	C+	0	n.p.	Below
Lusoponte Vasco da Gama Bridge	0,54 0,442	0,69 0,70	0,875	0,582	0,416	1,000	0,433	0,796	B_{EX}+	7,4%	11,1 %	In line
Rion-Antirion Bridge	0,543 0,558	0,59 0,60	0,688	0,698	0,256	0,909	0,333	0,873	B_{EX}-	7,9%	10,5 %	In line

Table A.3.4: Figure of Merit: Actual vs Forecast Traffic for bridge/tunnel projects' first operation **after crisis**

Project Title	FEI Award / FEI Reporting	InI Award / InI Reporting	GI	CSI	RSI	LoC	RAI	FSI	Static Rating	Dynamic Rating: Cat. Below	Dynamic Rating: Cat. Above	Traffic Performance After Crisis
Blanka Tunnel	0,650 0,658	0,67 0,67	0,188	0,000	0,222	0,818	1,000	1,000	B_{EN}-	-23,1 %	n.p.	In line

Table A.3.5: Figure of Merit: Actual vs Forecast Traffic for bridge/tunnel projects' operation **after crisis**

Project Title	FEI before crisis / FEI Reporting	InI before crisis / InI Reporting	GI	CSI	RSI	LoC	RAI	FSI	Static Rating	Dynamic Rating: Category Below	Dynamic Rating: Category Above	Traffic Performance before Crisis
Herrentunnel Lübeck	0,635 0,717	0,79 0,80	0,563	0,528	0,107	0,455	0,000	0,848	C+	0	n.p.	Far Below
Rion-Antirion Bridge	0,558 0,358	0,60 0,57	0,688	0,698	0,256	0,909	0,333	0,873	B_{EX}-	10,4 %	7,5 %	Below

Rating Actual vs Forecast Revenues

The rating of bridge/tunnel projects in terms of actual vs forecast revenue level is presented in the following tables. Table A.3.6 presents the rating of projects that started operation before the economic crisis, while Table A.3.7 presents cases that started operation after the beginning of the economic crisis. As before, A.3.8 presents the cases that operated before the crisis after the crisis. The estimated rating index for the revenue level is also compared against the corresponding traffic rating in both tables.

Table A.3.6: Figure of Merit: Actual vs Forecast Revenue for bridge/tunnel projects operating **before crisis**

Project Title	InI Award / InI before crisis	RRI	RAI	GI	CSI	RSI	FSI	Static Rating Traffic	Static Rating Revenue	Dynamic Rating Cat. Below	Dynamic Rating Cat. Above	Revenue Performance before Crisis
Lusoponte Vasco da Gama Bridge	0,69 / <0,70	0,659	0,433	0,875	0,582	0,416	0,796	B_{EX}+	A	27,5%	0	In line
Rion-Antirion Bridge	0,59 / 0,60	0,667	0,333	0,688	0,698	0,256	0,873	B_{EX}+	A-	15,5%	0	In line
Herrentunnel Lübeck	0,81 / 0,79	0,444	0,000	0,563	0,528	0,107	0,848	C+	C	0	n.p.	In line

Table A.3.7: Figure of Merit: Actual vs Forecast Revenue for bridge/tunnel projects 1st time operating **after crisis**

Project Title	InI Award / InI Reporting	RRI	RAI	GI	CSI	RSI	FSI	Static Rating Traffic	Static Rating Revenue	Dynamic Rating Cat. Below	Dynamic Rating Cat. Above	Revenue Performance before Crisis
Blanka Tunnel	0,67 / 0,67	0,000	1,000	0,188	0,000	0,222	0,796	B_{EN}-	A-	27,5%	0	In line

Table A.3.8: Figure of Merit: Actual vs Forecast Revenue for bridge/tunnel projects 1st operation before the crisis **after crisis**

Project Title	InI before crisis	RRI	RAI	GI	CSI	RSI	FSI	Static Rating Traffic	Static Rating Revenue	Dynamic Rating Cat. Below	Dynamic Rating Cat. Above	Revenue Performance before Crisis
Rion-Antirion Bridge	0,60 / 0,57	0,667	0,333	0,688	0,698	0,256	0,873	B_{EX}+	A-	15,5%	0	In line
Herrentunnel Lübeck	0,79 / 0,80	0,444	0,000	0,563	0,528	0,107	0,848	C+	C	0	n.p.	In line

A.4 Airport projects

Rating Cost to Completion

The rating of airport projects in terms of cost to completion is presented in Table A.4.1 based on the rating system described in section 5.4. The rating is estimated based on the values of the relevant BENEFIT indicators and is compared against the cost to completion outcome for each case.

Table A.4.1: Figure of Merit: Cost to Completion for airport projects

Project Title	FEI Award	InI Award	GI	CSI	RSI	LoC	FSI	Static Rating	Dynamic Rating		Cost Performance
	FEI Inauguration	InI Inauguration							Cat. below	Cat. Above	
Berlin Brandenburg Airport (BER)	0,628	0,78	0,375	-0,300	0,290	0,909	0,963	C+	0	n.p.	Overrun
	0,717	0,80									
Modlin Regional Airport - Reopening	0,617	0,64	0,438	0,000	0,000	0,000	0,906	C+	0	n.p.	Overrun
	0,617	0,66									
Athens International Airport	0,543	0,59	0,750	0,433	0,402	1,000	0,702	B_{EX}-	7,9 %	10,5 %	In line
	0,543	0,60									
Larnaca and Paphos International Airports	0,555	0,70	0,688	0,748	0,364	1,000	0,678	B_{EX}	9,9 %	8,1 %	In line
	0,683	0,73									

Rating Time to Completion

The rating of airport projects in terms of time to completion is presented in Table A.4.2. The rating index is estimated based on the values of the relevant BENEFIT indicators and is compared against the performance of the time to completion outcome for each case.

Table A.4.2: Figure of Merit: Time to Completion for airport projects

Project Title	FEI Award	InI Award	GI	CSI	RSI	LoC	RAI	RRI	FSI	Static Rating	Dynamic Rating		Time Performance
	FEI Inauguration	InI Inauguration									Cat. Below	Cat. Above	
Berlin Brandenburg Airport (BER)	0,628	0,78	0,375	-0,300	0,290	0,909	0,450	0,775	0,963	C+	0	n.p.	Late
	0,717	0,80											
Modlin Regional Airport - Reopening	0,617	0,64	0,438	0,000	0,000	0,000	0,000	0,667	0,906	C+	0	n.p.	Late
	0,617	0,66											
Athens International Airport	0,543	0,59	0,750	0,433	0,402	1,000	0,410	0,705	0,702	B_{EX}+	7,9 %	10,5 %	In line
	0,543	0,60											
Larnaca and Paphos International Airports	0,555	0,70	0,688	0,748	0,364	1,000	0,333	0,667	0,678	B_{EX}+	9,9 %	8,1%	In line
	0,683	0,73											

Annex 2: fsQCA of Port Cases

B.1 Introduction

In this paper we are examining which the factors and combinations of factors are which could affect the success of port infrastructures. A fuzzy set Qualitative Comparative Analysis (fs QCA) is conducted. The cases used are 6 European port projects. The number of cases examined is limited because of the restricted availability of port project data in our database.

Port is the location where the goods (or/and passengers) are transferred between ships and land (Heavor, 2015) and it the most complex transport system. Why is it the most complex? According to Heavor (2015) its complexity derives from three main reasons: 1) the potential interaction of all modes and logistics chains, 2) the operation of transport in terminals that takes place under the jurisdiction of other companies and the 3) great externalities which are "borne" by, for example, the discharges of ships and terminals and also the traffic congestion. Apart from complex environments, ports are also heterogeneous (Van De Voorde, 2015 p.6) and thus investments on port projects enclose high risks. The investment in port infrastructures should be done wisely, thus supporting ports' "weakest" link and eliminating any type of bottlenecks which could benefit to the ports as a whole. In order to reduce the risks of port investments, it would be useful, if financers and policy makers knew in advance which factors will lead a port infrastructure project to success and thus the investment would be probably more attractive. This is the reason why in this paper we examine the success factors of port infrastructure projects. This is the short term goal of this research; alleviating the decision making of financers and policy makers and reducing the risks involved as much as possible, but the long term goal of this research work is that development will be enhanced through the new ports infrastructures or through the improvement of existing ones. Transport infrastructures in general contribute to the economic growth and competitiveness (Nazemzadeh et al., 2015) and also to the regional economic development and social development (OECD, 2011 and International Transport Forum, 2002). Also, according to the IMF research study published in October 2014 in the World Economic Outlook report, an increase in infrastructure investment in developed economies (like the ones we will examine in this paper-European cases are used) could support growth and also in developing economies could contribute to address the already existing and emerging infrastructure obstacles. Also, in this IMF study it was found that in advanced economies "1% percentage of GDP increase in investment spending increases the level of output by about 0.4 percent in the same year and by 1.5 percent four years after the increase".

Not only the complexity of ports system but also the high investments needed for the construction, maintenance and improvement of ports make critical the need to identify the combination of factors that contribute significantly to the success of port infrastructure projects. Especially now that ships are getting bigger so as economies of scale to be achieved (lower cost per unit cargo). Thus, ports should also be adapted in this "change", they should be improved and have their capacity enlarged, so as these big ships to be able to berth there. Otherwise, probably another competitive port, that has the advantage to be bigger and thus without port access problems, will attract the bigger ships (Malchow, 2015 and Vanelslander, 2015).

In the next sections of this paper, the following will be presented. Section 2 will present the method, case studies, variables and models which are used for this analysis. More particularly, section 2 will describe how the method fs QCA works, what are the main characteristics of the case studies used, how the variables inserted in our models are selected and which are the models we are testing. Section 3 presents the results of the four analyses conducted: cost analysis, time analysis, traffic analysis and revenue analysis. In section 4, we will sum up the main findings and will come to conclusions.

B.2 Method-Cases-Variables

Method Description

The method used in this research study is the fuzzy set Qualitative Comparative analysis (fs QCA) and the software used is the Fs/QCA 2.5. Fuzzy set Qualitative Comparative analysis is a comparative method that offers a middle path between quantitative and qualitative measurement (Ragin 2008, p71). It is called comparative because "it explores and finds similarities and differences in outcomes across comparable cases by comparing configurations of conditions" (Ragin, 1987, 1994; 2000; 2003; Rihoux & Ragin, 2008;

Rihoux, 2008, as cited in Marx & Dusa, 2011). According to Ragin (2008), fuzzy sets are at the same time qualitative and quantitative because they are case-oriented and variable-oriented. They are case-oriented because they focus on sets and set membership (qualitative states). In case-oriented analyses, the identity of cases and the sets, to which a case may belong, matter. Fuzzy sets are also variable-oriented because they allow usig degrees of membership and thus having fine-grained variation among cases. This aspect provides a basis for precise measurement, which is very important in quantitative research.

Fuzzy set QCA is not restricted to binary values [1 (membership in the set) or 0 (non-membership in the set)] like crisp set QCA is, which is the original version of the QCA (crisp-set QCA) (Rihoux & Ragin, 2009, chapter 5) but the values can be calibrated according to different "degrees of membership" in the fuzzy sets. For example: 1) Three-value fuzzy set: fully in (1), neither fully in nor fully out (0.5) and fully out (0), 2) Four-value fuzzy set: fully in (1), more in than out (0.67), more out than in (0.33) and fully out (0) 3) Six-value fuzzy set: fully in (1), mostly but not fully in (0.9), more or less in (0.6), more or less out (0.4), mostly but not fully out (0.1) and fully out (0) and 4) Continuous fuzzy set: fully in (1), more "in" than "out" ($0.5 < Xi < 1$, cross over/neither in nor out (0.5), more "out" than "in" ($0 < Xi < 0.5$) and fully out (0) (Rihoux & Ragin, 2009). Calibration is also explained in the following lines.

There are three reasons/arguments why QCA is used in this paper. First, a fuzzy-set QCA is highly appropriate for analysing small N cases or intermediate N cases (around 40-50 cases). Previous research has pointed out the benefits of using (fs)QCA on a medium-sized dataset, compared to traditional regression analysis (Vis, 2012). But QCA is not useful in very small samples (e.g. less than 12 cases) (Fiss, 2008). Second, QCA allows testing hypotheses or existing theories. More specifically, the researchers aim at operationalizing theory or hypothesis as explicitly as possible by defining a series of conditions that should yield a particular outcome (Rihoux & Ragin, 2009). In this deliverable, we are mainly interested in analysing how the different overall typology indicators combined, as conditions for particular cases of infrastructure projects, in order to explain high or low level of traffic, cost and time overrun ("success" indicators). Third, QCA forces researchers to achieve conceptual clarity through the calibration procedure, in which cases are assigned to sets (Boon & Koen, 2015). All variables are transformed into fuzzy sets using the "direct" method of calibration (Ragin, 2008 and Vanelslander 2015). Calibration is one of the six steps that need to be followed for the QCA. These steps include: (1) the identification of the outcomes that we want to test and the selection of relevant conditions, the combination of which will have an impact on the outcome, 2) the calibration of values into sets, 3) the necessity control, 4) the construction of a truth table , 5) the minimization of consistent configuration to form solution formula (cut off), and 6) the interpretation of solutions (Rihoux and Ragin, 2009). The selection of outcomes and conditions is made based on the research question and the in-depth knowledge of the cases and variables of the researcher, respectively. The maximum number of conditions that can be used depends on the number of the cases (see in Marx and Dusa (2011) the table, based on which the number of conditions is selected). In this analysis, eight conditions will be included, which is the maximum number of conditions that can be used for 41 cases.

The calibration, which is the most important step after the data gathering in the fuzzy-set QCA, refers to assigning specific membership scores to cases, on a scale from 0 meaning 'fully out of the set', to 1 meaning 'full membership in the set' (Verhoest et al., 2014). In general, there are two ways to conduct calibration, which are called direct and indirect calibration. On the one hand, researchers apply direct calibration by specifying the values of an interval scale that corresponds to three qualitative breakpoints (anchor points) that structure a fuzzy set: the full membership, full non-membership and the cross over point. On the other hand, using indirect calibration, the external standard used is the researcher's qualitative assessment of the degree to which cases with given scores on an interval scale are members of the target sets (Ragin, 2008). After defining the qualitative anchor points for each set (when cases are fully in a set (1), fully out (0), and the location of the crossover point (0.5)) then, each case is given a score to each set that reflects the degree to which it is in or out (Boon & Verhoest, 2015). The identification of the anchor points and the assignment of cases to sets are based on previous theory or evidence (Schneider & Wagemann, 2010).

As soon as the values are calibrated, they can be uploaded in the Fs/QCA 2.5 software, which is used for the analysis and thus we can start the necessity control. Necessity control shows to the researcher which are the conditions that are considered as necessary for our solution paths. Necessary are the conditions which are "stronger" than the other ones because they are always present in our solution paths and we know in advance that they have an impact on the outcome (the dependent variable). When the necessity control is completed, we can start structuring the truth table. Structuring the truth table is done through selecting the conditions/variables and the outcome we want to examine. Fuzzy set analysis not only gives us the ability to examine which are the combinations of indicators, that lead to an outcome (for example in our research one of the outcomes is high traffic), but also it allows examining which are the combinations/configurations that lead to "no outcome - absence of outcome" (e.g. no high traffic). According to Schneider & Wagemann (2010), the outcome and negation of outcome (~outcome) should always be dealt with in two separate analyses.

QCA thus allows for causal asymmetry, a concept foreign to correlational methods which conceive causal relations in symmetric terms (Fiss, 2008). Causal asymmetry means that the presence of the outcome may have different explanations than its absence (Verhoest et al. 2014). The next step after structuring the truth table is minimization of consistent configuration to form solution formula by using the "consistency cut off". This cut off actually refers to cutting off from the truth table the rows whose consistency is under the set threshold. "*The raw consistency column tells us how consistently a configuration is a subset of the outcome or in other words it satisfies the set relation of sufficiency*" (Legewie, 2013). This score determines whether a configuration of conditions consistently contributes to an outcome. The column for the outcome set is left blank, since it has to be coded based on the consistency scores. For example, if the consistency cut off threshold we select is 0.75, this means that in the blank column we will fill in 1 for all the rows whose raw consistency is bigger than 0.75 and 0 for the ones with a raw consistency smaller than 0.75. In this way, we only keep for our calculations the combinations of conditions which consistently contribute to the outcome. After the cutoff, we can continue the analysis without specifying assumptions or with specifying the assumptions. So, we assume under which circumstances a condition may contribute to the outcome (Legewie, 2013). We decide if the x condition will be present, if it will be absent or if it will be present or absent. After selecting the assumptions, we finally reach the final step of the fuzzy-set QCA analysis, which is analysing the output of the truth table analysis. In the output of the truth table analysis, three solutions are presented: the parsimonious, the intermediate and the complex solution. It is recommended to use the intermediate solution for interpreting the QCA results. The complex solution does not make the above-mentioned simplifying assumptions. It takes all the rows from the truth table which were coded 1 on the outcome and then applies some Boolean simplification so as to combine rows (Elliot, 2013). But if a larger number of causal conditions are included, then we will get quite complicated-complex solutions (Elliot, 2013). The parsimonious solution uses any and all remainder rows so as to simplify the solution. The parsimonious solution should only be used if we are certain that the assumptions made to create the solution are justified (Elliot, 2013). The intermediate solution only includes "easy" assumptions when simplifying the solution. The software asks us to specify these easy assumptions, when it calculates the intermediate solution; when we select all causal conditions to be present, we are telling the software that we assume that it is the presence of the causal conditions which leads to the outcome (Elliot, 2013). To sum up, the intermediate solution includes selected simplifying assumptions to reduce complexity but should not include assumptions which might be inconsistent with the theoretical and/or empirical knowledge (Legewie, 2013). In all three solutions, we can see the paths/combinations of conditions which lead to the outcome.

