BENEFIT

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

Deliverable: D 4.2–Lessons Learned – 2nd Stage Analysis

European Commission

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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.

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Executive Summary

The delivery of transport infrastructure is characterised by significant complexity including multiple factors that interrelate positively or negatively leading to observed performance. Multiple actors make decisions that influence the course of development and operation. Infrastructure projects are also vulnerable to external micro and macroeconomic influence, which impact on performance. In addition, transport infrastructure produces short, medium and long term impacts with respect to the economy, the environment, institutions and society in general. Therefore, multiple stakeholders are involved with different and, many times, competitive interests. In this context, success or failure can only be subjective depending on the particular objectives of each stakeholder and how they are met through project performance over time. Considering the anticipated positive (and negative) impacts, the sunk nature of investments in transport infrastructure and the range of stakeholder interests, significant research has been devoted to the topic of funding and financing of infrastructure and its performance. Researchers have focused on particular aspects of the transport infrastructure delivery. However, this research only presents aspects of the problem as long as it is not considered with respect and in context with all other factors that may influence outcomes.

The BENEFIT project takes an alternative approach. It initiates by considering transport infrastructure delivery, implementation, operation and maintenance as a system (see D3.1) bearing specific inputs and producing outputs (or outcomes) considered as the "performance" of the infrastructure investment. These outcomes may be project management related, transport goal related, investment related and other outcomes. The "system" includes key elements as illustrated in Figure 1.1.1 of this report. These "elements" have been studied and their key drivers have been aggregated to indicator – proxies (see D2.2, D2.3, D2.4 and D3.1). In this sense, the complexity of transport infrastructure funding and financing and the multiple factors involved are reduced to nine (9) indicators descriptive of the elements of the respective system: the Matching Framework as it is termed in BENEFIT.

The other innovative aspect of the BENEFIT approach is that, having as a starting point that different factors or combinations thereof (indicators) will influence different outcomes or combinations of outcomes, it does not attempt to assess performance in terms of success or failure. Its study objective is to identify the combinations or interactions between indicators that would have a positive or negative effect on a particular outcome or a combination of outcomes. In the context of the research conducted within BENEFIT, four outcomes are being studied: Actual vs estimated Cost to completion, Actual vs estimated Time to completion, Actual vs forecasted Traffic and Actual vs Forecasted Revenue. The first two outcomes are closely related to the construction phase of the project. The latter are connected to the operational phase of the project. Traffic is a key outcome in connection with transport goals and the justification of the public investment. Finally, Revenue describes the business case.

Finally, BENEFIT makes a key assumption: input to the system (Matching Framework) is correct. This in practical terms means that cost and time to completion, forecast traffic and revenues estimates are considered correct involving no bias. This, however, remains an assumption to be contested. This assumption also implies that the feasibility study and all other assessments leading to the final project decisions were also correct. Table 9.1.1 lists input factors, indicators and outcomes considered in the study and analyses.

The BENEFIT Matching Framework in this report is validated using the BENEFIT case studies (see Annex A.1). Cases were described over time through the values of the respective indicators, input factors (constant per case) and outcome variables. As they describe the key characteristics of the case at specific times in the project life cycle, each set of input factors, indicator and outcome values is termed a "snapshot" (see Annex A.2). Notably, the case studies forming the BENEFIT database are neither representative nor have they been selected randomly. They form a convenience sample of cases collected over time by members of the BENEFIT partnership. However, given the number of partners collecting information on cases, this sample could be considered relatively unbiased.

The snapshots and the case narratives form the basis for the validation of both the Matching Framework and the indicators. The scope of the analyses carried out and presented in this report had

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as an objective to assess the explanatory power of the indicators and through them the Matching Framework. The process allowed the derivation of **lessons learned** with respect to:

- The funding and financing of transport infrastructure
- The Matching Framework and its typology indicators

Of course, findings bear the limitations of the specific sample and the challenge is to identify those findings, which might be sample specific against those having a greater explanatory power. In this approach, a combination of analysis methods has been employed ranging from purely qualitative to semi-qualitative to quantitative. The analyses undertaken complement each other in terms of explanatory power and approach. At the same time, they allow for a comparative study of results and increase the interpretation capability of the research.

Case studies were analysed with respect to their outcomes qualitatively per transport infrastructure mode (see Chapter 3). Cases were also analysed qualitatively with respect to their snapshot information (see Chapter 5). The scope of the second qualitative analysis per mode was to assess the "reality fit" of the snapshot data. However, this also allowed for a new structured qualitative analysis of the case studies per mode employing the Matching Framework as an ex-post assessment tool.

Further analysis using snapshot data was conducted using Fuzzy Set Qualitative Comparative Analysis (FsQCA) (see Chapter 6), Importance Analysis (IA) (see Chapter 7) and micro-Econometrics Analysis (see Chapter 8). Through these analyses, research shifts gradually from the actual cases to relying more on the quality and explanatory power of the indicators. Their findings are compared in section 9.2 of chapter 9. This comparison results in identifying common findings, which reinforces their significance with respect to lessons learned. In addition, the identification of differences is also important as, through their interpretation, important conclusions may be drawn.

Findings from the numerical analysis were systematically compared with those of qualitative analyses allowing for an improved understanding and enriched discussion (see section 9.3 of chapter 9).

Following the analysis presented in this report and their comparative study, lessons learned may be summarised. However, it is noted once again that these should be considered in caution as they bear the limitations of the sample these lessons have been derived from.

In general, Funding and financing of transport infrastructure bears similarities but also distinct differences between transport modes. Different service models and accompanying activities may be developed depending on the transport mode and the infrastructure configuration in the transport network, with some modes and configurations allowing for a wider range of value adding activities and services. Regardless, in the BENEFIT database few projects include such activities and most foresee revenues depending on the mode specific activities that are included.

Exclusivity and connectivity to the transport network (which may be in favour or not of the competitive position of the project-infrastructure) are important factors in achieving performance outcomes.

With respect to the four basic performance outcomes studied (cost and time to completion, traffic and revenue forecasts), no signal combination of factors was identified having a positive effect on all four targets. For each performance target, at least partially, different factors seem to matter. Notably, this is the key reason and source of inconclusive discussion with respect to transport infrastructure project "success". In addition, factors might have different effects depending on how they are combined with other factors.

However, one factor that was identified to have an impact on all outcomes (cost and time to completion, traffic and revenue) was the implementation context and its indicators financial –economic context and institutional context. Notably, while the effect of implementation context is well acknowledged with respect to traffic and revenue, it has now been connected to construction cost and time to completion.

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With respect to time and cost outcomes

Cost and time to completion form part of the so-called "iron triangle" in project management (along with quality) in which the trade-offs in target outcomes are considered. Therefore, cost and time to completion are by definition correlated but not necessarily covariate.

Most transport infrastructure projects face technical problems. These concern design changes, technical failures, contractor failures, land acquisition and others. These problems result in cost and time delays and are present across all modes. However, they seem more frequent in rail and urban transit projects, road projects with low levels of financial-economic and institutional conditions (eg. south Europe) and in projects monitored by local public authorities (eg. urban transit projects). Two causes seem to be increasing the probability of cost and time overruns:

- Project technical maturity as opposed to technical difficulty. For example, national projects of special difficulty, such as bridges and tunnels, were found to perform relatively well.

- Competence (institutional and other) of the public authorities monitoring implementation for both PPP and traditional delivery of infrastructure. For example, poor performance of urban transit projects may be due to the competence of the (local) public authorities to address project maturity in terms of design and management of stakeholder objectives.

The two causes may also be inter-related.

Life cycle planning was found to improve the chances of achieving cost and time targets. Notably, life cycle planning is part of mature technical design.

Good governance (including competitive tendering and contracting arrangements) improves the potential of achieving cost and time targets. Notably, this may be considered an expression of public authority competence and good institutions.

In addition, projects with bundling services showed cost and time overruns. This may be explained by a combination of the difficulty of achieving project maturity and competence of public authorities when addressing projects with increased complexity.

The contribution of the competence of the contractor could not be assessed, as most projects were assigned to competent contractors (international actors). This is mostly the case for PPPs, while public projects are mostly assigned to local contractors. This finding may be sample specific, however, very pronounced. No statistical difference was found based on the competence of the contractor.

However, it was identified that scope, exclusivity and connectivity (level of control as termed in the BENEFIT Analysis) seems to improve the chances of meeting cost and time targets. This is evident in unique structures, ports and airports.

The following findings may be sample specific:

- Projects including a brownfield section were found to perform better with respect to cost and time.

- Projects aiming at combined revenues seem to perform better with respect to time.

- Public projects seem more prone to time overrun.

Finally, PPPs were found to have a greater probability to achieve cost and time targets if constructed prior to the crisis. This may be a sample-specific finding, since the BENEFIT case study database includes many projects from countries under recession in Europe. However, by the same token, the finding indicates the negative impact poor macro-economic conditions may have on the probability of PPPs to reach cost and time targets.

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With respect to Traffic Outcome

The financial economic context is a core factor influencing the achievement of the traffic outcome. This is a well-known fact in transport economics. Enabled to address the negative impacts were projects:

- Demonstrating higher "levels of control", i.e. a combination of exclusivity and network connectively serving business scope.
- Operated by contractors able to influence the demand
- Well-justified projects

It was identified, that projects with multiple revenue streams from other service activities were able to perform better. In this case, the competence of the operator was important.

In addition, projects with low risk income streams (potentially not relying on user charges) seem to perform better. This also holds true for PPP projects. As in the case of cost and time outcomes, it was identified that PPP projects were more probable to perform better prior to the crisis, while PPPs seem to have a higher probability of not reaching traffic targets. As before, this may be a sample-specific finding. However, the probability remains, especially in connection with the remuneration scheme implemented.

Finally, optimism bias was identified in a number of cases. Public projects seem to be more prone to overestimated traffic forecasts. However, it was found that overestimated traffic forecasts are related to inappropriate demand risk allocation. PPPs tend to be more conservative when appropriate or more demand risk is passed over to the concessionaire.

Finally, road projects being more vulnerable to macro-economic impact within the BENEFIT case study sample seem to have underperformed. While this may be a sample specific finding, it is also consistent with all over findings, as road projects usually demonstrate a lesser "level of control" in comparison with other infrastructure modes.

However, once again, it was identified that well justified and well-designed projects are able to perform even under adverse macroeconomic conditions.

With respect to Revenue Outcomes

Information with respect to revenue performance is typically not disclosed in PPP projects and difficult to assess in many public cases. Hence, the indicator used in the analyses is a constructed proxy based on the traffic outcome indicator in combination with re-negotiations and/or claims originating from revenue performance issues. In this sense, it includes considerable uncertainty and findings described below should be considered with caution.

A review of the business model of cases included in the BENEFIT case study database concluded that there are significant differences between modes and the models they develop. Overall, few revenue-enhancing activities are included in the case studies. In other words, most infrastructure projects rely typically on the prime transport service offered by the infrastructure.

Hence, confined to the prime infrastructure, projects rely on low risk remuneration schemes and factors that enhance their ability to attract traffic under adverse macro-economic conditions. However, what is now interesting is that this is the only outcome for which the econometrics analysis did not show a diversification in the probability to achieve this outcome for PPP projects prior to the crisis. Or in other words, PPPs achievement of revenue targets is independent of the crisis and the traffic outcome, which was found to depend on the crisis. This remark has two interpretations: for some projects, their characteristics (similar to the case of traffic outcomes) make them resilient and for others, through re-negotiations revenues are established.

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With respect to the Matching Framework and its Typology Indicators

A multiple analyses approach ranging from purely qualitative to semi-qualitative and qualitative was adopted in the validation process applied. The use of this multiple approach methodology allowed for both comparison and complementary interpretation of findings enhancing the investigation power of research and leading to more robust findings, which were not hampered by the limitations of the specific methodology applied.

The combined validation of indicators and the Matching Framework lead to a number of encouraging findings as well as issues that need further consideration and improvement.

Starting from its structural concept, it was confirmed that the Matching Framework functions well when considered as **Stakeholder Neutral** with higher indicator values representing **lower risk of their respective element** (typology) for the project. When indicators are not consistent with this basic concept, the potential of interpretations is limited or expressed through other indicators.

In this context, some indicators need further investigation and amendment. The current findings provide sufficient guidance in this direction, while activities under the following tasks foresee respective progress in research.

The Matching Framework is designed to be applied as an ex-post assessment tool. Despite limitations in some indicators, this was made possible and confirmed through the various analyses conducted. It is also interesting to note that between the pure qualitative analysis and the one focusing on the reality fit of the Matching Framework datasets (snapshots), the later formulated a more consistent methodological framework and lead to more enriched results.

The Matching Framework is designed to function as an ex-ante assessment tool. Despite limitations recognised, in its current form, it was able to predict performance at a moderate level (approximately 50%) across modes.

As noted, a key finding of the analyses presented in this report is the fact that all outcomes are not dependent on all or the same factors. Hence, it becomes very difficult to achieve all outcome targets emphasising on the same set of factors. Through the combined analysis carried out, it was possible to identify combinations of indicators that enhance the probability of achieving particular outcomes. It was also found that such multiple combinations may exist, but in all cases, apart from the financial-economic/institutional indicator, there is also one other indicator of crucial importance. Furthermore, points of interest are:

- Cost and time outcomes are most often addressed in combination (finding from the qualitative and econometrics analysis)
- Cost and time outcomes are mostly addressed through avoidance of their negative influencing factors (finding from the qualitative analysis and the FsQCA)
- Traffic outcome is mostly addressed through measures of resilience (finding from all analyses)
- Revenue outcome for PPPs may be addressed through the remuneration scheme (finding from all analyses)
- The Matching Framework is most suitably applied within the same mode.

Based on these findings, the Matching Framework is further improved in the following research under BENEFIT. Detailed steps with respect to the improvement of the identified limitations are suggested accordingly.

Finally, the combination of qualitative and various quantitative analyses proved to be a positive experience enhancing the interpretation power of each method of analysis in favour of the Matching Framework. Based on experience gained through the process, a more integrated approach in combining their findings is envisaged for the future research in BENEFIT.

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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.

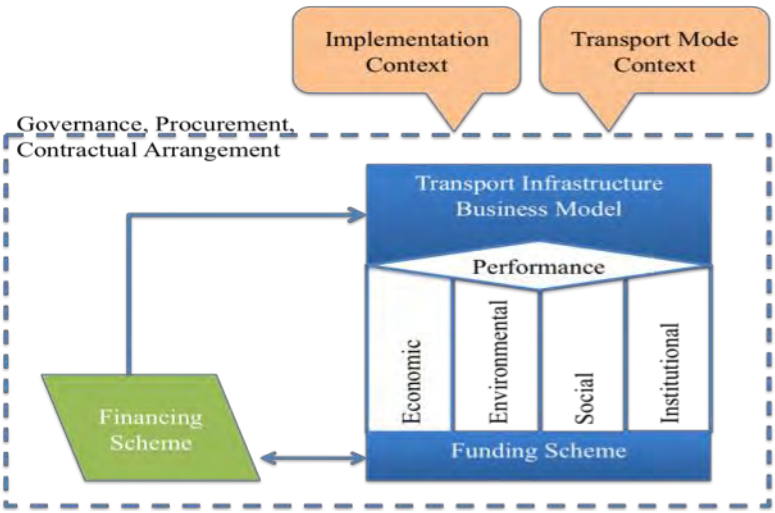

Figure 1.1.1: BENEFIT Key Elements in Transport Infrastructure Production, Operation and Maintenance

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 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.

1.2 Contribution of this Report to the BENEFIT Project

The work undertaken under Task 4.1 stage 2 aims to deliver against the following objectives, as stated in the BENEFIT proposal:

"With the completion of task 3.1 (matching principles) the Decision Matching Framework analysis approach will be applied. This has two objectives: (i) verification of the matching principles (hypotheses) and (ii) the provision of conclusions that may be transferred to the same typological setting. This final action will provide with sound recommendations at introducing changes to properly calibrate the models of funding schemes under different typological settings."

In this context, Task 4.1 stage 2 has as a major focus the verification and validation of the Matching Framework and the respective relationships identified in task 3.1. Respectively, Task 4.1 stage 2 follows and refines the validation process proposed in deliverable D3.1. More specifically, in the context of the validation process, case studies in the BENEFIT database are converted and represented over time by the Typology indicator values included in the Matching Framework. The set of indicators representing the case (project) at a specific time is refered to as a **snapshot**.

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In support of the validation process, the current report also includes the qualitative analysis of cases per mode in order to gain understanding of the case studies and allow the assessment of the "reality fit" of the respective case snapshots.

This task also builds on the work of WP2 and utilises the typologies already established in Tasks 2.2, 2.3 and 2.4. In the context of this validation, typology indicators are further validated. Hence, the present report, in addition to the validation of the Matching Framework, also includes:

- The lessons learned with respect to the cases of the BENEFIT database per mode
- The assessment of variables (factors) incorporated in the typology indicators. It is noted that the validation of the transport mode typology was conducted within the scope of Task 3.1.

The final scope of work is to:

- Validate the matching framework in terms of a "reality check",
- Identify the respective importance between the typology indicators,
- Validate the potential of transfer of experience that will allow the model to function in an ex-ante configuration allowing decision makers to improve on their proposed models of infrastructure delivery and finally
- Provide lessons learned with respect to the funding and financing of the transport infrastructure as identified through this research.

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 provide the results of the validation process followed with respect to the Matching Framework and lessons learned with respect to the funding and financing of transport infrastructure, as identified through the validation process and the qualitative analysis of the database case studies per mode.

Chapter 2 presents the methodological underpinnings of the validation process. Here, a multi-validation approach is followed using qualitative, semi-qualiutative and quantitative analysis in order to provide a robust validation to the model. In addition, while the semi-qualitative and quantitative analysis is conducted using the typology indicator values over time, qualitative analysis is carried out on the case studies included in the BENEFIT database. Findings are compared.

In Chapter 3, the case studies in the BENEFIT database are reviewed with respect to key outcomes. The Chapter provides both a thorough presentation to the case studies used to conduct the validation and a brief qualitative assessment. Lessons learned with respect to the funding and financing of transport infrastructure per mode are derived.

Chapter 4 presents the validation of the typology indicators. For each indicator a suitable validation approach is followed using the respective values of the case "snapshots". Respective corrections of the indicator value database follow the respective findings and consequent adjustments to the indicator aggregation. The Business Model Indicator is also assessed with respect to key factors included. This chapter also contributes to lessons learned with respect to the funding and financing of transport infrastructure.

Chapter 5 concerns the exercise of "reality fit". Following corrections made to indicator configuration, case snapshots are re-generated and undergo a "reality fit". They are considered per mode building on the insights obtained through the qualitative assessment of Chapter 3. Estimates of the goodness of fit per transport mode infrastructure are reported. Typology indicators are assessed with respect to their ability to properly represent cases with each transport mode. The Chapter concludes with lessons learned with respect to the BENEFIT Matching Framework and the typology indicators.

Chapters 6, 7 and 8 respectively present the findings of the Fuzzy Qualitative Comparative Analysis, the Importance Analysis and the Econometric Analysis carried out in the validation and assessment of the respective impact of the typology indicators of the Matching Framework on the various outcomes.

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Each Chapter concludes with lessons learned with respect to the funding and financing of transport infrastructure as identified through the respective analysis, followed by lessons learned with respect to the functionality of the Matching Framework and its typology indicators.

Chapter 9 concerns the comparative discussion of findings concluding with lessons learned with respect to the funding and financing of transport infrastructure followed by lessons learned with respect to the functionality of the Matching Framework and its typology indicators. Based on this, future research is depicted.

Chapter 10 concludes this report with the overall conclusions of the report.

The Annex of this report contains important and supplementary information pertaining to the various chapters. However, Annex A.1 provides an overview of the BENEFIT cases. These cases and the respective information are examined in chapters 3 and 4. The cases are also presented through their calculated typology indicator values over time (snapshots) based on the validation of the typology indicators in Annex A.2. The data in this Annex A.2 are used in Chapters 4 through 9. Information on cases has been provided by the respective partners (see Annex A.1 and A.2) to the best of their ability. It also follows that this is a convenience sample based on each partner's ability to access and collect respective information. The data has been validated through various iterations.

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BENEFIT

2 Methodology

2.1 Introduction

As described in D3.1, the validation of the "Matching Framework" is paramount in testing its ability to achieve its aims and objectives, firstly, as an ex-post and, secondly, as an ex-ante assessment tool. The validation pertains to whether the assumptions made in the development of the model are reasonable, as well as whether its acknowledged limitations are restricting its applicability.

Within BENEFIT, the process of validation is stepwise and iterative: the "Matching Framework" (MF) is corrected (as and if necessary) at each step before proceeding to the next. The bulk of the validation process is carried out in Task 4.1 stage 2. In support of this process, two additional validation steps were included. The first is considered as a **pre-validation step**. This concerns the review and brief qualitative assessment of the BENEFIT cases per mode[1]. The scope of this activity has been to improve understanding of the case studies within each mode and, through this activity prepare for the "reality fit"[2] check of the MF.

The second follows the depicted in D3.1 as Validation Step 1 and concerns the check of "reality fit" of the cases in their snapshot (Matching Framework) representation as compared to the qualitative analysis per mode and the validation of the typology indicators based on the input from the "reality fit" and the first full validation analysis.

More specifically, while the validation process followed, to a large extend, the one depicted in D3.1, a number of iterations were also included.

The following validation steps were conducted:

Validation Step 1:
A critical point in the development of the "Matching Framework" and the dimensions of the typologies that have been included pertains to the level of aggregation (or reduction of granularity) employed. As described in Deliverables D2.2, D2.3, D2.4 and D3.1, the dimensions adopted to represent each typology in the model were:

- Selected so as to keep the complexity of the proposed model as low as possible
- Scored based on scoring methodologies that were primarily based on data availability and/or proxy values from the BENEFIT database.

As a reminder, the elements of the BENEFIT Matching Framework (see Figure 1.1.1 of Chapter 1) are:

- The implementation context typology described by two indicators: the Financial – Economic Context and the Institutional Context indicators
- The Transport Mode Context Typology described by the Indicator for Reliability – Availability (IRA)
- The Governance Typology expressed by the governance indicator
- The Business Model Typology expressed by the Cost Saving and Revenue Support indicators
- The Funding Scheme Typology described by the Remuneration Scheme and Revenue Scheme indicators and, finally,
- The financing scheme expressed by the Financing Scheme indicator.

The Matching Framework considers inputs. As described in D3.1, these inputs concern decisions made prior to project initiation and refer to relatively "sunk" conditions of the Matching Framework

[1] see Chapter 3
[2] see Chapter 5

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system model such as: transport mode, infrastructure configuration (node or link), investment size, delivery model.

The Matching Framework delivers system outcomes. In D3.1, these were grouped in basic categories describing project management outcomes (cost and time to completion and quality fit for purpose), Transport goal outcomes expressed through traffic volumes served as well as general transport goals (reducing travel time, reducing travel cost, relieving congestion, improving reliability of transportation and improving safety of transportation, etc.), business outcomes (eg revenues) as well as general outcomes such as environmental, social, institutional as well as general economic outcomes. **BENEFIT does not attempt to assess success**. Its starting point is the consideration that unless all objectives are met then the assessment of success depends on each stakeholder's value system (or perception of success or specific interests). In this context, the scope of the Matching Framework is to identify conditions influencing outcomes (or combinations of outcomes) and from then on, allowing each stakeholder to evaluate preferred options in funding and financing of transport infrastructure.

Therefore, a first validation step is to assess if the proposed "Matching Framework" possesses enough detail to capture and reflect changes in anticipated project performance. In practical terms, this requires checking whether at certain points during the timeline of a project, changes in the "snapshots" of the project reflect the respective variations in project outcomes. These include:

- Claims in the case of publicly delivered projects
- Claims and/or contract renegotiations in the case of PPP projects
- Variations in actual versus forecast traffic (categorisation variable of Task 4.1 stage 1)
- Variation in cost to completion[3] (categorisation variable of Task 4.1 stage 1)
- Variation in time to completion[4] (categorisation variable of Task 4.1 stage 1)
- Variation in transport goals (relief of congestion, reduction of travel time, etc.)
- Variation in expected wider outcomes (economic, environmental, social, institutional)

Notably, in order to reduce complexity four outcomes have been considered:

- Cost to completion
- Time to completion
- Actual vs Forecasted Traffic
- Actual vs Forecasted Revenue (configured as a proxy based on actual vs forecasted traffic and contract renegotiations concerning revenue issues. See **Annex A.2**)

Implementing this validation step is based on the fact that all cases in the BENEFIT database have at least two "snapshots" captured. The first corresponds to the time of project award (or financial close in the case of private financing). The second reflects the project conditions at the time the case was reported. Other project "snapshots" may be considered based on the project timeline of events, as recorded in the BENEFIT database. The case snapshots in their final configuration at the current reporting time are presented in **Annex A.2** of the present report.

Conceptually, the validation process is based on a number of simple qualitative questions that stem from the following basic consideration:

Has there been a variation between initially anticipated and achieved project outcomes?

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[3] i.e. cost overruns
[4] i.e. time overruns

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2.2 The Validation Process

The validation process, as illustrated in Figure 2.2.1, leads either to cases whose level of detail is satisfactory or to cases that need to be revisited in terms of the level of aggregation employed in their analysis.

The findings from this first validation step are compared to the findings of the qualitative analysis[5]. The information derived from the joint findings will then be used in order to establish an appropriate level of aggregation for the constitutive elements (typology dimensions) of the "Matching Framework"[6].

It should be noted that a delicate point in this validation step is the identification of the potential of sub-optimal initial setup of infrastructure delivery, which will require careful consideration and analysis. The proposed way forward is always assuming that the system input (decisions) is correct. This initial assumption is only rejected if no other justification can be derived by the study of the system values.

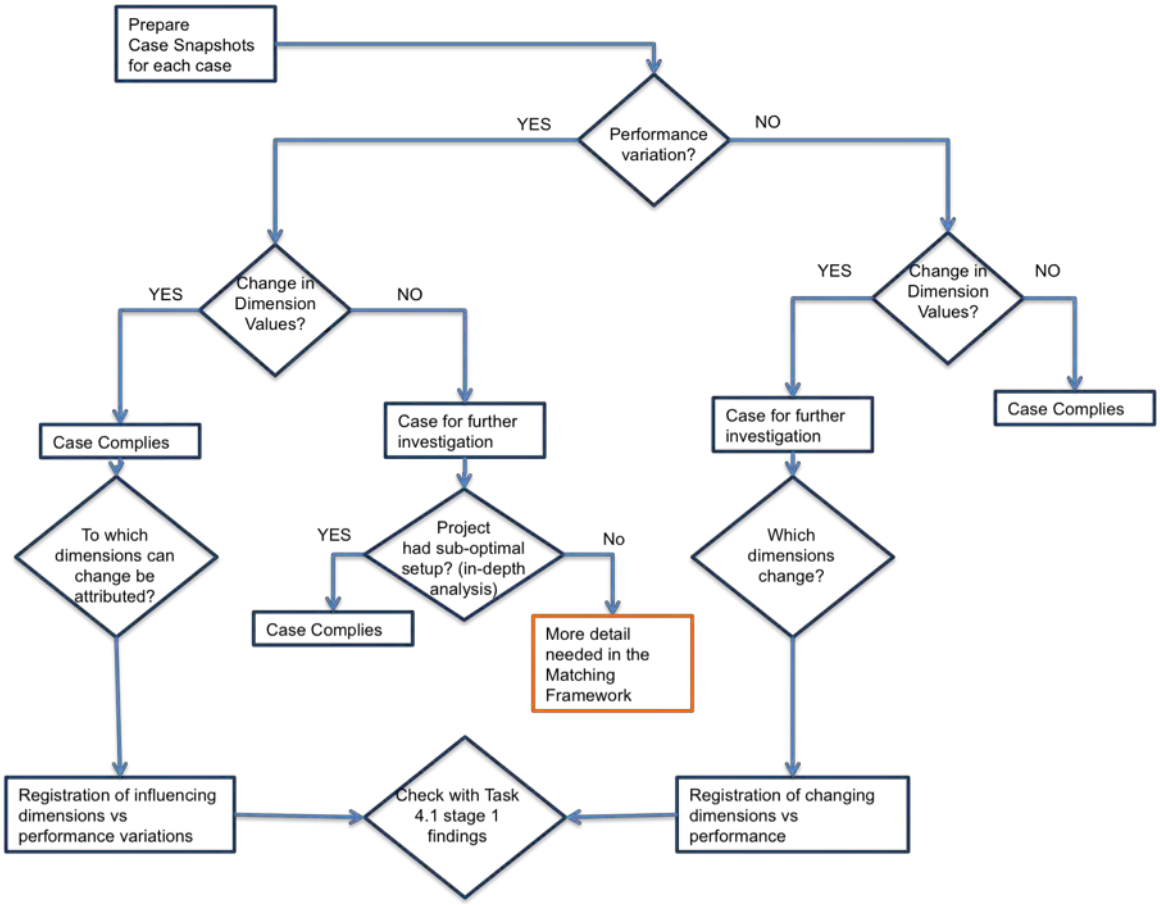

Figure 2.2.1: Step 1 of validation process

Validation Step 2

Following the successful completion of the first validation step, another issue critical for the validity and reliability of the "Matching Framework" as an analysis and subsequently decision support tool, stems from the working assumption that all typology dimensions employed are equally weighted.

[5] see Chapter 5
[6] see Chapter 4

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Refining this initial assumption is an important step in delivering a Framework capable for both ex-post and ex-ante assessments of infrastructure funding and financing. It is also an important step in securing the ability of the Framework to transfer lessons learned from one case to another.

As the validation of this assumption is of critical importance and in order to increase the robustness of the validation process, four parallel validation streams are undertaken:

- The first stream concerns a qualitative assessment of the typology dimensions to which changes, as identified during the first step of the validation process, can be attributed[7].
- The second stream concerns using all snapshots created during the first step of the validation process along with the respective project outcomes and carrying out a Fuzzy Qualitative Comparative Analysis (FQCA)[8].
- The third validation stream concerns the assessment of relative importance of the typology indicators[9].
- The fourth validation stream concerns an econometric analysis that will seek to identify both the relative importance of indicators with respect to outcomes and their probability in insuring the various outcomes[10]. Notably, econometrics analysis may also provide weightings. This will be considered in the future work of BENEFIT.

The findings of the four streams employed will be compared and the importance of each dimension included in the "Matching Framework" will be considered[11]. These findings will be again compared to the findings of the qualitative analysis per mode[12] on Lessons Learned for crosschecking.

Validation Step 3
A final validation of the "Matching Framework" concerns its ability to transfer lessons learned. In essence, this concerns the comparison of performance of different cases based on typology dimensions taking values in the same range[13]. In effect, this validation step seeks to answer the following questions:

Do projects with similar typology dimension scores perform the same?

What is the tolerance within which typology dimension scores qualify as "similar"?

Cases that may have been identified under Validation Step 1 that exhibit no performance variation while there is observed change in the scores assigned to their typology dimensions are scrutinised in this step and form the starting point of this validation step.

The analysis is carried out throughout the entire sample of snapshots within the framework of Task 4.1 stage 2.

Validation Step 4[14] (or Sensitivity Analysis)
A critical requirement of the BENEFIT project is to identify the limitations of the various funding and financing schemes.

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[7] See Chapter 5
[8] See Chapter 6
[9] See Chapter 7
[10] See Chapter 8
[11] See Chapter 9
[12] See Chapter 3
[13] See Chapter 10
[14] The following validation steps envisaged in Deliverable D3.1 are to be conducted in Tasks 4.2 and 4.3. They are included here for reasons of completeness.

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This is the focus of Task 4.2. Under this task, project snapshots will be compared and analysed with respect to the impact of the financing and the funding scheme typology dimensions on performance. The comparison will also address and investigate the variation in the scores these typology dimensions may sustain without "disturbing" the overall project performance. At this point, the "Matching Framework" should be adequately validated to be able to test hypothetical variations in the financing and funding scheme typology dimensions, in the form of a sensitivity analysis.

Validation Step 5 (or Calibration)
A final critical aspect of funding and financing transport infrastructure relates to how projects respond to changes in the macroeconomic environment. BENEFIT aims to investigate the adjustments that are triggered by such changes to certain typology dimension scores – and which, therefore, impact project setup – that would allow projects to cope with the various effects of the economic crisis.

This final calibration step of the model takes place in task 4.3, which places emphasis on the cases implemented in countries under financial/economic distress. At this point, the "Matching Framework" should be adequately validated to be able to test for hypothetical variations in the financing and funding scheme dimensions, similarly to step 4 previously.

After the successful completion of all validation steps, the "Matching Framework" should be able to be used for the ex-ante assessment of projects in WP5.

It should be noted that whenever a validation step cannot be completed successfully, the "Matching Framework" will be adjusted and the process repeated, starting again from Validation Step 1.

The present report concerns Validation Steps 1 – 3.

2.3 The Four Validation Streams

The scope of including four validation streams is to produce a complementary approach to the validation process. These include methods and techniques ranging from purely qualitative to purely quantitative as the matching framework model is heuristic and requires a constant "reality check", while at the same time aims to develop into a generic model, thus requiring a generic validation and assessment process.

The detailed description of each validation stream is described in the respective chapter.

2.4 Lessons Learned

Lessons learned are derived at each step of this report. They concern lessons learned with respect to the funding and financing of transport infrastructure and lessons learned with respect to the BENEFIT Matching Framework and its indicators. The first enrich our understanding with respect to the delivery of transport infrastructure. The second refine the future development of the Matching Framework and provide detailed guidelines for the following BENEFIT tasks.

2.5 Validation of the Indicator Typologies

The report also includes the further validation using case "snapshot" values of the typology indicators. Each indicator is validated using a suitable methodology, which is described in each respective section of Chapter 4. Based on the conclusions of this deliverable, further validation of the indicators is foreseen in the following tasks.

2.6 BENEFIT Case Studies

86 Case studies were used in the Qualitative Analysis of Chapter 3. These cases are listed along with an overview of their features in **Annex A.1.** Information on these case studies has been collected

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using the data collection protocol as described in Deliverable D2.1. Each case study is also accompanied by a structured narrative distribution included in the BENEFIT wiki.

61 Case Studies have been expressed in terms of indicators of the Matching Framework (Snapshots). This data is presented and described in **Annex A.2.** Notably, not all cases could be expressed in the Matching Framework due to data availability limitations. Only 53 case studies provide full useable snapshots for analyses.

2.7 Limitations

This research is based on the adoption of a case-study based model and a systems approach to problem-solving. It is heuristic in the sense that it "learns" through the inclusion of new cases. It offers a model that incorporates a structural analytical framework that is neither agency-based nor stakeholder based. It does *not* include actor strategies, actions and interactions. While this may seem, at first sight, as a limitation, it is not. The model takes into account the impact of any actor interaction through the values of the various typologies and their collective impact on the performance of the system. Hence, actors and interrelations are implicitly included, while the system continues to retain a relatively low level of complexity.

Finally, the Matching Framework and the analyses undertaken in this report are based on case study data and aggregated indicators thereof. The analyses are subject to the quality of this data and the synthesis of the case study sample (see **Annexes A.1** and **A.2**).

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3 BENEFIT Case Studies: Qualitative Analysis

The present Chapter adds to the "lessons learned" of Work Package 4 of the BENEFIT project. Its scope is to derive a better understanding of the cases in the BENEFIT database, which will be converted to snapshots describing them in terms of typology indicators over time.

The assessment is based on the case narratives included in the BENEFIT wiki and the BENEFIT Cases in Transport Infrastructure e-book[15]. Information is also mined from the BENEFIT case database, where project information has been collected based on the BENEFIT data collection protocol (see BENEFIT project deliverable D2.1). The objective of the qualitative analysis was to identify the reasons leading to the outcomes of individual cases and, whether some factors are recurring per mode. Lessons learned are also formulated accross cases by comparing the findings per mode. The methodology of content analysis was used for the elicitation of the relevant qualitative information existing in the narrative of the case studies.

The cases for each mode are reviewed regarding their outcome, including:

i. Cost performance, concerning construction cost to completion
ii. Time performance, concerning construction time to completion
iii. Traffic forecast
iv. Achievement of transport goals
v. Other economic outcomes
vi. Social outcomes
vii. Environmental outcomes
viii. Institutional outcomes

Renegotiations are also studied in the case of privately financed projects (PPP and other concessions).

Notably, these outcomes are those identified in the Matching framework as detailed in task 3.1 (Deliverable D3.1). This analysis does not consider forecasted vs actual revenues, as this outcome is developed as a proxy and used only in the semi-qualitative and quantitative analyses.

The parts of the narrative that are relevant to the eight dimensions of the qualitative analysis framework were singled out. The purpose of the analysis is to identify qualitative elements that indicate patterns of similarity or dissimilarity in the above-mentioned dimensions and draw insights on any potential systematic facts and behaviour of the case studies under analysis. Due to the small number of case studies analysed, drawing generalised conclusions is limited; however the value of the observations and their interpretation is helpful, especially when findings are compared between modes.

The analysis of cases per mode, while focusing on the same outcomes, follows a slightly different approach in order to exploit in the most appropriate way the available cases per mode. The approach followed is described in each respective section of this Chapter. Notably, the road mode analysis bearing more cases follows a descriptive statistics approach enriched with respective information from cases. The other modes follow an approach most suitable to the mode analysed and the available data.

The BENEFIT project argues in favour of transport infrastructure projects that promote a more integrated approach in infrastructure delivery. In task 2.2, the business model typology considers more integrated projects, which include different sources of project revenues and combined delivery of

[15] BENEFIT Case Studies, ISBN 978-618-82078-1-3

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transport and other infrastructure. This is based on the assumption that infrastructure projects with mixed revenue streams are more resilient to fluctuations in the local, national and global market.

The first section in this Chapter reviews the business models adopted in the cases forming the BENEFIT case study database.

The BENEFIT Case Study Database is described in Annex A.1 of the present document.

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3.1 Review of Business Models Identified in the BENEFIT Database

The present analysis reviews the BENEFIT case database with respect to the presence of the anticipated "revenue enhancement" measures. Based on the BENEFIT deliverable D2.2, cases are reviewed to identify if the following revenue enhancement measures are present:

1. Combination with other commercial activities
2. Brownfield upgrade included in construction
3. Brownfield included in operation
4. Co-construction with infrastructure of other mode
5. Co-construction/ operation with other non-transport infrastructure

To facilitate this review, cases are considered per mode and/or infrastructure type:

- Airports
- Urban transit (metros, tramways, bike sharing network projects)
- Ports
- Rail
- Road
- Bridges/ tunnels
- Terminals

This initial analysis seeks to identify if particular business models may be identified to develop within each transport infrastructure mode.

The presentation of this analysis is found in Annex A.3.1. Tables 3.1.1 and 3.1.2 summarise the findings of the analysis per infrastructure mode or type and group them in terms of Node or Line infrastructure. Through the previous analysis and the cross-comparison of modes it may be concluded that:

- Node Infrastructure serving passenger transportation potentially include commercial services that may generate revenues greater than 10% of total revenues

- Roads and more so, national / international roads include service stations and other similar commercial activities, which, however, usually contribute less than 10% of total revenues.

- The combination with brownfields is dominant in road projects and usually are included in the operation phase

- Tramways are commonly combined in their operation with other urban transit infrastructure in operation

- Infrastructure dedicated to freight was not found to be bundled with other features.

- Overall, few revenue enhancing features were identified in the cases in the BENEFIT database.

Apart from the prevailing Business Model features, some points of interest include:

- Urban projects across infrastructure modes usually include an urban regeneration component.

- Environmental works usually accompany long-distance (intercity or national/international) roads.

- With respect to rail-based projects, trams hold the middle ground with respect to intensity of investment (46.3 MEuros/km) in comparison to metros (91 MEuros/km) and rail (32.2 MEuros/km). Despite this observation, tramways and light rail were more attractive to private co-financing. Of course, this observation concerns the BENEFIT database cases.

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- The least costly investments within line infrastructure are roads with a concentration around 20 MEuros/km.

- By far more cost intensive are special infrastructure projects such as bridges and tunnels, with an average cost within the BENEFIT sample of 554 KEuros per meter.

- A final point worth remarking is that regardless of mode or intensity of investment, and with few exceptions, the contract duration for PPP type project delivery is in the range of 30 years throughout the cases in the BENEFIT database.

Table 3.1.1: Identified features in Node Infrastructure

Features	Airports	Ports	Terminals
# of Projects	5	10	3
Combination with other commercial activities (greater than 10% of total revenues)	2	1	1
Combination with other commercial activities (less than 10% of total revenues)	3	0	
Brownfield upgrade included in construction	4	0	1
Brownfield included in operation	4	0	
Co-construction with infrastructure of other mode	0	0	
Co-construction/ operation with other non-transport infrastructure	2	1	
Additional Features Identified			
Support to local activity (tourism)	3		
Equipment		10	
Urban Development			1

Table 3.1.2: Identified features in Line Infrastructure

Features	Metros	Trams	Bike sharing	Urban Transit TL	Urban Roads	Intercity Roads	National/ international Roads	Regional	Roads TL	Bridge/ Tunnel	Rail
# of Projects	7	10	2		6	5	12	7	30	9	7
Combination with other commercial activities (greater than 10% of total revenues)		1	2	3					10		0
Combination with other commercial activities (less than 10% of total revenues)	1			1	1	1	6	2		1	0
Brownfield upgrade included in construction	1			1	2	3	8	3	16		1
Brownfield included in operation		4		4			8		8	1	0
Co-construction with infrastructure of other mode		2		2						3	1
Co-construction/ operation with other non-transport infrastructure											0
Additional Features											
Renovation/ Urban Development		8		8	1				1	1	
Environmental Works					1	2	2		5		
Anti-flooding Works					1				1		

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3.2 Road Projects in BENEFIT

The road sector sample includes 31 projects, of which 24 are PPP and 7 are public. The projects are located in 15 European countries, as presented in Table 3.2.1.

Table 3.2.1: Road cluster in the BENEFIT database

Country	Number of projects		
	PPP	Public	Total
Belgium	1		1
Croatia	1		1
Finland	2		2
Germany		1	1
Greece	5		5
Italy	1		1
The Netherlands		1[16]	1
Norway	2		2
Poland	1		1
Portugal	2		2
Serbia	1	3	4
Spain	4		4
Slovenia		2	2
UK	4		4
Total	24	7	31

The projects were awarded in the period from 1987 to 2012 (Figure 3.2.1). Most of the PPP cases in the sample were awarded prior to the global financial crisis, while five out of seven public cases were awarded from 2009 to 2011.

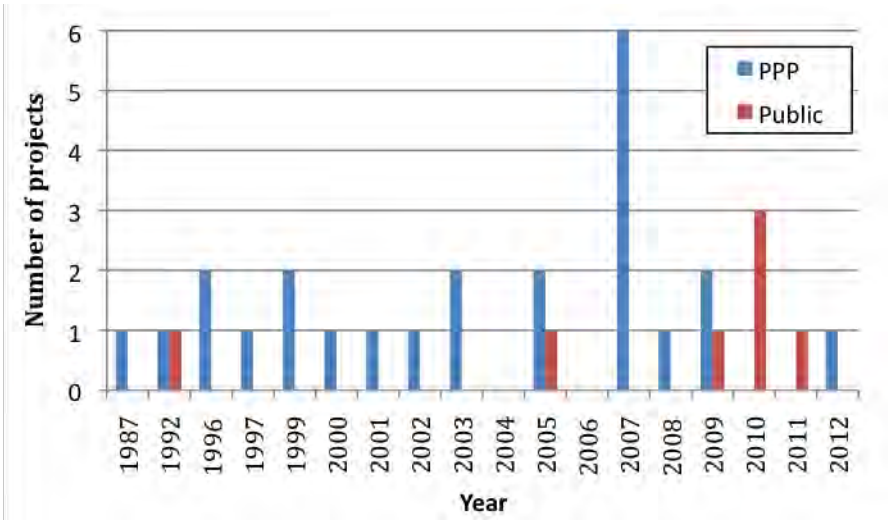

Figure 3.2.1: Year of award of road projects in the BENEFIT database

[16] The Combiplan Nijverdal (rail and road project) is included here but not in the road projects of section 3.1

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Table 3.2.2 presents the detailed list of road projects included in the BENEFIT Case Study database. The sample includes 13 Greenfield projects, 8 Brownfield projects and 10 projects that contain both Greenfield and Brownfield sections.

Table 3.2.2: List of case studies included in the analysis

Case study	Country	Year of award	PPP/ Public	Project type	Budget size[1]
Via Zeventem	Belgium	2007	PPP	Brownfield	Low
Istrian Y Motorway	Croatia	1997	PPP	Brownfield	High
E4 Helsinki-Lahti	Finland	2012	PPP	Both GF & BF	Medium
E18 Muurla-Lohja	Finland	2005	PPP	Greenfield	Medium
Bundesautobahn 20	Germany	1992	Public	Greenfield	High
Athens Ring Road	Greece	1996	PPP	Greenfield	High
Central Greece (E65) Motorway	Greece	2007	PPP	Both GF & BF	High
Elefsina Korinthos Patra Pyrgos Tsakona Motorway	Greece	2007	PPP	Both GF & BF	Medium
Ionia Odos Motorway	Greece	2007	PPP	Brownfield	High
Moreas Motorway	Greece	2007	PPP	Both GF & BF	Medium
BreBeMi	Italy	2003	PPP	Both GF & BF	Medium
Combiplan Nijverdal	The Netherlands	2010	Public	Brownfield	Medium
E18 Grimstad - Kristiansand	Norway	2005	PPP	Greenfield	Medium
E39 Orkdalsvegen Public Road	Norway	2003	PPP	Both GF & BF	Low
Horgos - Pozega	Serbia	2007	PPP	Both GF & BF	High
Belgrade By-pass Project, Section A	Serbia	2010	Public	Greenfield	Low
E-75, Donji Neradovac - Srpska kuca	Serbia	2011	Public	Brownfield	Low
E-75, Horgos-Novi Sad (2nd phase)	Serbia	2009	Public	Both GF & BF	Low
A5 Maribor Pince motorway	Slovenia	2005	Public	Brownfield	Medium
Koper - Izola Expressway	Slovenia	2010	Public	Greenfield	Low
C-16 Terrassa-Manresa Toll Motorway	Spain	1987	PPP	Greenfield	Low
Eje Aeropuerto (M-12) Motorway	Spain	2002	PPP	Greenfield	Medium
M-45	Spain	1999	PPP	Greenfield	Medium
Radial 2 Toll Motorway	Spain	2001	PPP	Greenfield	Medium
A2 Motorway	Poland	2009	PPP	Greenfield	High
A22 motorway	Portugal	2000	PPP	Both GF & BF	Low
A23 motorway	Portugal	1999	PPP	Greenfield	Medium
A-19 Dishforth	UK	1996	PPP	Brownfield	Low
BNRR (M6 Toll)	UK	1992	PPP	Greenfield	High
M-25 Orbital	UK	2009	PPP	Brownfield	High
M-80 (Haggs)	UK	2008	PPP	Both GF & BF	Medium

Note: [1]Low (<400 MEuros), Medium (400-1000 MEuros), High (>1000 MEuros)

The project size ranges from 27 million Euros to more than 2 billion Euros (expressed in 2013 prices). Nine projects had a size below 400 MEuros, an additional 13 projects had a size between 4000 and 1000 MEuros, and nine projects had a size above 1000 MEuros.

Three Greek PPP cases (Elefsina Korinthos Patra Pyrgos Tsakona Motorway, Central Greece (E65) Motorway and Ionia Odos), awarded in 2007, that haven't been completed yet, were excluded from the further analysis in order to avoid possible bias due to overweighting of projects in one coutry. The Moreas motorway that was also awarded as PPP project in 2007 has similar characteristics to all these three cases, but was the only one for which construction was not interrupted, while the other

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three cases underwent major restructuring. In addition, the Horgos – Pozega PPP project in Serbia never reached financial close, and part of that project was later implemented through public financing and included in the database. Therefore, the project was excluded from further analysis, so the final number of analyzed PPP cases was 20.

The qualitative assessment focuses on the outcome variables distribution and their relation to the following influencing characteristics: country, funding scheme (PPP vs. Public), project type (greenfield, brownfield and mixed), project timing (time of award), and project duration and size.

3.2.1 Cost Performance

Most of road projects in the BENEFIT database (17 out of 27, or 63%) have been delivered on budget, including 15 out of 20 (75%) PPP projects, and 2 out of 7 (28.5%) publicly financed projects (Figure 3.2.2).

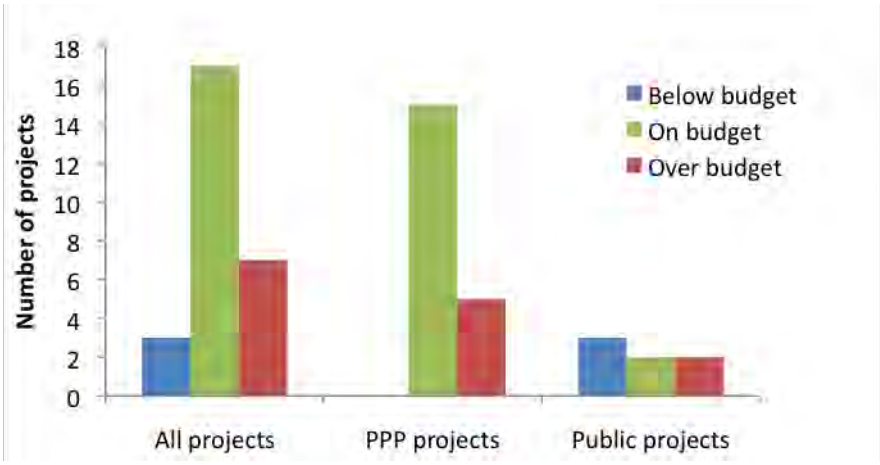

Figure 3.2.2: Distribution of PPP and public road projects regarding cost overrun

Publicly financed projects are relatively equally distributed across categories (three projects below budget, and two projects on budget and above budget). The three public projects delivered below budget are A5 Maribor - Pince Motorway, Koper - Izola Expressway in Slovenia and Bundesauto-bahn 20 in Germany.

All road projects that experienced cost overrun are located in southern European countries (Greece, Italy, Serbia and Spain), apart from the Combiplan Nijverdal project, located in the Netherlands (Figure 3.2.3). In Greece, Italy and Serbia, there is one case per country with a cost overrun (Moreas Motorway in Greece, BreBeMi in Italy and Horgos – Novi Sad in Serbia). In Spain, there are three (out of four) projects with cost overrun.

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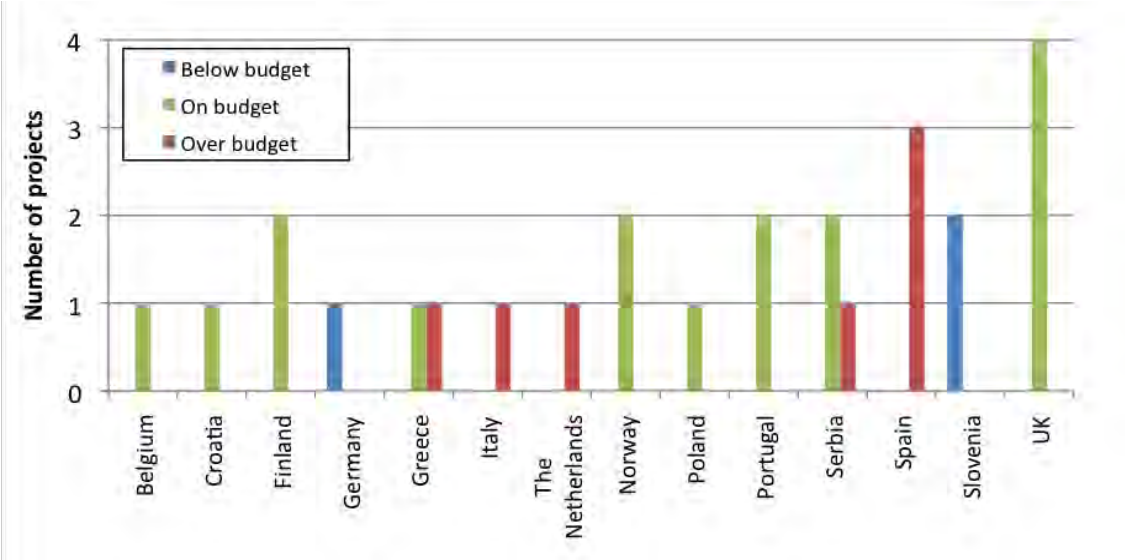

Figure 3.2.3: Distribution of road projects regarding cost overrun by country

Brownfield PPP and Greenfield Public road projects are delivered more successfully regarding cost criteria, since there was no cost overrun for these two categories (Figure 3.2.4).

The cost overrun is mainly present on medium sized projects (Figure 3.2.5). Five out of eleven (45%) medium sized projects experienced cost overrun. The percentage was around or below 20% for both small and big projects.

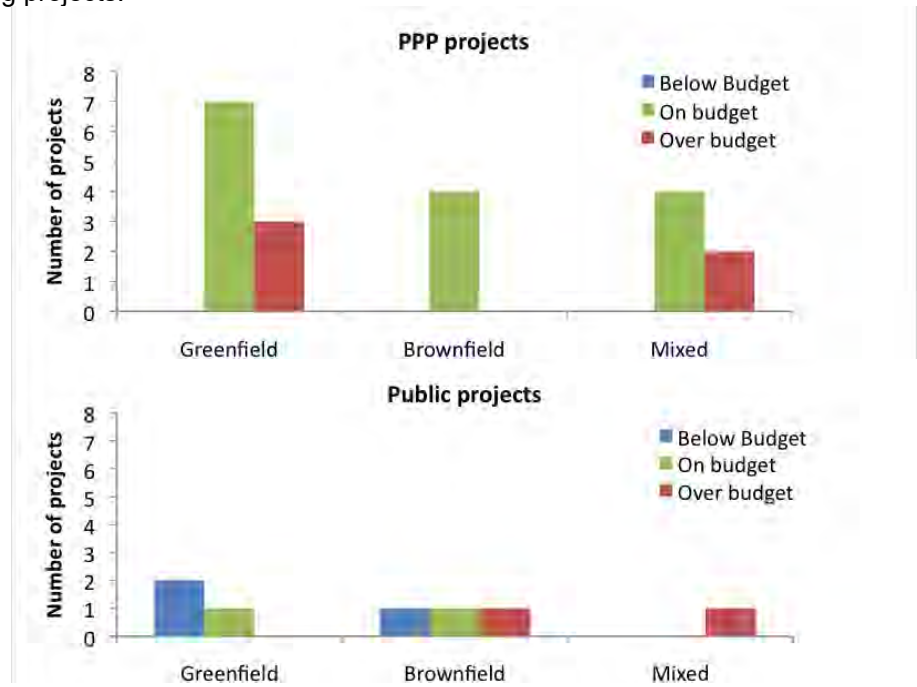

Figure 3.2.4: Distribution of PPP and public Greenfield and Brownfield projects regarding cost overrun

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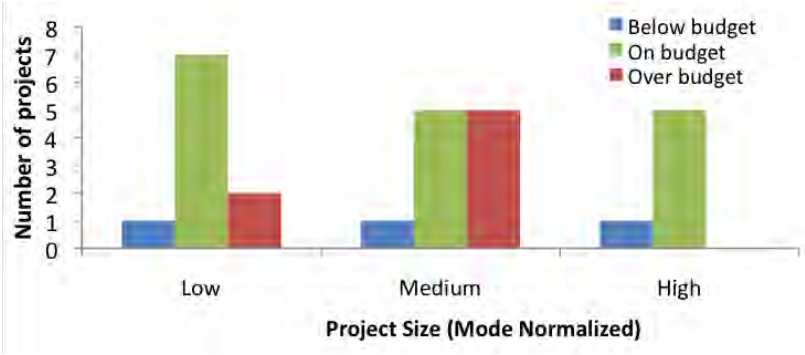

Figure 3.2.5: Distribution of cost overrun by project size

More than half of PPP projects awarded between 1999 and 2003 experienced cost overrun, as presented in Figure 3.2.6. Two public projects that had cost overrun were awarded in 2009 and 2010, after the global financial crisis.

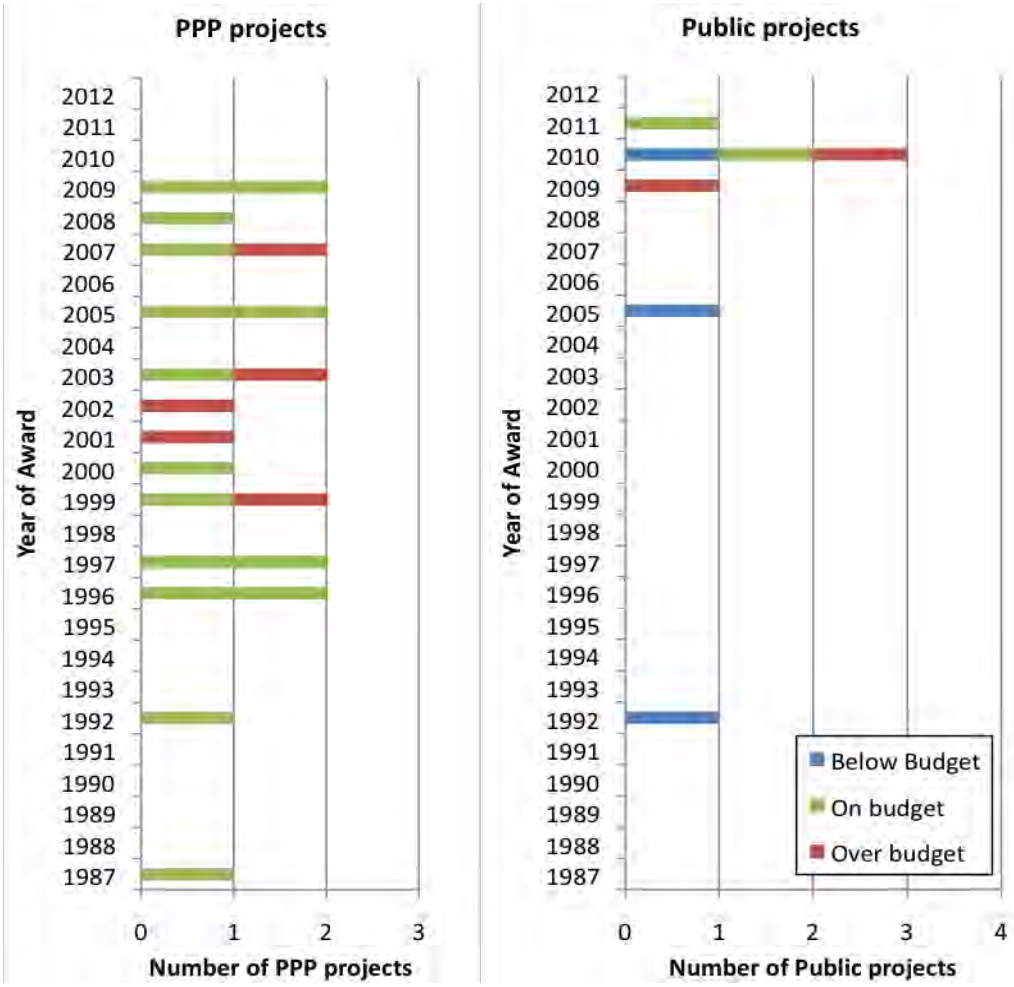

Figure 3.2.6: Distribution of cost overrun by year of project award

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3.2.2 Time Performance

Time performance appears to be more critical for road projects than cost overrun. PPP projects are superior compared to public projects regarding completion on time. 70% of PPP road projects (14 out of 20 projects) were delivered on time, while the situation with public projects is just the opposite – more than 70% of projects (five out of seven) were delayed. Two PPP road projects were delivered ahead of schedule (E18 Muurla-Lohja in Finland and A2 Motorway in Poland), 14 delivered on time and 11 delayed (Figure 3.2.7).

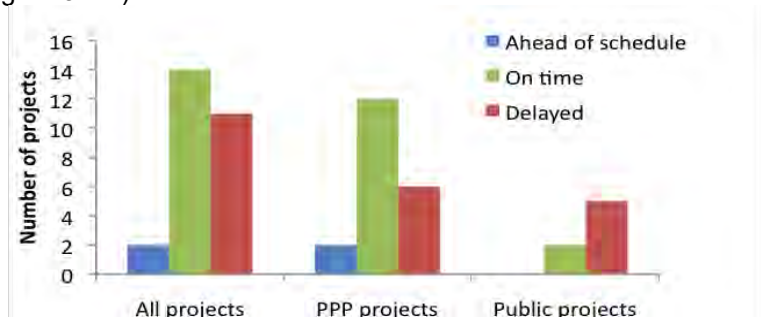

Figure 3.2.7: Distribution of PPP and public road projects regarding time overrun

Road projects that had time overrun are mostly those located in southern European countries (Greece, Italy, Serbia, Spain, and Slovenia). However, Combiplan Nijverdal in the Netherlands and M-25 motorway in the UK also experienced delays in project completion (Figure 3.2.8).

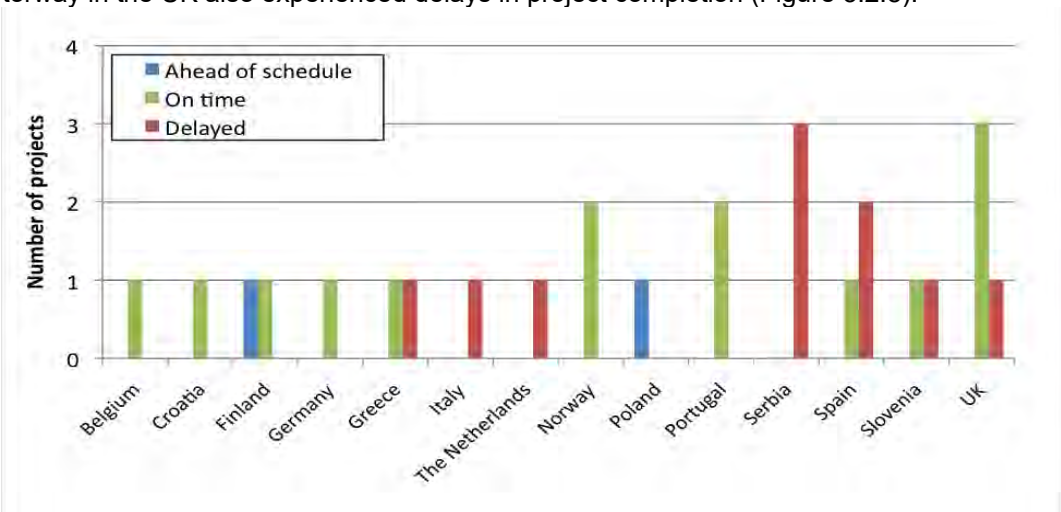

Figure 3.2.8: Distribution of road projects regarding time overrun by country

All road projects in Serbia and three out of four projects in Spain experienced time overrun. The distribution of delayed projects across Greenfield, Brownfield and Mixed categories is quite similar for both PPP and public projects, as presented in Figure 3.2.9.

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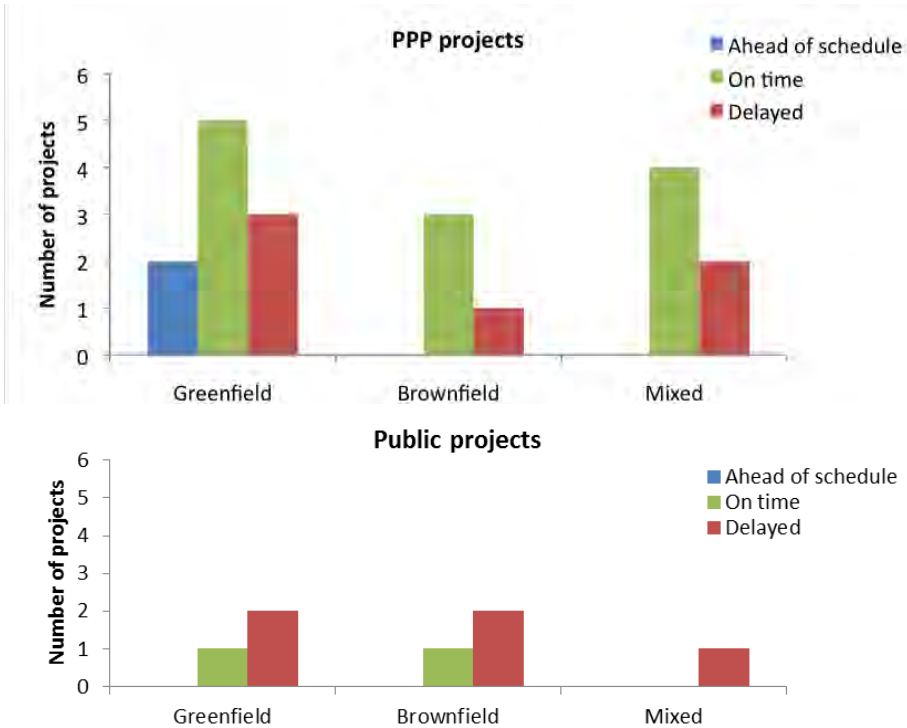

Figure 3.2.9: Distribution of PPP and public Greenfield and Brownfield projects regarding time overrun

Proportionally, more delayed are small projects compared to medium and large projects, as presented in Figure 3.2.10.

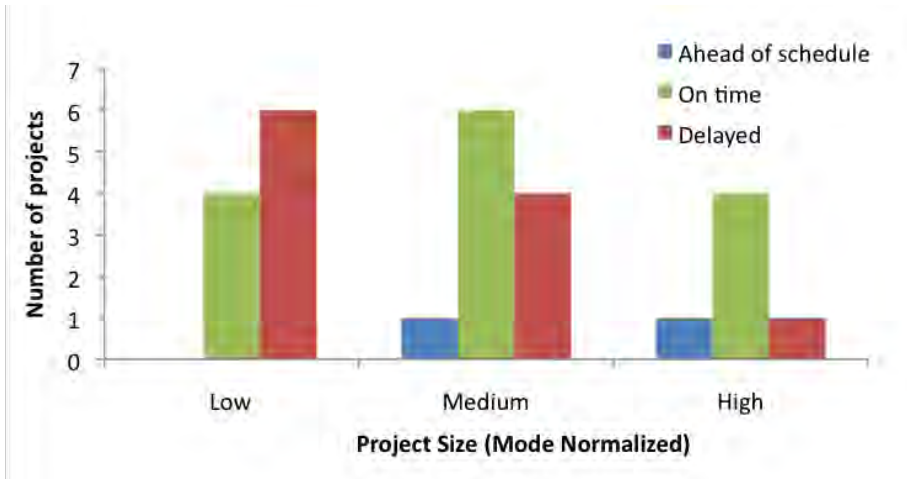

Figure 3.2.10: Distribution of time overrun by project size

All public projects awarded in the period 2009-2011 (five projects) are delivered as delayed. Problematic award years for PPP projects were 2001-2003, 2007 and 2009 (Figure 3.2.11).

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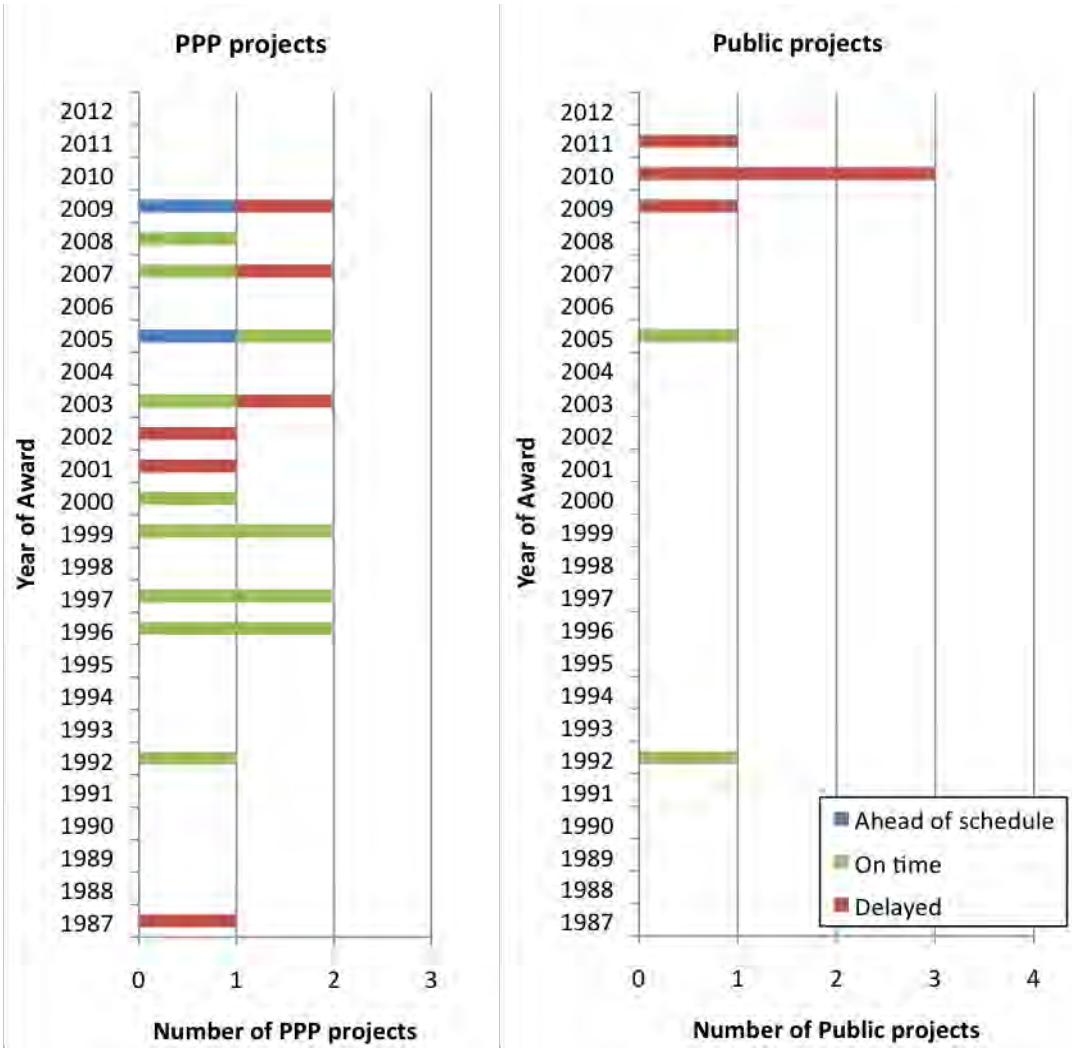

Figure 3.2.11: Distribution of time overrun by year of project award

3.2.3 Traffic forecast

Regarding actual vs. forecasted traffic outcome, there are five road projects exceeding traffic forecast, 10 for which the traffic was as forecasted, 10 below forecast and two for which traffic was far below forecast (Figure 3.2.12). Traffic forecasts seem to be slightly more optimistic for PPP projects, but also four out of five projects for which traffic was underestimated were PPP projects. Five projects with underestimated traffic include A5 Maribor-Pince motorway in Slovenia, Istrian Y in Croatia, A2 motorway in Poland, M-45 project in Spain and E-39 project in Norway. Two projects with heavy traffic overestimation include Belgrade by-pass in Serbia and A-22 motorway in Portugal. In the latter, the introduction of tolls following renegotiation in 2011 led to a substantial decrease in traffic.

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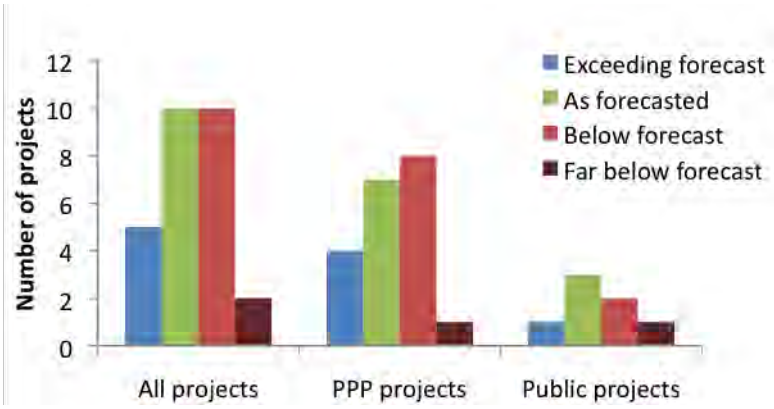

Figure 3.2.12: Distribution of PPP and public road projects regarding forecasted traffic

All road projects in the BENEFIT database located in southern European countries (Greece, Italy, Spain, and Portugal) and two out of three projects in Serbia had overestimated traffic (Figure 3.2.13).

This is to a great extent a result of the global economic and financial crisis. For the A-22 motorway in Portugal, the traffic was above expectations until 2011 when this project was renegotiated and tolls were introduced, which resulted in substantial traffic decrease. For the A-23 project in Portugal, Radial 2 Toll Motorway and Eje Aeropuerto in Spain, for which traffic was below expectations from inauguration. Renegotiations in 2011 in the case of A-23 and the economic crisis in two Spanish cases lead to even lower traffic. Similarly, the Athens Ring Road, that was a very successful project until 2009, with traffic above expectations, eventually faced substantial drop in traffic due to the economic crisis. For two cases, M-45 in Spain, and E-4 in Finland, traffic was from the inauguration above expectations, and decreased to “as expected” at a peak of the economic crisis, but recovered since then. For two projects in Serbia (E-75 Horgos – Novi Sad and Belgrade Bypass), the lower than expected traffic, is partially the result of substantial traffic overestimation during project conceptualization, but also of the global crisis. In addition, Combiplan Nijverdal in the Netherlands and the BNRR (M6 Tollroad) project in the UK are also experiencing traffic below the forecasted. The Combiplan Nijverdal project situation is explained by the fact that the project has not been in full operation. The project had also cost and time overruns indicating wider problems with this project. Notably, the Combiplan Nijverdal included both road and rail co-construction and faced technical problems amongst others.

PPP road projects have better traffic performance when delivered as Brownfield projects (Figure 3.2.14), since traffic forecasts are based on the existing traffic flows are much more reliable. Six out of ten PPP Greenfield road projects have traffic overestimation, in addition to three out of seven projects that included combination of Greenfield and Brownfield sections. No similar observation can be made for public projects where distribution of sections with overestimated traffic is very similar between Greenfield and Brownfield categories.

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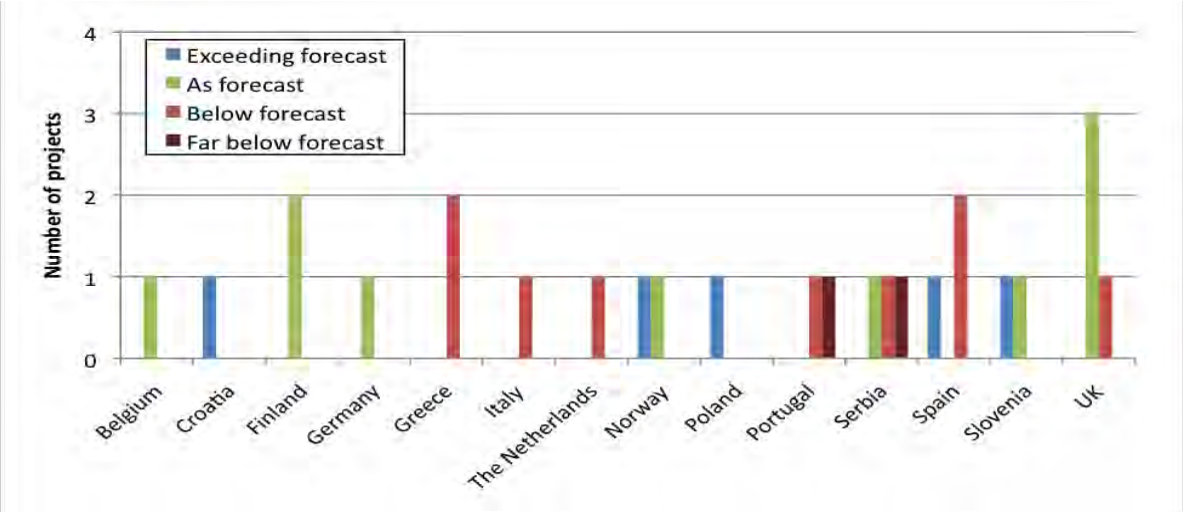

Figure 3.2.13: Distribution of road projects regarding traffic forecast, by country

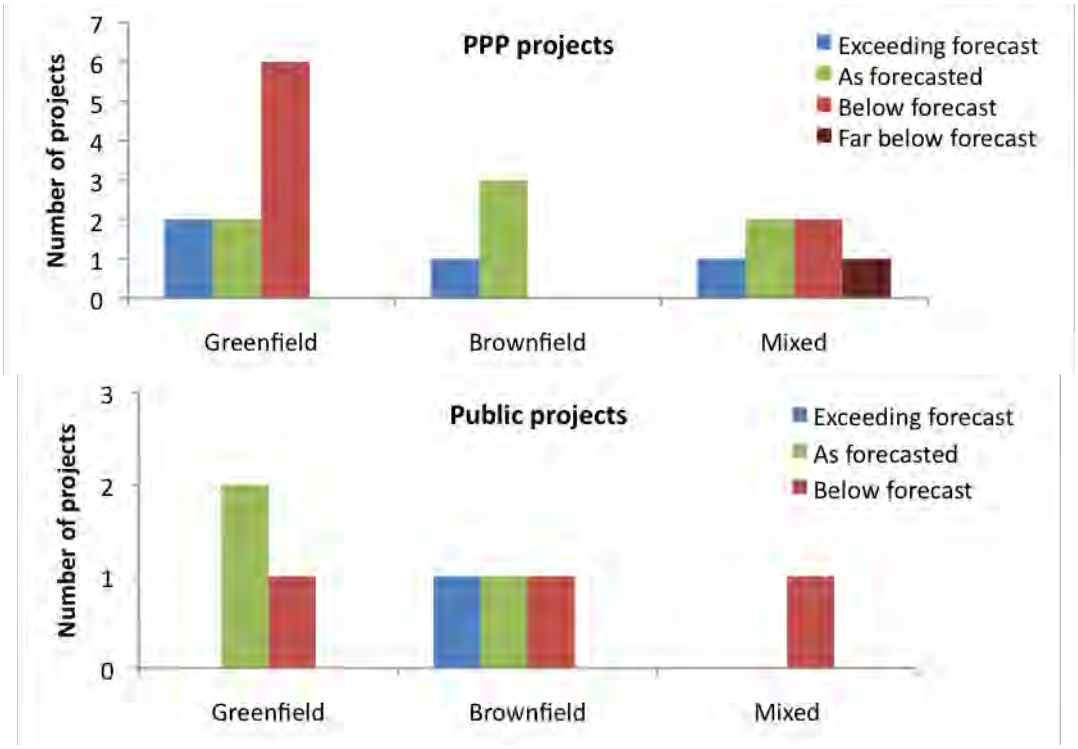

Figure 3.2.14: Distribution of PPP and public Greenfield and Brownfield projects regarding traffic forecast

Traffic overestimation is more present on medium and high size projects (Figure 3.2.15), possibly as a result of intention to justify the high investment of projects. However, there are also small projects with heavily overestimated traffic, like the already mentioned Belgrade by-pass in Serbia and A-22 in Portugal. Well performing projects with traffic above forecasted or in line with forecast are distributed almost equally in all three categories.

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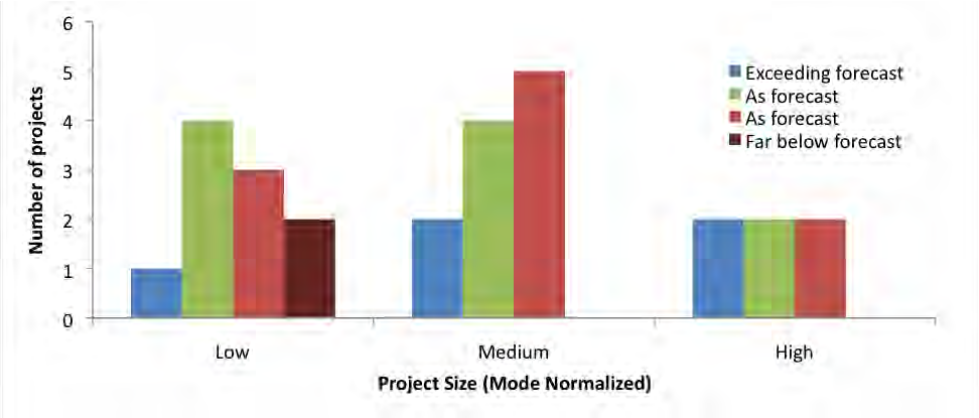

Figure 3.2.15: Distribution of traffic forecast by project size

Both PPP road projects awarded before 1992 and more than half of projects awarded between 1996 and 2003 have traffic below forecasted. It appears that traffic forecast has improved in more recent projects. Three public projects awarded in 2009 and 2010 have overestimated traffic, possibly due to the impact of the global financial crisis (Figure 3.2.16).

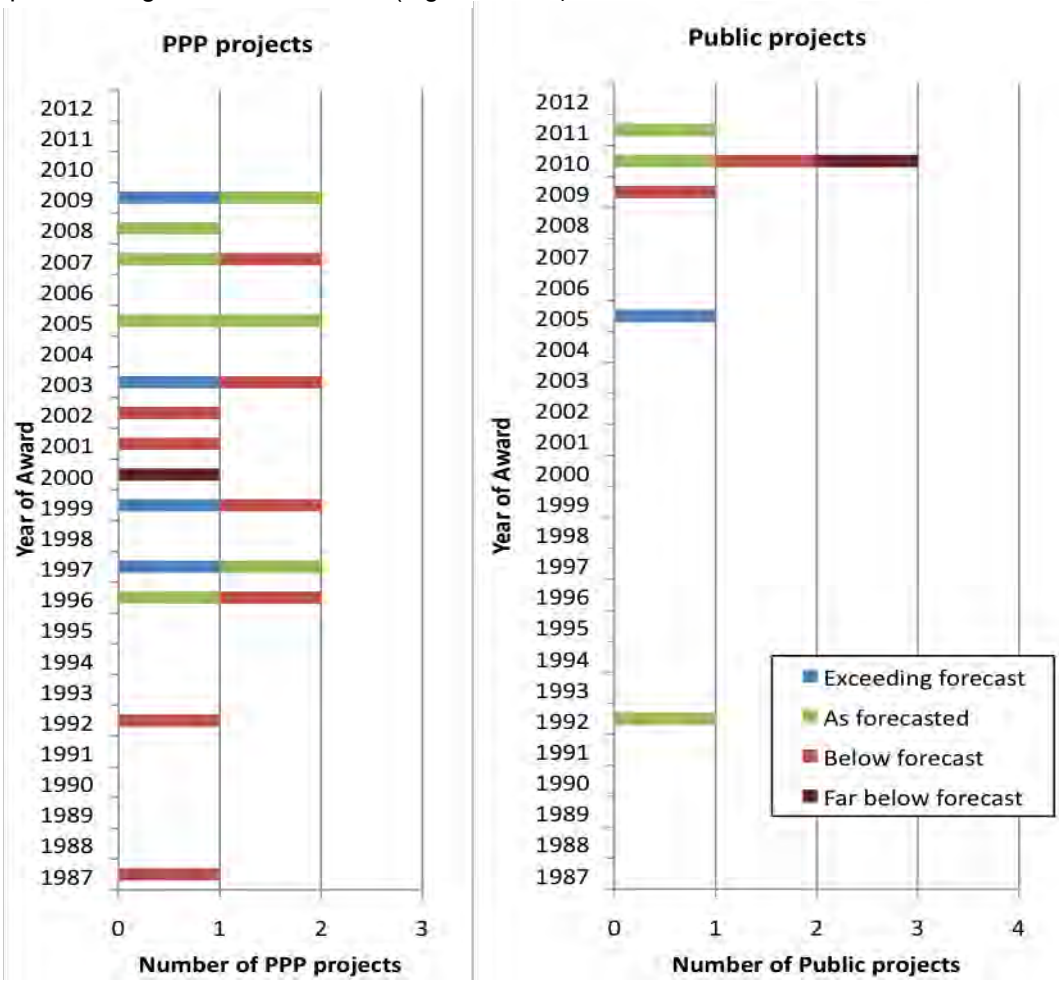

Figure 3.2.16: Distribution of traffic forecast by year of project award

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3.2.4 Achieving transport goals

Most road projects in the BENEFIT database fulfilled transport goals as expected (23 out of 26 projects, or 88%). Within PPP cases, there are two projects exceeding expectations (Athens Ring road in Greece and E-39 in Norway), two projects below expectations (A23 - Beira Interior in Portugal and C-16 Terrassa-Manresa Toll Motorway in Spain) and one far below expectations (A22 – Algarve in Portugal). Within Public cases, there is one project exceeding expectations (A5 Maribor - Pince Motorway) and all other projects fulfilled transport goals as expected (Figure 3.2.17).

In general, projects appear to be well planned to achieve the expected transportation function. However, due to the global financial crisis two already mentioned projects in Portugal and one in Spain had problems in achieving transport goals. These projects are either Greenfield (A23 - Beira Interior C-16 Terrassa-Manresa Toll Motorway) or include both Greenfield and Brownfield sections (A21 – Algarve), as presented in Figure 3.2.18.

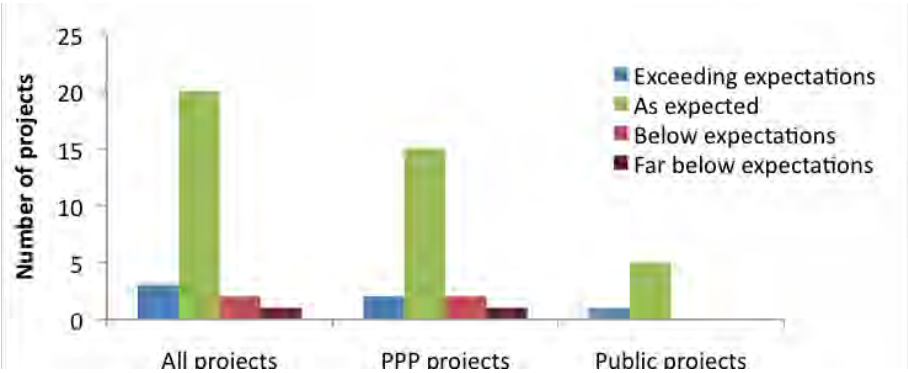

Figure 3.2.17: Distribution of PPP and public road projects regarding fulfilment of transport goals

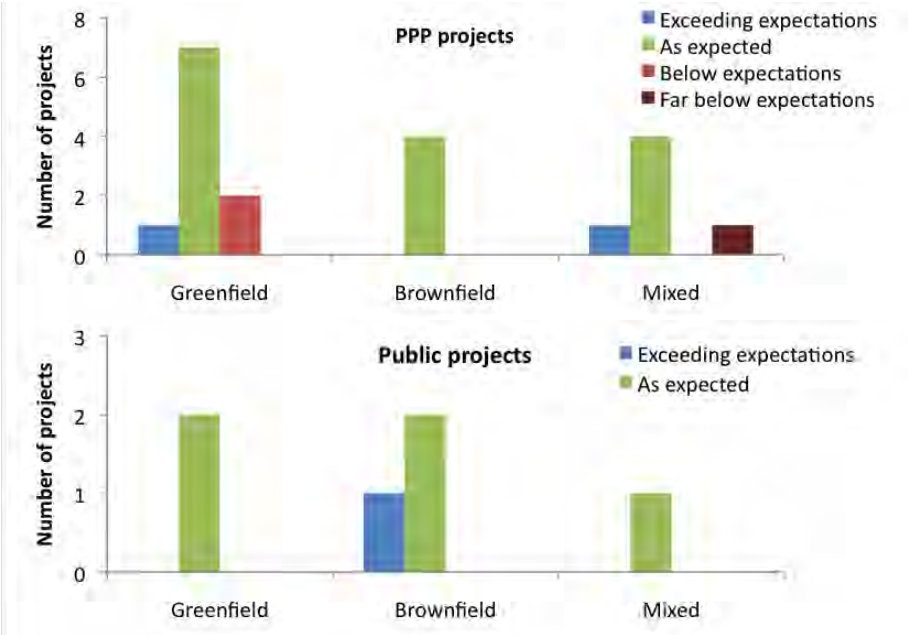

Figure 3.2.18: Distribution of PPP and public Greenfield and Brownfield projects regarding fulfilling transport goals

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Regarding project size, it is interesting to notice that transport goals fulfilment below or far below expectations is present in low and medium size projects (Figure 3.2.19).

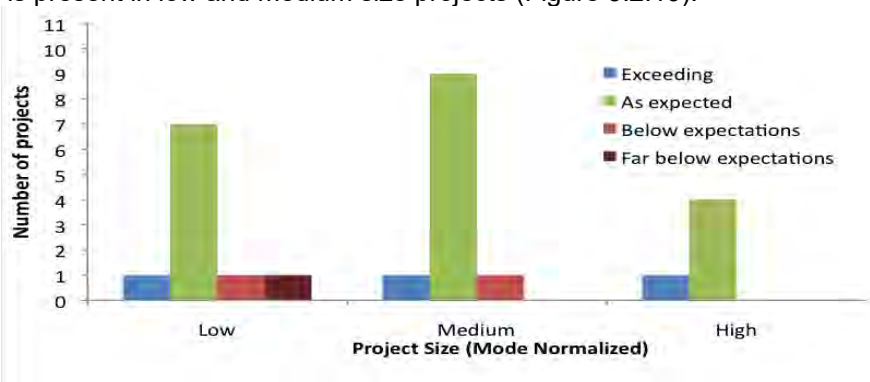

Figure 3.2.19: Distribution of projects regarding achieving transport goals by project size

All three PPP road projects that have not fulfilled transport goals were awarded in 1999 and 2000.

3.2.5 Summary of Findings

Based on the qualitative assessment of road cases in the BENEFIT database, the following findings can be summarized:

- There is substantial difference in performance between projects in northern and western European countries, and projects in southern European countries. Most projects that experienced cost and time overrun and traffic overestimation are located in southern countries. Projects in Belgium, Croatia, Finland, Germany, Norway and Poland are, according to all four criteria, performing in line with expectations or better. Out of four projects in the UK, only one (M-25 Motorway London Orbital) has a delay, and only one project (BNRR - M6 Tollroad) has actual traffic below forecast.

- Most issues regarding cost, time or traffic performance of PPP projects are present in projects awarded before 2003.

- On the other side, public projects awarded between 2009 and 2011 show deficiencies regarding time overrun and traffic forecast in most cases. Cost overrun is also present in two out of five cases.

- PPP road projects are in general better performing regarding cost and time overrun than public projects. However, the traffic forecast is typically more optimistic for PPP projects.

- The main reasons for cost overrun in road projects are typically related to scope changes, expropriation and archaeology problems, economic crisis, and sometimes to other technical issues (Moreas Motorway and Combiplan-Njiverdal).

- The most typical reasons for delays in road projects are economic crisis, expropriation problems, design changes, technical and archaeology issues, but also bankruptcy of the contractor (Koper-Izola Motorway). On the Horgos-Novi Sad motorway, the contractor also went into bankruptcy although it didn't have an effect to project outcomes.

- The global financial crisis had significant impact on traffic levels, particularly on projects in southern European countries. The traffic levels decreased in most of the projects as a result of the crisis directly, or renegotiations that led to introduction of tolls (A-22 and A-23 in Portugal).

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However, some sound cases were able to recover to traffic levels before the crisis (M-45 in Spain and E-4 in Finland).

- Most of the road projects in the BENEFIT database fulfilled transport goals as expected.

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3.3 Urban Transit Projects in BENEFIT

The qualitative assessment performed for urban transport projects is based on 13 cases. This sample of 13 cases comprises:

- 2 metro projects (the Warsaw metro and the Málaga metro)
- 9 tramway or similar projects[17];
- 2 free bike sharing network projects.

Initially, the five case studies derived from the previous OMEGA Megaproject[18] were not taken into account in this assessment because they had been analysed in a specific case study template, which was different from the template used for the other projects. Taking them into account would have required a greater assimilation of information. This work may possibly be undertaken in the following BENEFIT project tasks.

The overall success rate of the 13 cases examined underwent subjective assessment by the authors of each case. Based on this assessment, we have:

- 7 projects considered as being "quite successful": Metro do Porto, Warsaw Metro II, Brabo 1, Manchester Metrolink light rail, Lyon tramway T4, SEVICI and Lyon Velo'V;
- 5 projects considered as being of "more limited" success: Málaga metro, Sul do Tejo metro, Reims tramway, Caen TVR and Athens tramway.

A significant proportion of projects included in our sample seem to have encountered difficulties either in their construction phase or during operation. Comparing these projects is a difficult process. This is because the study sample includes projects:

- From fairly different European countries (4 French projects, 2 Portuguese projects, 2 Spanish projects, 1 German project, 1 Greek project, 1 Polish project, 1 Belgian project, 1 English project); Commissioned at quite different periods -see Figure 3.3.1).