The interpretation of the results is mainly based on the consistency and coverage values indicated in the solutions and the combination of conditions in the solution formula that resulted in the outcome. Consistency shows the extent to which the solution path is consistent to reality or in other words the extent to which this solution path leads to the outcome. The higher the consistency, the more chances we have to get this outcome with this solution path. Some scientists consider as a satisfying consistency the consistency which is higher than 0.75 but others set an even higher and more strict threshold and accept as a satisfying consistency the one which is higher than 0.85. For example, if our consistency is 0.95 we could say that, 95% of presence or absence of outcome can be explained by conditions and/or combination of conditions in different solution formulas and that 5% deviates or contradicts from the general pattern found in the data. The latter represent outcomes with different solution paths. Low consistency is probably caused by irrelevant conditions and/or missing crucial conditions, using inadequate indicators, and miss-calibration conditions or outcome (Legewie, 2013). Coverage expresses the percentage of cases which have a particular solution path. Thresholds are not so strict for the coverage as for the consistency. The other important step is to interpret each solution formula, which contains different combinations of conditions corresponding with the cases. Part of the interpretation step of the results is to identify which are the core conditions in the solution paths. Core conditions are the conditions (or combinations of conditions) which are included in the parsimonious and the intermediate solutions. In other words, so as to identify these core conditions, we check all the solution paths of the parsimonious solutions and we then check which of these paths are included in the paths of the intermediate solutions. These conditions are considered as "stronger" conditions affecting more the outcome in comparison with the non-core conditions (peripheral conditions). For interpreting the results, it is also necessary to check the number of cases explained by each solution path and as a result to pay attention to the coverage of each solution path. This means that when we finish our analysis and we gather all the solution paths, it is important to know what is the coverage (raw) of each path so as to be able to know the "importance" of each path since it can explain a bigger number of cases in comparison with some other paths which may appear in our results but which may be "neglected" because they can only explain a few cases of the sample.

So as to sum up, fs-QCA analysis will allow identifying which are the most important conditions or combinations of conditions, that have an impact on the project infrastructure outcomes (cost, time and traffic).

Case studies

The data used for this analysis is retrieved from the database of the European Commission's project BENEFIT. This data is collected through desk research and interviews with direct stakeholders of transport infrastructure projects. These projects are projects of different transport modes and different European countries. The interviews are made based on questionnaires developed especially about our research work. These questionnaires include the main key characteristics related to financing and funding transport infrastructures. The answered questionnaires for each of the case studies (projects) are uploaded on the BENEFIT[33] site. The dataset, which we used in this analysis, is composed by 6 projects - cases from 3 European countries, covering only ports (Table B.1). Projects are delivered either by the public sector or by public and private partnerships (PPPs). Some projects are new infrastructures (greenfield), some of them existing (brownfield) and some include parts which are greenfield and brownfield (Table B.2). The cases used for this analysis are the following 6 port cases:

Table B.1: Case studies used for the analysis

Case	Country
1. Barcelona Europe South Terminal	Spain
2. Muelle Costa Terminal Barcelona	Spain
3. Port of Agaete	Spain
4. Port of Sines Terminal XXI	Portugal
5. Port of Leixoes	Portugal
6. Piraeus Container Terminal	Greece

The cases used for the present analysis are the following 6 port cases: 1) Barcelona Europe South Terminal, 2) Muelle Costa Terminal Barcelona, 3) Port of Agaete, 4) Port of Sines Terminal XXI, 5) Port of Leixoes and 6) Piraeus Container Terminal. The selection of these particular cases is made based only on the availability of the data, retrieved from the BENEFIT database. In order to have a better understanding of the results, it is important to describe briefly each of the port projects. All the projects used are projects in Mediterranean countries, which were mostly hit by the financial crisis. The main characteristics of each of the six projects are also presented in the table below (Table B.2).

[33] The official website of the BENEFIT project is the following: http://www.benefit4transport.eu/

The 1st project, the **"*Barcelona Europe South Terminal*"** is a port project in Spain, which is now in operation. It is delivered through a concession of operation and is used only for the transportation of freight. It is a greenfield project which means that it is a new infrastructure. The total investment was 860 million euro (2012) and it was included in the trans-European transport network TEN-T[34] (TEN-T periphery). The location of the project is regional. The contracting authority of this project was *Barcelona Port Authority (BPA)* and the project was nationally driven. Therefore there was some involvement of the central government. Projects sponsors were the *"Hutchison Ports Holding (HPH) and Grupo Mestre"* and the special purpose vehicle (SPV) set up was the *TERCAT, S.A.* The project was funded through 6 banks and it was funded through user charges. The tendering was made through an open call. The duration of the project was 30 years and the "contract private provision" was the following: Design, Finance, Build/ construct, Operate/ Manage, Maintain and Transfer of Ownership. Construction risk, maintenance risk, risk of exploitation and commercial revenue risk were allocated totally to the contractor and the design risk and the force majeure were mostly allocated to the contractor. The economic, social, environmental and institutional impacts were as expected. However, the project was delayed, over budget and the traffic was below forecasts. The only performance indicator that was as expected was the "revenues".

The 2nd project, the ***"Muelle Costa Terminal Barcelona"*** is also a port project in Spain which is now in operation. It is also a greenfield project delivered through concession but it is used for passengers and not for cargo as the 1st one. The total investment of the project was 22 million euro (2013) and it was also included in the TEN-T. The location of the project is regional. The contracting authority of this project was also the Barcelona Port Authority (BPA) and the project was nationally driven. Therefore there was some involvement of the central government. We can see that there are quite some similarities between the 1st and 2nd project used. The project sponsor was the "Grimaldi Group through Atlantica di Navigazione SpA" and no SPV was needed to be set up for the concession. Concession was awarded to Atlantica di Navigazione SpA." The project was funded through user charges. The tendering was made through negotiations. The duration of the project was 15 years with an extension possibility up to 22.5 years. The contract private provision was: Finance, Build/ Construct, Operate/ Manage, Maintain and Transfer of Ownership. The maintenance risk, risk of exploitation, commercial revenue risk and financial risk were allocated totally to the contractor. The design, construction and force majeure risk were allocated mostly to the contractor. All the economic, social, environmental and institutional impacts were as expected. Also the project was on budget, on time and the revenues and traffic were as expected to be, based on the forecasts.

The 3rd project, the **"Port of Agaete"** is also a port project in Spain which is in operation. It is a brownfield project, which means that the infrastructure was already existing. The infrastructure was delivered through a concession of operation and it was used for the transportation of both passengers and freight. The total investment of the project was 7.5 million euro and also the project was not included in TEN-T. Regarding the location of the project, it is regional. The project was nationally driven and the contracting authority was the 1) Spanish Ministry for Public Works and the 2) Regional government. There was also some involvement of the central government. The project sponsors were the 1) Spanish Central Government, the 2) regional Government of the Canary Islands and the 3) private ferry operator, FRED OLSEN. *"More particularly, the Spanish Central Government was the initial and main sponsor of the project. After 1986 all the responsibilities were transferred to the regional Government of the Canary Islands. The private ferry operator, FRED OLSEN, was eagerly interested in the project and promoted several studies and public announcements. Its good relationships with the regional government can be considered as a key factor in the project." "The building project of the Port of Agaete was fully financed by the public sector"* and it was funded by user charges. The tendering was made through a restricted call. Regarding the risk allocation, the design and maintenance, regulatory and force majeure risks were allocated totally to the public sector and the construction risk was rather publicly allocated. The risk of exploitation, the commercial revenue risk and the financial risk were allocated totally to the contractor. The social and environmental outcomes were as expected but the economic and institutional outcomes of the project were far below expectations.

[34] Trans-European transport network (TEN-T): European Union as from January 2014, has a new policy which aims to reduce the gaps among Member States' transport networks. In order this aim to be achieved EU provides financial support to these projects (European Commission, 2016).

The project was on budget (on cost) but it was not on time (delayed). However, the traffic and revenues were exceeding the forecasts.

The 4th project, the **“Port of Sines Terminal XXI”** is a port project in Portugal which is in operation. It is delivered through a Public and Private Partnership (PPP). It is a brownfield and greenfield project which is used for freight transportation. The total investment was 333 million euro and it was a TEN-T priority project. Regarding the project locality, it is international. The contracting authority was the “APS - Administração do Porto de Sines, S.A. (Sines Port Administration)” and also the project was locally driven. Therefore, the involvement of the central government was limited. *“The two project sponsors are the APS-Administração do Porto de Sines, S.A. (Sines Port Administration)” and the PSA Sines Container Terminal, S. A. (Port of Singapore Authority). More particularly, PSA Sines Container Terminal, S. A. (Port of Singapore Authority) is the main private agent. It is an SPV which was wholly owned initially by PSA Europe Pte., a subsidiary of PSA Corp., the operating arm of the port of Singapore. PSA is one of the major international port groups. Having started as the Port of Singapore Authority, it began internationalisation in the 1990s and its current portfolio includes port projects and operations across Asia, Europe and South America. PSA is fully owned by Temasek Holdings, an investment company owned by the Government of Singapore.” “The SPV company created for the Port of Sines contract – PSA Sines Container Terminal, S.A.– was initially owned by PSA with 99,9999%. Ownership has changed during the contract. Between 2006-2008 shares were sold off in tranches to Porthub Ltd SA, a Panama-registered company of unknown ownership. In 2008 this owned 49% of PSA Sines Container Terminal, a figure which fell to 38% in 2009.” Public sector investment amounts to 30,8%, heavily front-end loaded. Private sector investment amounts to 69,2% and is more evenly distributed along the contract duration.”* Public sector investment was mostly funded by EU funds and a bank loan. The project was funded through user charges and secondary revenues such as assets promotion, sub-concessions, royalties. The tendering was made through negotiations and in the contract the private partner was in charge of Designing, Financing, Building/ Constructing, Operating/ Managing, Maintaining and Transferring of Ownership. The duration of the contract was 30 years, with the option to extend for a further 30 years. The design, construction and maintenance risks were allocated totally to the contractor. The regulatory risk, the risk of exploitation and the force majeure risk were allocated rather to the contractor and the financial and the commercial revenue risk were allocated mostly to the contractor. The economic and environmental impacts were as expected but the social and the institutional ones were below the expectations. The project was on cost (on budget) but it was delayed. The traffic and revenues were as expected to be based on the forecasts.

The 5th project **“Port of Leixoes”** is the 2nd Portuguese port infrastructure project used in our analysis. It is a brownfield and greenfield project which was delivered through a PPP. It is used for the transportation of freight and the total investment for it was 350 million euro (2012). The project locality of this port infrastructure project is regional. The contracting authority is the “Port Authority (APDL)” and the project is nationally driven. The central government was also involved in the project. The project was funded through usage payment and secondary revenues such as assets promotion, sub-concessions and royalties. The duration of the project was 25 years with option for 5 additional years. The design, construction, maintenance and the force majeure risk were allocated rather to the public sector and the regulatory risk mostly to the public sector. The risk of exploitation, the financial and the commercial revenue risks are allocated mostly to the contractor. The economic, social, environmental and institutional impacts were as expected. The project was on cost, on time and the revenues and the traffic were as expected as well.

The 6th project **“Piraeus Container Terminal”** is a port project located in Greece. Its geographical location is urban. This project, which is in operation, is a brownfield and greenfield project and it was delivered through a Public and Private Partnership. It is used for the transportation of freight. The total investment was 620 million euro and the project was a TEN-T core project. The contracting authority was the Ministry of Merchant Marine. This project was nationally driven and the involvement of the central government was absolute direct. The SPV was the Piraeus Container Terminal S.A., which was owned 100% by the Cosco Pacific. Tendering was made through an open call and through negotiations as well. Regarding the financing of the project, *“at the time of the tender, the estimated cost of upgrading Pier II and building the new terminal at Pier III was just under €500m. Around half of the costs not covered by the* *terminal's operating cash flow are expected to be met by debt. Like most of the other large international terminal operators, Cosco Pacific is likely to use corporate debt – bonds or senior loans secured by parent company assets – rather than project-specific non-recourse financing".* The money spent will be recovered through user chargers (funding scheme). The contract duration is 30 years with an extension option of 5 years. In the contract the private partner was in charge of Financing, Building/ Constructing, Operating/ Managing and Maintaining the project. Risk of exploitation, design, financial and commercial revenue risk are allocated totally to the contractor. The construction and maintenance risks were allocated mostly to the contractor. The regulatory risk is allocated totally to the public sector and the force majeure risk rather to the public sector. The economic and institutional impacts were exceeding the expectations but the social and environmental outcomes were below the expectations. Also, the project was on cost and the revenues and traffic were exceeding the expectations but the project was not delivered on time (delayed).

Table B. 2: Main characteristics of the 6 port projects used in the analysis

Ports Main project characteristics	Barcelona Europe South Terminal	Muelle Costa Terminal Barcelona	Port of Agaete	Port of Sines Terminal XXI	Port of Leixoes	Piraeus Container Terminal
Country	Spain	Spain	Spain	Portugal	Portugal	Greece
Project status	Operating	Operating	Operating	Operating	Operating	Operating
Delivery Mode	Concession of operation	Concession of operation	Concession of operation	PPP	PPP	PPP
Use	Only freight/cargo	Passenger	mix	Freight	Freight	Freight
Brownfield/Greenfield	Greenfield	Greenfield	Brownfield	Greenfield	Both	Both
Total Investment	860 (2012)	EUR 22M (2013)	€7.5 million	EUR 333M	350 000 000 (2012)	620 M euro
TEN-T character	TEN-T periphery	Included in TEN-T	Not Included in TEN-T	TEN-T priority project	---------	TEN-T core
Project locality	Regional	Regional	Regional	International	Regional	Urban
Contracting authority	Barcelona Port Authority (BPA)	Barcelona Port Authority (BPA)	(1) Spanish Ministry for Public Works (2) Regional government	APS - Administração do Porto de Sines, S.A. (Sines Port Administration)	Port Authority (APDL)	Ministry of Merchant Marine
Port driven (from a national or local level)	Nationally driven	Nationally driven	Nationally driven	Locally driven	Nationally driven	Nationally driven
Level of central government involvement	Some involvement	Some involvement	Some involvement	Limited involvement	Involvement	Absolute direct involvement
Project sponsor	Hutchison Ports Holding (HPH) and Grupo Mestre	Grimaldi Group through Atlantica di Navigazione SpA.	1. Spanish Central Government 2. regional Government of the Canary Islands 3. The private ferry operator, FRED OLSEN	PSA and APS	---------	Cosco Pacific
SPV (Special Purpose Vehicle)	TERCAT, S.A.	No SPV needed.	n/a	PSA Sines Container Terminal, S.A.	----------	Piraeus Container Terminal S.A. – 100% Cosco Pacific owned.
Funding (availability fee/concession fee)	User charges	User charges	User charges	1. User charges 2. Secondary revenues	1. Usage payment 2. Secondary revenues	User charges
Financing	6 banks	NOT available	Public sector	**Private partner** (69.2%) **& Public partner** (mostly through bank loan and subsidies) (30.8%)	---------	Around half of the costs not covered by the terminal's operating cash flow are expected to be met by debt.

						Cosco Pacific is likely to use corporate debt – bonds or senior loans secured by parent company assets
Tendering	Open Call	Negotiations	Restricted Call	Negotiations	---------	Negotiations Open Call
Contract: **Private Provision**	Design Finance Build/ construct Operate/ Manage Maintain Transfer of Ownership	Finance Build/ construct Operate/ Manage Maintain Transfer of Ownership	----not a PPP --	Design Finance Build/ construct Operate/ Manage Maintain Transfer of Ownership	----------	Finance Build/ construct Operate/ Manage Maintain
Duration of projects (yrs)	30 years	15 (extension possibility up to 22.5 years)	--------	30 years, with the option to extend for a further 30 years	25 years with option for 5 additional years	30 (with an extension option of 5 years)
Risk allocation						
Design risk	Mostly contractor	Mostly contractor	Totally public	Totally contractor	Rather public	Totally contractor
Construction risk	Totally contractor	Mostly contractor	Rather public	Totally contractor	Rather public	Mostly contractor
Maintenance risk	Totally contractor	Totally contractor	Totally public	Totally contractor	Rather public	Mostly contractor
Risk of exploitation	Totally contractor	Totally contractor	Totally contractor	Rather contractor	Mostly contractor	Totally contractor
Commercial revenue risk	Totally contractor	Totally contractor	Totally contractor	Mostly contractor	Mostly contractor	Totally contractor
Financial risk	-	Totally contractor	Totally contractor	Mostly contractor	Mostly contractor	Totally contractor
Regulatory risk	-	-	Totally public	Rather contractor	Mostly public	Totally public
Force majeure	Mostly contractor	Mostly contractor	Totally public	Rather contractor	Rather public	Rather public
OUTCOMES & IMPACTS						
COST OVERRRUN	Over Budget = -1	On Budget = 0	On budget=0	On budget=0	On Budget = 0	On Budget = 0
TIME OVERRUN	Delayed = -1	On Time = 0	Delayed=-1	Delayed=--1	On Time = 0	Delayed=-1
ACTUAL VS FORECASTED TRAFFIC	Below Forecast = -1	As Forecast = 0	Exceeding =1	As Forecast = 0	As Forecast = 0	Exceeding =1
REVENUE VS FORECASTED (PROXY)	AS EXPECTED = 0	AS EXPECTED = 0	Exceeding =1	AS EXPECTED = 0	AS EXPECTED = 0	Exceeding =1
OTHER ECONOMIC OUTCOMES	As expected = 0	As Expected = 0	Far Below Expectations = -2	As Expected = 0	As Expected = 0	Exceeding =1
SOCIAL OUTCOMES	As expected = 0	As Expected = 0	As Expected = 0	Below Expectations = -1	As Expected = 0	Below Expectations = -1
ENVIRONMENTAL OUTCOMES	As expected = 0	As Expected = 0	As Expected = 0	As Expected = 0	As Expected = 0	Below Expectations = -1
INSTITUTIONALS OUTCOMES	As expected = 0	As Expected = 0	Far Below Expectations = -2	Below Expectations = -1	As Expected = 0	Exceeding = 1

Source: BENEFIT database, http://www.benefit4transport.eu/

The variables included in our dataset are the following (table B.3).