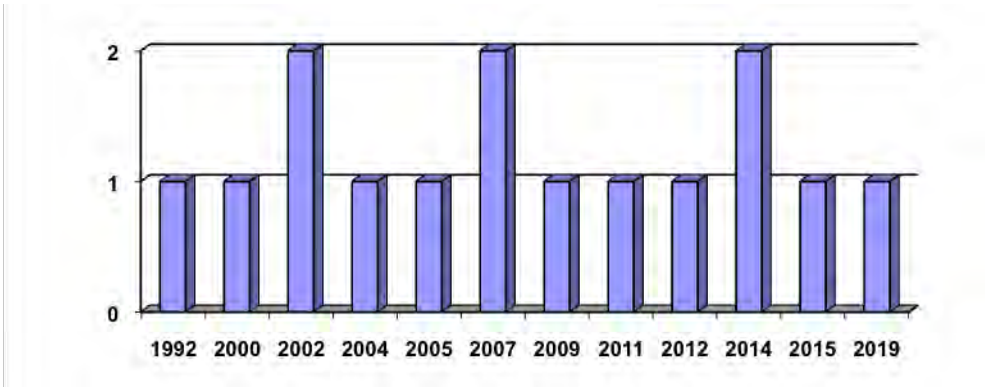

Figure 3.3.1: Date of commissioning of the urban transport projects[19]

The sample cases are also sorted according to the way they are financed (4 cases classified as public financing and 9 cases considered as public-private partnerships (PPP)). In the case of urban transport, this distinction is a difficult one to make. The case studies in our sample very often involved "mixed" financing/funding schemes that can be classified into two categories:

- Projects covered by a DB-type contract and run by an operator considered as a local authority

[17] The "metros" of Sul do Tejo and Porto, and the Karlsruhe tram-train have been considered as tram projects.
[18] Attiko Metro, Beneluxijn, London Jubilee Line Extension, Paris Meteor and RandstadRail
[19] The three phases of the Manchester Metrolink project have been considered here as three separate projects because of the relatively high degree of independence from each other.

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or an Arm's length Public Entity (this situation is met in the cases of the Warsaw Metro II or the Sul do Tejo Metro);

- Projects that, in contrast, involved construction under public control and an OM-type operating contract awarded to a private partner (this situation is met in the cases of Lyon T4 tramway or Manchester Metrolink phase 3).

Furthermore, some projects in the study sample are classified as "PPP", while the concessionaires concerned are wholly or partly made up of public partners. In the case of the Metro do Porto project, the concessionaire (Metro do Porto SA) is actually only made up of public partners (Municipality of Porto, Portuguese State, Portuguese National Railway Company and the public transport company of Porto). In the case of the Brabo 1 project, the concessionaire is a private consortium, which contains both private and public partners. As a contrasting definition, the Athens Tramway is considered a public project even though during construction and operation, an independent private (but public arms-length) company was the responsible entity.

Moreover, the existence of a PPP does not necessarily give rise to private financing: the first phase of the Manchester Metrolink project is based on a private concession, while the project funding remains exclusively public (19% of debts contracted with the European Union and 81% of subsidies provided by the British government in the form of equity).

At another level, it will be noted that this sample contains many large-scale projects. These projects comprise the development of a new transport network (cases of Porto metro, Manchester Metrolink, Sul do Tejo metro, Málaga metro, the Athens Metro, the Athens Tramway) rather than adding a line to an already existing network. Even if all these projects are considered as "local" in their geographical dimension, they are therefore emblematic, nationwide transport projects with specific involvement of central government. This situation is unusually met in the urban public transport field. These projects may therefore in fact have different characteristics from those encountered in the case of more localized and limited urban transport projects.

This part aims to qualitatively analyse urban transport projects with regard to their main results. The results systematically analysed in the case studies relate to the themes of Cost, Time and Traffic. The analysis will therefore detail these three aspects.

3.3.1 Cost performance

Cost criteria are key criteria for the success of urban transport projects. The costs of these projects are often reduced to only capital expenditure, whereas operating expenditure, throughout the lifetime of the project, accounts for much larger amounts.

The data available through case studies or from the BENEFIT database are also subject to this difficulty: while the costs related to construction are easily identifiable, the operating costs of the project are hardly ever available. Two reasons may explain this discrepancy:

- Some projects examined were commissioned recently (Manchester Metrolink Phase 3, Warsaw Metro II, Karlsruhe tram-train). Any assessment of the financial conditions of operating is therefore limited;
- While construction is subjected to a line-by-line (or at least project-by-project) analysis, projects are often operated in a larger public transport network. This integration, which is a critical success factor, makes isolating operating costs complex and theoretical.

3.3.1.1 Construction costs

The assessment with respect to construction costs is based on the discrepancy between budgeted cost and actual cost (Template part 1.8. Cost/ Budgeted of Investments). If the variation in these costs can reflect the degree of success of the construction phase, the initial level of these costs should also be a parameter for analysis.

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In this regard, the construction budget of the projects in the sample[20] when reduced to the number of kilometres of built infrastructure show large variations, both for tram projects and for metro projects:

Tram – Construction budget (in Euro2013)	▪ €13.0 million/km for the two Athens tram lines ▪ €30,9 million/km for the six lines of the Porto metro project ▪ €24,8 million/km for the T4 tram line in Lyon ▪ €33,2 million/km for the two Reims tram lines
Metros – Construction budget (in Euro2013)	▪ €33,2 million/km for the first two Málaga metro lines ▪ €174 million/km for the Warsaw metro line

Beyond the technical complexity of the projects (comparison between the Warsaw and Malaga metros is difficult: the first one is a fully underground heavy metro, whereas the second one is a light metro), several factors may justify these cost variations:

- The scope of the project costs: French trams, in addition to transport infrastructure, include for example urban renewal expenditures that may ultimately represent significant amounts (2,3% of the costs of the Caen TVR);
- The type of contract: in the case of a PPP, some project costs are actually concession costs (remuneration of the concessionaire, for example). The equivalent costs in terms of public funding (the debt burden) are generally not taken into account.

In addition, the case studies show that for the same technical project construction costs can vary significantly depending on the context. The Design and Build contract of the second Warsaw metro line required two tenders:

- The first tender, requiring a very tight schedule (the Warsaw municipality wanted the project to be in operation for the Euro 2012 football tournament), led the municipality to declare excessively high construction costs;
- The second attempt, a year later, enabled the municipality to select a consortium that was already a bidder in the first tender but this time submitting an offer that was cheaper by €350M.

The construction cost is very sensitive to the overall context of the project but also depends on the level of expertise of the contracting authority. It should also be noted that the Athens tramway and the Málaga metro projects, which have the lowest construction costs per kilometre for tram and metro projects respectively, encountered both significant cost overruns (a 30% increase in the case of Athens tramway and a 50% increase in the case of the Málaga metro).

An analysis of the discrepancy between budgeted cost and actual cost reveals three categories:

- Projects that kept to their construction budget: Manchester Metrolink, Lyon T4 tramway, Reims tramway, Brabo 1;
- Projects that slightly exceeded their construction budget: Sul do Tejo metro, Athens tramway, Warsaw metro II, Caen TVR;
- Projects that went significantly over budget: Málaga metro, Karlsruhe tram-train).

In the case of the latter two projects, the reasons for the additional costs were:

- Karlsruhe tram-train: poor project planning and difficulties related to civil engineering work;
- Málaga metro: lack of upstream assessment, poor work planning and additional work added;

The lack of project preparation seems to be a cause of additional costs in these two different cases. This drawback can also be observed in the case of Athens tramway for which the change of alignment, to avoid vibrations on archaeological sites, has led to an increase of construction costs. This observation has to lead us to wonder about the basic assumption that all projects analysed have been correctly assessed, designed and planned. In fact, the lack of maturity seems to be obvious for

[20] We do not include the 2 free bike sharing projects (Velo'V and SEVICI) for which capital expenditure is limited.

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these three projects and may be reflected either in the technical difficulties encountered during the construction phase (poor planning of staffing needs, for example) or in the modifications to the project itself between the budget definition phase and the implementation phase (lack of consultation with the various project stakeholders).

While projects without transfer of design/construction risk to the private sector may seem, in theory, to be more vulnerable to such vagaries, in practice, PPP contracts do not seem to provide a sufficient guarantee, as shown in the case of the Málaga metro.

A transfer of design/construction risk to the private sector does not necessarily mean that deadlines will be respected (Athens tramway) or costs complied with. In the second situation, the contracting authority seems to be unable to prove the constructor's responsibility for these additional costs. Regardless of risk sharing, it can, therefore, be observed that changes in financing schemes are systematically made by increasing public participation (as with the Sul do Tejo tramway, the Porto metro and the Athens tramway).

3.3.1.2 Operating costs:

Information relating to these costs is quite rare in the documents examined. The discrepancy between planned operating costs and the operating costs observed should be tackled systematically through the funding of these costs by the expected incomes.

A lower than expected funding ratio may therefore have two significations: an underestimation of operating costs in themselves or an overestimation of the expected revenue to offset them.

Operating urban public transport is often loss-making. The percentage of resources (excluding commercial revenue) necessary to compensate for this imbalance varies from case to case (Figure 3.3.2). At contract award stage, for projects where this figure is available, it is noted:

- 4 projects that plan a funding ratio of 100% of operating costs by revenues from users and ancillary revenues (such as advertising);
- 4 other projects that show a funding ratio of between 34% (Reims tramway) and 50% (Lyon T4 tramway).

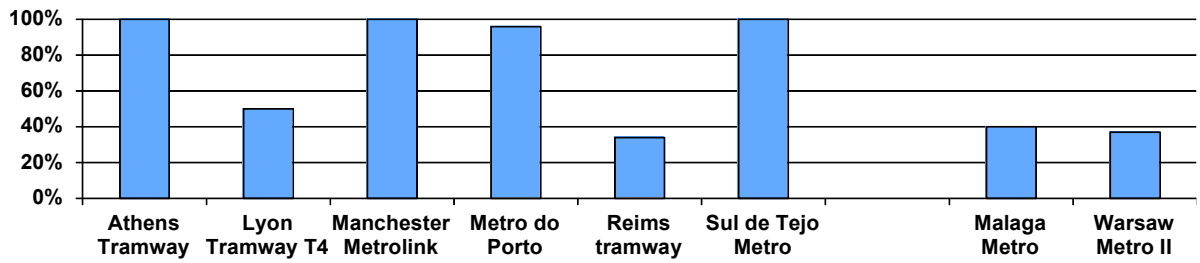

Figure 3.3.2: Covering concession-holder operating costs by commercial revenue (user charges + advertising) provided for when the contract is signed

These figures vary greatly because of the operating conditions of these new projects: either the project is subject to a specific operating contract, or operation covers an entire public transport network, whereby the operator collects the commercial revenues from the entire network and the funding ratio mentioned has been calculated for the whole network.

The case studies analysed are always structuring lines of their public transport networks. As these structuring lines are expected to have high level of ridership, their cost coverage ratio, limited to the line itself, exceeds that of the whole network, which contains less frequented secondary lines.

In the case of the Reims tramway, for which the data required for the calculation are available, the cost coverage ratio expected for the whole network is 35% against 72% for the tramway lines alone.

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It is likely for the 4 projects hoping for cost coverage ratios close to 100%, that operation is defined for the new lines only. For the other 4 projects with lower funding ratios, the funding ratio to be taken into account is that of the public transport network after commissioning the tram/metro projects.

Level of fares seems also to play a main role in the ability of the operator to reach planned operating costs. In the case of the Athens tramway, level of fares at the implementation of the project was far higher than estimations made in the ex-ante analysis. This element can explain a ridership below expectations. In this case, as commercial risks are public, adaptations of these fares have been possible.

In a case of Design/Build/Operate/Maintain contract, level of fares are either set by the private partner or set in the contract for a long period. In these two situations, case studies encounter difficulties:

- In the case of the Manchester Metrolink Phase 2, the private partner was blamed for increasing fares in order to avoid additional rolling stock purchases. This situation contributed to premature termination of the concession.
- In the case of the Reims tramway, the cost coverage ratio below expectation can partly be explained by the inability of the operator to increase level of fares.

3.3.2 Time performance

This theme is dealt with in the database through three types of indicator:

- The duration of the tender procedures;
- The duration of the different stages (design /build/rolling stock delivery);
- The duration of the contracts themselves.

The "outcomes" of the project on this theme are their ability to meet deadlines, especially that of the date of commissioning. With regard to this criterion:

- Only two projects appear to have been commissioned right on schedule: Metro do Porto, Brabo 1;
- Four projects encountered significant difficulties in terms of on-time commissioning: Sul do Tejo tramway (2.5 years late), Athens tramway (4 years late in delivering rolling stock), Warsaw metro (11 months late), Málaga metro (work began 2 years late, commissioning 4 years late).

The reasons given to justify these delays are varied: failure of private contractors (Athens tramway), difficulties encountered during land acquisition procedures (Sul do Tejo metro), technical difficulties encountered during the construction phase (Karlsruhe tram-train, Warsaw metro), and additional work/insufficient project planning (Málaga metro).

Of the 13 projects examined, the "time" parameter appears as an objective in itself in only two cases:

- The Warsaw metro project, initially planned for the Euro 2012 football tournament, although this requirement was not ultimately respected;
- The Athens tramway project, scheduled for commissioning before the 2004 Olympic Games.

For the other projects, respecting construction and commissioning deadlines have implications primarily:

- On the cost of projects, late commissioning systematically resulting in cost overruns;
- On acceptance of the project by the public: while cost overruns are not necessarily known to the public, commissioning delays may generate discontent (especially when combined with longer construction phases). In fact, only two projects show a change in the level of user satisfaction: the Athens tramway (due to changes in fares) and the Warsaw metro (due to the poor quality of signage inside the metro). Commissioning delays (which were significant in these two projects) do not seem to have resulted in a sharp deterioration in user perception of the project.

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The "time" parameter is also involved in the operating phase through the contract durations. The operation of transport projects analysed may be classified into three categories:

- Public operation managed either directly by the contracting authority, or by an Arm's length Public Entity created for the occasion (as is the case with Tram SA for the Athens tramway);
- Private operation, in the case of an OM-type contract with a private company independent of the construction process (which is the case of the Lyon Tramway T4 where construction is financed and supervised by the public transport authority and operation is delegated via a PPP to Keolis);
- Private operation, in the case of a DBOM-type contract including both construction and operation of the line (such as the Sul do Tejo metro and Reims tramway projects).

The duration of contracts is not a parameter for public operation: as the public authority operates its project directly, operating conditions can be adapted without renegotiation or breach of contract (as in the case of the Athens tramway where, in 2011, operation of the tramway was switched to from Tram SA to STASY, which is still a subsidiary of the organizing authority).

However, in cases falling under the 2nd or 3rd category, the duration of contracts has a significant impact, with:

- Fairly "short" contracts in the case of Operate/Maintain-type PPPs specific to operating (6 years for the Lyon tramway, 5 years in the second operating phase for Porto metro, and up to 10 years for the third phase of the Manchester Metrolink project);
- Longer contracts for DBOM-type PPP projects including both construction and operation (34.5 years for the Reims tramway and the Caen TVR, 30 years for the Sul do Tejo metro, 35 years for the Málaga metro, 15 and 17 years for phases 1 and 2 of the Manchester Metrolink project).

Contract duration seems here to become one of the major success factors for the project in its operating phase. When operation is transferred to the private sector for a long period of time, projects systematically encounter difficulties visible through contract renegotiations or breaches of contract. For example:

- Phases 2 and 3 of the Manchester Metrolink project put a premature end to the 15 and 17 year concessions implemented during phases 1 and 2. The transition from phase 2 to phase 3 was intended to change the network operator;
- The Reims tramway contract was renegotiated after less than four years of operation. This renegotiation resulted in a complete reorganization of the operating conditions;
- The Málaga Metro project underwent numerous renegotiations designed in particular to revise upward the financial participation of the contracting authority.

Public transport requires many adjustments of its operating parameters (frequency, timetables, and overlapping of structuring and secondary networks). These adjustments are usually defined after commissioning in the light of changing mobility practices. Defining an operating scheme for a transport line (and *a fortiori* a transport network) for a period of time greater than 10 years often limits these continuous adjustment processes, resulting in recourse to renegotiation processes or premature breaches of contract.

3.3.3 Traffic forecast

Ridership in public transport projects is the parameter most frequently put forward to assess how successful they are. This theme is dealt with in the database through an indicator based on the difference between expected and observed rate of use.

This indicator could be supplemented by an analysis of how ambitious this forecast ridership is. This analysis is difficult to make because of:

- the presence, in our sample, of very large-scale projects for which comparison with existing cases is impossible;
- the diversity of situations: the first public transport line using dedicated lanes on a network

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often leads to a much more significant increase in rate of use than lines added afterwards.

The case studies examined (with the exception of the two free bike sharing projects) tend to feature overestimated ridership forecasts. For example:

- Six projects have overestimated rate of use objectives (Porto metro, Sul do Tejo metro, Athens tramway, Reims tramway and Caen TVR, Málaga metro)
- Three projects have observed ridership in line with expectations (Brabo 1, Lyon T4 tramway and Manchester Metrolink)[21].

This tendency to overestimate is contrary to the analyses made by Cerema on 14 French tram/metro projects[22]. This contradiction highlights how unusual the projects in our sample are and suggests that one should be cautious as to how representative this sample is.

Case studies analysis highlights the strong link between the financial sustainability of the project (especially during its operational phase) and this ridership.

For the six projects with overestimated ridership, the cost coverage ratio of the project is less than the expected. This discrepancy is:

- compensated for by the public authority in 5 cases out of 6 by an increase in the operating subsidy;
- in the case of the Reims tramway, the shortfall for the operator did not lead to a reassessment of the operating subsidy but to a reduction in the public transport supply.

It should be noted that this support given by the contracting authority to the financial balance of the project during the operating phase is independent of the assignment of commercial risk: the Málaga metro, the Reims tramway and the Caen TVR are operated in PPP contracts in which these risks are theoretically transferred to the private concessionaire.

3.3.4 Summary of Findings

In conclusion, cases in database considered as “urban transport projects” are few, mainly nation-wide projects and funded through PPP. Due to these characteristics, conclusions based on this sample have to be treated with caution.

A significant proportion of projects in our sample seem to have to deal with difficulties, which highlight the extreme complexity of urban transport projects. Assessing an overall success or failure of these projects is rather difficult especially during their operating phases.

If some projects seem to have met cost difficulties during their construction phases, these difficulties can hardly be taken into consideration because their foundations lie in the lack of maturity of these projects rather than in their inherent business models.

On the contrary, difficulties met during the operating phases are easier to relate to the general outcomes of the project. Some projects seem to have difficulties to be managed during their operating phases due mainly to a tendency to overestimate their ridership. Therefore, ridership lower than expected implies smaller cost coverage ratios leading to financial difficulties for the operator.

Due to our restricted sample, we are not allowed to identify systematic reasons to this specific feature of urban transport projects; however two elements have to be highlighted.

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[21] The Karlsruhe tram-train projects have not yet been commissioned. The Warsaw Metro II project is too recent for this type of analysis to be made.

[22] These analyses had pointed to an underestimation of rate of use data in 12 cases out of 14. This analysis suggests that one should be cautious as to how representative the sample is.

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Firstly, the duration of contracts has to be considered as one of the most important factors, which can impact general outcomes of the project. DBOM-type contracts involve a transfer of the operating phase to the private sector for a long period of time. As operational conditions have to be accurately defined and frequently updated, these transfers lead to contract renegotiations or breaches of contract.

Secondly, risk allocation seems to play a minor role in the success or failure of the operating phase, as it remains very theoretical. In fact, urban public transport projects are mainly locally driven projects with a high involvement of elected local politicians. Consequently, these projects show high political sensitivity and their risk sharing have to be appreciated through this sensibility. In practice, projects coping with difficulties show a reassessing of the risk sharing during the operating phase. In a nutshell, the public authority accepts to bear a part of commercial risk bigger than planned in order to ensure that the public transport projects (or public transport networks) will be run as expected.

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3.4 Rail Projects in BENEFIT

3.4.1 Description

The rail cases included in this analysis are presented in Table 3.4.1.

All have been publically funded projects with the exception of the Liefkenshoekspoorverbinding-Liefkenshoek Rail Link serving the Port of Antwerp in Belgium. In this case, the PPP contract duration is 43 years and this is the only rail project that is used exclusively for freight transportation, while all other projects are used for passengers. The Combiplan Nijverdal, which is a combined rail and road project, serves for transportation for both freight and passenger traffic. The Hague Central Station is included in this group as a Station servicing rail. However, the specific project also includes other transport services and it also includes re-generation works and housing.

These cases are reviewed with respect to their outcomes concerning cost, time, traffic volumes, transport goals, other economic outcomes, social outcomes, environmental outcomes, institutional outcomes and possible renegotiations in case the projects are realized through PPP arrangement. The review is based solely on project BENEFIT material and the reliability of the review depends only on the reliability of the source materials.

Of the projects available, all but one are public funded cases. This limits the conclusions that can be drawn with regard to PPP related aspects. The Gardemobanen represents a special case, just like many Norwegian toll roads, where the state or regional governments play a significant role as an investor. Table 3.4.2 summarises the rail project sample.

Table 3.4.1: Rail Cases overview

Project Name	Country	Year Awarded	Construction Budget MEuros (2013)	Length	Operated by
Liefkenshoekspoorverbinding -Liefkenshoek Rail Link	Belgium	2008	690	16.2 km	Concessionaire
MXP T2-Railink-up	Italy	2014	115	3.8 km	
Gardermobanen (Airport Exprestrain)	Norway	1994	1044.75	64 km	Airport Expresstrain (trains) & Jernbaneverket (tracks, rails & stations) – Public S.A.
Combiplan Nijverdal	The Netherlands	2010	282.00		Combination of Public Authorities
TGV Mediterranean	France	1995	5312.77	216 km + 28 km	SNCF
NBS Köln-Rhein/Main	Germany	1995	6488.22	177 km	DB
HSL-Zuid	France	2000	7290.73	125 km	
The Hague Central Station	The Netherlands	2011	112.74	N/A	ProRail

The budgeted costs of the rail projects varied between 112 M€ and 7.3 billion €. The four big high speed rail projects, with the cost above one billion €, were awarded between 1990 and 2000. Smaller projects in the sample were awarded more recently.

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Table. 3.4.2: Rail project sample

Case Study (Country)	Type of project financing	Project type (Brownfield/ Greenfield)	Operational	Users
Combiplan Nijverdal (NL)	Public	Brownfield	Yes	Freight & passengers
The Hague New Train Central Station (NL)	Public	Brownfield	Yes	Passengers
Liefkenshoekspoorverbinding (BE)	PPP	Greenfield	Yes	Freight
Malpensa Rail link (IT)	Public	Both	Yes	Passengers
Gardermobanen (NO)	Public	Both	Yes	Passengers
TGV Mediterranean	Public	Greenfield	Yes	Passengers
NBS Köln-Rhein/Main	Public	Greenfield	Yes	Passengers
HSL-Zuid	Public	Greenfield	Yes	Passengers

Table 3.4.3: Outcomes per project in terms of BENEFIT matching framework (snapshot data)

Outcomes *(opening or beginning of operation)*	Combiplan Nijverdal (public)	The Hague Central Station (public)	Liefkenshoek Rail Link (PPP)	Malpensa Airport Rail Link (public)
Cost	Over budget	As expected	As expected	n.a.
Time	Delayed	Delayed	Delayed	Delayed
Traffic volumes	Below forecast	As expected	As expected	n.a.
Transport goals	As expected	As expected	Below expectations	n.a.
Other economic outcomes	As expected	As expected	As expected	n.a.
Social outcomes	As expected	As expected	As expected	n.a.
Environmental outcomes	As expected	As expected	As expected	n.a.
Institutional outcomes	As expected	As expected	As expected	n.a.
Renegotiations	None	None	None	n.a.

Outcomes	Gardermobanen (public)	TGV Mediterranean (public)	NBS Köln-Rhein/Main (public)	HSL-Zuid (public)
Cost	Over budget	n.a	As expected	n.a.
Time	Delayed (but operation available on time)	Delayed	Delayed	Delayed
Traffic volumes	Exceeded forecast	Exceeded forecast	Exceeded forecast	Exceeded forecast
Transport goals	As expected	As expected	As expected	As expected
Other economic outcomes	As expected	As expected	As expected	As expected
Social outcomes	As expected	As expected	As expected	As expected
Environmental outcomes	As expected	As expected	As expected	As expected
Institutional outcomes	As expected	As expected	As expected	As expected
Renegotiations	None	None	None	None

n.a: not available

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No clear patterns based on the above data can be identified except for the fact that all projects were delayed. Four large public projects were quite successful since traffic on all four of them exceeded forecast. Social, environmental and other outcomes seem to be invariant across the cases. The Malpensa Rail Link case provides very little information.

The other source of data is the narratives and descriptive profiles of the projects. None of the narratives regarded their project as a failure or even unsuccessful. The assessments varied from neutral to successful despite the fact that outcome assessment was not really indicating great successes. Also based on narratives, the projects seemed to answer to a clear demand and were meeting societal infrastructure needs, which in the absence of clear failures, might explain neutral or even positive outcome assessments.

The only PPP case (Liefkenshoek) was motivated by the lack of government funds, according to case narratives.

All projects experienced time delays. For Combiplan, this was due to technical difficulties with the traffic system. For Liefkenshoek, tunnels were mentioned as a technical challenge, but not as a cause of delay. For the Hague station, technical issues could have been the cause of delay, since they were explicitly mentioned and these resulted in claims between contracting parties. These technical issues sprung from design changes. Also communications issues were mentioned. Furthermore, it would be worthwhile to point out that for Combiplan Nijverdal the rail station and railway tunnel were completed on time, but the opening of the road tunnel was delayed.

Based on the narrative on Gardermobanen, there were technical issues (leakages in the tunnel) that led to the delay of one year (in the finalization of tunnel) and cost overrun of 25%. However, it is also stated that the project was inaugurated on time, with the exception that the part of the old track was used in the first year until the tunnel was finished, which also shows additional flexibility, when project is a mix of brownfield and greenfield. The project is also considered successful from the point of achieving its transport goals.

It is worth mentioning that for some projects, such as the Liefkenshoekspoorverbinding, there was increase in cost due to changes in design standards, or additional costs related to design, complementary works and changes in pricing regulations as in the case of Hague Central station. For Combiplan, the cost overrun was 5-10%, and for Gardemobanen 25-30%, as mentioned above.

3.4.2 Summary of Findings

In light of the above, the delay problems encountered in all projects do not seem to be originating from whether the method of contracting is PPP but from the very traditional issues faced by all major infrastructure projects. These issues have been covered well by project research literature and clearly identified by project management practitioners.

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3.5 Bridge and Tunnel Projects in BENEFIT

3.5.1 Analysis

The qualitative assessment performed for bridges and tunnels projects is based on 10 cases. This sample of 10 cases comprises:

- 4 bridges (Rion-Antirion Bridge, Millau Viaduct, Lusoponte – Vasco da Gama Bridge, The Øresund Link), and
- 6 tunnels (The Øresund Link, Herrentunnel Lübeck, Coen Tunnel, Berlin Tiergarten Tunnel, Södra länken, Blanka Tunnel Complex).

The cases analysed herein are specific, that is, bridges and tunnels are most commonly used to overcome natural barriers with the alternatives being usually much longer connections or necessitating the changing of means of transport (road to ferry, etc.). This natural monopoly favours the PPP model for project delivery– 5 of analysed projects were executed in PPP delivery mode, of which only one did achieve commercial success (the project of Herrentunnel for which there is a real alternative route – parallel road only 5 km longer and occupying only 4 minutes more, but no additional costs for users).

Unless there is a convenient alternative and this is rather rare (1 analysed PPP case: Herrentunnel Lübeck), the infrastructure connects already existing parts of the network and has exclusive or rather exclusive nature. In addition, concession agreements often restrict competition for alternative connections (e.g. withdrawal of state-subsidised ferry near the Rion-Antirion Bridge).

Bridges and tunnels characterise physical network integration links that integrate previously separate parts of the transport infrastructure, including a significant impact on travel time savings, e.g. Rion-Antirion Bridge 40', Lusoponte – Vasco da Gama Bridge 20', the Millau Viaduct 20' Øresund link over 1 hour, Berlin Tiergarten Tunnel 15-30' for rail trip.

New connections between existing, previously separate parts of the transport infrastructure are usually rated highly, although acceptance of related costs is a problem (Södra länken, Blanka Tunnel, Herrentunnel, Rion-Antirion Bridge, Lusoponte – Vasco da Gama Bridge).

The analysed projects are characterised by a relatively long duration of the period from conception to completion (Millau Viaduct 17 years, the Øresund link 44 years, Blanka Tunnel 23 years, Rio-Antirio Bridge 100 years - conception).

The analysed projects come from different countries (1 project transnational: Denmark-Sweden, besides the Czech Republic, France, Germany, Greece, Netherland, Portugal and Sweden.).

The following aim to qualitatively analyse bridge and tunnel projects with regard to their main outcomes. The outcomes systematically analysed in the case studies relate to the outcomes of Cost, Time and Traffic. The analysis will therefore detail these three aspects.

3.5.1.1 Cost performance

Construction costs of bridges and tunnels are high and are often increased by technical problems that typically arise due to the complexity of this type of infrastructure. According to these technical challenges these often bring with them. The cost per km is presented in Table 3.5.1

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In PPP projects co-financed by a private party, the implementation cost was in line with the original budget, or even below the planned budget (Table 3.5.2). The costs of the projects from public sources were not as planned [23]:

Table 3.5.1: The cost of Bridge and Tunnel projects in the BENEFIT database

	Length	Cost	Cost/km
Bridges			
Rion-Antirion Bridge	2.883 km 2252 m + Two approach viaducts, with 392 meters on Rio side (composite deck) and 239 meters on Antirion side	740 M €	256 M €
Lusoponte – Vasco da Gama Bridge	17.2 km	645 M €	37,5 M €
Millau Viaduct	2.46 km	510 M €	207 M €
Tunnels			
Herrentunnel	0.866 km	135 M €	155 M €
Second Coen Tunnel	0.66 km	2,1 bn €	3,18 bn €
Södra länken	6.0 km	1330 M €	221 M €
Blanka Tunnel complex	6.4 km	1560 M €	243 M €
Berlin Tiergarten Tunnel	2.9 km	390 M € (Wikipedia) 9,04 bn $ (Omega Centre)	134 M € 3 117 M €
Øresund link (tunnel+island+bridge)	15.9 km (7.845 bridge, artificial island 4.050 and tunnel 3.510)	4,1 bn €	257 M €

Table 3.5.2: Cost performance of PPP projects

Project	Budget	Realisation
Rion-Antirion Bridge	740 M €	+2%
Lusoponte – Vasco da Gama Bridge	645 M €	According to plan
Millau Viaduct	660 M €	-18%
Herrentunnel	180 M €	-25%

Table 3.5.3: Cost performance of Public projects

Project	Budget	Realisation
Øresund link	2.96 bn €	+38%
Södra länken	980 M €	+36%
Blanka Tunnel complex	766 M €	+103%

3.5.1.2 Time performance

In the database, this theme is dealt with through four types of indicator:

- The duration of conceptual works and political decision

[23] The project Berlin Tiergarten Tunnel (public) needs to be checked from the point of view of budget as the data seems to be inconsistent

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- The duration of tender procedures;
- The duration of different stages,
- The duration of the contracts themselves.

Only Lusoponte – Vasco da Gama Bridge was completed in a relatively short period of 6 years. Other major projects are characterised by slow conceptual and political decision-making process, preparation of the project, tendering process and selection of the contractor (e.g. Rion-Antirion Bridge: 20 years, Millau Viaduct 13 years, Øresund link 23 years, Södra länken 11 years while 44 years from the first general plan).

Only construction works on large projects were implemented according to schedule, or even completed before the deadline (Rion-Antirion Bridge 4 months ahead).

3.5.1.3 Traffic forecast

In PPP projects on bridges and tunnels, traffic estimates were prepared conservatively – real traffic is greater than expected, except in the Herrentunnel case, where there is a little longer (5 km, 4 minutes) alternative, non-tolled road (traffic estimated 37,000 vs. real 22,000 traffic). Adoption of the conservative forecasts of traffic clearly reduces the risk of concessionaires, particularly in the model of the remuneration received from users.

It may be noted that these structures, which significantly contributed to the reduction of travel time have no issues achieving traffic forecasts:

- Rion-Antirion Bridge – 14-17% above estimated traffic
- Millau Viaduct – 20% above estimated traffic
- Øresund link – first estimations to be between 8,000 and 10,000 vehicles per day, estimations in 1999 indicated 13,606 vehicles and the present traffic is around 18-19,000 VPD.

Although usually for transport infrastructure projects traffic is rather underestimated and for the railway overestimated (Flyvbjerg, Holm and Buhl, 2006), in the case of Berlin Tiergarten Tunnel, rail traffic is greater than the forecasted one, while the vehicle traffic lower (rail traffic 10% over estimate, road traffic 12% below estimate).

3.5.2 Summary of Findings

Both the size of the projects and their vast associated cost result in long to very long preparation periods (ranging from 17 to even 100 years). The analysed projects were characterised by a relatively long duration of the period from conception to completion. Designing and constructing special structures require good preparation, so before signing the contract, several years of preparatory work for design and construction are needed.

Moreover, the political sensitivity of such projects has a huge repercussion on timing. Change of plans regarding sources of financing, unrealistic expectations for market competition, etc. often result in a decade of delays in project implementation.

In the analysed cases only one bridge, Lusoponte – Vasco da Gama Bridge, was completed in a relatively short period of 6 years. Other major projects were characterised by long periods of conceptual and political decision-making process, preparation of the project, tendering process and selection of the contractor.

By studying cases available for the qualitative assessment, it can be 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 level.

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The remaining two cases, the Herrentunnel Lübeck (Germany) and Blanka Tunnel Complex (Czech Republic) did not achieve all outcomes. Both are regionally driven projects. However, the first project is not successful in the operational phase as the usage of the tunnel is much lower than forecasted. The second one is still in the construction phase. The budget of the Blanka Tunnel Complex has been exceeded twice.

Tunnels and bridges as superstructures are cost intensive. First of all, designs of bridges and tunnels confirm that public projects are planned optimistically in terms of cost. This is a trend for many types of infrastructure projects. For expensive projects such as bridges or tunnels, costs underestimations range from 28% to 100% (proportion of the original budget). That is confirmed by previous studies Flyvbjerg[24] (2006) for projects before 2006, where for tunnel and bridge projects the average budget overruns amounted to 33.8%.

It is also confirmed that the projects planned and financed by the private party (PPP model) are planned realistically in terms of deadlines of construction, and prudently in terms of construction costs and future revenues. Furthermore, in PPP projects regarding bridges and tunnels, traffic estimates were prepared conservatively – actual traffic was greater than expected. Adopting conservative traffic forecasts, clearly reduces the risk for concessionaires, particularly with regard to the remuneration model.

In some cases, they are provided through concession agreements to strengthen the natural monopoly of the construction by eliminating competing projects (e.g. ferry for the Rion-Antirion Bridge, putting under management of concessionaire alternative bridge connection - Lusoponte – Vasco da Gama Bridge), and through providing revenue for the investment. However, in PPP projects, it was important to co-finance the loans granted by the European Investment Bank, which are usually a significant part of commercial financing.

In conclusion, two elements seem to be specific for the bridges and tunnels projects:

- PPP delivery-based bridges and tunnels are planned realistically in terms of deadlines of construction, and 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 diligence budgeting is not typically found in public cases, whose costs are usually underestimated, as in the case of the Blanka Tunnel (more than 100%).

- Projects that include road traffic are typically underestimated in the range of forecasted vehicles' traffic. This is a common trend for PPP projects, where projects are planned conservatively and generally consistent with international trends observed (Flyvbjerg, Holm and Buhl, 2006[25]).

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[24] Flyvbjerg, B. (2006, 8). From Nobel Prize to Project Management: Getting Risks Right. *Project Management Journal, 37*(3), 5-15.

[25] Flyvbjerg, B., Holm, M. K., & Buhl, S. L. (2006). Inaccuracy in Traffic Forecasts. *Transport Reviews, 26*(1), 1-24.

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3.6 Airports Projects in BENEFIT

This section describes the qualitative analysis performed regarding the airport infrastructure cases of the BENEFIT database, including five (5) airports in five (5) different European countries, as presented in Table 3.6.1. The analysis of the content of the case studies was performed as a coding exercise, the results of which are presented in a tabular form in Annex A.3.2, while the subsequent paragraphs describe in more detail the methodology and the observations, as well as present the insights and potential lessons learned, derived as interpretations of the observed facts.

Table 3.6.1: Airports cluster of BENEFIT database

Airport	**City**	**Country**
Athens International Airport	Athens	Greece
Berlin Brandenburg Airport	Berlin	Germany
Sá Carneiro Airport	Porto	Portugal
Modlin Regional Airport	Modlin	Poland
Larnaca and Paphos International Airports	Larnaca & Paphos	Cyprus

3.6.1 Methodology

The research team proceeded in a coding exercise, where three coders analysed the individual portions of text and identified the themes emerging from the relevant text referred to. In the beginning, coders proceeded in a free coding trial, meaning that each member of the team coded a small text sample irrespectively of the other coders, and then in a debriefing session the respective convergence and/or divergence was evaluated and a common coding rationale was decided so as to ensure the reliability of the outcome. The heterogeneity of the cases regarding the aforementioned dimensions resulted in a relatively broad set of emergent issues, the majority of which could be aggregated to a certain degree. In a nutshell, the research team attempted to identify not only the outcomes, but also the underlying reasons that led to these outcomes. This contributes to the better understanding of the factors that in some of the cases result in the same outcome. More precisely, the same outcome, e.g. cost overruns, creates a perception of downstream homogeneity of the cases, with high upstream heterogeneity of the impacting factors that in the majority of the cases are context-specific. Furthermore, the metric for the assessment of patterns of the emergent issues is the total frequency of occurrence per issue per dimension, defined as the sum of occurrence in each one of the case studies. Finally, it should be noted that a further disaggregation between PPP and public projects was done, adding another element to the insights derived by the qualitative analysis.

Each dimension is analysed in terms of emergent issues derived from in vivo coding. The following paragraphs describe in more detail the inputs and outputs of the analysis and interpret the respective results.

3.6.2 Assessment

3.6.2.1 Cost performance

Despite that almost all of the projects analysed were delivered behind schedule, half had investments in line with the expected budget. Those projects are also PPP contracts. The public finance cases had presented cost overruns due to several reasons. Construction failures are again one reason pointed out for unsuccessful outcomes. Other reasons include uncertainties over additional funding sources, additional funding authorizations and award value issues. The Sá Carneiro Airport, for instance, had an award value 5% higher than budgeted.

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3.6.2.2 Time performance

Almost all airport cases were delivered behind schedule. Larnaca and Paphos Airports were an exception. The main reasons of those delays are construction failures. However, Environmental and Government issues have also an impact on project deliverables. An example is the Sá Carneiro Airport, which had a 10 months delay in the beginning of the construction phase because the environmental impact study was found non-compliant. A Government change caused the project delay at the tendering procedure in Athens. In addition, bankruptcy of the construction planning company, changes in EU security regulations and mismanagement also prompted a delay in the Berlin Brandenburg case study. Similarly, it seems that projects in which negotiations are carried out at the beginning of projects' development (namely, in planning / tendering stages) tend to be less delayed than projects in which negotiations are done during their construction phases.

3.6.2.3 Traffic forecast

Two airport cases have presented demand in line with or above the forecasted in the project planning phase. Independently from their contractual structure, the Sá Carneiro and Athens airports have been presenting outstanding and satisfactory traffic since their inauguration. Despite the 2008 financial crisis effects and other project delays, both projects have met their expected traffic estimations. This positive outcome may be associated to the added value created by those airports in their influence area. Both airports have been constructed to address accessibility bottlenecks at regions combining strong tourism and economic activities with already implemented intermodal connections.

For instance, the Sá Carneiro airport, although expanded for the EURO 2004 requirements, its expansion was mostly oriented towards serving the north of Portugal and compete with minor airports in northwest of Spain. In order to achieve both goals, the airport is connected by roads and rail services to the Oporto metropolitan area (industrial and population hub in Portugal), southern Portugal and Spain. The same is true for the Athens airport acting as a gateway for the city of Athens and the Greek islands. When those cases are compared with the other two airports, which have not realized their forecasted traffic demand, the lack of intermodal connectivity appears to provide a meaningful tendency for the outcomes. The island state of Cyprus points specifically to the effects of this isolation, but the Modlin case also mentions the lack of connectivity as one of the reasons for the traffic deviation.

In short, traffic outcomes may be associated to the necessary connectivity of the airport infrastructures to the rest of the local economy and the transport network. For the four analysed cases, success and failures regarding traffic forecast may be associated to economic integration. The Berlin Brandenburg airport is still in the construction phase.

3.6.2.4 Transport Goals

Almost all airports are of regular passenger cargo transport type. Only the Modlin case is a low cost international transport, realizing a negligible number of charter flights and general aviation. General transport goals include capacity, safety, technology, infrastructure quality and intermodal connectivity. All case studies analysed presented high quality of infrastructure but no information with regard to the technology used. Intermodal connectivity seems to be an important goal in those projects, partly because it leads to an increase of capacity and revenues.

3.6.2.5 Economic Outcomes

Economic value is created in all of the airport cases and is either direct or indirect, that is related to transport goals, which at a subsequent level produce economic benefits, as explicitly highlighted in the narrative of the Athens airport. More precisely, increase of accessibility, whether in the case of permanent economic activities, such as tourism (e.g. Greece and Cyprus) and establishment of an economy at a supra-regional level (e.g. Cyprus) or in the case of one-off events, as for instance the organization of international scope events such as the European Football Championship (e.g. Portugal and Poland), has determinant impacts on the local, regional and national economy. Or, in other words, the realization of the transport goal of increased accessibility, resulting in increased inflows, impacts profoundly the economic system structured upon human activities facilitated through mobility.

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Moreover, in one of the cases, namely the Berlin airport, the narrative highlighted the land value creation effects of airports, particularly related to the commercial expansion of the land within and around the airport. Indeed, value capture and the economic flourishing of businesses are important economic outcomes of an airport. Finally, the inter-linkages among the four policy areas of transport, environment, economy and health can be established through a framework, where improvement of environmental conditions, aggravated through transportation, especially in the case of a pollution-intensive transport mode, such as the airplanes, have a long-term impact on the health of the population inside and around an airport (e.g. residents, travellers, staff etc.) and, consequently, their productivity and contribution to the economic system as a whole.

3.6.2.6 Environmental Outcomes

As mentioned in the previous paragraph, the environmental impacts of airports are high and need to be addressed in an effective and consistent way. Factors such as the extended amount of area occupied by the airport infrastructure, as well as the fuel and noise related pollution burden, are important sources of conflict and public unrest, with inherent economic and political costs. Furthermore, environmental regulatory processes, when not complied with or when the project affects sensitive areas (e.g. Modlin airport) can have determinant impacts on the success, timeliness or even the overall implementation of the infrastructure project.

Addressing the environmental impacts of the infrastructure per se and the operations of the infrastructure is of crucial importance and a number of mitigation strategies were identified through content analysis in all airport cases, with different manifestations of the overall environmental performance. Especially in the case of the Athens airport, environmental accreditation ensures compliance and standardization of processes and practices, while environmental awareness rising of other members is part of the environmental strategy of the airport. Finally, the economic burden incurred upon the responsible parties has two components; firstly the cost of the mitigation strategies which can span along a large spectrum depending on the extension of the intervention, for example ranging from soft measures to implementation of relevant infrastructure, and secondly, the cost of reimbursing environmental-related claims, such as in the case of Sá Carneiro and Modlin airports. Finally, a tendency towards action in this area is observed, labelled as environmental friendly design practices (e.g. Larnaca and Paphos Airports) or best practices (e.g. Athens Airport).

3.6.2.7 Institutional Outcomes

Following the two basic institutional branches analysed in BENEFIT, the contractual structure designed in the airport cases clearly presents a strong division line between the institutional outcomes of PPP and Public funded cases. If in one hand the Athens, Larnaca and Paphos airports have been delivered by a single Build Operate Transfer PPP contract, all publicly financed projects (Berlin Brandenburg, Sá Carneiro and Modlin Airport) were contracted in separated contracts for specific parts of the civil works (e.g. Runway construction, terminals, earthworks). More than just a contractual structure, this tendency may point to two different institutional environments between public and building contractors.

In this contextual analysis, the PPP single contract structure would be associated to a business developer orientation, while the public works would be better associated with a service provider attitude. For the cases, those differences may be observed when the institutional context developed for in the PPP cases present more degrees of operational freedom for their concessionaire regarding the project´s cost and revenue structure. On the opposite, in the cases where the public authority has claimed for several individual contracts oriented to support an unbundled operation contract, each contract is dissociated from the total project purpose and connected to a service provider.

For a qualitative assessment of the airport cases, these tendencies represent only the first frames of the institutional outcomes. Case incentive may be better explored regarding their business model, but those outcomes already point to two contracting structures and institutional environment backgrounds, which may be associated to other outcomes, for instance time and costs outcomes.

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3.6.2.8 Renegotiations

During the project lifetime, renegotiations are used as strategic solutions for eventual or estimation mismatches. This premise is confirmed by the analysed sample since all five airport cases have been renegotiated a least one time in their lifecycle. However each renegotiation carried out in those cases has its own idiosyncratic characteristic. Although there might be considered renegotiation tendencies, regarding the airport sample, the differentiation study begins with the renegotiation occurrence phase.

From the pre tendering phase to the privatization, renegotiations have happened at different phases of the projects in the sample. In the Athens airport case, renegotiation occurred during the tendering phase due to political changes. In the Berlin Brandenburg airport, renegotiation took place in the award phase due to the bankruptcy of the building contractor, while the Larnaca and Paphos airports were renegotiated with their second best bidder due to problems in the award with the first one. Those cases have been managed with relative success and low impacts, but as long as we go deep into the contractual responsibilities phases, renegotiations tend to be more frequent.

For instance, the Berlin Brandenburg funding scheme has been renegotiated during the construction phase in order to cover cost overruns and the Sá Carneiro and Modlin airports renegotiated their design in order to solve construction/design problems. And, finally, after the construction, the Sá Carneiro contract was renegotiated in order to be privatized. In short, all cases have been renegotiated for several reasons, the big difference between those groups is that some of them with major and others with minor associated costs.

Although looking strictly at this sample, the only tendency is that airports tend to be renegotiated at least one time during their lifecycle, it may be important to think about the collateral outcomes of those renegotiations, in other words renegotiation costs. All renegotiations incurred costs (Time, Money or Traffic), however the Berlin Brandenburg case is the one that exhibited the major ones. Since renegotiations are inevitable and in some cases may be encouraged, all contracts have to be ready to deal with them and mitigate their negative collaterals.

3.6.3 Summary of Findings

In conclusion, the data set may not support a general trend for the airport mode, but several contractual gaps have been analysed regarding their manifestations in the sector. Finally, this conclusion presents a contingency table analysis for the frequency of the outcomes reported for the cases. Accordingly, Table 3.6.2 presents the frequency of outcomes reported in the airport cases. In order to facilitate the analysis, positive frequencies have been marked by green and negative by red.

Table 3.6.2: Outcomes frequency in the airport cases

Project Title	Athens International Airport	Berlin Brandenburg Airport (BER)	Larnaca and Paphos International Airports	Modlin Regional Airport
Country	Greece	Germany	Cyprus	Poland
COST OVERRRUN	0	-1	0	-1
TIME OVERRUN	0	-1	0	-3
ACTUAL VS FORECASTED TRAFFIC	-2	1	-3	-4
TRANSPORT GOALS	2	0	1	-4
OTHER ECONOMIC OUTCOMES	3	0	1	-4
SOCIAL OUTCOMES	3	0	1	-4
ENVIRONMENTAL OUTCOMES	1	0	0	0
INSTITUTIONALS OUTCOMES	0	0	0	-3

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Looking for a general trend, Table 3.6.2 analyses the overall frequency along the project life and composes all indicators by summing up the scores. Although this compound indicator may simplify the analysis, there is only one case of a positive outcome offsetting a negative score in the environmental outcome of the Athens Airport. For more clarifications, a detailed description is presented in the environmental outcomes section.

Hence, looking through this contingency analysis, it is possible to observe some similarities in the occurrence of negative and positive outcomes. For instance, costs and time overruns happen in both the Berlin Brandenburg and Modlin cases. For reasons expressed in the previous section, this frequency may be associated to contractual (e.g. governance or cost saving) similarities of these two cases, which were not repeated or have been mitigated in the PPP cases. Based on this evidence, it is also important to consider the divergences between the finance and remuneration scheme types of those contracts.

Moving to the transport goals, social and economic outcomes, all three outcomes seem to be directly correlated in three cases (Athens, Lanarca, Paphos and Modlin airports), positively for the first ones and negatively for the last case. Moreover, it is interesting to observe that all those goals do not support a strong correlation with the actual use of the airport infrastructure since actual traffic at all three cases is below the forecasted. Regarding the typology analysis presented later in this work, those findings will be connected, at first, with the business model and governance indicators and then with the remuneration scheme.

So far, the above may be considered as the general trends of the airport projects regarding their outcomes. Regarding limitations of this brief analytical background, this conclusion does not intend to determine tendencies in the sector but, the combination of factors so far highlighted already proposes some cross typologies synergies and occurrence of specific outcomes. Based on those prospects, the validation of the framework may focus on complementarities, reinforcements and overlapping among typologies factors. Section 5.6 compares the same cases regarding their scores on the typology indexes and historical characteristics. This study may provide more insights for the comprehension of the airport sector tendencies regarding financing and funding.

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3.7 Ports Projects in BENEFIT

3.7.1 Analysis

Regarding the case of the port of Agaete, the authorities identified the lack of a closer and faster connection by sea between the two main islands of The Canary Islands. Until then, the main connection was from the two main ports in the two main cities of both islands (Santa Cruz in Tenerife and Las Palmas de GC in Gran Canaria). Agaete has the closer port to Santa Cruz of Tenerife. Moreover, the shipping company (Fred Olsen) operates with fast catamarans (Ro-Ro services). Both circumstances, the closer distance and a faster mean of transport reduces the travel time by one hour and a half compared to the aforementioned services from city to city. On the other hand, the Terminal Muelle Costa (TMC) in Barcelona was conceived to provide both Short Sea Shipping (SSS) and, as in the case of Agaete, Ro-Ro services. In both cases, so far, one single shipping company operates the terminals: *Fred Olsen* in Agaete and *Grimaldi lines* in the Terminal Muelle Costa in Barcelona. The Barcelona Europe South Container Terminal (BESCT) is the most expensive of the six projects analyzed herein. The project was awarded to a joint venture, TERCAT S.A., formed by Hutchison Ports Holdings and Grupo Mestre. In the case of the Piraeus Container Terminal (PCT), the PPP project was aimed at the following objectives: firstly, upgrading and management of Pier I, secondly, the future construction of Pier III. The project was awarded to the Piraeus Container Terminal S.A. whose sole shareholder was “Cosco Pacific Limited”. Contrary to the previous cases, the project was handled at national level (Ministry of Merchant Marine of Greek) that opted for a negotiation rather than a tendered procedure.

The four projects can be labelled as successful cases from almost the beginning; whereas the Barcelona Europe South Container Terminal project suffered from cost and time overruns as well as a lack of a suitable traffic forecast. Nonetheless, the terminal has been able to overcome the previous situation and, in 2013, container exports grew strongly. In 2014, port container traffic at the port of Barcelona was close to its 2007 pre-crisis level. The Piraeus Container Terminal also suffered from the economic crisis that hit strongly the Greek economy by the time of the beginning of the project. Nonetheless, the awarded company, Piraeus Container Terminal S.A. could effectively manage the project especially because of the followings factors:

- The dominant position of Piraeus in the Greek and Mediterranean container market.
- The strong financial position of the concessionaire, which has the resources to absorb several years of losses if necessary.
- Links between the terminal operating company and the major Cosco shipping line, which will increase its ability to meet the throughput guarantees.
- The ratification law granted Cosco Pacific various income tax exemptions in terms of VAT and depreciation obligations, which are more favourable compared to the standard obligations of a Greek corporation, including Concession of the Port of Piraeus (OLP). Also, accumulated losses could be offset against the taxable profits of later periods without any time constraint.
- Incentive of OLP and concessionaire equally sharing profits if an IRR of 16% is exceeded.
- Cosco's capability for long-term planning (further plans to expand—actions that the company expects will boost volumes to more than six million containers by 2016). It should be noted that it ordered 12 ERTG cranes (above its contractual obligations), allowing for an additional increase of 1.1 million TEUs in the capacity of Piers II and III (4.7 million TEUs in 2015 instead of the 3.7 million TEUs originally planned).

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- Chinese cultural attitudes, which seek to avoid the loss of face associated with failure. The political support provided by the Chinese Government may also be a significant success factor, either facilitating the renegotiation of the contract at some later stage, or providing Cosco Pacific with incentives to continue operating the terminal primarily for political reasons.

- Now in competition with Cosco, the port authority operating Pier I terminal has increased productivity and improved operations and services, reporting a 27.5 % increase in container throughput from 2011 to 2012. Previously inefficient and with outdated infrastructure, the port struggled to secure financing (even from the EIB).

Contrary to the aforementioned cases, the case of the port of Leixoes (POL) in Portugal did not suffer from any delay and all outputs were according to expectations. On the other hand, and similar to the case of the Piraeus, this project provided a significant increase in both productivity (from 21 containers/h/portic to 30 containers/h/portic) and traffic (from 0.8% to 4.9%).

Finally, and also in Portugal, the port of Sines (POS) was also conceived as a container terminal and it is the project with the worse performance of all cases analysed herein. The project suffered from delay and a lack of a proper traffic and revenue forecasts among others factors. The project also had to cope with the strong competition of other ports (transhipment hubs) of the regions, such as Algeciras in Spain or Tanger Med in Morocco.

3.7.1.1 Cost Performance

Table 3.7.1: Budget of the projects

Port	Budget (Million Euros)
Port of Agaete	5.7 (3.1 in 1982 and 2.6 in 1987)
Terminal Muelle Costa (TMC)	22
Barcelona Europe South Container Terminal (BESCT)	860
Piraeus Container Terminal (PCT)	153.6
Port of Leixoes (POL)	350
Port of Sines (POS)	330

As shown in Table 3.7.1, the Barcelona Europe South Container Terminal project was, by far, the most expensive project and also the only one with cost overrun.

3.7.1.2 Time Performance

Four cases suffer from delays. In the case of the port of Agaete, governmental issues incurred the delays[26]. The Barcelona Europe South Container Terminal suffered a delay as a consequence of the

[26] The time line of Agaete was as follows:
1981: Initial planning project (*Project I*)
1982: May 19th: Public tendering; June 16th: Public works awarded to private construction firm (SATO); July 28th: Contract signature; August 30th: Start of public works. Public opinion against the project due to concerns on visual impact.
1983: June 16th: Second planning (*Modified Project II*) is started. Public works are temporarily paused; July 1st: Public works are definitively halted.
1985: October 23rd: Administration and management of local ports are transferred from the central government to the regional government (by Royal Decree 2250/1985).
1986: January. Regional government updates the existing project (Modified Project III)

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movement of 640 M cement blocks during construction. Regarding the Piraeus Container terminal, the delay was provoked by a union issue, which reversed a previous decision that allowed greater flexibility in employment conditions. Briefly, the labour unions won a major concession from the port management that newly hired personnel would be offered the same salary and working conditions. Finally, in the case of the Port of Sines, the stage 1A was delayed by 26 months and stage 1B was delayed by nearly 6 months. The reason for the delay was that the different stages of the project relied on the revenues generated during the previous stages. Nonetheless, the traffic volume has been lower than expected in each stage.

3.7.1.3 Traffic Forecast

The port of Agaete was a success regarding the traffic expectations, especially because it led to an increased mobility of residents and tourists. The traffic in 2013 was of 773,509 passengers and the traffic forecast in 2020 is around 900,000 passengers. Regarding the Terminal Muelle Costa, the traffic evolved according to expectations. The Barcelona Europe South Container Terminal saw its traffic declining from its initial expectations mainly because of the impact of the economic crisis. On the contrary, the traffic in the Piraeus Container Terminal has been slightly increasing despite that the economic crisis also hit strongly the Greek economy by the time of the beginning of the projects, (Pier II: 12 million TEUs in 2011, 2.2 million TEUs in 2012 and 2.6 million TEUs in 2013). Moreover, the PPP project faced a strong competition with the Piraeus Port Authority which owned and operated the pier I. Nonetheless, actual traffic in Pier II greatly exceeded forecasts, rising sharply from 1.2 million TEUs in 2011 to 2.2 million TEUs in 2012 and reaching 2.6 million TEUs in 2013, with capacity utilization of over 80%. Traffic has also been lower than expected in the case of the Port of Sines at the beginning. Since 2010, traffic began to rise due to an increase in exports of national products such as marble, granite, paper pulp, chemicals or glass. Contrary to previous cases, the port of Leixoes matched its traffic forecast during all the project timeline.

3.7.2 Summary of Findings

Five out of the six cases more-or-less achieved outcomes. Only the Barcelona Europe South Container Terminal saw its costs rise over budget, whereas four of them (Agaete, Terminal Muelle Costa, Barcelona Europe South Container Terminal, Piraeus Container terminal and the port of Sines) suffered from delays. With regard to traffic, Agaete, Terminal Muelle Costa, Piraeus Container Terminal and the Port of Leixoes reached or exceeded their traffic forecast. The Barcelona Europe South Terminal was able to overcome an initial decline in traffic. On the contrary, the Port of Sines had a traffic performance below forecast. The cause behind the success or failure of these projects seems to rest on the foundation of the aim of the projects. Most of them, except from the Port of Sines, detected either a strength or a real necessity to carry out the projects which turned out to be key to their success beyond any other consideration related to the tendering process or the traffic forecast, among other issues.

Public works are restarted by the same building company (now, SATOCAN)
1987: Agreement between the regional government and the island government (Cabildo Insular) to update the budget and speed up the works. Modified Project IV, with technical updates.
1993: Main works are finished; Commercial use of the port is negotiated between regional government and central government.
1994: December. Passenger and road traffic license is awarded to *Fred Olsen*, a ferry operator between Gran Canaria (Agaete) and Tenerife (Santa Cruz). Fred Olsen operates as a monopoly due to 'lack of capacity'. Pays a fee to regional government.
1999: Additional works required adapting the port to 'fast-ferry' operations. Fred Olsen performs them.
2014: Large increase in passenger traffic since 2000; A second passenger license is currently being negotiated (sharing existing facilities); There is a project for further enlargement of the port of Agaete (*Plan de Puertos de Canarias*, 2013) to be carried out from 2015 onwards.
2015; (January) Passenger services opened to competition. Two private ferry operators (*Fred Olsen* and *Líneas Armas*) will share port facilities.

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3.8 Conclusions: Qualitative Analysis – Lessons Learned

This section summarizes the findings in each mode and across modes. Unfortunately, the sample size was quite limited for most modes, which limits to some extent the possibility to draw conclusions. In addition, as noted previously (see Annex A.1), the BENEFIT set of case studies is by no means representative. Therefore, conclusions should be considered with caution.

3.8.1 Business Models Identified in the BENEFIT case study database

Most projects in the BENEFIT case study database are concentrated on the delivery of the prime infrastructure not including additional features and services that may enhance the service (business) offer. Overall, few revenue enhancing features were identified in the cases in the BENEFIT database. Key findings include:

- Node Infrastructure serving passenger transportation potentially include commercial services that may generate revenues greater than 10% of total revenues
- Roads and more so, national / international roads include service stations and other similar commercial activities, which, however, usually contribute less than 10% of total revenues.
- The combination with brownfields is dominant in road projects and usually are included in the operation phase
- Tramways are commonly combined in their operation with other urban transit infrastructure in operation
- Infrastructure dedicated to freight was not found to be bundled with other features.

Apart from the prevailing Business Model features, some points of interest include:

- Urban projects across infrastructure modes usually include an urban regeneration component.
- Environmental works usually accompany long-distance (intercity or national/international) roads.
- With respect to rail-based projects, trams hold the middle ground with respect to intensity of investment (46.3 MEuros/km) in comparison to metros (91 MEuros/km) and rail (32.2 MEuros/km). Despite this observation, tramways and light rail were more attractive to private co-financing. Of course, this observation concerns the BENEFIT database cases.
- The least costly investments within line infrastructure, excluding Bridges and tunnels, are roads with a concentration around 20 MEuros/km.
- By far more cost intensive are special infrastructure projects such as bridges and tunnels, with an average cost within our sample of 554 KEuros per meter.
- A final point worth remarking is that regardless of mode or intensity of investment and with few exceptions the contract duration for PPP type project delivery is in the range of 30 years throughout the cases in the BENEFIT database.

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3.8.2 Funding and Financing of Transport Infrastructure – Lessons Learned

Findings are structured with respect to outcomes.

3.8.2.1 Cost and Time

Cost and Time outcomes are related to the construction phase of a project. The common finding for all modes is that delays were encountered in a substantial number of transport infrastructure projects. In many situations, these may concern traditional project management issues faced by all major infrastructure projects. Contractor failures and technical difficulties are identified as common reasons for cost and time overruns in this analysis across different modes. More specifically:

- For urban transport projects it appears that a transfer of design/construction risk to the private sector does not necessarily mean that deadlines will be respected or costs complied with. The analysis of the same mode shows that contract duration seems also to be one of the major success factors for the project in its operating phase. When operation is transferred to the private sector for a long period of time, projects systematically encounter difficulties visible through contract renegotiations or breaches of contract.

- For airports, construction failures are the main reason for delays and one of the reasons pointed out for cost overrun. Other reasons include uncertainties over additional funding sources, additional funding authorizations and award value.

- All rail projects had delays due to technical difficulties and issues especially related to design changes.

- The implementation context is also important. There is substantial difference in performance between road projects in northern and western European countries, and projects in southern European countries. Most of the road projects that experienced cost and time overrun are located in southern countries. In addition, it is suspected that the economic crisis had an impact on both cost and time to completion of projects.

Cost

Reasons for cost overrun in road projects are typically stated as scope changes, expropriation and archaeology problems, economic crisis, and sometimes other technical issues. Urban transport projects that had low initial cost typically experienced significant cost overrun. However, for road cases in our sample, most cost overruns were identified in medium sized projects.

Within our road sample, brownfield PPP and greenfield projects performed relatively better.

Time

Typical reasons for delays in road projects are economic crisis, expropriation problems, design changes, technical and archaeology issues, but also bankruptcy of the contractor. Based on the analysis of road projects, it can be concluded that delays are more frequent in public than in PPP projects. Reasons for delays in urban transport projects are: failure of private contractors, difficulties encountered during land acquisition procedures, technical difficulties and additional work/insufficient project planning.

3.8.2.2 Traffic

It can be noted that the traffic outcomes may be associated with the necessary connectivity of the infrastructures to the rest of the local economy and the transport network. It is especially the case for the airport mode, where success and failures regarding traffic forecast are associated to economic integration. Exclusivity is also considered important in achieving traffic targets.

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For ports and bridge and tunnel projects, the aim and justification of projects appears to be critical for their performance. The well-planned and justified projects appear to be more robust in the context of outcomes, despite the difficulties arising from the global financial crisis.

Some urban transit projects seem to have difficulties to be managed during their operating phases due mainly to a tendency to overestimate their ridership. Therefore, ridership lower than expected implies smaller cost coverage ratios leading to financial difficulties for the operator.

In many PPP projects an optimism bias in traffic forecasts could be identified. However, in bridge and tunnel projects it appears that traffic estimates were prepared more conservatively. Finally in ports, it seems that the achievement of traffic objectives is related to project scope.

3.8.3 Matching Framework and its Typology Indicators – Lessons Learned

While identifying lessons learned with respect to the funding scheme was not the key objective of this chapter, key findings were identified. These are listed below per Typology.

Implementation Context Typology

The implementation context was reported to influence performance for roads and urban transit projects. This observation was not only with respect to traffic but also with respect to cost and time to completion achievements.

Governance

The type of contract structure and contractual length seem to be important elements in situations, such as urban transit, where policies and travel behaviour may change.

Risk sharing and risk allocation were identified as important aspects, which, especially with respect to publically sensitive projects, are usually not respected.

Business Model

- Overall, few revenue enhancing features were identified in the cases in the BENEFIT database. This implies low values of the Revenue Support indicator (see **Annex A.2**).

- Technical difficulties and project technical immaturity have been a primary cause for cost overruns and time delays. This feature is included in the Cost Saving Indicator. However, in many cases this seemed independent of the capability to construct and more related to the maturity of the project (see urban transit as well as bridge and tunnel projects).

- Risk allocation is considered an important element in achieving traffic targets.

- Capability to operate has been identified as an important factor in urban transit, airport and port projects. Capability to operate is included in both the Cost saving and the Revenue support indicators but with an equal weighting to other factors.

- Capability to monitor operation (and construction) by the public authority for both PPPs and public projects seems important (see urban transit projects). However, this factor is not included in the respective indicators.

- Finally, connectivity, exclusivity and scope of project are considered in the Revenue Support indicator. However, its weighting might need visiting.

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4 Typology Indicator Validation

The validation of indicators is presented in this chapter per typology. When respective validation has been carried out under a different task, a short reference is made.

4.1 Implementation Context Typology Indicators

The implementation context refers to three indexes, being the institutional context index, the macro-economic and financial context index and the PPP-governmental support index. The latter has not been used so far in the analyses and only has relevance when dealing with privately financed projects.

The PPP governmental support index (Verhoest et al. 2015), in case it is used in the project, has been validated in previous publications, where the overall index is confronted with the results of cluster analysis, using the sub-dimensions of this index. The country ranking yielded by the PPP governmental support index is reflected in the clusters, which result from the cluster analysis of the sub-dimensions of this index (see Murwantara et al. 2015).

Regarding the institutional context index some additional checks have been performed. First, country rankings yielded by the institutional context index were reflected in the clusters resulting from cluster analysis with the dimensions of institutional context. This was performed for three years, 2001; 2007 and 2013. This test showed that the index reflects the underlying dimensions well through time. Hence, the use of the overall institutional context index is defendable as it reflects sufficiently well the scores of the underlying dimensions. This was further supported by correlation analyses, studying the correlations between the institutional context index and the scores on the different dimensions, on the one hand, and studying the correlations between the dimensions, on the other hand. Also, these tests showed the robustness of the institutional context index and the extent to which it adequately represents the underlying dimensions. One note needs to be made: the dimension on regulatory restrictiveness (OECD ECTR scores) is for specific years (e.g. see 2013) less strong correlated with the other dimensions and with the overall index. However, the cluster analysis showed that the distorting effect of this is small. In conclusion, the institutional context index can be used as a good representation of the underlying dimensions (see **Annex A.4,** the 'cluster analysis for institutional index' and 'correlation for institutional index').

Regarding the macro-economic and financial index, no further tests are needed as this index is using the values of the 'growth competitiveness index', as developed and validated by the World Economic Forum.

Further information on the implementation context typology indicators is provided in D2.2 and D3.1.

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4.2 Transport Mode context typology

The transport mode typology indicators, which are selected to be included in the BENEFIT model, are the: 1) reliability (% time of disruptions during operation), and: 2) availability (% of availability) indicators. These indicators were selected among a long list of indicators after applying the QCA analysis. For the application of the QCA analysis, 35 variables were used for examining the 34 PPP case studies of our database. For examining the public case studies, 33 variables and 19 public case studies were included in the analysis. After running the analysis separately for the private and public cases, the same combination of variables (path) came out. Both analyses showed that the combination of indicators that has the highest impact on the success of the project is the combination of reliability and availability. The "project success" was measured based on the variable *"General level of project's perceived success"* retrieved from the BENEFIT database. The analysis made for the PPP cases showed that high availability and high reliability will lead to a higher level of project success. The raw coverage of this combination of indicators was very high (approx. 0.925), which means that about 92.5 % of the cases were explained by this combination of indicators. Consistency was also high, almost 0.85 (0.847). The analysis made for the Public cases also showed that high availability and high reliability will lead to a higher level of project success and the coverage and consistency were even higher, 0.94 and 0.888, respectively.

The same combination of indicators also came out after combining all cases (PPP and Public) and running the analysis using 54 cases in total and 34 variables. The combination of the conditions/variables also had high coverage and consistency, that is, 0.925 and 0.847, respectively. Based on the above QCA analysis, the reliability and availability indicators are validated and thus can be included in the BENEFIT model. Selecting indicators from each typology, which affect most the success/outcomes of the transport infrastructure projects, was actually the main criterion for the selection of the indicators that would ultimately be included in the model developed. In this way, policy makers and investors could be aware of the factors (indicators/variables) that would mostly have an impact on the success of a transport infrastructure project.

Further information on the transport mode context typology indicator is provided in D2.2 and D3.1.

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4.3 Business Model Indicators

4.3.1 Introduction

Under task 2.2, the dimensions and indicators listed for the Business Model typology were proposed. Their overall assessment reflects the overall level of robustness of the Business Model (BM), i.e. the ability of a project to deliver on its aims and objectives in the fullest possible way.

The Business Model Typology includes two parts: the "potential cost saving function" and the "revenue support function". These "functions" include key constructs and factors. The factors contributing to the Business Model Indicators are assessed, both individually and as aggregated indicators, against the cases of the BENEFIT database, as well as the cases in indicator form (snapshots). The full presentation of the validation and the respective methodology followed are presented in Annex to this report. The present Chapter 4.3 presents the conclusions of this validation.

The validation initiates with the review of the cases in the database with respect to their potential revenue support (**Annex A.3.1**), as presented in Chapter 3, and then follows by investigating key factors included in the indicators. These include:

- "Level of Control**", defined as the overall attractiveness to traffic of the infrastructure as resulting from its positioning in the transport network and the contractual agreement** (section 4.3.2)
- Capability of the Operator (section 4.3.3)
- Capability to Construct (section 4.3.4)
- Brownfield section resilience to macro-economic fluctuations (section 4.3.5)
- Bundling of Activities (section 4.3.6)

The validation of the above key factors followed a qualitative and semi-qualitative approach based on hypotheses testing. The key findings are presented in the following sections 4.3.2 – 4.3.6. The review of the potential structure of the project with respect to revenue support forms part of the Qualitative Analysis conducted in Chapter 3. Finally, the Business Model indicators were also validated using the snapshot data. This analysis is presented in section 4.3.7.

Based on these validations, the final configuration of the Business Model Indicators is presented in section 4.3.8.

4.3.2 Key factor: Level of Control vs Allocation of Traffic Demand

Given the complexity, size and long construction duration of transport infrastructure projects, there is a wide range of potential risks, which can affect expected performance in both cases of PPP and public delivery, namely financial and credit risk, technical risk, construction risk, operating risk, traffic demand risk, revenue structure risk, legal, political and regulatory risk, force majeure, etc. (cf. Cabrera *et al.,* 2015). Risk allocation is at the heart of any contractual arrangement, and given its critical importance, particularly in PPP projects, several studies have been conducted to examine how to achieve efficient risk allocation (cf. Jin and Zhang, 2011). Special emphasis has been placed when considering PPPs, especially with respect to risks encountered during the operation of the infrastructure delivered, as this is the key differentiating factor between traditional and PPP delivery of infrastructure. Amongst risks potentially manifesting during operation are traffic demand and revenue risk. With regard to traffic demand, there are several cases of transport projects with large variation between the ex-post estimated traffic and the actual traffic observed during operation (cf. Matas *et al.* 2009). While demand and revenue risk are closely related, they have a different impact on the viability of projects depending on the financing scheme used to deliver the transport infrastructure and the remuneration scheme applied when considering private co-financing:

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- **Traditional delivery of infrastructure** through the use of public funds is more focused on achieving the expected traffic demand, as this is the key indicator justifying the overall public investment. This indicator is also closely related to achieving other benefits envisaged in the justification of the respective public investment.

- **Private co-financed delivery of infrastructure (or PPP)** is, in addition, interested in achieving the anticipated return on equity (ROE). The ROE or other similar indicator is, in many cases, publically known and refers to the return over the contractual period. Figures over time for a specific project are seldom released and usually considered confidential. **Notably, while actual traffic may be less than expected, returns to the private project sponsor may continue to be within the anticipated range**. When revenues fail to meet contractual expectations, then this manifests by triggering a re-negotiation or a contract amendment (Guasch, 2004).

Therefore, in this analysis a project is considered to be performing when:
- Actual traffic is greater or equal to forecasted for the case of traditional delivery
- No re-negotiation has taken place for the case of PPP delivery. If actual traffic is greater or equal to the forecasted, then this is considered an additional benefit.

The scope of the current analysis is to identify the potential impact of traffic demand risk allocation on project performance with respect to traffic.

Adopting actual versus forecasted traffic as an indicator of performance implies the accuracy of estimates, which is not always the case. Identifying when forecasts are inaccurate is not straightforward in a changing macroeconomic environment, as traffic demand is derived and correlated to macroeconomic developments. When experiencing positive macroeconomic conditions, failure to meet traffic forecasts can be attributed to inaccurate estimates. When this is not the case, then respective assumptions need to be made.

Finally, while risk allocation (demand risk allocation) is substantial in PPP and similar configurations of transport infrastructure delivery, this is not the case for public delivery. The present analysis takes a uniform approach by considering that in public delivery an operator (public arms-length entity) is responsible for the operation and maintenance of the infrastructure.

The methodology followed and the hypotheses tested are presented in the next section**,** where the concept of Level of Control is further analysed.

4.3.2.1 Methodology

In order to address the scope of the present analysis information from the BENEFIT database is elaborated and assessed in terms of:
1. Appropriate risk transfer
2. Performance
3. Assessment of performance

The assessment concerns the assessment of the factor “level of control” included in the Business Model Indicator of Revenue Support. In additional, the analysis has also lead to the formulation of conclusions and lessons learned.

1) Appropriate Risk Transfer

Grimsey and Lewis (2004) state that PPP risks should be allocated to the party best able to manage them. Loosemore *et al*. (2006) complement this statement by setting rules, whereas a risk should be undertaken by a party when this party has:

i. Full awareness of the risk to be undertaken
ii. Greater capacity to manage the risk effectively and efficiently
iii. The capacity and resources to cope with the risk eventuating
iv. The preference to undertake the specific risk

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v. The possibility to charge the respective risk premium.

The above refers to the level of control a party may have over a specific risk and in this case, the demand risk. In this context, the analysis sets out by systematically assessing the **level of control a party may have on traffic demand.** Building on the approach set forward by Roumboutsos and Pantelias (2015), this concerns assessing:

1. The position and function of the infrastructure in the transport network:
    i. The scope of the project: business development vs traffic (business) servicing
    ii. The level of exclusivity of the infrastructure in the transport network
    iii. The level of positive or negative influence to the positioning of the infrastructure by the existing level of network integration
2. The level of risk associated to the project direct revenue streams
3. The pricing policy applied
4. The level of risk associated to the remuneration scheme (in case of PPPs).

The assessment with respect to the level of control is compared to traffic demand risk allocation and assessed as:

i. Optimal when there is a relative matching
ii. Suboptimal with more risk transferred to the private sector or operator than justified
iii. Suboptimal with more risk retained by the public sector than justified

Notably, the overall rationale behind the process of risk allocation is achieving Value for Money (VfM). Indeed, allocating risks among the different contractual parties does not come for free. Risk bearing has a price for either side and the aim of the risk allocation is to manage risk at the minimum cost for the overall transaction.

Suboptimal risk allocation with respect to the classification above has a different impact on overall project cost. In the first case (more risk transferred to the private sector/operator), this implies ex-ante pricier projects. The second case (more risk retained by the public sector) concerns the potential of ex-post costs related to demand risk materialising.

Furthermore, this initial assessment is intensified or ameliorated depending on whether there is effective revenue support, the pricing policy attached to the use of the infrastructure (and which party sets the price), as well as the remuneration scheme applied in the case of private co-financing.

Table 4.3.1: Scoring applied in the analysis

#	Variable	PPP case	Public case	Comment
1	Business developer vs Business Servicer	As defined in the dataset [Business developer = 6 to Business Servicer = 1]	Similar assessment based on the type of project	Final score: Physical Level of Control: Summed (#1+#2+#3) and normalised to the range [1, 6]
2	Level of project exclusivity	As defined in the dataset [Totally exclusive = 6 to totally competitive environment = 1]		
3.	Impact of integration	Each case is studied and assessed in the range [-3, 3] depending on the positive impact on exclusivity		
4.	Demand Risk Allocation	As defined in the dataset [Totally public = 1to totally contractor = 6]		
5.	Revenue source	Assessed through dataset information as: No user charges = 1 User charges & other sources contributing more than 5% = 2 User charges & other revenue sources contributing less than 5% = 3		This score is considered to increase the demand risk
6.	Revenue support	Assessed through dataset information as: No support = 0		Mitigation of demand risk to the

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#	Variable	PPP case	Public case	Comment
		Guarantees etc. = 1 Revenue guarantee / subsidies etc. = 2		public sector
7.	Restrictions in pricing	Assessed through dataset as: No restrictions = 0 Set in the initial contract = 1 Proposed by contractor but approved by public authority = 2 Imposed by public authority = 3	Assessed through dataset as: No restrictions = 0 Set in the initial contract = 1 Proposed by contractor but approved by public authority = 2 Imposed by public authority = 3	This is considered as a reduction in the level of control
8.	Remuneration scheme	Compared to the revenue source (see #5)	The same as the revenue source (see #5)	
9.	Incentives	Assessed through dataset information as: Yes = 1 No = 0	Always No, unless otherwise mentioned	

In assessing the level of control, input variables were selected drawing on key themes, initially identified in the risk analysis literature and expanded to incorporate new issues of added value to the present analysis. The methodology follows a scoring approach in line with the scoring considered in the BENEFIT database or derived from it. The scoring followed is presented in Table 4.3.1.

Figure 4.3.1 illustrates this assessment.

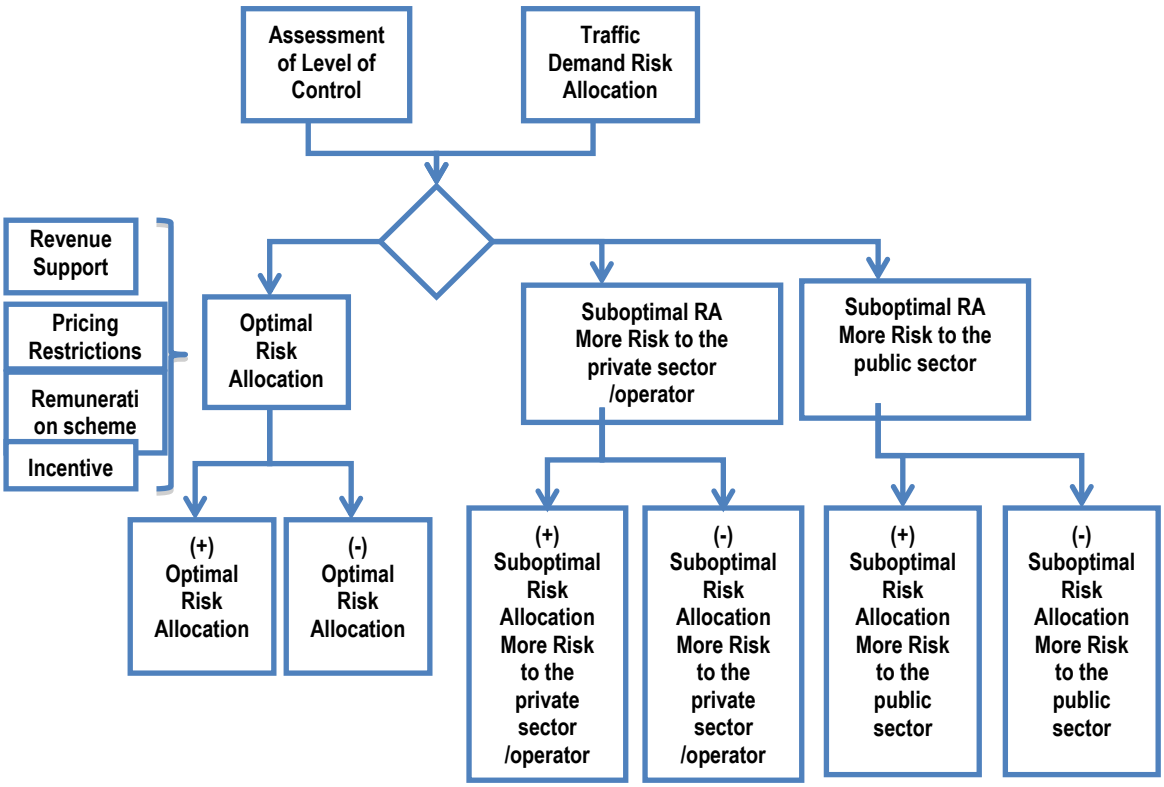

Figure 4.3.1: Assessing Risk allocation

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2) Performance

As described in the above, in this analysis a project is considered to be performing when:

- Actual traffic is greater or equal to forecasted for the case of traditional delivery
- No re-negotiation has taken place for the case of PPP delivery. If actual traffic is greater or equal to the forecasted, then this is considered an additional benefit.

In addition, the present analysis employs the indicators "actual versus forecasted traffic" and "occurrence of contractual renegotiations" as key proxies of performance. Relevant literature provides evidence of a variety of reasons that can lead to contractual renegotiations for both PPP and public procurement cases (Montecinos and Saavedra, 2104; Engel *et. al*, 2011; Guasch, 2004). However, only renegotiations relevant to the scope of the present analysis are being taken into consideration herein, particularly those related to the revenue or remuneration scheme. Table 4.3.2 below presents the scoring of the selected proxies.

Table 4.3.2: Scoring of selected proxies

#	Variable	PPP case	Public case
1.	Actual vs forecasted traffic	Same scoring as dataset: Exceeding forecast = 1 In line with forecast = 0 Below Forecast = -1 Far below forecast = -2	Same
2	Macroeconomic (GDP)	Same scoring as dataset: Improved = 1 Same level = 0 Reduced = -1	Same
3	Renegotiations	Number of relevant renegotiations	Not Applicable

3) Assessment of Performance

As considered in the introduction, using actual versus forecasted traffic as a performance proxy bears limitations as observed variations may be due to many factors including inaccurate initial estimates. As traffic demand is derived and dependent, amongst other factors, on the prevailing macroeconomic conditions, the basic assumption followed in this analysis is:

H1: The "traffic demand vs forecasted" indicator should follow the macroeconomic proxy indicator.

When this assumption (hypothesis) does not hold true, further investigation is needed to identify whether the variation is due to inaccurate forecasts or contractual structural issues and in this case, demand risk allocation.

Three values of the macroeconomic proxy are considered and respective situations may be identified:

GDP proxy = 0: **Under stable macroeconomic conditions actual traffic should be in line with forecasts**. Cases in line with this condition are reviewed with respect to appropriateness of risk allocation. In cases where the hypothesis does not hold true, then this may be due to either optimistic/pessimistic forecasts or the contractual setup.

GDP proxy = 1: **Under positive macroeconomic conditions actual traffic should be better than forecasted.** Cases in line with this condition are reviewed with respect to appropriateness of risk allocation. In cases where the hypothesis does not hold true, then this may be due to either optimistic forecasts or the contractual setup.

GDP proxy = -1: **Under negative macroeconomic conditions, actual traffic is expected to be below expectations**. Cases in line with this condition are reviewed with respect to appropriateness of risk allocation. In cases where the hypothesis does not hold true,

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then this may be due to the contractual setup or other factors requiring further investigation.

4.3.2.2 Analysis

Following the scoring system presented in the previous section, 61 usable cases studies from the BENEFIT database were assessed. It should be noted that although this is not an objective sample based on purposive sampling, the selection of these cases provides a useful benchmark for the current analysis, since these are representative of the population of transport infrastructure projects delivered either by PPP or by public procurement, covering a wide range of transport infrastructure types in 17 countries and selected by more than 14 different organisations. This essentially renders the sample random, which eliminates bias in the analysis and allows for a number of general observations to be made and/or key trends to be identified.

1) Appropriate Risk Transfer

Tables A.5.1.1 and A.5.1.2 in Annex A.5.1 present the assessment of PPP and Public case studies, respectively, in terms of resulting scores for each individual case. An indication of the "appropriateness" of risk allocation is quantitatively obtained herein by the difference (ΔS) between the normalised score for the Level of Control and the score for Demand Risk Allocation. Based on the latter, the **PPP and public case studies are classified under the following three key categories**:

- Cases with more risk passed onto the Private Sector / Operator (ΔS<-1) then justified by the level of control
- Cases with approximately appropriate risk passed onto the Private Sector / Operator (-1 ≤ΔS≤+1) based on level of control
- Cases with more risk retained by the Public Sector (ΔS>+1) then justified by the level of control

A separate column has also been added denoting in a qualitative manner (+,-) the positive or negative influence of other related factors in terms of enhancing or reducing level of control, which were not factored in the score estimation.

In total, 39 cases are considered under the PPP group of cases (Table A.5.1.1). While the sample is marginally random it is interesting to note that 21 cases (54% of the sample) indicate that more risk than justifiable has been transferred to the private sector (concessionaire). In half of these cases, various mitigation or support measures were present in order to reduce the impact of the excessive transfer of risk. Two cases (Reims tramway and Terminal Muelle Costa), given the favourable support measures may be considered under "appropriate risk allocation". In the rest, the contractual arrangement intensified the risk transfer. These cases may be considered as:

1. Vulnerable to macroeconomic changes as the concessionaire does not have the ability to manage the traffic and, potentially, the revenue risk. This vulnerability is increased by the fact that in 18 over the 21 cases studied user charges are the main source of revenue and remuneration.
2. More costly, as most probably this excessive transfer of risk has come at a price for the public sector.
3. When mitigation measures are foreseen the above consideration is intensified, as mitigation measures add to the public sector cost of the project.

In total, 15 cases seem to demonstrate appropriate traffic demand risk allocation. It is also notable that apart from three cases (Athens International Airport, Larnaca and Paphos International Airports and E39 Orkdalsvegen Public Road) all cases also enjoy mitigation measures. Based on theoretical underpinnings, this group should be performing better than the rest.

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Finally, in three cases more risk has been retained by the public sector than the setting of the project could justify. **With the exception of the Deurganckdoksluis-Deurganckdock lock, all cases also enjoy support through mitigation measures**. In this group, the public sector is absorbing all traffic/revenue risk ex-post and, in many ways, reducing potential incentives to concessionaires.

In total, 23 cases are considered under the group of projects delivered and operated by the public sector (Table A.5.1.2). The assessment is applied equally to these projects considering that there is a public "arms-length" private company operating the infrastructure.

Only one case (Modlin Regional Airport) has been identified whereby the operator is passed on considerable more risk than is in a position to control. The main revenue source comes from user charges (capped by the contracting authority) and, at the same time, no revenue support or incentives are provided.

In five Public case studies, risk sharing is more equitable between the public partner and the operator. For two of these cases (Athens Tramway and A5 Maribor - Pince Motorway), there is increased control on the pricing level and no revenue support, which is not matched by the corresponding revenue scheme. User charges are applied in all cases in this category, but they are normally combined with other revenue sources. In two cases (Météor and Tram T4 of Lyon Tramway), risk is mitigated by revenue support measures, although the restrictions on pricing remain increased.

Most assessed Public case studies fall within this category, whereby 17 projects were identified with the majority of risk retained by the public sector. It is noted that effective revenue support is provided in only 2 cases (Motorway E-75, Section Donji Neradovac – Srpska kuca and Attiko Metro). In addition, ten (10) of these cases involve availability fees as revenue source, while five of them (Warsaw's Metro II-nd line; Motorway E-75, Section Donji Neradovac – Srpska kuca; Motorway E-75, Section Horgos Novi Sad (2ndphase); Gardermobanen (Airport Exprestrain and Berlin Brandenburg Airport) also include user charges in different percentages, but with a high level of pricing restrictions.

Notably, given the level of control assessed, some of the cases in the last group (such as Gardermobanen (Airport Exprestrain), Tram-Train "Kombilösung" Karlsruhe, The Hague New Central Train Station, Berlin Brandenburg Airport (BER), RandstadRail, Combiplan Nijverdal, NBS Köln-Rhein/Main) could have been considered for PPP, as the operator would have been in a good position to manage the traffic demand risk. Notably, this was the original plan for the Berlin Airport.

2) Performance

Following the assessment of level of control and traffic demand risk allocation, the performance, as defined in the introduction, is assessed per case. Tables A.5.1.3 and A.5.1.4 in Annex A.5.1 illustrate this assessment.

This assessment as noted in the introduction is hampered by the possibility of inaccurate forecasts.

Amongst the 21 cases with more risk transferred to the private sector, in all cases with actual traffic "far below forecast" (-2), the contract was re-negotiated. In six cases (27% of cases) actual traffic was above the forecasted (+1). This observation requires further investigation as it may suggest systematic under-estimation of traffic forecasts. In four cases with actual traffic below forecast (-1), re-negotiations were not triggered. Attiki Odos and Rio-Antirio Bridge constitute successful projects, whereby the drop in traffic was a direct outcome of the severe economic crisis in Greece following a period of successful operation. The BreBeMi recently inaugurated operation and the BNRR is a case where the concessionaire sets toll prices to serve anticipated returns regardless of the traffic attracted. Finally, Reims with traffic below forecast was re-negotiated.

Amongst the 15 cases with appropriate traffic risk allocation, the respective contract was briefly renegotiated only in the Moreas motorway case after four years of continuous drop in GDP, while the project had initiated staged inauguration of constructed sections and full operation of the brownfeld. In

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the other four cases, where actual traffic was below the forecasted, no re-negotiation was initiated. Finally, within this group, actual traffic was greater than the forecasted in only two cases.

Amongst the three cases with more risk retained by the public sector, no renegotiations were triggered and all three projects performed in line or above traffic expectations.

Notably, while the sample cannot be considered as representative, more re-negotiations have featured when more risk, than justifiable was transferred to the private party.

The public cases feature varying performance. **In the case of more risk passed on to the operator than appropriate, there is clear under-performance and no ability to manage the respective risk.**

The cases with appropriate risk transfer, with the exception of the Athens Tramway, perform better (+1) or as expected. With respect to the Athens Tramway, this may be a case of traffic forecasts over-estimated. However, the project suffered technical difficulties during the delivery of rolling stock and the first five years of operation, which definitely had an impact on attracting ridership.

The cases with more risk retained by the public sector demonstrate varying performance. With 12 cases over 17 performing "in line" or "better" (0 or +1) and the rest worse than expected. It is interesting to note that amongst the six cases (excluding Berlin Airport), which could have been considered under PPP, only one (Randstad Rail) performs less than expected. This may potentially be considered as a case of over-estimated forecast.

Table 4.3.3 summarises the above discussion.

Table 4.3.3 Distribution of Appropriateness of Demand Risk Allocation

Level of Appropriate Risk Allocation	Delivery Type	Number	% in Delivery Type	% in Total
More Risk to the Concessionaire		21	53.8	33.9
Appropriate Risk Allocation	PPP	15	38.5	24.2
More Risk Retained by the Public Party		3	7.7	4.8
More Risk to the Concessionaire		1	4.3	1.6
Appropriate Risk Allocation	Public	5	21.7	8.1
More Risk Retained by the Public Party		17	73.9	27.4
Total		62		100

3) Assessment of Performance

Following the assessment of level of control, project scheme performance is evaluated under the three overarching hypotheses stated previously. Regarding H1, according to which actual traffic should be in line with forecasts under stable macroeconomic conditions, Table A.5.1.5 lists the cases for which H1 is valid, while Tables A.5.1.6 and A.5.1.7 those for which the hypothesis is invalid, related to pessimistic and optimistic traffic forecasts, respectively.

Ten cases have been identified in line with the hypothesis when the GDP proxy =0 (Table A.5.1.5). With regard to the PPP cases, 5 of them appear to have a strong position, albeit the private partner has been assigned more risk than capable of assuming. Three other PPP projects exhibit appropriate risk allocation between the two parties and most probably an effective and robust contractual set-up from the onset. This is further supported by the absence of any renegotiations in 7 of the 8 PPP cases. Considering that revenues are not entirely dependent on user charges in 6 cases (A19 Dishforth to Tyne Tunnel; E18 Muurla-Lohja; M80 Haggs; Reims tramway; Caen-TVR; Liefkenshoek Rail Link), there is indication that these PPPs might not have performed, should they had included user charges.

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For the public cases, these are projects where less risk is passed onto the operator, denoting, thus the strong network position of the project, which overshadows any high pricing restrictions or revenue risks.

There are eleven cases identified in line with the hypothesis when the GDP proxy =1. What is interesting in this group is the concentration of public cases. Three PPP projects follow the hypothesis under positive macroeconomic conditions. Istrian Y motorway is a special PPP case where traffic forecast was particularly underestimated.

Finally, under adverse macroeconomic conditions it would be expected that projects are underperforming with respect to traffic. However, it is worth noting that PPPs with more risk transferred to the concessionaire are not performing relatively better; on the contrary, the traffic indicator [-2] is worse than the remaining PPP cases with more equitable risk allocation. This creates an increased cost for the public party as, on one hand, a premium was possibly passed over to the private party ex-ante for shouldering more risk than justified and, on the other hand, in all five cases contractual renegotiations took place to restore the situation. The PPP case of BreBeMi project appears to perform better that the first five, but it has only recently inaugurated operation. Attiki Odos and the Rio-Antirio Bridge demonstrated a successful operational period prior to the economic crisis. In addition, both projects may be considered as special cases. Both these projects were conceived a long time before their construction (40 and 100 years respectively) and represent highly needed transport infrastructures and, thus, relatively high actual traffic flows.

The remaining four PPP cases with approximately appropriate allocation of risk seem to perform in line with expectations, while only the Moreas motorway project contract was briefly renegotiated.

Regarding the Public case studies, the Athens tramway traffic is far below forecasts and, hence, this could be a case of overestimation, as this has been the behaviour from the start of operation (2004) regardless of the technical problems it faced. The case of Motorway E-75, Section Horgos Novi Sad (2ndphase) seems to be behaving as expected.

The cases that perform better than expected based on the GDP proxy are listed in Table A.5.1.6 in Annex A.5.1. If no other interpretation can be given, it could be assumed that these cases had pessimistic initial forecasts (underestimation of expected traffic). However, improved traffic performance may be also due to a number of reasons, including the capability of the operator to attract traffic and other travel related behaviour.

Under stable macroeconomic conditions in 8 case actual traffic demand exceeds forecasts, suggesting a well-positioned infrastructure in terms of scope, exclusivity and network integration. The latter could also yield the conclusion that the 5 public cases with less risk passed onto the operator could have potentially been delivered through PPP. The Gardermobanen (Airport Exprestrain) and the Berlin Brandenburg Airport (BER) reappear in this group of potential PPPs delivered through public funds. The Randstad Rail case may be confirmed as a case of under-estimated forecast.

The 3 PPP cases also imply well-positioned projects. However, the concentration of Public Projects in this group is noticeable.

Under negative macroeconomic conditions, 7 projects perform better than anticipated. This is the most interesting group as, while the macroeconomic proxy used takes a negative value, the projects perform as expected (Metro de Malaga; Koper - Izola Expressway and The Hague Central Train station) or even better (the remaining 3 cases).

The Public cases involve a combination of user charges and state revenue support, while risk to the operator is either appropriate or even less than appropriate.

More than anticipated risk is retained by the public sector in the case of the A2 motorway in Poland. This is also a unique case within the sample, whereby project revenues are generated from user

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charges, but the concessionaire is remunerated through availability fees. No user charges are applied for the M-45 project, while shadow tolls are the remuneration scheme.

The cases that perform less than expected based on the GDP proxy are listed in Table A.5.1.7 in Annex A.5.1. If no other interpretation can be given, it could be assumed that these cases had optimistic initial forecasts (overestimation of expected traffic). However, negative traffic performance may be also due to a number of other reasons.

The Reims case seems to be the only case suggesting over-estimated traffic forecast under stable macroeconomic conditions.

Five PPP cases, while the expected traffic is in line with expectations, do not follow the increase of GDP. Brabo 1, a tramway, is mostly influenced by local conditions.

The BNRR project and the Modlin Regional Airport are examples of PPP and public cases, respectively, that provided too optimistic demand forecasts under favourable macroeconomic conditions. However, the reasons of variation differ. In the BNRR, toll prices are set by the concessionaire, generating revenues serving the private sector's particular business case. The Modlin Airport operator has been transferred more risk than justifiable, when especially network connections to the airport are missing. The other PPP case, the Adriatic Gateway CT, may be considered a clear case of optimistic traffic forecast as risk is estimated as appropriately assigned based on level of control.

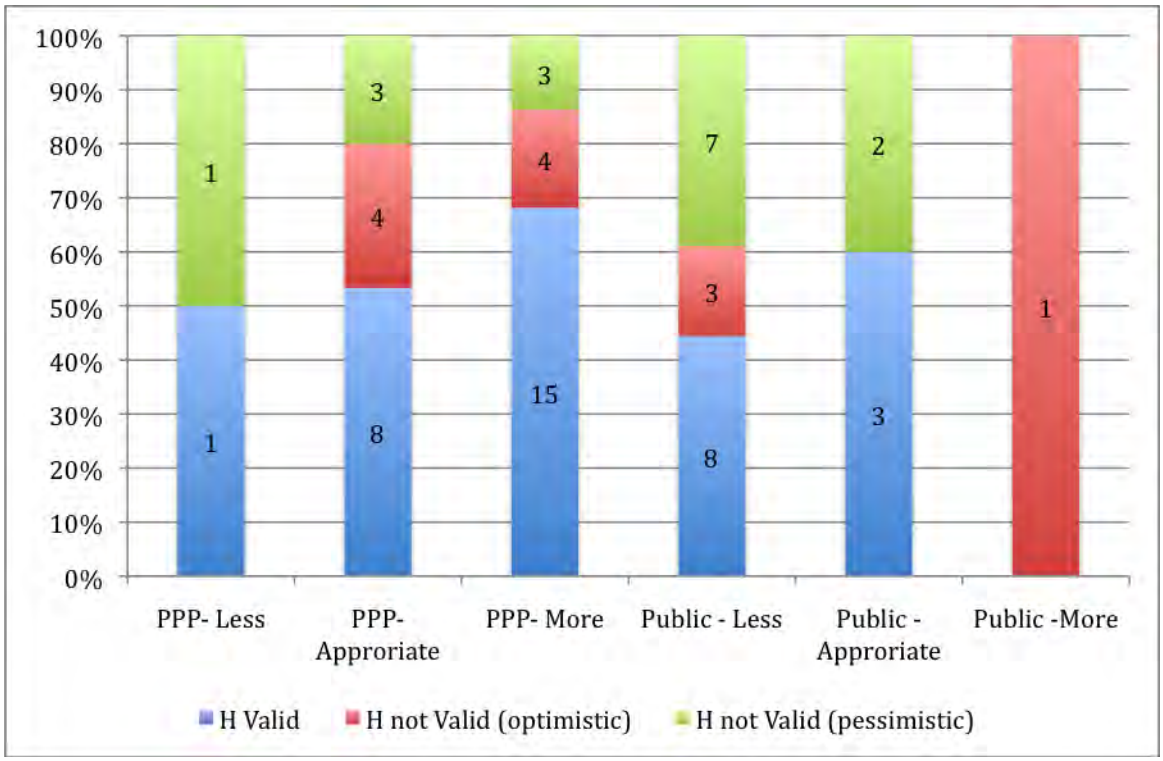

Figure 4.3.2: Assessment of traffic forecasts

For the three Public cases (Belgrade By-pass Project; Bundesautobahn 20; Combiplan Nijverdalor), it could also be optimism bias as less risk was passed onto the operator than the position of the infrastructure could manage. In addition, in all public cases, users were not charged for the service, hence, no impact from a potentially adverse pricing policy can be witnessed.

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In the conclusion to this report, it is interesting to note the association of risk allocation with the over-arching hypothesis of traffic indicator following the macroeconomic proxy. Figure 4.3.2 illustrates how cases (PPP and Public) comply with the hypothesis. Considering Figure 4.3.2, it is evident that forecasts for PPPs tend to be more accurate or even conservative when more or appropriate risk is transferred. When risk is appropriately allocated (PPPs and Public), forecasts seem to be more accurate.

4.3.2.3 Conclusions and Lessons Learned

This section summarises the findings of the analysis conducted in the previous with the scope to identify a number of key trends and resulting lessons learned with regard to the potential impact of traffic demand risk allocation on project performance.

Undoubtedly, appropriate risk allocation allows projects (both PPP and Public) to perform better, a hypothesis that was validated in the sample of the present analysis. Nevertheless, one of the key observations is that in PPPs, the contracting authorities systematically pass over to the private sector more demand risk than may be controlled, increasing the project's vulnerability to macroeconomic changes, as well as incurring additional risk premium and/or mitigation costs to the public sector. In many cases, revenue support or other mitigation measures are put in place to reduce risk exposure. These cases are, however, also characterised (at least within the specific sample) by restrictions in pricing (or prices are set and/or approved by the public authority), reducing thus further the risk control of the private sector. The number of re-negotiations that took place in several such cases is testament to the above risk misallocation. In public delivered infrastructure, most traffic demand risk is appropriately retained by the central state. Only one case entailed a disproportional risk transfer to the operator.

Other useful observations could be made with regard to the revenue and remuneration schemes. In PPPs, while there is a possibility to differentiate the revenue stream from the repayment scheme, this is usually not applied. A recurring trend in private-public procurement is the use of user charges (31 over 40 cases studied), while the opposite occurs in projects delivered by the public sector (9 over 23 cases studies). However, revenue support or no user charges could be justified when macroeconomic conditions are not favourable.

Moreover, the analysis identified a considerable number of cases where projects did not perform in line with expectations of traffic demand regardless of the effect of the macroeconomic conditions. Passing traffic demand risk over to the operator/concessionaire tends to also create expectations of larger traffic volumes. Optimism bias was noted in certain cases; however, the general tendency observed was the employment of conservative traffic estimates in PPPs. In any case, demand forecasts have been observed to be more accurate in conditions of equitable risk allocation.

The analysis also identified a number of cases delivered by the public sector, as cases that could have been delivered through PPP. This relates to cases whereby the level of control is such, and/or the project is well positioned, that the operator would have been in a strong position to manage the traffic demand risk.

Finally, contracting authorities typically place emphasis on creating exclusivity terms for the project (especially in the case of PPPs), transferring more risk than justifiable to the private sector, ignoring though the impact of network integration, such as missing connections, or other mitigation measures that could potentially surpass the project's exclusivity regarding the level of control.

The particular added-value and novelty of the analysis followed herein is that it adopts a holistic/ horizontal approach and a rationale applicable to all types of infrastructure project delivery, without the need to distinguish among procurement types (PPP/public) or transport modes. In light of the above, there are a number of general lessons learned that may be derived and be transferable with regard to appropriately allocating traffic demand risk in project delivery:

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- Appropriate risk allocation should be considered under all cases, public and PPP, as there is strong evidence of good performance.
- Passing more risk over to the operator/concessionaire does not necessarily protect against adverse performance. On the contrary, it may lead to pricier projects (risk premiums and cost of renegotiation).
- When the public sector sets user prices, it effectively reduces the level of control passed over to the operator/concessionaire (regardless of whether a combination of mitigation measures is in place).
- The impact of network integration may be equally or more important with respect to level of control with natural or imposed exclusivity and should be equally considered.
- Revenue support or no user charges with a combination of availability fees or similar remuneration scheme could be introduced when macroeconomic conditions are not favourable.
- Public delivered projects could perform equally well as PPPs with an appropriate level of control to the operator and a well-positioned infrastructure in terms of scope, exclusivity and network integration.

Hence, while "level of control" is important, especially with respect to assessing traffic demand allocation, in many cases it seems that this risk management best practice has been abused.

4.3.3 Key factor: Capability to Operate

Capability to operate is an important feature both in public and PPP type of infrastructure delivery. It influences the cost saving function, as the inclusion of capable operator during the construction phase may support life cycle planning and the operation. In order to validate the Capability to Operate factor included in the Business Model Indicator, the following two hypotheses were tested.

H1: The capability of the operator to manage demand risk and more so the supply chain contributes to project performance

H2: The capability of the operator contributes in achieving traffic targets.

4.3.3.1 Testing of Hypothesis H1

All cases in the BENEFIT database with the operator considered to have capability to influence (if not manage) the supply chain were collected. These include four projects from the port sector, the Europa Freight Terminal, the Liefkenshoekspoorverbinding-Liefkenshoek Rail Link dedicated to serve freight traffic to and from the port of Antwerp and the BNRR (M6 Toll).

The latter, while a toll motorway with little "level of control" assigned, is governed by a contract that allows the operator to set prices without any government intervention. Given this fact, the operator has chosen to favour, through toll pricing, freight traffic.

A qualitative review of the listed cases (see Table A.5.2.1 in Annex A.5.2) indicates that there is no specific trend. However, it is worth noting that, while all projects are PPPs, for none of the projects listed has there been a re-negotiation triggered. The fact leads to the estimation that revenues continue to justify the investment and cover operation/maintenance costs for the operator. It is noted that if this assumption holds, then the projects may be categorised as providing returns to the concessionaires, but producing lesser benefits than anticipated for society. The BNRR has been criticised as such a case.

The Spearman's non-parametric test for the selected sample of cases (Table A.5.2.2 in Annex A.5.2) also shows the positive correlation between "Level of Control" and achieved actual traffic demand

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versus forecasted. It is worth noting that within this sample, actual versus forecasted traffic presents a negative correlation to the GDP proxy. While this finding is not in line with common knowledge, it does, however, suggest that revealed performance in this specific sample is managed rather than conditioned by the external context.

Hence, bearing influence on the supply chain is important, especially when traffic demand is allocated to the operator. This may be strategically manipulated by concessionaires.

4.3.3.2 Testing of Hypothesis H2

In the context of this analysis, capability to operate is being considered with respect to traffic targets. In this analysis, the capability to operate is a proxy index. The analysis also looks into "level of control" associated with the infrastructure, while again the level of achievement of traffic demand is accompanied by the variance of GDP as a proxy of potential macroeconomic influence.

In order to assess the capability of the contractor the following qualitative assessment was followed to construct a capability index derived from the data collection protocol. More specifically, information from the "With-Who" and "Whichway" part of the BENEFIT protocol was mined. The synthesis of the operator agent was identified. Each partner within the operator is assigned a qualitative indicator based on its position in the national and international market. In other words, position in the market place is used as a proxy to assess capability. The indicator is constructed as follows:

High capability = 3	High capability operators are those with international experience, ranking high on the list of transport infrastructure providers.
Medium capability = 2	Medium capability is assigned to top national operators as well as operators providing services internationally but who are not high on the list of transport infrastructure providers
Low capability = 1	Low capability is assigned to national operators (who only function on a national level)
No capability = 0	Concerns partners with no relative experience.

The overall capability indicator is then calculated by adding the weighted share of each group in the agent. The overall score is normalised to the unit.

Capability Index = [% High Capability partners * 3 + % Medium Capability partners * 2 +
+ % Low Capability partners * 1 + % No Capability partners * 0] / 3

The review of table A.5.2.3 does not lead to the identification of any particular trend. Trends may be obscured by:

- The combination of level of control and capability to operate and operator strategies (as observed in Hypothesis H1).
- Overestimated traffic forecasts which cannot be managed by neither the level of control of the infrastructure nor the capability to operate

Finally, the Spearman's non-parametric test (see Table A.5.2.4 in Annex A.5.2) did not show any meaningful correlation.

In addition, the negative correlation within this sample between "level of control" and "capability to operate" may indicate the relative importance of the operator's capability in securing traffic.

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However, when the cases tested are those that include the bundling of features supporting revenues, there is a very high level of correlation confirming that the hypothesis is valid in cases where bundling of activities exists (see Table A.5.2.5).

4.3.4 Key factor: Capability to Construct

In order to validate the "Capability to Construct" factor included in the Business Model Indicator, the following hypothesis was tested:

H1: The capability of the constructor contributes in achieving construction cost and time targets.

The focus of this hypothesis is the capability of the constructor and how this attribute, targeted during the tendering procedure, contributes to achieving construction cost and time targets.

In order to assess the capability of the contractor, the following qualitative assessment was followed to construct a construction capability index.

Information from the "With-Who" and "Whichway" part of the BENEFIT protocol was mined. More specifically, the synthesis of the constructor agent was identified. Each partner within the constructor is assigned a qualitative indicator based on its position in the national and international market. In other words, position in the market place is used as a proxy to assess capability. The indicator is constructed as follows:

High capability = 3	High capability constructors are those with international experienced ranking high on the list of transport infrastructure providers.
Medium capability = 2	Medium capability is assigned to top national contractors as well as contractors providing services internationally but who are not high on the list of transport infrastructure providers
Low capability = 1	Low capability is assigned to national constructors (when only on a national level)
No capability = 0	Concerns partners with no relative experience.

The overall capability indicator is then calculated by adding the weighted share of each group in the agent. The overall score is normalised to the unit.

Capability Index = [% High Capability partners * 3 + % Medium Capability partners * 2 +
+ % Low Capability partners * 1 + % No Capability partners * 0] / 3

All cases, for which construction management targets were known, were collected. These comprise table A.5.3.1 in Annex A.5.3.The sample of cases that may be used due to the availability of data remains relatively small: 33 cases of which 22 correspond to Private co-financing and the rest (11 cases) to public delivery of infrastructure.

No prevailing correlation was identified, since most projects were carried out by "capable" constructors. What is definitely noticeable is the participation of international construction companies in the private co-financing projects as opposed to local and smaller contractors involved in the public delivery of infrastructure. More specifically, only in 3 of 22 cases of private co-financing is the capability index below 0.5, while within the public financing group, 7 in 11 cases bear a capability index below the same value of the indicator.

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Again, the 3 PPP cases with indicator values below 0.5 performed in line with the forecasted budget and time. Amongst the remaining 19 cases with capability index above 0.5, 3 cases witnessed cost overrun and 5 time overrun. However, in three cases construction was stopped due to lengthy renegotiations due to the economic crisis and in one case the project is witnessing delay in the initiation of works, which are irrelevant to the capability to construct. When considering the public delivery group of cases, cost overrun occurred in 5 out of 11 cases and time overrun in 6.

The only correlation shown by the Spearman's non-parametric test is with respect to delivery type and capability index, supporting the observation that international players are involved in PPP projects. The fact that PPP may perform relatively better may be traced to reasons other than the project characteristics but related to the financing scheme. That is, better performance may be due to the monitoring carried out by the lending institutions. In a similar way, the frequency of cost and time overruns in public projects may be related to the actual procedure of "financing" through public budget and the employment of the respective EU directives, which until recently allowed an increase in project budgets.

Following on this, a few more hypotheses were tested:

H2: Achieving construction targets is dependent on the size of the investment

H3: Achieving construction targets is dependent on infrastructure configuration (node – link)

H4: Achieving construction targets is dependent on user mix

Table A.5.3.1 in Annex A.5.3 also includes a categorisation based on project budget (level of investment). Considering that difference in investment per unit constructed between the various modes, Investment budgets within each mode were categorised as high, medium, low (indicator 3, 2 and 1 respectively). No trend is identified with respect to investment size and meeting construction targets. More specifically, 11 projects may be characterised as low investment in relation to their respective mode, 11 as medium and 10 as high investment. Five low investment projects did not meet their construction targets, 4 medium investment ones and 5 high investment ones.

One may conclude that the frequency of cost and time overrun is greater in publically delivered projects. However, the Spearman's non-parametric test (see Table A5.3.2) did not show any such correlation. The test remains the same as the level of investment refers to the entire dataset and not within each transport mode (see Table A.5.3.3). In addition, the same test does not show any correlation with respect to node-link description, and the user mix.

4.3.5 Key Factor: Brownfield section improves resilience to macro-economic fluctuations

The focus of the present analysis is to assess the impact of brownfield sections on performance of road projects with respect to improving the probability of achieving demand forecasts. Therefore, the hypothesis tested is:

H1: Brownfield sections in road projects improve the probability of achieving demand forecasts and contribute to project performance

The rationale behind this hypothesis is the fact that brownfield infrastructure has accomplished traffic demand and therefore, the greater the contribution of the brownfield in the project, the more precise traffic forecasts should be. In order to carry out the analysis, an indicator **"length of brownfield over length of greenfield**" is introduced.

Notably, **road projects** also include **commercial activities** (service stations, motels etc.). However, these inputs are disregarded in the present analysis, as even if they do exist, they contribute by less than 10% of total revenues.

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Table A.5.4.1 in Annex A.5.4 includes the 11 cases of the BENEFIT database, which comply with the Hypothesis criteria. One (Horgos-Pozega) was cancelled due to **social opposition** following its award. For two more, project management information is, currently, not available. Amongst the remaining eight (8), only one performed over budget.

By reviewing Table A.5.4.1, it is evident that the hypothesis holds clearly in only three cases (Haggs M80, E4 Helsinki-Lahti, and E39 Orkdalsvegen Public Road).

Table A.5.4.1 also includes the GDP variations as a proxy of the overall macroeconomic conditions. Given this indication, a few more cases may be considered to confirm the hypothesis: BreBeMi, Moreas Motorway and, possibly, Ionia Odos, E-65 Central Greece and Elefsina Korinthos Patra Pyrgos Tsakona Motorway.

Two cases (A22 – Algarve and Motorway E-75, Section Donji Neradovac – Srpska kuca), while including a considerable share of brownfield sections, perform below expectations, indicating the possibility of initially overestimated traffic forecast.

Again, Spearman's non-parametric test for the selected sample of cases listed in Table A.5.4.1 (see Table A.5.4.2) supports the above qualitative findings indicating that the addition of a brownfield section does not improve the potential of achieving the forecasted traffic. On the contrary, brownfield additions may support optimistic forecasts. However, within this group of projects incorporating brownfield sections there seems to be an influence on the time to completion.

4.3.6 Key Factor: Bundling of Activities

The BENEFIT project puts forward the need to deliver integrated infrastructure. This concept is included in the construction of the Business Model Indicators. Therefore, a key hypothesis to be tested is:

H1: Integrating alternative revenue activities (e.g. Commercial activities) and combined transport infrastructure delivery contributes to project performance

Table A.5.5.1 in Annex A.5.5 lists the cases for which this hypothesis may be tested. These include 15 projects representing all transport modes.

The analysis focuses on identifying the influence on performance of:
- Alternative revenues (e.g. from commercial activities),
- The existence of a common operator within the wider transport network, as this would improve the management of the transport system and reduce operation costs (potential economies of scale),
- The co-construction and/or co-operation of transport infrastructure serving different modes.

In order to allow for comparisons between the cases, indicators were introduced as follows:

The "Commercial Revenues Indicator", takes values [1, 3], with:
- 1 for Commercial Revenues < 10% of total project revenues
- 2 for 10% ≤ Commercial Revenues < 25% of total project revenues
- 3 for Commercial Revenues > 25% of total project revenues

The "Common Operator indicator" is proposed as a binary No/Yes indicator with:
- 0 for No combined operation and
- 1 for Common Operator

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The “potential Revenue from Other Transport Operation” Indicator is assessed based on the assumption that the co-constructed/operated infrastructure would be capable of generating revenues and benefits.

The indicator takes values in the range [1, 3] with:

- 1 for Potential Revenues < 10% of prime project revenues
- 2 for 10% ≤Potential Revenues < 25% of prime project revenues
- 3 for Potential Revenues > 25% of prime project revenues

The review of Table A.5.5.1 indicates that:

- All four projects in the list having both a common operator and high “potential revenues from other transport operation” perform in line with expectations or better.
- The three projects in operation with a high “Commercial Revenues indicator” also perform in line with or better than expectations. Following this last assessment, it is worth clarifying that while the commercial revenues indicator concerns revenues from other activities, the categorisation indicator concerns traffic. It may be that the commercial activities attract additional demand for the service offered.
- Lesser contribution from other activities does not seem to improve traffic performance. It should, however, be contributing to revenues as, while there is a drop in traffic, no renegotiation has initiated for two of the three cases that bear this characteristic.

Finally, it is interesting to note that many cases have not performed well with respect to meeting their construction time and cost targets. The reasons for this lesser performance vary.

The Larnaca and Marina Redevelopment Project has not managed to achieve financial close 3 years after its award. Reasons referred to are the financial and economic crisis but, also, the synthesis and scope of the project, which is neither purely port nor marina nor real estate development.

The Berlin Brandenburg Airport (BER) has faced numerous administrative and technical problems leading to considerable delays and cost overruns.

The RandstadRail, Berlin Tiergarten Tunnel and the Hague New Central Train Station seem to have faced considerable administration and coordination problems, while technical problems also manifested.

Finally, **lesser performance with respect to cost and time of construction completion may be due to** the negative influence of the increased complexity of the project or the fact that the number of stakeholders increases with the activities bundled.

The above qualitative assessment is supported by the Spearman’s non-parametric test for the selected sample of cases listed in Table A5.5.1 (see table A.5.5.2). Through the test, a positive correlation is identified between the indicators describing commercial revenue, common operator and combined transport infrastructure/service operation with the categorisation indicator actual versus forecasted traffic.

Furthermore, it is also worth noting, based on the test, that actual traffic versus forecast is not significantly correlated to GDP and, thus, suggests that **these models show resilience to macroeconomic changes.** In addition, the potential correlation in this case is positive, in line with common knowledge. Along the same approach, the level of control indicator is negatively correlated to the GDP proxy, enhancing the notion of resilience in this sample.

Finally, it is interesting to note that most of the projects in this list evidenced a very long planning period (see Table A.5.5.3). Of course, long planning periods are not only connected with technical

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planning, but also with the process of securing the appropriate financing and may work in favour and against project performance as context may change over the long planning period.

4.3.7 Validation of the BM indicators Using Snapshot Data

4.3.7.1 Spearman's non-parametric tests

In order to identify potential associations, Spearman's non-parametric tests were carried out per infrastructure mode group. This specific test checks the correlation between two variables, in this case between a key characteristic and an outcome. Spearman's non-parametric test was chosen since the interest is to identify whether the relation between the key characteristics and the outcomes may be described by a monotonic function while at the same time there is no knowledge of the joint probability distribution of the two variables.

The results are summarised in tables in **Annex A.5.6.** When studying the results, one needs to keep in mind that each outcome is the combined effect of many other factors not included in this analysis, such as the macroeconomic context within which the project is constructed and operated, as well as the governance structure, the funding and financing scheme (see the BENEFIT project). Hence, the outcome cannot be explained only based on the key characteristics of the business model. It is, however, important to review the results and identify that correlations do exist and that the key characteristics identified contribute to the outcomes.

The dataset used to conduct Spearman's non-parametric tests was based on the cases discussed previously collecting data from various times of the each infrastructure's life-cycle. This is important as the contribution to the outcomes of the key characteristic varies over time as contextual conditions change.

With respect to Table A.5.6.1 (in **Annex A.5.6**) illustrating the results of the Spearman's non-parametric tests per infrastructure mode, the first remark concerns the missing value cells. These correspond to the fact that no such key characteristic was identified to make the correlation. Just a mere overview of the table sets shows that in most cases emphasis is placed on the cost saving potential (as correlations indicate), but no such effort is placed when seeking to support revenue streams. This was also identified through the qualitative review of the database in the previous section. Further to this remark, it is noticeable that this trend is far more evident in bridge/tunnel and road projects. Implying that this trend is more pronounced when there is high level of control (bridge/tunnel projects) and very little (road projects).

Another important finding, which is also the scope of this analysis, is that **the key characteristics identified do correlate with the outcomes**. This is a finding that justifies the methodology of business model approach for infrastructure delivery. However, it is also noticeable that the key characteristics **do not correlate the same to the outcomes** across all modes of infrastructure. This is a strong indication of the specificities that accompany each infrastructure mode and puts forward the need of developing mode (or maybe case) specific business models or applying the Matching Framework within projects of the same mode.

It has to be noted once again that the **findings are sample specific** and the sample is neither representative nor of equal size per mode. It is, however, a random sample of cases, as different individuals have collected these cases over time and from many countries. The development of the different business models evidenced per transport infrastructure mode also suggests so. The following findings have to be viewed under this consideration.

Capability to construct and the respective risk allocation were found to be important in all cases. As expected, greater correlation was identified for the delivery of bridge and tunnel projects, which are usually of greater technical difficulty. The least correlation of these key characteristics was found with respect to roads including brownfield sections. This is also an anticipated finding, as these present the least technical difficultly but may be hampered by land appropriation issues. Again, in line,

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with reported literature (cf. Akintoye et al, 2003), optimal construction risk allocation is the more important of the two key characteristics.

Capability to innovate shows mostly a positive correlation across outcomes and modes. Variations could be sample specific. It is, however, interesting to note the non-existing correlation with respect to greenfield roads and the weak correlation in ports. This could be due to totally different reasons. In roads, it could be that other factors (or key characteristics) are more important. In ports, it may be related to the specific sample.

Life-cycle planning demonstrates the same trend as capability to innovate. This could be a sample specific finding or it could suggest that innovation is part of life-cycle planning and bears similar impacts (correlations) to outcomes.

One would expect "capability to operate" and "optimal operation risk allocation" to be correlated to the traffic outcome. This anticipated finding is identified in the case of metros and tramways but not so in other transport infrastructure modes. This finding again may be sample specific as many of the case observation points correspond to the economic crisis period when the contribution of the ability to operate may have been cancelled by the impact of the economic crisis on traffic. Metros and tramways, as serving urban areas, may have been influenced to a lesser degree, especially as the economic crisis may have pushed car users to modal shift with a positive effect on urban transit traffic.

When considering key characteristics of revenue support, correlations are scattered indicating the lack of these measures and a preference that projects only include the prime infrastructure. However, it is interesting to note that "level of control" is the only key characteristic with a positive correlation across all outcomes and transport infrastructure modes. This also justifies the effort placed in case of private financed infrastructure to contractually support the exclusivity of the project and develop network integration in its favour. This characteristic seems to be least correlated for ports.

Optimal demand risk allocation shows a varying correlation to traffic across modes. However, this may be due to the stronger impact of the economic crisis. It is also worth noting once again, that correlations are positive. The only key characteristic, which is consistently positively correlated across all infrastructure modes and outcomes, is the "level of control". Notably, this is also contractually induced in most PPP cases, which form the majority of this sample.

4.3.7.2 Importance Analysis

An importance analysis was undertaken to identify potential relations between the factors contributing to the "cost saving" indicator of the BM typology. The background to the Importance Analysis is presented in Chapter 7 of this document. Its scope is to identify the relevant importance of the various components (factors) of the Business Model with respect to the overall indicators. Results are presented in **Annex A.5.6.** Findings suggested that weighting should remain neutral as was initially proposed (see Deliverable D3.1).

4.3.8 Configuration of the BM Typology Indicators

As described in Deliverable D3.1, the Business Model Typology Indicator consists of two sub-indicators (functions): The Cost Saving and the Revenue Support function as illustrated in Figure 4.3.3.

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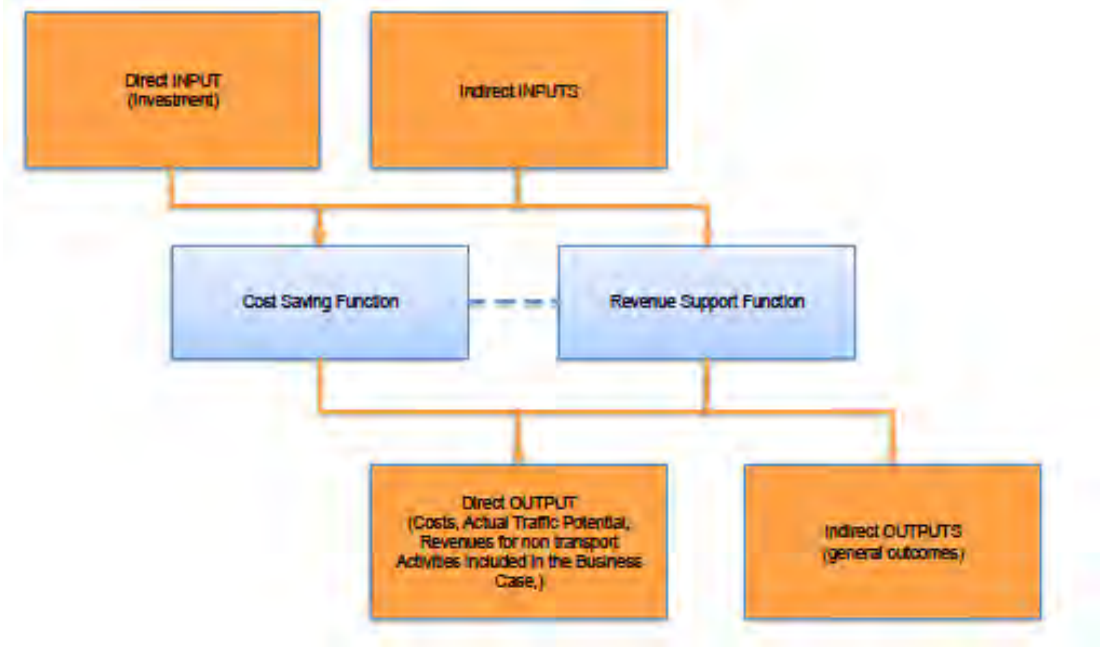

Figure 4.3.3: Business Model Functions

The Cost Saving function is connected to the Revenue Support function only during the initial stages of infrastructure delivery, since the functionality of the operation can only be affected if the construction is completed. Once construction is completed this connection ceases to exist as a parallel system configuration.

Cost Saving Function

The Cost Saving function is composed of two parts: the Construction Cost (sub)function and the Operation/Maintenance Cost (sub)function. They are set in a series configuration as operation /maintenance depends on the realisation of construction. Once construction has been completed, this (sub)function ceases to exist in the system. Figure 4.3.4 below describes the setup of the Cost Saving function.

The Cost Saving function can be intuitively described to be measuring “ability” to avoid or reduce cost overruns.

The Cost Saving sub-functions were validated during this task as described in the present section and considered to be significant. Spearman’s non-parametric tests indicated that the Cost Saving function should differ in the operation phase according to the formulation presented below.

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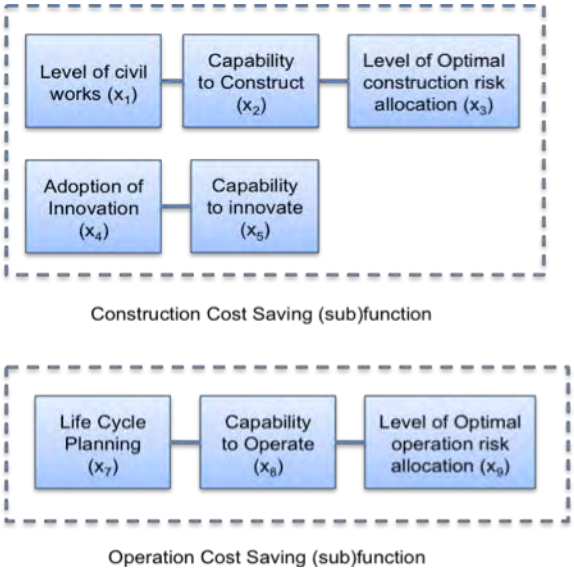

Figure 4.3.4: Cost Saving sub-functions

$\Phi_{CS}=x_2x_3 - (x_1 - x_1x_2x_3) + x_4x_5 + x_7x_8x_9$, during the construction phase, and

$\Phi_{CS}= x_7x_8x_9$, during the operation phase,

Notably the **term x_{COR} describing** the Cost Overrun of the construction phase in percent (%) has now been **omitted.**

When $\Phi_{CS} = 0$, no cost saving is observed. When $\Phi_{CS} < 0$, then cost overruns or a tendency for cost increase may be observed.

Finally, with respect to the calculation of the various variables, the preparation of the snapshot data indicated the need to improve on the life cycle indicator. In the original approach, it was assigned a binary value [0, 1] depending on whether the delivery mode was PPP (bundling of construction and operation phase) or not. This was changed to a guided assessment of the life cycle planning that was effected in the project.

Revenue Support Function

The Revenue Support function involves the following elements, subject to their existence:

(i) a sub-function modelling revenues from the Greenfield part of the project
(ii) a sub-function modelling revenues from the Brownfield part of the project
(iii) a sub-function modelling revenues from other transport activities from within the project or potentially from different one(s) (cross-subsidisation)
(iv) a sub-function modelling revenues from other non-transport activities from within the project or elsewhere
(v) a sub-function modelling other wider impacts (economic, environmental, social, institutional)

The BM is structured so as to comprise all possible benefits and revenues that may be “harvested” by the funding scheme element providing detail to commonly employed revenue enhancing sources. A BM, however, may not be limited to the sources identified as (i) to (iv). There could be more described in the same detail. The function (v) is usually not directly harvested by the funding scheme and forms the general projects outcomes. The produced revenues are usually captured through indirect taxation or wider non-quantifiable benefits to society.

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Figure 4.3.5 below describes the system configuration of the respective sub-functions.

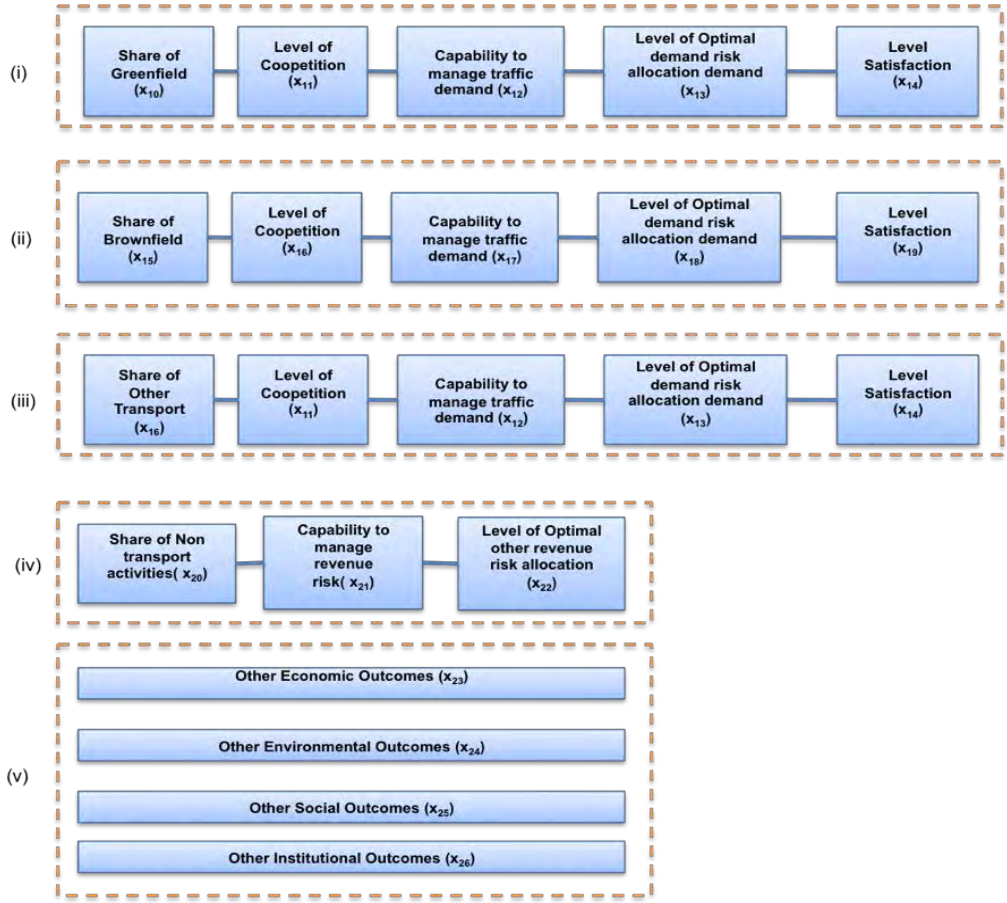

Figure 4.3.5: Revenue Support sub-functions

The key factors of the Revenue Support function can be intuitively described to be measuring "ability" to increase revenues. Key factors included in the formulation were validated and presented in the current section. Most were found to be valid or the results of the validation could not sufficiently justify their omission or further adjustment.

However, the component (v) referring to general outcomes **has been dropped** providing a more "operational" configuration of the indicator. For reasons of comparability with other indicators, the unit (1) initially proposed in deliverable D3.1 has also been **omitted**. This is a reduction with respect to the theoretical underpinnings of the configuration (see D3.1), but it does not influence the use of the indicator.

Hence, the final formulation is as follows:

$$\Phi_{RS} = x_{10}x_{11}x_{12}x_{13}x_{14} + x_{15}x_{16}x_{17}x_{18}x_{19} + x_{6}x_{11}x_{12}x_{13}x_{14} + x_{20}x_{21}x_{22}$$

Finally, through the validation process a number of conclusions and lessons learned were reached. For reasons of completeness and in order to avoid repetitions, these are summarised in the Conclusion section of this Chapter. However, one point of direct significance to the Business Model Typology Indicator is that **its explanatory power is greater and more suitable between cases of the same mode of infrastructure or bearing similar revenue characteristics** such as cases with bundled activities.

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4.4 Governance typology

As output of the BENEFIT project Task 2.4, two dimensions clustering characteristics of project governance were identified, namely 'efficiency/**effectiveness of governance'** and '**contractual flexibility'**. These two dimensions come from an extensive review of literature. A critical assumption was made in choosing these two dimensions. The scope of project governance is limited to transactions reflected in the project contract as suggested by Clarke (2004, 2007) and Mallin (2004, 2006). This means that the influence of external stakeholders is not considered in the governance aspects of project. Further, it was initially assumed that cooperation-based project governance mechanisms reflected in the selected governance indicators generally have a positive influence on project performance and lead to more optimal project outcomes in comparison to traditional procurement and contracting procedures. Likewise, it is hypothesized that the implementation intensity of the selected formal governance mechanisms (contractual conditions) is positively associated with project performance. The latter two assumptions have been substantiated by Eriksson and Westerberg (2011) and verified to a large extent by survey based research performed by Chen and Manley (2014) and Li, Arditi and Wang (2012). This shows the initial validation process undertaken in selecting the indicators.

On the basis of Chen and Manley (2014), Li, Arditi and Wang (2012) and Susarla (2012) quantitative research works, a set of relevant indicators was found that can be linked to 'efficiency/effectiveness of governance' and 'contractual flexibility' governance dimensions. The identified indicators also lead to reducing transaction costs according to Li, Arditi and Wang (2012). The indicators found in the literature have been extensively validated with statistical tests and exhibit high factor loadings. Factor loadings reveal the extent to which a certain variable is relevant to a specific latent variable or in this case to project governance. This further shows the initial validation process undertaken. To choose the proposed indicators, further checks were carried out including the examination of the indicators mutual exclusivity, the evaluation of the indicators consistency with the proposed system model methodology (the matching framework) and more importantly their subtlety and measurability. The selected indicators are presented in Table 4.4.1:

Table 4.4.1: Governance indicators

Indicator	Factor loadings	Associated dimension
G1.The client selected only one service provider [bidder] to participate in the pricing stage	0.83^{++}	Efficiency/ effectiveness of governance
G2.The client and the key service providers [bidders] collectively estimated the expected project cost	0.76^{++}	
G3.Encouragement of competition between bidders	0.84^{+}	
G4.Integration of design and construction	0.89^{+}	
G5.The key service providers [contractor] to pay a penalty if completion dates were not met	0.78^{++}	
G6.The key service providers [contractor] solely carried the risk of rising costs	0.77^{++}	
G7.The client and key service providers [contractor] [to share] shared equal proportions of profit due to cost under-runs	0.78^{++}	
G8. Bonding requirements	0.84^{+}	
G9. Commercial/revenue & financial risks are not concentrated	0.64^{+}	
G10. Clauses enable updating of service and/or price changes	*	Contractual flexibility
G11. Clauses indicate that client has an option to terminate the agreement without cause	**	

The factor G10 (denoted *) was found to be associated significantly with Pareto improving amendments. Pareto improving amendments are considered as renegotiations that improve the welfare of one party without worsening the other (e.g., Guasch et al. 2007, 2008) in Susarla (2012).

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These Pareto improving amendments usually lead to a reduction of transaction costs. This variable is evidently connected with the contractual flexibility component of the governance typology. Flexibility provisions reduce the likelihood of rent seeking by both parties lowering mal-adaptation and underinvestment (Susarla, 2012).

The factor G11 (denote **) was also found to be associated significantly with Pareto improving amendments. This variable is also connected with the contractual flexibility component of governance typology. Termination for convenience rights grants unilateral control to the client, reducing the likelihood that a contractor can engage in opportunistic rent seeking. The threat of unilateral termination by the client correspondingly lowers the likelihood of underinvestment by the contractor. Such enhanced performance incentives for a contractor correspondingly lower incentives for a client to force concessions or strategic termination, thus lowering the likelihood of mal-adaptation and underinvestment, facilitating smooth adaptation to unfolding contingencies and leading to Pareto improving amendments (Susarla, 2012).

For variables G4, G4, G8 and G9 (denoted $^{+}$) the factor loading is in relation to a latent variable most significantly associated with reduction transaction cost according to Li, Arditi and Wang (2012).

For variables G1, G2, G5, G6 and G7 (denoted $^{++}$) the factor loading is in relation to formal mechanisms of project governance associated positively with project performance according to Chen and Manley (2014).

Note that factors associated with informal mechanism of governance (non-contractual conditions as identified by Chen and Manley (2014) and related to issues such as leadership, communication, decision making, competency) are not considered here, since they have a moderate effect on project performance if measured by means of their contribution to transaction costs reduction **(**Li, Arditi and Wang, 2012). Note that, formal governance comprises contractual incentives for clear and equitable risk allocation (Lahdenperä 2010; Love et al. 2011 in Chen and Manley (2014)). Informal governance comprises non-contractual incentives to enhance mutual trust, enable cooperation, facilitate open communication, and share knowledge (Rahman and Kumaraswamy 2012 in Chen and Manley (2014)).

From the table it is evident that the indicators selected consider aspects of project governance such as early involvement of the contractor in the design and estimation of costs, procurement procedures, integration of design and construction, incentives and dis-incentives regime, risk allocation, flexibility of the contract and actions that enable the contracting authority to maintain bargaining power during possible renegotiations. All this reflects the many aspects of the relations between the contracting authority and contractors.

Further validation of the indicators was undertaken by carrying out Importance Analysis (IA), (see **Chapter 7**) using 40 European case study projects with data reflected in more than 50 records[27]. The case study projects are described in **Annex A.1** and **Annex A.2**. The IA used in this study is described in Chapter 7 of this report. This analysis consisted of determining the relevance of the indicators as a function of its probability and degree of influence to generate cost and time under-runs in the projects studied. As a result of this analysis, the indicator G7 in Table 4.4.1 was identified as irrelevant and accordingly removed from the set of indicators initially proposed. In the setting of the IA, the modelling approach (Bayesian networks) and the data used, it was also verified that the combined and optimal implementation of the procurement procedures and contractual arrangements, reflected in the proposed governance factors, significantly increases the likelihood of cost and time under-run occurring (up to 0.68 and 0.68 chance respectively).

[27] The number of records used for the IA seemed to provide acceptable accuracy according to tests carried out by Onisko, Druzdzel and Wasyluk (2001).

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The validation of the set of indicators associated with governance included verification for usability. These verifications indicated that three out of 15 providers of information had difficulties in setting values for the indicators. In response, indicators descriptions and details on their usage were improved accordingly.

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4.5 Funding scheme typology

4.5.1 The model

The point of departure in defining relevant Funding scheme dimensions, from the perspective of general project attractiveness, has been to consider the relevant objectives and constraints that are of interest to the relevant actors, i.e. the public and private parties involved.

Such objectives/constraints should, in abstract terms, have the following characteristics:

- Be important for project/scenario attractiveness;
- Be aligned with the decision maker's assessment criteria;
- Be related to funding schemes;
- Be, as much as possible, independent of each other.

For the public party responsible to go forward with the project, the following core and distinct objectives / constraints related to Funding schemes were considered:

Objective 1: Attracting enough private financing through a sufficient and secure income stream
Objective 2: Minimizing public expenditure during project (public funding)
Objective 3: Guaranteeing an optimal project performance (for users)
Objective 4: Assuring market efficiency (efficient pricing)
Objective 5: Obtaining public acceptance

For the hypothetical private party (financing entity), the basic question is whether the Remuneration scheme is attractive from a financing perspective, i.e. whether the expected income and associated risks pass the test of economic attractiveness. This objective of the private party is essentially the condition for the attainment of the first objective of the public party above (i.e. attracting enough private financing). The two issues are essentially the same and are merged below.

The objectives and constraints above are influenced by two core elements of the funding scheme: the revenue streams of the project and the remuneration scheme of the project contractor. These correspond to the Funding schemes typology Dimensions and were defined in the following way:

- Revenue stream: revenues specifically generated by or for the project. These should not include money from the general public budget (subventions).
- Remuneration scheme: streams of income received by the project contractor.

Both affect the objectives of the public party. The objectives of the hypothetical private party are affected by the remuneration scheme.

In the model designed for the BENEFIT matching framework, these dimensions are formed by a number of sub-dimensions and indicators which are explained below.

4.5.1.1 Dimension "Revenue Stream"

- Cost coverage (revenue stream)

The indicator Cost Coverage reflects the percentage of project costs that are covered by the revenues generated by or for the project. The objective is to assess the capacity of the project to guarantee sufficient revenues to pay for it.

The revenues considered in this indicator exclude possible public subventions coming from the general public budget, since the objective is to assess the capacity to secure revenues for the project independently of the public budget. These revenues could include income that is not generated directly by the project, but which is generated specifically and in a transparent way for the project. In any case, it is the existence of the project that justifies the collection of the revenues considered.

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- Risk of Revenue

The indicator Risk of Revenue reflects the risks associated with the expected revenues of the project. The relevance of this indicator depends essentially on the risk aversion of the State. By considering this indicator as relevant, the base model implicitly assumes that there is some level of risk aversion by the State. Furthermore, although the risk of revenues may also interfere with the availability of the private party to finance the project (in the case where the project owner is directly paid by the revenues generated by the project), such effect is captured within the Remuneration Scheme dimension.

The score of the indicator is given by the weighted average of the risk assessment of each source of the revenue streams considered in the previous indicator.

- Market and environmental efficiency (allocative efficiency and internalization of environmental costs)

The indicator Market and environmental efficiency refers to the capacity of the funding scheme to correct, or not introduce, distortions in the transport market. This includes two main elements: (a) allocative efficiency, which reflects the efficiency with which the existing infrastructures are being used, whereby the existing pricing of the infrastructure use should not introduce distortions towards underuse or overuse (congestion) of the infrastructure; and (b) internalization of external costs, i.e. the issue of whether the existing pricing is able to correct (internalize) costs caused to third parties by the users of the infrastructure.

A funding scheme which promotes environmental efficiency should respond to two simplified conditions: that the infrastructure use pricing scheme reflects the social marginal costs of infrastructure use; and that pricing in competitive infrastructure/services follow similar principles and quantification methods. These two elements are considered in the model. The later element is a strict condition for a positive assessment – the indicator gets the lower score whenever the condition of price consistency across competitive infrastructure is not met.

- Public acceptability of Funding scheme

Some funding schemes may not be viable due to political reasons related to public acceptability. This indicator is composed by two assessment criteria which contribute to acceptability: the existence of direct perceived benefits to the funding agents; and the perception that the revenues collected are applied towards something desired by the public.

4.5.1.2 Dimension "Remuneration scheme"

- Cost recovery (remuneration scheme)

The cost recovery indicator is a conditional indicator for the viability of the remuneration scheme, in the sense that the private financing of the project will not exist if the project is not considered to be profitable by the project owner. Therefore, if the funding scheme does not pass the test of cost recovery of the remuneration scheme, the project is not viable with such a funding scheme and a different solution must be found.

The model assessment of cost recovery includes any source of income (or penalty) of the remuneration scheme, including potential State subventions.

- Risk of income (remuneration scheme)

The risk of income of the remuneration scheme represents in practice an additional cost, which is the risk aversion premium requested by the financing party. In the scope of this model, such cost cannot be precisely estimated and therefore the risk of income is taken as a separate indicator.

- Optimal operational performance (incentives to Agent)

This indicator assesses the effects on the quality of the infrastructure/service delivery from the incentives put by the income streams of the project operator. The score depends on how appropriate each income stream is in incentivizing an operating behaviour that guarantees availability and quality of the service.

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4.5.2 Scoring method and weighting of indicators

All indicators are scored in a continuous scale of 0 to 1, where 0 reflects the worse potential effect on the outcomes of the project and 1 reflects the best possible effect. The weighting of indicators that base the final score of each dimension were drawn based on a subjective opinion on relative importance.

4.5.3 Attribution of inputs to the model

The funding scheme indicators are partly based on quantitative data of the project (particularly data on expected and actual revenues and remuneration income) and qualitative assessment. On the indicators subject to a qualitative assessment, the guidance provided gives generally two options:

- Scenario assessment: Giving scores based on general characteristics of the project/scenario and its funding scheme, which should be correlated with given (negative or positive) outcomes
- Giving scores based on a more detailed (subjective) knowledge of the project specificities and context

The first option allows to score a project based on scarce information, but will tend to be less accurate than the subjective assessment based on a closer knowledge of the case.

4.5.4 Validation

The validation of the funding matching framework was conducted in two ways:

- The understanding of the case study authors on the appropriateness and comprehensiveness of the framework;
- The verification of plausibility of the case study applications regarding the scores attributed to the indicators and dimensions.

A number of key elements were considered and assessed in the validation. The main issues extracted from this process are provided in the following observations and reflections:

4.5.4.1 Comprehensiveness of the model and its application

- The model description suffered four iterations following questions and comments by the case authors. The final version appears to be comprehensive;

- Even when the case author is not fully familiar with all the concepts behind the model (like incentives to operational performance, market efficiency or public acceptability), the 'scenario' guidance seems to guarantee some robustness to the scores attributed;

4.5.4.2 Adaptability to different levels of information

- The model scoring guidance was meant to allow for scoring based on different levels of information on the case;
- It was clear from the process that there were distinct levels of knowledge on the specificities of the case which were relevant to the funding typology characterization;
- The approach of adaptability to level of knowledge seemed to be adequate and allowed for a better characterization of projects with a better knowledge without losing the possibility to characterize projects with a lower level of knowledge;
- In few cases, the lack of data on the project (particularly on the sources of funding and respective quantities) seemed to lead to oversimplification of the model inputs provided, which could lead to biases in the analysis. This could be partly, but not entirely, addressed by a clearer guidance on the parameterization of the model.

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4.5.4.3 Appropriateness of scales applied to indicators and dimensions

- The rationale applied in the definition of scales was to capture a range of plausible potential effects of the project characteristics on feasibility and performance. The variability of scores across the cases assessed so far provides a reference on the ability of the dimensions to cover different situations. The average values stand close to the median of the scale and the standard deviations are 23% and 24% for the Revenue Scheme and the Remuneration Scheme dimensions, respectively, indicating a reasonable variability across the spectrum.

		avg	st dev
Remuneration Scheme	PPP / concession	0,463	0,241
Revenue Streams	PPP / concession	0,519	0,242
	all	0,516	0,226

- Since each of the funding dimensions is composed by several indicators, there is a balancing effect between those indicators. Since they are essentially independent, the diversification of scoring sources implies that the variability of the dimension scores is probabilistically reduced. Still, as seen from the results above, the variability is significant.

4.5.4.4 Weighting applied

- The significance of each indicator to the viability and outcomes of the project varies from project to project;
- Consequently, the weights defined should not be regarded as a fixed feature of the model, but rather a flexible parameter which may be adjusted according to specificities of the project;
- The Cost Recovery indicator of the Remuneration Scheme assumes a strict conditional nature (the dimension assumes the lowest possible score whenever it is not met). This strict condition should be extended in the model to the project feasibility as a whole. Any (private financed) project scenario is feasible only if this condition is met;
- To be realistic on their impact on project feasibility, other indicators could be subject to the same type of strict conditional weighting on the full project scenario score. This is the case of the acceptability indicator, which seems to hold on its own the potential to make a given project / scenario not viable. The current scoring of this indicator may be regarded as a proxy to the probability that the funding scheme will be considered not acceptable and, if that event occurs, the project will not be feasible under the given funding setup. In conclusion, rather than a score which influences the overall score of the project, it reflects the possibility of the project not being viable at all.
- Each indicator and sub-dimension refers to an effect on a given feasibility or performance factor. However, the importance of performance factors varies from project to project, and from actor to actor. This implies that **the weighting** of indicators and dimensions should be adjusted to the set of objectives considered for the given project and actor. In the context of the Matching Framework weighting is neutral.

4.5.4.5 Overlaps between dimensions

- The two dimensions of the Funding typology – Revenue Streams and Remuneration Scheme – are correlated, because in many instances the remuneration flows are similar or equal to the revenue streams. However, this does not mean that they are overlapping. The two dimensions represent independent effects on factors of viability or performance of the project. Even though they are correlated, the impacts under assessment are distinct;
- Transport mode context – Reliability/availability: this dimension reflects the outcome of the project regarding reliability and availability of the infrastructure or service, which should be a consequence of an adequate framework of incentives towards operational performance, as captured by the respective indicator under the Remuneration Scheme dimension;

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- Governance – commercial risks: this indicator reflects the effects of sharing risks between the private and public parties considering their impact on the project operator behaviour, partly overlapping with the Optimal Operational Performance indicator of the remuneration scheme;
- Business model – Innovation: the possibility for innovation captured by the business model typology could overlap with the Optimal Operational Performance indicator, which should in principle include an incentive to innovations which improve the capability to provide a good service. On the other hand, the innovation factor in the business model refers to innovation with a larger scope than innovation as influenced by income. The indicators may be regarded as partially dependent;
- Business model – Revenue Support: this indicator incorporates the revenue effects provided by the ability to manage demand, which is a way to reduce the income risk. Therefore, this indicator is partly endogenous with the Risk indicators of the remuneration and revenue schemes.

4.5.5 Final observations following the Funding scheme typology model validation

The application of case studies in the model of funding schemes leads to the following main observations:

- The final version of the model and its related guidance notes are sufficiently comprehensive and allow for a parameterization of the model according to the characteristics and data of a variety of cases;
- The model is somewhat flexible to different levels of information on the cases and may be applied for lower or higher levels of information. Better levels of information should lead to better ability of the model to reflect real effects of the funding characteristics on the feasibility and performance factors of the project;
- The scales applied to indicators and dimensions did provide a significant range of variation of cases from ‘negative’ to ‘positive’ influences, indicating that the spectrum covered by the scale and assessment criteria applied is capable of demonstrating the existing diversity across different projects;
- A final evaluation of a project scenario will always depend on the definition of the performance objectives of the project. This implies that the type and quantification of the weighting applied to reflect the contribution of each indicator and sub-dimension to the aggregate score will always depend on the specific objectives of the actor and project in question.

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4.6 Financing scheme typology

4.6.1 Introduction

Following on the basic work on financial scheme in Task 2 (see Deliverable D2.4), a numerical financial indicator variable has been developed in the context of Task 3.1, Matching Framework (see Deliverable D3.2). The validation step 1, preparation of case study snapshots, as well as the preliminary validation analysis, allowed to revisit and validate the financing scheme indicator of the respective typology.

In particular, the comparative relation of equity sources and debt sources was scrutinised and a general revision of the numerical specifications was initiated. However, the general conception and building philosophy of the financial typology indicator was left unchanged and, in fact, reinforced. Moreover, the categories of debt and equity sources described in Deliverables D2.4 and D3.1 were largely left unchanged, including a further refinement of one debt and one equity category.

Finally, while the indicator is the same for both publically funded and privately financed projects, their interpretation should vary depending on the delivery mode. In other words, the low indicator values, which are consistently given to *public projects must not be interpreted in the same way as a low indicator value in some of the private projects*.

In the following section 4.6.2, **the new numerical specification of the financial indicator variable is introduced and explained. S**ection 4.6.3 reports descriptive statistics on the financial indicators of our case study database. Then, in section 4.6.4, results of the validation task for the financial indicator are reported.

4.6.2 Financial indicator: Description and new specification

As was set out in detail in the final report to Task 2, the financial scheme is regarded to reflect the outlook of the investment project as a *business concern*. The higher the financial indicator, the brighter should be the business outlook of the project. The indicator is based on the following general hypotheses.

4.6.2.1 General Hypotheses:

H1 The general constructive hypothesis of the indicator is as follows: A source of finance – i.e. type of financial instrument and of investor typically using this instrument – should get a <u>high indicator parameter</u> if it is well-known and theoretically plausible that this source is rarely chosen for risky, not well-managed projects, or projects that have a bad outlook as a business concern for some other reason. Hence, if such source of finance is observed, it should indicate a good outlook of the project as a business concern.

H2 In consequence <u>sources of debt and equity were ranked</u> in categories as shown in Tables 4.6.1 and 4.6.2 below, where source A should get a higher indicator parameter than B, and so on. Moreover, the relative weight of debt versus equity sources should follow the numerical pattern as shown in the tables. This is the best relative weighting of all sources of finance, which could be conceived of, based on theoretical reasoning, plausibility, and casual empiricism known to the authors.

H3 It is noted that <u>government sources</u> (debt, equity, or plain subsidies) are low-ranked (Table 4.6.3) since, first of all, the government pursues other goals with transport projects than just a business concern and, secondly, the government often has difficulties to install and enforce an efficient management. Note that a debt instrument that is fully backed by

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government guarantees should be evaluated as a government source of finance, since banks granting such credits regard not the project's future cash flow but just the government guarantee as a backing for their credits.

H4 The aggregate financial indicator is the weighted sum of the indicators of its financial sources. Here total finance includes government subsidies if present, i.e. refers to the project's total investment cost. The normalized financial indicator equals the aggregate indicator divided by 5, so that its value is confined to the interval between 0 and 1 (actually its minimum value is 0.2 when considering totally public funded projects).

H5 This whole line of reasoning applies to PPP projects. For purely public projects it would not be expected to see many non-government sources in the first place. Thus, most public projects will have a low value of the financial indicator. However, for public projects no strong correlations of the financial indicators are expected with any other performance or typology indicators. As a consequence, analytical treatments should be separated for PPP and public projects or just confined to the PPP.

Table 4.6.1: Indicator parameters for different sources of finance – equity

Equity Category by Investor		Indicator Value
Equity A	The general public (tradable shares), commercial banks	4
Equity B	Infrastructure funds and private equity funds	3
Equity C	Individual affiliated investors (e.g. contractors, operators and other project sponsors)	2
Equity D	Government	1

Table 4.6.2: Indicator parameters for different sources of finance – debt

Debt Category by Investor		Indicator Value
Debt A	The general public (tradable bonds), other institutional investors (e.g. pension funds, insurance companies, other funds), non-leading banks	5
Debt B	Lead banks	4
Debt C	EIB and other multilateral banks that are mainly self-financing	3
Debt D	National or int'l development banks (e.g. EBRD, KfW in Germany, etc.)	2
Debt E	Government	1

Table 4.6.3: Indicator parameters for different sources of finance – other government sources

Other government categories	Indicator Value
Gov't guaranteed debt	1
Gov't subsidies	1

Aggregate financial indicator: $I = \sum_i a_i * s_i$

where: i = source of finance, a_i = indicator value attached to this source, and s_i = share of this source of total finance.

Normalized financial indicator: $I_{normalized} = I/5$

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4.6.3 Descriptive statistics of the financial indicator

There are 55 cases in the complete database of snapshots containing information about financial indicators and most other indicators or information of interest. Among these, there are 40 PPP cases and 15 public cases. For later reference, these cases are identified and enumerated according to the lists of Tables 4.6.4 and 4.6.5.

Table 4.6.4: PPP cases with ID

ID	Case	ID	Case
1	A-19 Dishforth	21	Liefkenshoek Rail Link
2	A2 Motorway	22	Lusoponte-VG Bridge
3	A22 Motorway	23	Velo_'V
4	A23 Motorway	24	M-25 Orbital
5	Athens International Airport	25	M-45
6	Athens Ring Road	26	M-80 (Haggs)
7	BNRR (M6 Toll)	27	Metro de Malaga
8	Brabo 1	28	Metro de Porto
9	BreBeMi	29	Metrolink LRT, Manchester
10	Central Greece (E65) Motorway	30	Moreas Motorway
11	Central PT Depot of city of Pilsen	31	Piraeus Container Terminal
12	Deurganck dock Lock	32	Quadrante Europa Terminal Gate
13	E39 Orkdalsvegen Public Road	33	Radial 2 Toll Motorway
14	Eje Aeropuerto (M-12) Motorway	34	Reims tramway
15	Elefsina Korinthos Patra Pyrgos Tsakona Motorway	35	Rion-Antirion Bridge
16	FERTAGUS Train	36	Via-Invest Zaventem
17	Herrentunne lLübeck	37	Portof Leixoes
18	Ionia Odos Motorway	38	E18 Muurla-Lohja
19	Larnaca and Paphos International Airports	39	E4 Helsinki-Lahti
20	Larnaca Port and Marina Re-development	40	Port of Sines Terminal XXI

Table 4.6.5: public cases with ID

ID	Case
1	A5 Maribor Pince Motorway
2	Athens Tramway
3	Belgrade By-pass Project, Section A: Batajnica-Dobanovci
4	Berlin Brandenburg Airport (BER)
5	Blanka Tunnel
6	Combiplan Nijverdal
7	Koper-Izola Expressway
8	Tram 4 Lyon
9	Modlin Regional Airport
10	Motorway E-75 Donji
11	Motorway E-75 Horgos
12	MXPT2-Railink-up
13	The Hague New Central Train Station
14	Warsaw's Metro II-nd line
15	Tram-Train Kombilösung Karlsruhe

For each case there are at least two snapshots, in some cases considerably more. However, the financial schemes are constant across different snapshots for 28 PPP and for 12 public cases. In other words, there are changes in financial schemes in only 12 PPP and 3 public cases.

In the validation process carried out, only the most recent (last) snapshot of each case was used (i.e. when there are only two snapshots we looked at the second one; when there are five we looked at the

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fifth one). The last snapshot is most likely to contain both (i) the initial evaluation by investors as expressed by the financial structure and (ii) the ex post performance indicators like cost overrun and time overrun of the construction phase and other.

The following figures show the overall distribution – by means of box plots – of the aggregate financial indicator (Figure 4.6.1) and of the normalized financial indicator (Figure 4.6.2), separately for public (left) and PPP (right) cases.

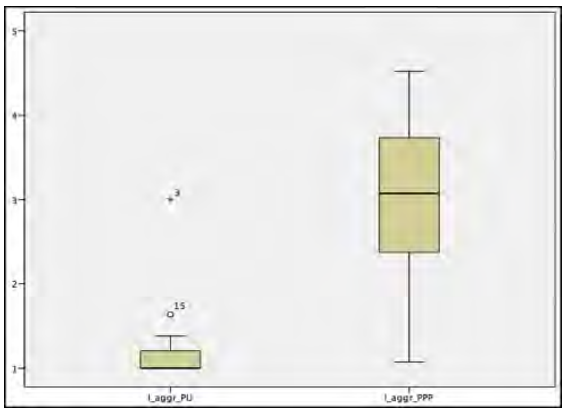

Figure 4.6.1: Graphic representation of the financial scheme indicator values

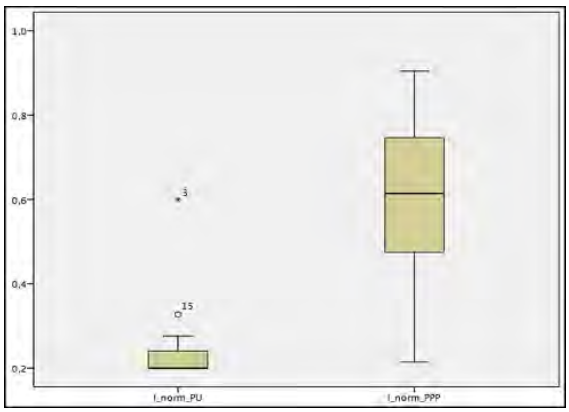

Figure 4.6.2: Graphic representation of the financial scheme indicator normalized values

As expected, indicator values of the public cases (left-hand box plots in both figures) are compressed towards the minimum value, which is 1 in Figure 4.6.1 and 0.2 in Figure 4.6.2. For PPP cases, in contrast, indicator values are well distributed over the whole spans.

This already confirms our basic hypothesis (H5) that only PPP are of interest for detailed analysis concerning the financial indicators.

The following plots, Figure 4.6.3 (a) to (d), show bar diagrams for all 55 cases. Again the difference between PPP and public projects comes out clearly, as the latter have a very high share of “government involvement” (any kind of) and often in the form of government subsidies, while private projects show a mixed picture.

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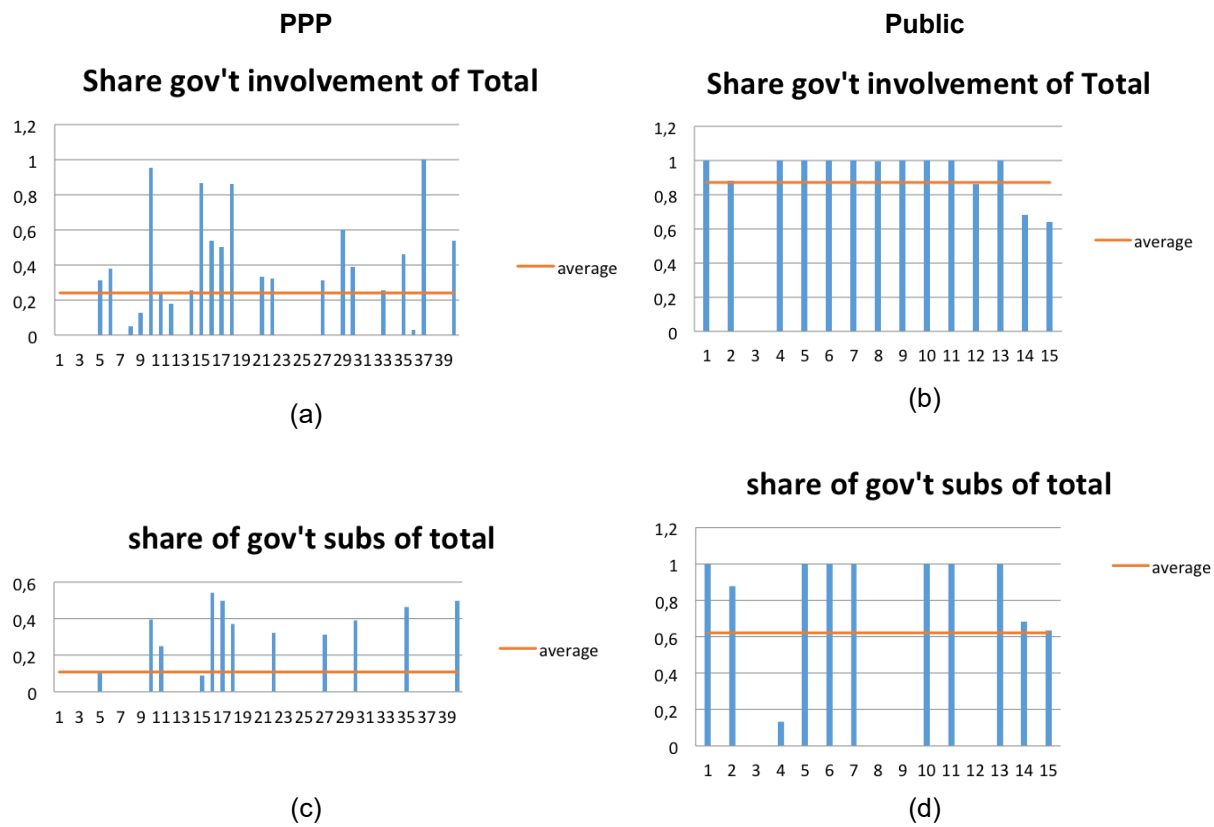

Total = total financial resources (incl. subsidies)
Gov't involvement" = government debt & equity + government guaranteed debt + subsidies

Figure 4.6.3: Government Subsidies and total government involvement: public vs. private

Lastly, only the financial structure of PPP projects was considered. Figure 4.6.4 (a) to (c) shows debt-equity shares of total finance less government subsidies. If near-government sources of debt are included (like government debt, government guaranteed debt, and debt from public development banks), the share of this total debt is about 64% on average. If one focuses just on the private sources of debt, its share is 51% on average. In any case, the variance of private projects' financial structures is considerable.

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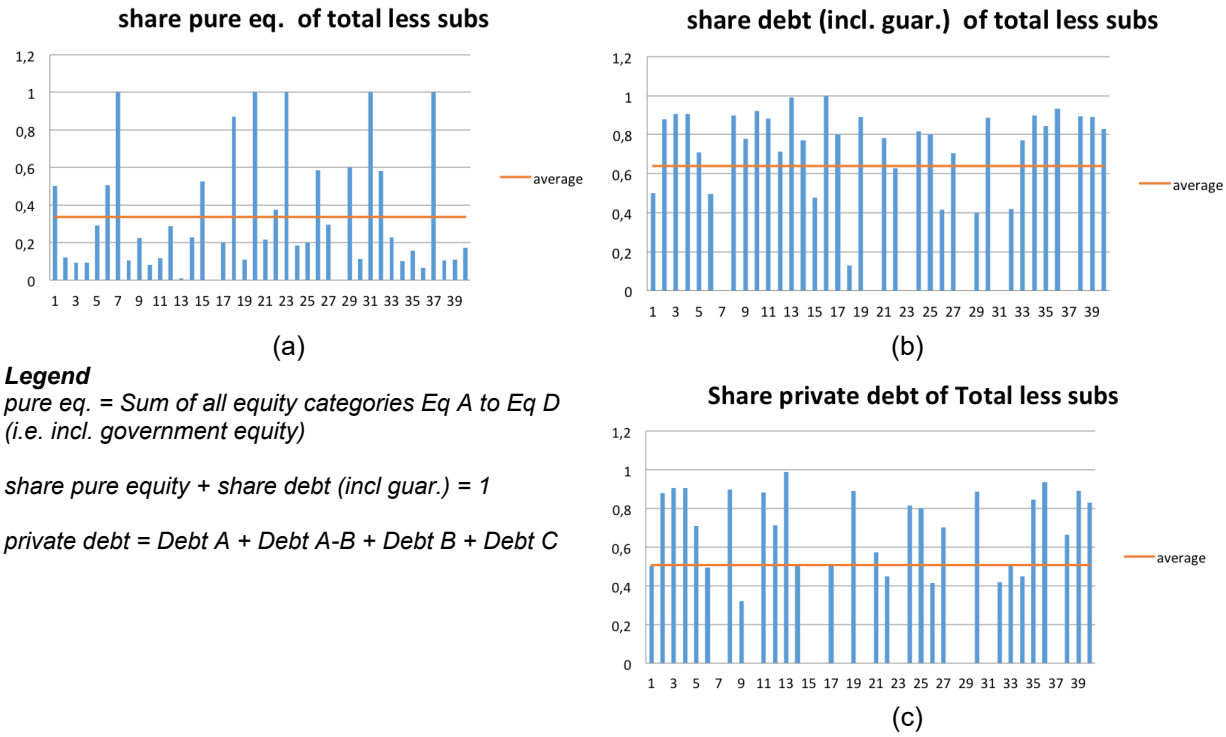

Legend
pure eq. = Sum of all equity categories Eq A to Eq D (i.e. incl. government equity)

share pure equity + share debt (incl guar.) = 1

private debt = Debt A + Debt A-B + Debt B + Debt C

Figure 4.6.4: Financial structure of PPPs (of total finance excluding government subsidies)

4.6.4 Validation of the financial indicator

The validation is confined to PPP projects, and is based on descriptive statistics and inspection of Pearson correlation coefficients. As for all the other typology indicators, the validation was against *performance indicators*. In addition, the relationship of the financial indicator to the *other typology indicators* was also reviewed.

The performance indicators are: cost overrun of construction, time overrun of construction, actual versus forecasted traffic, environmental outcomes, social outcomes, other economic outcomes, and meeting of transport policy goals.

The other typology indicators are:

- Two indicators on institutional and economic environment: (i) institutional setting, (ii) financial and macro-economic environment
- The transport mode indicator reflecting reliability and availability
- The composite governance indicator
- Two business model indicators: (i) cost saving, (ii) revenue support
- Two funding scheme indicators: (i) remuneration scheme, (ii) revenue scheme

In the following, the words "financial indicators" are used to refer either to a single source's indicator parameter or the aggregate indicator that was described in section 4.6.2 above. It is to be noted that, when the aggregated indicator is expected to be positively correlated, then this implies that:

- A single source's indicator that has been given a *high* parameter should also be positively correlated (and particularly strongly so),
- Whereas a single source's indicator that has been given a *low* parameter should be negatively correlated (or, if also positive, only weakly so).

This pattern is in the following referred to as "positive correlation of the financial indicators". With this convention, the following more specific hypotheses on the financial indicator can be stated.

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4.6.4.1 Specific Hypotheses:

H6 Among the *performance indicators*, financial indicators should be positively correlated with (i) absence of cost overrun and (ii) absence of time overrun. In principle it should also be positively correlated with (iii) absence of a large difference between actual and forecasted traffic. But as project managers have more influence on cost and time of construction, rather than on traffic[28], we expect (i) and (ii) to be more pronounced than (iii). Note that, by construction of the performance indicators (0 or 1 meaning absence of the problem, -1 or -2 meaning its presence), a positive correlation should in fact be expected for the aggregated financial indicator. This would imply – by the above reasoning – a fairly strong positive correlation for a single source with a high indicator parameter, but a negative correlation for a single source with a low parameter.

H7 We expect no strong positive correlation of the financial indicators with the other performance indicators (environmental, social, other economic, and transport policy goals), as these are not indicators of success as a *business concern* (might actually be detrimental to it).

H8 Among the *other typology indicators*, the financial indicators should be positively correlated with: institutional and macro-economic environment indicators, the reliability –availability indicator, governance indicators, and business model indicators. At the moment, a strong relationship to the funding scheme indicators is not to be expected, since the latter ones incorporate aspects like marginal cost pricing or public acceptance which are not well related (sometimes detrimental) to the project as a business concern.

4.6.4.2 Evaluation in light of the empirical results:

The Figure of **Annex A.7** shows the Pearson correlation coefficients of the aggregate financial indicator and of the individual financial sources with the performance indicators and the other typology indicators. Yellow and orange cells highlight significant correlations at the 0.01 percent level (yellow cell, two stars), at the 0.05 percent level (yellow cell, one star), and at a level between 0.05 and 0.1 (orange cell). In green non-significant correlations are highlighted, which are in line with the authors' expectations. However, red cells indicate disappointments, in most cases the absence of correlations that have been expected according to the hypotheses.

The following results are in line with expectations:

- There are no strong and significant correlations (yellow or orange cells) that directly contradict any one of the above hypotheses H6 to H8 (with one really minor exception).

- The normalized aggregated indicator shows a significant positive correlation with one relevant performance indicator (time overrun). It is positively affected by positive external conditions.

- Individual sources:
  - Debt A is indicative of time overrun (significant and correct positive sign) and affected by favourable financial and economic conditions (significant and correct sign)
  - Similar could be said about Equity A – but only one project has a positive entry in Equity A at all, so these correlations should be seen sceptically.

[28] This statement refers to road projects in particular, which dominate the database. With respect to airports this might be different, since non-aviation revenues play a dominant part there and may well be affected by proper management. But airports and similar point infrastructures make up only a small portion of our database.

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- Debt C and Equity C are inconclusive (insignificant) with respect to the three relevant performance indicators and with respect to the six relevant typology indicators (see green cells). Similar holds for Debt D. This is what could be expected, since these categories are in the middle between the high ranked indicators (that should show a positive correlation) and the low ones (that should show a negative correlation).

- Debt E (government debt) has, as expected, a significantly negative correlation to all three relevant performance indicators and to the business model indicators.

- Similarly, Government guaranteed debt has a significantly negative correlation to all three relevant performance indicators and to favourable external conditions.

The following results contradict expectation (see red entries in Table in **Annex A.7**):

- The normalized aggregate financial indicator lacks a significant correlation to the performance indicator cost overrun (and to traffic – but that could be expected). Moreover, it is not correlated with the typology indicators for governance and business model.

- Individual sources:
  - Debt A is uncorrelated with the typology indicators governance and business model.

  - Particularly disappointing is the fact that the financing categories mixed Debt A-B and Debt B are completely uninformative (insignificant) with respect to all of the relevant performance and typology indicators listed in Figure A.7.1[29]. This requires further investigation.

  - Equity D, government equity, behaves completely different from government debt and government guaranteed debt. This requires further investigation.

  - The same holds for government subsidy. This could be explained, since many PPPs get a base subsidy such that only the "remaining" business (and need for finance) can be considered as a viable business case. Hence, the hypotheses H3 should be amended concerning the subsidies.

All in all, it is remarkable that of the many source categories (11 in total) only the following ones turn out to be indicative: Debt A (positively correlated), Debt E (negatively correlated), government guaranteed debt (negatively correlated), and Equity A (positively correlated).

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[29] The categories Debt A (commercial non-lead banks) and B (lead banks) have been regarded as bearing a very similar message, and even more so the mixed category Debt A-B. For example, the project partners making the case studies often were quite unsure as to the distinction between lead and non-lead banks, which led to the introduction of the mixed category A-B. However, it turns out that only the category Debt A is informative, while categories A-B and B are completely uninformative.

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4.6.5 Conclusions

The empirical validation exercise of the financial indicator based on Pearson correlation coefficients produced mixed results. On the positive side, there were no strong and significant correlations that would contradict the authors' hypotheses, and a few ones that were in line. On the negative side, many of the relationships, which were expected, could not be confirmed.

Particularly disturbing are the insignificancies, in the sample, of the debt categories A-B and B, which were expected to be especially informative. More generally, of 11 financial source categories only 4 turned out to be significant. In the authors' opinion, this precludes the option to build a financial indicator based only on such source categories, which have shown a significant empirical impact in the sample. That would mean to base the indicator on a very narrow set of financial sources, excluding in particular the ones that are theoretically well-founded.

It is therefore concluded that the proposed financial indicator will be described by the relations proposed in section 4.6.2.

Further research will be devoted to interpret and assess hypotheses in more detail, and probably also in a more disaggregated way in task 4.2.

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4.7 Conclusions on the Validation of the Typology Indicators

Following the development of task 3.1, where the Matching Framework was developed and the typology indicator scoring and calculation were proposed, each case study in the BENEFIT case database was represented through a set of snapshots over time for which the values of the typology indicators were calculated.

This process allowed for the refinement of the typology indicator scoring and configuration, as the process identified shortcomings and indicated the need for improvements. As suggested from the validation presentation, further considerations are suggested to take place in the following tasks.

More specifically, task 4.2 focuses on the financing and funding scheme typologies. The respective indicators may be validated with respect to their respective contributing sub-dimensions, so as the influence of and interrelations with other typology indicators may be identified.

Task 4.3 focuses on the impact of the financial and economic crisis. A project's sensitivity to variations of the implementation context on a national and, possibly, local level should be identified. In combination, the range of the Business Model indicators, which may show resilience to macro-economic fluctuations, should be further investigated.

Through the typology validation process, findings also contributed to lessons learned.

4.7.1 Funding and Financing of Transport Infrastructure – Lessons Learned

4.7.1.1 Cost & Time

The analysis indicated that projects, regardless of financing method, that include bundling of activities (transport and/or commercial) perform better and demonstrate a degree of resilience to macroeconomic changes. The level of control of the infrastructure is a positive factor in this case.

Private co-financed projects are, in principle, awarded to international actors. The capability to construct and operate, when assessed based on the market position of the contractor/operator, does not influence performance in terms of cost to completion and time to completion. However, when the project includes bundling of activities, a clear correlation was found to exist between the capability to construct and achieving cost and time targets.

Within the group of projects incorporating brownfield sections there seems to be a positive influence on the time to completion. This may be a sample specific finding.

Moreover, the investment size based on the analysis carried out, does not influence the achievement of cost and time targets, nor does there seem to be a correlation with respect to the project physical description in terms of node-link and traffic mix.

Finally, it was verified that the combined and optimal implementation of the procurement procedures and contractual arrangements reflected in significant increase in the likelihood of cost and time achievement.

4.7.1.2 Traffic

Undoubtedly, appropriate risk allocation allows projects (both PPP and Public) to perform better, a hypothesis that was validated in the sample of the present analysis. Nevertheless, one of the key observations is that in PPPs, the contracting authorities systematically pass over to the private sector more demand risk than may be controlled, increasing the project's vulnerability to macroeconomic changes, as well as incurring additional risk premium and/or mitigation costs to the public sector. In many cases, revenue support or other mitigation measures are put in place to reduce risk exposure. These cases are, however, also characterised (at least within the specific sample) by restrictions in

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pricing (or prices are set and/or approved by the public authority), reducing thus further the risk control of the private sector. The number of re-negotiations that took place in several such cases is testament to the above risk misallocation. In public delivered infrastructure, most traffic demand risk is appropriately retained by the central state. Only one case entailed a disproportional risk transfer to the operator.

Contracting authorities typically place emphasis on creating exclusivity terms for the project (especially in the case of PPPs), transferring more risk than justifiable to the private sector, ignoring though the impact of network integration, such as missing connections, or other mitigation measures that could potentially surpass the project's exclusivity regarding the level of control.

A considerable number of cases in the BENEFIT database did not perform in line with expectations of traffic demand regardless of the effect of the macroeconomic conditions. Passing traffic demand risk over to the operator/concessionaire tends to also create expectations of larger traffic volumes. Optimism bias was noted in certain cases. In addition:

- When demand/revenue risk is appropriately allocated (PPPs and Public), forecasts seem to be more accurate.
- There is evidence that forecasts for PPPs tend to be more accurate or even conservative when more or appropriate demand/revenue risk is transferred.
- The impact of network integration may be equally or more important with respect to level of control with natural or imposed exclusivity and should be equally considered.
- Public delivered projects could perform equally well as PPPs with an appropriate level of control to the operator and a well-positioned infrastructure in terms of scope, exclusivity and network integration.

In addition, findings indicate that:

- Projects that include the bundling of features supporting revenues were found to correlate with the achievement of traffic forecasts.
- The addition of a brownfield section does not improve the potential of achieving the forecasted traffic. On the contrary, brownfield additions may support optimistic forecasts.
- There seems to be a positive correlation between the indicators describing commercial revenue, common operator and combined transport infrastructure/service operation with the categorisation indicator actual versus forecasted traffic.

4.7.1.3 Revenue

In PPPs, while there is a possibility to differentiate the revenue stream from the repayment scheme, this is usually not applied. A recurring trend in private-public procurement is the use of user charges (31 over 40 cases studied), while the opposite occurs in projects delivered by the public sector (9 over 23 cases studies).

Findings suggest that bearing influence on the supply chain is important, especially when traffic demand is allocated to the operator. However, concessionaires may strategically manipulate this.

4.7.2 Matching Framework and its Typology Indicators – Lessons Learned

Implementation Context Typology

The robustness of the financial economic context and the institutional indicator was demonstrated.

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Transport Mode Context Typology
The reliability – availability indicator was thoroughly tested and found suitable.

Governance Typology
The Governance indicator was validated and adjusted accordingly.

Business Model Typology
Key factors aggregated in the Business Model indicators were examined. In summary, findings are:

- The "level of control", incorporating the scope of the project, the level of exclusivity, the impact of the level of integration on the exclusivity of the infrastructure, was assessed as an important factor in achieving traffic targets.
- Appropriate demand/revenue risk allocation was also found to contribute positively in reaching traffic targets.
- Control over the supply chain is important in achieving traffic targets.
- Capability to construct and operate was only important in cases of bundled activities both for cost and time, as well as for traffic targets.
- The inclusion of a brownfield section improved revenues, but did not add to the resilience of the project.

The indicators were adjusted but did not include corrections for all the above findings (brownfield and contractors capability). They remain for further investigation.

Furthermore, investment size on the overall sample was found not to be an influencing factor. This is in contrast with the findings of Chapter 3 with respect to road projects.

Funding Scheme Typology
Funding scheme indicators were qualitatively assessed. Key questions remain with respect to their correlation with other typology indicators and the inclusion of socially assessed factors, which may also be considered as project outcomes (revenue scheme indicator).

Financing Scheme Typology
The financing scheme indicator was improved with respect to the representation of sources of financing and tested against basic hypotheses. The validation was not conclusive and remains for further investigation. A key issue remains with the discontinuous interpretation of the indicator.

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5 Matching Framework: Assessing the Reality Fit

The chapter reports on the qualitative analysis concerning the "reality fit" assessment of the Matching Framework, based on the snapshots that were developed for individual cases. The case snapshot values are presented along with a descriptive overview in **Annex A.2**.

The assessment is carried out by typology, i.e. Implementation context, transport mode context, governance, business model, funding scheme and financing scheme. The scope of this analysis is twofold:

1. Assessment of the quality of description of the cases based on the indicators. More specifically, the objective is to assess whether the cases may be described sufficiently and adquently by their respective snapshot indicators over time and whether the trend of the indicators presents the project evolution.

2. Assessment of the ability of the Matching Framework to be applied as a framework for ex-post assessment of projects.

The first scope is important in guiding the further analysis and validation of the Matching Framework. The second tests the Matching Framework ability of function as an ex-post assessment tool.

The analysis, as in Chapter 3, is carried out by mode.

5.1 Road Projects in BENEFIT

The assessment of all road cases, except from three Greek cases mentioned in Chapter 3, for which snapshots are available (24 cases), was performed per typology.

5.1.1 Implementation Context

Two indicators are used for the Implementation mode context:

- Institutional context
  - Reflects the political, regulatory and administrative stability of the country
  - Relatively stable - doesn't change much between snapshots
- Macroeconomic and Financial context
  - Varies significantly between different snapshots, particularly in southern European countries, showing a stronger impact of the 2008 financial and economic crisis.

Considering the difference in road projects' performance across north-western and southern European countries, the Implementation Context has been reviewed as a comparison between these two clusters of countries.

All projects that experienced cost overrun, except one, are located in the southern countries cluster (Portugal, Spain, Italy, Slovenia, Serbia and Greece). Similar situations concerning construction delays and traffic overestimation were also mostly present in projects in the South and found only in two projects in northern countries. The min, max and average values of Institutional context indicator and Macroeconomic and Financial Context indicator are significantly lower for this cluster than for the north-western European countries one (Table 5.1.1).

The Institutional context indicator ranges from 0.44 (Serbia) to 0.87 (Finland). Greece has the lowest value of the Macroeconomic and Financial Context indicator (0.358), while the highest corresponds to Norway (0.79).

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Table 5.1.1: The Implementation context indicators values

Indicators	Min	Average	Max
Institutional context			
Southern European Countries	0.44	0.62	0.76
North Western European Countries	0.61	0.79	0.87
Macroeconomic and Financial Context			
Southern European Countries	0.36	0.56	0.68
North Western European Countries	0.63	0.70	0.79

5.1.2 Transport Mode Context

Two indicators are employed to describe quality of service of a new transport project in comparison with the quality of service expected:

- Reliability
- Availability.

The Reliability/Availability (IRA) indicator is equal to 1 for most of the road cases in the BENEFIT database. Out of the 24 cases for which snapshots are available, the IRA indicator has the value of 100% at award time – planning stage - and no change afterwards in the snapshots for 23 cases.

The only road project (apart from three Greek cases for which works were halted in 2010 and were not included in the analysis) that has a change in the Reliability/Availability (IRA) indicator is the Combiplan Nijverdal in the Netherlands, where the IRA indicator decreases from 100% at the time of completion of works (2013) to 50% at the reporting time (2014). The project faced technical problems.

5.1.3 Governance Typology

For the analysis of Governance typology, 10 indicators describing the efficiency/effectiveness of governance and flexibility of contracts have been reviewed and one composite indicator developed.

The Governance composite indicator seems to be influenced by the country context, and is typically constant across all road cases in one country, except for Greece (where it takes values 0.813 and 0.875), UK (with values 0.875 and 0.75), and Serbia (with values 0.313 and 0.438). The indicator value ranges from 0.313 (Serbia) to 0.875 (Greece), as presented in Table 5.1.2. The range of the Governance indicator is much wider for southern European countries, than for the North-Western cluster of countries.

Table 5.1.2: Ranges of Governance indicator for road projects in the BENEFIT database

Governance Indicator	Min	Average	Max
Southern European Countries	0.313	0.60	0.875
North Western European Countries	0.458	0.73	0.875

All projects in north-western European countries (mostly successful, except from the Combiplan Nijverdal), have high values for the Governance indicator, ranging between 0.722 and 0.875. Both Finnish cases, the Norwegian case (E39 Orkdalsvegen Public Road) and the Polish case (A2 Motorway) have the value for Governance indicator of 0.750. Road projects in the UK have the highest average value for the Governance indicator; the value is 0.75 for two cases, and 0.875 for the other two.

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The lowest values of Governance indicators are present for two cases in Serbia (0.313), while Belgrade Bypass has the higher value of 0.438. Both projects in Portugal have value of 0.688 and four projects in Spain 0.625, although M-45 depicts much better performance than others. For projects in Greece, the values are quite high, ranging from 0.813 for Moreas motorway, to 0.875 for Attiki Odos. The high values of Governance indicator for these two projects may explain their performance, especially considering the performance of the Moreas project, which was awarded at the same time as the other three Greek cases hit by the financial crisis during construction. The values in Serbia are so low because only three out of the eight Governance sub-indicators have values other than zero (G3- Encouragement of competition between bidders; G5 -The key service providers [contractor] to pay a penalty if completion dates were not met; G6. The key service providers [contractor] solely carried the risk of rising costs (G5 and G6 are combined in one sub-indicator) and G8- Bonding requirements). In cases where the value of the Governance indicator has the highest value (0.875), this means that 7 of 8 sub-indicators have the value of one (max value).

Road projects also mostly do not show change in the Governance composite indicator across snapshots. The only change is noticed in the Combiplan Nijverdal, which is a public road/rail project in the Netherlands. In that project, there is a change from the Governance composite indicator value 0.458 at completion of works (2013), to reporting time (2014), when it takes the value of 0.375. The change is due to the decrease of G1/G2, G3, G4, G5/G6 and G10 indicators from 0.67 to 0.50, while G8 (Bonding requirements) increased from 0.33 to 0.50 (Table 5.1.3).

Table 5.1.3: The change in the Governance indicator for Combiplan Nijverdal project

Governance indicators	Snapshot 3	Snapshot 4
G1.The client selected only one service provider [bidder] to participate in the pricing stage	0.67	0.50
G2.The client and the key service providers [bidders] collectively estimated the expected project cost		
G3.Encouragement of competition between bidders	0.67	0.50
G4.Integration of design and construction	0.67	0.50
G5.The key service providers [contractor] to pay a penalty if completion dates were not met	0.67	0.50
G6.The key service providers [contractor] solely carried the risk of rising costs		
G7. Bonding requirements	0.33	0.50
G8. Commercial/revenue & financial risks are not concentrated	0.00	0.00
G9. Clauses enable updating of service and/or price changes	0.67	0.50
G10. Clauses indicate that client has an option to terminate the agreement without cause	0.00	0.00
Overall Composite Indicator	0.46	0.38

It is interesting to note that whenever a value of the indicator was 0.75, projects were successful according to all four criteria (Cost and Time to completion, traffic and transport goals). This is noticed in six projects in north-western countries, i.e. both projects in Finland, E39 Orkdalsvegen Public Road in Norway, A2 Motorway in Poland, M80 Haggs and A19 Dishforth to Tyne Tunnel in the UK.

5.1.4 Business Model Typology

The Business model (BM) typology consists of two parts:

- Cost saving – project's ability to keep cost under control in construction and operation phases and the degree of innovation of the project

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- Revenue support – project's ability to optimize and secure revenues

Both BM typology indicators for road projects were considered at the award time, and then, in cases where there was a change during operation.