Table B.3: Variables used in the analysis

No.	Variables	Inputs - Typology indicators - Outcomes
1	Institutional Indicator	Typology indicator
2	Financial Economic Indicator	Typology indicator
3	Reliability-Availability (IRA)	Typology indicator
4	Overall governance	Typology indicator
5	Cost saving	Typology indicator
6	Remuneration scheme	Typology indicator
7	Revenue scheme	Typology indicator
8	Financing scheme	Typology indicator
9	Cost	Outcome[35]
10	Time	Outcome
11	Traffic	Outcome
12	Revenues	Outcome

The values of each variable refer either to the year of completion of inauguration of the project for the cost and time analysis or to the reporting time of each case (mostly between 2010-2015) for the traffic and revenue analysis. The reporting time captures the values of each variable at the most recent year during which the data was collected.

Models

Six groups of two conditions are created based on the correlation of variables as presented in table 4 below. Based on this table and by selecting the pairs of indicators with the highest correlation, six groups of two conditions were created:

- **Group 1**: Institutional setting – Financial & economic setting
- **Group 2**: Governance – Cost saving
- **Group 3:** Remuneration scheme - Revenue scheme
- **Group 4:** Financing scheme – Governance
- **Group 5:** Governance – institutional setting
- **Group 6:** IRA-cost saving (only for traffic and revenue outcomes)

The 6th Group is only expected to be used for the traffic and revenues analysis because the reliability and availability indicator (ira) can be only measured when the infrastructure projects are in operation and not during their construction phase (see cost and time analysis).

[35] Outcomes are the variables that are inserted in our models as dependent variables and we want to test which combinations of variables (inputs and typology indicators) will have an impact on each of the outcomes.

Table B.4: Correlation of variables

	financ~c	instit~r	ira	govind~r	costsa~g	revenu~t	remune~e	reven~me	normin~r
financiale~c	1.0000								
institutio~r	0.7146	1.0000							
ira	0.1116	0.1145	1.0000						
govindicator	0.1546	0.3759	0.2795	1.0000					
costsaving	0.0341	0.1760	0.3485	0.5093	1.0000				
revenuesup~t	-0.3148	-0.2615	0.0905	0.1033	0.1923	1.0000			
remunerati~e	0.1482	0.1607	0.0994	-0.0672	0.0676	-0.0127	1.0000		
revenuesch~e	-0.0021	-0.0347	-0.0108	0.2349	0.0647	0.2697	-0.3580	1.0000	
normindica~r	0.2019	0.2553	0.3079	0.3814	0.2534	-0.0460	-0.1204	-0.0023	1.0000

Source: Roumboutsos et al. (2016)

The **main hypothesis** of our analysis is the following: we expect that when all the typology conditions are positive (present), they will lead in combination to the presence of the outcomes. Also, when the typology conditions are absent, their combined absence will lead to the absence of the outcomes. The more the value of the condition comes closer to the value ‘1’, the more positively it affects the respective outcome and vice versa (for the detailed presentation of the range of values of each indicator, see Appendix). The models tested based on the above suggested groups of conditions are the following:

Table B.5: Models tested

Models	**Included conditions**
Models for the presence and the absence of the ‘on cost’ outcome	1. Institutional Scheme- Financing scheme 2. Governance – Cost saving 3. Remuneration scheme –Revenue scheme 4. Financing scheme-Governance 5. Governance- Institutional Setting 6. Cost saving- Institutional setting 7. Cost saving- Revenue scheme
Models for the presence and the absence of the ‘on time’ outcome	1. Institutional Scheme- Financing scheme 2. Governance – Cost saving 3. Remuneration scheme –Revenue scheme 4. Financing scheme-Governance 5. Governance- Institutional Setting 6. Financing scheme-Remuneration scheme
Models for the presence and the absence of the ‘on traffic’ outcome	1. Governance – Cost saving 2. Financing scheme-Governance 3. Governance- Institutional Setting 4. institutional setting - cost saving
Models for the presence and the absence of the ‘on revenue’ outcome	1. Governance – Cost saving 2. Financing scheme-Governance

B.3 Results

In this section, the results of the four outcome analyses will be presented: cost, time, traffic and revenue analysis results. Results are presented per outcome. Firstly, the necessity control is presented and then the main analysis (sufficiency control) is conducted, which gives to us the main results.

Cost analysis

Necessity Control

A condition is considered as necessary when its consistency is >0.90. The necessity control of the on cost outcome showed that revenue scheme is a necessary condition when the on cost outcome is absent (consistency= 0.93) and also the condition financing scheme is also a necessary condition when it is absent and the on cost outcome is present. The above mean that a) in the solution paths of the absence of the on cost outcome, high revenue scheme will be almost always one of the conditions appearing in the paths and b) in the solution paths of the presence of the on cost outcome, low (absent) financing scheme will almost always appear (in the 92% of the paths)

Table B.6: Necessity control of COST OUTCOME

Conditions	On Cost	
	Presence	Absence
High Institutional Setting	0.67 (0.82)	0.79 (0.41)
Low Institutional Setting	0.52 (0.85)	0.66 (0.46)
High Economic & Financial Setting	0.28 (0.85)	0.40 (0.53)
Low Economic & Financial Setting	0.85 (0.77)	**0.** (0.35)
High Governance	0.57 (0.84)	0.61 (0.38)
Low Governance	0.58 (0.78)	0.75 (0.43)
High Cost Saving	0.54 (0.92)	0.50 (0.37)
Low Cost Saving	0.63 (0.75)	**0.89** (0.45)
High Remuneration Scheme	0.56 (0.82)	0.67 (0.42)
Low Remuneration Scheme	0.61 (0.81)	0.72 (0.41)
High Revenue Scheme	0.82 (0.76)	**0.93** (0.37)
Low Revenue Scheme	0.32 (0.92)	0.39 (0.48)
High Financing Scheme	0.21 (0.64)	0.57 (0.74)
Low Financing Scheme	**0.92** (0.83)	0.72 (0.28)

* indicates the necessary condition, which is above the threshold that we set (.90)

The number of port infrastructure projects which will be examined for the 1) cost and time outcome and the 2) revenue and traffic outcome are six. Since the number of available projects are only a few, only two conditions can be included in our QCA analysis (excluding the outcome). The conditions used for the analysis are the following:

1. Institutional setting
2. Financial-economic setting
3. **IRA (only for traffic and revenue)**
4. Governance
5. Cost saving
6. Remuneration scheme
7. Revenue scheme
8. Financing scheme

Group 1: Institutional setting – Financial–economic setting

No results are found for the parsimonious solution, so no condition can be considered as core. Also, **no results** are found for the **absence of the outcome**. This shows that we can only explain the projects which were on cost and not the projects which were over cost.

The on cost outcome analysis showed that a low financial and economic setting could explain 85% of the projects being on cost. This condition is inconsistent to our initial hypothesis, saying that high – present conditions will normally lead to the presence of the cost outcome and vice versa.

The 2nd solution path showed us that a high institutional setting could explain 67% of the projects being on cost. This condition acts consistently to our main hypothesis, mentioned above. The consistency is quite high for this solution path (0.82), higher than the 1st path's consistency which can be considered moderate. The overall coverage of the "presence of the on cost" analysis is quite high (0.90) and the consistency is moderate (0.78).

Table B.7 : COST – ONLY PRESENCE - Consistency cut off (0.81)

Conditions	OUTCOME COST: presence of outcome and conditions	
	Solution 1	Solution 2
Institutional Setting		+
Financial & Economic Setting	~	
Individual Consistency	0.77	0.82
Coverage (Raw)	0.85	0.67
Coverage (Unique)	0.23	0.06
Number of cases	5	5
	Port of Leixoes (0.91,0.8), Port of Agaete (0.88,0.8), Muelle Costa Terminal Barcelona (0.87,0.8),**Piraeus container**	Port of Leixoes (0.65,0.8), Muelle Costa Terminal Barcelona (0.62,0.8), Port of Agaete (0.62,0.8), Port of Sines Terminal XXI (0.59,1)
Overall Consistency/Coverage	(0.78/**0.90**)	

Regarding the 2nd group, which is combined by the conditions of governance and cost saving, we found that high cost saving explains 54% of the cases being on cost. The consistency is significantly high (0.92). Moreover, the cost saving condition is not only consistent to our expectations but it is also a core condition, thus indicated in green colour. This means that the presence of this condition appears also in the parsimonious solution.

Group 2: Governance – Cost saving

Table B.8 : COST – ONLY PRESENCE - Consistency cut off (0.90)

Conditions	OUTCOME COST : presence of outcome and conditions
	Solution 1
Governance	
Cost saving	+
Individual Consistency	0.92
Coverage (Raw)	0.54
Coverage (Unique)	0.54
Number of cases	2
	Piraeus Container Port of Leixoes (0.58,0.8)
Overall Consistency/Coverage	(0.92/**0.54**)

No results were found for the absence of the cost outcome for the group 2 of variables, as a result we cannot identify which condition (or combination of conditions) could explain the port projects being over cost.

The 3rd group-model created by inserting as conditions the remuneration and revenue scheme shows that the high revenue scheme could be a sufficient condition for 82% of port projects being on cost. The consistency is quite moderate for that model though.

Group 3: Remuneration scheme- Revenue scheme

Table[36] B.9 : COST – ONLY PRESENCE - Consistency cut off (0.81)

Conditions	OUTCOME COST : of outcome and conditions
	Solution 1
Remuneration scheme	
Revenue scheme	+
Individual Consistency	0.76
Coverage (Raw)	0.82
Coverage (Unique)	0.82
Number of cases	5
	Muelle Costa Terminal Barcelona (0.88,0.8), Port of Leixoes (0.88,0.8), Piraeus Container, Port of Agaete (0.75,0.8)
Overall Consistency/Coverage	(0.76/**0.82**)

No results were found for the absence of the cost outcome for the group 3 of variables.
The group – model 4 showed that low financing scheme could explain 92 % of the cases being on cost and the consistency is quite high as well (0.83). However, financing scheme acts inconsistently because we were expecting the presence of this condition to lead projects to be on cost and not the absence of this condition.

Group 4: Financing scheme – Governance
Table[37] B.10: COST – ONLY PRESENCE - Consistency cut off (0.83)

Conditions	OUTCOME COST : presence of outcome and conditions
	Solution 1
Financing scheme	~
Governance	
Individual Consistency	0.83
Coverage (Raw)	0.92
Coverage (Unique)	0.92
Number of cases	
	Port of Agaete (0.94,0.8), Port of Leixoes (0.94,0.8), Muelle Costa Terminal Barcelona (0.78,0.8), Belgrade Bybass Project (0.78,0.8), Port of Sines Terminal XXI (0.69,1)
Overall Consistency/Coverage	(0.83/0.92)

No results were found for the absence of the cost outcome for the group 4 of variables.
Examining the presence of the on cost outcome of the group-model 5 gave us two solution paths. The 1st path shows that low governance can explain 58% of the cases and the 2nd path shows that high institutional setting can explain 67% of the cases. It seems that in this model the 2nd solution path is “stronger” than the 1st, in terms of consistency and coverage.

Group 5: Governance – institutional setting

[36] No results are found for the parsimonious solution, so no condition can be considered as core.
[37] No results are found for the parsimonious solution, so no condition can be considered as core.

Table[38] B.11: COST – ONLY PRESENCE - Consistency cut off (0.77)

Conditions	OUTCOME COST: presence of outcome and conditions	
	Solution 1	Solution 2
Governance	~	
Institutional Setting		+
Individual Consistency	0.78	0.82
Coverage (Raw)	**0.58**	**0.67**
Coverage (Unique)	0.08	0.17
Number of cases		
	Muelle Costa Terminal Barcelona (0.7,0.8), Port of Sines Terminal XXI (0.6,1), Piraeus Container	Port of Leixoes (0.65,0.8), Muelle Costa Terminal Barcelona (0.62,0.8), Port of Agaete (0.62,0.8), Port of Sines Terminal XXI (0.59,1)
Overall Consistency/Coverage	(**0.82**/0.75)	

No results were found for the absence of the cost outcome for the group 5 of variables.

Simplifying the results

Even if the conditions examined for each of the five groups are different, we will present the results per outcome, gathering all the "5-group" results. Four tables will be presented because for each outcome only the presence or only the absence of it gave us results: 1) presence of cost, 2) absence of time, 3) presence of traffic and 4) presence of revenues.

In table B.12 "presence – cost - simplification method", all the paths of all the five groups of the cost analysis are presented. Thus we can see that **institutional setting, cost saving and revenue scheme are always consistent** whereas financial & economic setting, financing scheme and governance (one time out of the two) were inconsistent. Also, it is good to point out that remuneration scheme never appears in any solution path and also that **the only core condition is the cost saving**. It is also important to mention that "*among the models presented, the overall coverage is very high. This suggests that the explanatory power of these solutions is quite strong. The same conclusion holds for the individual solution paths" (Roumboutsos et al. 2016, p.160).*

Table B.12: PRESENCE – COST – simplification method

COST	Institutional Setting	Financial and Economic Setting	Governance	Cost saving	Remuneration scheme	Revenue Scheme	Financing scheme	Coverage (raw)	Coverage (unique)	Overall coverage
Group 1 **(S1)**		~						0.85	0.23	0.90
(S2)	+							0.67	0.06	
Group 2 (S1)				+				0.54	0.54	**0.54**
Group 3 (S1)						+		0.82	0.82	0.82
Group 4 (S1)							~	0.92	0.92	0.92
Group 5 (S1)			~					0.58	0.08	0.75
(S2)	+							0.67	0.17	
Appearance	2/4	1/2	1/3	1/1	0/1	1/1	1/1			
Score of consistency per condition	2/2	0/1	0/1	1/1	-	1/1	0/1			
Core – per condition				1/1						

[38] No results are found for the parsimonious solution, so no condition can be considered as core.

The above results which show the consistent and inconsistent conditions can be also presented in the following table where the conditions are ranked according to how many times they appeared to be consistent or inconsistent in the paths. Based on this table, we will re-run the cost analysis using only the consistent conditions and omitting the inconsistent ones.

Table B.13: Overall Conclusions- Cost

CONSISTENT	INCONSISTENT
- **Institutional setting** [39]	1. **Financial –economic setting**
- **Cost saving**	2. **Financing scheme**
- **Revenue scheme** (same ranking)	3. **Governance** (same ranking)
- **Remuneration scheme (it never appears in paths)**	

New analysis-cost

The models examined are the following two for the cost outcome:

- Cost (a): Cost saving, Institutional setting
- Cost (b): Cost saving, Revenue scheme

The cost saving is used in the two models because in the initial analysis it appeared to be not only consistent but also core.

The analysis of the new cost model (a) gave us two solution paths. The paths were covering up to 67% of these projects. 67% of the port projects on cost were explained by a high institutional setting (path 1) and 54% of the projects by a high cost saving (path 2), with consistencies of 82% and 92% respectively.

Table[40] B.14: **Cost (a)** – ONLY PRESENCE - Consistency cut off (0.79)

Conditions	OUTCOME COST: presence of outcome and conditions	
	Solution 1	
Cost saving		+
Institutional setting	+	
Individual Consistency	0.82	0.92
Coverage (Raw)	**0.67**	**0.54**
Coverage (Unique)	0.24	0.11
Number of cases	5	2
	Port of Leixoes (0.65,0.8), Muelle Costa Terminal Barcelona (0.62,0.8), Port of Agaete (0.62,0.8), Port of Sines Terminal XXI (0.59,1)	Piraeus Container (0.84,0.8), Port of Leixoes (0.58,0.8)
Overall Consistency/Coverage	(0.83/**0.78**)	

[39] The ranking is based on the score of consistency and inconsistency of each condition. The more times the condition is consistent (or inconsistent) the higher it will be in the ranking of the "overall conclusions" table.

[40] No results are found for the parsimonious solution, so no condition can be considered as core.

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The analysis of the 2nd new cost model showed us that 49% of the port projects on cost were explained by the combination of high cost saving and high revenue scheme. The last path is the only path of the on cost analysis which shows that a combination of conditions and not only one condition individually affect a port project to be on cost. Although the new models gave us less good results because the coverage was much lower than the initial models' coverage, the new cost model b, gave us a path composed not by one but by two conditions.