The Cost saving (CS) indicator is significantly higher for projects in North Western European countries, ranging from 0.3 to 1.0, the average being 0.65, compared to southern countries where the CS indicator ranges between -0.09 and 0.926, and has an average value of 0.37 (Table 5.1.4). The CS indicator shows different trends mostly on well performing cases in the North Western countries, but also for projects in Southern countries.

For the Norwegian project E-39, the CS indicator is constant and equal to 1. However, for two cases in Finland and three in the UK that are all well performing, there is a drop in the CS indicator during the operational phase, which can be explained by the change in ownership structure and financial crisis.

In the case of the Slovenian A5 Maribor - Pince Motorway (that is well performing according to all four outcomes), the CS indicator rises from 0.263 to 0.500 between inauguration in 2008 and reporting time in 2014.

Table 5.1.4: The ranges of Business models indicators

Indicators	Min	Average	Max
Cost saving Indicator			
Southern European Countries	-0.09	0.37	0.926
North Western European Countries	0.297	0.65	1.00
Revenue Support Indicator			
Southern European Countries	0.001	0.05	0.14
North Western European Countries	0.002	0.05	0.111

Regarding four Spanish cases, there is a significant drop in the CS indicator between snapshots. The example is project C-16 (delivered on budget, but delayed, and not achieving expected traffic and transport goals), for which a big drop in the CS indicator has been noticed, from the start of operation in 1990 (0.622) to reporting time (0.150). The project was struggling with traffic levels from its opening and went through several renegotiations and adjustment of toll rates, as well as the length of the concession period.

The only well performing project in Greece (Atiki Odos) shows increase in the CS indicator from 0.387 to 0.82. This is due to the fact that capability to construct (X2 sub-indicator) has risen (from 0,475 to 0,500).

The Revenue Support (RS) indicator has the same average value for both clusters of countries, but wider range (lower minimum and higher maximum values) in Southern countries, compared to North Western countries. The RS indicator is generally very low (0.05), almost identical and fairly constant for all cases, which shows a general inability of road projects to generate other revenues. This was also identified in the review of business models across infrastructure modes.

5.1.5 Funding Scheme Typology

The funding model typology contains two indicators:

- Remuneration indicator (for PPP projects only) – that describes the project's ability to pay the concessionaire.
- Revenue indicator – that describes the project's ability to generate revenues.

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For PPP road projects the revenue is typically generated through user charges. Two typical schemes are identified: (i) the concessionaire directly collects tolls, and (ii) tolls are collected by the Contracting authority, which remunerates the concessionaire through shadow tolls or availability payments (as in the case of projects in Portugal and Poland).

Public road projects may generate revenue through user charges (either tolls or vignettes), or their use may be free for users (non-tolled roads).

Traffic is very sensitive to user charges, which is confirmed in the cases in the BENEFIT database. All PPP projects with availability fee or shadow tolls perform either “In line with forecast” or “Exceeding” traffic forecast. For some projects (i.e BNRR), user aversion to pay tolls led to lower traffic than expected.

Figure 5.1.1 presents the values of the remuneration scheme indicator versus actual traffic in comparison to the forecasted one. The remuneration scheme indicator takes values between 0.5 and 1.0 for PPP projects that have traffic in line or exceeding forecast, while for PPP projects that had traffic below or far below forecasted the remuneration indicator takes values form 0.17 to 0.67. There is also, as expected, significant difference between median values for PPP projects that have traffic in line or exceeding forecast, and PPP projects that had traffic below or far below forecasted, 0.67 and 0.24, respectively. Public projects that have traffic in line or exceeding forecast have a single value for the remuneration indicator, 0.5, while the value of the indicator for Public projects that had traffic below or far below forecasted ranges between 0.5 and 0.83. The median value is the same for both types of projects i.e. 0.5.

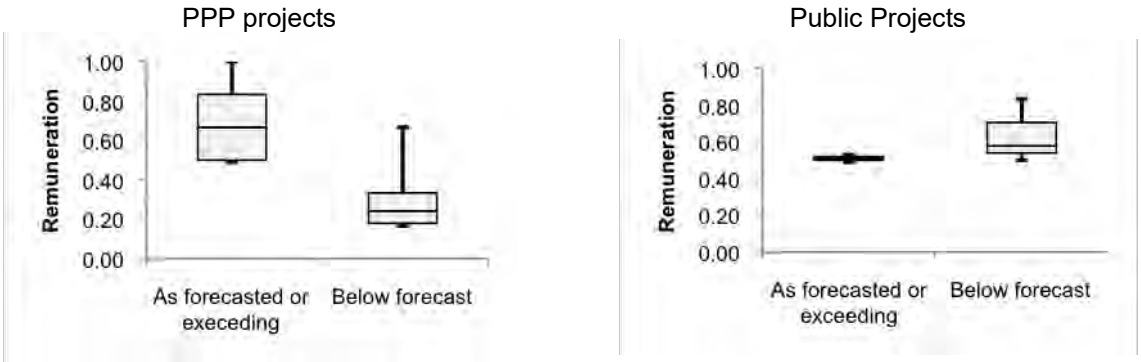

Figure 5.1.1: Remuneration scheme indicator vs traffic forecast

Figure 5.1.2 presents the revenue indicator versus the three project outcome variables: cost, time and traffic forecast.

The following observations may be made:

- *Cost overrun vs. revenue scheme indicator:* PPP projects delivered on budget and PPP projects that have cost overrun have similar ranges of revenue scheme indicator value. However, the median is significantly higher for revenue indicator for projects over budget. Public projects without and public projects with cost overrun have similar ranges of revenue indicator value. However, the median is significantly lower for the revenue scheme indicator for projects with cost overrun.

- *Time overrun vs. revenue scheme indicator:* PPP projects delivered on time and PPP projects that have been delayed have similar ranges of revenue indicator values, however, the median is significantly higher for the revenue indicator for delayed projects. Public projects delivered on time have a single value for the revenue scheme indicator, i.e. 0.78, while the value of the indicator for delayed project ranges between 0.08 and 0.78, with the median value of 0.51.

- *Traffic forecast vs. revenue scheme indicator:* PPP projects that have traffic in line or exceeding forecast and PPP projects that had traffic below or far below forecasted have similar ranges of

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revenue indicator values, however, the median is significantly higher for the revenue indicator of optimistically forecasted projects. The revenue indicator takes values between 0.51 and 0.78 for PPP projects that have traffic in line of exceeding forecast, while for Public projects that had traffic below or far below forecasted the revenue index takes values from 0.08 to 0.58. There is also significant difference between median values for Public projects that have traffic in line of exceeding forecast, and PPP projects that had traffic below or far below forecasted, 0.78 and 0.13, respectively.

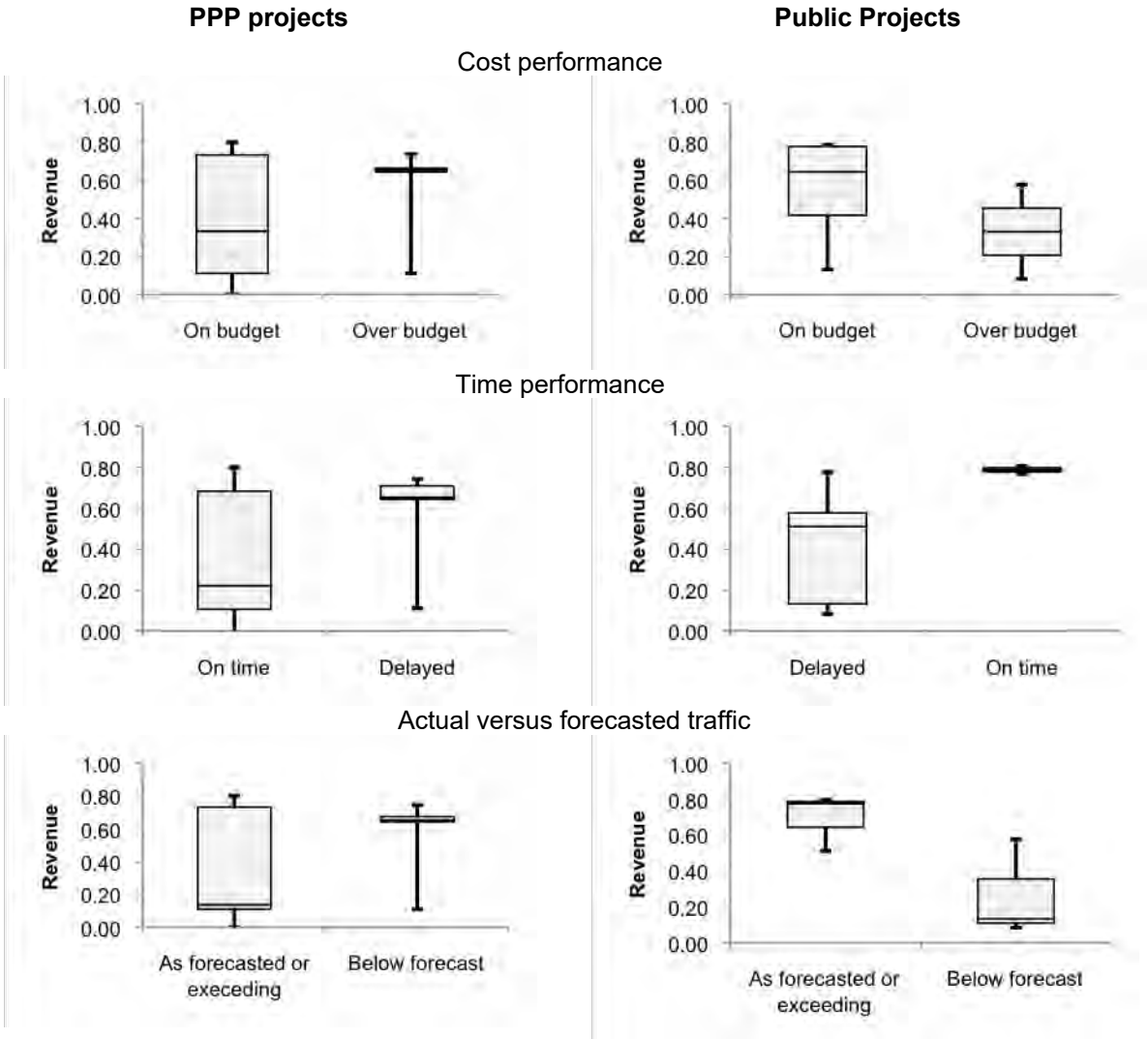

Figure 5.1.2: Revenue Scheme indicator vs various outcome variables

5.1.6 Financing Scheme Typology

The financing scheme typology aims at assessing the financing of the construction of the project.

The Financing Scheme indicator is available for 18 PPP and for 6 public road cases. The indicator ranges between 0.454 and 0.904 and between 0.2 and 0.6, for PPP and public projects, respectively. For five out of six public projects the Financing Scheme indicator is equal to 0.2, while for the Belgrade Bypass project in Serbia it is equal to 0.6, since the project is financed by European banks.

The Financing Scheme indicator is constant over the operation phase for all public and for 13 out of 18 PPP cases. For the remaining PPP cases (Radial 2 motorway, Eje Aeropuerto and C-16 Terrassa-

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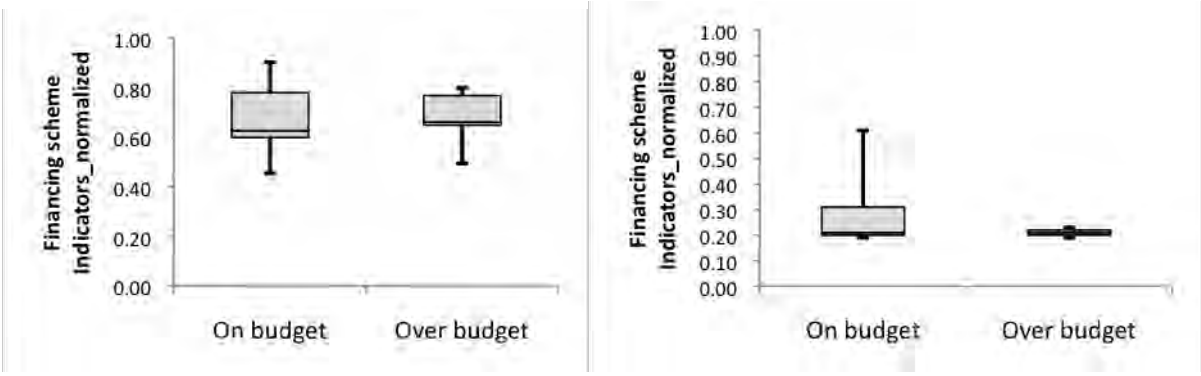
Manresa Toll Motorway in Spain, Moreas Motorway in Greece, and BNRR (M6 TOLL) in the UK), the financing scheme indicator is decreasing to lower values through snapshots, indicating more government contribution and support to the projects.

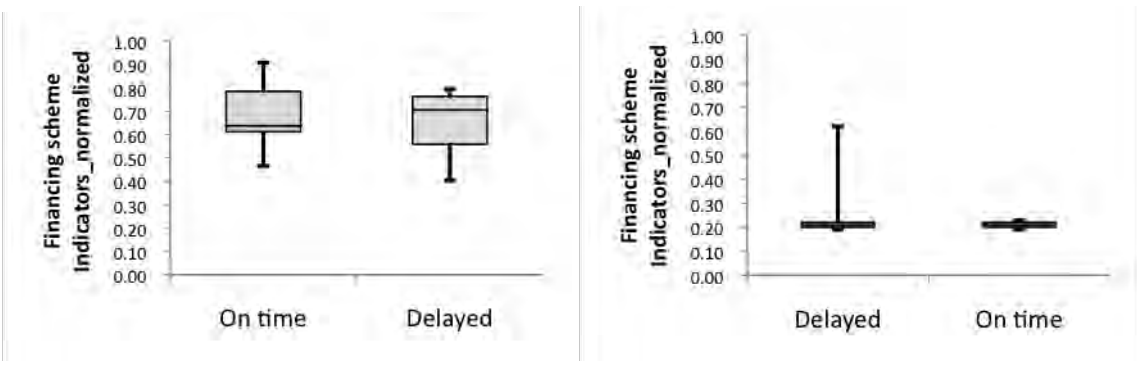
Most of the PPP road projects in the BENEFIT database were financed without government subsidy (except projects in Greece, and the phase II of the Istrian Y in Croatia). Government subsidy for projects in Greece ranges between 27 and 32%, and has changed as a result of renegotiation for these projects.

The financing scheme indicator is generally lower for public projects, than for PPP projects, as presented in Figure 5.1.3. However, the values for projects that were constructed on budget and that had cost overrun are relatively similar and it is not possible to differentiate these two groups of projects based on the Financing scheme indicator.



a) PPP projects b) Public projects

Figure 5.1.3: Financing scheme indicator versus cost performance of PPP and public road projects



a) PPP projects b) Public projects

Figure 5.1.4: Financing scheme indicator versus time performance of PPP and public road projects

Similarly to cost performance, time performance also cannot be differentiated through the Financing scheme indicator, as presented in Figure 5.1.4. However, the range of values for public projects that were delayed is wider towards higher values of the indicator.

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Figure 5.1.5 presents the range of values of the Financing scheme indicator for projects that had traffic as expected or exceeding, and for projects that had overestimated traffic. The values of the Financing scheme indicator are slightly lower and have wider range for PPP cases that have overestimated traffic, compared to PPP cases with traffic as expected or above expectations. Wider range, but also higher values of the Financing scheme indicator are observed for Public cases with traffic below forecasted, compared to Public cases with traffic as expected.

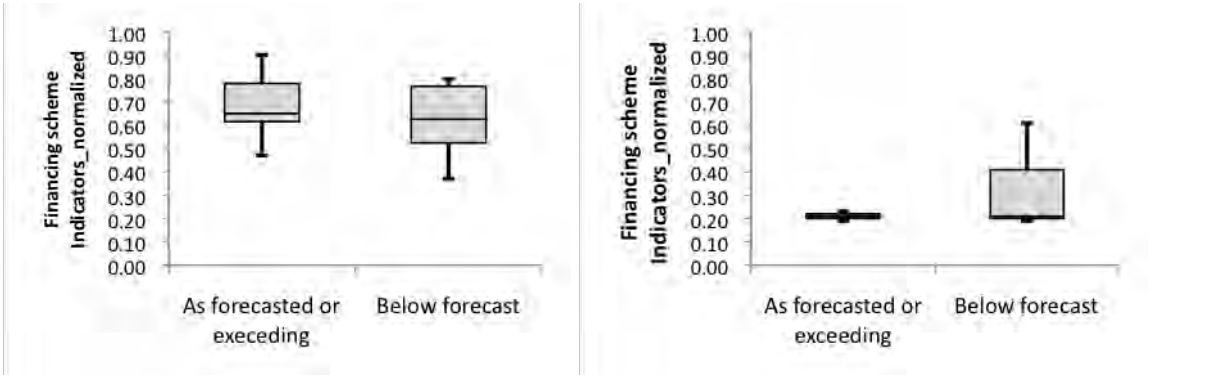

Figure 5.1.5: Financing scheme indicator versus traffic forecast

Finally, Figure 5.1.6 provides the comparison of percentage of debt versus project outcomes. PPP projects that have experienced cost overrun have had Total Debt greater than 69%, while PPP projects delivered on budget have a range of debt from 0 to 99 %, with a median value of 65%. However, the value of total debt did not show any influence on the outcome of time overrun nor traffic forecasting.

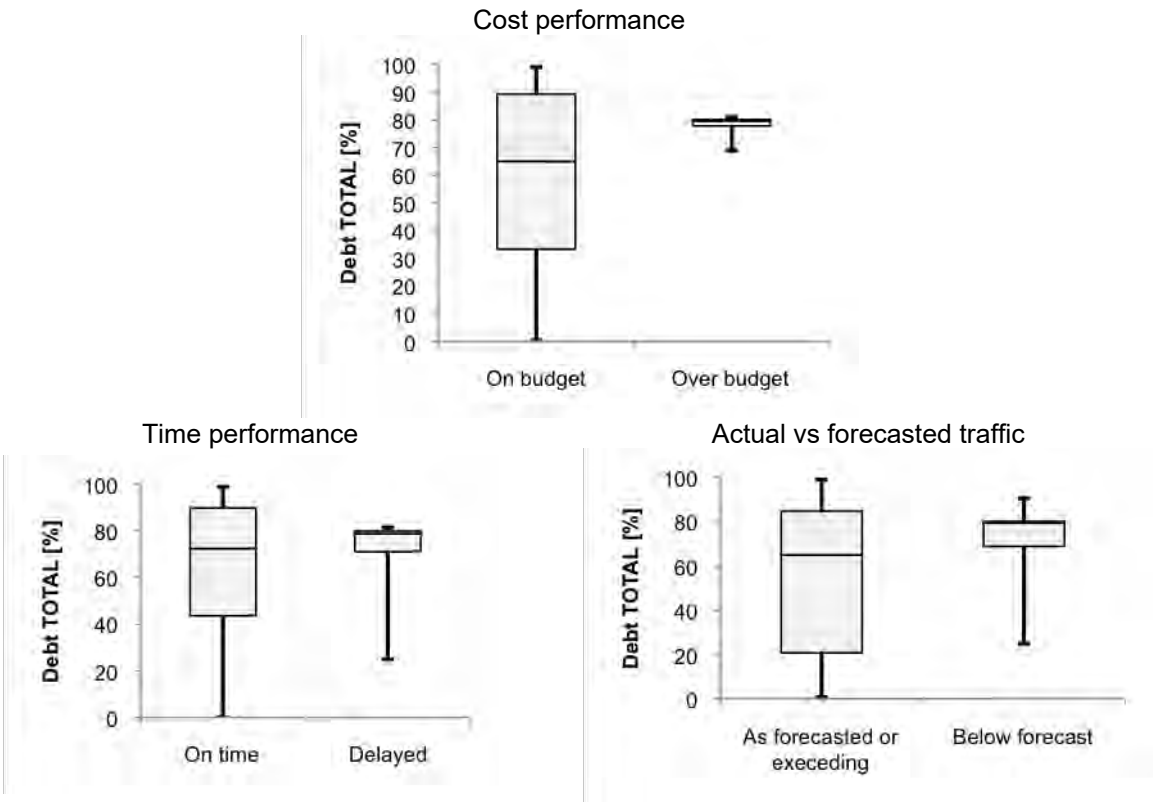

Figure 5.1.6: Total debt for PPP projects vs various outcome variables

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5.1.7 Summary of findings

Both Implementation context indicators, Institutional Context and Macroeconomic and Financial Context indicators, are much lower for southern European countries, where most projects having cost and time overrun are located. The lower values of Institutional Context indicator show weaknesses in the political, regulatory and administrative stability of these countries compared to north-western countries, while generally lower values of Macroeconomic and Financial context indicator show the greater impact of the global financial crisis in these countries.

The Reliability/Availability (IRA) indicator is equal to 1 for all except one case in the BENEFIT database that were used in the analysis, generally showing that road projects, either greenfield or brownfield are reliable and available to users. The only project that had decrease in the IRA indicator was the Combiplan Nijverdal, where opening to traffic was delayed due to technical difficulties in tunnel construction.

The Governance composite indicator seems to be influenced by the country context, and is typically constant or varies within relatively narrow ranges across all road cases in one country. All projects in north-western European countries (mostly successful, except from the Combiplan Nijverdal), have high values for the Governance indicator. The value of the Governance indicator in southern countries ranges from low values in Serbia, to high value for the Attiki Odos case, which is considered a successful project in Greece, meaning that the governance indicator was able to show the difference between well performing and poor performing projects.

The average value of the Cost saving (CS) indicator is significantly higher for projects in north-western European countries compared to southern countries. However, for several well performing cases in Finland and UK there was a drop in the CS indicator during the operational phase, which can be explained by the change in ownership structure and financial crisis. For the C-16 project in Spain the CS indicator has decreased during the operational phase as a result of problems related to traffic levels that lead to several renegotiations. On the other side, the CS indicator increased during operation for the only well performing project in Greece (Attiki Odos).

The Revenue Support (RS) indicator has the same average value for both clusters of countries, but wider range (lower minimum and higher maximum values) in Southern countries, compared to North Western countries. The RS indicator is generally very low (0.05), almost identical and fairly constant for all cases, which shows a general inability of road projects to generate other revenues.

The values of the Remuneration indicator for well performing PPP projects were higher than for poor performing ones, indicating higher project's ability to pay the concessionaire.

On the other side, the revenue indicator, that describes the project's ability to generate revenues, has contradictory values. For PPP projects, it is generally lower for well performing projects compared to poor performing ones. For public projects, higher values of revenue indicator indicate that these projects are better performing in terms of cost and traffic, but more poorly in terms of time.

The Financing scheme indicator is generally lower for public projects, indicating better capability of PPP projects to attract private financing. However, it was not possible to differentiate well performing from poor performing projects in the context of cost and time overrun, based on the Financing scheme indicator. For most of the projects it is constant over time, but for three projects in Spain, one in Greece and one in the UK it is decreasing over time, indicating more government contribution and support needed for the projects. The value of total debt doesn't seem to influence the outcome of the projects.

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5.2 Urban Transit Projects in BENEFIT

5.2.1 Implementation context typology

The implementation context typology includes two indicators: an institutional context indicator and a macroeconomic and financial context indicator.

The first indicator reflects the political, regulatory and administrative stability of the country in which the transport project is being developed. Over the time periods analysed, the indicators are relatively stable from one snapshot to the next. This indicator varies from 0.63 for Poland in 2009 to 0.83 for the UK in 2000.

As part of the qualitative analysis, the impact of the institutional context is not easy to identify, except for the Málaga metro project, which defines electoral cycles as one of the causes of contract renegotiation. In other cases, regulatory changes, disagreements between administrations or renewal of elected representatives do not seem to have had any significant impact on project success.

One possible explanation for the low impact of this indicator is probably the relative brevity of urban transport projects. While road or rail projects can span across decades (and hence may be faced with notable institutional changes), urban projects are examined over a time period of ten years at the most[30].

The second indicator reflects the economic context in which these transport projects are carried out. This indicator varies significantly between different snapshots particularly in the case of southern European countries, showing a stronger impact of the 2008 economic crisis on their economies. In a more qualitative analysis of the projects, the economic crisis is rarely mentioned as a parameter that has limited the success of projects.

Three cases should, however, be mentioned:

- The Athens tramway, where the economic crisis, linked to the application of high fares, led to a sharp drop in terms of rate of frequentation. This drop went hand in hand with a decrease in advertising revenues;
- The Brabo 1 tram project, for which the crisis limited candidates' ability to submit their financial offer in time;
- The Sevici bike sharing project, for which the crisis limited the advertising revenue of the private concession holder and required fares to be renegotiated.

Generally, ridership in urban transport seems to be less impacted by the economic crisis than other modes (such as freight for example). **With the exception of the Athens tramway, no cases depict a strong link between economic crisis and ridership.**

On the contrary, advertising revenues are very dependent on the general consumption level.

5.2.2 Transport mode typology

The transport mode typology includes two indicators that aim at describing the quality of service offered by the new transport project in comparison with the quality of service expected:

- reliability of the transport service: in the field of public transport, reliability is understood as the number of missions arriving on time;
- availability of transport service: in the field of public transport, availability refers to the time of day and the time of year when the service is accessible to users.

[30] Snapshots of the Manchester Metrolink project range from 1989 to 2014 (25 years), but this was for three consecutive projects.

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In most cases (9 out of 13), the reliability indicator is at the maximum (1). In other cases, the quality of service does not reach the goals set because of:

- purely technical difficulties (rolling stock malfunction in the case of the Caen TVR);
- a rolling stock fleet smaller than expected (Athens tramway);
- difficulties in funding operating expenses that result in the deterioration of service by the operator (Reims tramway).

The indicators of this typology appear to be relatively independent of the construction conditions: projects that featured complex constructions like the Warsaw Metro ultimately displayed a quality of service consistent with the initial goals. Conversely, a project such as the Reims tramway, is encountering significant operating difficulties, whereas there were no particular obstacles standing in the way of its construction.

5.2.3 Governance typology

Governance typology includes 10 indicators describing efficiency/effectiveness of governance and flexibility of the contract.

If funding scheme or financing scheme typologies bring a sense of the wholeness of the project, this indicator rather has to be analysed contract by contract insofar as the overall indicator is an average of the different contracts.

With the exception of two case studies, this indicator does not vary from one snapshot to another. Generally, values are close to 0.6 and do not seem to be very useful to differentiate the public transport projects.

In fact, contracts are assessed one time, at the end of the tendering procedure, and are considered as unmodified for the rest of the project.

However, the case studies analysis highlights differences between initial contract and reality, even if these differences are not necessary added to the contract. On this point, G5 and G9 indicators are very symptomatic of this gap between theory and reality. These indicators focus on:

- the existence of penalties if completion dates were not met;
- the sharing of exploitation and commercial risks.

On the first point, most contracts include a penalty for delay in construction. However, except for the Athens tramway case, we do not find urban transport cases where such penalties seem to have really been implemented (and have shown their effectiveness). On the contrary, in the case of projects facing up severe delays in construction like the Malaga metro or the Sul do Tejo tramway, additional costs due to delays have solely been born by the contracting authority.

With regard to the second element, in the case of projects operated by a private partner (DBOM or OM contracts), contracts include a commercial/operation risk sharing (or a risk solely born by the operator). In reality, this sharing does not seem to be implemented when these projects are facing real difficulties (cases of Reims tramway, Porto Metro…).

In these situations, the contracting authority has to compensate the gap between fare revenues expected and fare revenues observed with a higher public subvention.

So, the governance typology is often filled in with a very theoretical view of the relationship between constructor/operator and contracting authority. This typology gives the impression that the relationship does not change during the life of the project, when the main part of the BENEFIT case studies shows that adaptations have been necessary.

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5.2.4 Business Model typology

The business model typology consists of two parts: cost saving and revenue support indicators.

Cost saving

This part of the business model illustrates the project's ability to keep its costs under control in relation to the construction phase, the operating phase and the degree of innovation of the project.

The values of this indicator are very different from one project to another and vary for the same project, in 6 out of 13 cases.

It can be seen that projects like Brabo 1 or Manchester Metrolink, which have good results in this aspect, have high levels of cost saving.

Two criteria considered in this typology, however, require a more detailed qualitative analysis:

- a criterion assessing the ability of private partners to carry out their mission (capacity criterion);
- a criterion taking into account the allocation of risk to private partners.

Firstly, the high ability of private partners to build/operate the project does not seem to be able to explain the difficulties encountered. Two examples illustrate this point:

- In the case of the Athens tramway, the rolling stock contract holder has a high ability to carry out the contract (0.83). But this contract is a real failure (delivery not compliant with expectations and four years late).
- In the case of the Reims tramway, the first years of network operation are considered as being disastrous by the public transport authority, while the chosen operator (Transdev) has a high level of expertise.

In the specific case of operational phase, the level of expertise of private partners should not be analysed as intrinsic data but considered in assessing the quality of cooperation between contracting authority and concessionaire. In Reims, difficulties encountered during the operational phase can mainly be explained by the poor quality of this relationship.

About risk sharing, a high cost saving indicator requires both that the constructor/operator have a high level of expertise and that risk be allocated to those partners. For projects managed by the contracting authority, the construction risk often remains in the hands of the contracting owner, which does not necessarily mean that construction costs are not kept under control (the Lyon T4 tramway has a low cost saving indicator, whereas the construction process did not encounter any obstacles).

More broadly, risk sharing is often dealt with in a binary manner using 0/1 indicators, where 1 means that the risk is borne by the constructor/operator when the constructor/operator has the capability to construct/operate.

The qualitative analysis conducted on 13 urban transport cases shows that the question of risk allocation is tricky to assess. In fact, risk allocation provided for in the contracts is hardly ever observed in practice. The contracting authority adapts the level of subsidies (during both construction and operational phases), independently of risk sharing. So the typology partially fails to take into account these changes in the actual allocation of risk during the project lifetime.

5.2.4.1 Revenue support

Revenue Support reflects the project's ability to optimize and secure revenue. Four types of revenue are taken into account by this indicator: revenue from the Greenfield part of the project, revenue from the Brownfield part of the project, revenue from other transport activities and revenue from activities other than transport.

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In the case of the 13 urban transport projects, this indicator is rather low (maximum 0.12). This low score can be explained by the characteristics of urban public transport.
So, the projects examined:

- are considered as new infrastructure (100% Greenfield);
- are only rarely combined with other investments;
- primarily generate revenue from transport. Only advertising revenue can be considered as being outside of this field. With the exception of a few projects (the Athens tramway and the Velo'V and Sevici bike sharing projects), these revenues are very limited.

A low score on this indicator therefore does not reflect the inability of urban projects to generate a steady revenue stream, but to generate only one type of revenue.

5.2.5 Funding scheme typology

The funding scheme typology includes two parts:

- The remuneration scheme, used to evaluate the project's ability to pay its concessionaire;
- The revenue scheme, used to assess the project's ability to generate financial revenues.

Public transport projects of the tram or metro type generate two types of revenues: user charges and advertising revenues. In all cases (except the Lyon Velo'V project), these two forms of revenues are at best sufficient to cover operating costs. Revenue generated is therefore (directly or indirectly) a part of the concessionaire's remuneration (generally with a public subsidy from the public transport authority which aims at balancing operating costs and operating revenues). The revenue scheme is therefore here only a part of the remuneration scheme.

For each snapshot, the level of the overall indicator is mainly dependent on the percentage of each type of revenues and the risk associated with collecting such revenues (a government subsidy being considered "less risky" than an equivalent share of user charges).

The funding schemes of the projects examined vary in most cases between the design phase and the operational phase. While these changes give rise to many variations in the funding scheme typology indicators, these variations are often counter-intuitive.

For example, in the case of the Athens tramway, the remuneration scheme indicator is higher for Snapshot n°4 than for Snapshot n°5, whereas the funding scheme of the project has deteriorated (in Snapshot n°5, the remuneration scheme needs to include 10% of public subsidy because the operator was unable to cover its operation costs only with its commercial revenues).

So a project will generally get better marks in the case of mixed funding including commercial revenues and public subsidy than in the case of funding based solely on commercial revenues.

However, in practice, the move from funding secured exclusively by commercial revenues to funding that includes a public subsidy indicates a project malfunction (the latter has not been able to obtain funding as planned).

The snapshots have the drawback here of evaluating a funding scheme at a given moment in time. Actually, the success (or the failure) of a funding scheme has to be assessed over time and primarily via a comparison between planned funding scheme and funding scheme observed (which describes the ability of the project to apply the planned funding scheme).

Moreover, the study sample analysed includes both DBOM-type contracts and contracts that separate construction and operation. This distinction makes it difficult to compare these indicators across projects. This is because:

- In the case of separate contracts, particularly for projects whose construction phase funding is exclusively public, the remuneration of the concessionaire or coverage of project costs is often limited to operating expenses. This explains why some projects (like the Manchester Metrolink

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or the Athens tramway) have cost coverage ratios close to 100% with only commercial revenues.

- For DBOM contracts, the concessionaire's remuneration includes both construction costs (debt repayment) and operating costs. The cost coverage of a project by commercial revenues is low (approximately 19% for the Reims tramway).

Therefore, a comparison between these two types of projects makes no sense.

5.2.6 Financing scheme typology

The financing scheme typology aims at assessing the financing of the construction of the project. Not surprisingly, projects which have to face changing construction costs, show variations in their financing scheme indicators:

- In the case of the Malaga Metro, the indicator decreases from 0,334 to 0,296 due to the increases of public debt and public equity;
- In the case of Karlsruhe tram-train, the indicator increases from 0,173 to 0,215 due to the increases of public equity and private debt.

We observe that case studies have different debt levels (Figure 5.2.1). On the whole, projects financed through PPP show debt levels much higher than publicly financed projects. In fact, in most cases, the private concessionaire contributes to the financing scheme through debt.

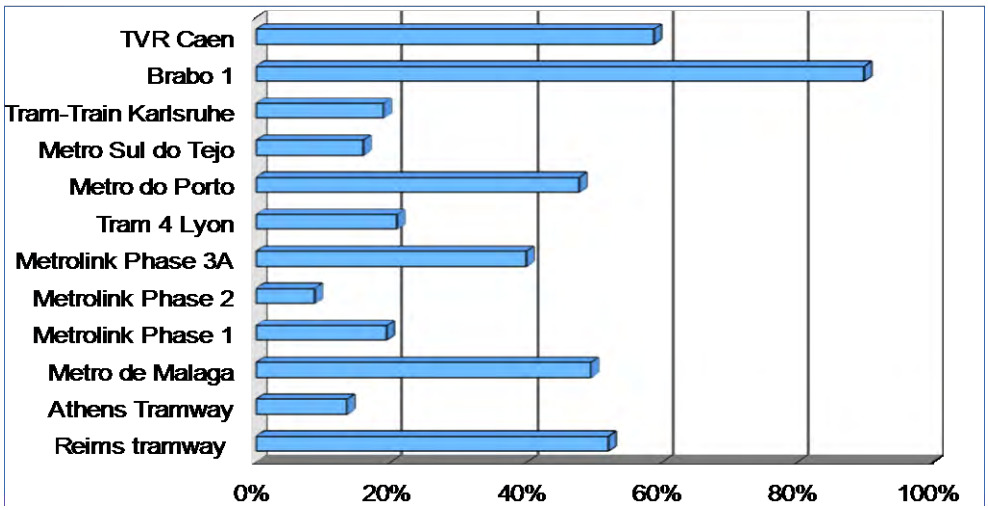

Figure 5.2.1: Share of debt project by project at the contract award

This observation has to be moderate: division between debt and equity is difficult to make for public subventions. In fact, loans for a local authority or for a State are not taken on a project by project basis, but generally. So, in the cases of publicly financed projects, public subventions are often considered as equity, while public sponsors probably have to bear loans.

The level of the financing scheme indicator seems directly linked to the level of debt. In short, a high percentage of debt in the overall budget of the project leads to a high financing scheme indicator. This choice assumes that the concessionaire's debt mirrors its involvement in the project.

This assumption can be checked in some cases (the financing scheme of Manchester Metrolink Phase 1 was criticised because the concessionaire only contributed to the project with a small amount of equity). However, in practice, a high level of private debt for a public transport project implies an important risk for the project. As our sample shows, public transport projects have to deal with a delicate financial balance. In a case of private concessionaire bearing an important private debt, the reimbursement of debt is achieved through two types of revenues:

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- Commercial revenues (which, at best, are enough to meet the operation costs);
- Public subventions, which include, in this situation, a type of usage payment or availability fees (Brabo 1, Malaga Metro…).

So, if these projects met difficulties during the operation phase (for example, commercial revenues below expectations), these difficulties have consequences on both construction and operation phases. This situation has been met in the case of Reims tramway: the relationship between the private operator and contracting authority was not sufficient to solve the operating difficulties of the public transport network (as it usually does). A renegotiation with involvement of the whole private consortium was necessary, which took time and lead to a reconsideration of the financing scheme, which was not necessary at that moment.

5.2.7 Summary of Findings

In conclusion, two elements seem very specific to urban transport projects:

- these projects feature, beyond construction, complex operational phases. These phases have to be designed accurately (which is often impossible at the construction contract award) and have to enable adaptations during the lifetime of the project;
- even if central government involvement can be high in some cases, these projects are seen as local projects. Therefore, their successes or failures are directly linked to the ability of the local contracting authority to manage them.

These two characteristics have repercussions on how the Matching Framework achieves to capture them correctly.

The key role of the operational phase compared to the construction phase in the overall success of these projects can be assessed in the funding scheme typology, if a distinction between BDOM-type contracts (where cost coverage is estimated for both construction and operation) and OM-type contract is made. This typology seems to use the most effective data to describe the overall success of an urban transport project.

The political sensitivity of the project has a huge repercussion on risk sharing. Governance typology assesses this sharing as defined in the contract. In fact, the contracting authorities seem to be unable to let the private concessionaire assume wholly construction, operation or commercial risks. When urban public transport projects encounter difficulties (which was especially frequent with cases in the BENEFIT case studies sample), contracting authorities make sure that these difficulties:

- do not impact quality of service offered;
- do not have repercussion on the very existence of the service (commercial revenues below expectation as in the case of Reims tramway can lead to the bankruptcy of the concessionaire).

So, in practice, risk sharing is frequently reassessed during the lifetime of the project. These adaptations are difficult to capture in one or other of the different typologies. The cost saving indicator (in the Business Model typology), which tries to make a link between “capacity” to construct/operate of the concessionaire is probably the most suitable indicator to take into account these evolutions.

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5.3 Bridge and Tunnel Projects in BENEFIT

5.3.1 Implementation Context Typology

The objective of the context typology is to capture how conducive the country context is for implementation of transport infrastructure projects, varying from country to country.
The implementation context typology consists of two indicators: institutional context indicator and macroeconomic and financial context indicator.

The first one is related to political, regulatory and administrative stability of a particular country in which the transport project is set up. Such indicators for European countries that compose implementation context for both private and public projects are stable.

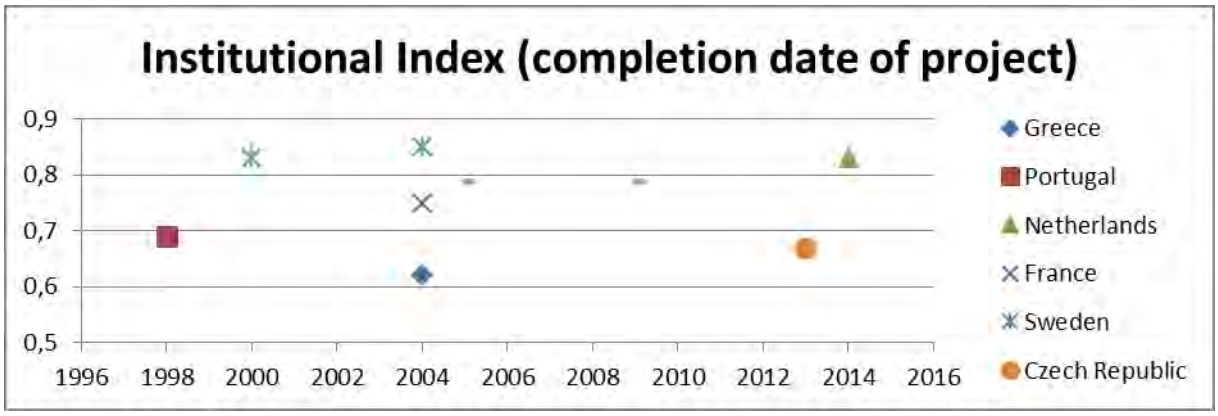

Figure 5.3.1: Institutional index for bridges and tunnels projects at award

Analysing cases available for the qualitative assessment, it can be observed that large transport projects related to structures such as bridges and tunnels need support on a governmental/national level. The latter concerns both public and private cases. Seven cases out of nine analysed could be regarded as successful and those are nationally driven projects with political support on a central level: Rion-Antirion Bridge (Greece), Lusoponte – Vasco da Gama Bridge (Portugal), Coen Tunnel (the Netherlands), Millau Viaduct (France), the Øresund Link (Denmark-Sweden), Berlin Tiergarten Tunnel (Germany), and Södra länken (Sweden).

The remaining two cases, the Herrentunnel Lübeck (Germany) and the Blanka Tunnel Complex (Czech Republic) could be considered as not successful. Both are regionally driven projects. However, the first is not successful in the operational phase as the usage of the tunnel is much less than forecasted. The second one is in the construction phase. The original budget of the Blanka Tunnel Complex has been exceeded twice. The idea to build the Blanka Tunnel Complex has always been pursued primarily by the representatives of the city of Prague. There has been a cross party support for the realisation with the exception of the Green Party. However, the central government involvement was considered as very limited and mainly related to regulations. Changes in regulations have partly contributed to increases in total costs of the project. Among them, additional requirements for safety measures in tunnels by the State Mining Administration (SMA) played a particularly important role. The SMA also fined the contractor for landslides during the construction works[31].

It appears that the implementation context on the level of institutional support, regulatory and administrative stability is significant when dealing with superstructures such as bridges and tunnels.

[31] Case study of Blanka Tunnel Complex

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The second indicator reflects the economic context in which transport projects are developed. The significant change that could have a great impact on the cases was the 2008 economic crisis. However, the construction phase for most of analysed cases was completed before the beginning of the crisis. Yet, there is reference to the economic crisis in one case, namely the Rion-Antirion Bridge (Greece). Nevertheless, it is related to the operational phase of the project. Actual traffic volumes were 12-17% higher than originally forecasted. During 2004-2007, the overall number of vehicles sharply increased. Following the economic crisis this figure dropped to 8,300 vehicles in 2013, with a further reduction of 5% expected in 2014.

Even if there are few cases to analyse when considering bridges and tunnels, it seems that a big and sudden change on the macroeconomic level may have an impact on realising such projects during the whole life cycle.

5.3.2 Transport mode typology

The transport mode typology is a combination of two indicators that characterise the quality of service offered by the transport project comparing with the quality of service expected and reduction of downtime:

- reliability, % time of disruptions during operation,
- availability, % of available use over period of time.

Availability and reliability are significant features of any service, especially in the transportation sector where the notion of availability and reliability is often related to safety and security. For instance, a characteristic, which applies to all infrastructure types, is the increased capability to operate under adverse weather conditions.

In all cases described in the form of snapshots (4 out of 9 in general), including 3 PPP projects: Rio-Antirion Bridge (Greece), Lusoponte – Vasco da Gama Bridge (Portugal), Herrentunnel Lübeck (Germany) and one financed from public sources: Blanka Tunnel Complex (Czech Republic), the reliability indicator is at the maximum (1/100%) level. However, the Blanka Tunnel Complex has not been yet fully completed because of delays in project delivery, thus it cannot be investigated integrally.

5.3.3 Governance typology

As per the output of the BENEFIT project Task 2.4, two dimensions describing project governance were identified, namely ‘efficiency/effectiveness of governance’ and ‘contractual flexibility’. There are 10 indicators identified describing these dimensions.

The scope of project governance is limited to transactions caught in the project contract. It means that the influence of external stakeholders is not considered in the governance aspects of the project. Moreover, it is assumed that cooperation-based project governance mechanisms reflected in the selected governance indicators generally have a positive influence on project performance. Likewise, it is assumed that the implementation intensity of the selected formal governance mechanisms (contractual conditions) is positively associated with project performance.

In the snapshot analysis, there is one overall composite indicator, and when considering bridges and tunnels it varies extensively, from a maximum of 0.813 in the case of Vasco da Gama Bridge (PPP project) to 0.188 in the case of Blanka Tunnel Complex (public project). In all analysed cases, the overall composite indicator is at the same level during the whole project realisation, meaning that it remains unchanged in each particular snapshot.

However, the case studies analysis highlights the significance of the planning phase in choosing the right contractor, who is able to deliver the project on the right time and scope. It is not an easy task, especially when both technical and organisational difficulties are identified early enough. Taking the example of the Rion-Antirion Bridge (PPP project): In 1980, the first International Tender Call was announced but the interest was inadequate. Then, 7 years later International tender call was

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announced and no offer was approved, as the Ministry expressed doubts about the technical basis of the offers. Only in 1996, the final Contract Approval was signed with the bidder. Therefore, the entire preparation process lasted years, but the construction went without many problems.

Whereas in analysing the Blanka Tunnel Complex in the context of the G5 indicator, which relates to the key service providers [contractor] paying a penalty if completion dates are not met, it is observed that although the original date for completion of all works set to 2011 was not met, there was no penalty incurred.

However, based on the available data analysis, mainly the encouragement of competition between bidders was desired. That situation relates to the G3 indicator. This variable was found to be a statistical significant factor that ultimately contributes to reducing transaction costs. This variable favours uncertainty in the transaction environment for a project to be reduced and is also associated with the risk awareness feature of an optimal risk allocation.

As there are 10 governance typology indicators and related to contracts, the data is fragmented going from case to case, thus, a theoretical and general view of the relationship between constructor/operator and contracting authority is observed.

5.3.4 Business Model typology

The business model typology consists of two parts: cost saving and revenue support.

Cost saving

This part of the business model illustrates the project's ability to keep its costs under control in relation to the construction phase, the operational phase and the degree of innovation of the project. The values of this indicator are very different from one project to another and vary for the same project, in 4 out of 9 cases. The high value is observed for the Herrentunnel, and the lowest for the Blanka tunnel (twice over budget). The cost saving indicator values are presented in Table 5.3.1.

Table 5.3.1: Cost savings indicator

Indicator	Lusoponte Vasco da Gama Bridge	Lusoponte Vasco da Gama Bridge	Rion-Antirion Bridge	Rion-Antirion Bridge	Rion-Antirion Bridge	Rion-Antirion Bridge
	Portugal	Portugal	Greece	Greece	Greece	Greece
	Snapshot 1 - award (1994)	Snapshot 2 (1999)	Snapshot 1- award (1996)	Snapshot 2- inauguration (2004)	Snapshot 3- (2008)	Snapshot 4- reporting period (2014)
Cost Saving	0.534	0.437	0.762	0.762	0.858	0.929

Indicator	Blanka Tunnel	Blanka Tunnel	Herrentunnel Lübeck	Herrentunnel Lübeck	Herrentunnel Lübeck
	Czech Republic	Czech Republic	Germany	Germany	Germany
	Snapshot 1- award (2006)	Snapshot 2- reporting period(2015)	Snapshot 1: Award (1999)	Snapshot 2: End of construction phase (2005)	Snapshot 3: Reporting time (2014)
Cost Saving	0.030	-0.303	1,000	1,000	1,000

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Considering the two extreme cases (Blanka Tunnel: -0.303 and Herrentunnel: 1) the reality confirms the indicator assessment. Blanka Tunnel demonstrates 103% cost overrun, while Herrentunnel was completed 25% below the estimated budget.

5.3.4.1 Revenue support

Revenue Support reflects the project's ability to optimise and secure revenues. Four types of revenues are taken into account by this indicator: revenues from the Greenfield part of the project, revenues from the Brownfield part of the project, revenues from other transport activities and revenues from activities other than transport.

In the case of the tunnels and bridges mode, this indicator is from 0.009 to 0.27 (the biggest value of this indicator from all analysed cases). The revenue support indicator values are presented in Table 5.3.2.

Table 5.3.2: The revenue support indicator values

Indicator	Lusoponte Vasco da Gama Bridge	Lusoponte Vasco da Gama Bridge	Rion-Antirion Bridge	Rion-Antirion Bridge	Rion-Antirion Bridge	Rion-Antirion Bridge
	Portugal	Portugal	Greece	Greece	Greece	Greece
	Snapshot 1 - award (1994)	Snapshot 2 (1999)	Snapshot 1- award (1996)	Snapshot 2- inaguration (2004)	Snapshot 3- (2008)	Snapshot 4- reporting period (2014)
Revenue support	0.270	0.270	0.085	0.085	0.114	0.114

Indicator	Blanka Tunnel	Blanka Tunnel	Herrentunnel Lübeck	Herrentunnel Lübeck	Herrentunnel Lübeck
	Czech Republic	Czech Republic	Germany	Germany	Germany
	Snapshot 1- award (2006)	Snapshot 2- reporting period(2015)	Snapshot 1: Award (1999)	Snapshot 2: End of contruction phase (2005)	Snapshot 3: Reporting time (2014)
Revenue support	0.059	0.059	0.009	0.009	0.009

These indicators show the revenues are restricted to the prime infrastructure.

5.3.5 Funding scheme typology

All tunnel and bridge projects realised in the PPP delivery mode and the Øresund Link (a type of hybrid project implemented by the States, but using commercial sources of financing) have implemented user payment schemes (toll - user fees).

In some cases, they are provided through concession agreements to strengthen the natural monopoly of the construction and eliminate the alternative (e.g. ferry for the Rion-Antirion Bridge, putting under management of the concessionaire alternative bridge connection - Lusoponte – Vasco da Gama Bridge), and provide revenues for the investment.

User fees and alternative routes for reviewed projects are presented in Table 5.3.3.

Table 5.3.3: User fees and alternative routes

Project	Cost for car	Alternative route

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Rion-Antirion Bridge	13.20 €	By ferry, about 35 minutes longer + fee for the ferry (links eliminated under concession contract). The combination of land about 400 km long.
Millau viaduct	7.50-9.40 €	16 km and over 20 minutes longer mountain route (hairpin road)
Øresund link	22-47 €	Over 1 hour ferry + fee for the ferry (closed down after the opening of the Øresund link). Alternative connection for Helsingborg ferry costs about 50 € (car + 2 passengers), the same time of passage takes 20 minutes, to which travel time for loading and unloading must be added
Herrentunnel	1.5 €	5 km / 4minutes alternative free of charge route

Table 5.3.4: Funding scheme indicators

Funding Scheme	Lusoponte Vasco da Gama Bridge	Lusoponte Vasco da Gama Bridge	Rion-Antirion Bridge	Rion-Antirion Bridge	Rion-Antirion Bridge	Rion-Antirion Bridge
	Portugal	Portugal	Greece	Greece	Greece	Greece
	Snapshot 1 - award (1994)	Snapshot 2 (1999)	Snapshot 1- award (1996)	Snapshot 2- inauguration (2004)	Snapshot 3- (2008)	Snapshot 4- reporting period (2014)
Remuneration Scheme	0.333	0.358	0.333	0.333	0.333	0.333
Revenue Scheme	0.600	0.633	0.689	0.689	0.733	0.733

Funding Scheme	Blanka Tunnel	Blanka Tunnel	Herrentunnel Lübeck	Herrentunnel Lübeck	Herrentunnel Lübeck
	Czech Republic	Czech Republic	Germany	Germany	Germany
	Snapshot 1- award (2006)	Snapshot 2- reporting period(2015)	Snapshot 1: Award (1999)	Snapshot 2: End of construction phase (2005)	Snapshot 3: Reporting time (2014)
Remuneration Scheme	0.500	0.500	0.167	0.167	0.000
Revenue Scheme	0.056	0.056	0.333	0.333	0.248

5.3.6 Financing scheme typology

In PPP projects the share of public sources varied and ranged from 0% to 67%. For PPP projects, it was important to co-finance the loans granted by the EIB, which are usually a significant part of commercial financing (Table 5.3.5).

Table 5.3.5: Financing structure of projects

Project[32]	Subventions (M €)	Equity (M €)	EIB loans (M €)	Commercial loans (M €)
Rion-Antirion Bridge	376.5	68.5	370	-

[32] For Second Coen Tunnel there is no information about structure of financing

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Lusoponte – Vasco da Gama Bridge	369	199	299	120
Millau Viaduct		≈370	143 - long term loan 50 - short term loan during construction	
Herrentunnel	90	18	80	-

For public cases, source of funding is a State and/or local governments. An unusual case among analysed cases is the Øresund link, which did not burden the state budgets of Denmark and Sweden. The financing model for this project agreed upon was a user fee model, in which the upfront costs are met by loans on the national and international credit markets. The normalized indicator for the four reviewed projects is presented in Table 5.3.6.

Table 5.3.6: Financing Scheme indicator

Lusoponte Vasco da Gama Bridge	Rion-Antirion Bridge	Blanka Tunnel	Herrentunnel Lübeck
Portugal	Greece	Czech Republic	Germany
Financing Scheme - normalised indicator			
0.496	0.260	0.125	0.306

The range from 0.125 for the Blanka Tunnel to 0.496 for the Vasco da Gama Bridge is observed.

5.3.7 Summary of Findings

The bridges and tunnels projects analysed are usually related to superstructures, characterised by a large budget and a unique, often designed and used for the first time technology. These projects require good preparation, so before signing the contract, several years of preparatory work takes place for the later design and construction.

In conclusion, two elements seem specific to bridges and tunnels:

- Projects implemented under the PPP are carefully planned and implemented according to schedule. The fact should be underlined particularly for such technically ambitious projects as the Millau Viaduct or Rion-Antirion Bridge.

- PPP projects are planned conservatively - most expenditure was planned at the real level or above, while revenues were planned under real influence. Such an approach clearly reduces the risk of the private party.

- Projects implemented only at the local level proved to be not successful (Herrentunnel, Blanka Tunnel Complex).

- Projects carried out only by a public body, have underestimated costs (often grossly, as with the Blanka Tunnel – more than 100%).

The political sensitivity of the project has a huge repercussion on timing. Change of plans regarding sources of financing, unrealistic expectations for market competition often result in a decade of delays in project implementation.

The analysis shows that the exclusivity of tunnels and bridges leads to the possibility to ensure adequate traffic and thus revenues, despite the cost to the user, because the benefits in terms of time savings are greater than the charge incurred. This is important, because it immunizes such projects to

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adverse external factors. In countries that experienced a large drop in the Economic Financial Index (Greece, Portugal), projects recorded a revenue scheme indicator better than at the stage of planning, which confirms the above hypothesis on careful risk based planning and forecast in PPP projects (Figures 5.3.2 and 5.3.3).

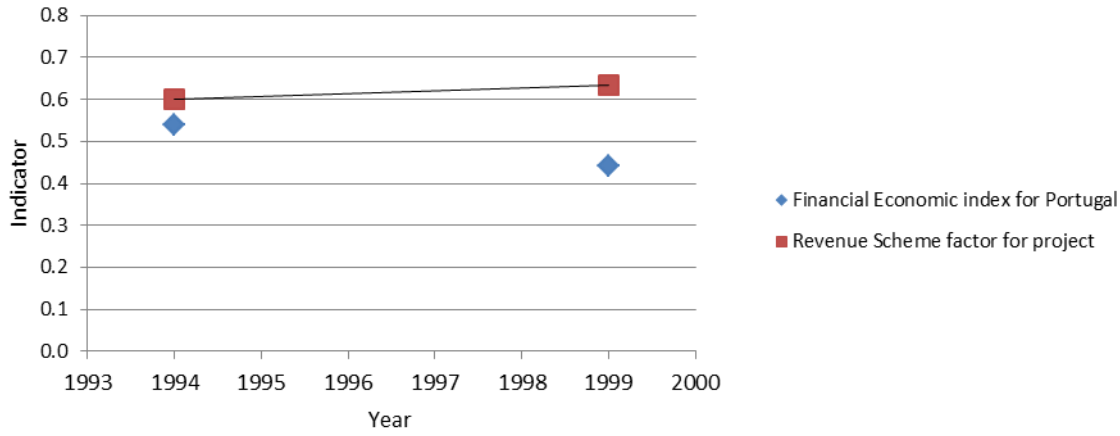

Figure 5.3.2: Financial Economic Index for Portugal and Revenue Scheme Indicator for Lusoponte Vasco da Gama Bridge Project

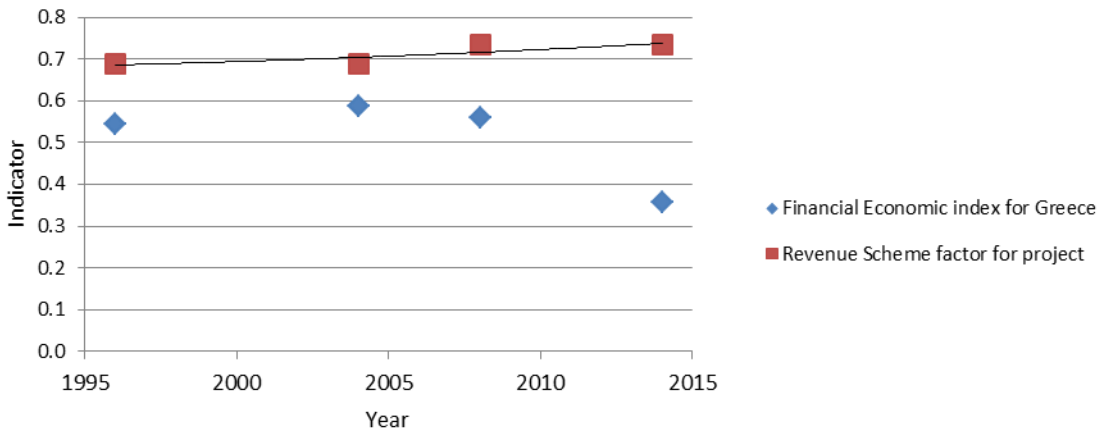

Figure 5.3.3: Financial Economic Index for Greece and Revenue Scheme Indicator for Rio-Antirion bridge project

This applies to projects characterized by exclusivity. A different example is the Herrentunnel for which there is a free alternative, convenient for users (only 5 minutes long), and hence results are significantly lower than expected, although the Financial Economic Index in the meantime has been significantly improved (Figure 5.3.4).

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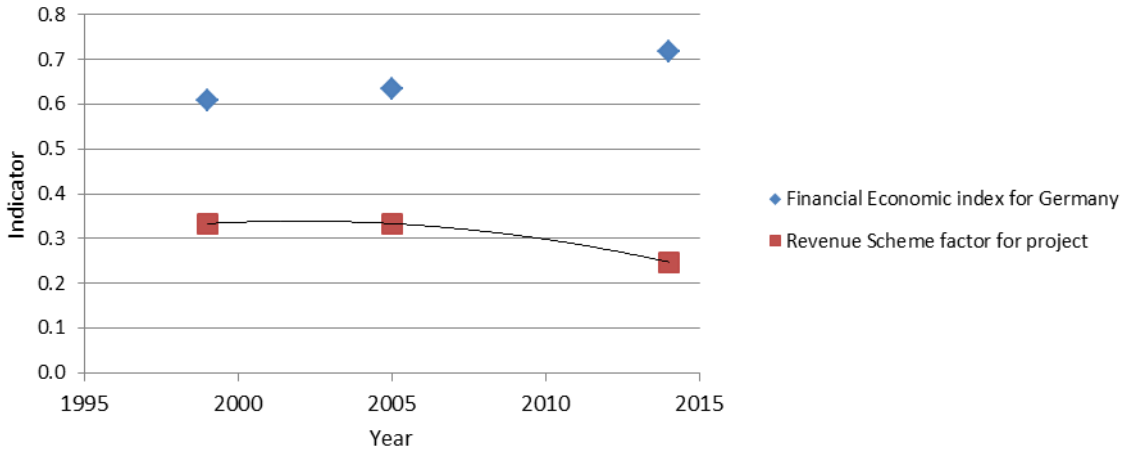

Figure 5.3.4: Financial Economic Index for Germany and Revenue Scheme Indicator for Herrentunnel Lübeck project

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5.4 Airports Projects in BENEFIT

5.4.1 Implementation Context Typology

The objective of the context typology is to capture how conducive the country context is for implementation of transport infrastructure projects, varying from country to country. The implementation context typology consists of two indicators: institutional context indicator and macroeconomic and financial context indicator. Table 5.4.1 presents the respective scores:

Table 5.4.1: Implementation Context indicators for airport cases

Project Title		Athens International Airport	Berlin Brandenburg Airport (BER)	Larnaca and Paphos International Airports	Modlin Regional Airport
Country		Greece	Germany	Cyprus	Poland
Institutional Context Indicator	Snapshot 1 value (year)	0.59 (1995)	0.78 (2005)	0.70 (2005)	0.64 (2010)
	Snapshot 2 value (year)	0.60 (2001)	0.80 (2015)	0.75 (2008)	0.65 (2012)
	Snapshot 3 value (year)	0.59 (2009)		0.73 (2009)	0.66 (2013)
	Snapshot 4 value (year)	**0.57** (2014)		0.71 (2014)	0.66 (2015)
Financial Economic Context Indicator	Snapshot 1 value (year)	0.543 (1995)	0.628 (2005)	0.555 (2005)	0.617 (2010)
	Snapshot 2 value (year)	0.543 (2001)	0.717 (2015)	0.700 (2008)	0.600 (2012)
	Snapshot 3 value (year)	0.500 (2009)		0.683 (2009)	0.617 (2013)
	Snapshot 4 value (year)	**0.358** (2014)		**0.425** (2014)	0.617 (2015)

What is noticeable is the relative independence of the implementation context indicators and performance in the specific iarport projects. More spefically, the Athens International airport is developed in the coutry (Greece) with the smaller value of the institutional context indicator and the greatest drop in the Financial – Economic Indicator due to the recession, has been performing better than anticipated. It is also noticeable that regardless of the impact of the economic crisis, institutional and Financial_Economic Context indicators, in this case have always been smaller in relation to the other projects. Hence, the drop in the Financial-Economic Indicator value is smaller than in the case of Cyprus where traffic figures have been significantly impacted. Therefore, indicator values suggest that other factors are more determining in achieving project outcome targets.

5.4.2 Transport Mode Typology

The transport mode indicator is designed to reflect two operational dimensions of the service, availability and reliability. Although, the Berlin Brandenburg case has reported delays in the award and construction phases, which have postponed the inauguration of the service, the Modlin airport is the only case, for which transport mode context scores below 1 (full availability and reliability) have been reported in three snapshots. Table 5.4.2 presents these scores:

Table 5.4.2: Transport mode indicators for Modlin Airport case

Project Title	Modlin Regional Airport	Modlin Regional Airport	Modlin Regional Airport	Modlin Regional Airport
Country	Poland	Poland	Poland	Poland
MATCHING FRAMEWORK INPUT	Snapshot 1 - award time 2010	Snapshot 2 - opening time 2012	Snapshot 3 - reopening time - 2013	Snapshot 4 – reporting 2015
Transport Mode Context	100%	56%	25%	75%

After the award time, the Modlin airport has been suffering from serious construction and operational problems, which have led to the airport closure and after that a contract termination with the Airline Company. Those two events have clearly affected the availability and reliability of the service.

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However, since the airport reopening in 2013, it has been restoring its services. In short, although it is complicated to infer a tendency for the airport sector, most cases have presented high availability/reliability indices. Nevertheless, it is important to consider that there are big risks related to the construction phases with major impacts on the service operation.

5.4.3 Governance Typology

The overall governance score has been designed to represent two dimensions of the contractual governance, 'efficiency/effectiveness of governance' and 'contractual flexibility'. In short, higher scores represent contracts able to ensure the realization of the project goal either by the efficient regulation and control or renegotiation capacity. Table 5.4.3 presents the governance scores for the airport cases sample.

Table 5.4.3: Governance indicators for airport cases

Project Title	**Athens International Airport**	**Berlin Brandenburg Airport (BER)**	**Berlin Brandenburg Airport (BER)**	**Larnaca and Paphos International Airports**	**Modlin Regional Airport**
Snapshots	1 to 4	1	2	1 to 4	1 to 4
Country	Greece	Germany	Germany	Cyprus	Poland
Governance	0,813	0,625	0,25	0,875	0,438

According to the previous table, PPP contracts are the cases standing in the performance edge of the governance dimension. Although the first snapshot describing the Brandenburg airport has a high governance score for a public case, it is still far below in comparative terms from that of the Athens, and Larnaca and Paphos airports. As it was mentioned in the institutional outcomes section, the low performance observed in the public finance cases may be associated to the incentive network designed by the contractual arrangement spread over several contracts. It seems that, although the development of a direct relationship between contractor and contracted party is expected to bring control efficiency to the contract, this structure might be reducing the other governance capabilities.

This point may also be associated with the role of the performance clauses mostly used at PPP contracts. In theory, those clauses are introduced in those contracts in order to provide operational boundaries for the operations without interfering in the management expertise and strategies of the operator. Positively ranked in the governance (G10 index component), the relevance of the performance clauses introduced in the Larnaca and Paphos airports might be pushing up the project score. For the Athens Airport, the price standards and revenue management's flexibility may be improving the governance score. Comparatively, those clauses do not seem to have the same relevance for most of the contracts in public cases.

In short, in order to equally compare those cases it is important to evaluate the orientation purpose designed by each contract form. If the policy taker has decided to delivery certain infrastructure in a public funded format, it is important to comprehend the governance boundaries of the project and score its capability according to it. Some comments regarding the symmetries of the scores are developed after the financial context section. Those elements might be considered meaningful for the comprehension of the cases in a singular standard.

5.4.4 Business Model Typology

The business model subsystem of the BENEFIT model is approached by two indicators related to the resources available to the project and the rate of their reduction/increase in terms of cost increase/savings. Table 5.4.4 presents the behaviour of these indicators in the various instances of the project´s life, examined through the snapshots. Two elements were examined, the magnitude of the average value of the indicators and the tendency as the average change of the values from one snapshot to the other. In general, the higher the value the better the performance of the project in relation to the attributes represented by the indicators. Furthermore, one should also bear in mind the

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interrelations of these two attributes. As presented in the Typology Interrelationship Matrix (D 3.133), both indicators are interrelated with each other, as well as with the gearing ratio and the sources of finance, while revenue support is also related to the revenue streams and their selection.

Table 5.4.4: Business Model indicators for airport cases

Project Title		Athens International Airport	Berlin Brandenburg Airport (BER)	Larnaca and Paphos International Airports	Modlin Regional Airport
Country		Greece	Germany	Cyprus	Poland
		Business Model			
Cost Saving	Snapshot 1	0.533	0.272	0.821	-0.222
	Snapshot 2	0.533	-0.144	0.821	-0.222
	Snapshot 3	0.500		0.821	-0.333
	Snapshot 4	0.500		0.828	0.167
	Average	*0,517*	*0,064*	*0,822*	*-0,153*
	Average Δ	*-2,1%*	*-153,1%*	*0,3%*	*-33,3%*
Revenue support	Snapshot 1	0.252	0.121	0.205	0.039
	Snapshot 2	0.252	0.126	0.205	0.022
	Snapshot 3	0.252		0.205	0.000
	Snapshot 4	0.250		0.205	0.007
	Average	*0,251*	*0,124*	*0,205*	*0,017*
	Average Δ	*-0,3%*	*3,8%*	*0,0%*	*-72,0%*

Beginning with the cost savings component, the international airports of Larnaca and Paphos, exhibit the highest performance followed by the Athens International airport. The latter has implemented cost saving and incentive measures to counteract for the reduced revenue streams as a result of the economic crisis, which can be interpreted as the slight decreasing trend of the revenue support indicator. Moreover, the Larnaca and Paphos Airports are the only ones exhibiting an increasing trend in cost savings. On the other side, the Berlin Brandenburg Airport scores a bit higher than zero, while Modlin Regional airport scores negatively, primarily as a result of the airport´s closure period due to safety reasons. The airport ceased operations from December 2012 until 2013, but when it reopened only one of the two low cost operators resumed operations. Thus, this fact justifies the lowest indicator values of the Modlin airport, whether related to cost savings, or revenue support. Furthermore, the problematic connection of the airport with other transport modes resulted in lower traffic and consequently lower revenue share.

A closer look at the second aspect of the business model, namely revenue support, shows that the two PPP airports of Athens and Larnaca and Paphos rank again in the first two positions. Especially for the airport of Athens, provision of both aeronautical and non-aeronautical services, as well as real estate development initiatives have contributed, among other factors, to the strong revenue support comparative advantage. Furthermore, the Berlin Brandenburg Airport exhibits a small increasing trend on the revenue support side, which is the only positive in the sample, while the Modlin Regional airport shows the steepest decrease for all the reasons presented in the previous paragraph.

5.4.5 Funding Scheme Typology

The Funding Indicator is divided into Revenue and Remuneration scheme indicators. The first one is related to revenues specifically generated by or for the project. These should not include money from the general public budget (subventions). Remuneration scheme is related to the streams of income received by the project manager.

Almost all airports analysed provide both passenger and cargo transport. The Modlin Airport is a particular case since it is a regional airport with only passenger traffic. Its investment size is smaller

[33] BENEFIT Deliverable: D 3.1 – Methodological Framework for Ex-post Analysis

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than the rest of the cases. Consequently, it should be analysed separately. In general, the scores present different levels of funding schemes represented by the cases (Table 5.4.5). Public-private partnership contracts have lower values of Remuneration than the public contracting. On the contrary, Revenue scores are higher for those cases than for the public ones.

Table 5.4.5: Funding Indicators for airport cases throughout the snapshots

Project Title		Athens International Airport	Berlin Brandenburg Airport (BER)	Larnaca and Paphos International Airports	Modlin Regional Airport
Country		Greece	Germany	Cyprus	Poland
		Funding Scheme			
Remuneration Scheme	Snapshot 1	0.295	0.667	0.333	0.500
	Snapshot 2	0.295	0.667	0.333	0.667
	Snapshot 3	0.295		0.333	0.000
	Snapshot 4	0.297		0.333	0.025
	Average	*0.296*	*0.667*	*0.333*	*0.298*
Revenue Scheme	Snapshot 1	0.771	0.687	0.800	0.600
	Snapshot 2	0.815	0.690	0.800	0.667
	Snapshot 3	0.815		0.800	0.533
	Snapshot 4	0.815		0.800	0.540
	Average	*0.804*	*0.688*	*0.800*	*0.585*

With the exception of the Modlin case, the scores increase with time. In other words, the scores increase with the project development: award phase has lower value than the inauguration and/or reporting time. On average, the Berlin Brandenburg Airport has the highest remuneration scheme score while the Athens airport the lowest. The situation is contrary when the analysis is done for the revenue scheme: Athens presents the highest value while the Berlin case the lowest. The Larnaca and Paphos International Airports case is always in the middle. The first two cases have user charges and non-aeronautical activities revenues. With respect to the Athens airport, approximately 40% of the company's turnover and a significant share of its profits come from non-aeronautical activities. After the inauguration, the airport reports a satisfactory end-of-year traffic with minimal losses and high profits. Consequently, it makes sense that this case study has the highest revenue value.

The viability of the entire Larnaca and Paphos Airports project depends on the growth of the airlines passenger traffic, since revenues come solely from users' charges. However, the actual passenger traffic so far did not match the forecast scenarios included in the contract. Hence, if the revenues growth directly with the passenger traffic growth, this leads to a lower value of the score of the Revenue indicator. Nevertheless, the concessionaire seeks out other forms of revenues and the Cyprus Government assists the Hermes Airport towards this direction.

Finally, around 90% of the revenues of the Modlin Regional Airport come from users' charges and 5% come from commercial activities. The airport's specific orientation at low-cost airlines is reflected in certain components of the infrastructure, particularly the terminal with no designated business waiting area, no luxury commercial or food court areas and no jetways. Consequently, it leads to generally lower values of Revenue and Remuneration schemes indicators.

5.4.6 Financing Scheme Typology

The Financing Indicator used in the snapshots description assumes that cases with relatively high score values represent a project with relatively low risk as perceived by investors. Table 5.4.6 presents the scores for the cases analysed in the airports sample.

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Table 5.4.6: Financing Indicators for airport cases

Project Title	Athens International Airport	Berlin Brandenburg Airport (BER)	Larnaca and Paphos International Airports	Modlin Regional Airport
Country	Greece	Germany	Cyprus	Poland
Financing Scheme	0,368	0,125	0,773	0,165

The scores presented in the previous table displays three different levels of financing schemes represented by the cases. According to the risk scale proposed by the financing index construction, Larnaca and Paphos airports have the lowest financing risk followed by the Athens airport and respectively Modlin and Berlin Brandemburg airports. A more detailed comparison between those structures may highlight the relevant factors that have led to those differences.

Beginning with the equity components, high scores in the equity indicators represent the assets diversification to private stakeholders. From this principle, it is possible to track the relevance of the private participation (100%) in the Larnaca and Paphos and (10%) in the Athens Airport in the attractiveness for financing of those projects. Comparatively, the other two cases appear to be much more dependent on the public equity sources.

The same tendency is evident in the debt components. It is of major significance for the PPP cases, since compared to public financed infrastructure, those investments depend more in debt finance. For instance, 43% of the Athens Airport investment has been financed by EIB loans. Together with commercial banks loans, those sources have covered the entire debt structure of the Athens Airport investment. Similarly and even more attractive, the Larnaca and Paphos airports project has captured all debt from leading banks and specific investors (e.g. tradable bonds). This difference reflects a higher diversification in the financial portfolio between those cases and the Berlin Brandenburg and Modlin airports, which have mostly used public finance sources.

Clearly, for the analysed sample, PPP cases have managed to access good risk-return interest rates for private investors. However, it is necessary to understand which Business Model elements have ensured those levels. For the public financed cases, the lower scores were already expected due to the public financial dependency of those contracts. For those cases, it may be necessary to consider the substitution costs of those expenditures regarding other pubic investment options.

5.4.7 Summary of Findings

Once again it is important to refer to the small sample used in this analysis and how it cannot present a tendency for the airport sector but may compare how the typologies index has assimilated the airport cases performance. Regarding these two goals, the conclusions presented in this section look for some synergies between typologies index and what those performances might be representing.

From a general overview, the Larnaca and Paphos and Athens Airport cases are the cases, which have the best scores for all indices except for the implementation context and remuneration scheme. This performance has already been anticipated by the outcome analysis presented in chapter 3 and might be considered a complementarity check between the two sections. This framework fits better with complementary rather than substitutive effect within typologies and their scores, i.e. better projects tend to perform well in multiple dimensions.

Nevertheless, it is necessary to remember that, as it was outlined in chapter 3, the better performance concept in the airport sector has been assessed independently from the actual traffic outcomes (e.g. neither Athens or Larnaca and Paphos airport have reached their forecasted traffic level). Regarding

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this warning, the validation of those synergies depends on a broader study about the outcomes, especially when considering that none of the analysed projects had usage performance in line with the forecasted.

Moving to the opposite side of the sample, the association between implementation context and remuneration scheme may be highlighting some inconsistency in the financial risk assessment. Considering that the financing scheme indicator represents projects with lower investment risks, the assessment of those risks regarding only private finance interest may be missing other project elements. For instance, the public financed cases in stronger economies might reflect economic decisions (for example Germany), or in the opposite side, some part of the financing attractiveness might be representing operational guarantees designed in the contractual clauses. In order to avoid those uncertainties, the financing index must explore those effects.

In short, the typologies framework has represented the structure of the cases in the airport sector. Despite some mismatches that shall be clarified in order to reinforce the typologies, in a relative comparison with the airport sector, typologies have structured a coherent scale capable of connecting key contractual features with outcomes.

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5.5 Ports Projects in BENEFIT

5.5.1 Implementation context

This typology is comprised of two indicators: institutional indicator and financial economic indicator. Five out of six projects were carried out during the economic crisis that began in 2008. Fortunately, four of these projects had a good performance despite the crisis.

5.5.2 Transport mode typology

The transport mode typology includes two indicators that aim at describing the quality of service offered by the new transport project in comparison with the quality of service expected:

- reliability of the transport service: in the field of public transport, reliability is understood as the number of missions arriving on time;
- availability of transport service: in the field of public transport, availability refers to the time of day and the time of year when the service is accessible to users.

Both the reliability and availability have a score of 1 for five out of six cases. The port of Sines shows an IRA index (reliability and availability) of 75%.

5.5.3 Governance typology

Governance typology includes 10 indicators describing efficiency/effectiveness of governance and flexibility of the contract. This indicator rather has to be analysed on a contract by contract basis insofar, as the overall indicator is an average of the different contracts.

The Port of Agaete provides an overall composite indicator of 0.33 in 1982 and 0.44 in the other two snapshots (1994 and 2015). The change in the indicator comes from the fact that the works for the port began in 1982 and, in 1994, the passenger and road traffic license is awarded to *Fred Olsen* and begins to operate. For the other two cases, the indicator also accounts 0.333 in the last snapshot for the Terminal Muelle Costa, Barcelona Europe South Container Terminal and Piraeus Container Terminal. As it was previously highlighted, for this last case, the national government handled the negotiation instead of a tender process. The Port of Sines provides a slightly better index (0.438). Finally, the Port of Leixoes provides the highest governance indicator of the six cases. Compared to the previous cases, the Port of Leixoes has better values for the indicators in those of “bonding requirements”, “all exploitation, commercial/revenue and financial risks” or “clauses indicate that client has an option to terminate the agreement without cause”.

5.5.4 Business Model typology

The Business Model typology is disentangled in two parts: cost saving and revenue support.

5.5.4.1 Cost saving

This part of the business model illustrates the project's ability to keep its costs under control in relation to the construction phase, the operating phase and the degree of innovation of the project.

The capacity to operate as well as the degree of innovation is not significant in the cases analysed here. Regarding the costs, the Terminal Muelle Costa and the Barcelona Europe South Container Terminal suffered from cost overruns: two extra million in the case of Terminal Muelle Costa and 200 extra million in the case of Barcelona Europe South Container Terminal. With regard to the Piraeus Container Terminal, the awarded company was able to keep cost under control during all stages. Nonetheless, the company estimated its operating costs in 2005 to be as much as 40% higher than those of efficient competing ports. The main reason behind that was the lower productivity in comparison to European standards. On the contrary, the port of Leixoes was capable of keeping the cost under control during the project timeline.

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5.5.4.2 Revenue support

Revenue Support reflects the project's ability to optimize and secure revenues. Four types of revenues are taken into account by this indicator: revenues from the Greenfield part of the project, revenues from the Brownfield part of the project, revenues from other transport activities and revenues from activities other than transport.

In this sense, the service offered in the Port of Agaete has been a success and the source of revenues has been ensured. The company is coping with a large increase in passenger traffic since 2000. The shipping company *Fred Olsen* offers tourist packages to visit some attractions in both islands. It also offers a (free) bus shuttle service from Las Palmas de Gran Canaria to Agaete and from Santa Cruz de Tenerife to Los Cristianos in the South of the islands, where the company operates three routes to El Hierro, La Gomera and La Palma. This service eases the connection by road between the city and Agaete, which strengthens its demand compared to the airport.

On the other hand, the Terminal Muelle Costa has experienced a remarkable increase in the port´s SSS activity. Although the economic crisis hit the initial figures of the Barcelona Europe South Container Terminal, in 2013, port container traffic was close to its 2007 pre-crisis level. In 2014, the whole port container traffic experienced 7% year-on-year increase. Regarding the Port of Leixoes, most of the revenues come from user charges, whereas secondary revenues include assets promotion, sub-concessions and royalties. In the case of the Port of Sines, the terminal has failed to attract transhipment traffic primarily because of the massive investments that have taken place at two competing transhipment hubs – Algeciras and Tanger Med – which have been able to capture the economies of scale that are absent at Sines. The project is located in a region which generates relatively small container flows.

5.5.5 Funding Scheme typology

The funding scheme typology is disentangled in two parts:

- The remuneration scheme, used to evaluate the project's ability to pay its concessionaire;
- The revenue scheme, used to assess the project's ability to generate financial revenues.

The regional government obtained €1.2 million from public funds for the usage of the dock facilities (*by Fred Olsen*). It also obtained 17,000 Euros for renting warehouses and terminal facilities.

On the other hand, the *Grimaldi lines* agree to ensure a minimum traffic requirement in the case of Terminal Muelle Costa, as well as 4.2M as annual fee. The Barcelona Europe South Container Terminal also established some commitments regarding certain minimum traffic growth. Additionally, the company pay 2.15 Euros per TEU, 22M for the concession and 28M for occupation and use of port public domain.

With regard to the Piraeus Container Terminal, the project is headed by Cosco Pacific Limited, a large state-owned Chinese terminal operator associated with Cosco Container Line, which allow the company to absorb several years of losses. Additionally, the company has demonstrated a high capability for long-term planning. Finally, the port authority (OLP) in charge of the Pier I has increased productivity and improved operations and services; reporting a 27.5% increase in container throughput. The agreement ensures a maximum IRR-16%. If exceeded, profits available for distribution shall be evenly distributed to the Concessionaire and OLP, at commensurate rates (50% - 50%). The percentage of gross revenue offered by Cosco was 21% for the first 8 years and then 24.5% with the second bidder offering 19.0%.

In the case of the Port of Leixoes, the contract includes a tariff with both a fixed and a variable part. The first goes to the concessionaire (port authority), whereas the second goes to the concession. Finally, in the case of the Port of Sines, throughput has been lower than expected, and concession fees per TEU rise with throughput. Thus, earnings from concession fees have been very much lower than expected.

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5.5.6 Financing Scheme typology

The financing scheme typology aims at assessing the financing of the construction of the project. There is a lack of suitable financial information for the cases analysed here. Briefly, the financing indicators are 0.125, 0.375, 0.538, 0.4, 0.2 and 0.460 for the Port of Agaete, Terminal Muelle Costa, Barcelona Europe South Container Terminal, Piraeus Container, Port of Leixoes and Port of Sines, respectively.

5.5.7 Summary of Findings

In general, all projects can be considered as successful cases except from the Port of Sines. Despite the projects sharing a common mode (ports), it is difficult to draw conclusions given the differences in each project. Firstly, two out of six ports are focused on passenger transport whereas the rest of the ports are focused on containers traffic. Secondly, each case took place in different countries and under different circumstances. For instance, the Piraeus Container Terminal was carried out during the economic crisis that hit strongly the Greek economy. Despite that, the project was a success. In Portugal, that was also hit severely by the economic crisis, the port of Leixoes had a good performance from the very beginning and did not suffer from extra cost, delays or traffic forecast. On the contrary, and also in Portugal and during the same period, the Port of Sines showed a bad performance from the beginning and the projects addressed several issues during the timeline of the project. The cause behind the success or failure of these projects seems to rest on the foundation of the aim of the projects. More precisely, for instance, the dominant position of Piraeus in the Greek and Mediterranean container market played an important role in the success of the project as well as the importance market share of Cosco Pacific, the awarded company. On the other hand, the Port of Sines did not have such a dominant position in the container markets, while it faced strong competition from two competing transhipment hubs – Algeciras and Tanger Med – which have been able to capture the economies of scale that are absent at Sines. With regard to passenger ports, and focusing on the case of Agaete, the authorities identified the lack of a closer and faster connection by sea between the two main islands of The Canary Islands. Until then, the main connection was from the two main ports in the two main cities of both islands (Santa Cruz in Tenerife and Las Palmas de GC in Gran Canaria). Agaete has the closer port to Santa Cruz of Tenerife. Moreover, the shipping company (Fred Olsen) operates with fast catamarans (Ro-Ro services). Both circumstances, the closer distance and a faster mean of transport reduces the travel time by one hour and a half compared to the aforementioned services from city to city.

Summarizing, before analysing important issues related to the tendering process or the traffic forecast among other aspects, the analysis of the strengths and real necessities of the projects seem to be key to the future success; at least in ports projects.

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5.6 Conclusions: Reality Fit

The scope of the current chapter is to report with respect to the qualitative reality fit of the typology indicators. Findings across modes are presented herewith. In the process, lessons learned were also identified with respect to the funding and financing of transport infrastructure. Once again, conclusions should be considered with caution as these are based on a limited and non-representative sample of cases.

5.6.1 Matching Framework and its Typology Indicators – Lessons Learned

5.6.1.1 Implementation Context Typology

Both implementation context indicators, Institutional Context and Macroeconomic and Financial Context indicators are much lower for southern European countries and low values of Macroeconomic and Financial indicator in recent years show greater impact of the global financial crisis in these countries. The indicators qualitatively represent well the macro-economic and institutional conditions in each country.

5.6.1.2 Transport Mode Context Typology

The Reliability/Availability (IRA) indicator is equal to 1 for most of the projects in the BENEFIT database that were used in the analysis, generally showing that transport infrastructure projects, either greenfield or brownfield are reliable and available to users, without being able to distinguish between modes.

5.6.1.3 Governance Typology

The Governance composite indicator is typically constant for all snapshots for a particular project. It appears that changes in the governance during project implementation have rarely been picked up. This has particularly been the case for urban transport projects where political sensitivity has a huge repercussion on risk sharing and the contracting authorities seem to be unable to let private concessionaire assume wholly construction, operation or commercial risk. On the other side, for road and ports projects, it appears that the Governance indicator was able to show difference between well and poorly performing projects. Finally, while the indicator is structured based on the contractual reasoning of the project, it seems appropriate to adjust values overtime based on the actual way the contract has been implemented. For example is penalties are foreseen and not enforced, then should lead to a respective change in the value of the indicator.

5.6.1.4 Business Model Typology

The cost saving indicator was capable to indicate problems during implementation, related to change in ownership structure, or low traffic levels, for several projects in different modes (roads, airports, bridges and tunnels). Similarly, based on this indicator, it was possible to distinguish well from poor performing port cases. However, it should be noted that it is more focused on the construction phase, while in the urban transport mode the operational phase is critical.

A low value of revenue support indicator for most modes and projects indicates low capability of transport infrastructure projects to generate other types of revenues in addition to revenues from the main transport mode. However, it still makes possible to distinguish between well and poorly performing cases, such as for airports. The highest values of Revenue support indicator were observed for airports in Greece and Cyprus and Lusoponte Vasco de Gama Bridge in Portugal. In addition, the indicator takes into account the quality of the connection to the network, which makes a significant difference in projects like airports.

Bridge and tunnel cases indicate how important the planning phase of projects is, but also how important is to secure revenues through the strengthening of natural monopoly and exclusivity in the contracts. The planning phase is also critical for port projects, but also distribution of revenues in the contract plays an important role. This factor is included in the Business Model indicators.

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5.6.1.5 Funding Scheme Typology

The analysis also found that Funding scheme indicators are sometimes counter-intuitive. For example, the funding schemes of the urban transport projects examined vary in most cases between the design phase and the operational phase. While these changes give rise to many variations in the funding scheme typology indicators, these variations are often counter-intuitive. A project will generally get better marks in the case of mixed funding including commercial revenues and public subsidy than in the case of funding based solely on commercial revenues. However, in practice, the move from funding secured exclusively by commercial revenue to funding that includes a public subsidy indicates a project malfunction (the latter has not been able to obtain funding as planned).

The values of the Remuneration indicator for well performing road PPP projects were higher than for poor performing ones, indicating higher project's ability to pay the concessionaire. On the other side, the revenue indicator for road PPP projects was generally lower for well performing projects compared to poor performing ones. For public road projects, higher values of revenue indicator indicate that these projects are better performing in terms of cost and traffic, but poorer in terms of time.

Airport PPP contracts have lower values of Remuneration than the public projects. On the contrary, Revenue scores are higher for those cases than for the public financed cases.

5.6.1.6 Financing Scheme Typology

The Financing indicator is generally lower for public projects, indicating better capability of PPP project to attract private financing. The high values of the Financing Indicator assume that these projects have relatively low risk as perceived by investors. The values of the indicator are in general much higher for PPP projects.

For urban transport projects, the level of the financing scheme indicator seems to be directly linked to the level of debt. In short, a high percentage of debt in the overall budget of the project leads to a high financing scheme indicator. This choice assumes that the concessionaire's debt means its involvement in the project. On the other side, public equity that has often been provided as a support to bridges and tunnels, airport and road projects, has frequently been financed through loans, which doesn't seem to be captured by the indicator.

5.6.2 Funding and Financing of Transport Infrastructure – Lessons Learned

5.6.2.1 Implementation Context

A demonstrative value of the implementation context indicators is the economic crisis. However, the impact of the crisis on the projects also substantially depends on the transport mode. For road projects it was found that most poorly performing projects are located in the southern countries. Bridge and tunnel projects are also impacted as a consequence of the need of these projects to be supported from the national level. For other modes, the impact of the crisis was smaller. For urban transport projects it seems that the impact of the crisis is less pronounced due to the brevity of these projects compared to road and rail cases and the crisis has rarely been mentioned as a parameter that limited the success of projects. However, there are still some urban transport projects that suffered from the decrease in ridership or advertising revenues as a result of the crisis. For airports, ports and bridges and tunnels, it was clear that the planning phase is critical for projects and that well planned and justified projects were less impacted by the crisis.

5.6.2.2 Governance Typology

The Governance composite indicator seems to be influenced by the country context. The analysis also found difference between projects designed and implemented at local and those at regional or international level. The difference is in the ability to contract, as noticed in urban transport mode, and in the fact that local projects have been less successful, what is noticed in bridges and tunnels. For bridges and tunnels it is specifically said that the project political sensitivity has a huge repercussion on projects timing. Change of plans regarding sources of financing and unrealistic expectations for market competition often result in a decade of delays in project implementation. In the airports mode,

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implementation as PPP or public project seems to have an impact on findings. It appears that capability of public sector to monitor project implementation is currently not present in the Governance indicator.

5.6.2.3 Cost

What is symptomatic for some modes and could be an interesting finding is that public bodies seem to underestimate costs (evidence from bridges and tunnels) and overestimate traffic (evidence from roads and tunnels and bridges).

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6 Fuzzy Set Qualitative Comparative Analysis Validation[34]

6.1 Method description

Fuzzy set Qualitative Comparative analysis is a comparative method that offers a middle path between quantitative and qualitative methods (Ragin 2008, p71). It is called comparative because "it explores and finds similarities and differences in outcome across comparable cases by comparing configurations of conditions" (Ragin, 1987, 1994; 2000; 2003; Rihoux & Ragin, 2008; Rihoux, 2008, as cited in Marx & Dusa, 2011)[35]. The method identifies which conditions are necessary and sufficient to bring about a certain outcome. The method refers to the INUS conception of causality. X is a *necessary condition* for Y is to say that it is impossible to have Y without X. X is a sufficient condition for Y is to say that the presence of X guarantees the presence of Y (X → Y). QCA hence focuses strongly on how different conditions in combination interact to bring about a certain outcome. This is different from statistical methods, which focus on how explanatory variables independently affect the explained variable (dependent variable).

"FsQCA is a set-theoretic approach (Ragin 2000). Set-theoretic approaches describe causal complexity in terms of relationships between conditions (in frequentist methods: independent variables) and an outcome (in frequentist methods: dependent variable). The assessment of causal complexity in set-theoretic methods is based on a few assumptions:

i. Conjunctural causation; a condition will only have an effect in combination with other factors.
ii. Equifinality; an outcome can be elucidated by multiple, mutually non-exclusive (paths of) conditions.
iii. Causal asymmetry; the presence of the outcome may have different explanations than its absence" (quoted from Verhoest, Molenveld and Willems, 2014).

These listed assumptions are clearly different from statistical methods (Schneider and Wagemann 2012). In this kind of analysis, we are mainly interested in how different factors together, in interaction (that is, configurations of conditions), bring about a certain outcome.

There are three reasons/arguments why QCA is used. 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, a QCA allows us to test hypotheses or existing theories. More specifically, the researchers aim at operationalizing theory or hypotheses 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 typology conditions combine, as conditions for particular cases of infrastructure projects, in order to explain the presence of cost and time underrun as well as achieving traffic and revenue on or above forecasts ("success" indicators, called 'outcomes' in QCA). Third, QCA forces researchers to achieve conceptual clarity through the calibration procedure, in which cases are assigned to sets.

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[34] The authors thank Astrid Molenveld for her contribution to preparing and finalising this chapter.

[35] 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). Case-orientedness is about preserving the rich information about the complexity of the cases (configuration of case). Fuzzy sets are also condition-oriented, which refers to the comparison and the degree of membership of a case on a variable/condition. This aspect provides a basis for precise measurement, which is very important in quantitative research.

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The steps of FsQCA include: (1) the identification of the outcomes that we want to analyse and the selection of relevant conditions, of which the combination will have an impact on the outcome, 2) the calibration of values into sets, 3) the construction of a truth table[36], 4) the minimization of consistent configurations to form solution formula, and 5) 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 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). 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) (Vanelslander et al., 2015 and Rihoux & Ragin, 2009, chapter 5) but the values can be calibrated according to different "degrees of membership" in the fuzzy sets. For example, a four-value fuzzy set encompasses: fully in (1), more in than out (0.67), more out than in (0.33) and fully out (0) (Rihoux & Ragin, 2009). Calibration is also explained in the following lines.

In general, there are two ways of conducting calibration: direct and indirect. On the one hand, one might apply direct calibration by specifying the values of an interval scale that corresponds to three qualitative breakpoints (anchor points), structuring 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. The identification of the anchor points and the assignment of cases to sets are based on previous theory or evidence (Schneider & Wagemann, 2010). In our analyses, all variables are transformed into fuzzy sets using the "direct" method of calibration (Ragin, 2008 and Vanelslander 2015).

As soon as the values are calibrated, the dataset can be uploaded in the Fs/QCA 2.5 software, which is used for the analysis. Then one can start to structure the truth table. The truth table is made by selecting the conditions/variables and the outcome to be examined. Fuzzy set analysis not only gives us the ability to examine which are the combinations of conditions, that lead to an outcome (for example in our research one of the outcomes is being on cost), but also it allows us to examine which are the combinations/configurations that lead to "no outcome - absence of outcome" (e.g. not being on cost, i.e. having cost overrun). According to Schneider & Wagemann (2010) the presence and the absence of the outcome should always be dealt with in two separate analyses.

The next step after structuring the truth table is minimizing the consistent configurations to form solution formula by using the "consistency cut-off". This cut-off actually refers to cutting off from the truth table the rows which consistency is under the threshold we set. "The raw consistency column tells us how consistently a configuration is a subset of the outcome or in other words how 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 the number 1 for all the rows whose

[36] Another step could be also added before the construction of the truth table. This step includes checking for necessary conditions (Rihoux & Ragin, 2009, p.110). A necessary condition is a condition, which should be present so as the outcome to occur but its presence does not guarantee the occurrence of the outcome. In general, a necessary condition is interpreted as a superset of the outcome, whereas a sufficient condition is interpreted as a subset of the outcome. The truth table is actually an analysis of sufficiency (Rihoux & Ragin, 2009, p.110).

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raw consistency is greater than 0.75 and the number 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 cut-off, we can continue the analysis either without specifying assumptions or with specifying the assumptions. So, we assume/decide under which circumstances a condition may contribute to the outcome (Legewie, 2013). We decide whether the condition will be present, or whether it will be absent. After selecting the assumptions, we finally reach the final step of the fuzzy-set QCA analysis, which is 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 in case theoretical hypotheses are formulated. The **complex solution** does not make the above-mentioned simplifying assumptions. It takes all the rows from the truth table which were coded with the number 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 rather complicated solutions (Elliot, 2013). The **parsimonious solution** uses any and all remainder[37] 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 to specify these easy assumptions, when it calculates the intermediate solution; when one selects all causal conditions to be present, the software is instructed that one assumes 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 the 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 combination of conditions in solution formula 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. Hence, it assesses the degree to which a subset relation has been approximated. The higher the consistency of a solution path, the higher the chance you have that a case with such a path also shows the outcome. In the sufficiency analyses, consistency measures the degree to which a path is sufficient for the outcome to occur, indicating in which percentage of the cases this is the case. Some scientists consider a consistency of 0.75 as a satisfying consistency but others set an even higher and more strict threshold and accept only 0.85 or higher as a satisfying consistency. Low consistency is caused by including irrelevant conditions and/or missing crucial conditions, using inadequate values for the conditions, and miscalibrating the conditions or outcomes (Legewie, 2013). In the current analysis a consistency of 0.75 has been used.

Coverage, by contrast, assesses the degree to which a cause or causal combination ''accounts for'' instances of an outcome. When there are several paths to the same outcome, the coverage of any given causal combination may be small. Thus, coverage gauges empirical relevance or importance. Coverage expresses the percentage of cases, which have a particular solution path. Coverage, hence, reports the proportion of membership in the outcome explained by the overall solution term, indicating the percentage of the cases for which that is the case. 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. We can differentiate between 'solution coverage' (indicating how much is covered by the solution term by all paths together); 'raw coverage' (indicating which share of the outcome is explained by a certain alternative path); and 'unique coverage' (indicating which share of the outcome is exclusively explained by a certain alternative path).

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[37] **Logical remainder**: In QCA, limited diversity is shown through the empty cells in the truth table, i.e., no cases that belong to these rows are contained in a data set. These empty rows are called "logical remainders." Being able to identify logical remainders and in this way making limited diversity visible is one of the strengths of QCA (Legewie, 2013).

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Hence, Qualitative Comparative Analysis (QCA) deals with conditions or combinations of conditions, which will lead to certain outcomes. An important issue is how many conditions and cases are the most appropriate to be included in the model. Having a lot of conditions in the model increases the risk of having higher complexity. Thus, we have a high probability of finding contradictory cases. One of the most important parts of the QCA is to develop the truth table. The truth table tells us how many logically possible combinations of values on the causal variable (condition) we have, when the formula is 2^n, meaning when doing the full model (say 7 conditions in our case), the number of possible combinations would be 2^7 or 128 possible combinations. In case of 5 conditions, there would be 32 possible combinations representing only 25% of the combinations, which we would have if we were using 7 conditions. In order to reduce the complexity, it is good to try to simplify the model from 7 conditions to a number as little as possible for explaining the outcome. This is the reason why in the results section a simplification model is applied, by doing exercises for all possible combinations without the inputs (only typology indicators) or with the inputs.

The contribution of the fs-QCA analysis will be important for the validation of the BENEFIT model because through this analysis we will identify which are the most important conditions or combinations of conditions that have an impact on the project infrastructure outcomes (cost, time traffic and revenues).

6.2 Hypotheses and models

Our main models are built based on the "typology indicators" of the Matching Framework (see BENEFIT deliverables D3.1, D2.2, D2.3 and D2.4) or "typology conditions", as they are called using the terminology of the fsQCA method.

Apart from the typology conditions for structuring our models, also some additional conditions regarding inputs are used. These inputs are the 1) mode, 2) use of the infrastructure (for passengers or cargo or both), 3) investment size (high-medium-low), 4) delivery mode (PPP-Public) and 5) Transport Network Configuration (node or link). In the results we will refer to them as 1) roads, 2) passengers, 3) investment size, 4) PPPs and 5) links, respectively. In this part, these conditions are referred to as 'inputs' because once decisions have been taken about them, they do not change in a later stage of the project (see Table 6.2.1).

Table 6.2.1: Conditions and outcomes used in the analysis

No.	Variables	Conditions regarding inputs or typology indicators / Outcomes
1	Roads	Input condition
2	Passengers	Input condition
3	Investment size	Input condition
5	PPP	Input condition
6	Links	Input condition
7	Institutional Context Indicator	Typology condition
8	Financial-economic context Indicator	Typology condition
9	Reliability-Availability (IRA)	Typology condition
10	Governance	Typology condition
11	Cost saving	Typology condition
12	Remuneration scheme	Typology condition
13	Revenue scheme	Typology condition
14	Financing scheme	Typology condition
15	On Cost	Outcome
16	On Time	Outcome
17	On Traffic	Outcome
18	On Revenues	Outcome

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We will analyse both the necessity and sufficiency of conditions for outcomes to be present or absent. The outcomes selected for our analysis refer to four elements:

1) on cost: when this outcome is present, it means that a transport infrastructure project is on or below costs, while its absence implies that the project is over cost.
2) on time, when this outcome is present, it means that a transport infrastructure project is finalized on or before the planned time, while its absence implies that the project is over time.
3) on traffic: when this outcome is present, it means that actual traffic at the transport infrastructure is meeting or exceeding traffic forecasts, while its absence implies that actual traffic is below the forecasted level of traffic.
4) on revenues: when this outcome is present, it means that actual revenues generated by the transport infrastructure are meeting or exceeding revenue forecasts, while its absence implies that actual revenues are below the forecasted level of revenues.

Following the Benefit model 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.

In case of all the typology conditions, the more their value come closer to the value of '1', the more positively they affect the respective outcome and vice versa (for the detailed presentation of the range of values of each indicator, see **Annex A.1**).

We hence test the following hypotheses:

H_{cost} *- Presence of the 'on cost' outcome:*
A combination of a good institutional context and a good financial-economic context and a high cost saving, a high governance, a high remuneration scheme, a high revenue scheme, a high financing scheme will lead projects to be 'on cost'.

H'_{cost} *- Absence of the 'on cost' outcome:*
A combination of a bad institutional context and a bad financial-economic context and a low cost saving, a low governance, a low remuneration scheme, a low revenue scheme, a low financing scheme will lead projects to be 'over cost'.

H_{time} *- Presence of the 'on time' outcome:*
A combination of a good institutional context and a good financial-economic context and a high cost saving, a high governance, a high remuneration scheme, a high revenue scheme, a high financing scheme will lead projects to be 'on time'.

H'_{time} *- Absence of the 'on time' outcome:*
A combination of a bad institutional context and a bad financial-economic context and a low cost saving, a low governance, a low remuneration scheme, a low revenue scheme, a low financing scheme will lead to projects be 'over time'.

$H_{traffic}$ *- Presence of the 'on traffic' outcome:*
A combination of a good institutional context and a good financial-economic context and a high cost saving, a high governance, a high remuneration scheme, a high revenue scheme, a high financing scheme will lead to projects to have actual traffic levels to be equal or above the forecasted traffic level.

$H'_{traffic}$ *- Absence of the 'on traffic' outcome:*
A combination of a bad institutional context and a bad financial-economic context and a low cost saving, a low governance, a low remuneration scheme, a low revenue scheme, a low financing scheme will lead to projects to have actual traffic levels to be below the forecasted traffic level.

$H_{revenue}$ *- Presence of the 'on revenue' outcome:*

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A combination of a good institutional context and a good financial-economic context and a high cost saving, a high governance, a high remuneration scheme, a high revenue scheme, a high financing scheme will lead to projects to have actual revenue levels to be equal or above the forecasted revenue level.

H'$_{revenue}$ *- Absence of the 'on revenue' outcome:*
A combination of a bad institutional context and a bad financial-economic context and a low cost saving, a low governance, a low remuneration scheme, a low revenue scheme, a low financing scheme will lead to projects to have actual revenue levels to be below the forecasted revenue level.

Based on these conditions and outcomes, the models used for the fs QCA analysis were built. As it will be also mentioned in the results section, not all typology conditions are used for the analysis[38]. As a result the models tested are constructed using the rest of the typology conditions in the following way:

Models	Involved projects	Included conditions
Models for the presence and the absence of the 'on cost' outcome	Full sample	Institutional context, Financial-economic context, Cost saving, Governance, Remuneration scheme, Revenue scheme, Financing scheme
Models for the presence and the absence of the 'on cost' outcome	Full sample	Institutional context, Financial-economic context, Cost saving, Governance, Remuneration scheme, Revenue scheme, Financing scheme + Input conditions
Models for the presence and the absence of the 'on cost' outcome	PPP sample	Institutional context, Financial-economic context, Cost saving, Governance, Remuneration scheme, Revenue scheme, Financing scheme
Models for the presence and the absence of the 'on cost' outcome	Road sample	Institutional context, Governance, Remuneration scheme, Revenue Scheme and Financing scheme
Models for the presence and the absence of the 'on time' outcome	Full sample	Institutional context, Financial-economic context, Cost saving, Governance, Remuneration scheme, Revenue scheme, Financing scheme
Models for the presence and the absence of the 'on time' outcome	Full sample	Institutional context, Financial-economic context, Cost saving, Governance, Remuneration scheme, Revenue scheme, Financing scheme + Input conditions
Models for the presence and the absence of the 'on time' outcome	PPP sample	Institutional context, Financial-economic context, Cost saving, Governance, Remuneration scheme, Revenue scheme, Financing scheme
Models for the presence and the absence of the 'on time' outcome	Road sample	Institutional context, Financial and economic context, Cost Saving, Remuneration scheme, Financing scheme
Models for the presence and the absence of the 'on traffic' outcome	Full sample	Institutional context, Financial-economic context, Cost saving, Governance, Remuneration scheme, Revenue scheme, Financing scheme
Models for the presence and the absence of the 'on traffic' outcome	Full sample	Institutional context, Financial-economic context, Cost saving, Governance, Remuneration scheme, Revenue scheme, Financing scheme + Input conditions
Models for the presence and the absence of the 'on traffic' outcome	PPP sample	Institutional context, Financial-economic context, Cost saving, Governance, Remuneration scheme, Revenue scheme, Financing scheme
Models for the presence and the absence of the 'on traffic' outcome	Road sample	Financial-economic context, Remuneration scheme, Institutional context, Governance, Cost saving

[38] More particularly, the IRA indicator is not used as condition for the cost and time analysis because reliability and availability (IRA) of a transport infrastructure can be only tested when the transport infrastructure is in operation. Thus, when we examine the project at the moment of the completion of construction (inauguration phase), before the infrastructure is operational, we cannot say if it is reliable and available. Also, IRA is not used for the revenue and traffic outcome analysis since it is a necessary condition for both the presence and the absence of the outcomes revenue and traffic, rendering it a trivial condition. Revenue support is not used either in any of outcome models because it shows a very limited variation.

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Models	Involved projects	Included conditions
Models for the presence and the absence of the 'on revenue' outcome	Full sample	Institutional context, Financial-economic context, Cost saving, Governance, Remuneration scheme, Revenue scheme, Financing scheme
Models for the presence and the absence of the 'on revenue' outcome	Full sample	Institutional context, Financial-economic context, Cost saving, Governance, Remuneration scheme, Revenue scheme, Financing scheme + Input conditions
Models for the presence and the absence of the 'on revenue' outcome	PPP sample	Institutional context, Financial-economic context, Cost saving, Governance, Remuneration scheme, Revenue scheme, Financing scheme
Models for the presence and the absence of the 'on revenue' outcome	Road sample	Institutional context, Financial-economic context, Cost saving, Revenue scheme and Financing scheme

Each model is described in detail in the respective results section. More particularly, it is described why each model entails particular conditions.

By formulating these hypotheses ex ante, we can use the intermediate solution (and not the complex or the parsimonious solution). The intermediate solution was selected so as to minimize the configurations, instead of the complex solution or parsimonious solution. An intermediate solution has certain advantages. First, it is in between the conservative and the most parsimonious solution in terms of complexity. Second, an intermediate solution is a subset of the most parsimonious solution and a superset of the conservative solution (Schneider & Wagemann, 2013). When running an intermediate solution, simplifying assumptions are made to obtain a simpler minimal formula. Thus in our analyses, simplifying assumptions were set up in line with our hypotheses formulated above (table X). For the presence of the outcome (either on cost, on time, on traffic or on revenue), we assume that all conditions are present and vice versa, in case the outcome is absent, all conditions are specified as being absent.

Findings are presented in tabular form in the following sections of this chapter. A guide on how to "read" the results is offered in Annex A.8.

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6.3 Results of the analysis regarding 'on cost' as an outcome

In this section the necessary and sufficient conditions for the outcome 'on cost' are analysed. The presence of 'on cost' outcome refers to transport infrastructure projects to on or below costs. The absence of the 'on cost' outcome refers to projects to be over costs.

6.3.1 Results of analysis on the full sample

6.3.1.1 Analysis with only typology conditions

In this section, FsQCA analysis is conducted for the 'on cost' outcome. The aim of these analyses is to identify which combinations of conditions are necessary and sufficient to explain transport infrastructure projects to be on cost or over cost. In this section, we present the cost outcome models which entail the typology conditions and which exclude the input conditions (for models including input conditions, see table 6.3.3.-6.3.4 below). By the 'full' sample, we refer to the sample of the 52 cases tested for cost and time outcome analysis (see **Annex A.2**). This sample consists of the inauguration snapshot of each case or the last snapshot, when no inauguration is snapshot available.

We should make clear that the dataset used for the a) cost and time analysis and b) for the traffic and revenue analysis is different. While for the cost and time analysis we used 52 cases and the inauguration snapshot (or the last snapshot), for the traffic and revenue analysis we used 47 cases and the last snapshots of all cases. Only the projects, which were in operation are included in the traffic and revenue dataset, whereas for the cost and time projects also projects which were under construction, but on delay, are also included.

Necessity analysis

The necessity analysis has been conducted for the overall sample so as to see if there are any necessary conditions. Necessary are those conditions, which have a consistency of at least 0.90 in the necessity analysis. When a condition is identified as necessary it is impossible to have the 'on cost' outcome without that condition. In other words, a necessary condition is a condition, which is 'more significant' than the others.

The necessity analysis for the presence and the absence of the outcome 'on cost' was conducted for all the inputs, being mode (roads), use (passengers), investment size, delivery (PPPs) and network (links). It was also conducted for the following typology indicators: 1) the institutional context, 2) the financial-economic context, 3) the governance indicator, 4) the cost saving indicator, 5) the remuneration scheme, 6) the revenue scheme and 7) the financing scheme. The IRA indicator (Indicator of Reliability and Availability) was not tested for necessity because it was not included in the cost and time models as it is also mentioned in the 'theoretical reasoning' section.

In the Table 6.3.1 the necessity analysis is presented for all the indicators and all the inputs. No typology condition is appearing as being necessary.

Table 6.3.1 Necessity analysis of cost outcome

Conditions	On Cost	
	Presence	Absence
High Institutional Context	0.76 (0.64)	0.67 (0.51)
Low Institutional Context	0.42 (0.59)	0.52 (0.66)
High Economic & Financial Context	0.55 (0.63)	0.55 (0.57)
Low Economic & Financial Context	0.62 (0.60)	0.64 (0.56)
High Governance	0.83 (0.66)	0.65 (0.46)

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Conditions	On Cost	
	Presence	Absence
Low Governance	0.31 (0.50)	0.52 (0.74)
High Cost Saving	0.67 (0.65)	0.57 (0.50)
Low Cost Saving	0.49 (0.56)	0.60 (0.62)
High Remuneration Scheme	0.55 (0.60)	0.57 (0.57)
Low Remuneration Scheme	0.61 (0.61)	0.60 (0.54)
High Revenue Scheme	0.61 (0.63)	0.58 (0.54)
Low Revenue Scheme	0.55 (0.59)	0.60 (0.58)
High Financing Scheme	0.49 (0.68)	0.43 (0.54)
Low Financing Scheme	0.67 (0.57)	0.75 (0.57)
Roads	0.46 (0.55)	0.42 (0.45)
Non Roads	0.54 (0.51)	0.58 (0.49)
Passengers	0.24 (0.44)	0.34 (0.56)
Non-passengers	0.76 (0.56)	0.66 (0.44)
High Investment size	0.58 (0.56)	0.61 (0.52)
Low Investment size	0.50 (0.59)	0.48 (0.51)
PPPs	0.84 (0.59)	0.65 (0.41)
Non-PPPs	0.16 (0.34)	0.35 (0.66)
Links	0.64 (0.53)	0.63 (0.47)
Non-Links	0.36 (0.53)	0.37 (0.47)

* *indicates the necessary condition, which is above the threshold that we set (.90)*

Sufficiency analysis

The overall sample analysis includes 52 cases of all modes, entailing PPP and public cases. The models analysed in this section are the following:

H_{cost} *- Presence of the 'on cost' outcome: A combination of a good institutional context and a good financial-economic context and a high cost saving, a high governance, a high remuneration scheme, a high revenue scheme, a high financing scheme will lead projects to be 'on cost'.*

H'_{cost} *- Absence of the 'on cost'' outcome: A combination of a bad institutional context and a bad financial-economic context and a low cost saving, a low governance, a low remuneration scheme, a low revenue scheme, a low financing scheme will lead projects to be 'over cost'*

This model will be examined for the presence and the absence of the 'on cost' outcome, so in total we will examine two models. We have found no relevant solution paths for the presence of the 'on cost' outcome because the raw consistency of the paths was below the 0.75 consistency cut-off threshold. Having no relevant results for 'on cost' means that we are able to explain only which combinations of conditions lead a specific share of projects to be 'over cost'.

In Table 6.3.2 the solution paths of the absence of the 'on cost' outcome are presented. Core conditions are marked green. The overall consistency of the model is 84%. The absence of the 'on cost' outcome can be explained by two solution paths, of which the overall coverage is modest. 36% of the projects, which experience cost overruns are explained by these combinations of conditions. The low overall coverage implies that the explanatory power of these two solution paths is weak. Moreover both solution paths are strongly overlapping. The first path shows that low governance, low cost saving and a high remuneration scheme and low financing scheme are found in a rather small share of the cases, which are over cost or in other words have cost overrun. The remuneration

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scheme here acts differently as formulated in the hypotheses (see part 6.2) as it has a positive sign instead of an expected negative one. This first solution path has a quite high consistency (0.83) and its raw coverage equals to 0.31. Core conditions are the governance and the remuneration scheme, and hence these two factors are closer to providing a causal explanation for projects not being 'on cost'. In the 2nd solution path the core conditions are the same.

Table 6.3.2: **Sufficiency analysis for projects being 'over cost', including only the typology conditions (Consistency cut-off: 0.86)**

Conditions	OUTCOME: ABSENCE of being on cost	
	Solution 1	Solution 2
Institutional Context		~
Financial-economic context		
Governance	~	~
Cost Saving	~	
Remuneration scheme	+	+
Revenue Scheme		~
Financing scheme	~	~
Individual Consistency	0.83	0.87
Coverage (Raw)	0.31	0.26
Coverage (Unique)	0.1	0.05
Number of cases	3	1
Some relevant cases	Berlin Brandenburg Airport (BER), The Hague New Central Train Station, Combiplan Nijverdal	Warsaw's Metro II-nd line
Overall Consistency/Coverage	(0.84/0.36)	

6.3.1.2 Analysis with typology conditions and input conditions

Table 6.3.3 presents the results for the presence of the 'on cost' outcome, while Table 6.3.4 presents the results for the absence of the 'on cost' outcome. In these tables, solution paths per input condition are shown with an indication of how 'strong' each solution path as well as each condition is. The 'strength' of each condition is measured based on the times each condition appears as core in all the solution paths of the different models and also based on the times the condition was behaving according to the hypotheses, i.e. in a consistent way. Moreover, the 'strength' of each solution path is also measured based on the raw coverage of this path. The solution path with the highest raw coverage is considered to have the most explanatory power, since a larger share of the membership of the outcome is explained by the particular path.

When analysing the presence of the 'on cost' outcome, solutions were found for three over five input models: Roads (road or absence of roads), PPPs (PPP or absence of PPP, i.e. public projects) and Links (Link or absence of i.e. node) input models. In table 6.3.3 only solution paths are presented with an overall coverage above 0.30. This implies that only the solution for 'Roads' as input is shown, because the solutions related to the inputs of PPPs and Links had an overall coverage below 0.30, making these solutions insufficient. Across the models presented, the overall coverage is modest. This suggests that the explanatory power of these solutions is not quite strong. The same conclusion holds for the individual solution paths.

For the absence of the ''on cost' outcome (Table 6.3.4), solutions were found for all input models. However, only the roads and investment size solution paths are presented because the solutions linked to the rest of the inputs had an overall coverage <0.30 (this means that solutions related to the inputs of passengers, PPPs and Links are not shown). Again, the overall coverage of the models is rather modest. The same conclusion holds for the individual solution paths.

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Table 6.3.3: Sufficiency analysis for projects to be 'on cost', including the typology conditions as well as the input conditions (models with coverage < 0.3 are not shown)

COST	Institutional Context	Financial and Economic Context	Governance	Cost saving	Remuneration scheme	Revenue Scheme	Financing scheme	**Input**	Coverage (raw)	Coverage (unique)	Overall coverage
Presence **Roads (S1)**		~	+	+	~	+		~	0.20	0.2	0.45
(S2)		+	+	+	+		+	+	0.16	0.002	
(S3)	+		+	+	+		+	+	0.21	0.05	
(S4)	+	+	+	+	+			+	0.18	0.02	
(S5)	+	+	+		+	+	+	+	0.10	0.009	

Table 6.3.4: Sufficiency analysis for projects to be 'over cost' (absence of 'on cost' outcome), including the typology conditions as well as the input conditions (models with coverage below 0.3 are not shown)

COST	Institutional Context	Financial-economic context	Governance	Cost saving	Remuneration scheme	Revenue Scheme	Financing scheme	Input	Coverage (raw)	Coverage (unique)	Overall coverage
Absence **Only Typology Conditions (S1)**			~	~	+		~		0.31	0.1	0.36
(S2)	~		~		+	~	~		0.26	0.05	
Absence **Roads (S1)**	~		~			~	~	~	0.18	0.03	0.45
(S2)	~	~	~	~	~	~			0.27	0.01	
(S3)	~	~	~	~	~		~		0.31	0.04	
(S4)		+	~	~		+	~	~	0.21	0.02	
(S5)		+		~	+	~	~	~	0.21	0.03	
Absence **Investment Size (S1)**			~	~	~		~		0.31	0.1	0.36
(S2)	~		~		+	~	~		0.26	0.05	

The comparison of the two tables 6.3.3 and 6.3.4, and the related solutions, shows that 1) the institutional context, 2) the governance and 3) the cost saving always act in line with the formulated hypotheses. The revenue scheme and financing scheme acted only in one solution path contrary to what was formulated in the hypotheses. The conditions ''financial-economic context" and 'remuneration scheme' act in contrast to what was formulated in the hypotheses in many of the solution paths. It is important to point out that these conclusions result from all the solution paths (input model results) and not only from the ones shown in the tables above.

These results are the main findings of our cost outcome analysis and form the basis of the next model. In this model, the conditions inserted are the three conditions, which always act in line with the formulated hypotheses in the previous analysis: 1) governance, 2) cost saving and 3) institutional context. Testing for "strength", the new model is able to explain 50% of the cases in total, which are 'over cost' (Table 6.3.5). The model is tested for both the presence and the absence of the cost outcome and solutions were only found for the absence of the "on cost" outcome. It is interesting to

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point out that not only the raw and unique coverage of the new model is improved but also that the absence of governance appears as a core condition. This shows that a low governance indicator combined with other conditions could explain a substantial share of cases with cost overrun.

Table 6.3.5: Sufficiency analysis for projects to be 'over cost', including only the typology conditions (Consistency cut-off 0.75) – simplified model

Conditions	Absence of outcome 'on cost'	
	Solution 1	Solution 2
Governance	~	~
Cost saving	~	
Institutional context		~
Individual Consistency	0.749	0.76
Coverage (Raw)	0.44	0.40
Coverage (Unique)	0.10	0.07
Number of cases	11	5
Some relevant cases	Blanka Tunnel (0.89,1), Berlin Brandenburg Airport (0.84,1), Motorway E-75. Section Donji Neradovac - Srpska kuca (0.78,1), Motorway E-75. Section Horgos-Novi Sad (2nd phase) (0.78,1), Barcelona Europe South Terminal (0.7,1), Hague New central station (0.55,1), Combiplan Nijverdal (0.54,1)	Motorway E-75. Section Donji Neradovac - Srpska kuca (0.78,1), Motorway E-75. Section Horgos-Novi Sad (2nd phase) (0.78,1), Warsaw's Metro II-nd line (0.59,1),
Overall Consistency/Coverage	(0.75/0.50)	

6.3.2 Sub-sample analysis with focus on the PPP cases

Necessity Analysis

This section presents the results of the fs QCA analysis conducted on the subsample of PPP cases (39 cases). The necessity analysis showed that no typology conditions came out as being necessary (Table 6.3.6).

Table 6.3.6: Necessity analysis of cost outcome for the subsample of the PPP cases

Conditions	On Cost	
	Presence	Absence
High Institutional Context	0.80 (0.71)	0.74 (0.46)
Low Institutional Context	0.39 (0.68)	0.54 (0.65)
High Economic & Financial Context	0.56 (0.75)	0.53 (0.49)
Low Economic & Financial Context	0.62 (0.66)	0.73 (0.69)
High Governance	0.87 (0.68)	0.81 (0.44)
Low Governance	0.29 (0.68)	0.42 (0.69)
High Cost Saving	0.72 (0.69)	0.70 (0.47)
Low Cost Saving	0.45 (0.69)	0.54 (0.58)
High Remuneration Scheme	0.60 (0.72)	0.60 (0.49)
Low Remuneration Scheme	0.58 (0.67)	0.66 (0.54)
High Revenue Scheme	0.61 (0.68)	0.66 (0.51)
Low Revenue Scheme	0.56 (0.70)	0.58 (0.51)

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Conditions	On Cost	
	Presence	Absence
High Financing Scheme	0.54 (0.69)	0.61 (0.53)
Low Financing Scheme	0.63 (0.70)	0.65 (0.50)

** indicates the necessary condition, which is above the threshold that we set (.90)*

Sufficiency analysis

The same seven typology conditions which were used for the overall sample analysis (52 cases) are also used for the analysis of the PPP cases sub-sample (39 cases). The 'presence of the 'on cost' outcome' gave one solution with a specific combination of conditions, which appears in 32% of on cost or below cost projects. All the conditions are consistent (+ sign) and only the financing scheme is inconsistent (~ sign). Otherwise, the combination of low financing scheme with high institutional context, financial economic context, governance and cost saving is sufficient for these projects to be 'on costs'. Typically, these describe plausible conditions to achieve "on cost". A low value of the financing indicator suggests a large contribution by the public sector. This could be considered as being contrary to the hypotheses we formulated in the theoretical part (Table 6.3.7).

42% of the PPP cases with cost overrun show low institutional context and low revenue scheme indicators (Table 6.3.7).

Table 6.3.7: Sufficiency analysis for PPP projects to be 'on cost' and 'over cost', including the typology conditions

Conditions	OUTCOME: presence of 'on cost' (cut-off: 0.77)	OUTCOME: absence of 'on cost' (cut-off: 0.83)
	Solution 1	Solution 1
Institutional context	+	~
Financial-economic context	+	
Governance	+	
Cost Saving	+	
Remuneration scheme		
Revenue Scheme		~
Financing scheme	~	
Individual Consistency	0.79	0.76
Coverage (Raw)	0.32	0.42
Coverage (Unique)	0.32	0.42
Number of cases	4	1
Some relevant cases	Herrentunnel Lübeck (0.63,0.8), M-80 (Haggs) (0.56,0.8), MST-Metro Sul do Tejo (0.56,0.8)	
Overall Consistency/Coverage	(0.79/0.32)	(0.76/0.42)

After scrutinizing the results of the presence and the absence of the cost outcome, we conclude that all the indicators (financial-economic context, cost saving, revenue scheme, institutional context, governance) are acting in line with the formulated hypotheses. This is not the case for the financing scheme. Also remuneration scheme does not appear in the solution.

Based on the above conclusions, a new model was tested by inserting the five conditions which are acting according to the hypotheses: 1) financial-economic context, 2) cost saving, 3) revenue scheme, 4) institutional context and 5) governance. The new model seems more robust since 62 % of the PPP projects being on cost can be now explained in comparison with 32% in the initial full model. The

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solution path is more parsimonious, showing that high cost saving and high institutional context and good governance are sufficient conditions (Table 6.3.8).

Table 6.3.8: Sufficiency analysis for PPP projects to be 'on cost' – simpler model (Consistency cut-off 0.75)

Conditions	OUTCOME: of outcome and conditions
	Solution 1
Financial-economic context	
Costs saving	+
Revenue scheme	
Institutional context	+
Governance	+
Individual Consistency	0.75
Coverage (Raw)	0.62
Coverage (Unique)	0.62
Number of cases	21
E39 Orkdalsvegen Public Road (0.84, 0.8), Metrolink LRT. Manchester (0.84,0.8), M-25 Orbital (0.83,0.8), M-80 (Haggs) (0.76,0.8), E4 Helsinki-Lahti (0.76,0.8), Larnaca and Paphos International Airports (0.72,0.8), Herrentunnel Lübeck (0.7,0.8), VIa-Invest Zaventem (0.7,1), MST-Metro Sul do Tejo (0.65,0.8), A22 motorway (0.64,0.8), Lusoponte Vasco da Gama Bridge (0.63,0.8), A-19 Dishforth (0.6,0.8), Port of Leixoes (0.58,0.8), A23 motorway (0.54,0.8),	
Overall Consistency/Coverage	(0.75/0.62)

6.3.3 Sub-sample analysis with a focus on road cases

Further analyses were also conducted for the sub-sample of the road cases (23 cases). For these analyses only five typology conditions could maximally be used. The selection was made based on the section 6.3.1. So, the model used was the following:

COST: 1) Institutional context, 2) Governance, 3) Remuneration scheme, 4) Revenue Scheme and 5) Financing scheme

Necessity Analysis

Although no condition appears to be necessary (0.90 consistency), it is important to mention that the governance indicator had a consistency of 0.89. This means that this condition is close to be a necessary condition for projects to be 'on cost' (see table 6.3.9).

Table 6.3.9: Necessity analysis of cost outcome for the road cases

Conditions	On Cost	
	Presence	Absence
High Institutional Context	0.78 (0.71)	0.56 (0.42)
Low Institutional Context	0.36 (0.50)	0.61 (0.70)
High Governance	0.89 (0.68)	0.69 (0.43)
Low Governance	0.25 (0.49)	0.48 (0.79)
High Remuneration Scheme	0.67 (0.75)	0.43 (0.40)
Low Remuneration Scheme	0.48 (0.50)	0.74 (0.64)
High Revenue Scheme	0.50 (0.55)	0.65 (0.59)
Low Revenue Scheme	0.63 (0.68)	0.51 (0.45)
High Financing Scheme	0.67 (0.70)	0.55 (0.47)

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Conditions	On Cost	
	Presence	Absence
Low Financing Scheme	0.50 (0.57)	0.66 (0.62)

** indicates the necessary condition, which is above the threshold that we set (.90)*

Sufficiency analysis

A significant share of road cases which were 'on cost or below cost' (48%) are explained by the following combination of conditions: high **institutional context (core)**, combined with high governance and high **remuneration scheme (core)** and high **financing scheme (core)** (Table 6.3.10). 48% of the road cases being on cost are explained by the sufficient combinations in Table 6.3.10.

The other path presented in (solution 1) is very similar with path two. Only one condition is different (revenue scheme instead of financing scheme). Because the paths are overlapping, the unique coverage is low (0.03 and 0.09).

Table 6.3.10: Sufficiency analysis for the presence and the absence of the 'on cost' outcome, involving the subsample of road projects

Conditions	**OUTCOME: cost-presence of outcome and conditions (cut-off: 0.80)**	**OUTCOME: cost-absence of outcome and conditions (cut-off: 0.79)**	
	Solution 1	Solution 1	Solution 2
Institutional context	+	~	~
Governance	+	~	~
Remuneration scheme	+	~	~
Revenue Scheme		~	
Financing scheme	+		~
Individual Consistency	0.80	0.80	0.81
Coverage (Raw)	0.48	0.34	0.40
Coverage (Unique)	0.48	0.03	0.09
Number of cases	6	1	2
Some relevant cases	M-25 Orbital (0.81,0.8), A22 motorway (0.62,0.8), A23 motorway (0.62,0.8), E18 Muurla-Lohja (0.6,0.8), A-19 Dishforth (0.57,0.8)	-	Motorway E-75. Section Donji Neradovac - Srpska kuca (0.78,1), Motorway E-75. Section Horgos-Novi Sad (2nd phase) (0.78,1)
Overall Consistency/Coverage	(0.80/0.48)	(0.79/0.43)	

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The analyses started with the expectation that all typology conditions would act in combination to bring about the desired outcome. However, the subsequent rounds of analyses regarding the 'on cost' outcome result in the following **findings**:

- **Regarding the overall sample of infrastructure projects (52 cases):**
  - When including all typology indicators in our model we cannot find any paths showing sufficient conditions for projects to be 'on or above costs'. Regarding infrastructure projects which experience cost overrun, we can only find paths covering less or up to 50% of these projects after adopting more simple models with fewer conditions. 50% of the infrastructure projects over cost show low levels of governance with low levels of cost savings or with a bad institutional context as sufficient conditions.
  - When including road (mode) or PPP (delivery) as an extra condition additionally to the typology conditions, a minor share of the projects (around one third) being on time show relevant paths. However, clearly being a PPP project in combination with other conditions does not fully guarantee projects being on cost (or over costs).
  - Overall, when considering all analyses regarding the total sample of infrastructure projects, the following three conditions (in combination with other conditions) act at least in a share of the projects on costs and the projects over costs, as we expected them to do: governance, institutional context and cost saving. However, the combinations of conditions found only explain less than one third or half of the involved outcome, meaning that their explanatory value is rather low.

- **Regarding the sub-sample of PPP projects (39 cases):**
  - A high level of governance is *close to* being a necessary condition for projects to be on cost (0.87 consistency).
  - 21 PPP projects in our sample which are 'on or below costs' have high levels of cost saving and a good institutional context, in combination with a high level of governance as sufficient conditions (62% coverage). However, the consistency of this solution is not very convincing (75%).
  - Cost overrun in PPP projects in our sample is less straightforward to explain. Only 42% of the membership of this outcome is explained by the sufficient combination, which entails a bad institutional context and a bad revenue scheme (76% consistency).

- **Regarding the sub-sample of roads (23 cases):**
  - A high level of governance *is close* to being a necessary condition for projects to be on cost (0.89 consistency).
  - Somewhat less than half of the road projects which are on costs show to have a sufficient combination of a good institutional context, a good remuneration scheme and financing scheme, in combination with a high governance level. Similarly, the same conditions, although in their negative value, show to be a sufficient combination of conditions for less than half of the road projects which are over costs.
  - Overall, regarding the analyses concerning costs, there were no conditions which showed to be necessary and the coverage of the models was mostly weak (= or < 0.5), showing that it is not easy to find necessary and sufficient conditions to explain projects to be on time or over time. However, the explanatory power of the models improves to some extent when looking to sub-samples such as PPP projects.

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6.4 Results of the analysis regarding 'on time' as an outcome

6.4.1 Results of 'on time' analysis on the full sample

6.4.1.1 Analysis with only typology conditions

In this section, the combinations of conditions that are necessary and sufficient for transport infrastructure projects to be 'on time' are analysed. Thus, we will examine which combinations of conditions lead a share of projects to be on/before time (i.e. presence of the outcome) and over time (i.e. the absence of the outcome).

Necessity analysis

None of the typology conditions shows to be necessary in Table 6.4.1. Table 6.4.1 also presents the necessity analysis of the input conditions. The only necessary input condition is the 'PPPs' (consistency: 0.93). This means that in 93% of the cases being a PPP project is a necessary condition for projects to be 'on time'.

Table 6.4.1: Necessity analysis of the 'on time' outcome for the full sample

Conditions	On Time	
	Presence	Absence
High Institutional Context	0.80 (0.55)	0.63 (0.57)
Low Institutional Context	0.38 (0.44)	0.50 (0.76)
High Economic & Financial Context	0.57 (0.54)	0.49 (0.60)
Low Economic & Financial Context	0.58 (0.47)	0.63 (0.66)
High Governance	0.89 (0.58)	0.61 (0.52)
Low Governance	0.26 (0.34)	0.50 (0.85)
High Cost Saving	0.72 (0.58)	0.52 (0.55)
Low Cost Saving	0.44 (0.41)	0.60 (0.74)
High Remuneration Scheme	0.59 (0.54)	0.51 (0.61)
Low Remuneration Scheme	0.57 (0.47)	0.61 (0.66)
High Revenue Scheme	0.63 (0.53)	0.54 (0.60)
Low Revenue Scheme	0.52 (0.46)	0.58 (0.67)
High Financing Scheme	0.53 (0.61)	0.38 (0.57)
Low Financing Scheme	0.63 (0.44)	0.74 (0.67)
Roads	0.44 (0.43)	0.44 (0.57)
Non Roads	0.56 (0.43)	0.56 (0.57)
Passengers	0.34 (0.51)	0.25 (0.49)
Non-passengers	0.66 (0.41)	0.75 (0.59)
High Investment size	0.65 (0.51)	0.55 (0.56)
Low Investment size	0.44 (0.43)	0.52 (0.66)
PPPs	**0.93 (0.54)***	0.61 (0.46)
Non-PPPs	0.07 (0.12)	0.39 (0.88)
Links	0.65 (0.45)	0.62 (0.55)
Non-Links	0.35 (0.41)	0.38 (0.59)

** indicates the necessary condition, which is above the threshold that we set (.90)*

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Sufficiency analysis
The models analysed in this section are the following:

H_{time} *- Presence of the 'on time' outcome: A combination of a good institutional context and a good financial-economic context and a high cost saving, a high governance, a high remuneration scheme, a high revenue scheme, a high financing scheme will lead projects to be 'on time'*

H'_{time} *- Absence of the 'on time' outcome: A combination of a bad institutional context and a bad financial-economic context and a low cost saving, a low governance, a low remuneration scheme, a low revenue scheme, a low financing scheme will lead to projects be 'over time'*

There are no results for the presence of the 'on time' outcome. In Table 6.4.2 the solution for the 'absence of the on time outcome' analysis are presented. These solutions have an overall coverage referring to 63% of the cases with time overrun. The absence of being on time can be explained by 5 solution paths. The 'strongest' path, which is the path with the highest raw coverage, is the first path. The highest percentage of cases with time overrun are explained by a combination of low cost saving and low remuneration scheme. It is also important to mention that all the paths are very much overlapping (hence the unique coverage is very low).

Table 6.4.2: Sufficiency analysis for projects being 'over time', including only the typology conditions (cut-off: 0.78)

Conditions	OUTCOME: (on time)-absence of outcome and conditions				
	Solution 1	**Solution 2**	**Solution 3**	**Solution 4**	**Solution 5**
Institutional Context		~	~		
Financial-economic context		~		+	+
Governance			~	~	
Cost Saving	~			~	~
Remuneration scheme	~	~			
Revenue Scheme			~		~
Financing Scheme		~	~	~	~
Individual Consistency	0.79	0.8	0.90	0.88	0.82
Coverage (Raw)	0.46	0.41	0.30	0.29	0.31
Coverage (Unique)	0.1	0.04	0.02	0.02	0.03
Number of cases	9	7	1	6	5
Some relevant cases	Modlin Regional Airport (0.97,1), Motorway E-75. Section Donji Neradovac - Srpska kuca (0.84,1), Motorway E-75. Section Horgos-Novi Sad (2nd phase) (0.84,1), Piraeus Container (0.84,1), Port of Agaete (0.76,1), Metro de Malaga	Motorway E-75. Section Donji Neradovac - Srpska kuca (0.88,1), Motorway E-75. Section Horgos-Novi Sad (2nd phase) (0.78,1), Elefsina Korinthos Patra Pyrgos Tsakona Motorway (0.72,1),	Warsaw's Metro II-nd line (0.59,1)	Berlin Brandenburg Airport (0.84,1), Blanka Tunnel (0.7,1), Modlin Regional Airport (0.56,1), Hague New central station (0.55,1), Combiplan Nijverdal (0.54,1)	Blanka Tunnel (0.7,1), Reims tramway (0.56,1), Hague New central station (0.55,1), Combiplan Nijverdal (0.54,1)

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Conditions	OUTCOME: (on time)-absence of outcome and conditions				
	Solution 1	Solution 2	Solution 3	Solution 4	Solution 5
	(0.75,1),				
Overall Consistency/Coverage	(0.79/0.63)				

6.4.1.2 Analysis with typology conditions and input conditions

For the 'input models' (analysis adding one input condition additionally to the seven typology conditions), a solution was found for the 'Roads input model' with only 12% coverage (table is not shown here, since overall coverage is below 0.30).

For the absence of the 'on time' analysis solutions were found for all five inputs. However in table 6.4.3 the solution paths of only four out of the five input models are presented. The links solution paths are not shown because their overall coverage was <0.30.

Table 6.4.3: Sufficiency analysis for projects being 'over time', including the typology conditions and the input conditions

TIME	Institutional Context		Financial-economic context	Governance	Cost saving	Remuneration scheme	Revenue Scheme	Financing scheme	**Input**	Coverage (raw)	Coverage (unique)	Overall coverage
Only Typology Indicators (S1)					~	~				0.46	0.1	0.63
(S2)	~		~			~		~		0.41	0.04	
(S3)	~			~			~	~		0.30	0.02	
(S4)			+	~	~			~		0.29	0.02	
(S5)			+		~		~	~		0.31	0.03	
Roads (S1)				~	~		+	~	~	0.17	0.08	0.50
(S2)	~		~			~		~	+	0.20	0.09	
(S3)			+		~	+	~	~	~	0.19	0.07	
(S4)	~		~	~	~	~	~		~	0.12	0.01	
(S5)	~		+	~		+	~	~	~	0.13	0.02	
Passenger (S1)				~	~			~	~	0.31	0.12	0.43
(S2)	~			~			~	~		0.30	0.11	
(S3)	~		~	~	~	~	~		~	0.19	0.01	
Investment size (S1)				~	~			~		0.40	0.06	0.55
(S2)					~		~	~		0.40	0.04	
(S3)			+		~		+			0.3	0.01	
(S4)	~			~			~	~		0.30	0.04	
(S5)	~		~	~	~	~	~			0.26	0.01	
PPPs (S1)				~	~			~	~	0.22	0.08	0.44
(S2)	~			~			~	~	~	0.13	0.02	
(S3)			~		~	~	~	~		0.29	0.19	
(S4)	~		~		~	~		~	~	0.15	0.01	
(S5)	~			~	~	~	~	~	~	0.11	0.01	

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Based on the abovementioned analyses, we conclude that the following conditions, governance, cost saving, institutional context and financing scheme always act in line with the formulated hypotheses. The conditions financial-economic context and remuneration scheme act in many solution paths in a way which is contrary to what is formulated in the hypotheses. Revenue scheme also acts in two solution paths contrary to the hypotheses.

Based on these conclusions drawn for the 'on time' analysis, a new model was tested (Table 6.4.4). Only the conditions acting consistently are included: 1) governance, 2) cost saving, 3) institutional context and 4) financing scheme. No results were found for the presence. The new model analyses whether the combination of low governance, low cost saving, bad institutional stetting and low financing scheme leads to projects to be over time. Table 6.4.4 shows the solution, which is equally strong but with more parsimonious solution paths.

Table 6.4.4: Sufficiency analysis for projects being 'over time', including typology conditions which act in line with the hypotheses (Consistency cut-off 0.77)

Conditions	**OUTCOME: absence of 'on time'**		
	Solution 1	**Solution 2**	**Solution 3**
Governance		~	~
Cost saving	~	~	
Institutional context		~	~
Financing scheme	~		~
Individual Consistency	0.77	0.89	0.88
Coverage (Raw)	0.55	0.32	0.37
Coverage (Unique)	0.23	0.01	0.06
Number of cases	17	3	4
Some relevant cases	Modlin Regional Airport (0.94,1), Blanka Tunnel (0.94,1), Berlin Brandenburg Airport (0.92,1), Motorway E-75. Section Donji Neradovac - Srpska kuca (0.84,1), Motorway E-75. Section Horgos-Novi Sad (2nd phase) (0.84,1), Port of Agaete (0.76,1), Reims tramway (0.75,1), Metro de Malaga (0.73,1), FERTAGUS Train (0.6,1), A5 Maribor Pince Motorway (0.59,1), Liefkenshoek Rail Link (0.57,1), Hague New central station (0.55,1), Combiplan Nijverdal (0.54,1), Koper - Izola Expressway (0.51,1)	Motorway E-75. Section Donji Neradovac - Srpska kuca (0.78,1), Motorway E-75. Section Horgos-Novi Sad (2nd phase) (0.78,1), Piraeus Container (0.6,1)	Motorway E-75. Section Donji Neradovac - Srpska kuca (0.78,1), Motorway E-75. Section Horgos-Novi Sad (2nd phase) (0.78,1), Warsaw's Metro II-nd line (0.59,1), Belgrade Bybass Project (0.59,1)
Overall Consistency/Coverage	(0.78/0.62)		

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6.4.2 Results of the 'on time' analysis with respect to the PPP cases

Necessity analysis for the PPP – cases

The necessity analysis is made for the seven typology conditions. According to the necessity analysis conducted for the time outcome of the PPP cases sub-sample, no condition has consistency above or equal to 0.90 (Table 6.4.5).

Table 6.4.5: Necessity analysis of the 'on time' outcome for the PPP sample

Conditions	On Time	
	Presence	Absence
High Institutional Context	0.80 (0.65)	0.69 (0.48)
Low Institutional Context	0.36 (0.58)	0.50 (0.69)
High Economic & Financial Context	0.57 (0.69)	0.47 (0.49)
Low Economic & Financial Context	0.58 (0.56)	0.70 (0.58)
High Governance	0.89 (0.64)	0.75 (0.46)
Low Governance	0.25 (0.55)	0.41 (0.76)
High Cost Saving	0.74 (0.65)	0.64 (0.48)
Low Cost Saving	0.41(0.57)	0.54 (0.64)
High Remuneration Scheme	0.61 (0.67)	0.55 (0.51)
Low Remuneration Scheme	0.55 (0.59)	0.64 (0.59)
High Revenue Scheme	0.63 (0.63)	0.59 (0.51)
Low Revenue Scheme	0.52 (0.60)	0.58 (0.57)
High Financing Scheme	0.56 (0.65)	0.54 (0.54)
Low Financing Scheme	0.60 (0.61)	0.65 (0.56)

** indicates the necessary condition, which is above the threshold that we set (.90)*

Sufficiency analysis for the PPP cases

Only one solution path was found for the absence of the on time outcome, including low cost saving, low revenue scheme and low financing scheme. This is the combination by which a substantial share of cases with time overrun (39%) is explained (Table 6.4.6). The conditions 'cost saving' and 'revenue scheme' are also core conditions, making them more important to explain time overrun.

Table 6.4.6: Sufficiency analysis for PPP projects being 'over time', including the typology conditions (cut-off: 0.80)

Conditions	OUTCOME: (time)-absence of outcome and conditions
	Solution 1
Institutional Context	
Financial-economic context	
Governance	
Cost Saving	~
Remuneration scheme	
Revenue Scheme	~
Financing scheme	~
Individual Consistency	0.76
Coverage (Raw)	0.39
Coverage (Unique)	0.39
Number of cases	5
Some relevant cases	Reims tramway (0.69,1), Metro de Malaga (0.58,1), Liefkenshoek Rail Link (0.57,1), FERTAGUS Train (0.51,1)
Overall Consistency/Coverage	(0.76/0.39)

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The PPP cases analysis for the time outcome showed that the following conditions acted as formulated in the hypotheses: 1) cost saving, 2) revenue scheme and 3) financing scheme. The other conditions do not appear in the paths.

6.4.3 Results of the 'on time' analysis with respect to the road cases

The road cases sub-sample consists of 23 cases. The models examined are the following:

TIME: institutional context, financial-economic context, cost saving, remuneration scheme and financing scheme.

Necessity analysis for the road cases
The necessity analysis is conducted for the five conditions selected and is presented in Table 6.4.7. No condition showed to be necessary for projects to be on time or over time.

Table 6.4.7: Necessity analysis of the 'on time' outcome for the road cases

Conditions	On Time	
	Presence	Absence
High Institutional Context	0.85 (0.61)	0.54 (0.51)
Low Institutional Context	0.31 (0.34)	0.58 (0.83)
High Economic & Financial Context	0.61 (0.61)	0.41 (0.54)
Low Economic & Financial Context	0.54 (0.41)	0.70 (0.70)
High Cost Saving	0.74 (0.53)	0.65 (0.60)
Low Cost Saving	0.44 (0.49)	0.49 (0.71)
High Remuneration Scheme	0.77 (0.69)	0.39 (0.46)
Low Remuneration Scheme	0.40 (0.34)	0.74 (0.81)
High Financing Scheme	0.71 (0.59)	0.52 (0.56)
Low Financing Scheme	0.47 (0.43)	0.62 (0.73)

** indicates the necessary condition, which is above the threshold that we set (.90)*

Sufficiency analysis for the Road cases
The analysis of the 'presence of the on time outcome' yielded a solution, but with overall coverage below 0.30.

Testing the absence of the on time outcome for the road cases showed us that for 41% of the road cases with time overrun, financing scheme does not have any impact on projects being over time, as this condition does not appear in the solution path (see table 6.4.8). The other four conditions of the model are core conditions. However, the coverage of this solution is rather low (0.41).

Table 6.4.8: Sufficiency analysis for road projects being 'over time', including selected typology conditions (cut off: 0.92)

Conditions	OUTCOME: (time)-absence of outcome and conditions
	Solution 1
Institutional context	~
Financial-economic context	~
Cost Saving	~
Remuneration scheme	~
Financing scheme	
Individual Consistency	0.93

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Conditions	OUTCOME: (time)-absence of outcome and conditions
	Solution 1
Coverage (Raw)	0.41
Coverage (Unique)	0.41
Number of cases	3
Some relevant cases	Motorway E-75. Section Donji Neradovac - Srpska kuca (0.84,1), Piraeus Container (0.84,1), Motorway E-75. Section Horgos-Novi Sad (2nd phase) (0.78,1)
Overall Consistency/Coverage	(0.93/0.41)

Based on the results of the road analysis for the presence and absence of the time outcome, it is concluded that all indicators acted in line with the hypotheses except for the cost saving indicator. The next model therefore does not include the "cost saving" condition.

The results of the new model showed that for the presence of the 'on time' outcome, the coverage of the solution is now above 0.30 (Table 6.4.9).

Table 6.4.9: Sufficiency analysis for road projects being 'on time' and 'over time', including selected typology conditions

Conditions	OUTCOME: of outcome and conditions – Presence - Consistency cut-off : 0.7495	OUTCOME: of outcome and conditions – Absence consistency cut-off (0.91)
	Solution 1	Solution 1
Financial-economic context	+	~
Remuneration scheme	+	~
Financing scheme	+	
Institutional Context	+	~
Individual Consistency	0.7495	0.92
Coverage (Raw)	0.43	0.54
Coverage (Unique)	0.43	0.54
Number of cases	3	6
Some relevant cases	M-45 (0.64,0.8), E18 Muurla-Lohja (0.6,0.8), A-19 Dishforth (0.57,0.8)	Motorway E-75. Section Donji Neradovac - Srpska kuca (0.88,1), Piraeus Container (0.88,1), Motorway E-75. Section Horgos-Novi Sad (2nd phase) (0.78,1), Elefsina Korinthos Patra Pyrgos Tsakona Motorway (0.72,1), Moreas Motorway (0.72,1)
Overall Consistency/Coverage	(0.7495/0.43)	(0.92/0.54)

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The analyses started with the expectation that all typology conditions would act in combination to bring about the desired outcome. However, the subsequent rounds of analyses regarding the 'on time' outcome result in the following **findings**:

- **Regarding the overall sample of infrastructure projects (52 cases):**
  - A high level of governance is *close to* being a necessary condition for the presence of the 'on time' outcome (89% consistency). *Being a PPP project shows to be a necessary condition for infrastructure projects in our sample to be on time (93 % consistency).*
  - When including all typology indicators in our model we cannot find any paths showing sufficient conditions for projects to be 'on or below time'. This suggests that explaining which combination of conditions makes projects to be 'on time' is impossible for the full sample.
  - Regarding infrastructure projects, which experience time overrun, we found paths covering up to 63% of these projects. After adopting more simple models with fewer conditions the paths were covering almost the same percentage of projects (62%). 62% of the infrastructure projects over time show to have different combinations of low levels of governance, low levels of cost savings, a low level of financing scheme and a bad institutional context as sufficient conditions.
  - The input conditions did not have equivocal effects. When including PPP as an extra condition, we found paths for projects being over time, which are covering up to 44% of projects. Hence, not being a PPP project *in combination with other conditions* can lead projects to be over time.
  - Overall, when considering all analyses regarding the total sample of infrastructure projects, the following four conditions (in different combinations with each other) act at least in a share of the projects over time as we expected them to do: low levels of **governance, institutional context, cost saving, financing scheme**. The combination of conditions explain approximately 63% of the involved outcome, meaning that their explanatory value is quite satisfying.

- **Regarding the sub-sample of PPP projects (39 cases):**
  - We found no paths showing sufficient conditions for projects to be 'on or below time' when testing the sub-sample of PPP cases.
  - Testing the full typology conditions model and the more simple models (with fewer conditions) we identified low cost saving and low revenue scheme and low financing scheme as sufficient conditions. However, the percentage of cases explained by this combination is not very high (39%) and the consistency is not very convincing (76%). Cost saving and revenue scheme appear as core conditions in both analyses.

- **Regarding the sub-sample of roads (23 cases):**
  - Coverage of the solutions explaining projects to be over time is quite low for the subsample of road projects (mostly >0.5). Testing simpler models, low levels of financial-economic context, remuneration scheme and institutional context showed together to be sufficient conditions for road projects to be over time in 54% of the cases. The same combination of high levels of financial-economic context, remuneration scheme and institutional context together with high levels of financing scheme is a sufficient combination, which shows in 43% of the road projects to be on time.
  - Overall, regarding the analyses concerning time, there were no conditions which showed to be necessary **(only PPP input)**. Only for projects over time (around 60%), we found combinations of conditions. When looking at sub-samples the coverage of the models decreased.

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6.5 Results of the analysis regarding 'on traffic' as an outcome

6.5.1 Results of the 'on traffic' analysis with respect to the full sample

6.5.1.1 Analysis with only typology conditions

In this section, FsQCA analysis is conducted for the traffic outcome. We define "on traffic" as outcome meaning that the actual traffic is either as forecasted or exceeding the forecasts. We refer here to the sample of the 47 cases, which are composed by the last snapshots of all cases. Only the projects, which were in operation were included in the traffic dataset. The models analysed in this section are:

$H_{traffic}$ *- Presence of the 'on traffic' outcome: A combination of a good institutional context and a good financial-economic context and a high cost saving, a high governance, a high remuneration scheme, a high revenue scheme, a high financing scheme will lead to projects to have actual traffic levels to be equal or above the forecasted traffic level.*

$H'_{traffic}$ *- Absence of the 'on traffic' outcome: A combination of a bad institutional context and a bad financial-economic context and a low cost saving, a low governance, a low remuneration scheme, a low revenue scheme, a low financing scheme will lead to projects to have actual traffic levels to be below the forecasted traffic level.*

Necessity Analysis

The necessity analysis was conducted for the full sample so as to assess if there are any necessary conditions. The revenue support indicator cannot be taken into account in the model, because it shows a very limited degree of variation. Moreover, in this analysis, we also do not use the IRA indicator, because when doing the analysis of necessary conditions the IRA indicators acted as an "ambiguity condition", meaning it is a necessary condition for both the presence and the absence of the 'on traffic' outcome. Indeed, only one case in the sample (47 cases) had a value of IRA below 0.5 while 98% of the cases had a value above 0.5. Table 6.5.1 presents the analysis of necessary conditions. Apart from the IRA typology condition, no other typology condition appears as being necessary.

Table 6.5.1: Necessity analysis of the 'on traffic' outcome for the full sample

Conditions	On Traffic	
	Presence	Absence
High Institutional Context	0.82 (0.69)	0.73 (0.59)
Low Institutional Context	0.49 (0.67)	0.59 (0.78)
High Financial-economic context	0.52 (0.78)	0.40 (0.59)
Low Financial-economic context	0.71 (0.57)	0.84 (0.64)
High IRA	0.99 (0.52)*)	0.95(0.50)*)
Low IRA	0.03 (0.40)	0.08 (0.93)
High Governance	0.83 (0.63)	0.78 (0.55)
Low Governance	0.41 (0.66)	0.48 (0.72)
High Cost Saving	0.72 (0.67)	0.69 (0.59)
Low Cost Saving	0.56 (0.66)	0.61 (0.67)
High Remuneration Scheme	0.68 (0.75)	0.55 (0.56)
Low Remuneration Scheme	0.60(0.59)	0.76 (0.69)
High Revenue Scheme	0.62 (0.62)	0.64 (0.60)

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Conditions	On Traffic	
	Presence	Absence
Low Revenue Scheme	0.60 (0.64)	0.60 (0.59)
High Financing Scheme	0.52 (0.72)	0.49 (0.64)
Low Financing Scheme	0.74 (0.61)	0.79 (0.60)
Roads	0.42 (0.52)	0.43 (0.48)
Non Roads	0.58 (0.52)	0.57 (0.48)
Passenger	0.30 (0.53)	0.29 (0.48)
Non Passenger	0.70 (0.52)	0.71 (0.48)
High Investment Size	0.59 (0.56)	0.71 (0.63)
Low Investment Size	0.62 (0.69)	0.51 (0.53)
PPPs	0.82 (0.53)	0.79 (0.47)
Non PPPs	0.18 (0.48)	0.21 (0.52)
Links	0.62 (0.50)	0.66 (0.50)
Non Links	0.38 (0.55)	0.34 (0.45)

** indicates the necessary condition, which is above the threshold that we set (.90)*

Analysis of Sufficient Condition-only typology conditions

The typology conditions used for the 'on traffic' outcome analysis are: 1) the institutional context, 2) the financial-economic context, 3) the governance indicator, 4) the cost saving indicator, 5) the remuneration scheme, 6) the revenue scheme and 7) the financing scheme.

In this analysis, we used 7 indicators (as conditions): Institutional context, Financial-economic context, Cost saving, Governance, Remuneration scheme, Revenue scheme, Financing scheme, to explain both the outcomes presence and absence of on Traffic.

Table 6.5.2 shows the four solution paths. A high remuneration scheme is the most important condition for presence of on traffic, which is reflected by the core conditions in all solution paths. The second most important elements are cost saving and financial - economic context. Both of them are core conditions for the presence of on Traffic in at least some of the solution paths. Institutional context, governance, revenue and financing scheme are also appearing in solution paths, although as peripherical conditions. However, these solution paths have a quite low unique coverage, meaning that solution paths are overlapping.

Table 6.5.2: Sufficiency analysis for projects being 'on traffic', including the typology conditions

Conditions	Outcome: ON TRAFFIC			
	Solution 1	Solution 2	Solution 3	Solution 4
Institutional context		+	+	+
Financial economic context	+	+		
Governance			+	+
Cost Saving	+		+	+
Remuneration scheme	+	+	+	+
Revenue Scheme			+	
Financing Scheme				+
Individual Consistency	0.92	0.89	0.89	0.85
Coverage (Raw)	0.38	0.42	0.36	0.39
Coverage (Unique)	0.01	0.06	0.05	0.03

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Conditions	Outcome: ON TRAFFIC			
	Solution 1	**Solution 2**	**Solution 3**	**Solution 4**
Number of cases	2	4	5	4
Some relevant cases	Warsaw's Metro II-nd line (0.71,0.67), A2 Motorway (0.53,1)	E18 Muurla-Lohja (0.75,0.67), Central PT Depot of city of Pilsen (0.56,0.67)	M-25 Orbital (0.68,0.67), M-45 (0.62,1),	Port of Leixoes (0.58,0.67), Metrolink LRT. Manchester (0.55,1)
Overall Consistency/Coverage	0.84 (0.58)			

The analysis of the absence of the 'On Traffic' outcome results in only one solution path, with a consistency ratio and coverage ratio of 0.88 and 0.40 respectively (see table 6.5.3). A low remuneration scheme and a high financing scheme, together with a bad financial-economic context is a sufficient combination to explain projects having actual traffic below the forecasted traffic levels.

Table 6.5.3: Sufficiency analysis for projects being 'over traffic', including the typology conditions

	OUTCOME: Absence On TRAFFIC
	Solution 1
Institutional context	
Financial economic context	~
Governance	
Cost Saving	
Remuneration scheme	~
Revenue Scheme	
Financing scheme	+
Individual Consistency	0.88
Coverage (Raw)	0.40
Coverage (Unique)	0.40
Number of cases	3
Some relevant cases	Larnaca and Paphos International Airports (0.75,0.67),Eje Aeropuerto (M-12) Motorway (0.58,1), Radial 2 Toll Motorway (0.58,1)
Overall Consistency/Coverage	0.88 (0.40)

6.5.1.2 Analysis with typology conditions and input conditions

Tables 6.5.4 and 6.5.5 present the results including the input conditions. These include six models: one full model with seven conditions and five models by inserting all inputs (roads, passengers, investment size, PPPs and links).

Table 6.5.4: Sufficiency analysis for projects being 'on traffic', including the typology conditions and input conditions

TRAFFIC	Institutional context	Financial Economic context	Governance	Cost saving	Remuneration scheme	Revenue Scheme	Financing scheme	Input	Coverage (raw)	Coverage (Unique)	Solution Coverage
PRESENCE –FULL MODEL(S1)		+		+	+				0.38	0.01	
(S2)	+	+			+				0.42	0.06	0.58
(S3)	+		+	+	+	+			0.36	0.05	
(S4)	+		+	+	+		+		0.39	0.03	
PRESENCE –ROADS		+		+	+				0.38	0.01	

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TRAFFIC	Institutional context	Financial Economic context	Governance	Cost saving	Remuneration scheme	Revenue Scheme	Financing scheme	Input	Coverage (raw)	Coverage (Unique)	Solution Coverage
(S1)											0.51
(S2)	+	+			+				0.42	0.06	
(S3)	+		+		+	+		~	0.22	0.08	
PRESENCE_PASSENGER (s1)	+		+		+	+			0.41	0.16	0.52
(S2)		+		+	+			+	0.14	0.03	
(S3)		+	+	+	+		+		0.30	0.08	
PRESENCE_INVEST SIZE (S1)		+		+		+		+	0.23	0.01	
(S2)	+	+			+			+	0.27	0.06	0.41
(S3)	+		+	+	+		+	+	0.26	0.03	
(S4)	+		+	+	+	+		+	0.23	0.03	
PPPs (S1)		+		+		+	~		0.28	0.05	
(S2)		+	+		+			+	0.33	0.01	
(S3)	+	+	+	+	+			+	0.37	0.04	0.51
(S4)	+		+	+	+	+	~	+	0.28	0.09	
Links (S1)		+		+	+			~	0.15	0.03	
(S2)		+		+	+		~		0.28	0.01	
(S3)	+		+	+	+	+		+	0.15	0.05	0.44
(S4)	+		+	+	+	+	~		0.31	0.06	

Table 6.5.5 shows that the conditions institutional context, financial and economic context and remuneration scheme behave as formulated in the hypotheses, meaning that low levels of these conditions together with other conditions explain projects to have actual traffic below traffic forecasts.

Table 6.5.5: Sufficiency analysis for projects being 'over traffic', including the typology conditions and input conditions

TRAFFIC	Institutional Context	Financial Economic Context	Governance	Cost saving	Remuneration scheme	Revenue Scheme	Financing scheme	Input	Coverage (raw)	Coverage (unique)	Solution Coverage
FULL MODEL(S1)		~			~		+		0.40	0.40	0.40
ROADS (S1)		~			~		+		0.40	0.26	
(S2)	~	~			~			+	0.21	0.08	0.48
PASSENGER (s1)		~			~		+	~	0.31	0.31	0.31
INVEST SIZE (S1)		~			~		+		0.40	0.40	0.31
PPPs (S1)		~			~		+		0.40	0.40	0.31
Links (S1)		~			~		+		0.40	0.40	0.31

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Financial-economic context and remuneration scheme (often core condition), as well as institutional context as peripherical condition, are conditions which act in line with the hypotheses in explaining both the presence and absence of the 'on traffic' outcome. These conditions in combination with other conditions help to understand why projects have actual traffic levels equal or below the forecasted traffic levels. Governance, cost saving and revenue scheme are relevant (in different combinations) to help to explain the presence of 'on traffic'. However, the financing scheme acts contrary to what has been formulated in the hypotheses.

The following model used the six conditions, which acted in line with our hypotheses: institutional context, financial-economic context, governance, cost saving, remuneration scheme, and revenue scheme. Table 6.5.6 presents the four solution paths with overall consistency 0.83 and coverage 0.62 respectively. Interestingly, six conditions acted as expected. Remuneration scheme is the only core condition. Compared to the previous result (see table 6.5.3), this solution has a higher solution coverage.

Table 6.5.6: Sufficiency analysis for projects being 'on traffic', including selected typology conditions (Cut-off consistency 0.81)

Conditions	Outcome: ON TRAFFIC			
	Solution 1	Solution 2	Solution 3	Solution 4
Institutional context		+	+	+
Financial-economic context	+	+		
Governance			+	+
Cost Saving	+			
Remuneration scheme	+	+	+	+
Revenue Scheme			+	
Individual Consistency	0.92	0.89	0.87	0.85
Coverage (Raw)	0.38	0.42	0.41	0.53
Coverage (Unique)	0.01	0.03	0.02	0.04
Number of cases	2	4	5	7
Some relevant cases	Warsaw's Metro II-nd line (0.71,0.67),A2 Motorway (0.53,1)	E18 Muurla-Lohja (0.75,0.67), Central PT Depot of city of Pilsen (0.56,0.67)	E18 Muurla-Lohja (0.65,0.67),Port of Leixoes (0.65,0.67), Central PT Depot of city of Pilsen (0.56,0.67), Metrolink LRT. Manchester (0.55,1)	Metrolink LRT. Manchester (0.75,1), M-25 Orbital (0.68,0.67), , M-80 (Haggs) (0.62,0.67), M-45 (0.62,1), Port of Leixoes (0.58,0.67),
Overall Consistency/Coverage	0.83 (0.62)			

The analysis of absence of 'On traffic' outcome using six conditions results in one solution path, where a bad institutional context and a low remuneration scheme together with a bad financial-economic context is a sufficient combination for explaining 54% of the projects which are below traffic. Although the consistency ratio tends to be lower than in previous results (see Table 6.5.7), the coverage ratio was higher.

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Table 6.5.7: **Sufficiency analysis for projects being 'over traffic', including selected typology conditions (cut-off consistency= 0.85)**

	OUTCOME: Absence On TRAFFIC
	Solution 1
Institutional context	~
Financial-economic context	~
Governance	
Cost Saving	
Remuneration scheme	~
Revenue Scheme	
Individual Consistency	0.80
Coverage (Raw)	0.54
Coverage (Unique)	0.54
Number of cases	6
Some relevant cases	Motorway E-75. Section Horgos-Novi Sad (2nd phase) (0.88,0.67), Athens International Airport (0.72,0.67), Moreas Motorway (0.72,0.67), Rion-Antirion Bridge (0.72,0.67), Athens Ring Road (0.72,0.67)
Overall Consistency/Coverage	0.80 (0.54)

A model with only two conditions included (financial-economic context and remuneration scheme) shows only remuneration scheme explaining projects to be on traffic with consistency ratio 0.75 and coverage 0.68 (Table 6.5.8). The single solution path covers 16 cases. However, no solution formula for absence of the 'on traffic' outcome using these two conditions was found.

Table 6.5.8: Sufficiency analysis for projects being 'on traffic', including selected typology conditions (Cut-off consistency 0.78)

Conditions	Outcome: Presence of On Traffic
	Solution 1
Financial-economic context	
Remuneration scheme	+
Individual Consistency	0.75
Coverage (Raw)	0.68
Coverage (Unique)	0.68
Number of cases	16
Some relevant cases	A2 Motorway (0.97,1), A-19 Dishforth (0.9,0.67), Liefkenshoek Rail Link (0.9,0.67), Warsaw's Metro II-nd line (0.85,0.67), M-80 (Haggs) (0.75,0.67), M-25 Orbital (0.75,0.67), M-45 (0.75,1), Metrolink LRT. Manchester (0.75,1), Central PT Depot of city of Pilsen (0.75,0.67), E18 Muurla-Lohja (0.75,0.67), Port of Leixoes (0.75,0.67)
Overall Consistency/Coverage	0.75 (0.68)

6.5.2 Results of 'on traffic' analysis with respect to the PPPs Cases (38 Cases)

Analysis of necessary conditions – PPP cases

This analysis shows that there is no necessary condition for the presence and absence of the 'on traffic' outcome (Table 6.5.9).

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Table 6.5.9: Necessity analysis of the 'on traffic' outcome for the PPP cases

Conditions	On Traffic	
	Presence	Absence
High Institutional Context	0.86 (0.69)	0.77 (0.56)
Low Institutional Context	0.46 (0.69)	0.57 (0.78)
High Financial-economic context	0.51 (0.80)	0.40 (0.56)
Low Financial-economic context	0.72 (0.57)	0.85 (0.61)
High Governance Index	0.87 (0.61)	0.84 (0.53)
Low Governance Index	0.34 (0.71)	0.39 (0.73)
High Cost Saving	0.75 (0.66)	0.75 (0.59)
Low Cost Saving	0.53 (0.70)	0.57 (0.67)
High Remuneration Scheme Index	0.73 (0.77)	0.57 (0.54)
Low Remuneration Scheme Index	0.57 (0.60)	0.76 (0.72)
High Revenue Scheme Index	0.65 (0.64)	0.66 (0.57)
Low Revenue Scheme Index	0.56 (0.64)	0.59 (0.60)
High Financing Scheme Index	0.61 (0.72)	0.59 (0.63)
Low Financing Scheme Index	0.69 (0.65)	0.74 (0.63)

** indicates the necessary condition, which is above the threshold that we set (.90)*

Analysis of sufficient conditions – PPP cases

Table 6.5.10 presents the solution when analysing the sufficiency of all typology conditions for PPP projects to be 'on traffic'. The results show four solution paths with consistency 0.84 and coverage ratio 0.63. In general, this result is mostly in line with the result of the analysis on the overall sample. Again, these solution paths have a quite low unique coverage, meaning they overlap quite substantially.

Table 6.5.10: Sufficiency analysis for PPP projects being 'on traffic', including the typology conditions

Conditions	Outcome: ON TRAFFIC			
	Solution 1	Solution 2	Solution 3	Solution 4
Institutional Context	+	+		+
Financial Economic Context		+	+	
Governance	+	+	+	+
Cost Saving			+	+
Remuneration scheme	+	+	+	+
Revenue Scheme	+			
Financing Scheme			+	+
Individual Consistency	0.89	0.91	0.93	0.86
Coverage (Raw)	0.45	0.45	0.35	0.46
Coverage (Unique)	0.06	0.03	0.01	0.03
Number of cases	5	3	1	4
Some relevant cases	E18 Muurla-Lohja (0.65,0.67), Port of Leixoes (0.65,0.67),Central PT Depot of city of Pilsen	E18 Muurla-Lohja (0.75,0.67), Central PT Depot of city of Pilsen (0.56,0.67)	A2 Motorway (0.53,1)	M-25 Orbital (0.68,0.67), M-45 (0.62,1)

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Conditions	Outcome: ON TRAFFIC			
	Solution 1	Solution 2	Solution 3	Solution 4
	(0.56,0.67), Metrolink LRT. Manchester (0.55,1)			
Overall Consistency/Coverage	0.84 (0.63)			

As to the absence of the 'on Traffic' outcome, there is only one solution path with a consistency ratio of 0.88 and a coverage ratio of 0.47 (see 6.5.11): a low remuneration scheme, a high financing scheme combined with a bad financial-economic context is a sufficient combination for explaining 47% of the PPP projects which are below traffic. It can be noted that in this solution financing scheme is present whereas according to the formulated hypotheses we expected it to be absent.

Table 6.5.11: Sufficiency analysis for projects being 'over traffic', including the typology conditions

Conditions	Outcome: Absence of On Traffic
	Solution 1
Institutional Context	
Financial Economic Context	~
Governance	
Cost Saving	
Remuneration scheme	~
Revenue Scheme	
Financing Scheme	+
Individual Consistency	0.88
Coverage (Raw)	0.47
Coverage (Unique)	0.47
Number of cases	3
Some relevant cases	Larnaca and Paphos International Airports (0.75,0.67), Eje Aeropuerto (M-12) Motorway (0.58,1), Radial 2 Toll Motorway (0.58,1)
Overall Consistency/Coverage	0.88 (0.47)

Tables 6.5.10 and 6.5.11 show two conditions, remuneration scheme and financial-economic context, which act in line with the formulated hypotheses for explaining both the presence and absence of the 'on traffic' outcome in a substantial share of the PPP cases. These conditions in combination with other conditions help to understand why PPP projects have actual traffic levels equal or below the forecasted traffic levels. The institutional context, governance, cost saving and revenue scheme only act in line with our hypotheses when we analyse the presence of the 'on traffic' outcome. However, financing scheme acts contrary to what we expected based on the hypotheses.

Hence, we analysed the subsample of PPP cases using only financial-economic context and remuneration scheme as included conditions (Table 6.5.12). The result is one path with only remuneration scheme as core condition being able to explain 73% of the PPP cases, which are on traffic. The solution consistency is considered moderate (0.77). This solution shows how important the remuneration scheme is for PPP projects to perform on traffic.

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Table 6.5.12: Sufficiency analysis for PPP projects being 'on traffic', including selected typology conditions (Cut-off consistency 0.79)

Conditions	Outcome: Presence of On Traffic
	Solution 1
Institutional context	
Financial economic context	
Governance	
Cost Saving	
Remuneration scheme	+
Revenue Scheme	
Individual Consistency	0.77
Coverage (Raw)	0.73
Coverage (Unique)	0.73
Number of cases	14
Some relevant cases	A2 Motorway (0.97,1), A-19 Dishforth (0.9,0.67), Liefkenshoek Rail Link (0.9,0.67), M-80 (Haggs) (0.75,0.67), M-25 Orbital (0.75,0.67), M-45 (0.75,1), Metrolink LRT. Manchester (0.75,1), Central PT Depot of city of Pilsen (0.75,0.67), E18 Muurla-Lohja (0.75,0.67), Port of Leixoes (0.75,0.67)
Consistency/Coverage	0.77 (0.73)

6.5.3 Results of 'on traffic' analysis with respect to road cases (20 Cases)

Analysis of necessary conditions – road cases

A bad financial-economic context is a necessary condition for road projects to have actual traffic levels below the forecasted traffic levels (Table 6.5.12).

Table 6.5.12: Necessity analysis of the 'on traffic' outcome for the road cases

Conditions	On Traffic	
	Presence	Absence
High Institutional Context	0.80 (0.66)	0.68 (0.53)
Low Institutional Context	0.43 (0.59)	0.56 (0.72)
High Financial-economic context	0.57 (0.88)	0.30 (0.44)
Low Financial-economic context	0.63 (0.49)	**0.91 (0.67)***
High Governance Index	0.87 (0.60)	0.83 (0.54)
Low Governance Index	0.34 (0.69)	0.39 (0.74)
High Cost Saving	0.79 (0.65)	0.75 (0.58)
Low Cost Saving	0.49 (0.68)	0.55 (0.71)
High Remuneration Scheme Index	0.71 (0.73)	0.54 (0.51)
Low Remuneration Scheme Index	0.52 (0.55)	0.71 (0.70)

** indicates the necessary condition, which is above the threshold that we set (.90)*

Analysis of sufficient conditions – road cases

Due to a limited number of cases (20 road cases), the full model (7 conditions) cannot be run. In case of 20 cases, only five maximum conditions can be employed (Marx & Dusa, 2012). Based on the abovementioned conditions acting in line with what we expected in the hypotheses, the following conditions, being financial-economic context, remuneration scheme, institutional context, governance and cost saving are selected as conditions for the sufficiency analyses with respect to the road cases.

There are 3 solution paths with quite satisfying consistency and coverage ratio (see table 6.5.14); they show sufficient conditions for 63% of roads cases being in line or above traffic forecasts. Looking at

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the different paths together, the remuneration scheme, cost saving and financial-economic context are core conditions for explaining presence of on traffic; institutional context and governance are peripheral conditions.

Table 6.5.14: Sufficiency analysis for road projects being 'on traffic', including selected typology conditions

Conditions	Outcome: Presence On Traffic		
	Solution 1	Solution 2	Solution 3
Institutional context		+	+
Financial Economic context	+		+
Governance	+	+	+
Cost Saving	+	+	
Remuneration scheme	+	+	+
Individual Consistency	0.92	0.82	0.91
Coverage (Raw)	0.42	0.59	0.45
Coverage (Unique)	0.01	0.18	0.03
Number of cases	1	5	1
Some relevant cases	A2 Motorway (0.53,1)	M-25 Orbital (0.68,0.67), M-80 (Haggs) (0.62,0.67), M-45 (0.62,1)	E18 Muurla-Lohja (0.75,0.67)
Overall Consistency/Coverage	0.82 (0.63)		

The analysis of absence of the 'on traffic' outcome (meaning actual traffic being below the forecasted traffic) yields two solution paths with a quite high consistency ratio of 0.79 and a high coverage ratio of 0.81 (see Table 6.5.15). These paths together explain 81% of the road cases experiencing actual traffic being below traffic forecast. Interestingly, as mentioned in the analysis of necessary conditions, a bad financial-economic context is a necessary condition for road projects to be below traffic and also shows to be a core condition in one of the solution paths (Table 6.5.15). Moreover, cost saving and remuneration scheme are also core conditions in the solution path explaining the absence of the 'on traffic' outcome. Overall, this solution is considered rather high in terms of its strength for explaining road projects to have actual traffic levels below the forecasted level.

Table 6.5.15: Sufficiency analysis for road projects being 'over traffic', including selected typology conditions

Conditions	OUTCOME: Absence On TRAFFIC	
	Solution 1	Solution 2
Institutional context		
Financial Economic context	~	~
Governance		
Cost Saving	~	
Remuneration scheme		~
Individual Consistency	0.78	0.79
Coverage (Raw)	0.53	0.67
Coverage (Unique)	0.17	0.28
Number of cases	4	6
Some relevant cases	C-16 Terassa Manresa toll	Motorway E-75. Section Horgos-Novi Sad

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	motorway (0.71,0.67), Motorway E-75. Section Horgos-Novi Sad (2nd phase) (0.7,0.67)	(2nd phase) (0.94,0.67), Eje Aeropuerto (M-12) Motorway (0.88,1), Radial 2 Toll Motorway (0.88,1), Athens Ring Road (0.76,0.67), Moreas Motorway (0.75,0.67)
Overall Consistency/Coverage	0.79 (0.81)	

Three conditions being financial-economic context, remuneration scheme and cost saving, act in the way we expected based on the formulated hypotheses in the solutions for both the presence and the absence of the 'on traffic' outcome for road projects. These conditions in combination with other conditions help to understand why road projects have actual traffic levels equal or below the forecasted traffic levels. Additionally, governance and institutional context act as formulated in the hypotheses but only in the case of the analysis regarding the presence of the 'on traffic' outcome.

The analyses started with the expectation that all typology conditions would act in combination to bring about the desired outcome, i.e. projects achieving the forecasted traffic volume. However, the subsequent rounds of analyses regarding the 'on traffic' outcome result in the following **findings**:

- **Regarding the overall sample of infrastructure projects (47 cases):**
  - When including all typology indicators in our model, we find relevant paths showing sufficient conditions for projects to be 'on traffic or as forecast and/or exceeding forecast' as well as 'below traffic'. Regarding infrastructure projects which experience traffic to be equal or above the forecasted traffic, we can find paths covering 58% of the membership of this outcome. However, overall coverage is only 40% for outcome "below traffic". By adopting a simpler model with fewer conditions, the result shows an increase in terms of the coverage ratio, where 62% of the infrastructure projects on traffic and 54% of the infrastructure projects can be explained by the combination of conditions. In general, 62% of the cases which are 'on traffic' show to have a high remuneration scheme as core condition, in combination with some of the following peripherical conditions: a good institutional context, a high financial & economic context, a high governance, a high cost saving, a high revenue scheme, as sufficient conditions. On the other hand, 54% of the cases below traffic have the following sufficient combination of conditions: a low remuneration scheme, a bad institutional context (both core conditions) and a low financial & economic context (as peripherical condition).
  - Quite a high share of the projects (more than 50%) being on traffic show relevant paths when we include passenger (use) or PPP (delivery) as an extra condition additionally to the typology conditions.
  - Overall, when considering all analyses regarding the total sample of infrastructure projects, the following three conditions (in combination with other conditions) act at least in a share of the projects on traffic and the projects below traffic as we expected them to do: remuneration scheme, financial economic context and institutional context. In addition, governance, cost saving and revenue scheme are extra conditions found in combination with those three conditions for explaining on traffic. The combinations of conditions found explain more or less than 60% of the involved outcome, meaning that their explanatory value is rather high. An alternative analysis with only financial-economic context and remuneration scheme as conditions showed a high level of remuneration scheme to be a sufficient condition for 68% of projects, whose revenue is in line or exceeding the forecasted revenue.

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- **Regarding the sub-sample of PPP projects (38 cases):**
    - A high level of governance and a good institutional context are *close to* being a necessary condition for projects to be on traffic (0.87 consistency).
    - 64% of the PPP projects in our sample which are 'on traffic' have a high level of remuneration scheme as core conditions with different combinations of the following peripherical conditions: a high financial economic context; a good institutional context, a high level of governance, a high level of cost saving and a high level of revenue scheme as sufficient conditions (64% coverage). The consistency of this solution is quite satisfying (85%). In an alternative analysis checking only for financial-economic context and remuneration scheme, 73% of the PPP projects on traffic had remuneration scheme as sufficient condition. It shows the importance of the remuneration scheme for projects to perform on traffic.
    - Similar with presence of on traffic, a below traffic outcome in PPP projects in our sample can be explained rather straightforwardly. Around 52% of the membership of this outcome is explained by the sufficient combination, entailing a low level of remuneration scheme, a bad institutional context and a low financial economic context (83% consistency).
- **Regarding the sub-sample of roads (23 cases):**
    - A high level of governance *is close* to being a necessary condition for projects to be on traffic (0.87 consistency). A bad financial-economic context is a necessary condition for projects to perform below traffic.
    - The road projects which are on traffic show to have a sufficient combination of a good remuneration scheme, a high level of cost saving and a high financial economic context, in combination with a high governance level and a good institutional context, which covers 63% cases and of which the consistency ratio can be considered moderately high (0.82). Similarly, the same conditions, a low financial economic context in combination with either a low level of remuneration scheme or a low level of cost saving can explain projects on or below traffic. This solution has a very satisfying coverage (81%), but the consistency ratio is rather low (0.79 consistency).
- Overall, regarding the analyses concerning traffic, there were no conditions, which showed to be necessary and the coverage of the models was rather high (generally above 50-60%). Remuneration scheme, financial economic context and institutional context are of particular relevance as conditions.

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6.6 Results of the analysis regarding 'on revenue' as an outcome

6.6.1 Results of the 'on revenue' analysis with respect to the full sample

6.6.1.1 Analysis with only typology conditions

In this context, the outcome studied is 'on revenue' meaning that the actual revenue raised is either as forecasted or exceeding the forecasts. In this analysis, 7 indicators (as conditions) were used: institutional context, financial-economic context, cost saving, governance, remuneration scheme, revenue scheme, financing scheme, to explain the outcome 'on revenue'.

The models analysed in this section are:

$H_{revenue}$ *- Presence of the 'on revenue' outcome: A combination of a good institutional context and a good financial-economic context and a high cost saving, a high governance, a high remuneration scheme, a high revenue scheme, a high financing scheme will lead projects to have actual revenue levels equal or above the forecasted revenue level.*

$H'_{revenue}$ *- Absence of the 'on revenue' outcome: A combination of a bad institutional context and a bad financial-economic context and a low cost saving, a low governance, a low remuneration scheme, a low revenue scheme, a low financing scheme will lead projects to have actual revenue levels below the forecasted revenue level.*

Analysis of Necessary Conditions

Only IRA is a core condition for both the presence as well as absence of the 'on revenue' outcome, hence, this 'trivial' indicator is not taken into account for the analysis of sufficient conditions (Table 6.6.1).

Table 6.6.1: Necessity analysis of the 'on revenue' outcome for the full sample

Conditions	On Revenue	
	Presence	Absence
High Institutional Context	0.74 (0.84)	0.72 (0.35)
Low Institutional Context	0.43(0.78)	0.68 (0.53)
High Financial-economic context	0.43 (0.86)	0.47 (0.41)
Low Financial-economic context	0.70 (0.75)	0.84 (0.39)
High IRA	0.99 (0.70)*)	0.92 (0.29)*)
Low IRA	0.03 (0.40)	0.11 (0.80)
High Governance	0.79 (0.80)	0.79 (0.35)
Low Governance	0.36 (0.80)	0.56 (0.53)
High Cost Saving	0.65 (0.80)	0.73 (0.39)
Low Cost Saving	0.51 (0.82)	0.63 (0.43)
High Remuneration Scheme	0.56 (0.83)	0.61 (0.39)
Low Remuneration Scheme	0.59 (0.78)	0.74 (0.42)
High Revenue Scheme	0.60(0.81)	0.63 (0.37)
Low Revenue Scheme	0.53 (0.77)	0.68 (0.43)
High Financing Scheme	0.46 (0.87)	0.51 (0.42)
Low Financing Scheme	0.69 (0.77)	0.84 (0.40)
Roads	0.46 (0.76)	0.34 (0.24)

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Conditions	On Revenue	
	Presence	Absence
Non Roads	0.54 (0.65)	0.66 (0.35)
Passengers	0.26 (0.61)	0.38 (0.39)
Non Passenger	0.74 (0.73)	0.62 (0.27)
High Investment Size	0.59 (0.76)	0.63 (0.35)
Low Investment Size	0.50 (0.76)	0.58 (0.38)
PPPs	0.82 (0.71)	0.77 (0.29)
Non PPPs	0.18 (0.64)	0.23 (0.36)
Links	0.65 (0.71)	0.62 (0.29)
Non Links	0.35 (0.68)	0.38 (0.32)

** indicates the necessary condition, which is above the threshold that we set (.90)*

Analysis of Sufficient Condition for full Sample-only typology conditions

Regarding the presence of the 'on revenue' outcome, three solution paths delineate a quite high overall consistency (0.84), and overall coverage is also considered high as well (0.71). The institutional context, financial-economic context, and remuneration scheme are core conditions for the presence of the 'on revenue' outcome (see Table 6.6.2). Governance and cost saving are also relevant conditions for explaining the presence of the 'on revenue' as peripheral conditions. Only one solution path is having a high unique coverage, explaining 21 cases. In this path a good institutional context and a high governance are sufficient conditions for projects to be 'on revenue'.

No relevant solution formula for the absence of the 'on revenue' outcome was found.

Table 6.6.2: Sufficiency analysis for projects being 'on revenue', including the typology conditions

CONDITIONS	OUTCOME: On REVENUE		
	Solution 1	Solution 2	Solution 3
Institutional context	+	+	
Financial economic context		+	+
Governance	+		
Cost Saving			+
Remuneration scheme			+
Revenue Scheme			
Financing Scheme			
Individual Consistency	0.84	0.85	0.95
Coverage (Raw)	0.66	0.41	0.29
Coverage (Unique)	0.29	0.04	0.01
Number of cases	21	12	2
Some relevant cases	A-19 Dishforth (0.84,0.8), BNRR (M6 Toll) (0.84,0.8), E39 Orkdalsvegen Public Road (0.84,1), Metrolink LRT. Manchester (0.84,1), M-80 (Haggs) (0.84,0.8), M-25 Orbital (0.84,0.8), E18 Muurla-Lohja (0.84,0.8), E4 Helsinki-Lahti (0.84,1), Liefkenshoek Rail Link (0.81,0.8), Lyon's tramway T4 (0.72,1), Lyon's VeloV (0.72,1), Via-Invest Zaventem (0.7,0.8), Brabo 1 (0.7,0.8), Larnaca and Paphos Intern. Airports (0.67,0.8), Port of Leixoes	E4 Helsinki-Lahti (0.92,1), E39 Orkdalsvegen Public Road (0.91,1), E18 Muurla-Lohja (0.91,0.8), Combi plan Nijverdal (0.71,0.8), Metro do Porto (0.56,0.8), Lyon's tramway T4 (0.56,1), Lyon's VeloV (0.56,1), Central PT Depot of city	Warsaw's Metro II-nd line (0.71,0.8), A2 Motorway (0.53,1)

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CONDITIONS	OUTCOME: On REVENUE		
	Solution 1	Solution 2	Solution 3
	(0.65,0.8), Lusoponte Vasco da Gama Bridge (0.65,0.8), A23 motorway (0.65,0.8)	of Pilsen (0.56,0.8), Blanka Tunnel (0.56,0.8)	
Overall Consistency/Coverage	0.84 (0.71)		

6.6.1.2 Analysis with typology conditions and input conditions

In this section, all input conditions (roads, passenger, investment size, PPPs and link) are included in the model along with typology indicator conditions.

Table 6.6.3 shows the different combinations of conditions for the models with typology indicators and 5 input conditions: Roads, Passenger, Investment size, PPPs and Links.

There is no solution formula for analysis of absence of the 'on revenue' outcome.

Table 6.6.3: Sufficiency analysis for projects being 'on revenue', including the typology conditions and input conditions

REVENUE	Institutional Context	Financial Economic Context	Governance	Cost saving	Remuneration scheme	Revenue Scheme	Financing scheme	Input	Coverage (raw)	Coverage (unique)	Solution Coverage
PRESENCE –FULL MODEL(S1)	+		+						0.66	0,29	0,71
(S2)	+	+							0.41	0,04	
(S3)		+		+	+				0.29	0,01	
PRESENCE –ROADS (S1)						+		+	0.27	0.18	0.48
(S2)		+	~	+	+				0.16	0.01	
(S3)	+	+	~		+				0.18	0.02	
(S4)		+		+		+	+	+	0.14	0.00	
(S5)	+		+	+		+	+	+	0.18	0.03	
PRESENCE _PASSENGER (s1)				~		+		~	0.26	0.16	0.40
(S2)	+	+			+			~	0.23	0.05	
(S3)		+	+	+	+		+	~	0.17	0.00	
PRESENCE _INVEST SIZE (S1)	+	+						+	0.26	0.08	0.38
(S2)		+		+	+			+	0.18	0.04	
(S3)	+		+	+		+	+	+	0.18	0.01	
(S4)	+		+	+	+		+	+	0.20	0.03	
PPPs (S1)		+		+	+				0.29	0.01	0.36
(S2)	+	+			+				0.33	0.03	
(S3)	+	+		~				+	0.21	0.01	
(S4)	+		+			~		+	0.14	0.00	

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REVENUE	Institutional Context	Financial Economic Context	Governance	Cost saving	Remuneration scheme	Revenue Scheme	Financing scheme	Input	Coverage (raw)	Coverage (unique)	Solution Coverage
Links (S1)					+	+		~	0.11	0.02	0.40
(S2)		+		+	+		~		0.22	0.03	
(S3)	+	+			~			+	0.16	0.03	
(S4)	+		+	+	+	+		~	0.10	0.00	
(S5)	+		+	+	+	+	~	+	0.22	0.04	

The institutional context and financial-economic context act as conditions for the presence of the outcome 'on revenue' in line with the formulated hypotheses. These conditions in combination with other conditions help to understand why road projects have actual revenue levels equal to the forecasted traffic levels. Both remuneration scheme and cost saving indicators act in most solution paths in line with what is formulated in the hypotheses. Governance, revenue scheme and financing scheme can be considered as acting in several solution paths in a way which is contrary to what is formulated in the hypotheses.