Table B.15: **Cost (b)** ONLY PRESENCE - Consistency cut off (0.91)

Conditions	OUTCOME COST: presence of outcome and conditions
	Solution 1
Cost saving	+
Revenue scheme	+
Individual Consistency	0.91
Coverage (Raw)	**0.49**
Coverage (Unique)	0.49
Number of cases	2
	Project Piraeus Container (0.84,0.8), Port of Leixoes (0.58,0.8)
Overall Consistency/Coverage	(0.91/0.49)

Time Analysis

The necessity control of the time outcome showed that there are three necessary conditions for the presence of the on time outcome 1) low (absent) economic & financial setting, 2) high (present) revenue scheme and 3) low (absent) financing scheme. Their consistencies are 1, 1, and 0.99 respectively. Consistencies equal to 1 are the highest possible, meaning that low economic and financial setting will be always (100%) one of the conditions appearing in the combinations of conditions/solution paths of the on time outcome analysis. The same applies for the revenue scheme as well. Similarly, the low financing scheme will show up in 99% of the solution paths of the on time outcome analysis. We can consider these conditions as more "significant" than the others.

Table B.16: Necessity control of TIME OUTCOME

Conditions	**On Time**	
	Presence	**Absence**
High Institutional Setting	0.79 (0.37)	0.58 (0.75)
Low Institutional Setting	0.46 (0.28)	0.51 (0.87)
High Economic & Financial Setting	0.14 (0.16)	0.31 (1.0)
Low Economic & Financial Setting	**1.0** (0.35)	0.74 (0.70)
High Governance	0.68 (0.38)	0.46 (0.70)
Low Governance	0.47 (0.24)	0.60 (0.84)
High Cost Saving	0.45 (0.29)	0.47 (0.85)
Low Cost Saving	0.76 (0.34)	0.60 (0.75)
High Remuneration Scheme	0.78 (0.44)	0.45 (0.70)
Low Remuneration Scheme	0.47 (0.24)	0.64 (0.89)
High Revenue Scheme	**1.0** (0.35)	0.72 (0.70)
Low Revenue Scheme	0.15 (0.16)	0.33 (1.0)
High Financing Scheme	0.18 (0.20)	0.31 (0.99)
Low Financing Scheme	**0.99** (0.34)	0.75 (0.71)

*indicates the necessary condition, which is above the threshold that we set (.90)

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Regarding the sufficiency control conducted, the 5 groups-models created were also tested for the time outcome. For the cost outcome analysis, we found results only for the presence of the outcome, whereas in the time analysis we found results only for the absence of the time. This means that we can only explain the share of projects being over time and not the projects which were 'on and below' time. It is interesting to notice that in the 1st group (2nd solution path), the financial and economic setting being a core condition and explaining only 31% of the cases acts inconsistently with what it was expected but at least if we compare the results of the presence of the on cost analysis of the group 1 and the results of absence of the on time analysis of group 1, we will observe that at least the condition may act inconsistently in each separate analysis but it behaves in a "consistent" way because it appears with opposite signs for the presence of on cost and absence of on time analysis. Even if the consistency equals to 1 (the maximum), the coverage is lower than 50%, showing that the path is not very "strong" to be considered among the other strong/sufficient paths.

However, the 1st path is stronger in terms of individual consistency, coverage and also in terms of acting as expected. According to the 1st path, low institutional setting explains 51% the projects being over time and the consistency equals to 0.87, which is satisfying.

Group 1: Institutional setting – Financial –economic setting

Table B.17: TIME – ONLY ABSENCE - Consistency cut off (0.89)

Conditions	OUTCOME TIME: absence of outcome and conditions	
	Solution 1	Solution 2
Institutional setting	~	
Financial and economic setting		+
Individual Consistency	0.87	1.0
Coverage (Raw)	**0.51**	0.31
Coverage (Unique)	0.25	0.05
Number of cases	1	1
	Piraeus Container (0.67,1)	Port of Sines Terminal XXI (0.65,1)
Overall Consistency/Coverage	(0.88/**0.56**)	

Testing the 2nd group for the absence of the on time outcome gave us two solution paths, but we will take into consideration only the 1st one because the coverage of the 2nd one is less than 0.5 (0.47). The 1st path showed us that low governance explains 60% of the projects being over time in this model and the consistency was satisfying (0.84). The condition is also acting consistently; as it was expected.

Group 2: Governance – Cost saving

Table[41] 18: TIME – ONLY ABSENCE - Consistency cut off (0.8)

Conditions	OUTCOME TIME: absence of outcome and conditions	
	Solution 1	Solution 2
Governance	~	
Cost saving		+
Individual Consistency	0.84	0.85
Coverage (Raw)	**0.60**	0.47
Coverage (Unique)	0.22	0.09
Number of cases	4	2
	Barcelona Europe South Terminal	Piraeus Container (0.84,1),

[41] No results are found for the parsimonious solution, so no condition can be considered as core.

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	(0.7,1), Port of Sines Terminal XXI (0.6,1), Piraeus Container (0.59,1)	
Overall Consistency/Coverage	(0.78/**0.69**)	

The analysis of the 3rd group for the absence of the on time outcome gave us a quite strong path. According to this path, low remuneration scheme could explain 64 % of the projects and the consistency was quite high and equal to 0.89. It is also important to mention that the condition is acting consistently and that it is also a core condition.

Group 3: Remuneration scheme- Revenue scheme

Table B.19: TIME – ONLY ABSENCE - Consistency cut off (0.87)

Conditions	OUTCOME: of outcome and conditions
	Solution 1
Remuneration scheme	~
Revenue scheme	
Individual Consistency	0.89
Coverage (Raw)	0.64
Coverage (Unique)	0.64
Number of cases	1
	Port of Agaete (0.9,1)
Overall Consistency/Coverage	(0.89/**0.64**)

The 4th Group – model is the 2nd model so far that gave us a solution path which is composed not only by one only condition but by the combination of the two conditions inserted in the model as independent. That was not the case when we tested the 4th group for the presence of the on time outcome because only one condition was composing the path. This path shows that low governance (core condition) and low financing scheme could explain 55% of the port projects being over time. Both conditions act as they were expected to and also the consistency of the path is satisfying (0.83).

Group 4: Financing scheme – Governance

Table B.20: TIME – ONLY ABSENCE - Consistency cut off (0.83)

Conditions	OUTCOME TIME: absence of outcome and conditions
	Solution 1
Financing scheme	~
Governance	~
Individual Consistency	0.83
Coverage (Raw)	0.55
Coverage (Unique)	0.55
Number of cases	3
	Port of Sines Terminal XXI (0.6,1), Piraeus container (0.59,1)
Overall Consistency/Coverage	(0.83/**0.55**)

Testing group 5 gave us two solution paths. On the one hand, the 1st solution path showed that low governance explains 60% of the projects being over time. The consistency is quite high (0.84) and the condition is acting consistently. On the other hand, the 2nd solution path showed that high institutional setting could explain 58% of the cases of the projects being over time. The consistency is moderate though (0.75) and the condition is acting inconsistently.

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Group 5: Governance – institutional setting

Table[42] B.21: TIME – ONLY ABSENCE - Consistency cut off (0.78)

Conditions	OUTCOME TIME: absence of outcome and conditions	
	Solution 1	Solution 2
Governance	~	
Institutional setting		+
Individual Consistency	0.84	0.75
Coverage (Raw)	**0.60**	**0.58**
Coverage (Unique)	0.08	0.06
Number of cases	4	5
	Barcelona Europe South Terminal (0.7,1), Port of Sines Terminal XXI (0.6,1), Piraeus Container (0.59,1)	Barcelona Europe South Terminal (0.62,1), Port of Agaete (0.62,1), Port of Sines Terminal XXI (0.59,1)
Overall Consistency/Coverage	(0.75/**0.66**)	

In table B.22 "absence – time - simplification method", all the paths of all the five groups of the time analysis are presented. Thus we can see that **governance, remuneration and financing scheme are always consistent** whereas financial & economic setting, institutional setting and cost saving were inconsistent. Also, it is good to point out that revenue scheme never appears in any solution path. It is also important to mention that *"among the models presented below, the overall coverage is satisfyingly high (>50%). This suggests that the explanatory power of these solutions is quite strong. The same conclusion also holds for the most of the individual solution paths."*

Table 22: ABSENCE– TIME – simplification method

TIME	Institutional Setting	Financial and Economic Setting	Governance	Cost saving	Remuneration scheme	Revenue Scheme	Financing scheme	Coverage (raw)	Coverage (unique)	Overall coverage
Group 1 **(S1)**	~							**0.51**	0.25	**0.56**
(S2)		+						0.31	0.05	
Group 2 (S1)			~					**0.60**	0.22	**0.69**
(S2)				+				0.47	0.09	
Group 3 (S1)					~			0.64	0.64	**0.64**
Group 4 (S1)			~				~	0.55	0.55	**0.55**
Group 5 (S1)			~					0.60	0.08	**0.66**
(S2)	+							0.58	0.06	
Appearance	2/4	1/2	3/5	1/2	1/1	0/1	1/1			
Score of consistency per condition	1/2	0/1	3/3	0/1	1/1	-	1/1			
Core – per condition	1/2	1/1	1/3	-	1/1	-	-			

The above results which show the consistent and inconsistent conditions can be also presented in the following table where the conditions are ranked according to how many times they appeared to be consistent or inconsistent in the paths. Based on this table, we will re-run the time analysis using only the consistent conditions and omitting the inconsistent ones.

[42] No results are found for the parsimonious solution, so no condition can be considered as core.

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Table B.23: Overall Conclusions- Time

CONSISTENT	INCONSISTENT
- Governance [43]	1. Financial –economic setting and Cost saving (same ranking)
- Remunerations scheme	2. Isntitutional setting
- Financing scheme (same ranking)	
- Revenue scheme (it never appears in paths)	

New analysis-time

The two new models proposed to be tested for the "on time" outcome, using only the consistent conditions are the 1) governance & remuneration scheme (new model 1) and 2) the remuneration & financing scheme (new model 2). No results were found for the "new model 1" either for the presence or the absence of the "on time" outcome. Also, no results were found for the presence of the on time outcome of the "new model 2". We only found results for the absence of the "on time" outcome.

It is very interesting that results were found for the absence of the "on time" outcome. When testing all the models/groups for the cost, traffic and revenues outcome, we found only results for the presence of the outcomes and thus we could only explain why these projects were on cost, on traffic and on revenues. But for the time outcome, when testing the initial 5 groups of conditions we only found results for the absence of the outcome and again when testing the new model of financing scheme and remuneration scheme we only found results for the absence of the "on time" outcome.

What is also interesting is that when testing the new model of financing scheme and remuneration scheme (Table B.24), we found not one factor which can explain why port projects are over time but a combination of factors. When doing the analysis for all the outcomes we only found two times a solution path giving us a combination of factors. One of these times was again when testing the absence of "on time" outcome; particularly when testing the group of "financing scheme & governance" we also found that the absence of these two conditions would lead a significant percentage of port projects to be over time. The two times we found a combination of conditions, in which one of the independent variables which was used was the financing scheme. **Thus we could conclude that probably port projects being over time could be affected by the absence of the financing scheme when it is combined with another condition.**

After adopting this "stronger" model (table B.24) (using only the conditions being always consistent), the path was covering the same percentage of projects (64%). 64% of projects being over time were explained by the combination of low financing scheme and low remuneration scheme. The consistency was quite high (0.89).

[43] The ranking is based on the score of consistency and inconsistency of each condition. The more times the condition is consistent (or inconsistent) the higher it will be in the ranking of the "overall conclusions" table.

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Table B.24:**Time**[44]– **ONLY ABSENCE** - Consistency cut off (0.89)

Conditions	OUTCOME REVENUES: presence of outcome and conditions
	Solution 1
Financing scheme	~
Remuneration scheme	~
Individual Consistency	0.89
Coverage (Raw)	**0.64**
Coverage (Unique)	0.64
Number of cases	1
	Port of Agaete (0.9,1)
Overall Consistency/Coverage	(0.89/0.64)

Traffic

The necessity control of the traffic outcome showed that there are three necessary conditions for the on traffic outcome, two necessary conditions for the absence of the on traffic outcome (high institutional setting & low cost saving) and one for the presence of the on traffic outcome (low financing scheme). Their consistencies are very high, 0.97, 1.0 and 0.94 respectively, which means that these conditions will almost always appear in the on traffic outcome solution paths. To be more particular, 1) **high institutional setting** will show up in 97% of the solution paths of the absence of the on traffic outcome analysis, 2) **low cost saving** will be always (100%) one of the conditions appearing in the solution paths of the on absence of the on traffic outcome analysis and 3) similarly **low financing scheme** will appear as a condition in 94% of the solution paths of the presence of the on traffic outcome.

However, the conditions **1) Economic & Financial Setting, 2) IRA and 3) Revenue scheme** show some contradictory results because they appear to be necessary conditions for both the absence and the presence of the on traffic outcome. This means that for example low economic and financial setting is a necessary condition which can explain the port infrastructure projects being on traffic and below the forecasted traffic. Thus, the above three conditions being necessary for the absence and the presence of the outcome will be **excluded** from the fs QCA analysis, which is conducted for the traffic outcome.

The observations of the necessity control of the traffic outcome lead us to the sufficiency control of only a few of the six groups proposed. On the one hand, for the sufficiency control of the traffic outcome we can use only 3 out of the 6 groups proposed (based on the conditions' correlation) (table 26). These 3 groups are selected based on the necessity control of the conditions for the traffic outcome. Financing economic setting, IRA and revenue scheme appeared to be necessary for the absence and the presence of the traffic outcome and thus were excluded from the sufficiency control. The groups used are the ones composed by the five conditions behaving “normally” in the necessity control.

[44] No results are found for the parsimonious solution, so no condition can be considered as core.

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Table B.25: Necessity control of TRAFFIC OUTCOME

Conditions	On Traffic	
	Presence	Absence
High Institutional Setting	0.71 (0.91)	**0.97** (0.48)
Low Institutional Setting	0.59 (0.98)	0.83 (0.52)
High Economic & Financial Setting	0.21 (1.0)	0.45 (0.83)
Low Economic & Financial Setting	0.97 (0.82)	1.0 (0.32)
High Ira	0.98 (0.76)	1.0 (0.30)
Low Ira	0.09 (1.0)	0.20 (0.83)
High Governance	0.56 (0.90)	0.76 (0.47)
Low Governance	0.67 (0.88)	0.83 (0.42)
High Cost Saving	0.52 (1.0)	0.58 (0.42)
Low Cost Saving	0.70 (0.81)	**1.0** (0.45)
High Remuneration Scheme	0.60 (0.91)	**0.8975** (0.52)
Low Remuneration Scheme	0.69 (0.95)	0.85 (0.45)
High Revenue Scheme	0.91 (0.80)	1.0 (0.34)
Low Revenue Scheme	0.25 (1.0)	0.40 (0.63)
High Financing Scheme	0.28 (0.88)	0.66 (0.80)
Low Financing Scheme	0.94 (0.88)	0.897 (0.32)

* indicates the necessary condition, which is above the threshold that we set (.90)

Table B.26: Groups of conditions used for the on traffic outcome analysis, based on the necessity control

Conditions –behaving “normally” in necessary control- **TRAFFIC**	**3 Groups tested**
1. Institutional setting	• **Group 2**: Governance – Cost saving
2. Governance	• **Group 4:** Financing scheme – Governance
3. Cost saving	• **Group 5:** Governance – institutional setting
4. Remuneration scheme	
5. Financing scheme	

In this section we can see the results of the traffic outcome analysis of the groups 2, 4, 5. Results were found only for the presence of the traffic outcome and not for the absence. This means that we cannot explain the share of projects being below the forecasted traffic but we can only explain a share of projects which are “on or over traffic”.

The 2nd group analysis of governance and cost saving gave us two solution paths. The 1st solution path shows that the absence of governance can explain 67% of the port projects being on traffic. The consistency is quite satisfying (0.88). This discloses that the contractual arrangements of port projects do not really affect the traffic of a port. This seems quite logic, because normally the clauses of the contract are mostly related to the award phase, the construction phase of the project and the sharing of risks. The solution path shows that 52% of the cases being on traffic are explained by a high cost saving indicator. The consistency of this path is the maximum possible, 1.0, showing the significance of this indicator for achieving high traffic.

Group 2: Governance – Cost saving

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Table[45] B. 27: TRAFFIC – ONLY PRESENCE - Consistency cut off **(0.86)**

Conditions	OUTCOME TRAFFIC: presence of outcome and conditions	
	Solution 1	Solution 2
Governance	~	
Cost saving		+
Individual Consistency	0.88	1
Coverage (Raw)	**0.67**	0.52
Coverage (Unique)	0.27	0.12
Number of cases	4	2
	Piraeus Container Terminal (0.75,1), Muelle Costa Terminal Barcelona (0.7,0.67), Port of Sines Terminal XXI (0.6,0.67)	Piraeus Container Terminal (0.7,1), Port of Leixoes (0.58,0.67)
Overall Consistency/Coverage	(0.90/**0.79**)	

The 4th group analysis of the financing scheme and governance gave us results only for the presence of the on traffic outcome, as well. One solution path came out of this group's analysis, showing that the absence of (low) financing scheme[46] could contribute positively to a port project being on traffic. It is important to keep in mind that low financing scheme does not mean that there are less financial sources to finance the project but it is shows that this project investment was less attractive to the private sector. This path explains 94% of the cases with a consistency of 0.88.