The model including the four conditions which act in line with the hypotheses produces a solution which is good in terms of ratio consistency and coverage (table 6.6.4). Interestingly, a good institutional context as single condition is sufficient to explain projects to be on revenue, explaining 74% of the 'on revenue' outcome.

Table 6.6.4: Sufficiency analysis for projects being 'on revenue', including selected typology conditions (cut-off consistency: 0.83)

CONDITIONS	Outcome: Presence of on revenue	
	Solution 1	Solution 2
Institutional Context	+	
Financial-economic context		+
Cost Saving		+
Remuneration scheme		+
Individual Consistency	0.84	0.95
Coverage (Raw)	0.74	0.29
Coverage (Unique)	0.46	0.01
Number of cases	19	2
Some relevant cases	E18 Muurla-Lohja (0.93,0.8), E4 Helsinki-Lahti (0.93,1), E39 Orkdalsvegen Public Road (0.91,1), Combi plan Nijverdal (0.9,0.8), Metrolink LRT. Manchester (0.84,1), M-25 Orbital (0.84,0.8),M-80 (Haggs) (0.84,0.8), A-19 Dishforth (0.84,0.8), BNRR (M6 Toll) (0.84,0.8), Via-Invest Zaventem (0.81,0.8), Liefkenshoek Rail Link (0.81,0.8), Brabo 1 (0.81,0.8), Lyon's VeloV (0.72,1), Lyon's tramway T4 (0.72,1), Larnaca and Paphos Intern. Airports (0.67,0.8), Metro do Porto (0.65,0.8), A23 motorway (0.65,0.8),Port of Leixoes (0.65,0.8)	Warsaw's Metro II-nd line (0.71,0.8),A2 Motorway (0.53,1)
Overall Consistency/Coverage	0.84 (0.75)	

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6.6.2 Results of the 'on revenue' analysis with respect to the PPP cases

Analysis of Necessary Conditions

The necessity analysis for the sub-sample of PPP projects shows that none of the conditions is considered necessary for both the presence and absence of the 'on revenue' outcome (Table 6.6.5).

Table 6.6.5: Necessity analysis of the 'on revenue' outcome for the PPP cases

Conditions	on revenue	
	Presence	Absence
High Institutional Context	0.78 (0.85)	0.76 (0.34)
Low Institutional Context	0.39 (0.80)	0.66 (0.55)
High Financial-economic context	0.41 (0.86)	0.48 (0.41)
Low Financial-economic context	0.72 (0.77)	0.84 (0.37)
High Governance Index	0.85 (0.81)	0.85 (0.33)
Low Governance Index	0.30 (0.83)	0.50 (0.57)
High Cost Saving	0.68 (0.80)	0.80 (0.38)
Low Cost Saving	0.48 (0.85)	0.59 (0.43)
High Remuneration Scheme Index	0.58 (0.84)	0.67 (0.39)
Low Remuneration Scheme Index	0.57 (0.81)	0.72 (0.42)
High Revenue Scheme Index	0.64 (0.84)	0.62 (0.33)
Low Revenue Scheme Index	0.50 (0.76)	0.71 (0.44)
High Financing Scheme Index	0.55 (0.87)	0.61 (0.40)
Low Financing Scheme Index	0.63 (0.80)	0.81 (0.42)

** indicates the necessary condition, which is above the threshold that we set (.90)*

As presented in Table 6.6.6, four solution paths with a quite high overall consistency ratio and coverage ratio were found as sufficient conditions for PPP projects to be 'on revenue'. No solution formula was found for the absence of the 'on revenue' outcome.

Table 6.6.6: Sufficiency analysis for PPP projects being 'on revenue', including the typology conditions (only typology indicators-PPPs)

CONDITIONS	OUTCOME: Presence ON REVENUE			
	Solution 1	Solution 2	Solution 3	Solution 4
Institutional Context	+	+	+	
Financial Economic Context	~	+		+
Governance	+		+	+
Cost Saving		~		+
Remuneration scheme			+	+
Revenue Scheme				
Financing Scheme				+
Individual Consistency	0.86	0.89	0.86	0.94
Coverage (Raw)	0.53	0.26	0.52	0.26
Coverage (Unique)	0.11	0.01	0.06	0.00
Number of cases	12	3	11	1
Some relevant cases	Larnaca and Paphos International Airports (0.67,0.8), A23	E18 Muurla-Lohja	A-19 Dishforth (0.84,0.8), Liefkenshoek Rail	A2 Motorway (0.53,1)

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CONDITIONS	OUTCOME: Presence ON REVENUE			
	Solution 1	Solution 2	Solution 3	Solution 4
	motorway (0.65,0.8), Lusoponte Vasco da Gama Bridge (0.65,0.8), Port of Leixoes (0.65,0.8), Eje Aeropuerto (M-12) Motorway (0.62,0.8), M-45 (0.62,1), Radial 2 Toll Motorway (0.62,0.8), Metro de Malaga (0.62,0.8), C-16 Terassa Manresa toll motorway (0.62,0.8), FERTAGUS Train (0.59,0.8),	(0.66,0.8), Metro do Porto (0.56,0.8),	Link (0.81,0.8), M-80 (Haggs) (0.75,0.8), M-25 Orbital (0.75,0.8), Metrolink LRT. Manchester (0.75,1), E18 Muurla-Lohja (0.75,0.8), A23 motorway (0.65,0.8), Port of Leixoes (0.65,0.8), M-45 (0.62,1), C-16 Terassa Manresa toll motorway (0.62,0.8), Central PT Depot of city of Pilsen (0.56,0.8)	
Overall Consistency/Coverage	0.87 (0.66)			

Four conditions, being institutional context, governance, remuneration scheme and financing scheme, act in line with the hypotheses for PPP projects to be 'on revenue'. The financial-economic context and revenue scheme appear in at least one solution path to act differently than was expected in the hypotheses.

Hence a model with the following four conditions, institutional context, governance, remuneration scheme and financing scheme was analysed (Table 6.6.7). Two solution paths represent a consistency ratio of 0.89 and a coverage ratio of 0.58. In the strongest solution path, institutional context and financing scheme are both core conditions and sufficient for the presence of the 'on revenue' outcome. Surprisingly, in the other solution path, governance acted in contrast to what is expected in the hypotheses: the absence of a high governance is a core condition for the presence of the 'on revenue' outcome.

Table 6.6.7: Sufficiency analysis for PPP projects being 'on revenue', including selected typology conditions (cut-off consistency: 0.85)

Conditions	Outcome: Presence of on revenue	
	Solution 1	Solution 2
Institutional context	+	+
Financial economic context		
Governance	~	
Cost Saving		
Remuneration scheme		
Revenue Scheme		
Financing Scheme		+
Individual Consistency	0.86	0.89
Coverage (Raw)	0.28	0.52
Coverage (Unique)	0.06	0.29
Number of cases	4	14
	Metro do Porto (0.65,0.8), Barcelona Europe South Terminal	E39 Orkdalsvegen Public Road (0.91,1), E4 Helsinki-Lahti (0.89,1), M-25 Orbital

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Conditions	Outcome: Presence of on revenue	
	Solution 1	Solution 2
	(0.62,0.8), Muelle Costa Terminal Barcelona (0.62,0.8), Port of Sines Terminal XXI (0.59,0.8)	(0.81,0.8), Via-Invest Zaventem (0.81,0.8), Brabo 1 (0.81,0.8), Larnaca and Paphos International Airports (0.67,0.8), A23 motorway (0.62,0.8), M-45 (0.62,1), E18 Muurla-Lohja (0.6,0.8), Eje Aeropuerto (M-12) Motorway (0.58,0.8), Radial 2 Toll Motorway (0.58,0.8), A-19 Dishforth (0.57,0.8), Central PT Depot of city of Pilsen (0.56,0.8)
Overall Consistency/Coverage	0.89 (0.58)	

6.6.3 Results of the 'on revenue' analysis with respect to the road cases

Analysis of necessary conditions

The analysis results in two necessary conditions being low financial-economic context, and high cost saving, for road cases to have actual revenues which are below the forecasted level.

Table 6.6.8: Necessity analysis of the 'on revenue' outcome for the road cases

Conditions	on revenue	
	Presence	Absence
High Institutional context	0.74 (0.90)	0.74 (0.29)
Low Institutional context	0.41 (0.84)	0.74 (0.48)
High Economic & Financial context	0.43 (0.97)	0.41 (0.29)
Low Economic & Financial context	0.69 (0.79)	**0.96 (0.35)***
High Cost Saving	0.70 (0.85)	**0.91 (0.35)***
Low Cost Saving	0.46 (0.94)	0.62 (0.39)
High Revenue Scheme	0.58 (0.90)	0.64 (0.31)
Low Revenue Scheme	0.56 (0.83)	0.79 (0.37)
High Financing Scheme	0.59 (0.88)	0.73 (0.35)
Low Financing Scheme	0.56 (0.87)	0.76 (0.37)

** indicates the necessary condition, which is above the threshold that we set (.90)*

Analysis of sufficient conditions

Five indicators are selected as conditions: institutional context, financial-economic context, cost saving, revenue scheme and financing scheme. Table 6.6.9 show two solution paths for road projects to be 'on revenue'. No solution was found for the absence of the 'on revenue' outcome.

Table 6.6.9: Sufficiency analysis for road projects being 'on revenue', including selected typology conditions (only typology indicators – roads)

Conditions	Outcome: Presence of on revenue	
	Solution 1	Solution 2
Institutional Context		
Financial Economic Context		+
Cost Saving	~	+
Revenue Scheme	+	
Financing Scheme		+
Individual Consistency	0.97	0.98

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Conditions	Outcome: Presence of on revenue	
	Solution 1	Solution 2
Coverage (Raw)	0.34	0.34
Coverage (Unique)	0.20	0.20
Number of cases	5	3
Some relevant cases	C-16 Terassa Manresa toll motorway (0.71,0.8), E18 Muurla-Lohja (0.65,0.8), Motorway E-75. Section Horgos-Novi Sad (2nd phase) (0.63,0.8), Motorway E-75. Section Donji Neradovac - Srpska kuca (0.52,0.8), Koper - Izola Expressway (0.51,0.8)	E39 Orkdalsvegen Public Road (0.93,1), A2 Motorway (0.53,1), E4 Helsinki-Lahti (0.52,1)
Overall Consistency/Coverage	0.98 (0.54)	

The financial-economic context, revenue scheme and financial scheme act in line with the hypotheses for explaining the 'on revenue' outcome for road cases. Cost saving is a condition which does not act in line with the formulated hypotheses.

Based on this finding, three conditions are further analysed in terms of to which extent they jointly help to understand road projects to be 'on revenue': financial-economic context, revenue scheme and financing scheme (see Table 6.6.10). The two solution paths together elucidate a high overall consistency ratio (0.94) as well as a quite high overall coverage ratio (0.64). Please note that in the first solution path, the financing scheme does not act in line with the hypotheses. No solution was found for the absence of the 'on revenue' outcome.

Table 6.6.10: Sufficiency analysis for road projects being 'on revenue', including selected typology conditions (cut-off consistency: 0.89)

Conditions	Outcome: Presence of On Traffic	
	Solution 1	Solution 2
Financial-economic context		+
Revenue Scheme	+	
Financing Scheme	~	+
Individual Consistency	0.90	0.98
Coverage (Raw)	0.42	0.38
Coverage (Unique)	0.27	0.24
Number of cases	6	4
Some relevant cases	Koper – Izola Expressway (0.86,0.8), C-16 Terassa Manresa toll motorway (0.78,0.8), BNRR (M6 Toll) (0.72,0.8), Athens Ring Road (0.7,0.8), Motorway E-75. Section Horgos-Novi Sad (2nd phase) (0.63,0.8), Motorway E-75. Section Donji Neradovac – Srpska kuca (0.52,0.8)	E39 Orkdalsvegen Public Road (0.93,1), E4 Helsinki-Lahti (0.89,1), E18 Muurla-Lohja (0.6,0.8), A2 Motorway (0.53,1)
Consistency/Coverage	0.94 (0.66)	

Additionally, an alternative analysis using three conditions (institutional context, financial-economic context and remuneration scheme) resulted in two solution paths with an overall coverage ratio of 0.75, and covering 17 cases. In this analysis, a good institutional context is a core condition, and it individually explains the presence of 'on revenue' for 74% of the road cases being on revenue (15 cases). The combination of a good financial-economic context (core condition) and a high remuneration scheme (peripheral condition) can also explain the presence of the 'on revenue' outcome for road cases. Finally, this result can be considered "the best model" for explaining road cases to be 'on revenue' in terms of overall consistency ratio, coverage ratio (included unique coverage), and number of cases explained.

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The analyses started with the expectation that all typology conditions would act in combination to bring about the desired outcome. However, the subsequent rounds of analyses regarding the 'on revenue' outcome (both presence and absence) result in the following **findings**:

- **Regarding the overall sample of infrastructure projects (47 cases):**
  - When including all typology indicators in our model we find quite strong paths showing sufficient conditions for projects to be 'on revenue'; however no solution formula found on the analysis of projects being 'below revenue'. Regarding infrastructure projects which experience being 'on revenue', we find paths covering 71% of cases and consistency ratio is considered rather high (0.84). It is quite substantially increasing when adopting more simple models with fewer conditions (0.75 coverage).
  - Overall, when considering all analyses regarding the total sample of infrastructure projects, the following four conditions (in combination with other conditions) act at least in a share of the projects on revenue as we expected them to do: institutional context, financial economic context, remuneration scheme and cost saving. The combination of these four conditions found explains 75% of the membership of the involved outcome, meaning that the explanatory value of these solution paths is quite strong. A positive institutional context is a sufficient condition for 74% of the projects being on revenue, meaning that a positive institutional context has a particular strong explanatory power. A positive financial-economic context as core condition, high cost saving and remuneration scheme as peripherical conditions make sufficient conditions for 29% of the membership of the outcome 'on revenue'.
  - For the projects being 'below revenue' we cannot find any relevant solution paths.
- **Regarding the sub-sample of PPP projects (38 cases):**
  - 58% of the PPP projects in our sample, which are 'on revenue or exceeding than forecast' have a good institutional context, in combination with a high level of financing scheme or a low level of governance as sufficient conditions (58% coverage). However, the consistency of this solution is quite convincing (89%).
  - We cannot find the solution formula for explaining projects being below revenue.
- **Regarding the sub-sample of roads (20 cases):**
  - 66% of the road projects which are on revenue show to have a sufficient combination when a high revenue scheme is combined with a low level of financing scheme or when a high financial economic context is combined with a high revenue scheme. Consistency ratio can be considered very high (0.94).
  - Again, we cannot find the solution formula for explaining projects being below revenue. But we learned that a bad financial-economic context, as well as high levels of cost savings are necessary conditions for projects to be 'below revenue'.
- Overall, regarding the analyses concerning revenue, there were no conditions, which showed to be necessary, except for the subsample of road projects. Moreover, the coverage of the models was satisfactory (± 60%) and explanatory power of the model seems to be improved to some extent when using the simplification method as desired model (0.75 coverage). We cannot find sufficient combinations of conditions for projects earning below forecasted revenues.

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6.7 Conclusions & Discussion

The model was developed with insufficient hypotheses linking specific conditions to certain outcome. Therefore, no full explanation of specific conditions or combinations of conditions leading directly to certain outcomes may be given. This was expected given the complexity of transport infrastructure delivery and the multiple factors that may influence performance. In addition, the sample of cases considered in these analyses is neither representative nor homogenous (see **Annex A.1** and **A.2**) and findings bear this limitation.

However, the analyses conducted in this Chapter may provide indications of which combinations of factors (conditions or otherwise typology indicators), or the absence of, may lead to specific outcomes. This provides lessons learned with respect to the funding and financing of infrastructure. These lessons are derived with respect to the total sample, the PPP sample and the Road sample of cases of the BENEFIT database.

The analyses also provide indications on the extent to which typology indicators acted in line with the formulated hypotheses. This provides lessons learned with respect to the BENEFIT Matching Framework and its typology indicators.

Further insights on the causality of relations are needed to formulate hypotheses or propositions.

6.7.1 Funding and Financing of Transport Infrastructure – Lessons Learned

The analyses are carried out per performance outcome. They include a series of iterations starting with the hypothesis that all typology conditions are important in explaining the specific outcome. The number of conditions (or conditions) is reduced each time based on the conditions identified to be sufficient in combination with other conditions and to act in line with the formulated hypotheses in the previous round of analysis. The summary of findings per outcome and dataset (entire sample, PPP projects and Road projects) is presented herewith.

6.7.1.1 Cost

Identifying conditions explanatory of achieving cost targets proved challenging. No relevant sufficient combination was found for the entire sample (52 projects) to explain projects to be 'on costs'. For the absence of the outcome, there are indications (coverage less or up to 50%) that low levels of the **governance** condition in combination with low levels of **cost savings** or with a poor **institutional context** are sufficient conditions for projects to be over costs.

When considering only PPP projects (39 cases), a high level of the **governance** condition combined with a high level of the cost saving condition and a good institutional context could explain 21 cases (62% coverage but with low consistency, 75%). However, cost overrun in PPP projects is not sufficiently explained, as for only 42% of the cases could be explained by poor institutional context and **revenue scheme** (76% consistency).

In road projects (23 cases), a high level of governance *is close* to being a necessary condition for projects to be on cost (0.89 consistency). Somewhat less than half of the road projects, which are on cost show to have a sufficient combination of a good **institutional** context, a good **remuneration scheme** and **financing scheme**, in combination with a high **governance** level. Similarly, the same conditions, although in their negative value, show to be a sufficient combination of conditions for less than half of the road projects, which are over cost.

Overall, regarding the analyses concerning costs, there were no conditions which showed to be necessary and the coverage of the models was mostly weak (= or < 0.5), showing that it is not easy to find necessary and sufficient conditions to explain projects to be on cost. However, explanatory power of the models improves to some extent when looking to sub-samples such as PPP projects.

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6.7.1.2 Time

With respect to the entire sample of projects (52 cases), a high level of **governance** is *close to* being a necessary condition for the presence of the 'on time' outcome (89% consistency). *Being a PPP project shows to be a necessary condition for infrastructure projects in our sample to be on time (93% consistency).*

The achievement of the time target cannot be contributed to all conditions. Infrastructure projects experiencing time overrun seems to be explained (62% of the cases) by different combinations of low levels of the **governance**, the **cost savings**, the **financing scheme** conditions, as well as a poor **institutional context.** In addition, analyses suggested that public projects (not PPP) *in combination with other conditions* might demonstrate time overrun.

A clear trend was not identified within the PPP sample of cases (39). Potentially, low values of the cost saving, revenue scheme and financing scheme conditions may present sufficient conditions for time overrun (39% overall coverage).

Road projects (23 cases included in the analysis) underperform when low levels of **financial-economic context**, **remuneration scheme** and **institutional context** conditions are present (54% of the cases). The same combination of high levels of financial-economic context, remuneration scheme and institutional context together with high levels of financing scheme is a sufficient combination which shows in 43% of the road projects to be on time.

6.7.1.3 Traffic

Only projects in operation were included in this analysis (47 projects).

In general, 62% of the cases which are 'on traffic' show to have a high **remuneration** scheme condition as core condition, in combination with some of the following peripherical conditions: a good **institutional context**, a high **financial & economic context**, a high **governance**, a high **cost saving**, a high **revenue scheme**, as sufficient conditions. In addition, 54% of the cases below traffic have the following sufficient combination of conditions: a low remuneration scheme, a bad institutional context (both core conditions) and a low financial & economic context (as peripherical condition). A focus on passenger mode and PPPs seem to contribute to the objective.

Overall, when considering all analyses regarding the total sample of infrastructure projects, the following three conditions (in combination with other conditions) act, at least in a share of the projects on traffic and the projects below traffic, in line with the formulated hypotheses: **remuneration scheme**, **financial economic context** and **institutional context**. In addition, **governance**, **cost saving** and **revenue scheme** are extra conditions found in combination with those three conditions for explaining on traffic. The combinations of conditions found explain more or less than 60% of the involved outcome, meaning that their explanatory value is rather high. An alternative analysis with only financial-economic context and remuneration scheme as conditions showed a high level of remuneration scheme to be a sufficient condition for 68% of projects whose revenue is in line or exceeding the forecasted revenue.

Regarding PPP projects (38 cases), a high level of **governance** and a good **institutional context** are *close to* being a necessary condition for projects to be on traffic (0.87 consistency). 64% of the PPP projects in our sample which are 'on traffic' have a high level of **remuneration scheme** as core conditions with different combinations of the following peripherical conditions: a high **financial economic context**; a good **institutional context**, a high level of **governance**, a high level of **cost saving** and a high level of **revenue scheme** as sufficient conditions. The consistency of this solution is quite satisfying (85%). In an alternative analysis, checking only for financial-economic context and remuneration scheme, 73% of the PPP projects on traffic had remuneration scheme as sufficient condition. This shows the importance of remuneration scheme for projects to perform on traffic.

A below traffic outcome of PPP projects in our sample can be explained rather straightforwardly. Around 52% of the membership of this outcome is explained by the sufficient combination, entailing a

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low level of **remuneration scheme**, a bad **institutional context** and a low **financial economic context** (83% consistency).

With respect to roads (23 cases), a high level of governance *is close* to being a necessary condition for projects to be on traffic (0.87 consistency). A bad financial-economic context is a necessary condition for projects to perform below traffic. The road projects which are on traffic show to have a sufficient combination of a good **remuneration scheme**, a high level of **cost saving** and a high **financial economic context**, in combination with a high **governance** level and a good **institutional context** (63% of the cases with 0.82). The same conditions, a low financial economic context in combination of either a low level of remuneration scheme or a low level of cost saving can explain projects below traffic forecasts (satisfying coverage, 0.81, but rather low consistency 0.79).

Overall, regarding the analyses concerning traffic, there were no conditions, which showed to be necessary and the coverage of the models was rather high (generally above 50-60%). Remuneration scheme, financial economic context and institutional context are of particular relevance as conditions.

6.7.1.4 Revenue

When considering all analyses regarding the total sample of infrastructure projects, the following four conditions (in combination with other conditions) act at least in a share of the projects on revenue: institutional context, financial economic context, remuneration scheme and cost saving. The combination of these four conditions found explains 75% of the cases. In addition, a positive institutional context is a sufficient condition for 74% of the projects being on revenue, meaning that a positive institutional context has a particular strong explanatory power. A positive financial-economic context as core condition, high cost saving and remuneration scheme as peripherical conditions make sufficient conditions for 29% of the membership of the outcome 'on revenue'. However, no specific conditions were identified for projects below revenue targets.

Regarding PPP projects (38 cases), 58% of the PPP projects in our sample which are 'on revenue or exceeding than forecast' have a good **institutional context**, in combination with a high level of **financing scheme** or **a low level of governance** as sufficient conditions with high consistency (89%). Again, explanatory conditions for underperformance were not found.

66% of the road projects which are on revenue show to have a sufficient combination when a **high revenue scheme** is combined with a **low level of financing scheme** or when a **high financial economic context** is combined with a high revenue scheme with a rather very high consistency (0.94). Again, explanatory conditions for underperformance were not found. However, poor financial-economic context conditions as well as high levels of cost savings are necessary conditions for projects to be 'below revenue'.

6.7.2 Matching Framework and Typology Indicators – Lessons Learned

Reflecting the findings of the analysis on the matching framework and its typology indicators aims at improving both the understanding of the findings and the performance within the matching framework of the typology indicators. The discussion is structured along the findings of the analysis.

6.7.2.1 Cost

Notably, higher values of the governance indicator in combination with higher values of the cost saving and institutional indicators may support the achievement of cost targets and the finding is in-line with the conceptual structure of the indicators. This appears to be the case for the entire sample and PPP projects.

However, the presence of the revenue scheme, as well as the remuneration scheme and financing scheme indicators with respect to roads requires further consideration as these indicators are mostly related to the operation phase of the project. Moreover, high and low values of the above indicators are descriptive of PPPs and public project respectively. The listed projects in table 6.3.10 confirm this

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interpretation. In other words, the conclusion with respect to roads achieving or not cost targets is explained by the governance, the institutional context and whether the project is a PPP or not. This also coincides with the condition with respect to PPPs in the entire sample.

6.7.2.2 Time

Time overrun associated with low values of the governance, cost saving, financing scheme and institutional context indicators is in-line with the structure of the indicators. Moreover, low values of the financing scheme have been designed to describe public (non-PPP) projects. This is also confirmed by the respective condition identified.

The presence of the remuneration scheme in the road sample explaining performance with respect to time targets requires further investigation.

6.7.2.3 Traffic

With considerable high coverage indicators relative to traffic were identified to be: Remuneration scheme, financial economic context and institutional context. More specifically, higher values of the implementation context indicators (i.e. a positive macroeconomic environment and good institutions) and low risk income streams are related to achieving traffic targets. Also of relevance were found to be governance, cost saving and revenue scheme. Cost saving, mostly related to the construction phase appears for high values indicating life cycle planning and innovation uptake. This is in line with the structure of the indicators.

6.7.2.4 Revenue

For the overall sample high financial institutional context, economic context, remuneration scheme and cost saving were identified as having a positive relation. This is in line with the structure of the indicators.

For PPPs, the combination of good institutional context and high level of financing scheme refers to positive implementation conditions for projects strongly supported by the government. However, the alternative combination presents governance with an inconsistent behaviour deserving further investigation also into the project cases explained by this solution.

Finally, with respect to roads the combination with low financing scheme refers to projects with high government support.

The negative correlation of the cost saving indicator as a necessary indicator deserves further investigation.

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7 Importance Analysis

7.1 Importance Analysis (IA) Overview

In principle, and as part of a cause-reduction approach to management, management actions should act upon those dominant factors that most influence the occurrence of a given output. This section provides a brief description of the approach adopted in this study to identify these relevant factors to project outcomes, and ultimately validate them.

The literature provides a number of methods to determine critical variables from multi-dimensional phenomena, as are the variables under study, to allow measures to be identified. Ansten and Vaurio (1992) and Aven and Nøkland (2010) provide guidance on this matter. We advocate an approach in which, the dominance of a factor is a function of its probability of occurrence, its influence on the output variable and the uncertainty (variability of the factor) attached to it. To fulfil these requirements, the analysis framework to be used needs to be based on a sensitivity analysis and Bayesian Networks.

Sensitivity analysis is the study of how the uncertainty in the output of a mathematical model or system (whether numerical or otherwise) can be apportioned to the various sources of uncertainty in its inputs (Saltelli et al, 2008). Sensitivity analysis is an ideal method to evaluate models (Borgonovo and Plischke, 2016).

Bayesian Networks (BNs) organize the body of knowledge in any given area by mapping out cause-and-effect relationships among key variables and encoding them with numbers that represent the extent to which one variable is likely to affect another (Henriksen et al, 2008). BNs are essentially a tool for modelling the relationships between variables, and for capturing the uncertainty in the dependencies between these variables using conditional probabilities (van der Gaag, 1996). These conditional probabilities can be learnt under certain conditions from small data sets, as shown by Onisko, Druzdzel and Wasyluk (2001). The developed Bayesian Networks models were evaluated using traditional tests reported by Anderson et al. (2004) and Lee and Moore (2014). Such tests include independence tests to check marginal and conditional independence among factors in the models, marginal log-likelihood estimation, which is a comparative measure and is used to assess the goodness of fit, and cross-validation to verify the capability prediction of the models developed. In this analysis, note that the models developed include relationships of variables confirmed by rejection of the hypothesis of independence for each marginal and conditional relationship (using the cut-offs $p < 0:001$, $p<0.01$, and $p <0.05$ for different relationships). The choice of an optimal model is mainly done by the assessment of its marginal log-likelihood value in conjunction with the prediction accuracy estimated with the leave-one-out procedure reported by Lee and Moore (2014).

In a Bayesian network, a sensitivity analysis could be carried out using an empirical approach — by altering each of the variables and observing the related changes in the posterior probabilities of the output. In the standard approaches to sensitivity analysis, one variable is altered from the original set of input variables and the sensitivity value related to the remaining input variables is then calculated and compared with those of other subsets of input variables (Deng, 2010). In our study, Borgonovo's (2006) measure is used as a sensitivity indicator. This is an alternative approach that examines the global response of a model's output by looking at the whole output distribution changes while assessing the influence of uncertainty (Borgonovo, 2006). Borgonovo's measure evaluation is reported in Borgonovo (2006) and in Borgonovo et al. (2011) with numerical and analytical tests showing reliable results in terms of ranking relevant factors according to their influence on output uncertainty.

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The Borgonovo sensitivity analysis renders rankings that can be represented by tornado graphs as shown in Figure 7.1.1. A tornado graph presents those factors that have the largest normalized effects on the occurrence of an output factor in a model. In a tornado graph, the numbers on the upper horizontal axis (δ) indicate the estimated value of Borgonovo's importance measure. A relatively high value of Borgonovo's importance measure indicates that the output variable uncertainty is highly sensitive to the involved variable with this importance measure. If the measure is relatively low, the output will be fairly insensitive to the associated factor. In a tornado graph, factors are ordered according to their importance measure. In total, this analysis helps discard irrelevant variables to a given output variable.

Figure 7.1.1: Ranking of factors and their impact on the occurrence of a given output variable

7.2 Modelling and analysis of the matching framework model overview

The variables in the matching framework model were described earlier in this report. The case study projects where the data was obtained from are described in **Annex A.1** and their "snapshot" data on **Annex A.2**. As shown below in Figure 7.2.1, the proposed analysis consisted of determining the most relevant variables linked to a set of predefined output variables. The selected output variables are cost, time, traffic and revenue. The models analysed considered some plausible interactions among input factors. These interactions were identified by means of independence tests.

Table 7.2.1 shows how variables were discretized. Given the size of the data set (up to 116 records), it is only possible to discretize the variables into two or three degrees of freedom. Using a higher number of classes or **degrees of freedom will reduce the number of records for each class**, and accordingly, the **reliability of the inferences and conclusions of the analysis cannot be guaranteed**.

Note that the modelling approach is capable of dealing with non-parametric variables. This means that the analysis carried out is not constrained by any assumption of normality or any particular probability distribution assumption. This has been discussed by Anderson et al (2004).

A number of analyses were run with data sets with different sizes, as shown in Table 7.2.2.

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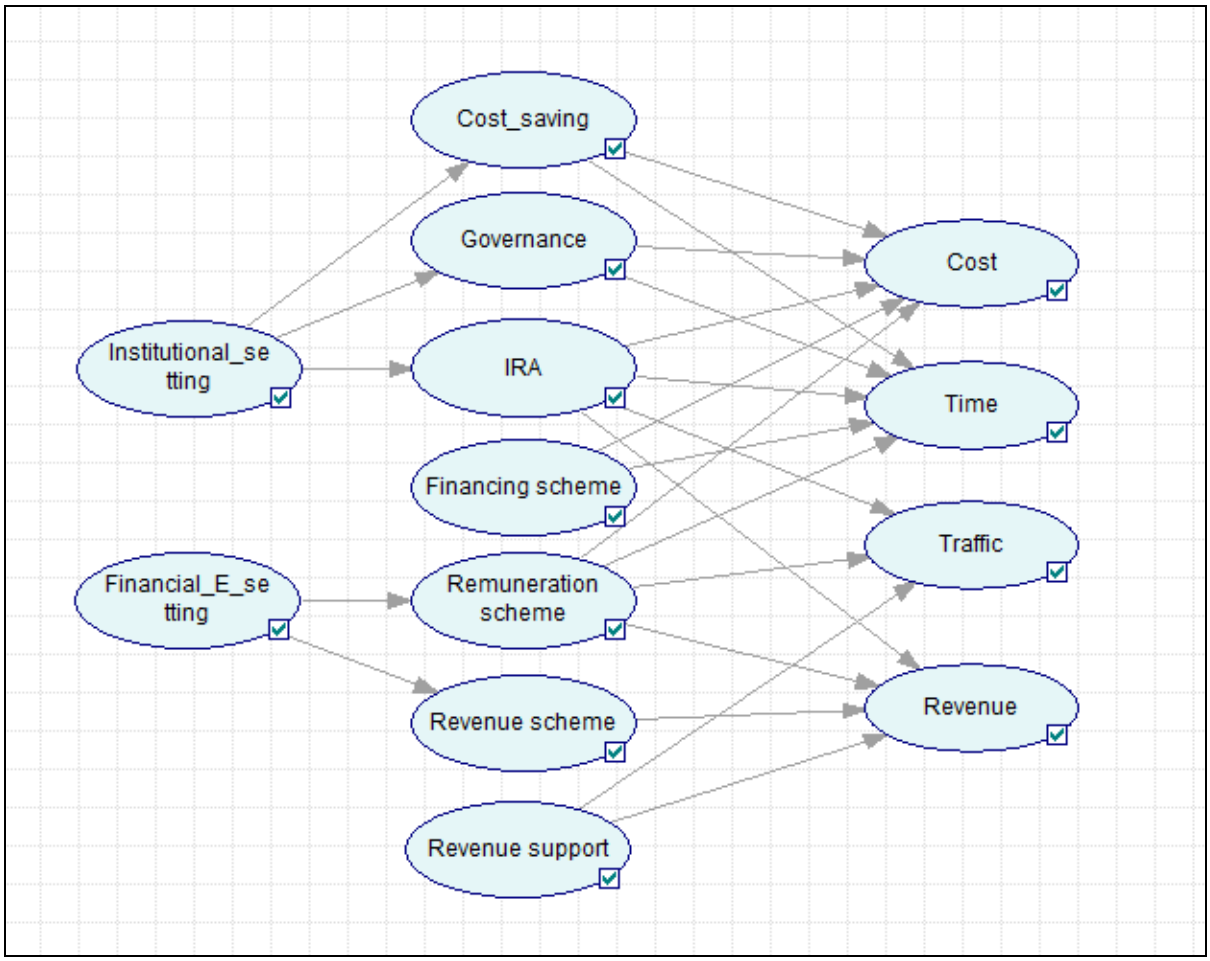

Figure 7.2.1: Structure of one of the models evaluated

Unfortunately, more analyses with different, smaller data sets cannot be carried out. Such additional analyses would not provide accurate results. Our validation approach is constrained by the size of the data sets. According to Onisko, Druzdzel and Wasyluk (2001) tests, the number of records to be used for the Analysis of Importance should be higher than 50 records. The remaining data subsets available, representing subsamples of the total sample of infrastructure projects, contain less than 50 records.

Table 7.2.3 depicts metrics of the analysis developed. These metrics provide information on the quality of the modelling.

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Table 7.2.1: Variables and their discretization

Type	Typology	Classes*
Input variables	Institutional context	a_more_than_073
		between 068 and 073
		c_below_068
	Financial Economic context	a_more_than_060
		between 046 and 060
		c_below_046
	IRA	a_more_than_075
		between 060 and 075
		c_below_060
	Governance	a_more_than_075
		between 061 and 075
		c_below_061
	Cost Saving	a_more_than_050
		between 028 and 050
		c_below_028
	Revenue support	a_more_than_014
		between 007 and 014
		c_below_007
	Remuneration Scheme	a_more_than_067
		between 050 and 067
		c_below_050
	Revenue Scheme	a_more_than_065
		between 037 and 065
		c_below_037
	Financing scheme	a_more_than_000
		b_equal to zero
		c_below_000
Output variables	Cost Overrun	a_cost_underrun[a]
		b_cost_overrun
	Time Overrun	a_time_underrun[b]
		b_time_overrun
	Actual vs Forecasted Traffic	a_forecast_as_expected[c]
		b_below_forecast[d]
	Revenue vs Forecasted Revenue	a_forecast_as_expected[e]
		b_below_forecast[f]

Notes: *Classes are determined using the 33th and 67th percentiles values of each variable data sets and these classes change according to the data set used.
[a] cost underrun class includes values associated with costs on budget
[b] time underrun class includes values associated with time to completion as planned
[c] the class includes values associated with actual traffic exceeding forecasts
[d] the class includes values associated with actual traffic far below expectations
[e] the class includes values associated with actual revenue exceeding forecasts
[f] the class includes values associated with actual revenue far below expectations

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Table 7.2.2: Analyses conducted for the validation of the matching framework

#	Description	Data size*/number of project cases	Objective of the analysis "Identification of factors relevant to …"
1	All records available	116/52	Cost
2			Time
3		108/47	Traffic
4			Revenue
5	Only records related to projects delivered by PPP	90/39	Cost
6			Time
7		88/38	Traffic
8			Revenue
9	Only records associated with road projects	57/23	Cost
10			Time
11		51/20	Traffic
12			Revenue

*Each data set size excludes 'snapshots' at award time.

Table 7.2.3: Metrics of the modelling analyses

#(1)	Description(2)	Marginal log-likelihood (3)	Average diagnostic accuracy (4)	Maximum probability achieved(5)	Objective of the analysis(6) "Identification of factors relevant to …"
1	All records available	-1108	65.40%	90.00%	Cost
2		-1108	80.06%	83.33%	Time
3		-1018	75.64%	84.90%	Traffic
4		-1018	69.19%	95.00%	Revenue
5	Only records related to projects delivered by PPP	-809	83.58%	87.50%	Cost
6		-809	75.10%	91.67%	Time
7		-782	75.47%	88.46%	Traffic
8		-782	65.79%	97.09%	Revenue
9	Only records associated with road projects	-476	75.00%	93.75%	Cost
10		-476	89.35%	87.50%	Time
11		-409	93.22%	92.86%	Traffic
12		-409	53.89%	87.50%	Revenue

According to Table 7.2.3, 11 out of 12 most optimal modelling analyses provide a very satisfactory diagnostic accuracy. The minimal percentage of correct diagnoses obtained was 65.40% (Analysis # 1). Unfortunately, the analysis carried out for the identification of factors relevant to the revenue variable using the road data subset (Analysis # 12) is not as reliable as the rest of the analyses. In terms of goodness of fit, which is measured by each model's marginal log-likelihood (column 3), we did not obtain significant differences among similar datasets. Thus the models analysed are rather equivalent in terms of goodness of fit to the data. The maximum probability value achieved (column 5) for the output variable analysed (column 6) when input variables are fixed at their optimum value reflects somewhat the level of completeness of each model considered. To a certain extent the models analysed are comprehensive. The most optimal dataset is the one composed by the records associated with road projects.

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7.3 Results and discussion

In Tables 7.3.1 to 7.3.4, results are presented per outcome and sample tested. The tornado graphs present those factors that have the largest normalized effects on the occurrence of an outcome in the Matching Framework. As noted earlier, the numbers on the upper horizontal axis indicate the estimated value of Borgonovo's importance measure in the graphs. A relatively high value of Borgonovo's importance measure indicates that the output variable (outcome) uncertainty is highly sensitive to the involved variable with this importance measure. If the measure is relatively low, the output will be fairly insensitive to the associated factor. In a tornado graph, factors are ordered according to their importance measure.

The results report variables, which are independent of particular outcomes (output variables), as well as others that are not relevant. It is noted that the models developed include relationships of variables confirmed by rejection of the hypothesis of independence for each marginal and conditional relationship (using the cut-offs: $p<0:001$, $p<0.01$, and $p<0.05$ for different relationships). The relevance of a given variable is given by the sensitivity analysis performed. An importance value threshold of 0.05 has been adopted as suggested by one used by Plischke, Borgonovo and Smith (2013).

7.3.1 Funding and Financing of Transport Infrastructure - Lessons Learned

All typology indicators representing respective aggregated factors (see Chapter 4 and BENEFIT deliverables D3.1, D2.2, D2.3 and D2.4) do not have the same influence on all outcomes. Notably, Cost and Time outcomes are related to the construction phase of a project, while traffic and revenues are prominent in operational performance. In the consideration of results, the synthesis of each sample tested should be considered (please see **Annex A.2**). It is noted that roads represent a large share, as do PPP case studies. Some points of interest are discussed below per outcome.

7.3.1.1 Cost

Across all sub-samples, the institutional and financial-economic context indicators appear to be the most frequent, as well as the indicators cost saving, governance and remuneration scheme. In addition, their relative ranking does not seem to vary significantly.

The Reliability – Availability factor appears not to be relevant, while the indicators revenue support and revenue scheme seem to be independent of cost variable. These findings are in line with what one could have expected given the fact that the indicators revenue support and revenue scheme are relevant to the operational phase, as is the reliability-availability indicator. Notably, there are cases in the sample where brownfield operation contributes to the construction budget. This would account for the small relevance of the indicator reliability-availability.

7.3.1.2 Time

As in the case of the Cost outcome (output variable), the indicators revenue support and revenue scheme appear as independent to the Time outcome. The reliability – availability indicator is also not considered as relevant. These findings could be explained as in the case of the Cost outcome.

The institutional context and governance indicators are important in all samples (i.e. entire sample, PPP data set and road data set). The cost saving indicator is important in the PPP dataset. The completion time for roads seems to be influenced by the financial-economic context and the remuneration scheme. The latter may be a likely finding of the particular sample, given the share of PPP roads. Notably, the remuneration scheme (mostly user tolls) in combination with the financial-economic context may have an influence on time to completion greater than the cost saving indicator suggesting a potential trade-off.

Further investigation may be needed with respect to the financing scheme and its respective role.

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Table 7.3.1: Results obtained with respect to the Outcome: COST

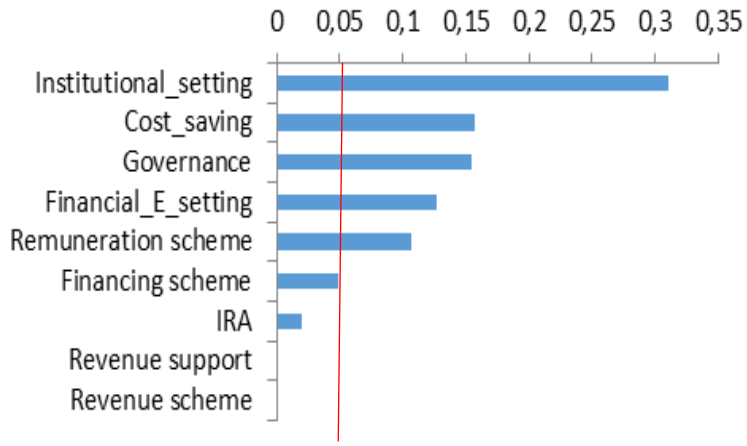
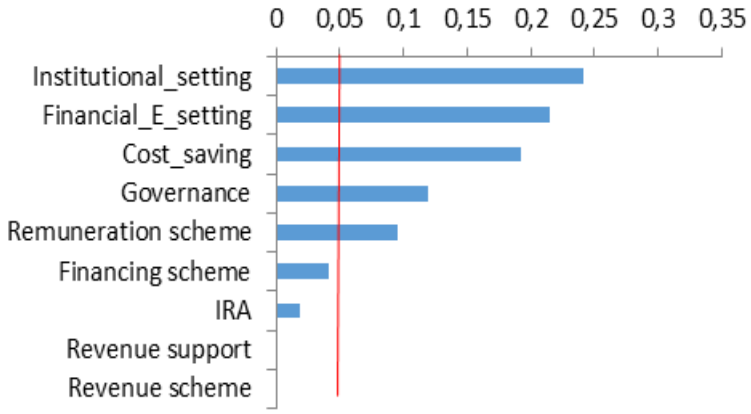
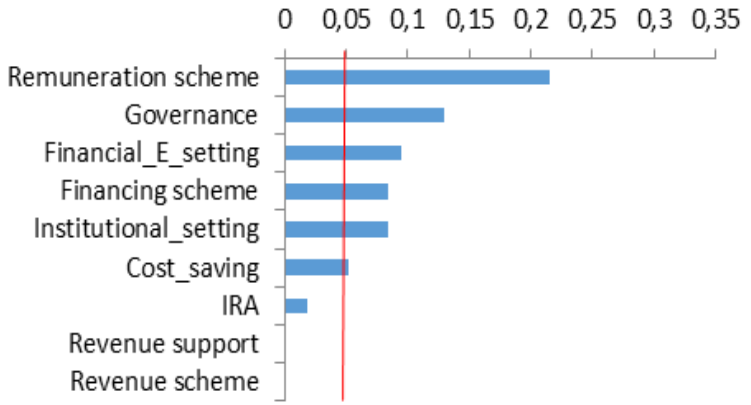
Tornado Graph	Sample
	**Entire Sample** <u>Relevant Indicators:</u> 1. Institutional context 2. Cost saving 3. Governance 4. Financial-economic context 5. Remuneration scheme 6. Financing scheme <u>Insignificant indicators (<0.05):</u> 1. Reliability – Availability <u>Independent Indicators:</u> 1. Revenue support 2. Revenue scheme
	**PPP Sample** <u>Relevant Indicators:</u> 1. Institutional context 2. Financial-economic context 3. Cost saving 4. Governance and 5. Remuneration scheme <u>Insignificant indicators (<0.05):</u> 1. Reliability – Availability 2. Financing scheme <u>Independent Indicators:</u> 1. Revenue support and 2. Revenue scheme
	**Road Sample** <u>Relevant Indicators:</u> 1. Remuneration scheme 2. Governance 3. Financial context 4. Financing scheme 5. Institutional context 6. Cost saving <u>Insignificant indicators (<0.05):</u> 1. Reliability – Availability <u>Independent Indicators:</u> 1. Revenue support and 2. Revenue scheme

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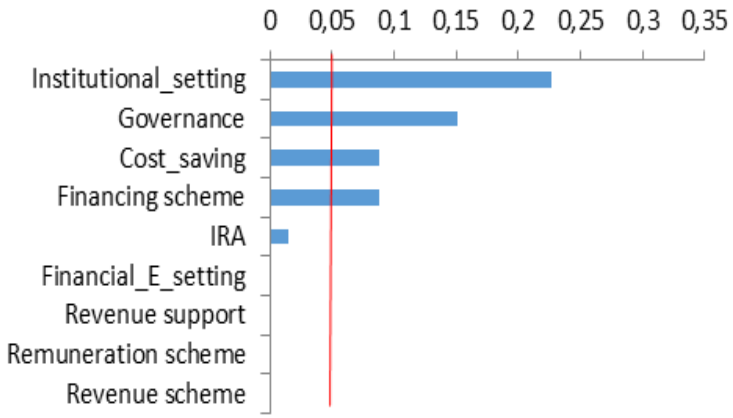
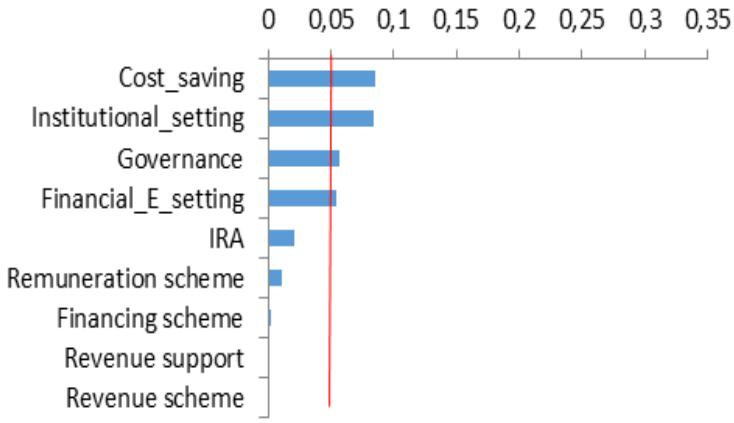
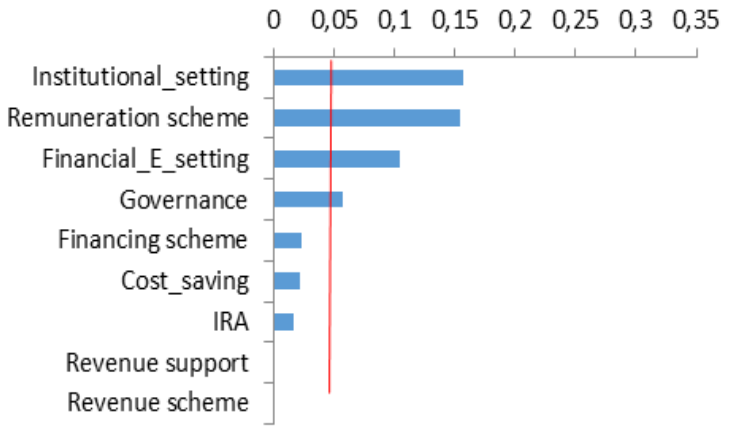
Table 7.3.2: Results obtained with respect to the Outcome: TIME

Tornado Graph	Sample
	**Entire Sample** Relevant Indicators: 1. Institutional context 2. Governance 3. Cost saving and 4. Financing scheme Insignificant indicators (<0.05): 1. Reliability – Availability 2. Financial-economic context and 3. Remuneration scheme Independent Indicators: 1. Revenue support 2. Revenue scheme
	**PPP Sample** Relevant Indicators: 1. Cost saving, 2. Institutional context and 3. Governance 4. Financial context Insignificant indicators (<0.05): 1. Reliability – Availability 2. Remuneration scheme 3. Financing scheme Independent Indicators: 1. Revenue support 2. Revenue scheme
	**Road Sample** Relevant Indicators: 1. Institutional context 2. Remuneration scheme 3. Financial-economic context 4. Governance Insignificant indicators (<0.05): 1. Reliability – Availability 2. Cost Saving, 3. Financing scheme Independent Indicators: 1. Revenue support 2. Revenue scheme

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7.3.1.3 Traffic

The influence of the financing–economic context indicator across all data sets with respect to the traffic outcome is an anticipated result, as traffic represents a derived demand dependent on economic activity. Other indicators anticipated to demonstrate influence are revenue support, revenue scheme and remuneration scheme. However, the revenue scheme indicator does not appear. This may be sample specific or an issue to be considered in the further validation of the indicator. Same consideration could apply for the financing scheme indicator, which appears as independent. The reliability – availability indicator appears as insignificant ($p < 0.05$), however this may be sample specific as most cases demonstrate high values of the indicator (see **Annex A.2**).

The relevant importance (ranking) of the various indicators varies across samples, with the findings of the road dataset being more differentiated. Notably, as discussed in Chapter 3, there is a significant difference with respect to traffic behaviour between modes. This could be the reason of differentiation. Notably, the indicators financing – economic context and remuneration scheme are the common factors across all datasets.

7.3.1.4 Revenue

Once again, the influence of the financing – economic context indicator across all data sets with respect to the traffic outcome is an anticipated result, as it is, often, closely related to traffic. The governance and cost savings indicators appear independent, as these are mostly geared to the construction rather than the operational phase of projects. The insignificance of the reliability-availability indicator probably is, as in the case of the traffic outcome, sample specific. The revenue support indicator also does not appear significant. This is sample specific as discussed in Chapter 3.

However, the inconsistent presence of the remuneration scheme and the indifference of the financing scheme across all data sets need further investigation.

7.3.2 Matching Framework and Typology Indicators – Lessons Learned

The study of findings with respect to the project outcomes with respect to the matching framework and the respective typology indicators based on this analysis suggests that most indicators are important, while to a different level for the various outcomes. Indicators requiring further investigation were found to be the revenue scheme and financing scheme indicators. In addition, the structure of the governance indicator seems to confine its explanatory value only to the construction phase of the project.

In addition, independence tests carried out, within the context of this analysis, show statistical association between institutional and financial-economic context indicators. This, however, has been anticipated. At a much lesser degree, the following pairs demonstrate association:

- Cost saving and governance indicators
- Remuneration scheme and revenue scheme indicators

These possible associations are likely due to each pair sharing some common factors, which, unfortunately, are not made explicit in the current matching framework model. The interactions among these factors have certain implications. Yet in these particular analyses, we believe, that the context priorities or determining the importance of factors in the models will not be substantially affected by the possible but not represented interactions. This is because, as much as the data allowed, the plausible relationships were incorporated into the models according to the independence tests results. Moreover, the missing interactions in the model are weak in the statistical sense, as reported in the econometric analysis described next in this report (see Chapter 8), and it is expected that their influence is not significant. To further substantiate this point, we earlier had carried out some analyses without considering interactions among input variables. The rankings obtained for those analyses were highly unstable in comparison to the ones reported here. This shows that the influence of interactions has been reduced significantly because some interactions have been modelled. Consequently, more robust rankings yield by the analysis presented herewith.

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Table 7.3.3: Results obtained with respect to the Outcome: TRAFFIC

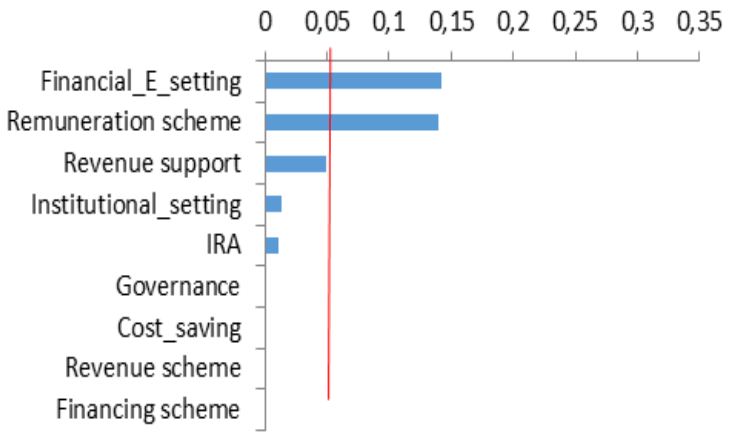
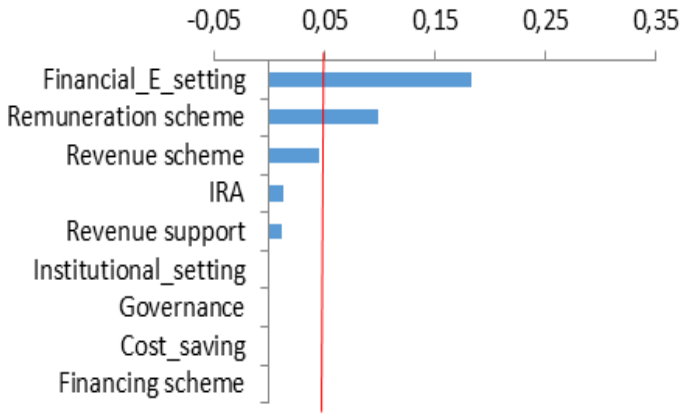
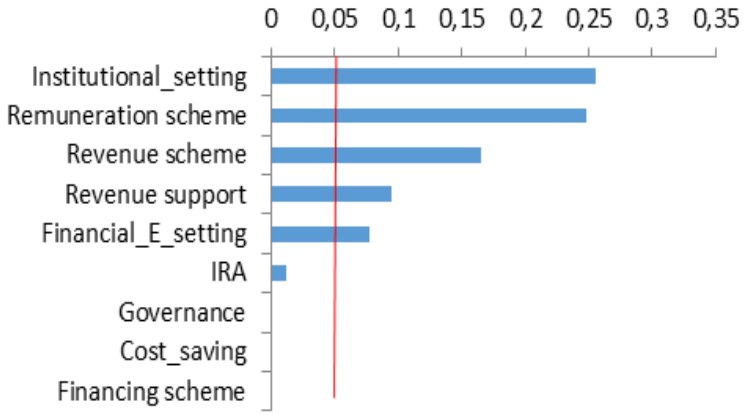
Tornado Graph	Sample
	**Entire Sample** <u>Relevant Indicators:</u> 1. Financial-economic context 2. Remuneration scheme 3. Revenue support <u>Insignificant indicators (<0.05):</u> 1. Reliability – Availability 2. Institutional context <u>Independent Indicators:</u> 1. Governance 2. Cost saving 3. Financing scheme 4. Revenue scheme
	**PPP Sample** <u>Relevant Indicators:</u> 1. Financial-economic context 2. Remuneration scheme <u>Insignificant indicators (<0.05):</u> 1. Reliability – Availability 2. Revenue scheme 3. Revenue support <u>Independent Indicators:</u> 1. Governance 2. Cost saving 3. Financing scheme 4. Institutional context
	**Road Sample** <u>Relevant Indicators:</u> 1. Institutional context 2. Remuneration scheme 3. Revenue Scheme 4. Revenue Support 5. Financial-economic context <u>Insignificant indicators (<0.05):</u> 1. Reliability – Availability <u>Independent Indicators:</u> 1. Governance 2. Cost saving 3. Financing scheme

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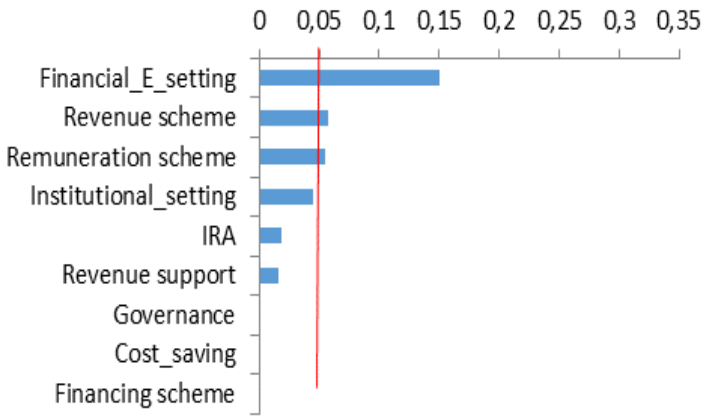
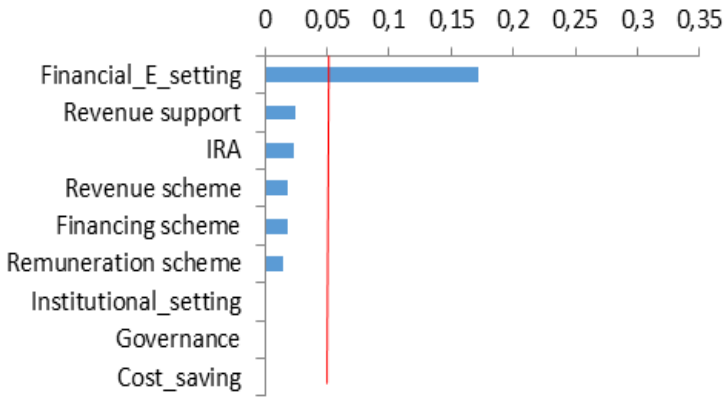
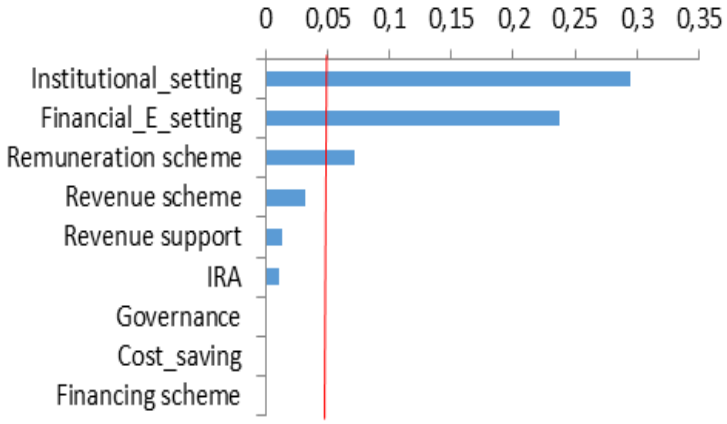
Table 7.3.4: Results obtained with respect to the Outcome: REVENUE

Tornado Graph	Sample
	**Entire Sample** <u>Relevant Indicators:</u> 1. Financial-economic context 2. Revenue scheme 3. Remuneration scheme <u>Insignificant indicators (<0.05):</u> 1. Revenue support 2. Reliability – Availability 3. Institutional context <u>Independent Indicators:</u> 1. Governance 2. Cost saving 3. Financing scheme
	**PPP Sample** <u>Relevant Indicators:</u> 1. Financial-economic context <u>Insignificant indicators (<0.05):</u> 1. Revenue support 2. Reliability – Availability 3. Revenue scheme 4. Financing scheme 5. Remuneration scheme <u>Independent Indicators:</u> 4. Governance 5. Cost saving 6. Institutional context
	**Road Sample** <u>Relevant Indicators:</u> 1. Institutional context 2. Financial context 3. Remuneration scheme <u>Insignificant indicators (<0.05):</u> 1. Revenue support 2. Reliability – Availability 3. Revenue Scheme <u>Independent Indicators:</u> 1. Governance 2. Cost saving 3. Financing Scheme

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8 Econometric Analysis Validation

8.1 Introduction

Within the overall context of the BENEFIT methodology, the aim of this section is to provide some empirical evidence regarding the factors that explain the conditions under which a transport infrastructure project may achieve certain performance outcomes. These include four variables (outcomes): “cost underrun”, “time underrun”, “actual versus forecasted traffic” and “actual versus forecasted revenue”. These variables take discrete values (binary outcomes), which imply the usage of a binary outcomes model (microeconometrics models). Among other aspects, these models treat the binary outcome like a probability. Two models are employed towards this aim: a *probit* model and a bivariate *probit* model, depending on the existence of correlation among the endogenous variables.

8.1.1 Variables

Two types of empirical strategies have been followed in this section in order to disclose the empirical factors (typology indicators) that may affect the probability of achieving particular outcomes. The first one focuses on the *underrun* variables (i.e, cost and time underrun), since they represent two ‘objective’ indicators of how the project performed with respect to the construction phase or supply side. The second strategy analyses ‘actual versus forecasted traffic’ and ‘actual versus forecasted revenue’, two elements on the demand side that relate to the project performance with the ex ante expectations. Both cost and time underrun are dichotomous variables that take the value 1 if the project was completed below budget or on budget and ahead of schedule or on time, respectively; and 0 otherwise. Similarly, ‘actual versus forecasted traffic’ (just ‘traffic’, hereafter) and ‘actual versus forecasted revenue’ (just ‘revenue’, hereafter) take value 1 if the project exceeded its forecasted figures, or as forecasted, and 0 otherwise.

The explanatory variables include: the financial economic context, institutional context, reliability and availability (IRA), governance, cost savings, revenue support, remuneration scheme, revenue scheme and financing scheme indicators as depicted by the BENEFIT Matching Framework. The variables show low standard deviations as can be also deduced from the minimum and maximum values (see Table 8.1.1 and also **Annex A.2**.). Variables with low standard deviation imply some econometric issues that will be explained below.

Table 8.1.1: Descriptive statistics

	Obs.	Mean	Std. Dev	Min.	Max.
Financial economic	183	0.582	0.106	0.305	0.842
Institutional context	185	0.695	0.097	0.38	0.87
IRA	185	0.961	0.130	0.25	1
Governance	177	0.649	0.177	0.187	1
Cost savings	185	0.417	0.322	-0.333	1
Revenue support	185	0.065	0.057	0	0.269
Remuneration scheme	185	0.489	0.232	0	1
Revenue scheme	185	0.512	0.252	0	0.944
Financing scheme	183	0.470	0.218	0.2	0.904

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Table 8.1.2: Correlation among variables

	Financial economic	Institutional context	IRA	Governance	Cost savings	Revenue support	Remuneration scheme	Revenue scheme	Financing scheme
Financial economic	1								
Institutional context	0.71	1							
IRA	0.11	0.11	1						
Governance	0.15	0.37	0.27	1					
Cost savings	0.03	0.17	0.34	0.50	1				
Revenue support	-0.31	-0.26	0.09	0.10	0.19	1			
Remuneration scheme	0.14	0.16	0.09	-0.06	0.06	-0.01	1		
Revenue scheme	-0.002	-0.03	-0.01	0.23	0.06	0.26	-0.35	1	
Financing scheme	0.20	0.25	0.30	0.38	0.25	-0.04	-0.12	-0.002	1

In general, the variables do not show correlation among them except for the financial-economic and Institutional context (0.71) indicators and governance and cost saving indicators (0.5) (see Table 8.1.2). According to Gujarati (2003) quoting Achen (1982), from a theoretical perspective, the existence of correlation (multicollinearity) is similar to a problem with few observations or variables with small variances; which in turn means the difficulty to get low standard errors. Despite the multicollinearity, the estimates are still the Best Linear Unbiased Estimator (BLUE). Gujarati (2003) highlights the practical consequences of dealing with multicollinearity. Among other issues, he remarks that the significance of the individual parameters tend to be close to zero. Thus, we opt for removing the "institutional context"[39] so as to avoid potential issues concerning the individual significance of such variables as well as to apply a robust estimator in all the models. Unfortunately, the problem concerning the low standard deviation of the variables cannot be addressed. Finally, the dataset is a highly unbalanced panel. Thus, the models are estimated assuming a cross-section dataset so as to avoid selection bias (Verbeek, 2012 and Baltagi, 2013).

8.1.2 Models

The discrete nature of the endogenous variables implies that the regression analysis must be carried out using a micro-econometric approach. Two models will allow us to address such issues: the *probit* model and the bivariate *probit* model. Regardless of the binary nature of the variables, the main distinction between both models is the correlated nature of the endogenous variables in the bi-variate model case.

8.1.2.1 Bivariate

According to Cameron and Trivedi (2005), the main distinction between a multivariate and multinomial model is in the specification of the functional form of the probabilities. In the multinomial case, the probability of each case can be assumed as independent and the density function can be written as:

$$f(y) = p_1^{y_1} * \ldots\ldots * p_m^{y_m} = \prod_{j=1}^{m} p_j^{y_j}$$

[39] The other correlated variables (cost saving and governance) show a lower correlation and the effect on its significance can be neglected.

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Where: subscripts *j* denotes the alternatives, which take values from *j* to *m.*
On the other hand, if we assume the existence of two interrelated variables, both variables can be treated as *m1*m2* univariate outcomes. In this case, the density probability function can be written as:

$$f(y_{1i}, y_{2i}) = \prod_{k=1}^{m_1} \prod_{j=1}^{m_2} p_{ijk}^{y_{ijk}}$$

Where: subscript *i* denotes the *i*th observation and y_{ijk} is an indicator for the observation *i* where $y_{ijk} = 1$ if $y_1 = j$ and $y_2 = k$; and $y_{ijk} = 0$ otherwise.
The maximum likelihood estimation consists of maximizing the bivariate normal distribution function:

$$prob(X_1 < x_1, X_2 < x_2) = \int_{-\infty}^{x_1'\beta_1} \int_{-\infty}^{x_2'\beta_2} \phi(z_1, z_2, \rho)\, dz_1 dz_2 = \Phi(x_1'\beta_1, x_2'\beta_2, \rho)$$

Where: $\phi(z_1, z_2, \rho)$ and $\Phi(x_1'\beta_1, x_2'\beta_2, \rho)$ are, respectively, the normal density and the cumulative density for (z_1, z_2) with zero means, unit variances and correlation ρ between the two alternatives. The ρ correlation matrix can be approached by the Cholesky decomposition (Cappellari & Jenkins, 2003). Greene (1997) provides a concise explanation of the maximum likelihood estimation in a bivariate context, whereas Cappellari and Jenkins (2003) refer to multivariate cases where the maximum likelihood is approached by simulation, the so-called maximum simulated likelihood. Train (2009) provides an intuitive explanation of the maximum simulated likelihood. The general specification of a bivariate *probit* model would have the following form:

$$y_1^* = x_1'\beta_1 + \varepsilon_1, \quad y_1^* = 1 \text{ if } y_1^* > 0,\ 0 \text{ otherwise}$$
$$y_2^* = x_2'\beta_2 + \varepsilon_2, \quad y_2^* = 1 \text{ if } y_2^* > 0,\ 0 \text{ otherwise}$$
$$\mathrm{E}[\varepsilon_1|\mathrm{x}_1,\mathrm{x}_2]=\mathrm{E}[\varepsilon_2|\mathrm{x}_1,\mathrm{x}_2]=0,$$
$$\mathrm{Var}[\varepsilon_1|\mathrm{x}_1,\mathrm{x}_2]=\mathrm{Var}[\varepsilon_2|\mathrm{x}_1,\mathrm{x}_2]=1,$$
$$\mathrm{Cov}[\varepsilon_1,\varepsilon_2|\mathrm{x}_1,\mathrm{x}_2]=\rho$$

The three conditions assume that the mean of the errors terms equals zero, the variance equals one and the errors correlation is ρ .

Probit[40]
A *probit* model arises when the endogenous variable takes a binary outcome:

$$y = \begin{cases} 1 \text{ with probability } p, \\ 0 \text{ with probability } 1 - p. \end{cases}$$

The *probit* model has the following conditional probability:

[40] Those interested in *probit* models are referred to Cameron and Trivedi (2005)

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$$p = \Phi(x'\beta) = \int_{-\infty}^{x'\beta} \phi(z)dz$$

Where: $\Phi(x'\beta)$ denotes the cumulative standard normal distribution with $z \sim N(0,\sigma^2)$; being $x'\beta$ the explanatory variables (transposed) multiplied by the coefficients.

8.2 Results

As already mentioned in the previous section, two models can be distinguished depending on the relationship established between the endogenous variables. Cost and time underrun show correlation. Thus, a bivariate *probit* model is estimated. For the case of traffic and revenue, there is no such correlation identified and, hence, both variables can be addressed separately using a *probit* model. Regarding the explanatory variables, all are used in a standardized way so as to get comparable estimates (coefficients) of the weight of each variable in the endogenous variable. The way to proceed with the estimation of the models can be summarized in the following algorithm:

- Firstly, all explanatory variables are included (except "Institutional context" for the reasons previously adduced).
- Secondly, those variables with the non-expected sign are omitted[41].
- Thirdly, a dummy variable for road projects is included.
- Fourthly, a multiplicative[42] road dummy variable is considered.
- Fifthly, a dummy variable for PPP projects is included.
- Sixthly, a multiplicative PPP dummy variable is also considered.
- Seventhly, a PPP dummy for the year previous to the economic crisis (*Ppp2*) is considered.
- Finally, a multiplicative PPP dummy for the year previous to the economic crisis is also included.

Table 8.2.1 summarises the models estimated, although not all of them are shown in this document for the purpose of brevity and the lack of remarkable results. For instance, the inclusion of a dummy variable that takes value 1 if the project is a road and 0 otherwise, does not provide significant results for the four outcomes analysed here. Besides, the multiplicative dummy variable does not work either. In this last case, the dummy variable multiplies each explanatory variable. This implies that there are no statistical differences in the road projects with respect to non-road projects. Thus, the results analysed in this document are focused on the PPP projects.

A "PPP" variable (*Ppp1*) takes value 1 if the project is a PPP project and 0 otherwise. Additionally, a PPP dummy for the years previous to the economic crisis (*Ppp2*) seems to provide significant results. This dummy takes value 1 if the project is a PPP project and it is previous to the economic crisis of 2008 and 0 otherwise. **Through the inclusion of this dummy variable for the years previous to the economic crisis one tries to isolate the effect of the economic crisis on PPP projects.** The economic crisis meant a turn of event in the economy that had to be taken into account in the analysis.

[41] Variables with an effect on the endogenous variables that should be contrary to the estimation obtained
[42] Find a explication of multiplicative dummy in Gujarati (2003)

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Table 8.2.1: Models

Models	Endogenous variables	Explanatory variables[43]	Results
Bivariate Probit **M1**	cost underrun and time underrun	Variables with the expected sign	Results in Table 8.2.2
Bivariate Probit **M2**	cost underrun and time underrun	Variables with the expected sign +ppp1 dummy	Results in Table 8.2.2
Bivariate Probit **M3**	cost underrun and time underrun	Variables with the expected sign +ppp2 dummy	Results in Table 8.2.2
Bivariate Probit	cost underrun and time underrun	Variables with the expected sign + multiplicative ppp1 dummy	Not significant results
Bivariate Probit	cost underrun and time underrun	Variables with the expected sign + multiplicative ppp2 dummy	Not significant results
Bivariate Probit	cost underrun and time underrun	Variables with the expected sign + road dummy	Not significant results
Bivariate Probit	cost underrun and time underrun	Variables with the expected sign + multiplicative road dummy	Not significant results
Probit **M4**	cost underrun	Variables with the expected sign	Results in Table 8.2.4
Probit **M5**	cost underrun	Variables with the expected sign +ppp1 dummy	Results in Table 8.2.4
Probit **M6**	cost underrun	Variables with the expected sign +ppp2 dummy	Results in Table 8.2.4
Probit	cost underrun	Variables with the expected sign + multiplicative ppp1 dummy	Not significant results
Probit	cost underrun	Variables with the expected sign + multiplicative ppp2 dummy	Not significant results
Probit	cost underrun	Variables with the expected sign + road dummy	Not significant results
Probit	cost underrun	Variables with the expected sign + multiplicative road dummy	Not significant results
Probit **M7**	time underrun	Variables with the expected sign	Results in Table 8.2.6
Probit **M8**	time underrun	Variables with the expected sign +ppp1 dummy	Results in Table 8.2.6
Probit **M9**	time underrun	Variables with the expected sign +ppp2 dummy	Results in Table 8.2.6
Probit	time underrun	Variables with the expected sign + multiplicative ppp1 dummy	Not significant results
Probit	time underrun	Variables with the expected sign + multiplicative ppp2 dummy	Not significant results
Probit	time underrun	Variables with the expected sign + road dummy	Not significant results
Probit	time underrun	Variables with the expected sign + multiplicative road dummy	Not significant results
Probit **M10**	traffic	Variables with the expected sign	Results in Table 8.2.8
Probit **M11**	traffic	Variables with the expected sign +ppp1 dummy	Results in Table 8.2.8
Probit **M12**	traffic	Variables with the expected sign +ppp2 dummy	Results in Table 8.2.8
Probit	traffic	Variables with the expected sign + multiplicative ppp1 dummy	Not significant results
Probit	traffic	Variables with the expected sign + multiplicative ppp2 dummy	Not significant results
Probit	traffic	Variables with the expected sign + road dummy	Not significant results
Probit	traffic	Variables with the expected sign + multiplicative road dummy	Not significant results

[43] The year of the award of the project is omitted from the estimation.

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Models	Endogenous variables	Explanatory variables[43]	Results
Probit **M13**	revenue	Variables with the expected sign	Results in Table 8.2.10
Probit **M14**	revenue	Variables with the expected sign +ppp1 dummy	Results in Table 8.2.10
Probit **M15**	revenue	Variables with the expected sign +ppp2 dummy	Results in Table 8.2.10
Probit	revenue	Variables with the expected sign + multiplicative ppp1 dummy	Not significant results
Probit	revenue	Variables with the expected sign + multiplicative ppp2 dummy	Not significant results
Probit	revenue	Variables with the expected sign + road dummy	Not significant results
Probit	revenue	Variables with the expected sign + multiplicative road dummy	Not significant results

8.2.1 Cost and Time Underrun Results

The first analysis is based on the relationship between cost and time underrun. According to Table 8.2.2, and focusing on model-run **M1** (entire sample), all the variables have the expected sign although not all are statistically significant.

In the "cost underrun" equation, leaving the constant aside, the "revenue support" indicator provides the highest effect (weight) in the explanation of the cost, followed by the "financial economic context" and the "governance" indicators.

In the "time underrun" equation, the key variables explaining the "time underrun" are the "revenue support" and the "financial economic context" indicators.

Following with model-run **M2,** PPP projects (Ppp1) have a negative and significant effect on the performance of both cost and time underrun. It should be highlighted that the negative value of the coefficient of the dummy variable should not be taken literally, but in terms of probability: PPP projects have a lower probability of finishing the project below budget or on budget as well as ahead of time or on time. Here again, the most influencial variable is the revenue support indicator follwed by the governance, financial-economic context and cost savings for "cost underrun". "Time underrun" is influenced by the indicators governance, financial-economic context and cost savings. This is further investigated in the model –run **M3.**

With regard to **M3**, in the "cost underrun" equation, leaving the constant aside, the variables by order of importance are: "Ppp2" (PPP projects prior to the economic crisis), "revenue support" and "financial economic context" indicators. In the "time underrun", the significant variable is "Ppp2". It should be also highlighted that the "athrho" variable is significant, which means that there is correlation between both equations in the three models as expected.

However, the suitable way to interpret the effect of the explanatory variables is in the probability of achieving the marginal effect. Table 8.2.3 depicts the marginal effect on the probability of achieving cost to completion and time to completion targets ($prob(cost\_overrun = 1,\ time\_overrun = 1)$). A marginal increase in the "remuneration support" index increases the probability of finishing the project below budget or on budget and ahead of schedule or on time by 8.8%. In addition, PPP projects constructed prior to the economic crisis of 2008 have a 19.4% higher probability of achieving these same targets.

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Table 8.2.2: Bivariate model estimates (M1, M2 and M3)

	M1		M2		M3	
	Log pseudolikelihood =-101.617	Observations 122	Log pseudolikelihood =-96.889	Observations 123	Log pseudolikelihood =-97.264	Observations 123
		Wald Chi2(18)= 39.03		Wald Chi2(18)= 36.82		Wald Chi2(18)= 42.06
		Prob Chi2=0.0001		Prob Chi2=0.0001		Prob Chi2=0.0000
	Coefficients	**Robust Std. Error**	**Coefficients**	**Robust Std. Error**	**Coefficients**	**Robust Std. Error**
Cost underrun:						
Ppp1	-		-0.849**	0.421	-	-
Ppp2	-		-	-	0.836**	0.389
Financial-economic context	0.420***	0.153	0.403***	0.158	0.313**	0.160
Institutional context	-	-	-	-	-	-
IRA	-	-	-	-	-	-
Governance	0.303*	0.166	0.527***	0.220	0.250	0.176
Cost savings	-	-	0.277*	0.155	0.057	0.163
Revenue support	0.855***	0.222	0.672***	0.229	0.686***	0.173
Remuneration scheme	0.0977	0.140	-	-	-	-
Revenue scheme	0.088	0.128	-	-	-	-
Financing scheme	-	-	-	-	-	-
Constant	1.094***	0.161	1.747***	0.363	0.963***	0.173
Time underrun:						
Ppp1	-	-	-0.842*	0.459	-	-
Ppp2	-	-	-	-	0.632*	0.378
Financial-economic context	0.269*	0.146	0.245*	0.150	0.162	0.143
Institutional context	-	-	-	-	-	-
Ira	-	-	0.062	0.097	0.049	0.102
Governance	0.262	0.172	0.505***	0.204	0.251	0.183
Cost savings	0.185	0.142	0.362*	0.205	0.176	0.173
Revenue support	0.287**	0.142	0.129	0.140	0.100	0.145
Remuneration scheme	0.147	0.126	-	-	0.074	0.129
Revenue scheme	-	-	-	-	-	-
Financing scheme	-	-	-	-	-	-
Constant	0.711***	0.246	1.417***	0.378	0.663***	0.157
athrho	1.034***	0.246	0.797***	0.220	0.844***	0.235
Rho	0.775	0.098	0.662	0.123	0.687	0.124

*** p<0.01, **p<0.05, *p<0.10

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Table 8.2.3: Marginal effect (M3)

	dy/dx	Robust Std. Error
Ppp2	0.194**	0.085
Financial-economic context	0.066	0.042
Governance	0.079	0.052
Cost savings	0.044	0.046
Remuneration support	0.088*	0.046
IRA	0.010	0.022
Remuneration scheme	0.0164	0.555

*** p<0.01, **p<0.05, *p<0.10

The analysis will proceed to analyse both "cost underrun" and "time underrun" independently. As it was already shown in Table 8.1.2, there is a correlation between these two output variables. So, this new approach may give bias results.

8.2.1.1 Cost underrun

The following analysis focuses on the "cost underrun" outcome. According to Table 8.2.4, in model-run **M4,** the indicator **"**revenue support" shows the highest effect on the cost (highest coefficient), while the "financial economic context" and the "governance" indicators are following in importance.

In model-run **M5** (PPP projects), leaving the constant aside, the "revenue support", "financial economic indicator" and the "governance" seem to explain the "cost underrun". With regard to model-run **M6** (PPP projects prior to the crisis), the main variables (indicators) by order of importance are: "revenue support", "governance" and "financial indicator". Table 8.2.5 depicts the marginal effect on the probability of "cost underrun". A marginal increase in the financial economic indicator raises the probability of finishing the project below budget or on budget by 6.3%. Regarding the "governance", a marginal increase in the governance index raises the probability of finishing the project below budget or on budget by 8.6%. Revenue support seems to have the greatest impact. The same reasoning can be done with the other variables, but taking into account its significance.

Figure 8.2.1 depicts the median band of the probability of "cost underrun". As shown in this figure, the probability increases steadily as the variable value increases. For the "revenue support" variable (indicator), it seems that the probability reaches its highest value as the variable takes the value of 1. In other words, improvement in the "revenue support" beyond this value does not increase the probability of finishing the project without extra costs. This is in line with the structure of the indicator and its range of values [0,1]. A similar reasoning can be done with regard to the "governance" variable where the probability reaches its highest value when the "governance" takes value 1. This, however, does not apply for the financial-economic context.

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Table 8.2.4: Probit model estimates (M4, M5 and M6)

	M4		M5		M6	
	Log pseudolikelihood =-52.991	Observations 123	Log pseudolikelihood =-49.474	Observations 123	Log pseudolikelihood =-49.474	Observations 123
		Wald Chi2(9)= 18.36		Wald Chi2(5)= 17.34		Wald Chi2(5)= 17.34
		Prob Chi2=0.0025		Prob Chi2=0.0039		Prob Chi2=0.0039
		Pseudo R2= 0.1814		Pseudo R2=0.2201		Pseudo R2=0.2201
	Coefficients	**Robust Std. Error**	**Coefficients**	**Robust Std. Error**	**Coefficients**	**Robust Std. Error**
Cost underrun:						
Ppp1	-	-	-0.744	0.533	-	-
Ppp2	-	-	-	-	0.530	0.394
Financial-economic context	0.382***	0.151	0.359**	0.158	0.2810*	0.156
Institutional context	-	-	-		-	-
Ira	0.044	0.134	0.018	0.163	-	-
Governance	0.294*	0.163	0.646***	0.225	0.384**	0.174
Cost savings	-	-	0.164	0.208	-	-
Revenue support	0.733***	0.232	0.989***	0.254	0.860***	0.262
Remuneration scheme	0.095	0.129	-	-	0.158	0.130
Revenue scheme	-	-	-	-	-	-
Financing scheme	-	-	0.008	0.199	-	-
Constant	1.032***	0.163	1.705***	0.440	1.026***	

*** p<0.01, **p<0.05, *p<0.10

Table 8.2.5: Marginal effect (M6)

	dy/dx	Robust Std. Error
Ppp2	0.530	0.394
Financial-economic context	0.063*	0.034
Governance	0.086**	0.037
Revenue support	0.193***	0.053
Remuneration scheme	0.357	0.028

*** p<0.01, **p<0.05, *p<0.10

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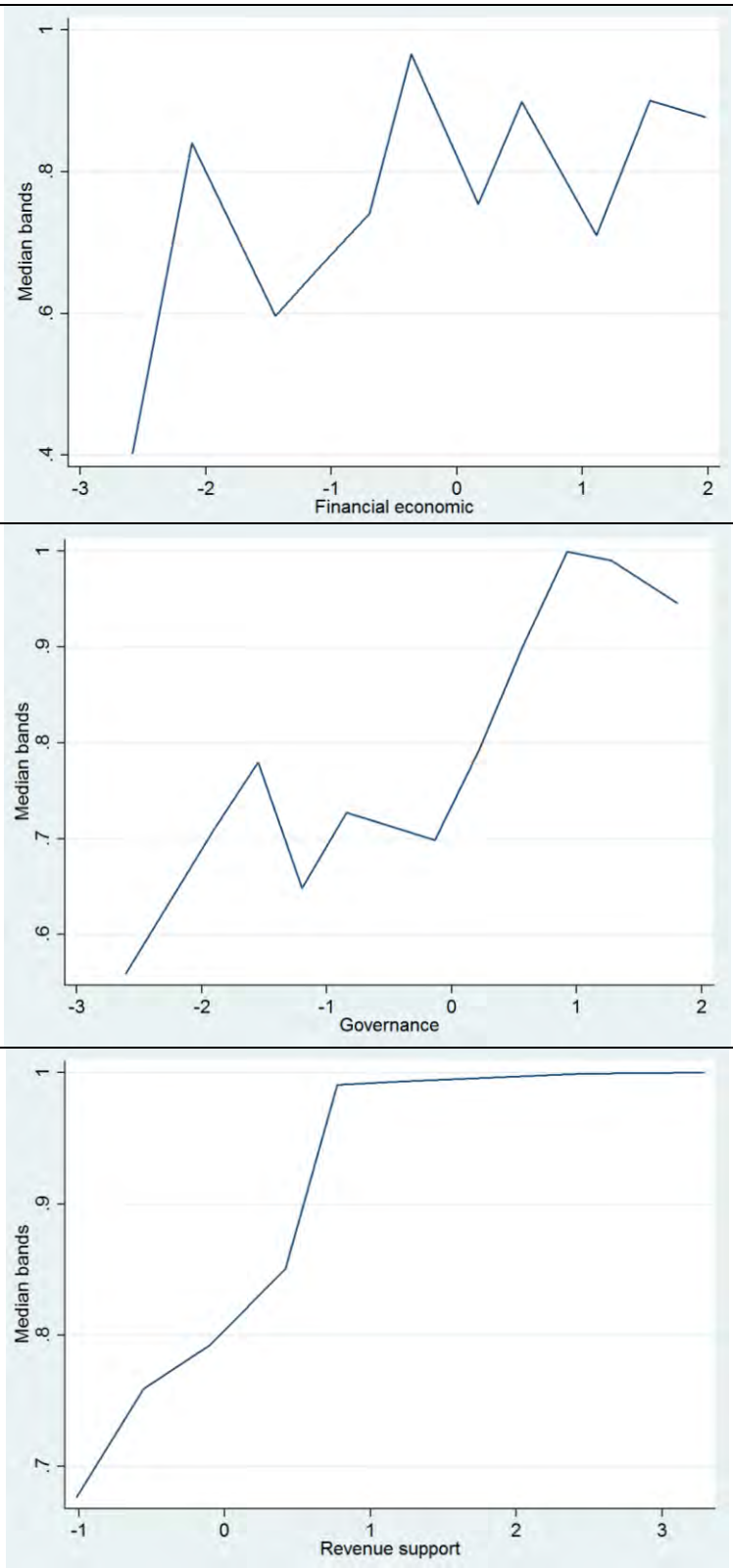

Figure 8.2.1: Median band of the probability (M6)

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8.2.1.2 Time underrun

In the "time underrun" model-run **M7** (Table 8.2.6), only the "revenue support" and the "financial economic context" explain the "time underrun". Following with model-run **M9** the significant variables by order of importance (weight) are, leaving the constant aside: "Ppp2", "governance" and "financial economic". As shown in Table 8.2.6 (**M8**), the Ppp1 variable does not seem to explain the "time underrun".

Table 8.2.6: Probit model estimates (M7, M8 and M9)

	M7		M8		M9	
	Log pseudolikelihood =-60.74	Observations 122	Log pseudolikelihood =-57.954	Observations 123	Log pseudolikelihood =-57.954	Observations 123
		Wald Chi2(9)= 19.26		Wald Chi2(5)= 25.04		Wald Chi2(5)= 25.04
		Prob Chi2=0.0074		Prob Chi2=0.0007		Prob Chi2=0.0007
		Pseudo R2=0.1470		Pseudo R2=0.2110		Pseudo R2=0.2110
	Coefficients	**Robust Std. Error**	**Coefficients**	**Robust Std. Error**	**Coefficients**	**Robust Std. Error**
Time underrun:						
Ppp1	-	-	-0.256	0.472	-	-
Ppp2	-	-	-	-	0.534*	0.338
Financial-economic context	0.260*	0.147	0.298**	0.148	0.243*	0.146
Institutional context	-	-	-	-	-	-
IRA	0.042	0.133	0.010	0.140	0.011	0.134
Governance	0.269	0.176	0.554***	0.192	0.455**	0.181
Cost savings	0.188	0.176	0.179	0.178	0.092	0.162
Revenue support	0.268*	0.143	0.281*	0.165	0.234	0.159
Remuneration scheme	0.160	0.126	0.088	0.134	0.168	0.131
Revenue scheme	-	-	-	-	-	-
Financing scheme	0.034	0.147-	0.021	0.193	-	-
Constant	0.707***	0.133	0.836**	0.360	0.537***	0.170

*** p<0.01, **p<0.05, *p<0.10

Proceeding with marginal effects (Table 8.2.7), a marginal increase in the financial economic indicator raises the probability of finishing the project ahead of schedule or on time by 6.4%. Regarding the "governance", a marginal increase in the governance indicator raises the probability of finishing the project ahead of schedule or on time by 12.1%. Finally, PPP projects prior to the economic crisis (Ppp2) have a 14.2% higher probability of finishing on time or ahead of schedule. In other words, PPP projects prior to the economic crisis seem to be more prone to producing better performance in terms of time of about 14.2%.

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Table 8.2.7: Marginal effect (M9)

	dy/dx	Robust Std. Error
Ppp2	0.142*	0.090
Financial-economic context	0.064*	0.037
Ira	0.003	0.035
Governance	0.121***	0.043
Cost savings	0.024	0.043
Revenue support	0.062	0.041
Remuneration scheme	0.044	0.033

*** p<0.01, **p<0.05, *p<0.10

Figure 8.2.2 depicts the median band of the probability of cost and time underrun. As shown in this graph, the probability increases steadily as the variables increase.

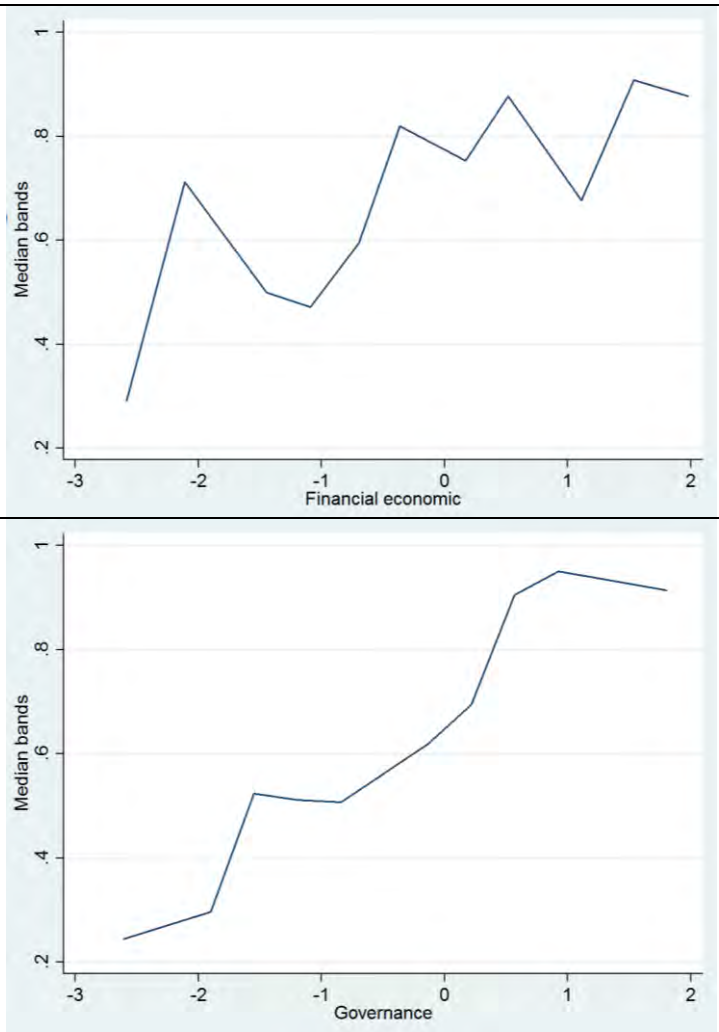

Figure 8.2.2: Median band of the probability (M9)

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8.2.2 Traffic

As shown in Table 8.2.8 (**M10**), and contrary to previous model-runs, the variable "remuneration scheme" seems to explain the performance of traffic performance. In fact, it is the variable (indicator) with the highest impact. Variables such as "IRA" and "financial economic context" also provide a significant effect on the traffic outcome. Focusing on model-run **M12**, the Ppp2 variable (PPP project prior to the crisis) shows the highest weight explaining the traffic followed by "remuneration scheme" and "financial economic context" indicators.

Table 8.2.8: Probit model estimates (M10, M11 and M12)

	M10		**M11**		**M12**	
	Log pseudolikelihood =-55.53	Observations 127	Log pseudolikelihood =-51.374	Observations 128	Log pseudolikelihood =-51.374	Observations 128
		Wald Chi2(9)= 32.38		Wald Chi2(5)= 25.35		Wald Chi2(5)= 25.35
		Prob Chi2=0.0000		Prob Chi2=0.0003		Prob Chi2=0.0003
		Pseudo R2=0.2666		Pseudo R2=0.2863		Pseudo R2=0.2863
	Coefficients	**Robust Std. Error**	**Coefficients**	**Robust Std. Error**	**Coefficients**	**Robust Std. Error**
Traffic:						
Ppp1	-	-	-0.44	0.391	-	-
Ppp2	-	-	-	-	0.911***	0.388
Financial-economic context	0.303**	0.145	0.444***	0.159	0.319**	0.147
Institutional context	-	-	-	-	-	-
Ira	0.430***	0.126	0.239*	0.144	0.174	0.160
Governance	-	-	-	-	-	-
Cost savings	0.089	0.143	0.292*	0.164	0.116	0.148
Revenue support	0.080	0.143	0.004	0.141	0.003	0.135
Remuneration scheme	0.628***	0.175	0.598***	0.172	0.799***	0.209
Revenue scheme	-	-	-	-	-	-
Financing scheme	-	-	-	-	-	-
Constant	0.751***	0.155	1.248***	0.310	0.701***	0.158

*** p<0.01, **p<0.05, *p<0.10

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With respect to marginal effect (Table 8.2.9), a marginal increase in the “financial economic context” indicator increases the probability of achieving traffic forecasts by about 7.2%. In other words, it is more likely to achieve the forecasted traffic when the financial-economic context improves. On the contrary, worst financial-economic scenarios may lead to lower actual traffic witnessed and, thus, this will provoke a mismatching between actual and forecasted traffic. The “remuneration scheme” has positive impacts on the probability to achieve traffic outcomes. More precisely, a marginal improvement in this indicator raises the probability by 18%. Finally, PPP projects conducted during the years prior to the economic crisis have a better performance in terms of traffic achievement. It is 20.5% more likely to achieve the forecasted traffic when the project is PPP operating before 2008.

Table 8.2.9: Marginal effect (**M12**)

	dy/dx	**Std. Error**
Ppp2	0.205***	0.077
Financial economic	0.072**	0.032
Ira	0.039	0.035
Cost savings	0.026	0.033
Revenue support	0.0007	0.030
Remuneration scheme	0.180***	0.037

*** p<0.01, **p<0.05, *p<0.10

Figure 8.2.3 shows the median band of the probability of the traffic with respect to the significant explanatory variables. As can be appreciated for the two explanatory variables, the probability of matching the actual and the forecasted traffic grows steadily when the explanatory variables increase/improve. Improvement in the “remuneration scheme” does not imply higher probability in the traffic beyond 0.5.

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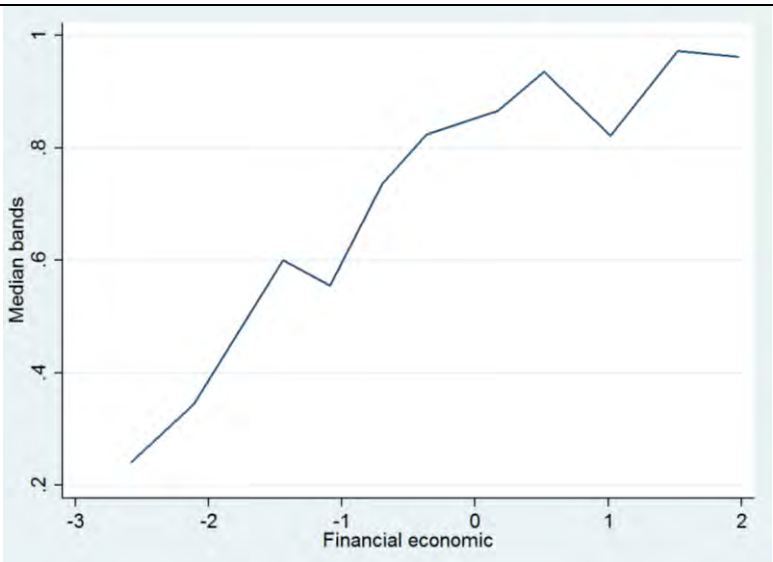

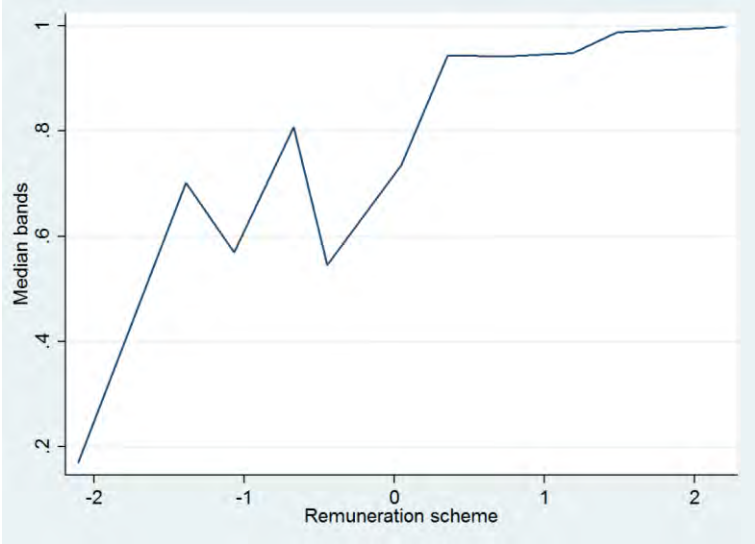

Figure 8.2.3: Median band of the probability (M12)

8.2.3 Revenue

As in the case of traffic, and contrary to other models, the "remuneration scheme" indicator has a significant effect on the revenue (Table 8.2.10, **M13**). Besides, both traffic and revenue share other significant variables such as "financial economic context" and "IRA". Nonetheless, the "revenue scheme" explains the revenue but not the traffic.

Proceeding with model-run **M15**, the revenue seems to be explained, in order of importance, by the following variables: "remuneration scheme", "cost savings" and "revenue scheme". Regarding the marginal effect (Table 8.2.11), an one-point increase in the "cost savings" indicator raises the probability of the revenue by 4.3%. Similar reasoning can be done with the other variables. Finally, a marginal improvement in the "remuneration scheme" indicator raises the probability of achieving forecasted revenues by 7%.

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Table 8.2.10: Probit model estimates (M13, M14 and M15)

	M13		M14		M15	
	Log pseudolikelihood =-32.037	Observations 127	Log pseudolikelihood =-30.613	Observations 128	Log pseudolikelihood =-30.613	Observations 128
		Wald Chi2(9)= 18.26		Wald Chi2(5)= 19.60		Wald Chi2(5)= 19.60
		Prob Chi2=0.0056		Prob Chi2=0.0065		Prob Chi2=0.0065
		Pseudo R2=0.2730		Pseudo R2=0.2719		Pseudo R2=0.2719
	Coefficients	**Robust Std. Error**	**Coefficients**	**Robust Std. Error**	**Coefficients**	**Robust Std. Error**
Revenue:						
Ppp1	-	-	-1.331**	0.703	-	-
Ppp2	-	-	-	-	0.405	0.554
Financial economic context	0.308*	0.175	0.463**	0.205	0.254	0.189
Institutional context	-	-	-	-	-	-
Ira	0.294**	0.128	0.221*	0.118	0.204	0.130
Governance	-	-	0.268	0.271	-	-
Cost savings	0.047	0.190	0.777***	0.278	0.332**	0.170
Revenue support	0.307	0.201	0.503	0.322	0.326	0.322
Remuneration scheme	0.563***	0.213	0.357*	0.210	0.537**	0.225
Revenue scheme	0.324*	0.172	0.220	0.189	0.307**	0.139
Financing scheme	-	-	-	-	-	-
Constant	1.623***	0.248	2.841***	0.549	1.621**	0.244

*** p<0.01, **p<0.05, *p<0.10

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Table 8.2.11: Marginal effect (M8)

	dy/dx	Std. Error
Ppp2	0.052	0.071
Financial economic	0.033	0.023
Ira	0.026	0.017
Cost savings	0.043*	0.023
Revenue support	0.042	0.040
Remuneration scheme	0.070***	0.029
Revenue scheme	0.040**	0.019

*** p<0.01, **p<0.05, *p<0.10

According to Figure 8.2.4, the median band of the probability of revenue seems to increase sharply at low levels of the “cost savings” indicator. The “revenue scheme” shows a more erratic path at low levels, but becomes more stable at higher levels. By contrast, “remuneration scheme” does not show a clear path.

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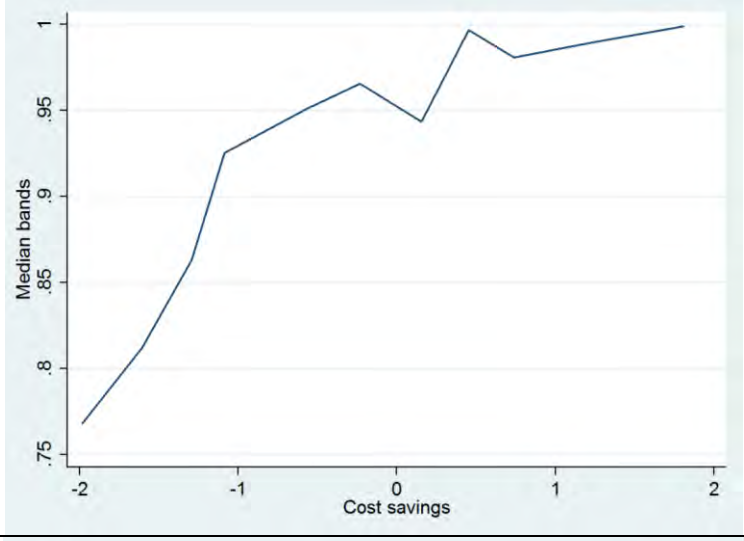

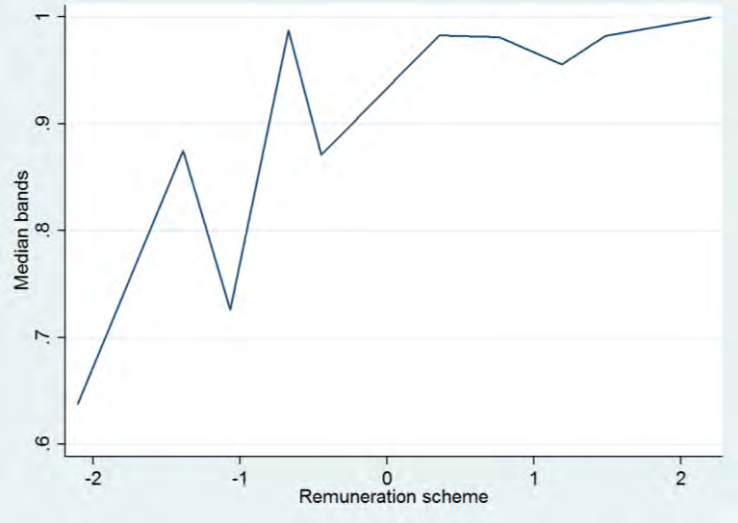

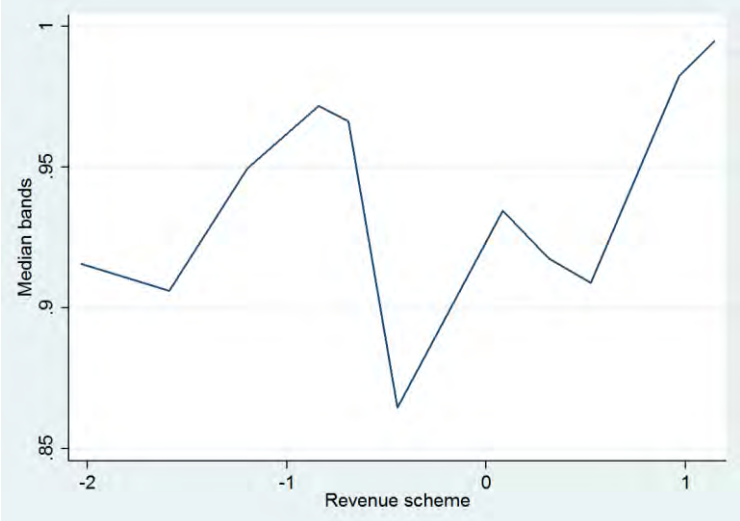

Figure 8.2.4: Median band of the probability (M15)

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8.3 Conclusions and Discussion

Analysing the factors (explanatory variables) that enhance the potential of a project to achieve particular outcome targets is not a straightforward issue. It must be acknowledged that countless circumstances may affect infrastructure projects and most of them cannot be tackled econometrically. In any case, the precise way to define the successful performance of a project is also a matter of concern. “Cost underrun”, “time underrun”, “actual versus forecasted traffic” or “actual versus forecasted revenue” are just proxy variables of performance. At the same time, another problem emerges when addressing the discrete nature of these variables and the best way to deal with them econometrically. Thus, the results and conclusions should be taken cautiously. In general, some conclusions can be drawn.

8.3.1 Funding and Financing of Transport Infrastructure - Lessons Learned

All typology indicators representing respective aggregated factors (see Chapter 4 and BENEFIT deliverables D3.1, D2.2, D2.3 and D2.4) do not have the same influence on all outcomes. Notably, Cost and Time outcomes are related to the construction phase of a project, while traffic and revenues are prominent in the operational performance. A key finding in this analysis is the characteristics difference and positive behaviour of PPP projects prior to the crisis. More specifically, PPP projects conducted prior to the economic crisis demonstrated a positive and significant effect in the “cost and time underrun”, the “time underrun” case and in the “traffic” model-runs. However, PPP projects, in general, have a lower probability of achieving “cost and time underrun”. This finding, however, may be sample specific as the BENEFIT case study database includes a significant share of PPPs during and after the economic crisis – some still in recession – which may distort findings. In addition, Bain (2009) had reported the negative influence of recession on road PPPs with respect to traffic if projects had not reached the ramp-up period. This analysis also identified the negative impact on cost and time to completion. The potential effect on cost and time was also identified by Ortega *et al* (2015). Notably, the general economic context of the country in which the project is conducted (“financial economic context” indicator) was identified to have an effect in practically all the models employed in this analysis.

Bearing the distinction between the construction phase and the operation phase, traffic and revenue outcomes seem to have a different performance compared to the “cost and time underrun” model-run in terms of explanatory variables. More specifically, and in summary:

8.3.1.1 Cost

Given the correlation identified between Cost and Time outcomes, their combined analysis (bivariate probit approach), identified that the revenue support, the financial-economic context and the governance indicators were those mostly influencing the probability to achieve the cost target. The financial – economic context and governance were again identified, when the cost outcome was analysed independently. An improvement in the aforementioned variables produces an increase in the chance of completing the project below budget or on budget. PPP projects do not produce any change in the costs.

However, the revenue support is an indicator connected with the operation phase. Their presence in the construction phase requires further investigation.

As noted above, based on the simultaneous estimation (bivariate probit approach), PPP projects conducted prior to the economic crisis seem to enhance the achievement of both cost and time (below budget or on budget and ahead of schedule or on time). The revenue support also seems to have the same positive effect on the probability of both cost and time underrun.

8.3.1.2 Time

The bivariate probit approach indicated that the time outcomes seem to be positively influenced equally by the financial-economic context and the revenue support indicators. The same indication

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was obtained when analysed independently. In the case of PPPs prior to the crisis, the governance and financial–economic context seem to explain results. The revenue support indicator does not appear to be significant. In addition, PPP projects prior to the economic crisis of 2008 seem to be more prone to completing the project either ahead of schedule or on time.

Again, revenue support is an indicator requiring further investigation.

8.3.1.3 Traffic

The key indicators having a positive effect on achieving traffic outcomes seem to be backed up by the remuneration scheme, the reliability-availability and the financial-economic context. Moreover, PPP projects prior to the economic crisis provide a better performance in terms of achieving traffic forecast with an estimated probability of 20.5%.

Notably, all indicators identified as having an impact are related to the operation phase of the project.

8.3.1.4 Revenue

The revenue scheme indicator has been found to be significant only with respect to the revenue outcome. Other indicators influencing the revenue outcome are cost savings, the remuneration scheme, the financial –economic and the reliability – availability indicators.

PPP projects do not seem to perform better than public projects in this sample. PPP projects prior to the crisis are mostly influenced by the remuneration scheme, the cost savings and the revenue scheme indicators.

Notably, the cost saving indicator is mostly associated with the construction phase. However, this aggregate indicator also includes a factor with respect to life cycle planning and innovation that may influence the operational phase and justify its potential influence on the revenue outcome.

8.3.2 Matching Framework and Typology Indicators - Lessons Learned

Bearing the limitations of micro-econometrics models and the specific sample, conclusions drawn are to be considered with caution. However, the analysis conducted provides rich results that may be considered in improving the Matching Framework and its typology indicators.

Revenue support is an indicator connected with the operation phase. Its presence in the construction phase requires further investigation. Moreover, the qualitative analysis (see Chapters 3 and 5 and **Annex 5** to Chapter 4) has indicated that projects with potentially higher values of the revenue support indicator demonstrate lower levels of achievement with respect to cost and time.

The indicators influencing traffic and revenue outcomes seem plausible and in line with anticipations. However, it is important to notice the fluctuations in the probability curves of both the remuneration and revenue scheme indicators and to a lesser degree that of the financial-economic context indicator.

The institutional context indicator was not included in this analysis due to its correlation with the financial-economic context indicator. It would be interesting to investigate the difference in results, should the institutional indicator be included instead.

Finally, contrary to expectations, the financing scheme indicator was not found statistically significant in any model run, suggesting the need for further investigation into this typology indicator.

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9 Discussion of findings & next steps

9.1 Introduction

The present chapter combines and discusses findings reached through the various analysis conducted in task 4.1. stage 2 and presented in this report. Their comparative and complementary study leads to valuable conclusions with respect to lessons learned concerning the funding and financing of transport infrastructure; the Matching Framework and its Typology indicators, as well as important knowledge with respect to the BENEFIT sample of cases. These conclusions also set the direction for further research within the BENEFIT project.

9.2 Comparative Analysis of FsQCA, Importance and Econometric Analysis Findings

9.2.1 Introduction

Three numerical analysis methods were employed in the validation process: FsQCA, Importance Analysis (IA) and (micro) Econometrics Analysis. In this section some general conclusions may be drawn comparing findings with respect to which indicators and how these may influence the four outcomes considered.

When conducting this comparison, it is crucial to keep in mind that each method has a different theoretical basis and, therefore, approaches the research question from a different perspective. Moreover, the conceptualization of causality is different. Econometric analysis searches for causality based on correlations and studies the independent effect of some variables on the dependent variable, while controlling for other variables. FsQCA looks for the combination of conditions that is necessary or sufficient to explain a certain outcome (INUS as concept of causality) and hence focuses strongly on how different conditions in combination interact to bring about a certain outcome. Importance (or Sensitivity) Analysis takes the middle ground. It is conceptually based on Bayesian Networks and maps out cause-and-effect relationships among key variables under conditions and estimates the marginal log-likelihood of proposed relationships.

Also, the different analysis methods are not fully comparable in terms of their inclusion of variables. In the econometric analysis, the institutional context indicator was not included as an independent variable as it was highly correlated to the financial-economic indicator (included as an independent variable). In the FsQCA, revenue support as a condition was not included, due to its low variance making it impossible to calibrate in a good way. Importance Analysis, however, was able to include all indicators in the analysis.

In addition, all methods do not treat all outcomes independently. The Econometrics analysis identifies a small correlation between Cost and Time to completion and, therefore, also considers these outcomes in combination.

Furthermore, the methods use different parts of the dataset. FsQCA used the inauguration for the assessment of Cost and Time while one later (if available) snapshot for the assessment of traffic and revenue. Importance analysis and Econometrics used all the snapshots excluding the award snapshot, which represents planning. Notably, Importance analysis and Econometrics view snapshots as observations, while FsQCA being closer to the actual cases cannot use the same case twice (or more times). This may also be a source of difference in findings.

On a more practical level, the way the value of variables is coded in order to perform the analyses, differs across the methods and, therefore special care should be taken in reading the results.

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When interpreting findings it is important to keep in mind that:

- All three methods use Typology Indicator values. Each indicator aggregates a number of factors. Therefore, findings should be interpreted based on the wider factors represented by each indicator (as opposed to the perceived meanings of indicator titles).

- Findings are influenced by the "correctness" of the input decisions, while the analysis methods are searching for causality effects between indicators. For example, no causality may be found with respect to actual vs forecasted traffic if the traffic forecast was overestimated as an input to begin with. This latter consideration influences mostly semi-qualitative methods (e.g. FsQCA).

9.2.2 Explaining transport infrastructure projects Cost to Completion Outcome

When comparing the results with respect to the outcome Cost to Completion on the entire sample (52 cases), we learn the following (see Table 9.2.1):

- The Importance Analysis (IA) shows that the institutional context, cost saving, governance and financial economic context indicators as well as the remuneration scheme indicator are relevant factors to cost as a dependent variable.

- In the Econometric Analysis (EA), a high level of governance, a good financial economic context, besides a high level of revenue support have a positive effect upon transport infrastructure projects to be on cost when considering the outcome cost as an independent variable.

- In the FsQCA analysis, only solutions for underperformance may be found: 50% of the infrastructure projects with cost overrun show to have low levels of governance with low levels of cost savings or with a poor institutional context as sufficient conditions.

Results are mutually supporting mainly in terms of the relevance of institutional context/ financial-economic context (which are quite highly correlated) and governance indicators. The cost-saving indicator seems to matter in the IA and FsQCA.

However, the presence of Revenue support (in EA) and the Remuneration scheme (in IA) Indicators deserves further consideration. Notably, the revenue support indicator also includes "level of control" combined with demand risk allocation. Qualitative analysis (see section 4.3) found that a correlation existed under conditions. Further consideration cannot be given for the remuneration scheme indicator, as the IA does not provide an indication of the direction of influence (positive or negative).

Table 9.2.1: Comparative results with respect to Cost to Completion (entire sample)

FsQCA (Explains cost overrun)	**IA**	**EA Cost Independent Model**	**EA Cost & Time Bivariate Model**
Institutional context	Institutional context	Revenue support	Revenue support
Cost saving	Cost saving	Financial economic context	Financial economic context
Governance	Governance	Governance	Governance
	Financial economic context		
	Remuneration scheme		

For the sub-sample of transport infrastructure project delivered by PPP, the following are observed (see Table 9.2.2):

- IA shows that institutional context, financial economic context, cost saving, governance and as well as remuneration scheme are relevant indicators to cost as a dependent variable.

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- In the econometric analysis, a high level of governance, a good financial economic context, besides a high level of revenue support, have a positive effect upon transport infrastructure projects to be on cost. However, PPPs overall were found to be less probable to reach cost targets in comparison with the entire sample of cases. The opposite probability existed for PPPs prior to the economic crisis.

- In the FsQCA analysis, a substantial number of PPP projects in our sample which are 'on or below cost' have high levels of cost saving and a good institutional context, in combination with a high level of governance as sufficient conditions (62% coverage; 75% consistency). Cost overrun in PPP projects in our sample is less straightforward to explain, with solutions with moderate to low coverage. Only 42% of the membership of this outcome is explained by the sufficient combination, which entails a poor institutional context and a poor revenue scheme (76% consistency).

Table 9.2.2: Comparative results with respect to Cost to Completion (PPP sample)

FsQCA (Explains cost overrun)	**IA**	**EA Cost Model**	**EA Cost & Time Bivariate Model**
Institutional context	Institutional context	**PPPs**	
Financial economic context	Financial economic context	Revenue Support	Revenue Support
Cost saving	Cost saving	Governance	Governance
Governance	Governance	Financial economic context	Financial economic context
Revenue scheme	Remuneration scheme		Cost saving
		PPPs before the Crisis	
		Revenue Support	Revenue Support
		Governance	Financial economic context
		Financial economic context	

The analyses are mutually supporting each others' results mainly in terms of the relevance of institutional context/financial-economic context (which are quite highly correlated) and governance, as well as cost-saving in case of both FsQCA and IA. Again the revenue support indicator identified by the EA bears the same characteristics as previously described.

Cost overrun explained through the revenue scheme indicator (FsQCA) refers to PPP projects with higher risk of revenue (eg. user charges). This compares with the low probability of achieving cost targets by PPP projects as indentified through the EA.

The Remuneration scheme indicator still remains for further investigation.

With respect to the subsample for road infrastructure projects, Econometrics analysis was not feasible due to the sample size, while from the findings provided by the IA and FsQCA, explanations are not so straightforward to make (see Table 9.2.3).

- Importance analysis shows that remuneration scheme, governance, financial economic context, institutional context, revenue scheme as well as cost saving are relevant factors to cost underrun as a dependent variable.

- In the FsQCA analysis, somewhat less than half of the road projects, which are on cost show to have a sufficient combination of a good institutional context, a high value of remuneration scheme and financing scheme, in combination with a high governance level. Similarly, the same conditions, although in their negative perception, show to be a sufficient combination of conditions for less than half of the road projects, which are over costs.

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Hence, it is hard to find clear results for road transport infrastructure projects, in terms of being on cost or over cost. However, considering the structure of the Remuneration and Revenue scheme, an alternative interpretation is plausible. More specifically, high values of the financing scheme are only present in PPP projects. In addition, high levels of the remuneration and revenue scheme indicators correspond to low risk remuneration schemes and low risk revenue scheme, respectively. In other words, findings may suggest that a positive financial/institutional context with high levels of governance (again achieved only by PPP projects) contribute in PPP road project with low risk revenue and remuneration schemes in achieving cost targets.

Table 9.2.3: Comparative results with respect to Cost to Completion (Road sample)

FsQCA	IA
Remuneration scheme	Remuneration scheme
Governance	Governance
	Financial economic context
Institutional context	Institutional context
	Revenue scheme
	Cost saving
Financing scheme	

9.2.3 Explaining transport infrastructure projects Time to Completion Outcome

When comparing the results of the three different analysis methods (IA, Econometric analysis and FsQCA) in terms of the full sample (52 cases), the following may be learned (see Table 9.2.4):

- Importance analysis shows that institutional context, cost saving, governance and financing scheme indicators are relevant factors to time underrun as a dependent variable.

- In the econometric analysis, a good financial economic context and revenue support indicator increase the probability of achieving time targets when analyzing for Time as a dependent variable and when in combination with Cost.

- In the FsQCA analysis concerning time, there were no conditions, which showed to be necessary (only PPP delivery mode for projects being on time). Only for *projects with time overrun* (around 60%), combinations of conditions were found. 62% of the infrastructure projects with time overrun show to have different combinations of low levels of governance, low levels of cost savings, a low level of financing scheme and a bad institutional context as sufficient conditions. No relevant solutions were found for projects being on time.

The analyses are mutually supporting results mainly in terms of the relevance of **institutional context/financial-economic context** (which are quite highly correlated), **governance**, and to some extent **cost-saving. Revenue support** showed to be significant in the econometric analysis and "independent" of time in the IA.[44] Again, as in the case of cost to completion, qualitative analysis has shown the contribution of "level of control" in achieving time targets.

[44] Revenue support is not considered in the FsQCA for statistical reasons.

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Table 9.2.4: Comparative results with respect to Time to Completion (entire sample)

FsQCA (PPP necessary)—only absence	IA	EA Time Model	EA Cost & Time Bivariate Model
Institutional context	Institutional context	Revenue support	Revenue support
Governance	Governance	Financial economic context	Financial economic context
Cost saving	Cost saving		
Financing scheme	Financing scheme		

For the sub-sample of transport infrastructure project delivered by PPP (see Table 9.2.5), it is found that:

- Importance analysis shows that institutional context, governance, and cost saving indicators are relevant factors to time underrun as a dependent variable.

- In the econometric analysis, a high level of governance and a good financial economic context have a positive impact upon PPP transport infrastructure projects to be on time. When time is analysed in combination with Cost, Cost saving also appears as significant. When time is analysed independently then Revenue support is significant. Overall, PPPs seem to have a small probability of achieving time targets. However, PPPs prior to the crisis are found to have a far greater probability of being on time. In addition, a key factor for PPPs before the crisis seems to be the financial economic context. In the analysis considering only time, Governance also appears as significant.

- In the FsQCA analysis, low cost saving, low revenue scheme and low financing scheme were identified as a sufficient combination of conditions for time overruns. However, the percentage of cases being over time explained by this combination is not very high (39%) and the consistency is not very convincing (76%). No solutions found for projects being on time.

The IA and econometric analyses are mutually supporting each others' results mainly in terms of the relevance of institutional context/financial-economic context (which are quite highly correlated) and governance. Cost-saving is to some extent relevant in all three analyses.

Table 9.2.5: Comparative results with respect to Time to Completion (PPP sample)

FsQCA - only Absence	IA	EA Time Model	EA Cost & Time Bivariate Model
Cost saving	Cost saving	**PPPs**	
Revenue scheme	Institutional context	Governance	Governance
Financing scheme	Governance	Revenue Support	Cost Saving
		Financial economic context	Financial economic context
		PPPs before the Crisis	
		Governance	Financial economic context
		Financial economic context	

For the sub-sample of road infrastructure projects, explanations are not so straightforward to make (see table 9.2.6).

- Importance analysis shows that institutional context, remuneration scheme, financial economic context, and governance are relevant factors to time underrun as a dependent variable.

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- In the FsQCA analysis, coverage of the solutions explaining projects to be over time is quite low for the subsample of road projects (mostly >0,5). Testing simpler models, low levels of financial-economic context, remuneration scheme and institutional context showed together to be sufficient conditions for road projects to have time overrun in 54% of the cases. The same combination of high levels of financial-economic context, remuneration scheme and institutional context together with high levels of financing scheme is a sufficient combination which shows 43% of the road projects to be on time.

Hence, institutional context, financial-economic context and remuneration scheme play a role in road projects being on or below time, but their effect (combined or not) is not fully clear and not so strong in explanatory power. Notably, while institutional context, financial-economic context as well as governance (IA) are anticipated, the Remuneration scheme indicator significance requires further investigation.

Table 9.2.6: Comparative results with respect to Time to Completion (Road sample)

FsQCA (presence and absence) low coverage/ presence little paths and low consistency	**IA**
Institutional context	Institutional context
Remuneration scheme	Remuneration scheme
Financial & Economic context	Financial & Economic context
	Governance

9.2.4 Explaining transport infrastructure projects in terms of achieving traffic forecasts

The conditions that are necessary and sufficient to explain transport infrastructure projects to have traffic in line or above forecasted traffic (presence of 'on traffic'), or below the forecasted traffic (absence of 'on traffic') were analysed. When comparing the results of the three different analysis methods (SA, Econometric analysis and FsQCA) in terms of the full sample (47 cases), the following are observed (see Table 9.2.7):

- Importance analysis shows that financial-economic context, remuneration scheme indicators and revenue support are relevant factors to being 'on traffic' as a dependent variable. Governance, cost saving, financing scheme and revenue scheme indicators are independent to 'on traffic' according to the data.

- In the econometric analysis, a good financial economic context and a high level of remuneration scheme along with high values of reliability – availability have an independent positive effect upon transport infrastructure projects to be on traffic.

- In the FsQCA analysis concerning 'on traffic', there were no conditions which showed to be necessary. 62% of the cases which are 'on traffic' show to have a high remuneration scheme as core condition, in combination with some of the following peripherical conditions: a good institutional context, a high financial & economic context, a high governance, a high cost saving, a high revenue scheme, as sufficient conditions. On the other hand, 54% of the cases below traffic have the following sufficient combination of conditions: a low remuneration scheme, a bad institutional context (both core conditions) and a low financial & economic context (as peripherical condition). So, remuneration scheme, institutional context, and financial-economic context (in different combinations and in case of presence, also in combination with other variables) are relevant in explaining both the presence and the absence of 'on traffic'.

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The analyses are mutually supporting each others' results mainly in terms of the relevance of **remuneration scheme,** and **financial-economic context** (which are quite highly correlated). Notably, traffic is a derived demand dependent on macroeconomic conditions. It is also worth noticing, that traffic forecasts are achieved with high values of the remuneration scheme, i.e. when low risk is associated with remuneration scheme (eg. availability fees). Under this approach it is not surprising that the Reliability – Availability Indicator appears as significant in the EA.

Table 9.2.7: Comparative results with respect to Traffic Outcome (entire sample)

FsQCA (PPP necessary)—only absence	IA	EA
Financial economic context	Financial economic context	Remuneration Scheme
Remuneration Scheme	Remuneration Scheme	Financial economic context
Institutional Context	Revenue Support	Reliability - Availability
Governance (only presence)		
Cost Saving (only presence)		
Revenue Scheme (only presence)		

For the subsample of transport infrastructure projects delivered through PPP, the results are very similar as those for the general sample (see Table 9.2.8):

- Importance analysis shows that financial-economic context and remuneration scheme are relevant factors to being 'on traffic' as a dependent variable.

- In the econometric analysis, a good financial economic context and a high level of remuneration scheme indicator have an independent positive effect upon transport infrastructure projects to be on traffic. Cost saving and Reliability – Availability indicators appear with a lesser significance. PPP projects have a slightly lesser probability of reaching time targets. However, PPP projects prior to the crisis were found to have a high probability (20.5%) of achieving traffic targets.

- In the FsQCA analysis concerning 'on traffic', there were no conditions which showed to be necessary. 64% of the PPP projects in our sample which are 'on traffic' have a high level of remuneration scheme as core conditions with different combinations of the following peripherical conditions: a high financial economic context; a good institutional context, a high level of governance, a high level of cost saving and a high level of revenue scheme as sufficient conditions (64% coverage). In an alternative analysis checking only for financial-economic context and remuneration scheme, 73% of the PPP projects on traffic had remuneration scheme as sufficient condition. This shows the importance of remuneration scheme for PPP projects to perform on traffic. Similar to the presence of on traffic, a below traffic in PPP projects in our sample is rather straightforward to explain. Around 52% of the membership of this outcome is explained by the sufficient combination, entailing a low level of remuneration scheme, a bad institutional context and a low financial economic context (83% consistency).

The analyses are mutually supporting each others' results mainly in terms of the relevance of remuneration scheme, and the **institutional context/financial-economic context** (which are quite highly correlated). The **remuneration scheme** plays a significant role in achieving traffic targets. This is very pronounced when interpreting the FsQCA findings for underperformance: low level remuneration scheme (i.e. high risk remuneration scheme eg. user charges), a bad institutional context and a low financial economic context (i.e poor implementation environment).

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Table 9.2.8: Comparative results with respect to Traffic Outcome (PPP sample)

FsQCA	IA	EA
Financial Economic Context	Financial Economic Context	**PPPs**
Remuneration Scheme	Remuneration Scheme	Remuneration Scheme
Governance (only presence)		Financial Economic Context
Institutional context (only presence)		Cost Saving*
Cost saving (only presence)		Reliability – Availability*
Revenue scheme (only presence		**PPPs before Crisis**
		Remuneration Scheme
		Financial Economic Context

*small significance

For the sub-sample for road infrastructure projects, explanations are not so straightforward to make (see Table 9.2.9).

- Importance analysis shows that institutional context, remuneration scheme, revenue scheme, revenue support and financial economic context are relevant factors to being 'on traffic' as a dependent variable.

- In the FsQCA analysis, a poor financial-economic context is a necessary condition for projects to perform below traffic. The road projects which are on traffic show to have a sufficient combination of a high value of remuneration scheme indicator, a high level of cost saving and a high financial economic context, in combination with a high governance level and a good institutional context, which cover 63% cases and of which the consistency ratio can be considered moderately high (0.82). Similarly the same conditions, a low financial economic context in combination of either a low level of remuneration scheme or a low level of cost saving, can explain projects on below traffic. This solution has a very satisfying coverage (0.81 %), but the consistency ratio is rather low (0.79% consistency).

Table 9.2.9: Comparative results with respect to Traffic Outcome (Road sample)

FsQCA	IA
Institutional context (only presence)	Institutional context
Remuneration Scheme	Remuneration Scheme
	Revenue Scheme
	Revenue Support
Financial Economic context	Financial Economic context
Cost Saving	
Governance (only presence)	

Hence, multiple factors, including certainly **financial-economic context** and **remuneration scheme**, play a role in road projects being on or below traffic, but they clearly work in different combinations with several other factors, such as institutional context. Notably, the financial economic context is very important in achieving traffic estimates since demand in traffic is derived, especially in the road sector, which is especially vulnerable. What is also noticeable is the fact that the achievement of traffic targets is combined with **low risk remuneration schemes** (high value of the indicator) and **low risk of revenue streams** (high value of the indicator).

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9.2.5 Explaining transport infrastructure projects in terms of achieving revenue forecasts

This section analyses the conditions necessary and sufficient to explain transport infrastructure projects to have revenues in line or above forecasted revenues (presence of 'on revenue'), or below the forecasted revenues (absence of 'on revenue'). When comparing the results of the three different analysis methods (SA, Econometric analysis and FsQCA) in terms of the full sample (47 cases), these show that indicators seem to interact quite strongly to bring about achievement with respect to the revenue outcome (see Table 9.2.10):

- Importance analysis shows that financial-economic context, revenue scheme and remuneration scheme are relevant factors to being 'on revenue' as a dependent variable. Governance, cost saving, and financing scheme are independent to 'on revenue' according to the analysis

- In the econometric analysis, remuneration scheme has an independent positive effect in all models upon transport infrastructure projects to be on revenue. Also of some significance are the Reliability – Availability, Revenue Scheme and Financial Economic context indicators in increasing the probability of achieving revenue targets.

- In the FsQCA analysis concerning 'on revenue", there were no conditions which showed to be necessary. The following four conditions (in combination with other conditions) act at least in a large share of the projects on revenue as expected: institutional context, financial economic context, remuneration scheme and cost saving. The combination of these four conditions found explains 75% of the membership of the involved outcome. A positive institutional context indicator is a sufficient condition for 74% of the projects being on revenue, meaning that a positive institutional context has a particular strong explanatory power. A positive financial-economic context as core condition, high cost saving and remuneration scheme as peripherical conditions make sufficient conditions for 29% of the membership of the outcome 'on revenue'. For the projects being 'below revenue' we cannot find any relevant solution paths.

The analyses are mutually supporting each others' results mainly in terms of the relevance of **remuneration scheme**, and **institutional context /financial-economic context** (which are quite highly correlated)**. Cost saving** seems to matter in the FsQCA.

Table 9.2.10: Comparative results with respect to Revenue Outcome (entire sample)

FsQCA (PPP necessary)—only absence	IA	EA
Financial Economic context	Financial Economic context	Remuneration Scheme
(inconsistent)	Revenue Scheme	Reliability – Availability*
Remuneration Scheme	Remuneration Scheme	Revenue Scheme*
Institutional Context		Financial Economic context*
Cost Saving		

**of lesser significance*

For the subsample of transport infrastructure projects delivered by PPP, our analyses regarding 'on revenue' shows the following:

- Importance analysis shows that only financial-economic context is a relevant factor to being 'on revenue' as a dependent variable.

- In the econometric analysis, cost saving followed by the financial –economic context, the remuneration scheme and the reliability-availability indicators increase the probability of achieving revenue targets. Prior to the economic crisis, the remuneration scheme, cost savings and revenue scheme were the key contributing factors. Once again, PPPs have lesser probability to achieve revenue results with respect to the entire sample, while the contrary holds for PPPs prior to the economic crisis.

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- In the FsQCA analysis concerning 'on revenue, 58% of the PPP projects in our sample which are 'on revenue or exceeding than forecast' have a good institutional context, in combination with a high level of financing scheme or a low level of governance as sufficient conditions (58% coverage). However, the consistency of this solution is quite convincing (89%). Both a high or a low level of financial-economic context and revenue scheme might result in PPP being 'on revenue', depending on which combination of the other relevant conditions they are in. For the projects being 'below revenue' we cannot find any relevant solution paths.

The analyses are hardly supporting each others' results. As we can see from the different analyses, **financial-economic context** is relevant. Its effect seems to depend on other variables according to FsQCA. Remuneration scheme is relevant in the econometric analysis, and in combination with other factors also in the FsQCA analysis. A high value of the financing scheme indicator found in the FsQCA suggests "attractive" PPP projects. Hence, the finding is in-line with the indicator structure.

Furthermore, the FsQCA found the financial-economic context and the revenue scheme inconsistent (i.e. rejecting the "hypothesis") in this analysis. While this finding might bear multiple explanations (eg. the uncertainty connected to the revenue proxy), it is also similar with the findings of section 4.3.2, where potential strategic behaviour of the operator was identified.

Table 9.2.11: Comparative results with respect to Revenue Outcome (PPP sample)

FsQCA (no results for absence)	**IA**	**EA**
(Inconsistent)	Financial Economic Context	**PPPs**
(Inconsistent)		Cost saving
Remuneration scheme		Financial Economic Context
Institutional context		Remuneration Scheme
Financing Scheme		Reliability – Availability*
Governance		**PPPs before Crisis**
		Remuneration Scheme
		Cost savings
		Revenue scheme

**small significance*

For the sub-sample of road infrastructure projects, the findings of the Importance analysis are less statistically valid. However, findings show:

- Importance analysis shows that institutional context, financial economic context and remuneration scheme are relevant factors to being 'on revenue' as a dependent variable.

- In the FsQCA analysis, 66% of the road projects which are on revenue show to have a sufficient combination when a high revenue scheme is combined with a low level of financing scheme or when a high financial economic context is combined with a high revenue scheme. Consistency ratio can be considered very high (0.94). Again, we cannot find the solution formula for explaining projects being below revenue. But we learned that a poor financial-economic context, as well as high levels of cost savings are necessary conditions for projects to be 'below revenue'.

Hence, multiple factors, including certainly the **financial-economic context**, play a role in road projects being on or below revenue. The findings of the Importance Analysis follow common knowledge. When considering the FsQCA findings, a deeper understanding of the indicator structure may provide some potential interpretation. For example, a high value in the revenue scheme indicator depicts a low risk revenue stream for the project and a low level of the financing scheme for public projects or PPP with significant government support. The level of cost savings indicator leading to negative performance may be related to the life cycle planning component of the cost saving function.

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High values of the cost saving indicator should also include a high value of the life cycle planning component. This is characteristic of PPP projects. Consequently, the condition may read "poor financial-economic context and PPP road projects are a necessary condition for not achieving revenue targets".

Table 9.2.12: Comparative results with respect to Revenue Outcome (Road sample)

FsQCA	IA
Financial Economic Context	Institutional Context
	Financial Economic Context
Revenue Scheme	Remuneration Scheme
Financing scheme (+/-)	

9.2.6 Discussion

The comparative presentation of findings provides useful insights and improved understanding of findings. It also acts as a "calibration process" with respect to the potential to extract overarching findings. Indeed, each method has its strengths and weaknesses, but conducting the different methods becomes relevant when they are used in a "complementary" way rather than as a pure "comparison" or "competition". Many empirical studies and articles discuss and use both QCA and statistical methods in order to obtain more valuable results. A number of these are listed: Barbara Vis (2010); Kangas (1994); Amenta and Poulsen (1996); Nelson (2004); Ford (2005); Katz & colleagues (2005); Hellstrom (2011); Stockemer (2013); and Buche et al (2015).

The following may be considered:

1. The four performance outcomes considered are fully or partially influenced by different factors. So there is no one formula for transport infrastructure projects leading to the combined achievement of all four performance targets. For each performance target, at least partially different factors seem to matter. Notably, this is the key reason and source of inconclusive discussion with respect to transport infrastructure project "success".

2. In addition, factors might have different effects depending on how they are combined with other factors.

3. In some cases, negative outcomes are more effectively explained.

4. It is clear that both the institutional and the financial-economic context influence in various degrees all performance targets. It should be mentioned, that while this has been well known for traffic and revenue outcomes, it is also, now, depicted with respect to cost and time outcomes.

5. The delivery mode seems important in terms of achieving outcome targets. PPPs do not seem to perform better. However, this may be a sample specific finding given the concentration of the sample on PPPs in countries under recession. Notably, analysis (econometric) indicates, that PPP projects prior to the economic crisis, had an increased probability of achieving outcome targets.

6. The analyses have made clear that some variables need extra attention in terms of the way they are constructed and what they mean. Variables such as the financing scheme and those linked to the funding scheme are hard to interpret and show to have very different effects, depending on the combination of other conditions they are interacting with. Moreover being a PPP or not clearly has an effect on the value of variables related to financing and funding scheme (but also governance for example), but this effect is not straightforward. This is more pronounced in the case of the financing scheme for which the interpretation is not continuous. The latter may be a key reason of the indicators' inconsistent behaviour within the scope of the FsQCA and its limited significance in the Importance and Econometric Analysis. Other indicators, such as the Revenue support indicator have a very small variance excluding it of the FsQCA analysis. However, both in the

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Importance and the Econometric Analysis this variable shows to be influencing some of the outcomes/dependent variables.

7. In general the composite nature of most variables with one or two levels of aggregation of sub-indicators is sometimes making the interpretation of the results more difficult, and might to some extent obscure more clear effects of their sub-indicators. In the next phase of the research, more attention should clearly be paid to these sub-indicators, how they perform and how they themselves relate to the performance outcomes.

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9.3 Complementing Analytical Findings through the Qualitative Analysis

As noted, the comparative study of the analyses findings of section 9.2 is limited by the explanatory power and accuracy of the typology indicators, their value ranges, their potential correlations and also by the synthesis of the sample used in the analyses. In the present section, these findings are interpreted under the light of the findings of the qualitative analysis conducted (see Chapters 3 and 5) and the validation of the indicators, as well as their findings pertaining to the infrastructure delivery (see Chapter 4). The discussion is structured based on performance outcome targets.

9.3.1 Cost and Time Outcomes

While FsQCA and Importance analyses were able to address each outcome independently, the Econometrics analysis identified correlations between these two outcomes and treated them in a combined analysis. Notably, these outcomes form part of the so-called "iron triangle" in project management (along with quality), in which the trade-offs in target outcomes are considered. Therefore, cost and time to completion are by definition correlated but not necessarily covariate. In a similar context, the qualitative analysis conducted per mode was unable to make the respective distinction. Notably, through FsQCA, clear "solutions" with respect to time and cost outcomes were not identified.

Overall, all three analyses, identified Institutional and Financial – Economic context, Cost saving and then governance as important contributing indicators. The Institutional and Financial – Economic context indicators are validated as sufficiently describing the implementation context (see Chapter 5). With respect to the construction phase, the Cost saving indicator includes factors considering the project's technical difficulty (as well as the capability of the contractor and the respective risk allocation). However, with respect to this technical difficulty factor, its value increases (i.e. the ability for cost saving), should the construction risk be allocated to a technically competent contractor. Cost saving, also includes a factor with respect to life cycle planning and innovation. During the construction phase, the indicator describes the maximum probability of achieving cost savings. During operation, the indicator describes the potential of cost savings during operation and, therefore, does not include the technical difficulty factor. It does, however, include the other two. The Governance indicator takes high values for PPP projects under certain conditions, which in any case cannot be met by public projects.

Based on the qualitative analysis, a common finding for all modes is that delays were encountered in a substantial number of transport infrastructure projects. In many situations, these may concern traditional project management issues faced by all major infrastructure projects. Contractor failures and technical difficulties are identified as common reasons for cost and time overrun in this analysis across different modes. In addition, the implementation context was also found to be important. There is substantial difference in performance between road projects in northern and western European countries, and projects in southern European countries. Most of the road projects that experienced cost and time overrun are located in southern countries. In addition, it is suspected that the economic crisis had an impact on both cost and time to completion of projects. Moreover, in the specific sample, it was found that within the road sample, brownfield PPP and greenfield projects performed relatively better with respect to cost. Bridge and tunnels PPPs (which in our sample were completed prior to the economic crisis also performed better. The same could be said for the port PPP projects as their key determining factor was identified as the "scope". The qualitative analysis conducted in support of the Business Model indicator also adds to findings with respect to cost and time to completion. "Level of Control", an aggregated indicator of projects' exclusivity, business orientation of scope and network connectivity, included in the Revenue Support indicator, was found to be correlated to cost and time to completion in projects including a brownfield section, projects for which the contractor had an influence over the supply chain (as in ports) and with respect to time, projects which shot at combined revenue streams. Finally, with respect to the Governance indicator, the qualitative analysis (chapter 5) showed that variations in projects governance were not always picked up. However, it was a relevant indicator in a comparative nature.

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With respect to the time target, FsQCA and IA identified the financing scheme indicator. FsQCA found a low financing scheme indicator to be a condition contributing to time overrun. Low values of the indicator describe public projects or PPP projects with significant contribution from the public sector (typically a problematic situation for PPPs). In line with this assessment, qualitative analysis found public project budgets to be underestimated.

As the overview of Table 9.3.1 indicates, that while overarching factors may be identified for cost and time targets, these are conditioned based on the mode and the characteristics of the project. In conclusion, the qualitative analysis reinforces the analyses findings with respect to cost and time outcomes and also explains the lack of potential solutions of the FsQCA analysis.

Table 9.3.1: Combined findings for Cost and Time to Completion (entire sample)

Prevailing Influential Indicators	Key Qualitative Findings	Comments
Institutional/Financial-economic context (FsQCA explaining cost and only overrun for time; IA and EA)	▪ Found to influence roads ▪ On other mode infrastructure influence varies depending on positioning (exclusivity) and scope.	This indicator prevails in the analytical methods due to the share of roads in the sample
Cost Saving (FsQCA cost and only overrun for time and IA)	▪ Technical difficulties are common (across all modes) reason of underperformance ▪ Properly planned (technically mature projects) perform better.	The structure of the indicator justifies the findings of the numerical analyses. In addition, projects properly planned do demonstrate a higher value of the life-cycle planning factor of the Cost Saving indicator.
Governance (cost and only overrun for timeand IA)	The governance indicator was able to pick up differences between projects with the exception of Urban Transit projects where the public authority's ability to monitor is important and not registered.	The indicator is justified by the qualitative analysis.
And		
Revenue Support (EA)	▪ Level of control (exclusivity, scope, network connectivity) impacts projects including brownfield sections, control over supply chain and/or combined revenue streams. Per mode identified performance: ▪ Airports with high connectivity ▪ Ports with strong scope ▪ Bridge/ Tunnel with high exclusivity	The suspected reason of the EA finding is the "Level of Control", as the indicator was not designed to describe the construction phase.
Remuneration Scheme (IA for Cost)	The qualitative analysis (chapter 5) identified issues concerning the reality fit of the indicator.	No interpretation could be offered. Further research required.
Financing Scheme for time (FsQCA explaining time overrun and IA)	Public projects seem to have underestimated budgets.	Low values of the indicator describe public projects or PPP projects with significant contribution from the public sector (typically a problematic situation for PPPs).

With respect to PPP findings, the numerical analyses lead more or less to the same findings. However, with respect to cost overrun, FsQCA identifies the contribution of a low value of the Revenue scheme and EA now includes Governance as well as Cost Saving, bringing findings to greater alignment. While the relevant interpretation of the identified indicators has been discussed, a poor revenue scheme indicator as a contributing factor to cost overrun in PPP projects requires further

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investigation. In general, a low value of the revenue scheme indicator corresponds to a high risk revenue stream (eg. user tolls). However, the indicator also includes a factor with respect to "acceptance". It is possible that this factor may be influential. Moreover, qualitative analysis with respect to this indicator gave mixed results. For example, the revenue indicator for road PPP projects was generally lower for well performing projects compared to poor performing ones. For public road projects, higher values of revenue scheme indicator suggest that these projects are better performing in terms of cost, but poorer in terms of time. Revenue scheme indicator scores for PPP airports are higher than for the public cases. In urban transit, cases were identified were public subsidies had to be increased, thus, giving a higher value to the indicator, when this should have intuitively shown a worsening situation. Hence, reasons can be mixed, also explaining the moderate to poor coverage of the FsQCA findings.

The EA analysis identified that PPPs prior to the economic crisis had an improved probability of achieving cost and time targets as opposed to the entire sample of PPPs, which presents a lower probability. Given the number of PPPs during and after the crisis and their concentration in countries with recession, the finding with respect to all PPPs is most likely sample-specific.

Table 9.3.2: Other Combined findings for Cost and Time to Completion (PPP sample)

Prevailing Influential Indicators	Key Qualitative Findings	Comments
Revenue Scheme (FsQCA for cost overrun)	▪ Mixed findings with no particular trend. ▪ No specific indication with respect to modes apart from road projects, apart from the impact on PPPs, which was mostly explained through the implementation context. Notably, projects with high risk revenue schemes are influenced more by the crisis.	The revenue scheme indicator requires further investigation.
PPPs prior to crisis (EA)	n.a.	n.a.

Cost and Time performance was analysed by the FsQCA and the IA for roads. Their findings, in practice coincide, as a high value of the financing scheme (FsQCA) indicates PPPs, while equally so the revenue scheme indicator suggests a PPP project (IA does not give an indication of direction). In this case, Table 9.3.3 only includes FsQCA findings. The qualitative analysis with respect to roads does not distinguish based on the remuneration scheme. It does, however, note that PPPs perform better with respect to time and cost. The same indicators were found to influence time but with a smaller consistency.

Table 9.3.3: FsQCA findings for Cost and Time to Completion (Road sample)

Prevailing Influential Indicators	Key Qualitative Findings	Comments
Cost Remuneration scheme Governance Institutional context Financing scheme	Road PPPs perform better with respect to time and cost.	PPP road projects with low risk remuneration and revenue schemes under positive implementation conditions. (PPP prior to the crisis)
Time Institutional Context Remuneration scheme Financial – Economic Context	▪ The economic crisis a reason for delays ▪ Technical problems, land acquisition etc.	

9.3.2 Traffic Outcome

According to the analyses, as presented in section 9.2, the financial economic context is a core factor influencing the achievement of the traffic outcome. This is a well-known fact in transport economics.

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This was also recognised in the qualitative analysis per mode. However, factors supporting traffic targets despite the influence of the financial-economic context were also identified. These concerned connectivity of the infrastructures to the rest of the economy and the transport network, exclusivity, scope (eg. in ports) and project justification. These factors are considered within the Revenue Support indicator, identified as important by the IA analysis.

More specifically, the indicator includes the aggregate factor "level of control", which also includes the impact of the respective demand/revenue risk allocation. According to the analysis conducted (see section 4.3), level of control has a positive impact on traffic (also on cost and time under conditions as described in the previous section) and the ability to achieve results "against" negative macroeconomic conditions.

The qualitative analysis identified a number of cases with possible optimism bias (i.e initial forecasts were overestimated). This was more evident for projects in urban transit. Analysis with respect to "level of control", appropriate risk allocation and traffic targets identified that forecasts seem to be more accurate when demand/revenue risk is appropriately allocated (PPPs and Public) and found evidence that forecasts for PPPs tend to be more accurate or even conservative when more or appropriate demand/revenue risk is transferred.

A qualitative assessment with respect to performance and the remuneration scheme as well as the revenue scheme indicator was not conducted. However, high values of the indicator represent low risk remuneration, which typically does not include user charges normally influenced by the ability (and willingness to pay) of users. High values of the remuneration scheme were found to have a positive contribution by all three numerical analysis. In addition, cost savings and revenue scheme were important. The cost saving indicator was not structured to describe traffic. However, it does include a factor with respect to life-cycle planning, which typically takes larger values when describing PPP projects. The reliability- availability indicator is a sensible inclusion by the EA.

The above discussion supports conclusions and the complementarity of findings. It also highlights adjustments that are needed in order to improve the explanatory power of the indicators.

Table 9.3.4: Combined findings for Traffic Performance (entire sample).

Prevailing Influential Indicators	Key Qualitative Findings	Comments
Remuneration Scheme (FsQCA core condition; IA; EA)	n.a.	It describes low risk remuneration schemes (no user charges)
Financial-economic context (FsQCA; IA; EA)	Considered a major reason	
And		
Institutional context Cost Saving Governance Revenue Scheme (FsQCA)	▪ Well prepared projects (life-cycle planning) ▪ Governance differentiation between projects ▪ Low risk revenues	
Revenue Support (IA)	▪ Level of control (exclusivity, scope, network connectivity) impacts projects including brownfield sections, control over supply chain and/or combined revenue streams. Per mode identified performance: ▪ Airports with high connectivity ▪ Ports with strong scope ▪ Bridge/ Tunnel with high exclusivity	
Reliability-Availability (EA)	n.a.	Reasonable finding.

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When considering PPPs, all three numerical findings emphasize the remuneration scheme in combination with a positive implementation context. While the qualitative analysis does not look into the impact of the remuneration scheme, it does emphasise the negative impact of the economic crisis. However, project scope and maturity are also emphasised in the qualitative analysis as project characteristics that may improve project resilience to external negative impacts. This is expressed implicitly by the Cost saving indicator found by the FsQCA and the EA. Revenue scheme refers to low risk revenues. In addition, the qualitative analysis (chapter 3, section 4.3 and Chapter 5) identified some optimism bias in some cases of PPPs (usually with less demand risk transferred) and in public projects. As before, the EA indicates that PPPs prior to the crisis had an increased probability of performing better. Finally, what is noticeable, is that while cost saving appears to improve the probability of achieving traffic forecasts in PPPs (see EA), the indicator does not appear as a factor for PPPs prior to the crisis, suggesting that following the crisis only well planned projects have a probability of achieving traffic targets. This is also confirmed by the qualitative analysis.

Table 9.3.4: Combined findings for Traffic Performance (PPP sample)

Prevailing Influential Indicators	Key Qualitative Findings	Comments
Remuneration Scheme (FsQCA; IA; EA)	n.a.	It describes low risk remuneration schemes (no user charges)
And		
Institutional context Cost Saving Governance Revenue Scheme (FsQCA)	Considered a major reason	
Financial-economic context (FsQCA; IA; EA)	▪ Well prepared projects (life-cycle planning) ▪ Governance differentiation between projects ▪ Low risk revenues	

With respect to road projects, the FsQCA and IA reached similar findings as in the cases of PPPs. IA also identified the indicator Revenue support which is well positioned to describe traffic and also possibly related to its feature with respect to level of control and appropriate risk allocation.

9.3.3 Revenue Outcome

Information with respect to revenue performance is typically not disclosed in PPP projects and difficult to assess in many public cases. Hence, the indicator used in the analyses is a constructed proxy based on the traffic outcome indicator in combination with re-negotiations and/or claims originating from revenue performance issues. In this sense, it includes considerable uncertainty as also identified by the Importance analysis. Therefore, the qualitative analysis did not include this assessment.

A review of the business model of cases included in the BENEFIT case study database concluded that there are significant differences between modes and the models they develop. Overall, few revenue enhancing activities are included in the case studies. This is the basic reason the Revenue Support Indicator takes small values and has a small range over the entire case study sample.

The qualitative analysis conducted identified factors pertaining to PPPs and low risk revenues streams and/or remuneration schemes. The financing scheme indicator only appears in the FsQCA even though the indicator is typically structured to represent the potential for a positive revenue outcome. Findings here coincide with those of section 9.2.5.

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9.4 Potential of Transfer of Lessons Learned

Identifying the potential to transfer lessons learned is a key objective of the BENEFIT project. By describing the context of the delivery, implementation, operation and maintenance of transport infrastructure through key indicators (Typologies descriptions), the complexity to the fundamental factors driving performance is reduced. The validation of the BENEFIT Matching Framework in this report aimed at validating the significance of the proposed indicators and their ability to explain outcomes. Notably, in the context of the Matching Framework, performance outcomes are also described through proxy indicators. The validation was both encouraging but also indicated the need to improve the structure of typology indicators. Therefore, this analysis is considered **premature** but conducted and included in this report to function as a future benchmark.

The basic concept to investigate with respect to the potential transfer of lessons learned, forming the respective research question, is whether “similar combinations of Matching Framework indicators” lead to the same combination of “performance outcomes”.

In this process, cluster analysis is employed as the research tool and the snapshot case study data (see Annex A.2) is exploited. Notably, the snapshots following the project award are used in this investigation, as the award snapshots only represent project planning at initiation. The present analysis constitutes an initial approach to the issue. Its key limitation, at the current stage, is the recognition that some indicators require further investigation.

The scope of the analysis is to identify whether indicator sets, as expressed through their snapshots, of similar values correspond to their respective performance outcome sets. Notably, indicator sets are “vectors” of nine values (representing the nine indicators attached to the Matching Framework Typologies), while performance outcomes include “vectors” of four values (representing the proxies of the four outcomes studies: cost and time to completion, traffic and revenue performance). Also, it is noted that the outcome vectors include discrete values of their proxies as performance is assessed for each outcome as: in-line, above expectations and below expectations. Consequently, 4^3 (i.e. 81) combinations of the outcome sets exist. Contrary to the outcome sets, the typology indicator sets include nine indicators with continuous values suggesting infinite combinations. Therefore, multiple combinations of indicator value sets may correspond to the same outcome. This has also been an outcome from the various analyses presented in this report: the fact that multiple combinations of indicator values (factors of the project context) may lead to specific outcomes or combinations thereof (example a combination of cost and time performance).

As the objective is to identify groups of snapshots with similar typology indicators and outcome values, hierarchical clustering was employed. The core idea in heretical clustering is based on objects being more related to nearby objects than to objects farther away. These algorithms connect "objects" to form "clusters" based on their distance. The analysis starts off considering only single-linkage clustering of both the indicator values and the outcomes. Notably, while this method is known for its simplicity, it is also known to for not being very robust towards outliers, which will either show up as additional clusters or even cause other clusters to merge ("chaining phenomenon").

Considering that more than one cluster of indicator values will respond to the same outcome group, indicator clusters are also considered at larger distances. Also, given the different performance of the PPP projects versus the public ones, these sets are also analysed separately for road projects, given the size of the sample.

Findings were assessed with respect to the hypothesis:

H1: Case snapshots included in indicator clusters should also appear in the same outcome clusters

Annex A.9 includes the results in tabular form. Hierarchical clustering was employed for the dataset of snapshots following award and their respective outcomes in two separate procedures. Considering the differences between modes as identified in Chapters 3 and 5 of this report, this analysis was

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conducted within each mode of transport infrastructure. More specifically, the analysis was conducted separately for snapshots and their respective outcomes considering: Road, Airport, Port, Rail, Bridge & Tunnel and Urban Transit Projects. Furthermore, Urban Transit projects were also analysed with respect to their sub-groups: Metros and Tramways/LTR.

Critical in assessing the hypothesis was the number of indicator clusters for which their members appear in different outcome clusters (rejection criterion).

As expected, results were not encouraging with rejection rates per mode ranging from 0% (metros) – 100% (rail). Increasing the average distance of cluster selection produced mixed results, as it improved results for some modes and reduced them in others. This is probably suggesting the difference in “indicator reality fit” between modes. For roads the rejection rate ranged from 40-70% depending on the clustering distance selected.

Testing the road projects with respect to PPPs and non-PPPs, the results improved to 38-65% rejection rate for PPPs depending on the clustering distance and 29-63% for non-PPP road projects. The road sample was also tested excluding projects for which there was indication of optimism bias with respect to traffic forecasts. Here, a further improvement was identified. Now, the hypothesis was rejected between 29-55% depending on the distance of clustering for PPP projects. Non-PPP road projects were not considered in this case due to their small number (only 3).

Considering the limitations identified with respect to indicator structure, the results of this “proof of concept” could be considered encouraging.

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9.5 Matching Framework and its Typology Indicators – Lessons Learned

The scope of the analyses carried out within the context of the current task was to validate and provide directions for the further development of the Matching Framework and its typology indicators. Lessons learned are structured with respect to the typologies.

Implementation Context Typology
Both implementation context indicators, Institutional Context and Financial –economic Context indicators - seem to represent well project implementation conditions. Their performance and findings with respect to these indicators were in-line with their expected influence.

Transport Mode Context Typology
The Reliability/Availability (IRA) indicator is equal to 1 for most of the projects in the BENEFIT database that were used in the analysis, generally showing that transport infrastructure projects, either greenfield or brownfield are reliable and available to users, without being able to distinguish between modes.

However, when considering this typology, the input to the Matching Framework with respect to transport mode and investment size should also be considered.

Governance Typology
The Governance composite indicator is typically constant for all snapshots for a particular project. It appears that changes in the governance during project implementation have rarely been picked up. This has particularly been the case for urban transport projects where political sensitivity has a huge repercussion on risk sharing and the contracting authorities seem to be unable to let the private concessionaire assume wholly construction, operation or commercial risk. On the other side, for road and ports projects, it appears that the Governance indicator was able to show the difference between well and poorly performing projects.

In addition, the Governance indicator performed consistently in the numerical analyses and its presence in the various findings could be justified through the qualitative analysis.

Business Model Typology
Both indicators describing the Business Model Typology are composite including other factors.

The cost saving indicator was capable to indicate problems during implementation, related to change in ownership structure, or low traffic levels, for several projects in different modes (roads, airports, bridges and tunnels). Similarly, based on this indicator, it was possible to distinguish well from poor performing port cases. However, it should be noted that it is more focused on the construction phase, while in the urban transport mode the operational phase is critical.

In addition, while the presence of the cost saving indicator could be sufficiently explained in the numerical analyses findings, certain factors seem to be more important than others and a respective weighting should be applied. Furthermore, qualitative findings have indicated the importance of the public authority in assessing a project's technical difficulty as opposed to contractor competence. This relation should be further investigated.

A low value of revenue support indicator for most modes and projects indicates low capability of transport infrastructure projects to generate other types of revenues in addition to revenues from the main transport mode. However, it still makes possible to distinguish between well and poorly performing cases. Notably, the most crucial factor included in the Revenue Support Indicator is the "Level of control". An appropriate weighting should be applied.

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In addition, the revenue support indicator is currently designed to include all possible alternative activities. However, not all are possible for each transport mode. A respective adjustment should be considered. This will also increase the value range of the indicator.

Funding Scheme Typology
The Funding scheme indicators were found to be sometimes counter-intuitive.

High and low values of the remuneration indicator did not always represent the same behaviour. Considering its structure, this may be due to its incentives component, which would require further consideration. However, the remuneration scheme as a finding could be justified and explained in the numerical analyses.

The Revenue scheme indicator presented problems with respect to its trend. These may be due to its structure as it also includes factors, which may cancel each other or may be outputs to other factors included in the indicator. Hence, the indicator requires re-structuring and thorough validation (numerical and other), and possibly the separation of factors describing different phenomena.

Financing Scheme Typology
The financing indicator bears the limitations of its design:
- Discontinuous interpretation.
- Stakeholder view of risk.

This seems to be the source of its limitations with respect to the reality fit and its interpretation when appearing in the numerical analyses findings. Moreover, its limited presence in the numerical analyses findings is also an indication of its need to align with the overarching concept in indicator design within the Matching Framework.

More specifically, the indicator should have a continuous interpretation and be representative of the financing risk in general and not specifically with respect to private sponsors. This should improve the explanatory power of the indicator within the Matching Framework.

On the contrary, the indicator in its present form should be investigated with respect to its suitability to be used as an indicator for project creditworthiness.

Matching Framework
The Matching Framework has been structured to be **Stakeholder Neutral** with indicators values tending to the value = 1 representing **lower risk of their respective element** (typology) for the project.

Most indicators fully respect this structural rule and have appeared as findings in the numerical analyses in formations that are both expected and justified by the qualitative analysis increasing the overall explanatory power of the Matching Framework. In this context, the Matching Framework was applied as an ex-post assessment tool. Through this application, interesting insights were gathered with respect to the funding and financing of transport infrastructure.

In addition, despite the limitations of certain typology indicators, interpretation was possible. This is also evidence of its strength. Notably, the adjustment of the said indicators would highly improve the functionality of the Matching Framework as a tool for ex-post analysis and as a platform to guide ex-ante analysis (see section 9.4).

Though the combined analysis carried out, it was possible to identify combinations of indicators that enhance the probability of achieving particular outcomes. It was also found that multiple such combinations may exist but in all cases, apart from the financial-economic/institutional indicator, there is also one other indicator of crucial importance. Furthermore, points of interest are:

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- Cost and time outcomes are most often addressed in combination (finding from the qualitative and econometrics analysis)
- Cost and time outcomes are mostly addressed through avoidance of their negative influencing factors (finding from the qualitative analysis and the FsQCA)
- Traffic outcome is mostly addressed through measures of resilience (finding from all analyses)
- Revenue outcome for PPPs may be addressed through the remuneration scheme (finding from all analyses)

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9.6 Next Steps

Following the discussion on findings in this chapter, research to be included in the next tasks of the BENEFIT project is outlined. This is mostly based on the indentified needs for further investigation and lessons learned with respect to the delivery of transport infrastructure. The section is structured with respect to the limitations identified and the lessons learned.

9.6.1 Improving Typology Indicators

Transport Mode Typology Indicator
While the selected indicator (Reliability – Availability) was found functioning well, it was also important to note that Matching Framework input variables (data) also form a latent part of this indicator. Hence, while no further improvements are considered, these "latent variables" should be considered in any further analysis, especially with respect analysis across modes.

Governance Typology Indicator
The governance indicator was found to function well as an assessment between project cases but failed to integrate changes in governance over the life of the same project.

Further investigation is required with regard to how changes in governance may be included over the life of the project in a systematic way. It is also important to emphasise the importance of properly reflecting these changes when generating the Matching Framework datasets (snapshots).

Business Model Typology Indicators
The Business Typology indicators were found to function properly and bear the appropriate explanatory power. However, factors aggregated within, such as the "level of control" of the infrastructure were found to be of particular importance. In addition, factors that were not considered and found particular important, such as the competence of the public authority, should be incorporated. Finally, while the revenue support indicator properly represented its conceptual structure, due to the structure of the projects it took low values. However, this is indicative of how project business models are structured and in this context it is fully representative. Despite this fact, it was also acknowledged that not all modes might include all potential revenue activities. The indicator in its present form is representative of all modes and therefore the indicator might never be able to take its maximum value. The decision to adopt the indicator to modes would limit the Matching Framework's explanatory power. In potential future versions of the Matching Framework adjusted to modes, a respective adjustment should be considered.

In conclusion, a restructuring of the business model indicator with respect to the relative importance of factors included should be undertaken.

Funding Scheme Typology Indicators
The funding scheme indicators were found to present contra-intuitive value trends disturbing the interpretation. The principal reason is considered to be structural, in the sense that divergent factors are included in the indicators. A re-structuring based on separation of divergent factors is proposed. This should also be based on the basic conceptual structure of the Matching Framework: i.e. the indicators need to be stakeholder neutral and presenting less risk for the funding scheme as values tend to 1.

Financing Scheme Typology Indicator
The financing scheme indicator was found to be the one presenting the greater limitations. This is particularly due to the fact that it is not fully aligned with the Matching Framework structural concept: i.e. it is not stakeholder neutral and it does not have a continuous interpretation with respect to the project's financing risk. Therefore, a re-structuring is suggested.

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That said, the indicator in its present form should be considered as a possible indicator of project creditworthiness to be studied under task 3.2.

Amendments of the indicators should be concluded within the context of task 4.2.

9.6.2 Exploitation of Lessons Learned

Matching Framework
One of the key findings of the current analyses has been the fact that combinations of indicators-factors improve the probability of achieving (or avoiding) particular outcomes. However, how these factors/indicators interrelate is not evident. Cause and effects within the identified groups of factors per outcome should be further studied.

In addition, with respect to these factors/indicators, while there are indications of their performance in low or high values the exact ranges of applicability of these ranges has not been depicted. This again constitutes an important part of future research.

Notably, the above-mentioned research needs were already identified at proposal submission and form part of **task 4.2**. The findings of this report guide research in task 4.2 to particular groups of factors/indicators with respect to particular respective outcomes.

The implementation environment has a particular impact on project traffic outcomes. It was found that particular project characteristics might improve the project's resilience to the negative impact of a poor financial-economic and institutional environment. The relative strength of these positive characteristics should be further investigated systematically with respect to both PPP and publically delivered projects. Furthermore, revenue outcomes were found to be also dependent on the remuneration scheme. The flexibility of the remuneration scheme should also be studied.

Notably, these research needs with respect to traffic and revenue outcome were already identified at proposal submission and form part of **task 4.3**. The findings of this report guide research in task 4.3 in investigating particular aspects.

Finally, indicator findings suggest the possible investigation of factors and indicators in disaggregated form in order to clearly identify their combined effects. In concluding this further research, the positive experience of combined numerical analysis should be repeated and findings compared with the ones reported herewith. Furthermore, building on the positive experience a methodology of interrelating the analyses should be considered and devised in order to improve the findings of each approach and lead to the potential weighting of indicators within the Matching Framework. More specifically, consideration should be given as to how how best to combine methods. Indeed, each method has its strengths and weaknesses; however, their combined application may bring about significant improvements. Many empirical studies and articles discuss about using both QCA and statistical methods in order to obtain more valuable results (cfr. Barbara Vis, 2010; Kangas, 1994; Amenta and Poulsen, 1996; Nelson, 2004; Ford, 2005; Katz & colleagues, 2005; Hellstrom, 2011; Stockemer, 2013; and Buche et al, 2015).

The repetition of combined numerical analysis is foreseen for the final part of **task 4.3**.

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10 Conclusions

10.1 Introduction

The delivery of transport infrastructure is characterised by significant complexity including multiple factors that interrelate positively or negatively leading to observed performance. Multiple actors make decisions that influence the course of development and operation. Infrastructure projects are also vulnerable to external micro and macroeconomic influence, which impact performance. In addition, transport infrastructure produces short, medium and long term impacts with respect to the economy, the environment, institutions and society in general. Therefore, multiple stakeholders are involved with different and, many times, competitive interests. In this context, success or failure can only be subjective depending on the particular objectives of each stakeholder and how they are met through project performance over time. Considering the anticipated positive (and negative) impacts, the sunk nature of investments in transport infrastructure and the range of stakeholder interests, significant research has been devoted to the topic of funding and financing of infrastructure and its performance. Researchers have focused on particular aspects of the transport infrastructure delivery. However, this research only presents aspects of the problem as long as it is not considered with respect and in context with all other factors that may influence outcomes.

The BENEFIT project takes an alternative approach. It initiates by considering transport infrastructure delivery, implementation, operation and maintenance as a system (see D3.1) bearing specific inputs and producing outputs (or outcomes) considered as the "performance" of the infrastructure system. These outcomes may be project management related, transport goal related, investment related and other outcomes. The "system" includes key elements as illustrated in Figure 1.1.1 of this report. These "elements" have been studied and their key drivers have been aggregated to indicator – proxies (see D2.2, D2.3, D2.4 and D3.1). In this sense, the complexity of transport infrastructure funding and financing and the multiple factors involved are reduced to nine (9) indicators descriptive of the elements of the respective system: the Matching Framework as it is termed in BENEFIT.

The other innovative aspect of the BENEFIT approach is that, having as a starting point that different factors or combinations thereof (indicators) will influence different outcomes or combinations of outcomes, it does not attempt to assess performance in terms of success or failure. Its study objective is to identify the combinations or interactions between indicators that would have a positive or negative effect on a particular outcome or a combination of outcomes. In the context of the research conducted within BENEFIT, four outcomes are being studied: Actual vs estimated Cost to completion, Actual vs estimated Time to completion, Actual vs forecasted Traffic and Actual vs Forecasted Revenue. The first two outcomes are closely related to the construction phase of the project. The latter are connected to the operational phase of the project. Traffic is a key outcome in connection with transport goals and the justification of the public investment. Finally, Revenue describes the business case.

Finally, BENEFIT makes a key assumption: input to the system (Matching Framework) is correct. This in practical terms means that cost and time to completion, forecasted traffic and revenues estimates are considered correct involving no bias. This, however, remains an assumption to be contested. This assumption also implies that the feasibility study and all other assessments leading to the final project decisions were also correct. Table 9.1.1 lists input factors, indicators and outcomes considered in the study and analyses.

The BENEFIT Matching Framework in this report is validated using the BENEFIT case studies (see Annex A.1). Cases were described over time through the values of the respective indicators, input factors (constant per case) and outcome variables. As they describe the key characteristics of the case at specific times in the project life cycle, each set of input factors, indicator and outcome values is termed a "snapshot" (see Annex A.2). Notably, the case studies forming the BENEFIT database are neither representative nor have they been selected randomly. They form a convenience sample of

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cases collected over time by members of the BENEFIT partnership. However, given the number of partners collecting information on cases (14 partners), this sample could be considered relatively unbiased.

Table 9.1.1: Input factors, Indicators and Outcomes considered in the BENEFIT Matching Framework

Input factors	Typologies	Typology Indicators	Outcomes
Principle Mode	Implementation Context	Institutional Context Indicator (ICI)	Actual vs estimated Cost to completion
Use		Financial - Economic Context Indicator (FECI)	
Investment size (normalised of sample and over sample and mode)	Transport Mode Context	Reliability-Availability Indicator (IRA)	Actual vs estimated Time to completion,
	Governance	Governance Indicator (GI)	
	Business Model	Cost saving Function (CS)	
		Revenue Support Function (RS)	Actual vs Forecasted Traffic
Delivery Mode	Funding Scheme	Remuneration scheme Indicator (RemS)	
Transport Network Configuration		Revenue scheme (RevS)	Actual vs Forecasted Revenue
	Financing Scheme	Financing scheme (FS)	

The snapshots and the case narratives form the basis for the validation of both the Matching Framework and the indicators. The scope of the analyses carried out and presented in this report had as an objective to assess the explanatory power of the indicators and through them the Matching Framework. The process allowed the derivation of **lessons learned** with respect to:

- The funding and financing of transport infrastructure
- The Matching Framework and its typology indicators

Of course, findings bear the limitations of the specific sample and the challenge is to identify those findings, which might be sample specific against those having a greater explanatory power. In this approach a combination of analysis methods has been employed ranging from purely qualitative to semi-qualitative to quantitative. The analyses undertaken complement each other in terms of explanatory power and approach. At the same time, they allow for a comparative study of results and increase the interpretation capability of the research.

Case studies were analysed with respect to their outcomes qualitatively per transport infrastructure mode (see Chapter 3). Cases were also analysed qualitatively with respect to their snapshot information (see Chapter 5). The scope of the second qualitative analysis per mode was to assess the "reality fit" of the snapshot data. However, this also allowed for a new structured qualitative analysis of the case studies per mode **employing the Matching Framework as an ex-post assessment tool**.

I addition, qualitative findings were also collected through the validation of indicators (see chapter 4).

Further analysis using snapshot data was conducted using Fuzzy Set Qualitative Comparative Analysis (FsQCA) (see Chapter 6), Importance Analysis (IA) (see Chapter 7) and micro-Econometrics Analysis (see Chapter 8). Through these analyses, research shifts gradually from the actual cases to relying more on the quality and explanatory power of the indicators. Their findings are compared in section 9.2 of chapter 9. This comparison results in identifying common findings, which reinforces their significance with respect to lessons learned. In addition, the identification of differences is also important as, through their interpretation, important conclusions may be drawn.

Findings from the numerical analysis were systematically compared with those of qualitative analyses allowing for an improved understanding and enriched discussion (see section 9.3 of chapter 9). This final chapter of the report presents lessons learned.

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10.2 Funding and Financing of Transport Infrastructure – Lessons Learned

Following the analysis presented in this report and their comparative study lessons learned may be summarised. However, it is noted once again that these should be considered in caution as they bear the limitations of the sample these lessons have been derived from (see **Annex A.1**).

10.2.1 General

Funding and financing of transport infrastructure bears similarities but also distinct differences between transport modes. Different service models and accompanying activities may be developed depending on the transport mode and the infrastructure configuration in the transport network, with some modes and configurations allowing for a wider range of value adding activities and services. Regardless, in the BENEFIT database few projects include such activities and most foresee revenues depending on the mode specific activities that are included.

Exclusivity and connectivity to the transport network (which may be in favour or not of the competitive position of the project-infrastructure) are important factors in achieving performance outcomes.

With respect to the four basic performance outcomes studied (cost and time to completion, traffic and revenue forecasts), no signal combination of factors was identified having a positive effect on all four targets. For each performance target, at least partially, different factors seem to matter. Notably, this is the key reason and source of inconclusive discussion with respect to transport infrastructure project "success". In addition, factors might have different effects depending on how they are combined with other factors.

However, one factor that was identified to have an impact on all outcomes (cost and time to completion, traffic and revenue) was the implementation context and its indicators financial –economic context and institutional context. Notably, while the effect of implementation context is well acknowledged with respect to traffic and revenue, it has **now been connected to construction cost and time to completion.**

10.2.2 Cost and Time Targets

Cost and time to completion form part of the so-called "iron triangle" in project management (along with quality) in which the trade-offs in target outcomes are considered. Therefore, cost and time to completion are by definition correlated but not necessarily covariate.

Most transport infrastructure projects face technical problems. These concern design changes, technical failures, contractor failures, land acquisition and others. These problems result in cost and time delays and are present across all modes. However, they seem more frequent in rail and urban transit projects, road projects with low levels of financial-economic and institutional conditions (eg. south Europe) and in projects monitored by local public authorities (eg. urban transit projects). Two causes seem to be increasing the probability of cost and time overruns:

- Project technical maturity as opposed to technical difficulty. For example, national projects of special difficulty, such as bridges and tunnels, were found to perform relatively well.

- Competence (institutional and other) of the public authorities monitoring implementation for both PPP and traditional delivery of infrastructure. For example, poor performance of urban transit projects may be due to the competence of the (local) public authorities to address project maturity in terms of design and management of stakeholder objectives.

The two causes may also be interrelated.

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Life cycle planning was found to improve the chances of achieving cost and time targets. Notably, life cycle planning is part of mature technical design.

Good governance (including competitive tendering and contracting arrangements) improves the potential of achieving cost and time targets. Notably, this may be considered an expression of public authority competence and good institutions.

In addition, projects with bundled services showed cost and time overruns. This may be explained by a combination of the difficulty of achieving project maturity and competence of public authorities when addressing projects with increased complexity.

The contribution of the competence of the contractor could not be assessed, as most projects were assigned to competent contractors (international actors). This is mostly the case for PPPs, while public projects are mostly assigned to local contractors. This finding may be sample specific, however, very pronounced. No statistical difference was found based on the competence of the contractor.

However, it was identified that scope, exclusivity and connectivity (level of control as termed in the BENEFIT Analysis) seems to improve the chances of meeting cost and time targets. This is evident in unique structures (eg. bridges and tunnels), ports and airports.

Findings that may be sample specific

The following findings may be sample specific:

- Projects including a brownfield section were found to perform better with respect to cost and time.
- Projects aiming at combined revenues seem to perform better with respect to time.
- Public projects seem more prone to time overrun.

Finally, PPPs were found to have a greater probability to achieve cost and time targets if constructed prior to the crisis. This may be a sample specific finding, since the BENEFIT case study database includes many projects from countries under recession in Europe. However, by the same token, the finding indicates the negative impact poor macro-economic conditions may have on the probability of PPPs to reach cost and time targets.

10.2.3 Traffic Outcome

The financial economic context is a core factor influencing the achievement of the traffic outcome. This is a well-known fact in transport economics. Enabled to address the negative impacts were projects:

- Demonstrating higher “levels of control”, i.e. a combination of exclusivity and connectively serving business scope.
- Operated by contractors able to influence the demand
- Well-justified projects

It was identified, that projects with multiple revenue streams from other service activities were able to perform better. In this case, the competence of the operator was important.

In addition, projects with low risk income streams (potentially not relying on user charges) seem to perform better. This also holds true for PPP projects. As in the case of cost and time outcomes, it was identified that PPP projects were more probable to perform better prior to the crisis, while PPPs seem to have a higher probability of not reaching traffic targets. As before, this may be a sample specific finding. However, the probability remains, especially in connection with the remuneration scheme implemented.

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Finally, optimism bias was identified in a number of cases. Public projects seem to be more prone to overestimated traffic forecasts. However, it was found that overestimated traffic forecasts are related to inappropriate demand risk allocation. PPPs tend to be more conservative when appropriate or more demand risk is passed over to the concessionaire.

Finally, road projects being more vulnerable to macro-economic impact within the BENEFIT case study sample seem to have underperformed. While this may be a sample specific finding, it is also consistent with all over findings, as road projects usually demonstrate a lesser “level of control” in comparison with other infrastructure modes.

However, once again, it was identified that well justified and well designed projects are able to perform even under adverse macroeconomic conditions.

10.2.4 Revenue Outcome

Information with respect to revenue performance is typically not disclosed in PPP projects and difficult to assess in many public cases. Hence, the indicator used in the analyses is a constructed proxy based on the traffic outcome indicator in combination with re-negotiations and/or claims originating from revenue performance issues. In this sense, it includes considerable uncertainty and findings described below should be considered with caution.

A review of the business model of cases included in the BENEFIT case study database concluded that there are significant differences between modes and the models they develop. Overall, few revenue enhancing activities are included in the case studies. In other words, most infrastructure projects rely typically on the prime transport service offered by the infrastructure.

Hence, confined to the prime infrastructure, projects rely on low risk remuneration schemes and factors that enhance their ability to attract traffic under adverse macro-economic conditions. However, what is now interesting is that this is the only outcome for which the econometrics analysis did not show a diversification in the probability to achieve this outcome for PPP projects prior to the crisis. Or in other words, PPPs achievement of revenue targets is independent of the crisis and the traffic outcome, which was found to depend on the crisis. This remark has two interpretations: for some projects their characteristics (similar to the case of traffic outcomes) make them resilient and for others through re-negotiations revenues are established.

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10.3 Matching Framework and its Typology Indicators – Lessons Learned

A multiple analyses approach ranging from purely qualitative to semi-qualitative and qualitative was adopted in the validation process applied. The use of this multiple approach methodology allowed for both comparison and complementary interpretation of findings enhancing the investigation power of research and leading to more robust findings, which were not hampered by the limitations of the specific methodology applied.

The combined validation of indicators and the Matching Framework lead to a number of encouraging findings as well as issues that need further consideration and improvement.

Starting from its structural concept, it was confirmed that the Matching Framework functions well when considered as **Stakeholder Neutral** with higher indicator values representing **lower risk of their respective element** (typology) for the project. When indicators are not consistent with this basic concept, the potential of interpretations is limited or expressed through other indicators.

In this context, some indicators need further investigation and amendment. The current findings provide sufficient guidance in this direction, while activities under the following tasks foresee respective progress in research.

The Matching Framework is designed to be applied as an ex-post assessment tool. Despite limitations to some indicators, this was made possible and confirmed through the various analyses conducted. It is also interesting to note that between the pure qualitative analysis and the one focusing on the reality fit of the Matching Framework datasets (snapshots), the later formulated a more consistent methodological framework and lead to more enriched results.

The Matching Framework is designed to function as an ex-ante assessment tool. Despite limitations recognised, in its current form, it was able to predict performance at a moderate level (approximately 50%) across modes.

As noted, a key finding of the analyses presented in this report is the fact that all outcomes are not dependent on all or the same factors. Hence, it becomes very difficult to achieve all outcome targets emphasising on the same set of factors. Though the combined analysis carried out, it was possible to identify combinations of indicators that enhance the probability of achieving particular outcomes. It was also found that such multiple combinations may exist, but in all cases, apart from the financial-economic/institutional indicator, there is also one other indicator of crucial importance. Furthermore, points of interest are:

- Cost and time outcomes are most often addressed in combination (finding from the qualitative and econometrics analysis)
- Cost and time outcomes are mostly addressed through avoidance of their negative influencing factors (finding from the qualitative analysis and the FsQCA)
- Traffic outcome is mostly addressed through measures of resilience (finding from all analyses)
- Revenue outcome for PPPs may be addressed through the remuneration scheme (finding from all analyses)
- The Matching Framework is most suitably applied within the same mode.

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Based on these findings, the Matching Framework is further improved in the following research under BENEFIT. Detailed steps with respect to the improvement of the indentified limitations are suggested accordingly.

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ANNEX A.3.1

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ANNEXES

- **A.1 BENEFIT Cases Database**
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A.1 BENEFIT Cases Database

The dataset assembled for the purpose of the analysis of the case studies includes **86** cases, of which **55 are** PPPs and **31** public projects.

The dataset has been created based on initially collected information from COST Action TU1001 (Roumboutsos et al, 2013; 2014) and the Omega Center Megaproject (see http://www.omegacentre.bartlett.ucl.ac.uk/publications/omega-case-studies/). The case studies were updated to meet the needs of the BENEFIT project, while new cases were added (see BENEFIT Wiki and e-Book). Information was collected through surveys, interviews and desk research carried out by the consortium partners. Table A.1.1 below contains all cases and their basic characteristics, namely: the country of implementation, the selected delivery mode, the primary and other transport modes served by the infrastructure, its physical configuration within the transport network, as well as the existence of greenfield and/or brownfield sections.

Notably, against expectations, the collection of information with respect to transport infrastructure projects publically funded and delivered through traditional procurement proved very cumbersome. Key reasons to this shortcoming were:

1. Infrastructure projects delivered through traditional procurement are seldom turn-key. They usually include multiple contracts, which are not registered in combination. Therefore, it is very difficult to identify information on all contracts related to the same infrastructure section.
2. Publically procured infrastructure projects are usually procured in small overlapping sections making it difficult to define the "project" and its outcomes.
3. Information for particular projects was scarce and not always organised.

Table A.1.1: Basic characteristics of the BENEFIT project case studies

#	Project Title	Author	Country	Other mode	Network config.	Field
Private Co-Financed Case Studies						
Primary Mode: Road						
1.	Attiki Odos (Athens Ring Road)	UAEGEAN	Greece	Rail	Link	Greenfield
2.	Brebemi	TRT	Italy		Link	Greenfield
3.	Horgos - Pozega	UoB	Serbia		Link	Both
4.	Ionia Odos Motorway	UAEGEAN	Greece		Link	Both
5.	Central Greece (E65) Motorway	UAEGEAN	Greece		Link	Both
6.	BNRR (M6 Toll)	UCLAN	UK		Link within a Link	Greenfield
7.	M80 Haggs	UCLAN	UK		Link	Both
8.	A19 Dishforth To Tyne Tunnel	UCLAN	UK		Link	Brownfield
9.	A22 - Algarve	IST	Portugal		Link	Both
10.	Radial 2 Toll Motorway	UCLAN	Spain		Link	Greenfield
11.	Eje Aeropuerto (M-12). Airport Axis Toll Motorway	UCLAN	Spain		Link	Greenfield
12.	M-45	UCLAN	Spain		Link	Greenfield
13.	A2 Motorway Poland	IBDiM	Poland		Link	Greenfield
14.	Istrian Y	UAEGEAN	Croatia		Link	Both
15.	A23 - Beira Interior	IST	Portugal		Link	Both
16.	E39 Orkdalsvegen Public Road	UAEGEAN	Norway		Link	Both
17.	Elefsina Korinthos Patra Pyrgos Tsakona Motorway	UAEGEAN	Greece		Link	Both
18.	Via-Invest Zaventem	UA	Belgium		Link	Both
19.	E18 Grimstad - Kristiansand	UAEGEAN	Norway		Link	Both

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#	Project Title	Author	Country	Other mode	Network config.	Field
20.	M-25 Motorway London Orbital	UCLAN	UK		Link	Brownfield
21.	Moreas Motorway	UAEGEAN	Greece		Link	Both
22.	C-16 Terrassa-Manresa Toll Motorway	ULPGC	Spain		Link	Greenfield
23.	E4 Helsinki-Lahti	OULU	Finland		Link	Both
24.	E18 Muurla-Lohja	OULU	Finland		Link	Greenfield
Primary Mode: Bridge and Tunnel						
25.	Rion-Antirion Bridge	UAEGEAN	Greece	Road	Link within a Link	Greenfield
26.	Lusoponte - Vasco Da Gama Bridge	TIS	Portugal	Road	Link within link	Both
27.	Coen Tunnel	UT	The Netherlan ds	Road	Link within link	Both
28.	Herrentunnel Lüebeck	KIT	Germany	Road	Link within a Link	Brownfield
29.	Millau Viaduct	UCL-OMEGA	France	Road	Link within a Link	Greenfield
30.	The Oresund Link	UCL-OMEGA	Sweden - Denmark	Road Rail	Link within a Link	Greenfield
Primary Mode: Seaport						
31.	Piraeus Container Terminal	UAEGEAN	Greece		Node within Node	Both
32.	Port of Sines Terminal XXI	IST	Portugal	Road Rail	Node	Greenfield
33.	Port of Leixoes	TIS	Portugal	Road Rail	Node within a Node	Both
34.	Deurganckdoksluis-Deurganckdock Lock	UA	Belgium		Node within a Node	Greenfield
35.	Venice Offshore - Onshore Terminal	UA	Italy		Node within a Node	Both
36.	Larnaka Port & Marina Re-Development	UAEGEAN	Cyprus	Marina & Real estate	Node	Both
37.	Valencia Cruise Terminal	ULPGC	Spain		Node within a Node	Greenfield
38.	Terminal Muelle Costa at Port of Barcelona	ULPGC	Spain	SSS, Freight & Passenger terminal	Node within a Node	Greenfield
39.	Barcelona Europe South Terminal	ULPGC	Spain		Node within a Node	Greenfield
40.	Adriatic Gateway Container Terminal	UAEGEAN	Croatia		Node within a Node	Both
Primary Mode: Airport						
41.	Athens International Airport 'Eleftherios Venizelos'	UAEGEAN	Greece	Road Freight terminal	Node	Greenfield
42.	Larnaca and Paphos	UAEGEAN	Cyprus		Node	Both

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#	Project Title	Author	Country	Other mode	Network config.	Field
	International Airports					
Primary Mode: Rail						
43.	Fertagus Train	IST	Portugal	Road Terminals Bus	Link	Both
44.	Liefkenshoekspoor-verbinding - Liefkenshoek Rail Link	UA	Belgium		Link	Greenfield
Primary Mode: Tram/LRT						
45.	Metrolink LRT, Manchester	UCLAN	UK	Metro	Link	Brownfield
46.	Reims Tramway	CEREMA	France	Bus	Link	Both
47.	Caen-TVR	CEREMA	France		Link	Both
48.	Brabo 1	UA	Belgium	Cycle lanes	Link within a Link	Both
49.	MST - Metro Sul do Tejo	IST	Portugal		Link	Greenfield
Primary Mode: Metro						
50.	Metro de Malaga	UCLAN	Spain		Link	Greenfield
51.	Metro do Porto S.A.	IST	Portugal	Funicular system	Link	Both
Primary Mode: Bicycles						
52.	Velo'V	CEREMA	France		Link	Greenfield
53.	SERVICI	ULPGC	Spain		Link	Greenfield
Primary Mode: Terminals						
54.	Quadrante Europa Terminal Gate	TRT	Italy		Node within a Node	Greenfield
55.	Central Public Transport Depot of the City of Pilsen	UAEGEAN	Czech Republic		Node	Brownfield
Publically Funded Case Studies						
Primary Mode: Road						
1.	Combiplan Nijverdal	UT	The Netherlands	Rail Terminals	Link	Brownfield
2.	A5 Maribor - Pince Motorway	UAEGEAN	Slovenia		Link	Both
3.	Koper - Izola Expressway	UAEGEAN	Slovenia		Link	Both
4.	Motorway E-75, Section Horgos - Novi Sad (2nd Phase)	UoB	Serbia		Link	Both
5.	Belgrade By-Pass Project, Section A: Batajnica-Dobanovci	UoB	Serbia		Link	Greenfield
6.	Motorway E-75, Section Donji Neradovac - Srpska Kuca	UoB	Serbia		Link	Brownfield
7.	Estradas de Portugal	TIS	Portugal		Link	Both
8.	Bundesautobahn 20	UCL-OMEGA	Germany		Link	Greenfield
Primary Mode: Bridge and Tunnel						
9.	Berlin Tiergarten Tunnel	UCL-OMEGA	Germany	Road Rail Terminals	Link within a Link	Brownfield
10.	Sodra Lanken (The Southern Link)	UCL-OMEGA	Sweden	Road	Link within a Link	Both
11.	Blanka Tunnel Complex	UAEGEAN	Czech Republic	Road Tramway	Link within a Link	Greenfield
Primary Mode: Seaport						
12.	OW-Plan Oostende-Integrated Coastal & Maritime Plan for Oostende	UA	Belgium		Node within a Node	Both

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#	Project Title	Author	Country	Other mode	Network config.	Field
13.	Port of Agaete	ULPGC	Spain	(concessioned operation)	Node	Brownfield
Primary Mode: Airport						
14.	Modlin Regional Airport	IBDiM	Poland	Rail Freight terminal	Node	Brownfield
15.	Berlin Brandenburg Airport (BER)	KIT	Germany	Road Rail	Node	Both
16.	Sa Carneiro Airport Expansion	IST	Portugal	Road Terminals Metro station	Node	Brownfield
Primary Mode: Rail						
17.	Gardermobanen (Airport Exprestrain)	UAEGEAN	Norway	Tunnel Station	Link	Both
18.	Tram-Train 'Kombiloesung' Karlsruhe	KIT	Germany	Road Metro	Link	Both
19.	NBS Köln-Rhein/Main	UCL-OMEGA	Germany		Link	Greenfield
20.	TGV Mediterranean	UCL-OMEGA	France	Terminals	Link within a Link	Both
21.	HSL-Zuid	UCL-OMEGA	The Netherlands		Link	Greenfield
22.	MXP T2-Railink-up	TRT	Italy		Link	Both
Primary Mode: Tram/LRT						
23.	Tram T4 (Line 4 Of Lyon Tramway)	CEREMA	France		Link	Both
24.	Athens Tramway	UAEGEAN	Greece		Link	Greenfield
25.	Randstadrail	UCL-OMEGA	The Netherlands	Road Terminals	Link	Both
Primary Mode: Metro						
26.	Warsaw's Metro II-nd Line	IBDiM	Poland		Link within a Link	Greenfield
27.	London Underground Jubilee Line Extension (JLE)	UCL-OMEGA	UK		Link within a Link	Brownfield
28.	Meteor	UCL-OMEGA	France		Link	Both
29.	Attiko Metro (Athens Metro Base Project)	UCL-OMEGA	Greece		Link	Greenfield
30.	Beneluxlijn	UCL-OMEGA	The Netherlands		Link	Greenfield
Primary Mode: Terminals						
31.	The Hague New Central Train Station	UT	The Netherlands	Rail	Node	Brownfield

LRT = Light Rail Transit

Figure A1.1 depicts the distribution of the 86 cases per primary transport mode. It is evident that the vast majority of projects of the BENEFIT Database (DB) are road projects (31), followed by 17 urban transit ones (entailing mostly tramway/light rail projects, whose popularity has increased in recent

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years) and seaport projects (12). The database contains a smaller sample of bridge/tunnels, rail and airport projects, while there are only 3 terminal projects and 2 of combined transport modes. The road, seaport and bridge/tunnel projects are mostly delivered through PPP schemes, while the rail, airport and mixed mode projects are publically financed. In general, this is considered a good distribution of transport modes served by each infrastructure project.