Group 4: Financing scheme – Governance

Table[47] B.28: TRAFFIC – ONLY PRESENCE - Consistency cut off (0.90)

Conditions	OUTCOME TRAFFIC: presence of outcome and conditions
	Solution 1
Financing scheme	~
Governance	
Individual Consistency	0.88
Coverage (Raw)	0.94
Coverage (Unique)	0.94
Number of cases	4
	Port of Agaete (0.94,1), Port of Leixoes (0.94,0.67), Muelle Costa Terminal Barcelona (0.78,0.67), Piraeus Container Terminal (0.78,1), Port of Sines Terminal XXI (0.69,0.67)
Overall Consistency/Coverage	(0.88/**0.94**)

Last but not least, the group 5 was tested. We had also only results for the presence of the on traffic outcome. This analysis provided us with two solution paths. Again we can see, as we also observed in the analysis of group 2, that the absence of the governance can explain a big percentage of projects being on traffic (67% of the cases) having also a satisfying consistency 0.88. The 2nd solution path shows that a high institutional setting of a country can positively affect 71% of the port cases being on traffic. The consistency of this path is quite high (0.91). This path is consistent to our main hypothesis saying that *"when all the typology conditions are positive (present), they will lead in combination to the presence of the outcomes. Also, when the typology conditions are absent, their combined absence will lead to the absence of the outcomes"*[48]. It seems quite logic that a high institutional indicator could affect positively traffic of ports mostly because of its legal and regulatory

[45] No results are found for the parsimonious solution, so no condition can be considered as core.
[46] Financing scheme indicator is now refined and updated for next QCA analyses.
[47] No results are found for the parsimonious solution, so no condition can be considered as core.
[48] This hypothesis, expectation does not apply for the financing scheme because low financing scheme indicator means that the project is less attractive to the private sector.

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framework and also because of the political stability, control of corruption and government effectiveness.

Group 5: Governance – institutional setting

Table[49] B.29: TRAFFIC – ONLY PRESENCE - Consistency cut off (0.89)

Conditions	OUTCOME TRAFFIC: presence of outcome and conditions	
	Solution 1	Solution 2
Governance	~	
Institutional setting		+
Individual Consistency	0.88	0.91
Coverage (Raw)	0.67	0.71
Coverage (Unique)	0.12	0.17
Number of cases	4	5
	Piraeus Container Terminal (0.75,1), Barcelona Europe South Terminal (0.7,0.33), Muelle Costa Terminal Barcelona (0.7,0.67), Port of Sines Terminal XXI (0.6,0.67)	Port of Leixoes (0.65,0.67), Barcelona Europe South Terminal (0.62,0.33), Muelle Costa Terminal Barcelona (0.62,0.67), Port of Agaete (0.62,1), Port of Sines Terminal XXI (0.59,0.67)
Overall Consistency/Coverage	(0.90/**0.83**)	

In table B.30, the solution paths of all the groups tested for the presence of the on traffic outcome analysis are presented. The coverage of these paths is very high reaching up to 94%. The consistency is also very high, coming up to 90%. Based on table 30, the conditions being always consistent were the institutional setting and the cost saving, whereas the governance and financing scheme indicators were inconsistent. These results are also presented in table B.31.

Table B.30: PRESENCE – TRAFFIC – simplification method

Traffic	Institutional Setting	Governance	Cost saving	Financing scheme	Consistency	Coverage (raw)	Coverage (unique)	Overall coverage	Overall Consistency
Group 2 (S1)		~			0.88	0.67	0.27	0.79	**0.90**
(S2)			+		1	0.52	0.12		
Group 4 (S1)				~	**0.88**	**0.94**	**0.94**	**0.94**	0.88
Group 5 (S1)		~			0.88	0.67	0.12	0.83	**0.90**
(S2)	+				0.91	0.71	0.17		
Appearance	1/2	2/5	1/2	1/1					
Score of consistency per condition	1/1	0/2	1/1	0/1*					

Based on the “overall conclusions” in table B.31, we will repeat the on traffic outcome analysis, this time using as conditions the **1) institutional setting and the 2) cost saving,** which were always consistent in all solution paths.

[49] No results are found for the parsimonious solution, so no condition can be considered as core.

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Table B.31: Overall Conclusions - Traffic

CONSISTENT	INCONSISTENT
- Institutional setting [50] (1/1)	1. Governance (2/2)
- Cost saving (1/1)	2. Financings scheme (1/1)
(same ranking)	

The conditions 1) institutional setting and the 2) cost saving were both consistent in the new analysis as well. The 1st solution path showed us that 52% of the cases being on traffic can be explained by high cost saving. The consistency of this path was the maximum possible (1.0). Based on the 2nd solution path, 71% of the cases being on traffic can be explained by a high institutional setting. The consistency was quite high as well.

"New" Group : Institutional setting– Cost saving

Table[51] B.32: Traffic – ONLY PRESENCE - Consistency cut off (0.91)

Conditions	OUTCOME Traffic: presence of outcome and conditions	
	Solution 1	Solution 2
Institutional setting		+
Cost saving	+	
Individual Consistency	**1.0**	**0.91**
Coverage (Raw)	**0.52**	**0.71**
Coverage (Unique)	0.10	0.29
Number of cases	2	5
	Piraeus Container Terminal (0.7,1), Port of Leixoes (0.58,0.67)	Port of Leixoes (0.65,0.67), Muelle Costa Terminal Barcelona (0.62,0.67), Port of Agaete (0.62,1), Port of Sines Terminal XXI (0.59,0.67)
Overall Consistency/Coverage	(0.92/0.81)	

Revenues

As it was also observed in the necessity control of the traffic outcome, abnormal behaviour is also observed for some of the conditions when doing the necessity control for the revenues outcome. The 1) institutional setting, 2) economic & financial Setting, 3) remuneration scheme and 4) revenue scheme are excluded from the sufficiency control because of their "abnormal" behaviour.

Thus we consider as necessary conditions 1) the **high governance** with consistency 1.0 for the absence of the on revenues outcome, 2) **the low cost saving** and 3) the **low financing scheme** which also have a consistency of 1.0 for the absence of the on revenues outcome.

Similarly with the traffic outcome, we conduct the sufficiency control only for 2 groups of conditions out of the 6 groups initially proposed. These 2 groups are selected based on the necessity control conducted for the on revenues outcome. The conditions behaving "normally" in the necessity control are the governance, cost saving and the financing scheme conditions and these compose the two groups which will be tested; group 2: governance and cost saving and group 4: financing scheme and governance.

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[50] The ranking is based on the score of consistency and inconsistency of each condition. The more times the condition is consistent (or inconsistent) the higher it will be in the ranking of the "overall conclusions" table.

[51] No results are found for the parsimonious solution, so no condition can be considered as core.

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Table B.33: Necessity control of REVENUES OUTCOME

Conditions	On Revenues	
	Presence	**Absence**
High Institutional Setting	0.65 (1.0)	1.0 (0.24)
Low Institutional Setting	0.50 (1.0)	1.0 (0.31)
High Economic & Financial Setting	0.17 (1.0)	0.78 (0.70)
Low Economic & Financial Setting	0.95 (0.96)	1.0 (0.16)
High Ira	0.96 (0.89)	1.0 (0.14)
Low Ira	0.8 (1.0)	0.25 (0.5)
High Governance	0.49 (0.94)	1.0 (0.30)
Low Governance	0.63 (1.0)	0.81 (0.20)
High Cost Saving	0.44 (1.0)	0.88(0.31)
Low Cost Saving	0.70 (0.97)	1.0 (0.21)
High Remuneration Scheme	0.55 (1.0)	1.0 (0.28)
Low Remuneration Scheme	0.61 (1.0)	1.0 (0.25)
High Revenue Scheme	0.90 (0.95)	1.0 (0.16)
Low Revenue Scheme	0.21 (1.0)	0.70 (0.52)
High Financing Scheme	0.26 (1.0)	0.83 (0.48)
Low Financing Scheme	0.86 (0.97)	1.0 (0.17)

* indicates the necessary condition, which is above the threshold that we set (.90)

Table B.34: Groups of conditions used for the on the revenues outcome analysis, based on the necessity control

Conditions –behaving "normally" in necessary control- **REVENUES**	**2 Groups tested**
1. Governance	• **Group 2**: Governance – Cost saving • **Group 4:** Financing scheme – Governance
2. Cost saving	
3. Financing scheme	

Results were found only for the presence of the revenue outcome and not for the absence. This means that we cannot explain the share of projects being below the forecasted revenues but we can only explain a share of projects which are "on or over revenues". The analysis of both groups showed us not a pair of conditions but the one condition which can affect the projects being on revenues.

Particularly, the 1st solution path of the group 2 analysis of the governance and cost saving, shows that low governance can explain 63% of the projects being on revenues. The consistency of this path is 1.0, which shows the big explanatory value of this path for projects being on revenues. The 2nd path shows that 44% of the projects can be explained by a high cost saving. The explanatory value of the 2nd path is equally big with the one of the 1st path, since the consistency here is also 1.0. The coverage is not very high though (<50%). **It is interesting the fact that the exact same paths came out, when testing the group 2 of variables for the traffic and the revenue outcome.**

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Group 2: Governance – Cost saving

Table[52] B.35: REVENUES – ONLY PRESENCE - Consistency cut off (1.0)

Conditions	OUTCOME REVENUES: presence of outcome and conditions	
	Solution 1	Solution 2
Governance	~	
Cost saving		+
Individual Consistency	1.0	1.0
Coverage (Raw)	0.63	0.44
Coverage (Unique)	0.3	0.1
Number of cases	4	2
	Piraeus Container Terminal (0.75,1), Barcelona Europe South Terminal (0.7,0.8), Muelle Costa Terminal Barcelona (0.7,0.8), Port of Sines Terminal XXI (0.6,0.8)	Piraeus Container Terminal (0.7,1), Port of Leixoes (0.58,0.8)
Overall Consistency/Coverage	(1.0/**0.74**)	

The 4th group analysis of the on revenue outcome showed that low (absent) financing scheme can explain 86% of the port projects being on revenues. The consistency is very high (0.97). It is interesting that for the "traffic outcome and the revenues outcome analysis" of the group 4, we can see that the absence of the same condition can affect the success of the project (either being a success related to traffic or revenues).

Group 4: Financing scheme – Governance

Table[53] B.36: REVENUES – ONLY PRESENCE - Consistency cut off (0.95)

Conditions	OUTCOME REVENUES: presence of outcome and conditions
	Solution 1
Financing scheme	~
Governance	
Individual Consistency	0.97
Coverage (Raw)	0.86
Coverage (Unique)	0.86
Number of cases	5
	Port of Agaete (0.94,1), Port of Leixoes (0.94,0.8), Muelle Costa Terminal Barcelona (0.78,0.8), Piraeus Container Terminal (0.78,1), Port of Sines Terminal XXI (0.69,0.8)
Overall Consistency/Coverage	(0.97/**0.86**)

Gathering all the paths of the revenue outcome analysis showed us that the coverage of all paths is very high, covering up to 86% and also the consistency was very high, up to 100%. The only condition acting consistently was the cost saving (Table B.37).

Table 37: PRESENCE- REVENUES- simplification method

Revenues	Gover nance	Cost saving	Financing scheme	Consis tency	Coverage (raw)	Coverage (unique)	Overall coverage	Overall Consistency
Group 2 (S1)	~			**1**	0.63	0.3	0.74	**1.0**
(S2)		+		**1**	0.44	0.1		
Group 4 (S1)			~	**0.97**	0.86	0.86	**0.86**	**0.97**
Appearance	1/3	½	1/1					
Score of consistency per condition	0/1	1/1	0/1*					

[52] No results are found for the parsimonious solution, so no condition can be considered as core.
[53] No results are found for the parsimonious solution, so no condition can be considered as core.

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Since only one of the conditions used in the original analysis act consistently to our main hypothesis (Table B.38), then it is not possible to re-run the sufficiency analysis for revenues because we need to use at least two conditions excluding the outcome. At least two conditions are needed excluding the outcome because the logic behind the QCA is that this analysis identifies combinations or in other words configurations of conditions. This is the strength of the method; that we can identify not only one factor affecting our outcome but a combination of factors that affect it. Unfortunately in this analysis, **most of the paths include only one condition affecting the outcome, because we only used two conditions as independent variables.**

Table B.38: Overall Conclusions- Revenues

CONSISTENT	INCONSISTENT
- Cost saving (1/1)	1. Financing scheme (1/1*)
	2. Governance (1/1) (same ranking)

In **table B.39**, we gathered the consistent conditions of the four outcome analysis, and we can see that cost saving acts always consistently in 3 out of the four outcomes and institutional setting in two out of the four outcome analysis.

Table B.39: Consistent conditions per outcome

CONSISTENT-COST	CONSISTENT-TIME	CONSISTENT-TRAFFIC	CONSISTENT-REVENUES
Institutional setting	Governance	Institutional setting [54] (1/1)	Cost saving (1/1)
Cost saving	Remunerations scheme	Cost saving (1/1) (same ranking)	
Revenue scheme	Financing scheme		

B.4 Conclusions

Cost

- A high level of revenue scheme is a necessary condition for the absence of the "on cost" outcome (93% consistency). Also low level of revenue scheme shows to be a necessary condition for the port infrastructure projects in our sample which are on cost (92% consistency).
- When testing all the five groups of conditions (5 models), we could not find any paths showing sufficient conditions to be over cost. This means that we cannot identify which combinations of conditions lead projects to be over cost.
- Regarding port infrastructure projects being on cost, we found paths covering up to 92% of the projects. 92% of the port projects being on cost can be explained by a low financing scheme. The other paths showed that port projects on cost could be affected by either low financial & economic setting, or high institutional setting, or high cost saving (core condition), or high revenue scheme, or low governance. The only path that appears twice is the one showing that high institutional setting could affect port projects being on cost.

[54] The ranking is based on the score of consistency and inconsistency of each condition. The more times the condition is consistent (or inconsistent) the higher it will be in the ranking of the "overall conclusions" table.

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- After adopting “stronger” models (using only the conditions being always consistent), the paths were covering up to 67% of these projects. 67% of the port projects on cost were explained by a high institutional setting, 54% of the projects by a high cost saving and 49% of the port projects on cost were explained by the combination of high cost saving and high revenue scheme. The last path is the only path of the on cost analysis which shows that a combination of conditions and not only one condition individually affect a port project to be on cost.
- The following three conditions act always as we expected them to do: **cost saving, institutional setting** and **revenue scheme.**

Time

- A low level of financial and economic setting, a high level of revenue scheme and a low level of financing scheme are all necessary conditions for the presence of the “on time” outcome. The consistency of these conditions is 1.0, 1.0 and 0.99 respectively.
- When testing all our models for the time outcome we cannot find any paths showing sufficient conditions for projects being “on or below time”. This means that it is not possible to explain which conditions or combinations of conditions make projects being on time.
- Regarding port projects, which experience time overrun, we found paths covering up to 64% of these projects. 64% of the port projects being over time can be explained by a low remuneration scheme. The other paths showed that port projects over time could be affected by either a high financial & economic setting, or by low governance, or by high cost saving or low financing scheme or low/high institutional setting.
- After adopting “stronger” models (using only the conditions being always consistent), the paths were covering the same percentage of projects (64%). 64% of projects being over time were explained by the combination of low financing scheme and low remuneration scheme. The last path is the only path of the time analysis which shows that a combination of conditions and not only one condition individually affect a port project to be over time. It is critical to point out that the only two times that a combination of conditions appear to affect a significant share of port projects (either being on cost or being over time) is when we conduct the analysis with the “new-stronger” models.
- The indicators **governance, remuneration scheme** and **financing scheme** acted always consistently.

Traffic

- A high institutional setting and a low cost saving were necessary conditions for the absence of the traffic outcome. Their consistency was 0.97 and 1.0 respectively. Also low financing scheme is a necessary condition for the presence of the traffic outcome (consistency 0.94%). Some other conditions such as low economic & financial setting, high IRA and high revenue scheme appear to be necessary conditions both for the absence and presence of the traffic outcome and thus acting “abnormally” are excluded from our analysis.
- When testing all our models for the traffic outcome, we cannot find any paths showing sufficient conditions for projects to be “below traffic”. This means that it is impossible to explain which conditions or combinations of conditions explain projects being below the forecasted traffic and we can only explain the projects which are on traffic.
- Regarding the port projects which are “on traffic” we found paths covering up to 94% of these projects. 94% of the port projects being on traffic were explain by low financing scheme. The other paths showed that port projects on traffic could be affected by either a low governance (path appearing twice), or a high cost saving or a high institutional setting.
- After adopting “stronger” models (using only the conditions being always consistent), the paths were covering a smaller percentage of projects (up to 71%). More particularly, 71% of

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the port projects being on traffic are affected by a high institutional setting and 52% of these projects are affected by a high cost saving.

- The conditions that always acted consistently were the **institutional setting** and **cost saving**.

Revenues

- A high level of governance, a low level of cost saving and a low financing scheme are necessary conditions for the absence of the revenues outcome (consistency 100%). Low economic & financial setting, high IRA and high revenue scheme appear consistent for the presence and the absence of the traffic outcome and thus are excluded from the sufficiency analysis, as was also made for the traffic analysis. Ain addition the condition remuneration scheme was also excluded because it appears as necessary both when it is low or high.
- We could not find any paths showing sufficient conditions for projects to be below revenues. This means that it is impossible to explain which conditions or combinations of conditions make projects to be below the forecasted revenues.
- Regarding the port projects, which were on revenues, we found paths covering up to 86% of these projects. 86% of the projects on revenues are explained by a low financing scheme. The other paths, which could explain smaller share of project being on revenues, showed that the port projects could be also affected by either a low governance or a high cost saving.
- The condition that always acted consistently was the **cost saving**.

It is important to mention that the limitation of this research is the number of cases tested, which is very small; 6 cases. It is a limitation because QCA needs at least 12 cases to show to us reliable results. However, this does not mean that conducting the analysis with only 6 cases is wrong. It is also possible but the difficulty comes to the selection of only the two conditions that each time can be inserted in the analysis as independent variables. Although the conclusions cannot be used as recipes that will ensure the success of port infrastructure projects, they can be used as useful indications for what policy makers should take into account when dealing with similar port infrastructure projects like the ones tested. This research can be also a trigger for further related research, aiming on the examination of the factors affecting the success and failure of port infrastructure projects.

B.5 References

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Appendix: Calibration method

All typology indicators (as conditions) were calibrated using direct calibration, since all raw values (i.e. original values) of these indicators were represented by continuous values ranging mostly between 0 to 1. More specifically, the cost saving and the financing scheme have a different raw value, being -0.333 (full non membership) and 1 (full membership), respectively, and 0.125 (full non membership) and 1 (full membership). By using direct calibration, we set up three different thresholds: full membership (0.95); cross over point (0.5) and full non-membership (0.05). The Input conditions were calibrated into crisp set and fuzzy set: 1) Mode: Roads (1)

Table: Method of Calibration

ITEMS	SCORING	METHOD		CALIBRATION
		TYPE	Scaling	CS/fs-QCA
1. OUTCOME				
• Cost	Below budget, On budget, Over budget	INDIRECT	Below budget=1	1
			On budget=0	0,8
			Over budget=-1	0
• Time	Ahead schedule, On time, Delayed	INDIRECT	Ahead schedule	1
			On time	0,8
			Delayed	0
• Traffic (Actual vs forecasted)	Exceeding, as forecasted, below forecasted, far below forecasted	INDIRECT	Exceeding	1
			As forecasted	0,67
			Below forecasted	0,33
			Far below forecasted	0
• Revenue (Actual vs forecasted)	Exceeding, As forecasted, below forecasted	INDIRECT	Exceeding	1
			As forecasted	0,8
			Below forecasted	0

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ITEMS	SCORING	METHOD		CALIBRATION
		TYPE	Scaling	CS/fs-QCA
2. INPUTS				
• Mode (Roads-Non Roads)	Airport, Roads, Terminal, Ports, Airports, Public transport	Crisp set	Roads Non-Roads	1 0
• Use (Passenger-Non Passenger)	Passenger, Freight, Mix	Crisp set	Passenger Non Passenger	1 0
• Investment size	High, Medium, Low	INDIRECT	High Medium Low	1 0,6 0
• Delivery (PPPs-Public)	PPPs, Concessionaires, Public	Crisp set	PPPs Public	1 0
• Network (Links-Non Links)	Link, Link within link, node within node, node	Crisp set	Link Non-Link	1 0
3. TYPOLOGIES				
• Institutional setting	Index varies between 0 to 1 (Review index 26 C's from 2000 to 2013)	DIRECT	Threshold for full membership (0,95)	0,90
			Cross over point	0,65
			Threshold for non- full membership (0,05)	0,40
• Financial-economic setting	Index varies between 0 to 1 (Review index 26 C's from 2000 to 2014)	DIRECT	Threshold for full membership (0,95)	0,80
			Cross over point	0,60
			Threshold for non- full membership (0,05)	0,40
• IRA	Index varies between 0% to 100%	INDIRECT	IRA ≥ 90%	1
			80% ≤ IRA < 90%	0,8
			70% ≤ IRA < 80%	0,6
			60% ≤ IRA < 70%	0,4
			50% ≤ IRA < 60%	0,2
			IRA ≤ 50%	0
• Overall Governance	Index varies between 0 to 1	DIRECT	Threshold for full membership (0,95)	0,95
			Cross over point	0,50
			Threshold for non- full membership (0,05)	0,05
• Cost Saving	Index varies between -0,333 to 1	DIRECT	Threshold for full membership (0,95)	0,9335
			Cross over point	0,333
			Threshold for non- full membership (0,05)	-0,2665
• Remuneration Scheme	Index varies between 0 to 1	DIRECT	Threshold for full membership (0,95)	0,95
			Cross over point	0,5
			Threshold for non- full membership (0,05)	0,05
• Revenue Scheme	Index varies between 0 to 1	DIRECT	Threshold for full membership (0,95)	0,95
			Cross over point	0,5
			Threshold for non- full membership (0,05)	0,05
• Financing Scheme	Index varies between 0,125 to 1	DIRECT	Threshold for full membership (0,95)	0,96
			Cross over point	0,563
			Threshold for non- full membership (0,05)	0,17

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Annex 3: fsQCA of Non-Road Cases

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C.1 Non-Road sample-Cost (29 cases – max. six conditions)

The Cost analysis was conducted also for the Non-Road sample, composed of 29 cases. Thus maximally six conditions could be used.

Part A: COST-NON ROADS FULL MODELS' ANALYSIS

Necessity analysis

The condition that showed closed to be necessary for non-road projects to be on cost is the high financing scheme (consistency: 0.89). The necessity analysis is conducted for the eight conditions, even if five conditions can be maximally used. The reason why is because we use necessity analysis as the means which will show us which are the five conditions that can be used for the analysis out of the eight in total. In the same way, in the previous QCA analysis conducted we omitted some of the conditions which appeared to behave abnormally in the necessity analysis (being necessary for the presence and the absence of the outcome); in the same way we can now select the conditions with the highest consistencies (>0.75) in the necessity analysis.

Table C.1: Necessity analysis of the 'on cost' outcome for the non-road sample

Conditions	On Cost	
	Presence	Absence
High Institutional Context	0.77 (0.74)	0.74 (0.46)
Low Institutional Context	0.42 (0.71)	0.55 (0.62)
High Economic & Financial Context	0.58 (0.71)	0.64 (0.52)
Low Economic & Financial Context	0.61 (0.71)	0.65 (0.54)
High Governance	0.77 (0.73)	0.70 (0.44)
Low Governance	0.41 (0.67)	0.58 (0.69)
High Cost Saving	0.61 (0.81)	0.47 (0.42)
Low Cost Saving	0.56 (0.62)	0.79 (0.57)
High Remuneration Attractiveness	0.46 (0.63)	0.65 (0.60)
Low Remuneration Attractiveness	0.71 (0.75)	0.59 (0.42)
High Revenue Robustness	0.69 (0.71)	0.71 (0.49)
Low Revenue Robustness	0.50 (0.73)	0.57 (0.55)
High Transport market efficiency and acceptability	0.59 (0.75)	0.50 (0.44)
Low Transport market efficiency and acceptability	0.57 (0.63)	0.74 (0.55)
High Financing Scheme (NEW)	0.89 (0.67)	0.84 (0.42)
Low Financing Scheme (NEW)	0.22 (0.68)	0.33 (0.67)

The conditions with consistencies > 0.75 are the 1) Institutional context, 2) Governance, 3) Cost Saving and 4) Financing Scheme.

Sufficiency analysis

The results show that two solution paths 59% the road projects being on cost are explained by cost saving (as core conditions), in combination with high governance AND high financing scheme (solution 1a) OR high institutional setting AND governance (Solution 1b) (Table C.2). The consistency ratio was quite high 0,85.

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Table C.2: Sufficiency analysis of road projects being 'over cost' (cut off: 0.78)

Conditions	OUTCOME: presence of "on cost"	
	Solution 1a	Solution 1b
Institutional Context		+
Governance	+	+
Cost Saving	+	+
Financing scheme (NEW)	+	
Individual Consistency	0.84	0.85
Coverage (Raw)	0.57	0.54
Coverage (Unique)	0.06	0.02
Number of cases	11	10
Some relevant cases	Metrolink LRT. Manchester (0.78,0.8), Lusoponte Vasco da Gama Bridge (0.78,0.8), Rion-Antirion Bridge (0.78,0.8), Larnaca and Paphos International Airports (0.77,0.8), Port of Leixoes (0.73,0.8), FERTAGUS Train (0.7,1), Warsaw's Metro II-nd line (0.7,0), Deurganckdock Lock (0.66,0.8), MST-Metro Sul do Tejo (0.65,0.8), Central PT Depot of city of Pilsen (0.64,0.8), Athens International Airport (0.62,0.8), Herrentunnel Lübeck (0.6,0.8)	Liefkenshoek Rail Link (0.78,0.8), Metrolink LRT. Manchester (0.78,0.8), Larnaca and Paphos International Airports (0.72,0.8), FERTAGUS Train (0.67,1), Deurganckdock Lock (0.66,0.8), MST-Metro Sul do Tejo (0.65,0.8), Port of Leixoes (0.65,0.8), Lusoponte Vasco da Gama Bridge (0.65,0.8), Herrentunnel Lübeck (0.6,0.8), Central PT Depot of city of Pilsen (0.56,0.8)
Overall Consistency/Coverage	(0.85/0.0.59)	

Sufficiency analysis showed 31% of the projects being over cost can be explained by combination of high institutional setting AND high governance AND low financing scheme.

Table C.3: Sufficiency analysis of road projects being 'over cost' (cut off: 0.79)

Conditions	OUTCOME: absence of "on cost"
	Solution 1
Institutional Context	+
Cost Saving	
Governance	+
Financing scheme (NEW)	~
Individual Consistency	0.78
Coverage (Raw)	0.31
Coverage (Unique)	0.31
Number of cases	2
Some relevant cases	Lyon's VeloV (0.72,1), Liefkenshoek Rail Link (0.57,0.2)
Overall Consistency/Coverage	(0.78/0.0.31)

Part B: Simplification Method- Simplifying the Initial Road –Cost Full Models with Only Core Conditions

The presence of outcome gave us one solution path of one condition. Thus it does not make sense, a simplification method to be applied in this model, since we need at least two conditions in the QCA in order to conduct the analysis, because the aim is to identify combinations of conditions affecting the outcome and not independent conditions. However, although three conditions found as core conditions for explaining projects being cost overrun, however, when simplifying using the three condition, the results dropped both consistency and coverage each 0.77 and 0.27 respectively. Therefore, we did not use the results of simplification method.

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C.2 Time – Non Road sample (29 cases – max. six conditions)

The time outcome analysis for the road sample is conducted for 29 cases and 5 maximally 5 conditions (similarly with the cost – non road sample analysis).

Part A: Time-Non Road FULL MODELS' ANALYSIS

Necessity analysis
The high financing scheme (consistency=0.89) is closed to be necessary for explaining non-road projects to be on time or over time. As the same way what we did on the previous analysis (Cost analysis, we can now select the conditions with the highest consistencies (>0.75) in the necessity analysis.

The conditions with consistencies > 0.75 are the 1) Institutional context, 2) Governance, 3) Revenue Robustness and 4) Financing Scheme.

Table C.4: Necessity analysis of the 'on time' outcome for the non-road sample

Conditions	On Time	
	Presence	Absence
High Institutional Context	0.78 (0.62)	0.71 (0.53)
Low Institutional Context	0.42 (0.61)	0.50 (0.67)
High Economic & Financial Context	0.57 (0.60)	0.60 (0.59)
Low Economic & Financial Context	0.61 (0.62)	0.59 (0.56)
High Governance	0.82 (0.67)	0.62 (0.47)
Low Governance	0.35 (0.50)	0.57 (0.75)
High Cost Saving	0.63 (0.72)	0.44 (0.47)
Low Cost Saving	0.54 (0.51)	0.74 (0.65)
High Remuneration Attractiveness	0.44 (0.52)	0.60 (0.60)
Low Remuneration Attractiveness	0.72 (0.66)	0.57 (0.40)
High Revenue Robustness	0.75 (0.67)	0.61 (0.50)
Low Revenue Robustness	0.44 (0.55)	0.60 (0.69)
High Transport market efficiency and acceptability	0.58 (0.66)	0.49 (0.62)
Low Transport market efficiency and acceptability	0.57 (0.54)	0.68 (0.68)
High Financing Scheme (NEW)	0.89 (0.57)	0.82 (0.50)
Low Financing Scheme (NEW)	0.22 (0.57)	0.29 (0.70)

Sufficiency analysis
No solution was found for the presence of the "on time" outcome for the non-road projects, which means that we cannot explain the causal mechanism of selected conditions and the non-road projects being on time.

A solution was only found for the absence of the "on time" outcome. The solution found showing that 58% of the road projects being over time are explained by three solution paths which four conditions are core conditions, namely institutional setting, governance, revenue robustness and financing scheme. Although the consistency ratio is rather low (0.78), however as standard good practice of QCA is still acceptable.

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Table C.5: Sufficiency analysis of road projects being 'over time', (cut off: 0.80)

Conditions	OUTCOME: absence of "on time"		
	Solution 1	Solution 2	Solution 3
Institutional Context	~		~
Governance		~	
Revenue Robustness	~	~	
Financing scheme (NEW)			~
Individual Consistency	0.80	0.80	0.82
Coverage (Raw)	0.44	0.40	0.23
Coverage (Unique)	0.05	0.10	0.05
Number of cases	1	4	1
Some relevant cases	Warsaw's Metro II-nd line (0.59,1)	Blanka Tunnel (0.89,1), Port of Sines Terminal XXI (0.7,1), The Hague New Central Train Station (0.63,1)	Piraeus Container Terminal (0.67,1)
Overall Consistency/Coverage	(0.78/0.58)		

Part B: Simplification Method- Simplifying the Initial Full Models of road for the time outcome only with Core Condition

Since all conditions (4 conditions) are core conditions for explaining project being over time, then we do not need to simplify the model.

C.3 Traffic-Non Road sample (23 cases – max. five conditions)

The analysis of the road sample for the traffic outcome was conducted using 23 cases and maximally five conditions.

Part A: Traffic-Non Road Full Models' Analysis

Necessity analysis
The necessity analysis showed that high financing scheme is a necessary condition for explaining project below traffic (consistency: 0.95).

We then select the conditions with the highest consistencies (>0.75) in the necessity analysis.

The five conditions with consistencies > 0.75 are the 1) Institutional context, 2) Economic & Financial Context 3) Governance, 4) Remuneration attractiveness and 5) Financing Scheme.

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Table C.6: Necessity analysis of the 'on traffic' outcome for the road sample

Conditions	On Traffic	
	Presence	Absence
High Institutional Context	0.81 (0.75)	0.73 (0.58)
Low Institutional Context	0.51 (0.68)	0.62 (0.75)
High Economic & Financial Context	0.42 (0.68)	0.45 (0.66)
Low Economic & Financial Context	0.79 (0.61)	0.79 (0.55)
High Governance	0.82 (0.64)	0.76 (0.54)
Low Governance	0.41 (0.65)	0.50 (0.72)
High Cost Saving	0.69 (0.72)	0.60 (0.57)
Low Cost Saving	0.58 (0.61)	0.70 (0.67)
High Remuneration Attractiveness	0.61 (0.81)	0.46 (0.56)
Low Remuneration Attractiveness	0.66 (0.57)	0.84 (0.67)
High Revenue Robustness	0.78 (0.67)	0.71 (0.55)
Low Revenue Robustness	0.47 (0.63)	0.55 (0.71)
High transport Market Efficiency & acceptability	0.55 (0.62)	0.66 (0.67)
Low transport market efficiency & acceptability	0.66 (0.64)	0.63 (0.56)
High Financing Scheme (NEW)	0.84 (0.55)	0.95 (0.56)
Low Financing Scheme (NEW)	0.33 (0.87)	0.24 (0.58)

Sufficiency analysis

66% of the non-road projects being on traffic are explained by low financing scheme (solution 1) OR remuneration attractiveness AND high governance AND high institutional context (Table C.7). The consistency was rather high: 0.81.

Table C.7: Sufficiency analysis of road projects being 'on traffic' (cut off: 0.87)

Conditions	OUTCOME: presence of "on traffic"	
	Solution 1	Solution 2
Institutional Context		+
Economic & Financial Context		
Governance		+
Remuneration Attractiveness		+
Financing scheme (NEW)	~	
Individual Consistency	0.87	0.83
Coverage (Raw)	0.33	0.58
Coverage (Unique)	0.08	0.32
Number of cases		
Some relevant cases	Piraeus Container Terminal (0.79,1), Lyon's VeloV (0.79,1), Barcelona Europe South Terminal (0.6,0.33), Liefkenshoek Rail Link (0.57,0.67)	Liefkenshoek Rail Link (0.75,0.67), Brabo 1 (0.75,0.67), Lyon's tramway T4 (0.72,1), Reims tramway (0.72,0.33), FERTAGUS Train (0.59,0.67), Central PT Depot of city of Pilsen (0.56,0.67
Overall Consistency/Coverage	(0.81/0.66)	

The analysis of the absence of the on traffic outcome showed that 71% of the non-road projects being below traffic can be explained by low remuneration scheme combined with high economic and financial context (solution 1) OR low institutional context AND high financing scheme (solution 2) OR low institutional context AND high governance (solution 3) OR high institutional context AND low

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governance AND low financing scheme (solution 4).(Table C.8). The consistency was rather high, 0.79.

Table C.8: Sufficiency analysis of road projects being 'below traffic'(cut off: 0.79)

Conditions	OUTCOME: absence of "on traffic"			
	Solution 1	Solution 2	Solution 3	Solution 4
Institutional Context		~	~	+
Economic & Financial Context	+			
Governance			+	~
Remuneration Attractiveness	~	~	~	~
Financing scheme (NEW)		+		~
Individual Consistency	0.78	0.83	0.80	0.82
Coverage (Raw)	0.38	0.59	0.55	0.22
Coverage (Unique)	0.10	0.02	0.00	0.02
Number of cases				
Some relevant cases	Herrentunnel Lübeck (0.85,1), Modlin Regional Airport (0.56,1), Metro do Porto (0.56,1)	Rion-Antirion Bridge (0.72,0.67), Athens Tramway (0.71,1), Athens International Airport (0.65,0.67)	Rion-Antirion Bridge (0.72,0.67), Athens International Airport (0.65,0.67)	Barcelona Europe South Terminal (0.6,0.67)
Overall Consistency/Coverage	(0.79/0.71)			

Part B: Simplification Method- Simplifying the Initial Full Models of Road Sample for Traffic Outcome with Only Core Condition

The non-road samples for the below traffic outcome analysis is simplified by selecting the 2 core conditions: Financing Scheme and Remuneration attractiveness

The simplification method yields more simple solution formula which covering 69% of the non- road projects being on traffic can be explained by either low financing scheme OR high remuneration attractiveness.

Table C.9: Sufficiency analysis of road projects being 'on traffic' (cut off: 0.91)

Conditions	OUTCOME: absence of "on traffic"	
	Solution 1	Solution 2
Financing Scheme	~	
Remuneration Attractiveness		+
Individual Consistency	0.87	0.81
Coverage (Raw)	0.33	0.61
Coverage (Unique)	0.08	0.36
Number of cases	4	6
Some relevant cases	Piraeus Container Terminal (0.79,1), Lyon's VeloV (0.79,1), Liefkenshoek Rail Link (0.57,0.67)	Lyon's tramway T4 (0.97,1), Liefkenshoek Rail Link (0.75,0.67), Brabo 1 (0.75,0.67), Central PT Depot of city of Pilsen (0.75,0.67), FERTAGUS Train (0.59,0.67)
Overall Consistency/Coverage	(0.80/0.69)	

Due to all conditions as necessary, we cannot simplify the model for analysis the absence of on traffic or below traffic.

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C.4. Revenues-Non Road sample (23 cases – max. five conditions)

Necessity analysis

The conditions showed to be necessary for non-road projects to be below revenues is the low the High Financing Scheme (consistency: 0.96).

The necessity analysis is conducted for the seven conditions, even if five conditions can be maximally used (Table 10). The reason why is because we use necessity analysis as the means which will show us which are the five conditions that can be used for the analysis out of the seven in total. We select the conditions with the highest consistencies (>0.75) in the necessity analysis.

The conditions with consistencies > 0.75 were the: 1) Economic & Financial Context, 2) Governance, 3) Remuneration Attractiveness, 4) Revenue Robustness and 5) Financing scheme.

Table C.10: Necessity analysis of the 'on revenues' outcome for the road sample

Conditions	On Revenues	
	Presence	Absence
High Institutional Context	0.71 (0.78)	0.73 (0.40)
Low Institutional Context	0.46 (0.78)	0.61 (0.51)
High Economic & Financial Context	0.34 (0.72)	0.52 (0.53)
Low Economic & Financial Context	0.77 (0.76)	0.72 (0.35)
High Governance	0.77 (0.77)	0.78 (0.38)
Low Governance	0.38 (0.78)	0.53 (0.53)
High Cost Saving	0.61 (0.81)	0.61 (0.40)
Low Cost Saving	0.55 (0.74)	0.71 (0.47)
High Remuneration Attractiveness	0.48 (0.81)	0.55 (0.46)
Low Remuneration Attractiveness	0.68 (0.75)	0.77 (0.42)
High Revenue Robustness	0.76 (0.83)	0.64 (0.34)
Low Revenue Robustness	0.40 (0.69)	0.68 (0.58)
High Transport Market Efficiency & Acceptability	0.57 (0.81)	0.51 (0.36)
Low Transport Market Efficiency & Acceptability	0.56 (0.70)	0.74 (0.46)
High Financing Scheme (NEW)	0.84 (0.70)	0.96 (0.39)
Low Financing Scheme (NEW)	0.27 (0.93)	0.27 (0.45)

Sufficiency analysis

The result showed that the road projects being on revenues can be explained by a high revenue robustness was combined with low financing scheme (solution 1) OR high governance (solution 2). The overall solution consistency is quite high (0,84). However, although the overall coverage of the solutions below is very satisfying 0.68, the coverage of the individual solutions is quite low: <0.30 (Table C.11).

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Table C.11: Sufficiency analysis of road projects being 'on revenues' (cut off: 0. 81)

Conditions	OUTCOME: presence of "on revenues"	
	Solution 1	Solution 2
Economic & Financial Context		
Financing scheme (NEW)	~	
Remuneration Attractiveness		
Revenue Robustness	+	+
Governance		+
Individual Consistency	0.93	0.83
Coverage (Raw)	0.27	0.65
Coverage (Unique)	0.04	0.41
Number of cases	4	11
Some relevant cases	Lyon's VeloV (0.79,1), Piraeus Container Terminal (0.75,1), Barcelona Europe South Terminal (0.6,0.8), Liefkenshoek Rail Link (0.57,0.8)	Lyon's VeloV (0.84,1), Athens International Airport (0.79,0.8), Liefkenshoek Rail Link (0.78,0.8), Larnaca and Paphos International Airports (0.75,0.8), Metrolink LRT. Manchester (0.75,1), Port of Leixoes (0.75,0.8), Rion-Antirion Bridge (0.75,0.8), Lusoponte Vasco da Gama Bridge (0.74,0.8), Central PT Depot of city of Pilsen (0.7,0.8), MST-Metro Sul do Tejo (0.61,0), Metro de Malaga (0.6,0.8)
Overall Consistency/Coverage	(0.84/0.68)	

No solution formula found for the analysis of absence of on revenues or below revenues.

Part B: Simplification Method- Simplifying The Initial Road Models of Revenues with Only Core Condition

As mentioned on table, we then re-run the model with three core conditions: Governance, Revenue Robustnessand Financing Scheme

The new solution is indeed stronger than the initial ones, which showing 76% of the non-road projects being on revenues are explained by high revenue robustness as a core condition.

Table C.12: Sufficiency analysis of road projects being 'on revenues' (cut off: 0. 77)

Conditions	OUTCOME: presence of "on revenues"
	Solution 1
Financing Scheme	
Governance	
Revenue Robustness	+
Individual Consistency	0.83
Coverage (Raw)	0.76
Coverage (Unique)	0.76
Number of cases	17
Some relevant cases	Metro de Malaga (0.85,0.8), Lyon's VeloV (0.84,1), Liefkenshoek Rail Link (0.83,0.8), Athens International Airport (0.79,0.8), Larnaca and Paphos International Airports (0.75,0.8), Metrolink LRT. Manchester (0.75,1), Barcelona Europe South Terminal (0.75,0.8), Piraeus Container Terminal (0.75,1), Port of Agaete (0.75,1), Port of Leixoes (0.75,0.8), Port of Sines Terminal XXI (0.75,0.8), Rion-Antirion Bridge (0.75,0.8), Lusoponte Vasco da Gama Bridge (0.74,0.8), Central PT Depot of city of Pilsen (0.72,0.8),
Overall Consistency/Coverage	(0.83/0.76)

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Annex 4: Rebuttal

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REVIEW OF DELIVERABLE D3.2

TASK LEADER: UNIVERSITY OF THE AEGEAN

REBUTTAL

The Authors wish to thank the internal and external reviewers for their comments and suggestions. The following table describes how **comments** have been incorporated in the final document.

Reviewer's Comments	Authors' Response
Dejan Makovsek, OECD - External Reviewer	
I would propose that in this (possibly) other documents different indicators are not only in the abbreviations but also in the glossary – explain once again what each signifies so that readers do not have to go to earlier/other BENEFIT products to find out what they signify. Perhaps material, describing some of them in chapter 6.2 could be moved to the front as well.	Brief description has been added in the Glossary.
It is clear that a lot of effort was put in this report (which deserves every commendation) and I did encounter multiple very interesting points, which I believe should be fleshed out/devoted more research time before pursuing a peer reviewed publication to increase their impact. Of particular relevance are the interactions between time and cost and other indicators that might yield policy advice with regard to particular targets of cost and benefits a government/procurement authority might pursue.	Thank you. These will also be included in the Deliverable D5.3: Conclusions and Policy Guidelines.
Limitations: As the authors themselves have acknowledged at multiple parts of the report, the sample is relatively small and there may be representativity. Arguably this has been compensated to some extent by applying several analytic approaches rather than one.	This has been the very reason of applying multiple methodologies in the analysis.
It is challenging to create a clear separation between all indicators and with some this was possibly more difficult than with others. In particular this would concern indicators like FEI and InI, where a range of sub indicators were put in a compound indicator, where it is not fully clear what the ingredients actually measure (e.g. Have you checked what is in the OECD indicator? How is the OECD liberalization in transport indicator relevant for a PPP, which in effect is a temporary monopoly – moreover if it	The FEI and InI indicators have been tested and validated in deliverables D2.2 and D4.2. Existing co-linearity was identified by econometrics analysis (D4.2 and D4.4) and for this reason only InI (D4.2)

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is availability based, does it really matter how the services are managed in the rest of the sector?). Moreover, given that rich countries generally have good institutions and procedures, there is potentially a substantial element of co linearity between these measures present. That said it might have been more prudent to use fewer indicators	and FEI (D4.4) was included in the respective analysis. In this report, this correlation was also considered, as well as other potential ones.
With regard to time and cost overruns it is a serious challenge that it is not identified whose responsibility they were. In general cost (and time) overruns need to be internalized by the construction contractor, with a very strict and multi-layered contract structure in place between the SPV and contractor. If there are delays/cost overruns on the project, you need to be sure they occurred due to risk materialization on the private side and not as a result of additional wishes/changes on the public side. Those cost will be simply passed through to the procurement authority and have no impact on the financial health of the private operator. This is something that is generally very difficult to find out, without access to original documentation and interviews.	The objective is to identify whether there is likelihood (low, average, high) of cost or time overrun. Changes in project scope should be reflected on the target cost and not be considered as a "cost overrun".
The matching framework was no doubt a useful tool to organize/guide analysis in this research project and to develop a rating approach from this seems a natural next step. To gain practical traction though it is far too complicated and involves too extensive data requirements. A large number of required data points for each observation creates a lot of cost and deters owners of information from participation. Following a tighter narrative than BENEFIT, similar current efforts (by the EDHEC Risk Institute) are directed at a limited set of data points per investment, to establish time series database, which will allow the investors to assess the risk/return profile of distinct types of infrastructure projects/contracts types. It is expected that their approach will phase out the cumbersome rating approach of the large rating houses in the future (http://edhec.infrastructure.institute/).	The Matching Framework's date requirements are reasonable considering the complexity of the system it aims to model. It includes all relevant and necessary information so as to base assessment on structural project characteristics and, therefore, improve the likelihood of successful project delivery. It also uses data that are mostly available in the public domain.
Ultimately, BENEFIT does not pursue the questions of Value for Money, its target is a successful execution of the project. From a PUBLIC "BENEFIT" point of view the ultimately chosen metrics (cost to completion, time to completion, actual vs forecasted traffic, actual vs forecasted revenue), don't only interact with themselves but also with two other metrics: - the ultimate total cost of construction - the pace of construction. A more balanced representation would be to also include or at least mention that pursuing on time or on budget targets can also lead to disproportionate increase of total cost (http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2763123). Moreover, in demand based contracts there may also be a tendency to force a faster pace of construction at the expense of higher cost but also earlier benefits. Since a PPP spends a lot of the time in structuring (2 years or more) it may in total last longer	The justification of VfM as well as other metrics used to justify a project are considered as input to BENEFIT expressed through Cost and Time to completion, Traffic and Revenue Targets. Trade-offs between cost and time are well known in project management and these were also identified, as well as the conditions for pursuing them in Chapter 3.

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Reviewer's Comments	Authors' Response
to deliver a project than in traditional procurement, but with higher cost. In short, pursuing the goals you have set out have additional trade-offs that would be fair to mention.	
Section 3.2 Comparative analysis of indicator findings The statement "cases explained". Would it make sense to add out of how many?	It has been added. Thank you.
Section 3.2.2. 1. Although you seem to have measured it, it does not come as self-evident, why a low RAI (a more demand based PPP) would perform better in terms of on-time delivery than an availability based contract. On paper, based on the incentives, there are penalties for delays in both cases. The only case where a difference would be possible is: • in availability based contracts there may be a contract management/enforcement problem so the penalties are not applied; • in availability based contracts the penalties are lower than the actual potential loss of revenue through traffic short fall. The results could be more powerful if you could corroborate either of the two points.	The reasoning is correct. However, here we are dealing with observations. While there is no direct way to validate the reasoning, we could check against the assessed capability of the Contracting Authority, which is a factor included in the Cost Saving Indicator. This validation we will consider in our next and final deliverable.
In the traffic part (1 para, p. 31) it is suggested high RAI and high Cost saving indicator are both relevant for achieving traffic goals in a PPP. For RAI that may indeed be the case as there may be a tendency in demand based schemes to try to increase cost recovery at the expense of traffic flow. In the case of the Cost saving (on cost construction) case however, this may have nothing to do with the performance of the private partner, but with the scope changes proposed by the public authority (I suspect you had no way of controlling for this). Moreover, if being on time is of crucial importance for the operator, for projects with low RAI you should record higher cost overruns (being on time might involve additional cost to speed up the pace of construction and catch the dates - work during nights, holidays and weekends).	The RAI apart from the capability to construct (which becomes irrelevant after the completion of construction), also includes a few additional very relevant terms: Capability to operate and the Contracting Authority's capability to monitor. This clarification is made in the text. Thank you.
Page 33/34 In the OECD paper (shared with Athena R.), which spawned the idea and provided a base project list a figure involving a different representation but similar data is presented and referenced as work with the BENEFIT consortium. Perhaps it would be appropriate to modestly mention this cooperation here as well.	The appropriate reference is in D4.4. It has been now included here as well. Thank you.
With regard to the results – the finding that the RAI is associated with poorer "on traffic" performance should be given more attention. As far as I know the pricing policy in a demand based model is regulated, i.e. the private party does not have full liberty to set prices however it wants. That said, to achieve stricter targets in terms of rates of return (cost recovery) the toll on privately built and operated roads could be higher. Moreover, because of the crisis there may have also been a	The observation is valid. The BENEFIT MF has two indicators through which this observation can be potentially captured: 1. The Remuneration Attractiveness

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second order effect, where due to falling traffic levels – government allowed private operators to raise the tolls in some cases (Portugal is an example I believe) without properly investigating the net effect – further eroding the financial situation of the operator and consequentially the government (as it had to assure the full cost recovery of the private operator). What I would recommend you attempt (assuming enough observations) is to show if regardless of the crisis on road projects – that the demand based projects have a lower traffic outturn than availability based projects. I understand this is to some extent presented later in the paper, but I believe the sample should be substantially increased. If that is the case (and it probably is) this would be a MAJOR finding and would imply a loss of social welfare.	Indicator (RAI): A higher value will signify a higher riskiness of the remuneration source if an increase in tolls takes place 2. The Market Efficiency Indicator: This indicator, however, did not appear as overall important in the current analysis. As these considerations might not have been addressed properly, we will review and aim to address this point in the next and final deliverable.
Page 34/Third para How does GI highlight the importance of contractual flexibility (project finance PPP are by default seen as very contractually rigid concepts)? InI is important. OK. But why would the high value of the institutional indicator of a new PPP market entrants corroborate this? (didn't check D4.4.) I'm asking because in the EU and elsewhere the key driver of PPP uptake were budget and accounting considerations. Countries with budget issues tried to enter this arena early. Richer countries with political aversion started engaging later, when their public debt and other macro indicators (due to the crisis) became less rosy. Hence no immediate connection with InI.	The GI indicator includes the consideration of flexibility checking for existing terms in the contract (see D2.2, D4.2 and D4.4). InI: again this is an analysis of observations also confirmed through a latent cluster analysis of country characteristics included in D4.4.
Page 36/first para It's a stretch to suggest governments were pursuing availability based schemes to max out asset utilization. It is not at all common knowledge that this would even matter in the model selection. Governments could just as easily prefer the availability based model due to concerns over high cost of financing in demand based schemes or more recently the unwillingness of the private investors to engage in availability based schemes.	The 1st paragraph of page 36 reads as follows: "Finally, it is worthwhile commenting on the contribution of the Financing Scheme indicator (FSI). High values of the FSI correspond to projects financed by the public sector or private projects with a high contribution (or support) from the public sector. ..." There is not reference to

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	government choice. The text has been re-read.
Page 41 With regard to time and cost overruns it is a serious challenge that it is not identified whose responsibility they were. In general cost (and time) overruns need to be internalized by the construction contractor, with a very strict and multi-layered contract structure in place between the SPV and contractor. If there are delays/cost overruns on the project, you need to be sure they occurred due to risk materialization on the private side and not as a result of additional wishes/changes on the public side. Those cost will be simply passed through to the procurement authority and have no impact on the financial health of the private operator.	As previously mentioned the objective in BENEFIT is to identify the likelihood of "overruns" and not to allocate responsibility.
Furthermore, there is a difference between contract award (which is the relative point BENEFIT seems to measure time and cost overruns from). In many cases, the contract might be minimally adjusted by the financing consortia or quite a lot of time may pass before the project can actually reach financial close (this was the case during the financial crisis). Hence the crisis should spell out "delay" for very many projects. If this is not captured, there is a representatively problem.	In most PPP BENEFIT cases award and financial close took place in the same year (one snapshot). If different, a separate snapshot for the financial close was considered. Time is assessed from award in all cases.
Page 74 Why would it make sense to have a low cost saving indicator with the ports? The port concessionaire doesn't necessary have to build things himself, but as any SPV he may need to contract.	This is correct. However, we do not assess potential subcontractors, only the SPV. This is now also clarified in the text.
Pages 80-81 The narrative presented is broadly correct, but there are several conceptual jumps especially with regard to appropriateness for PPP and integrated companies. In general it should be recalled that the main reason for a PPP are efficiency gains from the competition for the contract. Due to a range of historical, political and technical factors this didn't take off in Europe. The best "PPP" format is actually the case of integrated companies around the world, which compete with each other and build their own infrastructure (US, Canada, Mexico…). More often than not the investment in new infrastructure more recently happens through an upfront commitment of the shippers/clients. The Japanese model is a special animal, which may be uniquely operational in the Japanese context. In general I would make this section shorter rather than covering different models scantly and making assertions about appropriateness for this or that.	BENEFIT has little information (very few cases with little information) on rail projects. The respective part has only been included for reasons of "completeness". A respective note has been added. Thank you.
Ibsen Cardenas/ Hans Voordijk, University of Twente – Official Internal Reviewer	
The proposal research component objective of "The enhancing business model approach will be compared to various common measures employed to strengthen infrastructure projects against risks such as Government credit guarantees; forfeiting of part of	These aspects are included in the indicators, i.e. Government credit

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future revenues; introducing the option of prolongation of the toll period (in case of tolls) and others" was not elaborated on.	guarantees in the FSI and forfeiting & prolongation in the RRI
For sections 2.2 and 2.3 the bibliographic analysis done should be characterised (i.e. reporting data base used, keywords searched, queries made, and the significance of the bibliographic findings) to show how the author biases were minimized when conducting the review.	The authors have established considerable expertise in this thematic area (more than 6 years of prior work) that enables them to use a representative selection of findings from their available literature.
There are reservations concerning the numbers of cases that support certain findings. These are identified by comments made by this reviewer within the text at the respective places. The assumptions made for the Fuzzy Set Qualitative Comparative Analysis (FsQCA) should be made more explicit. This to inform the readers of the text that the small number-cases findings have support according to FsQCA.	The present report does not assess analysis conducted in other Deliverables. This is the standard reporting format of the fsQCA. In addition, no conclusions were derived **solely** on the basis of the fsQCA results, but via consideration of the results produced by the combination of the fsQCA, Econometric Analysis and Importance Analysis, and, most importantly, the Qualitative Analysis. Finally, findings and conclusions were considered in light of the actual case studies/indicators.
Despite the observation made in number 5 of this form, the findings are clear and arguments to these are provided. However, note that neither Econometric analysis nor Importance Analysis were run for each delivery mode analysis. Therefore, it is only possible to report particular mode findings statements for road type projects from these analysis. For other project modes, inferences can be stated from Econometric analysis and Importance Analysis provided that it is stated that the particular findings per mode come from a more generic data set other than the one being analysed at each instance. We have identified each statement in the text that requires this clarification.	See above. Also findings per mode are based on the Qualitative Analysis and checked against the actual cases. The samples (and indicators) assessed per analysis are clearly described in section 3.2.

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The deliverable provide inputs as expected for the Task 5.1. Yet Figure 6.3.1 should be explained in more detail.	Figure 6.3.1 and remaining content of Chapter 6 constitute preliminary estimations, mainly of descriptive nature. Further elaboration is foreseen to be carried out in Task 5.1.
Boxes 1,2,7,10,11,13,15 y 16, should be explained in more details. Specific comments are attached to this boxes in the text.	The boxes summarise the overall findings for each outcome per each mode in the analysis of Chapter 3. More specifically: Box 1: summarises pages 37-40, Box 2: pages 40-43, Box 3: pages 43-46, etc.
Heuristic: Please give your assumed definition, because it seems controversial since the framework is case based but not judgment based	The MF is heuristic in the sense that it "learns" and gets refined as more cases are considered in the various analyses. In that respect, forthcoming results and new findings are expected to reflect the new information that will come with the introduction of additional cases to the BENEFIT dataset.
Koen Verhoest, University of Antwerp	
The Fuzzy Set Qualitative Comparative Analysis (FsQCA) to be corrected to *The Fuzzy-Set Qualitative Comparative Analysis (fsQCA)*	Thank you. Related text has been revised accordingly.
Page 26: "*The Fuzzy Set Qualitative Comparative Analysis (FsQCA) does not include the Reliability/Availability and the Revenue Support indicators, the latter being of high importance as it includes the "Level of Coopetition" or the control over traffic the project may have"*. May be, in this context, we need to explain why? "*This is because there is no variation on cases within two indicators, as required QCA analysis. On the one hand, almost all the calibrated values of the Reliability/Availability are more in than out in set membership (>0.5) and on the other hand, when calibrating revenue support indicator result in all the set of membership values more out than in (<0.5).*"	Thank you. Related text has been added and revised accordingly.
Page 27 (table 3.2.1) etc. On column FsQCA, no explanation to what extent these conditions refer to. Maybe, we need to specifically mention to what extent these combination found, for example: based on type of samples (full, PPP, roads); type of outcome (presence or absence); type of analysis (initial analysis or simplification method) FOR ALL OUTCOME (COST-TIME-	In these Tables, samples are listed in the first column, while outcomes are specified in the Tables' titles on the top.

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TRAFFIC-REVENUES).	
Pages 27⁄28 etc. As standard Good Practice of QCA (Schneider & Wagemann, 2010): QCA is a configurational method, therefore, when interpreting the results, an overt focus on the role of individual conditions in isolation from other conditions is **not in line** with this epistemological foundation of QCA. QCA and other methods should be treated as compliment rather than opposed each other. The explanation in page 27 is good example for this, and we can then use this description to explain other outcome. "*The Econometrics analysis identified that there is a definite negative impact of the crisis on the potential of projects to reach cost to completion targets. A marginal increase in the Financial-Economic Indicator (FEI) improves the probability of achievement of these targets significantly (bivariate model gave 56% and the logistic model 54.2%). This is reinforced by the fact that the Fs-QCA produced only one (1) path which included a low FEI and applied to only five (5) cases successfully with respect to the cost to completion outcome. The other paths with positive results included a high FEI whether before or after the 2008 year-mark*"	Thank you
Page 31, etc. It should be treated cautiously, because the financing scheme indicator apparently influence quite significantly (i.e. necessary condition on QCA) for explaining all outcomes. "the financing Scheme indicator seems to provide a positive contribution" . May be, we need to justify why the financing scheme is quite powerful indicators or the most explainable factors for analysis on all outcome (COST-TIME-TRAFFIC-REVENUES). Can we elucidate from theoretical perspective?	This is performed later in the report, in the analysis per mode.
Page 52 etc. Urban Transit. As we know, we only did the analysis for three different samples, being full samples, PPPs and Road samples. However, we can conclude for urban transit and other transport modes. I guess we use the full samples and PPP samples to describe this. For examples: "(1) This is reflected in the FsQCA findings where higher values of the Financing Scheme indicator are connected to time overruns" (p 52) "(2) the Econometrics analysis highlighted the significance of the Remuneration Attractiveness and Revenue Robustness indicators (as stemming from the Cost Saving and Revenue Support indicators) while the FsQCA emphasised the relevance of the Financing Scheme (even though not illustrated in the urban transit project values) and the Institutional indicator" (p 56) From which analysis this explanation refers to? Page 59 etc. Bridge & Tunnel "(1) The FsQCA, while not providing overall significant results,	Conclusions were not solely derived on the basis of the fsQCA results, but via taking into account the results produced by the combination of the fsQCA, Econometric Analysis and Importance Analysis, and, most importantly, the Qualitative Analysis. Also, findings and conclusions were considered in light of the actual cases/indicators.

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consider the negative impact of the Institutional and Financial-Economic context on time targets throughout the sample. PPPs perform better for a combination of high Institutional, Financial-Economic, Cost Saving, and Governance indicators with a low value of the Remuneration Attractiveness and a high Financing Scheme Indicator. These are typical levels of the indicator values of bridge and tunnel projects (p60) "(2) the FsQCA suggested that traffic forecasts are not achievable for low values of Remuneration Attractiveness. For PPPs, which encompass most cases in this group, a combination of high Cost Saving, Remuneration Attractiveness, Institutional, Governance and Financing Scheme indicators produce favourable conditions for achieving traffic targets. Notably, for all sample groups analysed, the FsQCA highlights the negative impact of combining low Remuneration Attractiveness with low values of Cost Saving, and/or Governance, and/or the Institutional Indicator. Such combinations should clearly be avoided for bridge and tunnel projects" (p 62) "(3) The FsQCA analysis identified that projects with higher levels of the Financing Scheme indicator were more capable of reaching revenue goals and so were cases with high values of the Institutional indicator" (p63) <u>Page 67 etc. Airport</u> "(1) The FsQCA analysis indicated the importance of a high Cost Saving indicator combined with a high Institutional indicator as well as high values of the Governance indicator in attaining cost to completion targets. The indicators of importance also include a high Financing Scheme indicator (p67) "(2) the FsQCA indicated the negative impact of the Institutional and Financial-Economic context on attaining time targets for the entire sample, but also specifically for PPPs" (p68) "(3) The FsQCA suggested that traffic forecasts are achievable with a low risk Remuneration Scheme accompanied by high Governance and Institutional indicators. While the latter are important, a low risk Remuneration Scheme (high Remuneration Attractiveness indicator) is not typically encountered in airports" (p69).	
<u>74 etc. Ports</u> " (1) the **FsQCA conducted specifically on the port samples** (see D4.4.) could not identify a combination of indicators leading to successful attainment of cost to completion targets. It did identify, however, that high Cost Saving, high Institutional and low Revenue Robustness indicator values appeared frequently in the sample (p74) --???? "(2) **FsQCA** carried out for the particular case of ports was inconclusive. Governance, Remuneration Attractiveness and Financing Scheme indicators seemed important (p75) "(3) **The FsQCA for the particular case of ports**, while overall inconclusive, identified the Institutional and Cost Saving Indicators to be relevant (the CSI includes the capability of the	With regard to the fsQCA analysis conducted for ports, an analysis on the port sample has been carried out. This has been included as Annex 2 in the present report.

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concessioner) (p75) "(4) **The FsQCA conducted for ports concluded on similar findings**. An important indicator in achieving revenue targets seemed to be the Cost Saving indicator (p76)	
In order to avoid misleading information, because the different samples influence the result of QCA analysis, so the QCA results of full samples as well as PPP samples can not necessarily be able to be applied on specific modes such as: Urban Transit, Bridge & Tunnel, Airports, Ports, Rail. Then, I think we need do the analysis for Non-Roads— and I have tried to run the analysis for non-road samples (**see result below**) When analysing the non-road projects, the number of cases for explaining COST & TIME are 29 cases, whereas TRAFFIC & REVENUES are 23 cases. This means we can run the analysis using at least 5 conditions. The adopting the analysis of non-road samples may bring about the different results or explanations.	This sample has its own limitations based on the same reasoning. The results were checked. No differences in results or in the line of reasoning were identified. The analysis of the "non-road" sample has been included as Annex 3 in the present report.
Thierry Vaneslander/ Eleni Moschouli, University of Antwerp	
I/we went through the entire deliverable again in detail, and made the attached corrections and comments.	Thank you. All corrections have been incorporated.
"However, urban rail systems are passenger oriented and the possibility to link logistics business is not there whereas for heavier inter-urban railways the option exists. " Not fully true: Monoprix in Paris, etc.	The respective part has only been included for reasons of "completeness". A respective note has been added. Thank you.
In chapter 4, a respective part on Rail is missing.	Thank you. It has been added.
In any case: excellent work!	Thank you.
Joao Bernadino, TIS	
"The **first chapter** seems a bit confusing. The definition of the project is somewhat confusing and too technical for someone who has not been working on it to understand. I had to read it several times before I could (partially) understand what BENEFIT was all about. Moreover, I got the impression that this chapter was written having in mind that the readers would already possess some prior knowledge on the subject and project in hand. Here are some specific examples why: The BENEFIT is referred to as an "innovative approach by analyzing funding schemes within an inter-related system", but the fact that this *system* refers to a transportation project is omitted. Several of the technical concepts of the BENEFIT project are mentioned throughout this first chapter (tasks, indicators used, cases used, outcomes defined…) without being thoroughly defined or explained. Although this is done in later chapters, it	The first chapter especially the introduction are parts directly taken from the proposal. This has been a standard format for all BENEFIT deliverables. While the comments are valid, it is too late in the process to change.

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still poses difficulties to someone who is reading the document, starting from the beginning and progressing towards the end, without prior knowledge on the subject.	
In the **second chapter**, the writing becomes much more accessible and understandable. However, in chapter 2.2.1, where the concept of *resilience* is discussed, there is a somewhat confusing leap from the discussion of *resilience* at an abstract level to the discussion of this concept at the concrete system-level.	The comment is partially valid as although the discussion is condensed the relevant points necessary for understanding the work described in subsequent sections are covered. The purpose of this section was not to treat Resilience in all of its shapes and forms but rather to leverage from the existing literature the elements that would be useful for the purpose of this deliverable. The interested reader can follow any of the included references to deepen their understanding on the subject.
From the **third chapter** onwards, the writing is very clear and the analyses, the methodology discussions, the results and their limitations’ discussions are clear and easy to comprehend.	Thank you. This is the core of the deliverable.
It is not explained in this document why these four elements were the chosen ones. Additionally, it might be interesting to mention somewhere that a very relevant Figure-of-merit is the project being built at all, but for methodological reasons (failed project were not considered) it was not possible to analyse	These four elements were chosen from the beginning of the project. See D4.1. However, a small note was added in the text and a longer justification in the executive summary. Abandoned projects were not included in our cases. However, it would be worth to have had defined an additional figure of merit: Fit for Purpose. This could be included in the next and final deliverable. Finally, there was one project that did not go ahead in our sample.

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Section 4.2.3 What criteria were applied to define this value? The same applies to the thresholds below	Threshold values are estimated in section 4.3. Admittedly, in section 4.2 ley issues of methodological approach are addressed. In order to do so and give examples information reported in later sections of the report is used.
Section 4.5 This assumes that the cases not explained by the BENEFIT DMF are not explained because there were irrational decisions. However, there may be cases with rational decisions which are still not explained by the DMF	Cases not explained are cases for which we went back to the actual case and investigated for "rational" reasons. For example, if we cannot find from qualitative analysis any reason for lesser actual traffic, we have to assume an overestimated forecast.
Section 4.5 There are other limitations. For example, - the fact that relevant explanatory factors may have been left out of the analysis (like specific indicators which were merged into aggregate dimensions) implied loss of information. - The fact that failed projects (not constructed) were not considered may have drawn way relevant indicators from the results	These again are sample limitations. Loss of information through indicator composition is addressed through the various analyses, which have a demonstrated a different sensitivity to indicators but mostly everything is validated against the qualitative case analysis. Admittedly, we (BENEFIT) have not looked into failed cases, i.e. cases that were awarded and were not realised even though our database includes two such case.
Section 4.5 – expected accuracy of rating What are the scores based on? Expert opinion?	The estimate (qualitative) is based on the number of cases per mode and the accuracy of assessments per outcome. It has been clarified in the text. Thank you.

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Section 6.2 Possible actions to increase project revenues could be: - Earmarking other revenues (e.g. fuel tax) [case of Estradas de Portugal] - Bundling infrastructure/services Increase infrastructure use price	Thank you. Suggestion has been included.
Section 6.2 None of the actions with the exception of the fourth and fifth would lead to an increase of the Revenue Robustness. Recall that government funding is not considered a revenue according to the Funding Typology.	This is valid. However, government contributions reduce the overall "cost" and therefore improve the cost coverage percentage leading to an overall increase in the indicator.
Based on the BENEFIT results and additional specific research, it would be possible to draw (tree-like) decision maps relating specific context and project conditions to recommended project design approaches.	This is a very interesting proposition which may be included either in task 5.1 (ex-ante assessment) or in the final conclusions – task 5.3.
John Ward, OMEGA Centre, UCL	
Small corrections in the text.	Thank you. They have been addressed.
UK missing from Figure 4.2.1	Thank you The UK has been included.
Champika Liyanage, UCLAN	
There are no comments from UCLan on the 3.2 document. I think it's well written and the discussions have been backed up with appropriate background literature, wherever possible. We have nothing to add to it.	Thank you.

End of Report

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