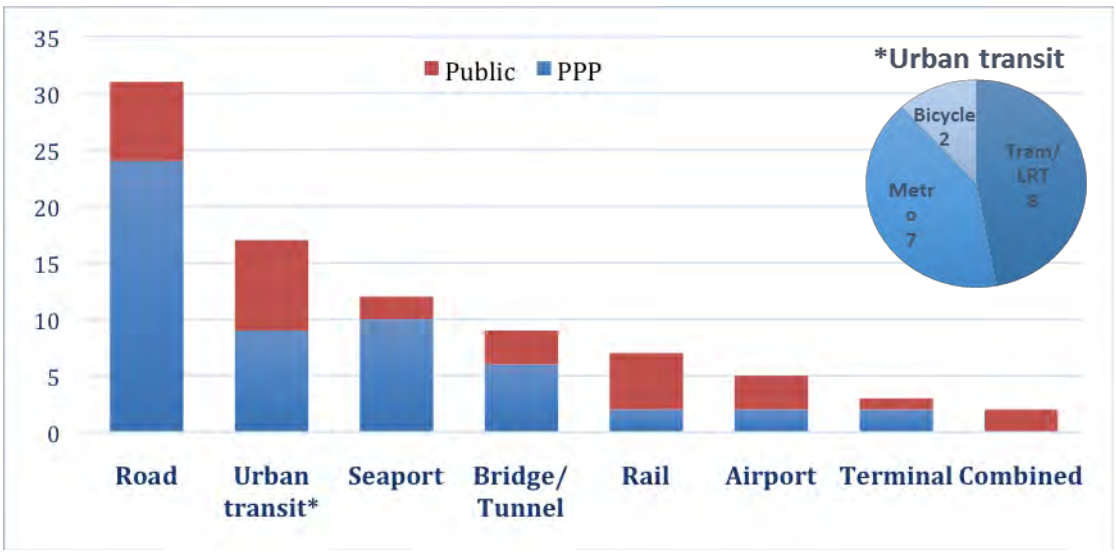

Figure A.1.1.: Distribution of PPP & Public Cases per Mode

Figure A.1.2 presents the distribution of cases per country of origin and per delivery mode (PPP or public). In total, the projects of the DB are located in 18 European countries, covering the entire geographical spectrum of Europe (North, South, East, West and Central Europe), demonstrating thus a good distribution for the sample. The majority of projects studied are located in Greece, Portugal and Spain (10 each), followed by France, Germany, UK and the Netherlands. The smallest contribution in the sample is from Sweden, Slovenia, Cyprus, Finland, Czech Republic and Croatia, with 2 projects each.

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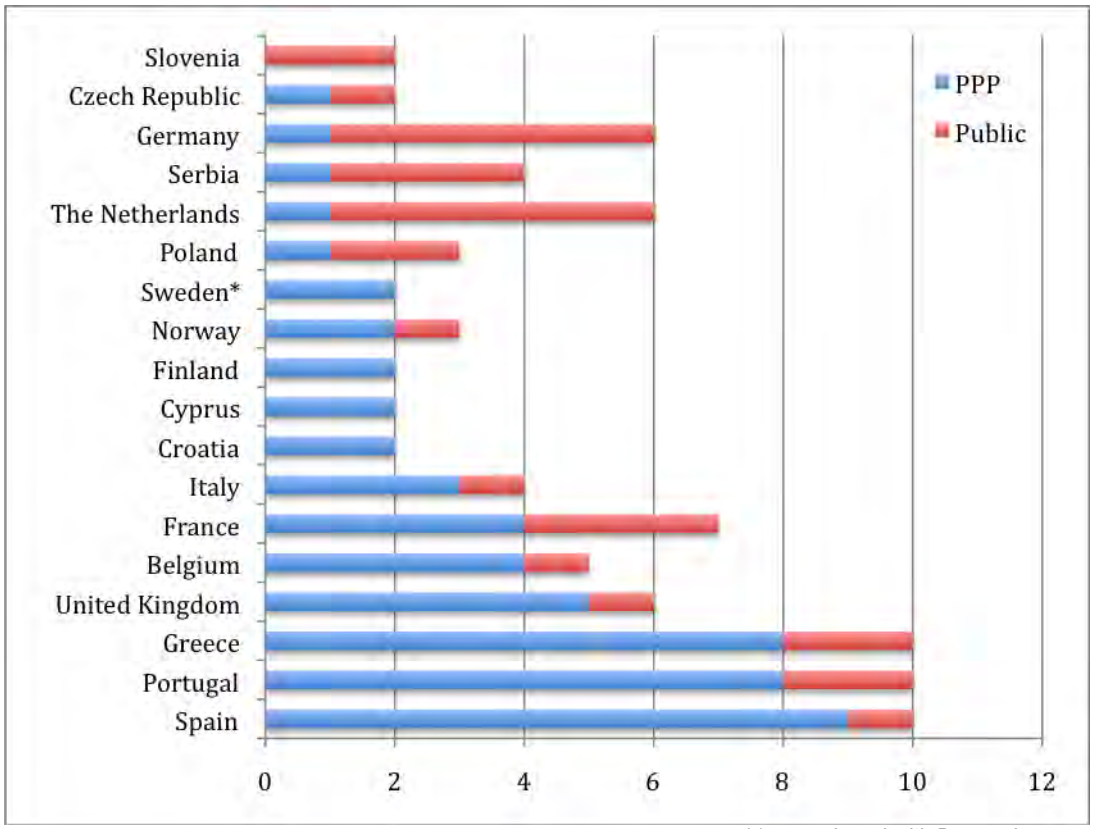

*1 case shared with Denmark

Figure A.1.2.: Distribution of Cases per Country & Delivery Mode

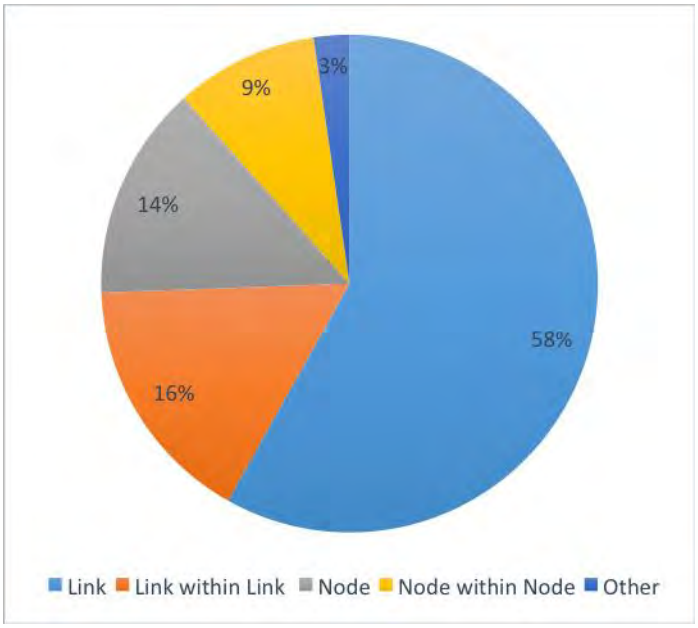

Figure A.1.3.: Distribution of Cases per Network Configuration

The distribution of cases regarding their respective network configuration is presented in Figure A.1.3. Reasonably, more than half of the cases constitute links (the majority being road projects), followed by "link within link" (bridges and tunnels). About 14% include node projects, such as seaports and

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airports, while the minority constitutes nodes within nodes (i.e terminals within ports). Similar to the tranport mode these serve, this is a fairly satisfactory distribution on the infrastructure's position in a transport network.

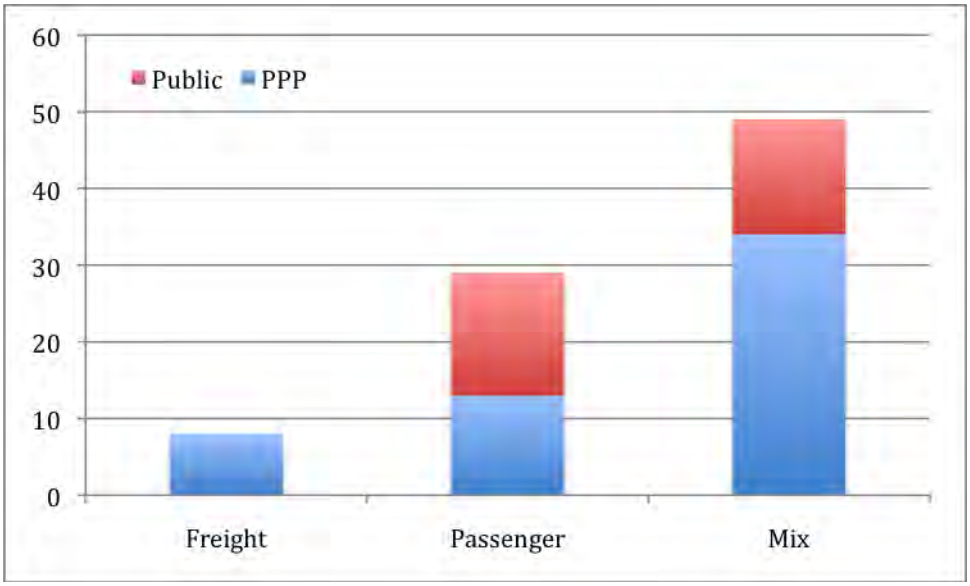

Figure A.1.4.: Distribution of Cases per Type of Users

Figure A.1.4. depicts the distribution of PPP and public cases by type of users. More than half of the cases include infrastructure that is used by both passengers and freight traffic, the majority of which is delivered by PPP scheme. About one third of the sample is only for passenger use, where public cases are slightly more than the PPP ones. There are only very few cases, whereby infrastructure serves only freight flows, these being mainly seaports and terminals, all of which concern PPP projects. Despite the latter, the distribution is considered satisfactory, given the high percentage of mix use.

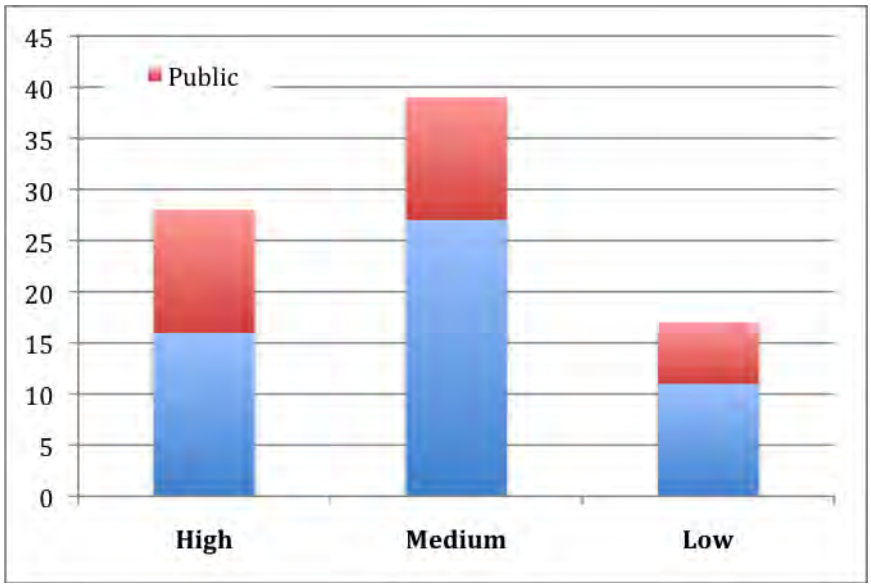

Figure A.1.5.: Distribution of Cases per Investment Size (normalised for sample)

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The distribution of PPP and public cases per investment size (normalised for sample) is presented in Figure A.1.5. Almost half of the cases concern medium size investments, the majority of them being delivered through PPP schemes, while a third concerns high investments which are more balanced between the two delivery methods (PPP & public). A non-negligible 20%, however, involves cases of low investments, most of which are PPP projects. Again, this is considered a fairly good distribution, considering the type of projects included in the database. In addition to the above, Figure A.1.6 presents the cases' distribution of the investment size per individual transport mode (normalisation per mode). On a modal basis, the distribution is balanced. Regarding the road projects, there is even distribution among investment sizes, given the various road projects' type and location. The same applies to bridges and tunnels. Seaport and rail projects include mainly higher investments, while the majority of the cases of tramways/light rail and airport infrastructure can be characterised as medium investments in relation to their respective mode. Finally, the majority of the metro projects in the DB are considered as low investment projects regarding this particular mode.

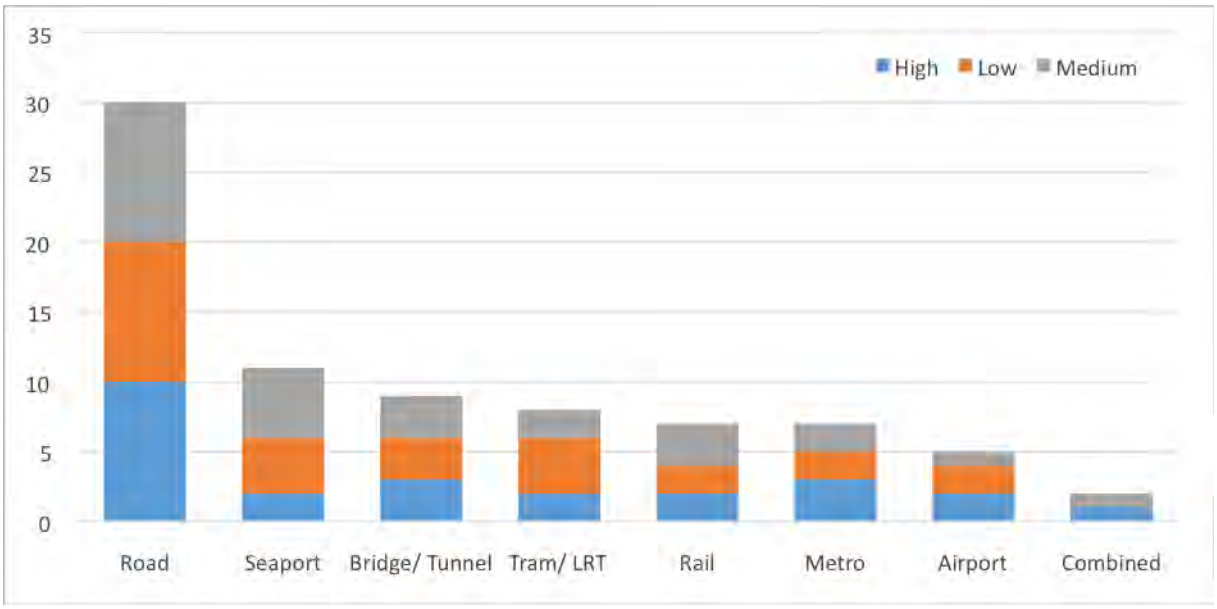

Figure A.1.6.: Distribution of Cases per Mode & Investment Size

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A.2 Matching Framework Snapshots

Within the context of research conducted under task 4.1 stage 2, case studies were converted into and represented through the matching framework (MF) typology indicators. Their representation over time was affected through a series of sets of indicators corresponding to particular times in the life cycle of the project (snapshots). For all cases, the required data was not available. In addition, all cases with information did not always have information available over time. Therefore, all snapshots could not be used in the various analyses. Moreover, the first snapshot of each case referred in most instances to the award time. This snapshot included information on the project setup but outcomes were all considered “in line” reflecting the planed expectations.

Despite the lesser number of cases that could be represented through their snapshots, there continued to be a fairly good distribution with respect to infrastructure serving countries (see Figure A.2.1) and modes (see Figure A.2.2).

The table A.2.1 below lists the cases, the number of snapshots generated and the number of usable snapshots. The distribution with respect to snapshots per case is illustrated in Figure A.2.3.

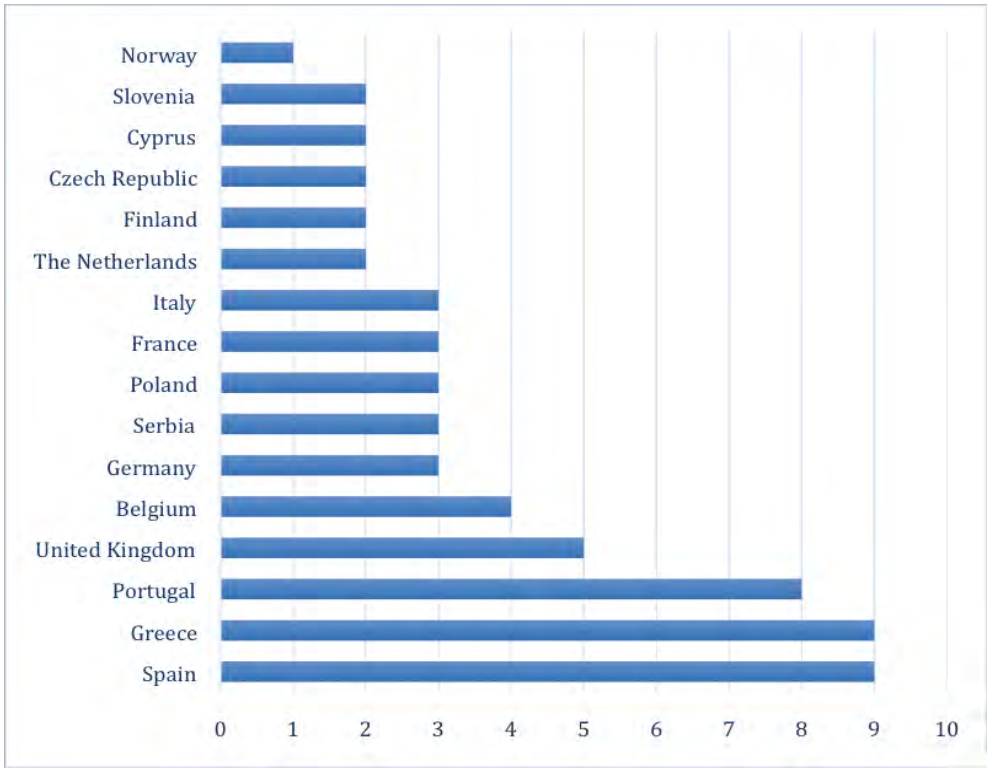

Figure A.2.1.: Distribution of Snapshots per Country

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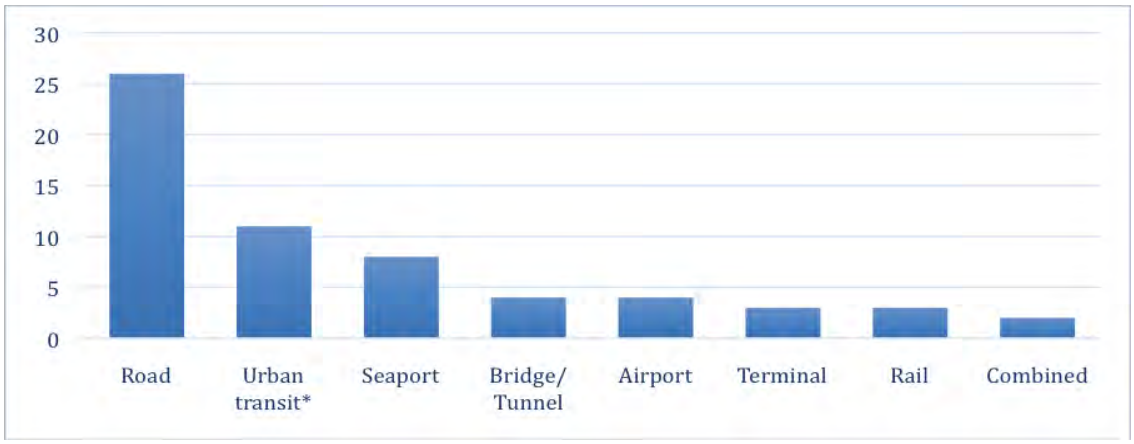

Figure A.2.2.: Distribution of Snapshots per Mode

Table A.2.1: Basic characteristics of the BENEFIT project case studies

#	Project Title	Author	Country	Number of snapshots	Number of Usable snapshots
Private Co-Financed Case Studies					
Primary Mode: Road					
	Attiki Odos (Athens Ring Road)	UAEGEAN	Greece	**5**	**5**
	Brebemi	TRT	Italy	**2**	**0**
	Horgos - Pozega	UoB	Serbia	**0**	**0**
	Ionia Odos Motorway	UAEGEAN	Greece	**3**	**3**
	Central Greece (E65) Motorway	UAEGEAN	Greece	**3**	**3**
	BNRR (M6 Toll)	UCLAN	UK	**5**	**5**
	M80 Haggs	UCLAN	UK	**3**	**3**
	A19 Dishforth To Tyne Tunnel	UCLAN	UK	**3**	**3**
	A22 - Algarve	IST	Portugal	**3**	**3**
	Radial 2 Toll Motorway	UCLAN	Spain	**5**	**5**
	Eje Aeropuerto (M-12). Airport Axis Toll Motorway	UCLAN	Spain	**5**	**5**
	M-45	UCLAN	Spain	**5**	**5**
	A2 Motorway Poland	IBDiM	Poland	**3**	**3**
	Istrian Y	UAEGEAN	Croatia	**0**	**0**
	A23 - Beira Interior	IST	Portugal	**3**	**3**
	E39 Orkdalsvegen Public Road	UAEGEAN	Norway	**3**	**3**
	Elefsina Korinthos Patra Pyrgos Tsakona Motorway	UAEGEAN	Greece	**3**	**3**
	Via-Invest Zaventem	UA	Belgium	**2**	**2**
	E18 Grimstad - Kristiansand	UAEGEAN	Norway	**0**	**0**
	M-25 Motorway London Orbital	UCLAN	UK	**3**	**3**
	Moreas Motorway	UAEGEAN	Greece	**2**	**2**
	C-16 Terrassa-Manresa Toll Motorway	ULPGC	Spain	**3**	**3**
	E4 Helsinki-Lahti	OULU	Finland	**7**	**5**
	E18 Muurla-Lohja	OULU	Finland	**6**	**5**
Primary Mode: Bridge and Tunnel					
	Rion-Antirion Bridge	UAEGEAN	Greece	**4**	**4**
	Lusoponte - Vasco Da Gama Bridge	TIS	Portugal	**2**	**2**
	Coen Tunnel	UT	The Netherlands	**0**	**0**
	Herrentunnel Lüebeck	KIT	Germany	**3**	**3**

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#	Project Title	Author	Country	Number of snapshots	Number of Usable snapshots
	Millau Viaduct	UCL-OMEGA	France	**0**	**0**
	The Oresund Link	UCL-OMEGA	Sweden - Denmark	**0**	**0**
Primary Mode: Seaport					
	Piraeus Container Terminal	UAEGEAN	Greece	**3**	**3**
	Port of Sines Terminal XXI	IST	Portugal	**3**	**3**
	Port of Leixoes	TIS	Portugal	**2**	**2**
	Deurganckdoksluis-Deurganckdock Lock	UA	Belgium	**2**	**2**
	Venice Offshore - Onshore Terminal	UA	Italy	**0**	**0**
	Larnaka Port & Marina Re-Development	UAEGEAN	Cyprus	**0**	**0**
	Valencia Cruise Terminal	ULPGC	Spain	**0**	**0**
	Terminal Muelle Costa at Port of Barcelona	ULPGC	Spain	**2**	**2**
	Barcelona Europe South Terminal	ULPGC	Spain	**2**	**2**
	Adriatic Gateway Container Terminal	UAEGEAN	Croatia	**0**	**0**
Primary Mode: Airport					
	Athens International Airport 'Eleftherios Venizelos'	UAEGEAN	Greece	**4**	**4**
	Larnaca and Paphos International Airports	UAEGEAN	Cyprus	**4**	**4**
Primary Mode: Rail					
	Fertagus Train	IST	Portugal	**3**	**3**
	Liefkenshoekspoor-verbinding -Liefkenshoek Rail Link	UA	Belgium	**2**	**2**
Primary Mode: Tram/LRT					
	Metrolink LRT, Manchester	UCLAN	UK	**7**	**7**
	Reims Tramway	CEREMA	France	**3**	**3**
	Caen-TVR	CEREMA	France	**0**	**0**
	Brabo 1	UA	Belgium	**2**	**2**
	MST - Metro Sul do Tejo	IST	Portugal	**4**	**4**
Primary Mode: Metro					
	Metro de Malaga	UCLAN	Spain	**3**	**3**
	Metro do Porto S.A.	IST	Portugal	**2**	**2**
Primary Mode: Bicycles					
	Velo'V	CEREMA	France	**0**	**0**
	SERVICI	ULPGC	Spain	**2**	**0**
Primary Mode: Terminals					
	Quadrante Europa Terminal Gate	TRT	Italy	**3**	**0**
	Central Public Transport Depot of the City of Pilsen	UAEGEAN	Czech Republic	**0**	**0**
Publically Funded Case Studies					
Primary Mode: Road					
	2. Combiplan Nijverdal UT The Netherlands **4** **3**				
	A5 Maribor - Pince Motorway	UAEGEAN	Slovenia	**3**	**3**
	Koper - Izola Expressway	UAEGEAN	Slovenia	**3**	**3**
	Motorway E-75, Section Horgos - Novi Sad (2nd Phase)	UoB	Serbia	**3**	**3**
	Belgrade By-Pass Project, Section A: Batajnica-Dobanovci	UoB	Serbia	**4**	**4**
	Motorway E-75, Section Donji Neradovac - Srpska Kuca	UoB	Serbia	**2**	**2**
	Estradas de Portugal	TIS	Portugal	**0**	**0**
	Bundesautobahn 20	UCL-OMEGA	Germany	**0**	**0**
Primary Mode: Bridge and Tunnel					
	Berlin Tiergarten Tunnel	UCL-OMEGA	Germany	**0**	**0**
	Sodra Lanken (The Southern Link)	UCL-OMEGA	Sweden	**0**	**0**
	Blanka Tunnel Complex	UAEGEAN	Czech	**2**	**2**

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#	Project Title	Author	Country	Number of snapshots	Number of Usable snapshots
			Republic		
Primary Mode: Seaport					
	OW-Plan Oostende-Integrated Coastal & Maritime Plan for Oostende	UA	Belgium	**0**	**0**
	Port of Agaete (concessioned operation)	ULPGC	Spain	**3**	**3**
Primary Mode: Airport					
	Modlin Regional Airport	IBDiM	Poland	**4**	**4**
	Berlin Brandenburg Airport (BER)	KIT	Germany	**2**	**2**
	Sa Carneiro Airport Expansion	IST	Portugal	**0**	**0**
Primary Mode: Rail					
	Gardermobanen (Airport Exprestrain)	UAEGEAN	Norway	**0**	**0**
	Tram-Train 'Kombiloesung' Karlsruhe	KIT	Germany	**2**	**2**
	NBS Köln-Rhein/Main	UCL-OMEGA	Germany	**0**	**0**
	TGV Mediterranean	UCL-OMEGA	France	**0**	**0**
	HSL-Zuid	UCL-OMEGA	The Netherlands	**0**	**0**
	MXP T2-Railink-up	TRT	Italy	**2**	**0**
Primary Mode: Tram/LRT					
	Tram T4 (Line 4 Of Lyon Tramway)	CEREMA	France	**3**	**3**
	Athens Tramway	UAEGEAN	Greece	**7**	**7**
	Randstadrail	UCL-OMEGA	The Netherlands	**0**	**0**
Primary Mode: Metro					
	Warsaw's Metro II-nd Line	IBDiM	Poland	**5**	**5**
	London Underground Jubilee Line Extension (JLE)	UCL-OMEGA	UK	**0**	**0**
	Meteor	UCL-OMEGA	France	**0**	**0**
	Attiko Metro (Athens Metro Base Project)	UCL-OMEGA	Greece	**0**	**0**
	Beneluxlijn	UCL-OMEGA	The Netherlands	**0**	**0**
Primary Mode: Terminals					
	The Hague New Central Train Station	UT	The Netherlands	**3**	**2**

LRT = Light Rail Transit

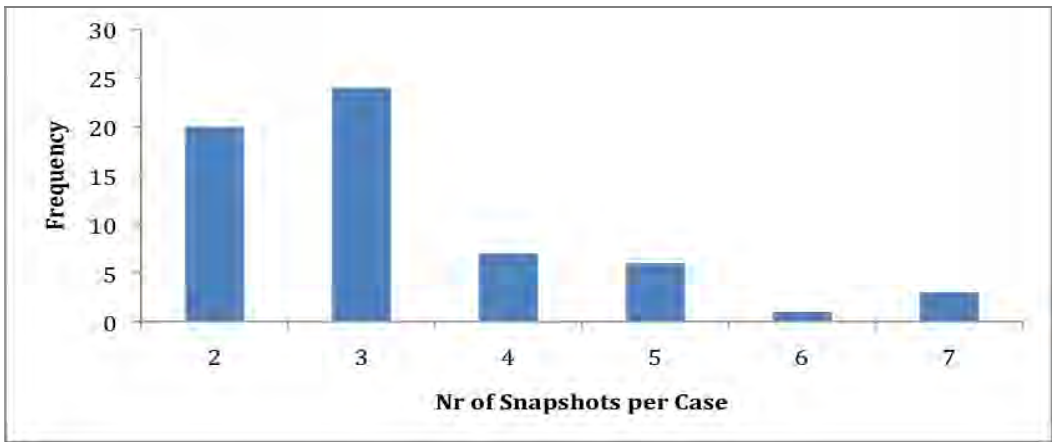

Figure A.2.3: Distribution of Snapshots per Case

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As noted above, each snapshot corresponds to the set of typology indicator values for a specific project at a particular time in its life cycle. Each case is represented by at least two snapshots: the snapshot at “award” and one at the reporting time. The “award” snapshot corresponds to the initial set-up and planning of the project. The snapshots following are observations of the project at different times. The snapshot at project inauguration includes the project outcomes with respect to cost to completion and time to completion. The traffic outcome for this snapshot is as planned. Only snapshots representing the project after inauguration include actual traffic outcomes. An effort was placed in preparing snapshots relevant to important milestones in a project’s life-cycle.

The distribution snapshots with respect to specific times in a project is presented in Figure A.2.4.

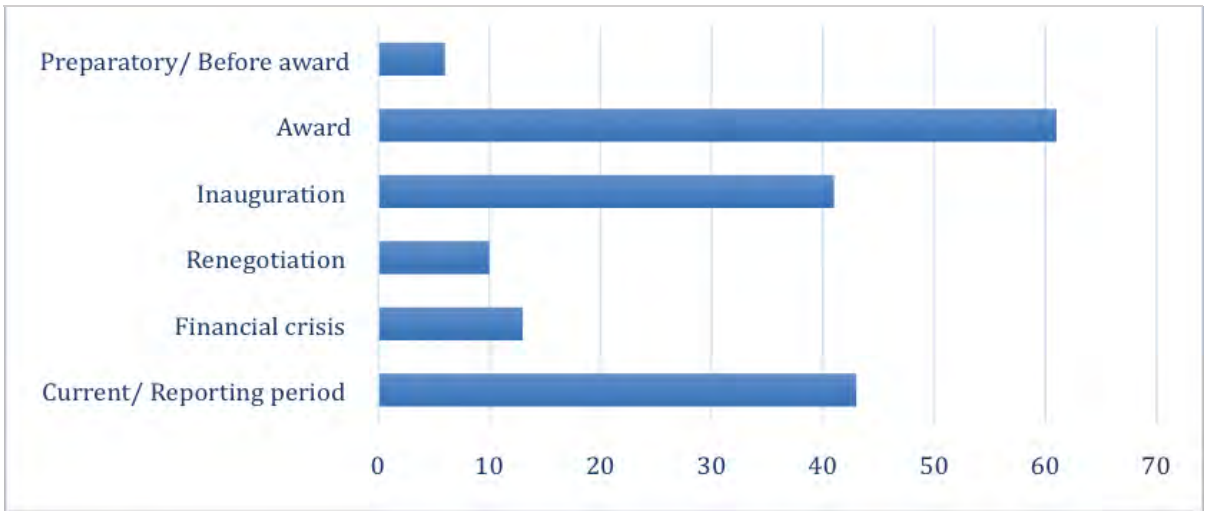

Figure A.2.4: Distribution of snapshots with respect to milestones in projects’ life

Concerning the ranges of values observed for the various indicators, these are illustrated in the box plot of Figure A.2.5.

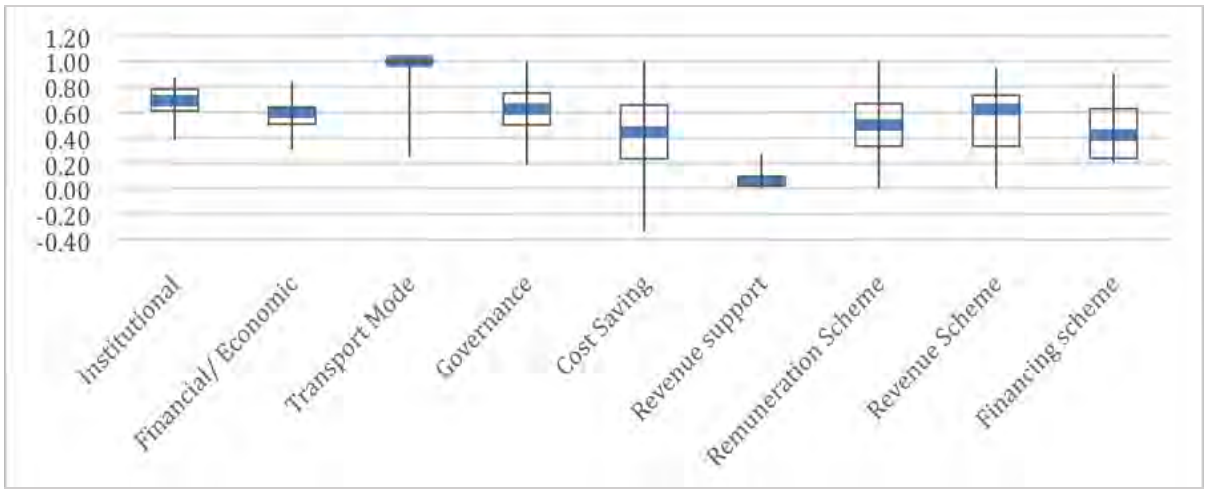

Figure A.2.5: Range of Typology Indicator Values

Notably, all indicator values are in the defined range of (0,1), with the exception of the Cost Saving Indicator, which may take values in the range (-0.33, 1). The institutional and Financial/Economic Indicators appear to have concentrated values. This is normal considering that all projects originate

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from European countries. However, there is also variation due to institutional reforms and the economic crisis. More concentrated is the Transport Mode Indicator with most projects taking the maximum value, even though lower values are also present in the sample allowing this indicator significant range. The Governance indicator again shows good variance. The Cost Saving indicator is probably the indicator with the greatest variance in values. This also applies for the greater part of the sample. This is in direct contrast with the Revenue Support indicator, which shows the least variance. This is due to the fact that it is based on the assessment of contributing streams of revenues. As most cases only focus revenue streams on the primary infrastructure, this indicator reflects this prevailing situation (see also **Annex 3.1**). The variance for the Funding scheme typology indicators represents the variety of remuneration schemes and revenue sources of the cases in the BENEFIT sample. Finally, the financing scheme indicator seems weighted towards its lower values, as these represent projects that have been “financed” by the public sector.

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A.3 Qualitative Analysis

A.3.1 Review of Business Models

A.3.1.1 Airports

Airports in many parts of the world are no longer viewed as public utilities, but rather as private enterprises aiming to maximise shareholder value and profits from a fixed facility (Adler et al., 2010). Based on their location, they may be natural location monopolies or operate in competitive markets as a result of the deregulation of both the airlines and the airports located in overlapping catchment areas (Tretheway and Kincaid, 2010; Starkie, 2002). Investments in airport expansion are highly risky as they depend on airline selection and the intervention of national and international regulators (Adler and Gellman, 2012), while they are also vulnerable to exogenous shocks (such as terrorism, extreme weather events, strikes, and airline collapses). Diversifying revenue sources to minimise the economic risk of dependence on air services is sought through development of airport property, considered surplus to core aviation requirements – often in the form of business parks and retail complexes (Morrison, 2009). This approach is captured in the concept of the "airport city" (Peneda et al., 2011), which from a spatial perspective concerns airport-centric development (Freestone and Baker, 2011). This trend is more evident in major global hub airports, such as Schiphol (Amsterdam), Frankfurt, Hong Kong, and Dallas–Fort Worth (Kasarda, 2009). The "airport city" model places the emphasis on real estate development and is combined with the tendency to secure monopoly status in cases of concessions (Cruz and Marques, 2011) to further minimise the pure air-service risk.

The BENEFIT database includes five examples of airport infrastructure projects. Two are delivered through a PPP scheme while the rest by public resources. Commercial activities to the extent discussed in the literature are not identified. The Athens International Airport has not developed to this level (only 23% of revenues account for commercial activities), while the potential of Berlin Brandenburg Airport is not known, as the project is not yet operational.

Larnaca and Paphos International Airports register small revenues. This could, however, be a special case as the concessionaire is, practically, the sole operator of passenger transportation to and from the insular country of Cyprus and commercial activities may develop in existing zones in the country (no need for transfer) due to the small distance involved. The project could in many ways be assessed in combination with the Larnaca Port and Marina re-development PPP project, which borders with the Larnaca Airport (see under 3.3. Ports). This particular project, launched during the recession, has yet to reach financial close (awarded in 2012). A similar project was launched in 2007 for the marina and real estate development in Paphos and was, then hampered by the credit crisis (2008-2009) and cancelled. Therefore, for this particular case, a different planning was foreseen which, due to global and national macroeconomic conditions, has not materialised.

The other two airports in the group are operating in a more competitive environment. Modlin Airport (an old military airport) was developed to serve low-cost carriers. The project faced construction and aviation administration setbacks coupled with accessibility problems (which seem rather the norm for airports only serving low-cost carriers). Sa Carneiro Airport supports the tourism sector and faces capacity issues. Hence, it does not need to develop further activities. In addition, the concept of "airport city" is more suitable for industrial locations. In this context, the Sa Carneiro Airport resembles that of Larnaca and Paphos International Airports in the sense that their returns are generated by serving passengers and the local tourism sector. In this respect, the tourism sector becomes a determining factor of their success.

A common characteristic is the considerable difference in construction cost between the countries' central airports that are bundled with commercial activities and the more peripheral ones that angle for revenues obtained mainly from service provision. This is evident in the cases of the Berlin

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Brandenburg Airport and the Athens International Airport. The strong exclusivity of the project is also a determinant characteristic. Accordingly, at the other end of the spectrum, stands the Modlin Regional Airport, which is a somewhat low investment, operating in a competitive environment with no foreseen commercial activities.

In conclusion this group demonstrates the following characteristics with respect to “revenue enhancing features”.

Features	**No of Airports**
Combination with other commercial activities (greater than 10%)	2
Combination with other commercial activities (less than 10%)	3
Brownfield upgrade included in construction	4
Brownfield included in operation	4
Co-construction with infrastructure of other mode	0
Co-construction/ operation with other non-transport infrastructure	2
Additional Features Identified	
Support to local activity (tourism)	3

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Table A.3.1.1: Airport Projects

Project Name	Delivery Type	Year Awarded / Construction Start	Contract Duration	Construction Budget MEuros (2013)	% public contribu-tion	Characteristics of Business Model					
						Exclusivity	Connections	Brown Field	Other Development	% other Revenues	Operated by
Athens International Airport	PPP	1995	30	3653	18	Exclusive	Yes through other projects	No	Commercial activities	23%	Concessionaire
Larnaca and Paphos International Airports	PPP	2005	25	749	n.a	Exclusive	Road	Upgrade of existing airports	Few	-	Concessionaire
Modlin Regional Airport	Public	2012	n.a.	83	100	Competitive environment	Other complemen-tary Project not realised	Upgrade of existing military airport	-	-	SPV ("Polish Airports" State Enterprise)
Sa Carneiro Airport Expansion	Public	2007	n.a.	324	100	Quite not Exclusive		Upgrade of existing airport	Commercial Activities	Some	ANA, the (then) public company that holds the concession for all Portuguese airports
Berlin Brandenburg Airport (BER)	Public	2006	n.a.	6110	100	Rather Exclusive	Rail Link + other	Upgrade of existing airport	Commercial activities	Under Constr.	Berlin Brandenburg Flughafen Holding GmbH, directing all airports of Berlin (TXL, SXF, THF) – Public

n.a.: not available

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A.3.1.2 Urban transit

With respect to urban transit projects, factors influencing ridership and perceived quality on a single transit line are:

- Service provided (high frequency, availability, etc.) - these conditions are often met in the case of metro or tramway lines;
- integration into the wider transit network (both physical integration which makes modal shift easier and institutional integration which makes fare integration easier);
- fare structure (social tariffs, specific fares for groups, families, etc.);
- level of urban density (which can be achieved through public policy shaping long-term land use development), especially for projects described by large sunk costs such as tramways and metro lines.

The group includes eight (8) metro projects, nine (9) tramway projects and two (2) bicycle rental services combined to the urban transit system. Excluding the bicycle services, public contributions are necessary to cover the investment costs. Actually, free bike sharing systems are subsidised but there are notable differences between these cases and metro or tramway cases on this point.

Metros

Metros form the backbone of urban transit in large urban areas. With the exception of the Athens Metro, all other projects concern extensions of existing metro systems. Only one project within the BENEFIT dataset may be considered as a pure PPP (Metro de Malaga), as Metro do Porto is a joint venture public entity. This is reasonable considering the high investment sizes - in this particular group of projects the average cost per km is 91 MEuro (in 2013 prices) - and the key scope of these projects, which is to reduce congestion and travel time within city centres, as well as improve the environment through emission reduction and support modal shift in urban areas. Therefore, metros may be considered a pure case with high welfare and low ability for returns on investment and, therefore not favoured for a PPP (or private co-financing) approach. However, this situation does not seem to be very different from tramway cases where PPP arrangements are usual (see below).

This is despite the strong position (level of exclusivity) metros enjoy in the urban transport network.

Tramway / Light Rail

The tramway has witnessed a strong comeback during the last decades. Trams and light rail have been re-introduced in an effort for urban re-development and reduction of emissions. Renovation activities have been registered in all cases (one exception) within this group of cases in the BENEFIT dataset, which includes ten (10) cases, of which six (6) have been delivered through PPP arrangements. Three PPP cases have received considerable public co-financing leading to a significant reduction in the overall financing need.

In this particular group of projects the average cost per km is 46.3 MEuros/ km delivered. This is approximately half the cost per km of the average metro in the BENEFIT sample, which may explain the considerable difference in the delivery mode employed in the two groups.

In addition, a typical structure of the tramway models evidenced in the BENEFIT dataset is the contractual inclusion of the bus service, leading the operator (private or public) in becoming the sole operator of the transit system in many cases (Lyon Tramway 4, Reims tramway; Caen-TRV; Metrolink LRT, Manchester; Tram-Train Kombilosung Karlsruhe). A slightly different development was adopted for the Athens Tramway, which initiated operation by a dedicated operator (Tram S.A.) and 6 years after inauguration was merged into a public operator responsible for all rail based transit (STASY S.A.). This also happens in the case of the tram operation in the RandstadRail project. The

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”cooperation” of the tramway projects with other urban transit ones is very evident in the cases of the Tram-Train Kombilosung and RandstadRail, where infrastructure is built to serve in combination the tram/light rail, rail and road (bus) service.

Another characteristic is the technical innovations and advancement of the rolling stock and the technical problems that may arise in this respect. Technical issues were the reason behind the numerous re-negotiations within the Caen-TVR project and the passenger disappointment of the Athens Tramway as the first five years of operation faced severe technical problems, thus reducing the expected quality of operation**.**

Finally, higher construction costs appear to be linked to more exclusive projects.

Bicycles

Free sharing bike systems have been supported as an addition to the urban transit network. There are many examples all over the world. The BENEFIT dataset includes two such cases. These services are frequently limited to inner cities (Lyon and Villeurbanne for Velo’V, city of Seville for Servici), when public transport networks are organised at larger scales. Revenues in both cases are supported through advertisements according to the fact that fares paid by users are very limited.

The two services are operated by the same French company, J-C Decaux. This company cannot be considered as a transport operator: its activities are mainly based on street furniture and advertising. These systems are mainly dependent on the advertising market and the operating costs. The two cases in the BENEFIT dataset have required either additional clauses in the initial contract or a renegotiation. The main variable for adjustment in the two cases was the user tariffs: traffic revenues shared differently between public and private partners in the case of Velo’V, increase of these fares in the case of Servici.

In conclusion this group demonstrates the following characteristics with respect to “revenue enhancing features”

Features	**Metro**	**Tram**	**Bicycle**	**Total No**
Combination with other commercial activities (greater than 10%)		1	2	3
Combination with other commercial activities (less than 10%)	1			1
Brownfield upgrade included in construction	1			1
Brownfield included in operation		4		4
Co-construction with infrastructure of other mode		2		2
Co-construction/ operation with other non-transport infrastructure				
Additional Features				
Revovation		8		8

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Table A.3.1.2: Metro Projects

Project Name	Delivery Type	Year Awarded	Contract duration years	Construction Budget MEuros (2013)	% public contribution	Characteristics of BM					
						Exclusivity	Length	Connections	Brown-field	Other Activities	Operated by
Metro de Malaga	PPP	2004	35 (ext. 38)	375.5	33	Somewhat Exclusive	11.2 km Line 1: 6.7km Line 2: 4.5km	Comple-mentary under-ground works		no	Concessionaire
Metro do Porto	Joint Venture (Public)	1998	50	1856.5	28.19	Rather Exclusive		Extension	Yes	-	Joint Venture (Public)
Athens Metro	Public	1992	n.a.	2 291	100	Rather Exclusive	51.1km	Extensions & connection with urban Rail (old) and new		Parking	1992 – 2011: Athens Metro (public) 2011- : STASY (Public resp. for all rail based transit in Athens)
Warsaw Metro II-nd line	Public	2009	n.a.	1064	100	Quite not exclusive	6.3km	Extension of existing system		-	SPVof Capital City of Warsaw
London Jubilee Line Extension	Public	1993	n.a.	3840	100	Rather Exclusive	16km	Connections to existing metro network		-	London Underground
Meteor	Public	1993	n.a.	1289.3	100	Quite not Exclusive	12km	Connections to existing metro network		-	RATP
Beneluxlijn	Public	1997	n.a.	996.32		Somewhat Exclusive	11.5km	Connections to existing metro network			RET

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Project Name	Delivery Type	Year Awarded	Contract duration years	Construction Budget MEuros (2013)	% public contribution	Characteristics of BM					
						Exclusivity	Length	Connections	Brown-field	Other Activities	Operated by
Fertagus train	PPP	1999	30 (renegotiated to 6; further renegotiated to 20)	27.36	**n.a.**	Quite not exclusive	54km	Rail/metro/ urban transport	**-**	**Revenue from commercial areas & parking, revenues from feeder bus system & advertising.**	Concessionaire

n.a.: not available

Table A.3.1.3: Tramway/ Light Rail projects

Project Name	Delivery Type	Year Awarded	Contract duration years	Construction Budget MEuros (2013)	% public contribution	Characteristics of BM					
						Exclusivity	Length	Connections	Brown-field	Other Activities	Operated by
MST - Metro Sul do Tejo	PPP	2002	30	465.5	88.3	Somewhat exclusive	22 km	With other transit network	No	No	Concessionaire
Reims Tramway	PPP	2006	34.5 (30 after constr.)	334.32	57.0	Competitive envir. / Exclusive	11.2 km	With other transit network – common operation with bus network	Bus network	Urban Renova-tion	Concessionaire
Caen-TVR	PPP	1994	30	294.95	42.4	Competitive envir. / Exclusive	14.8 km	With other transit network - common operation with bus network	Bus network	Urban Renova-tion	Concessionaire
Brabo 1	PPP	2009	35	124.50	n.a.	Competitive envir.	4 km	Existing network	Depot	Urban Renova-tion	Concessionaire

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Project Name	Delivery Type	Year Awarded	Contract duration years	Construction Budget MEuros (2013)	% public contribution	Characteristics of BM					
						Exclusivity	Length	Connections	Brown-field	Other Activities	Operated by
Metrolink LRT, Manchester	PPP	1992	Several phases Current: 17	5778.76	n.a.	Exclusive	10 km	Existing network 92 km - common operation with bus network	Existing network 92 km	Urban Renova-tion	Concessive concessionaire s building parts and operating older ones
Tram-Train Kombilosung Karlsruhe	Public	2010	n.a.	897.32	100	Exclusive	underground train/tram /road network 2.4km/ 1.6km	Existing network – under one operator		Urban Renova-tion	KASIG (public)
Tram T4 (Line 4 of Lyon Tramway)	Public	2006	n.a.	236.06	100	Rather Exclusive	9.5 km	Existing network	Existing network	Urban Renova-tion	Public Transport Authority (Sytral)
Athens Tramway	Public	2002	n.a.	331.9	100	Not exclusive	25 km	Stops with existing urban transit network		Urban Renova-tion	2002 – 2011 Tram S.A. (Public) 2011- : STASY (Public resp. for all rail based transit in Athens)
RandstadRail	Public	2003	n.a.	1375.26	n.a.	Somewhat exclusive	30km	Dedicated bus lane Metro running on same tracks	Tram line	Renovation	RET (metro & bus) HTM (tram – train)

n.a.: not available

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Table A.3.1.4: Bicycle Rental Service

Project Name	Delivery Type	Year Awarded / Construction Start	Construction Budget MEuros (2013)	% public contribution	Contract Duration	Characteristics of Business Model				
						Exclusivity	Connections	Brown Field	Other Development	Operated by
Velo V	PPP	2004	60.68	n.a.	13	Rather Exclusive	With Urban transit	No	Advertisements	Concessionaire
Servici	PPP	2000	95.5	n.a	20	Somewhat exclusive	With Urban transit	No	Advertisements	Concessionaire

n.a.: not available

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A.3.1.3 Ports

The strategic importance and profitability of ports lies in securing reliable supply chains. Fee structures are used to induce incentives for concessionaires to increase traffic (Cruz and Marques, 2012) and operational efficiency is key in retaining a competitive position. In addition, given the recent globalisation trends in the shipping market, what is becoming increasingly important for seaports, as well as seaport users, is not merely the efficiency of the seaport per se, but the efficiency of the supply chain in which the seaport and its users are involved (Panayides and Song, 2008). This is the case of commercial ports.

The BENEFIT case database includes ten (10) port cases. Five may be considered as typically commercial (Piraeus CT, Port of Sines Terminal XXI, Port of Leixoes, Barcelona Europe South Terminal and the Adriatic Gateway CT). These typically include investment in equipment and the concessionaire has a strong presence in the global market. Cosco, Hutchison Holdings, PSA are the concessionaires for the Piraeus CT, Barcelona Europe South Terminal and Sines Terminal XXI, respectively, while International Container Terminal Services Inc. (ICTSI) holds 51% of the Adriatic Gateway terminal.

In a similar approach, Terminal Muelle Costa at the port of Barcelona (a commercial port in support of Short Sea Shipping Policy) is operated by the Grimaldi group. The Valencia Cruise Terminal, which failed tender, was seeking a dedicated Cruise Terminal Operator following more or less the same pattern.

In all the above cases (PPPs), no public co-financing was offered, expect in cases where the government had particular development policies (Port of Sines and Valencia Cruise Terminal).

The Port of Agaete could be considered typical of a passenger service. The infrastructure was undertaken by the public sector, while the port is operated by a concessionaire.

Finally, the Larnaca Port and Marina re-development project is a particular case of a bundled project including an upgrade of the commercial port, the development of a cruise terminal, the upgrading of the marina and the real estate development of the area between the Port/marina of Larnaca and the Larnaca airport. The project sponsors include a multi-disciplinary group of investors in order to tackle the different (sub)projects involved. Since 2012 (project award) the project has not managed to reach financial close. The sponsors (Feb 2015) were considering initiating the project with own equity. The project does not fall under any typical category of projects. This fact, in combination with the downturn of the economy, are considered the reason that financial close has not been reached.

Interestingly, all projects considered concern PPP (either in the provision of infrastructure and/or service). It is also interesting to note that the contractual duration is considerably greater than average and does not correspond to the level of investment. A reason may be the fact that public delivered infrastructure for ports concerns projects in support of the port functionality, such as the OW-plan Oostende-Integrated Coastal and Maritime Plan for Oostende, which concerns breakwater development supporting both the port and the city. Notably, this project, while it concerns port infrastructure, it does not qualify as transport infrastructure in the same respect as other projects in the group or in the BENEFIT dataset.

In conclusion this group demonstrates the following characteristics with respect to “revenue enhancing features”:

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Features	No of Ports
Combination with other commercial activities (greater than 10%)	1
Combination with other commercial activities (less than 10%)	0
Brownfield upgrade included in construction	0
Brownfield included in operation	0
Co-construction with infrastructure of other mode	0
Co-construction/ operation with other non-transport infrastructure	1
Additional Features	
Equipment	10

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Table A.3.1.5: Port Infrastructure

Project Name	Delivery Type	Year Awarded	Contract duration years	Construction Budget MEuros (2013)	% public contribution	Characteristics of BM					
						Exclusivity	TL Investment MEuros (2013)	Conne-ctions	Brown-field	Other Activities	Operated by
Piraeus CT	PPP	2008	30 (option for additional 5)	151.63	0	Rather exclusive	620	Existing Port	1 Pier	No	Concessionaire
Port of Sines Terminal XXI	PPP	1999	30 (with option for additional 30)	216.58	30.8	Rather exclusive	338.41	Existing Port	No	Yes	Concessionaire
Port of Leixoes	PPP	1999	25	358.03		Competitive Env.	358.03	Existing Port	Yes	Yes	Concessionaire
Barcelona Europe South Terminal	PPP	2006	30	706.38	n.a.	Somewhat exclusive	920.43	Existing Port	No	No	Concessionaire
Adriatic Gateway Container Terminal	PPP	2009	30	135.48	n.a.	Rather Exclusive	183.97	Existing Port	Yes	No	Concessionaire
Terminal Muelle Costa at the port of Barcelona	PPP	2013	15 (with option for additional 7.5)	20.00	n.a.	Somewhat exclusive	22.0	Existing Port	No	No	Concessionaire
Valencia Cruise Terminal	PPP	2013	25	59.60	55.7	Competitive Env.	59.60	Existing Port	No	No	Failed tender
Port of Agaete	Public (construction) Private operation	1982	n.a.	11.09	100	Rather exclusive	11.09	Existing Port	Yes	Urban re-novation	FRED OLSEN Concessionaire
Larnaka Port & Marina re-dev/ment	PPP	2012	35 (port & marina) 99 (real estate)	689.16	n.a.	Quite not exclusive	787.6	Existing Port	Yes	Urban redeve-lopment (real estate)	Project has not reached financial close (Feb 2015)

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Project Name	Delivery Type	Year Awarded	Contract duration years	Construction Budget MEuros (2013)	% public contribution	Characteristics of BM					
						Exclusivity	TL Investment MEuros (2013)	Conne-ctions	Brown-field	Other Activities	Operated by
OW-plan Oostende-Integrated Coastal and Maritime Plan for Oostende	Public	2010	n.a.	69,90	100	Not applicable	103,03	Existing Port	Yes	City prote-ction	Port Authority

n.a.: not available

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A.3.1.4 Rail

Rail projects are characterised by great technical complexity and interfaces. Railways differ from completely disintegrated transport systems (aviation, roads, ports) in a sense that the degree of integration is higher to some extent. In practice, this means that operations and infrastructure are delivered as one, albeit current EU practice following multiple rail directives. For the most part, the higher degree of integration is a result of physical constraints of train movements. Another reason that adds to the complexity, concerning rail infrastructure in particular, is the marginal track pricing principle that is applied as a rule across the EU, although some flexibility in these pricing schemes is allowed. This makes the payback mechanisms of rail infrastructure PPPs more challenging. In the operations side, the situation is much simpler: as long as the operator is able to collect cash flow from customers it serves, the business case stands quite straightforward.

Dehornoy (2012), in a review of 27 rail PPP projects implemented since 1980, stressed that a rail PPP does not create additional value to the customer, but it may reduce the cost of a project by optimizing its design and management and reducing the amount of debt that is borrowed by public authorities. He also found that a shift may be taking place towards availability based PPPs from traffic based PPPs. The scope of his sample is balanced: roughly equal amount of pure infrastructure projects and integrated (infrastructure & operations) projects. An analysis carried out by Roland Berger (2013) indicated that the rail industry is considering municipal projects to have greater potential for PPPs than national. Notably, the seven cases grouped under rail in the BENEFIT database are, with two exceptions, delivered by the public sector. As in the case of metros, these are intensive investments (average 32.3 MEuros/km for the particular dataset – the Combiplan Nijverdal not included). However, at least in this sample, they are less intensive than the tramways/light rail (46.3 MEuro/km), which seem to bear some attractiveness for private investors.

Two cases concern rail links to airports. According to Dehornoy (2012), these are cases that could also be considered for PPP as they serve very dedicated traffic and have uniqueness in the transport system. The exclusiveness of airport (and port) links is a very typical example, where rail PPPs are considered to have a higher probability of success. Exclusive rights for the track also reduce the potential problems encountered with one infrastructure path on which multiple operators must be able to exercise their services.

Three cases concern high-speed rail links: TGV in France, HSL Zuid (HogesnelheidslijnZuid) in the Netherlands and NBS Köln-Rhein/Main in Germany.

Finally, Liefkenshoekspoorverbinding-Liefkenshoek Rail Link is a very interesting case of development dedicated to freight transport in support and in the service of the Port of Antwerp. Today, it is also the largest PPP in Belgium (690 MEuros). In many ways this project may be seen as having a model similar to the one prevailing in ports.

In conclusion this group demonstrates the following characteristics with respect to “revenue enhancing features”:

Features	**No of Rail projects**
Combination with other commercial activities (greater than 10%)	0
Combination with other commercial activities (less than 10%)	0
Brownfield upgrade included in construction	1
Brownfield included in operation	0
Co-construction with infrastructure of other mode	1
Co-construction/ operation with other non-transport infrastructure	0
Additional Features	

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Table A.3.1.6: Rail

Project Name	Delivery Type	Year Awarded	Contract duration years	Construction Budget MEuros (2013)	% public contri-bution	Characteristics of BM						
						Exclusivity	Length	Connections	Brown-field Length	Brown-field Connected (Y/N)	Other Activities	Operated by
Liefkenshoekspoorverbinding-Liefkenshoek Rail Link	PPP	2008	43	690	n.a.	Somewhat exclusive	16.2km	Port of Antwerp	-	-	Freight only	Con-cessioner
MXP T2-Railink-up	Public	2014	n.a.	115	100	Exclusive	3.8km	With other network	n.a.	Yes	-	
Gardermobanen (Airport Exprestrain)	Public	1994	n.a.	1044.75	100	Rather Exclusive	64km	With airport	-	-	-	Airport Expresstrain (trains) &Jernbaneverket (tracks, rails & stations) – Public S.A.
Combiplan Nijverdal	Public	2010	n.a.	282.00	100	Rather Exclusive		With other network	6km road 6km rail			n.a
TGV Mediterranean	Public	1995	n.a.	5312.77	100	Quite not exclusive	216 km + 28 km	With other network	-	-	-	SNCF
NBS Köln-Rhein/Main	Public	1995	n.a.	6488.22	100	Rather Exclusive	177km	With other network	-	-	-	DB
HSL-Zuid	Public	2000	n.a.	7290.73	100	Quite not exclusive	125km	With other network	-	-	-	

n.a.: not available

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A.3.1.5 Roads

The BENEFIT dataset of cases includes 30 cases concerning the delivery of road infrastructure. Twenty-four (24) cases have been delivered through a PPP arrangement and the rest by the public sector through traditional procurement. The heavy weighting of this sample on the PPP arrangement is due to two basic reasons:

1. Road PPPs are the prominent application of the PPP model of project delivery.
2. Traditional delivery of road projects involves multiple contracts over large periods of time. This is due to the fact that road development (as it may be procured in smaller sections) is conditioned to accommodate for the funding and public debt potential over time and the various levels of public authority involved. Hence, data collection for such cases becomes extremely difficult and cumbersome.

As in other cases, this is a convenience sample collected by the 14 partners of the BENEFIT consortium and their collaborators and, in this context, it justifies as random.

Table A.3.1.7 below provides overall descriptive statistics of the sample of projects.

Table A.3.1.7: Description of Road case study sample

	Private (co) financing	Public "Financing"	Total		Private (co) financing	Public "Financing"	Total
Location				**Development Type**			
Urban	5	1	6	Only Greenfield	10	4	14
Intercity	3	2	5	Only Brownfield	4	1	5
National	10	2	12	Mixed	10	1	11
Regional	6	1	7				
Total Length				**Greenfield Length**			
Below 50km	10	2	12	Below 50km	9	2	11
51-100km	4	2	6	51-100km	3	1	4
101-200km	4	1	5	101-200km	6	1	7
201-300km	3		3	201-300km	2		2
Over 301 km	3	1	4	Over 301 km		1	1

The sample is reviewed in terms of basic infrastructure characteristics: length, cost/km constructed, level of exclusivity within the transport network.

Then, in order to further review the Business Models evidenced in the delivery of road infrastructure, projects were categorised according to their location and the inclusion of a brownfield section.

Key Characteristics

Length

Figure A.3.1.1 provides distribution of projects by length and delivery mode.

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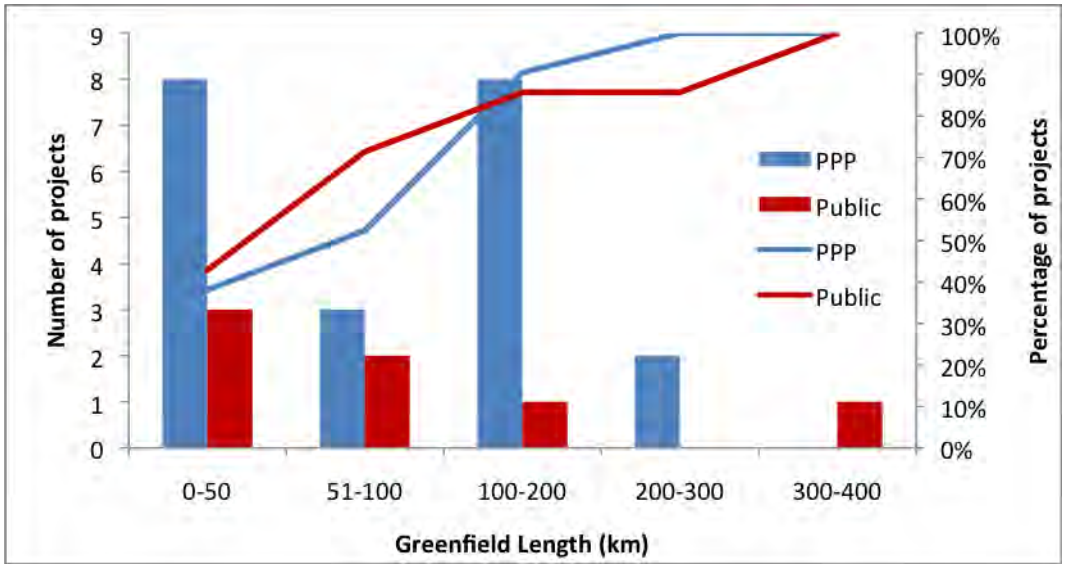

Figure A.3.1.1.: Distribution of Project by Greenfield Length and delivery mode

It is interesting to note that about one third of all projects concerns the construction of a road length of less than 50km. The concentration of PPPs in this group, as well as in the group between 100 and 200 km is larger than the average.

<u>Cost</u>
The distribution of cost per km for Public and PPP projects is presented in Figure A.3.1.2.

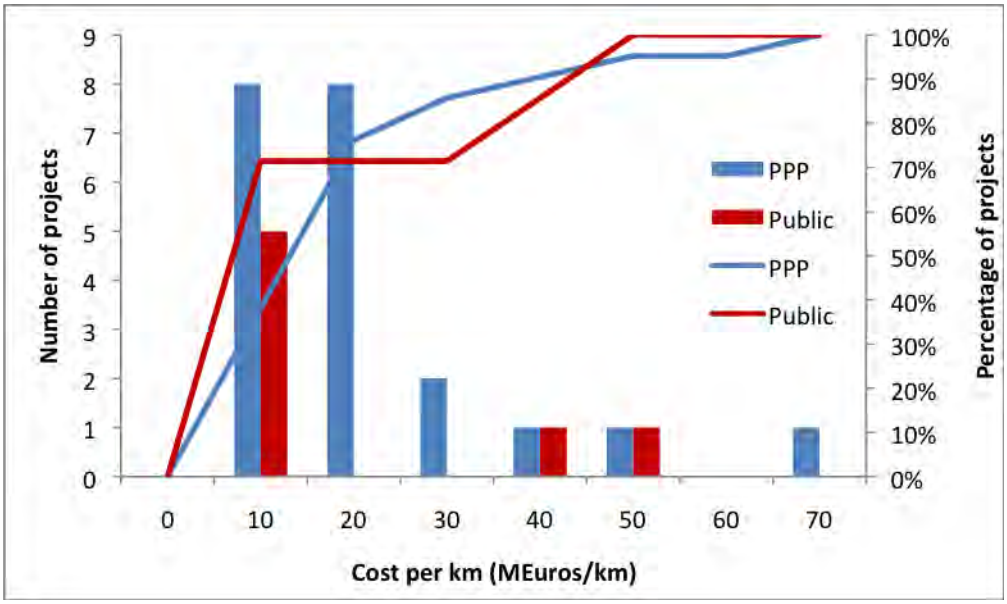

Figure A.3.1.2. Distribution of cost per km by delivery mode

Most of the projects (21 out of 31) have cost per km below 20 MEuros. The cumulative distribution of cost per km for borth PPP and public projects is quite similar. Two of the most expensive projects belong to PPP Greenfield Urban roads in Spain (Radial 2 Toll motorway with cost of 69.3 MEuros/km and Eje Aeropuerto (M-12) Toll Motorway with cost of 47.7 MEuros/km).

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Level of project exclusivity
Figure A.3.1.3 presents the distribution by project exclusivity and delivery mode.

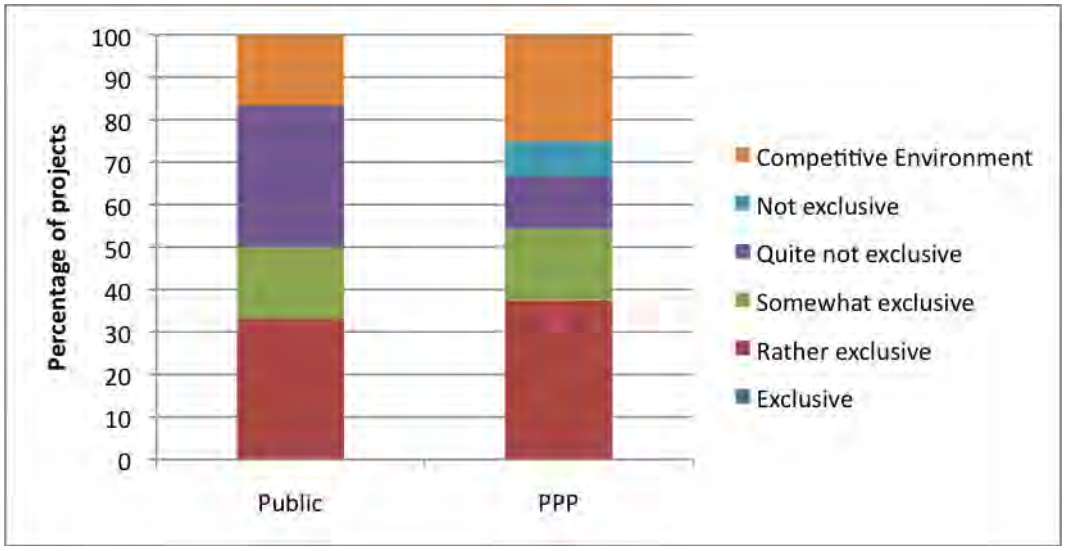

Figure A.3.1.3. Distribution of project exclusivity by delivery mode

Approximately half of the projects are "rather exclusive" or "somewhat exclusive" in both cases of delivery mode. Evidently no project is characterised as exclusive while, on the contrary, about 20-25% are situated in a competitive environment.

Business Model Characteristics

Analysis per Location

Urban roads

Six cases in the BENEFIT dataset concern urban roads of which one was delivered directly by the public sector. They are primarily characterised by a high cost of construction. Their objective is to by-pass the city centre and reduce respective traffic. Four of the projects are greenfield, and two brownfield. The length ranges from 9.4 km to 232 km and cost per km ranges from 1.85 MEuros/km to 69.3 MEuros/km. One project incorporated service stations, and two projects incorporated other works (anti flooding and environmental works).

Traffic is dependent on the city activity and tolls may be avoided by users (if applied), as there are usually alternative untolled routes. Value of time plays an important role.

Intercity roads/motorways

Five cases in the BENEFIT dataset concern intercity motorways of which one was delivered directly by the public sector. Intercity in many cases also forms part of a city by–pass route, hence bearing, for some sections, the characteristics of urban roads.

The project length ranges between 51.3 and 323 km, and cost per km ranges between 6.82 and 16.07 MEuros. One project incorporated service stations, and two projects incorporated other works (environmental works and access roads).

Traffic is dependent on the economic activity generated between the interconnected cities and whether the intercity road also serves national and international traffic.

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National/international
Twelve cases in the BENEFIT dataset concern national/international motorways of which two were delivered directly by the public sector. The project length ranges between 8 and 205 km. The majority in this group concern longer road projects (nine are over 100km). The longer roads include service and other real estate activities as well as provisions for environmental protection. Both activities are to be expected given the travel time (equivalent to length) and the fact that the road transverses rural areas. The cost per km ranged between 1.76 and 16.47 MEuros/km.

Traffic will depend on national and regional macroeconomic figures depending on the location of the country and the transit activity. An example is the A2 motorway in Poland.

Regional motorways
Seven cases in the BENEFIT dataset concern regional motorways of which one was delivered directly by the public sector. All are relatively shorter road projects. The project length ranges from 5.2 to 118 km. The cost per km ranged between 0.6 to 39.8 MEuros/km. In many cases these roads serve and support regional activities (example tourism). In this aspect E65 Central Greece and the Moreas Motorway could also be included in this category. In all cases no additional activities and sources of revenue are reported.

Analysis with respect to Brownfield Section

Apart from service stations along longer routes and renovation activities, which, however, contribute a small share of revenues, 14 cases involve a greenfield section, eight cases concern the maintenance/ upgrade of existing roads, and the remaining nine cases include mix of greenfield and brownfield sections. In nine of these cases, the brownfield road link connected to the project is tolled. Figure A.3.1.4 provides the distribution of projects by delivery mode.

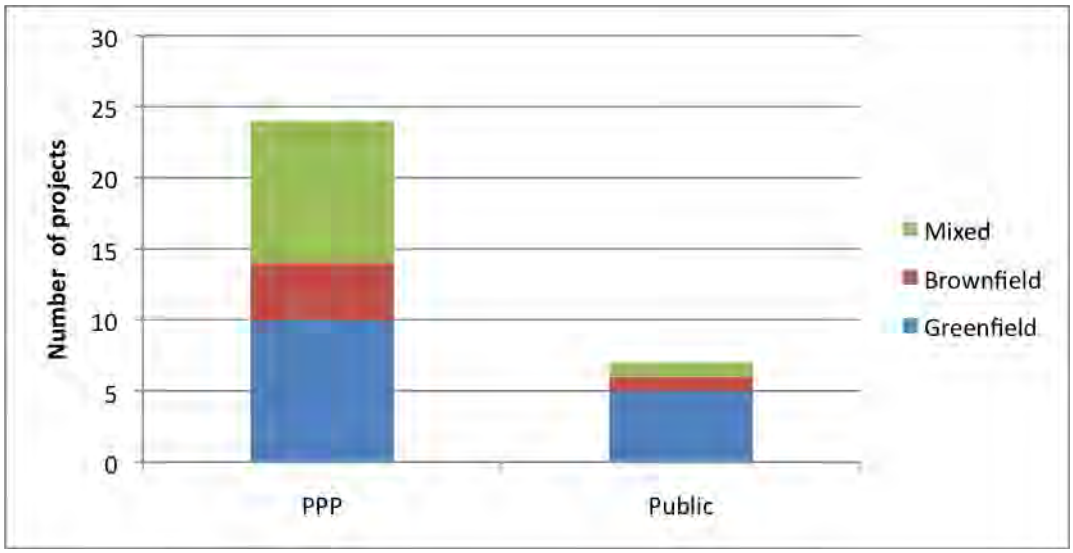

Figure A.3.1.4. Type of project by delivery mode

It is also worth noting that in two cases, the tolled brownfield is not directly connected to the new road. In one case, the contract was cancelled due to social opposition, and in the other a social movement was created against (concessionaire) tolls altogether.

Yet in other cases, where the brownfield is a continuation of the new construction, the generated tolls from the brownfield have been used to cross-fund the new project.

Finally, while the sample is rather small to provide conclusive evidence, it seems that mixed (geenfield and brownfield) projects represent a considerable share of PPP projects.

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In conclusion this group demonstrates the following characteristics with respect to “revenue enhancing features”:

Features	Urban	Intercity	National/ international	Regional	Total No
Combination with other commercial activities (greater than 10%)					
Combination with other commercial activities (less than 10%)	1	1	6	2	10
Brownfield upgrade included in construction	2	3	8	3	16
Brownfield included in operation			8		8
Co-construction with infrastructure of other mode					
Co-construction/ operation with other non-transport infrastructure					
Additional Features					
Environmental Works	1	2	2		5
Renovation	1				1
Anti-flooding	1				1

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Table A.3.1.8: Road Projects

Project Name	Delivery Type	Year Awarded	Contract duration years	Construction Budget MEuros (2013)	% public contri-bution	Characteristics of BM						
						Exclusivity	Length	Conne-ctions	Brown-field Length	Brown-field Connected (Y/N)	Other Activities	Operated by
Urban												
Attiki Odos	PPP	1996	24.58	1795.24	31.2	Rather exclusive	67 km	With other network	0	n.a.	Service stations Anti-flooding works (900MEuros 2013)	Concessionaire
Radial 2 Toll motorway	PPP	2001	24 (ext. to 39)	651.59	n.a.	Competitive Environment	80.7km	With other network			-	Concessionaire
Eje Aeropuerto (M-12) Toll Motorway	PPP	2002	25	448.10	n.a.	Competitive Environment	9.4km + Free Access ext. 45km	With other network			Enviro-mental works	Concessionaire
Via-Invest Zaventem	PPP	2007	30	60.52	n.a.	Competitive Environment			upgrade	Yes	Renovation	Concessionaire
Belgrade By-pass Project, Section A: Batajnica-Dobanovci	Public	2010	n.a.	127.76	100	Somewhat exclusive	69km (in sections 9.7km, 37.3km, 22 km)				-	PE "Roads of Serbia"
M-25 Motorway LONDON ORBITAL	PPP	2009	n.a.	1,100.85	n.a.	Somewhat exclusive			232km Upgrade	No	-	Concessionaire
Intercity												
E4 Helsinki-Lahti	PPP	2012	15.33	769.88	n.a.	Rather exclusive	20.5km	With other network	69km	Yes	-	Concessionaire

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Project Name	Delivery Type	Year Awarded	Contract duration years	Construction Budget MEuros (2013)	% public contri-bution	Characteristics of BM						
						Exclusivity	Length	Conne-ctions	Brown-field Length	Brown-field Connected (Y/N)	Other Activities	Operated by
E18 Muurla-Lohja	PPP	2005	21	824.39	n.a.	Somewhat exclusive	51.3km	With other network			-	Concessionaire
A5 Maribor - Pince Motorway	Public	2005	n.a.	748.93	100	Competitive Environment		With other network	85.2km		Enviro-mental works and secondary access	DARS Motorway Company
Bundesauto-bahn 20	Public	1992	n.a.	2,202.54	100	Rather exclusive	323km	With other network			Improve access to ports, the coast and Mecklenburg-Western Pommerania	Federal Government / States
BreBeMi	PPP	2003	19.5	944.17	n.a.	Competitive Environment	62 km	With other network	17.5 km and 17.1 km	Yes	Service stations	Concessionaire
National												
Motorway E-75, Section Horgos Novi Sad (second phase)	Public	2009	n.a.	189.71	100	Rather exclusive	108km	With other network			Land use (Petrol stations, Motels and Hotels)	PE “Roads of Serbia”
Motorway E-75, Section Donji Neradovac – Srpska kuca	Public	2011	n.a.	26.88	100	Quite not exclusive	7.96km	With other network	8.2km	Yes	-	PE “Roads of Serbia”
E39 Orkdalsvegen Public Road	PPP	2003	25 (+ 3 construction)	244.04	n.a.	Somewhat exclusive	27km	With other network	10km	Yes	-	Concessionaire

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Project Name	Delivery Type	Year Awarded	Contract duration years	Construction Budget MEuros (2013)	% public contri-bution	Characteristics of BM						
						Exclusivity	Length	Conne-ctions	Brown-field Length	Brown-field Connected (Y/N)	Other Activities	Operated by
E18 Grimstad – Kristiansand	PPP	2005	25 (may be ext. to 30)	493.62	n.a.	Rather exclusive	38.3km	With other network			-	Concessionaire
Istrian Y	PPP	1997	32 (may be ext. to 40)	2,322.06	45.30	Rather exclusive		With other network	141km upgrade (tolled)	Yes	Enviro-mental works	Concessionaire
A2 Motorway Poland	PPP	2009	30	1,409.44	n.a.	Somewhat exclusive	105.9km	With 2nd PPP			Enviro-mental works	Concessionaire overlap with 2nd PPP
Horgos-Pozega	PPP	2007	25	1507.48	n.a.	Quite not exclusive	148km	With other network	107km upgrade (tolled) 68km operation (tolled)	No	Service stations	Project cancelled due to social opposition
A23 - Beira Interior	PPP	1999	n.a.	624.00	n.a.	Quite not exclusive	178km	With other network				Concessionaire
Elefsina Korinthos Patra Pyrgos Tsakona Motorway	PPP	2007	30 years including design/ construction period	967.00	22.7	Rather exclusive	102km + 184km After Re-neg. 2014: 102 km	With other network	80km (tolled)	Yes	Service Station	Concessionaire
Central Greece (E65) Motorway	PPP	2007	30	1,746.94	30.65	Rather exclusive	174km	With other network	57km (tolled)	Yes	Service stations	Concessionaire
Moreas Motorway	PPP	2007	32	956.10	30.00	Rather exclusive	205km	With other network	82.6km (tolled)	Yes	Service Station	Concessionaire

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Project Name	Delivery Type	Year Awarded	Contract duration years	Construction Budget MEuros (2013)	% public contri-bution	Characteristics of BM						
						Exclusivity	Length	Conne-ctions	Brown-field Length	Brown-field Connected (Y/N)	Other Activities	Operated by
Ionia Odos	PPP	2007	30	1299.29	27.70	Rather exclusive	196km	With other network	183km (tolled)	No	Service stations	Concessionaire
Regional												
BNRR (M6 TOLL)	PPP	1992	53	1,711.97	2.00	Competitive Environment	43km	With other network	-	No	-	Con-cessionair
M80 Haggs	PPP	2008	30	572.17	n.a.	Rather exclusive	20km	With other network	10km	Yes	-	Concessionaire
A19 Dishforth to Tyne Tunnel	PPP	1996	30	70.42	n.a.	Competitive Environment	-	With other network	118km	-	-	Concessionaire
M-45	PPP	1999	25	465.06	n.a.	Not exclusive	37.1km	With other network			-	Concessionaire
A22 – Algarve	PPP	2000	30	253.00	n.a.	Quite not exclusive	35.6km	With other network	91.5km	Yes	-	Concessionaire
C-16 Terrassa-Manresa Toll Motorway	PPP	1987	50	233.10	12.9	Not exclusive	48.3km	With other network			-	Concessionaire
Koper - Izola Expressway	Public	2010	n.a.	165.20	100	Quite not exclusive	5.2km	With other network			-	DARS Motorway Company

n.a.: not available

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A.3.1.6 Bridge /Tunnel projects

Both bridges and tunnels concern unique structures in the transport network and, as such, they are positioned as natural monopolies.

The BENEFIT dataset includes nine (9) projects in this group. Five (5) are delivered through a PPP arrangement, three (3) through traditional public delivery and one is a joint venture including two countries as shareholders. However, for the two projects for which information is available, Rio-Antirio Bridge and Lusoponte, there is considerable public contribution (50.8% and 49.5%, respectively).

In all PPP cases, the natural exclusivity of the infrastructure is enhanced. An extreme example is the Lusoponte – Vasco de Gamma Bridge, which also includes as a brownfield the other Tagos river crossing. In this aspect, within the BENEFIT database, this project is very similar to the Larnaca and Paphos Airports project.

Two cases in this group serve two transport modes (road and rail) and most projects include a section of road or rail infrastructure leading to the bridge or tunnel (access infrastructure).

Finally, almost all tunnel projects faced construction problems.

In conclusion, the characteristic of the Business Model of this group is the potential to serve road and rail in combination and the enhancement of the already high exclusivity of the infrastructure. With respect to “revenue enhancing features”, the group presents the following:

Features	**No of Bridges/ Tunnels**
Combination with other commercial activities (greater than 10%)	
Combination with other commercial activities (less than 10%)	1
Brownfield upgrade included in construction	
Brownfield included in operation	1
Co-construction with infrastructure of other mode	3
Co-construction/ operation with other non-transport infrastructure	
Additional Features	
Urban development/ Renovation	1

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A.3.1.7 Terminals

The BENEFIT database includes only three cases describing terminals. These are very different projects both in scope and infrastructure delivery method.

The Hague Central Station is delivered by public financing and concerns a building and development project (shops, offices and residential housing) in support of city re-development.

The Pilsen Depot, delivered through PPP, concerns the tram depot of the city of Pilsen and could also be considered under the tramway projects, as the respective category includes projects involving the delivery of tram infrastructure (rail tracks), rolling stock and depots.

Finally, the Quadrante Europa Terminal Gate is delivered through a private shareholder's company constructed to operate as a freight terminal. In this aspect, the terminal may be considered as similar to the port projects described above.

Following the same approach, the group presents the following features:

Features	**No of Terminals**
Combination with other commercial activities (greater than 10%)	1
Combination with other commercial activities (less than 10%)	
Brownfield upgrade included in construction	1
Brownfield included in operation	
Co-construction with infrastructure of other mode	
Co-construction/ operation with other non-transport infrastructure	
Additional Features	
Urban development/ Renovation	1

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Table A.3.1.9: Bridge / Tunnel projects

Project Name	Delivery Type	Year Awarded	Contract duration	Construction Budget MEuros (2013)	% public contri-bution	Characteristics of BM					
						Exclusivity	Length	Connections	Brown-field	Other Activities	Operated by
Rio-Antirio Bridge	PPP	1996	42	1141	50.8	Rather Exclusive	2252m	Road		no	Concessionaire
The Oresund Link	Public Joint venture	1995	99	2323	19	Rather Exclusive	7845m	Road & Rail		-	Public Joint Venture Company
Herrentunnel Lübeck	PPP	2001	30	139	n.a.	Competitive Environment	780m	-		-	Concessionaire
Lusoponte – Vasco de Gamma Bridge	PPP	2005		1042	49.5	Exclusive (includes both bridges over the Tagos)	826 m	Road 12km	2 280m (old Bridge)	Service Stations	Concessionaire
Coen Tunnel	PPP	2009	30	1200	n.a	Rather Exclusive	750m	Road 14km		-	Concessionaire
Berlin Tiergarten Tunnel	Public	1995	n.a.	7689	100	Rather exclusive	2410m	Road and rail tunnel – City development		City Develop-ment	
Millau Viaduct	PPP	2001	78	679.61	n.a.	Somewhat exclusive	2460 m	Existing	No	-	Concessionaire
Sodra Lanken	Public	1996	n.a.	763.19		Rather Exclusive	4700m	Road (1.3km)	No	-	Swedish Road Administration

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Project Name	Delivery Type	Year Awarded	Contract duration	Construction Budget MEuros (2013)	% public contri-bution	Characteristics of BM					
						Exclusivity	Length	Connections	Brown-field	Other Activities	Operated by
Blanca Tunnel	Public	2006	n.a.	(766)	100%	Somewhat Exclusive`	6400m	Existing	No	-	Technickáspráv akomunikací (holding company of city of Prague)

n.a.: not available

Table A.3.1.10: Terminals

Project Name	Delivery Type	Year Awarded	Contract duration	Construction Budget MEuros (2013)	% public contri-bution	Characteristics of BM					
						Exclusivity	Connections	TL Invest-ments	Brown-field	Other Activities	Operated by
The Hague New Central Train Station	Public	2011	n.a.	112.74	100%	Rather Exclusive	Rail	177	100%	Development and integration of the city's institutional places/ shops/ offices/ residential housing	ProRail
Central Public Transport depot of the city of Pilsen	PPP	2012	29	58.7	3%	Exclusive	Tram	440	100%	Equipment Total investment	Concessionaire
Quadrante Europa Terminal Gate	PPP	2005	99	33.43	n.a.	Quite not Exclusive	Transport network	33.43	0%	-	Shareholder group

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A.3.2 Airports

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Table A3.2.1 – Coding results per airport

		PPP		Public Finance			
Dimension	**Coding**	**Athens Airport**	**Lanarca Paphos Airports**	**Berlim Branden-burg**	**Modlin**	**Sá Carneiro**	**Total**
Cost	Cost overrun reason #1: higher award value					1	1
	authorization of additional funding			1			1
	cost overrun			1		1	2
	Cost overrun reason #1: construction failures			1			1
	Investment is in line with the expected budget	1	1				2
	Investments have been restricted by budget limitations with partial implementation of the project				1		1
	subsidies increase to cover budget shortfall			1			1
	uncertainty over additional funding sources			1			1
Economic Goals	Economic value creation: high	1					1
	Expand north Portugal transport capacity, especially for EURO 2004					1	1
	Expand Poland transport capacity, especially for EURO 2012				1		1
	Land value creation: commercial			1			1
	Promote better access to tourism in Greece	1					1
	Reduce air transport inefficiencies in Berlin Area			1			1
	Promote better access to tourism in Cyprus		1				1
	Promote Cyprus as an international hub between Europe & Middle East		1				1
Environmental	Airport location is in conflict with an environmentally sensitive area				1		1
	Construction delays and failures			1			1
	Environmental claims regarding construction impact on the local fauna				1		1
	Environmental performance: high (Effective carbon footprint reduction measures)	1					1
Environmental (cont´d)	Environmental performance: low			1			1
	Environmental claims regarding construction noise			1			1
	Environmental accreditation	1					1

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		PPP		Public Finance			
Dimension	**Coding**	**Athens Airport**	**Lanarca Paphos Airports**	**Berlim Branden-burg**	**Modlin**	**Sá Carneiro**	**Total**
	Environmental sensibilization of other members: high	1					1
	Institutional claims regarding the environmental impact study for the work					1	1
	Introduction of better practices	1					1
	Negative effects on environmental goals			1	1	1	3
	Positive effects on environmental goals	1	1				2
	Reduction of GHG emissions	1					1
	Mitigation of noises and pollutions		1				1
	Introduction of environmental friendly design practices		1				1
Institutional	Business Developer component supported by a revenue support framework	1					1
	Combination of direct awards and tendering					1	1
	Commitment for project implementation: high			1			1
	Financial performance: high	1					1
	initial tendering - construction initiation period: 7 years			1			1
	Institutional framework oriented to service provider			1	1	1	3
	Judiciary rejection of agreement			1			1
	Multiple privatization efforts			1			1
	Number of contracts: 20				1		1
	Number of contracts: 65					1	1
	PPP greenfield development	1					1
	Several separated construction contracts for public operation			1	1	1	3
Institutional (cont´d)	Single BOT PPP contract	1	1				2
	Tendering process				1		1
	Tendering process with two bidders			1			1
Renegotiations	Bankruptcy of the construction company			1			1
	Reduction of carriers due technical and safety reasons that led to temporary closure of the infrastructure				1		1
	Renegotiation at the tendering phase	1					1

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		PPP		Public Finance			
Dimension	**Coding**	**Athens Airport**	**Lanarca Paphos Airports**	**Berlim Branden-burg**	**Modlin**	**Sá Carneiro**	**Total**
	Renegotiation in the construction phase			1			1
	Renegotiation in the operation phase					1	1
	Renegotiation reason #1: political (Change of gov´t)	1					1
	Sá Carneiro airport privatization					1	1
	Takeover in the form of privatization.					1	1
	Renegotiation at the award phase		1				1
	Negotiation failure between the contractor and the best bidder		1				1
Time	Delay at the construction phase			1	1	1	3
	Delay at the operation phase			1	1	1	3
	Delay at the planning phase			1			1
	Delay reason #1: construction failures			1	1		2
	Delay reason #2: constructor bankruptcy			1			1
	Delay reason #3: regulatory incompliance (EIA rejected)					1	1
	Delay reason #4: EU legislation changes			1			1
	Delay reason #5: lack of capacity (mismanagement)			1			1
	Delays at the tendering phase	1					1
	Project execution is in line with the expected timetable		1				1
Traffic	Below the forecasts		1		1		2
	higher than expected and growing					1	1
	In line with the forecasts	1					1
	The project is not operating yet			1			1
	Traffic reason #1: overestimation				1		1
	Traffic reason #2: lack of intermodal connections				1		1
	Traffic reason #3: Macroeconomic Conditions		1				1
	Traffic reason #4: Expensive usage rates		1				1
Transport Goals	Infra flexibility: high (modular design)			1			1
	Intermodal connectivity: high	1					1
	Intermodal connectivity: low (not realized)				1		1
	Intermodal connectivity: n/a			1			1

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		PPP		Public Finance			
Dimension	**Coding**	**Athens Airport**	**Lanarca Paphos Airports**	**Berlim Branden-burg**	**Modlin**	**Sá Carneiro**	**Total**
	International transport hub	1					1
	Low cost international transport				1		1
	Quality of infra: high (new terminal)			1			1
	Quality of infra: high (upgrades, new infra)					1	1
	Quality of infra: upgrade of existing and new infra				1		1
	Quality of infrastructure: high	1	1				2
	Regular Passenger Cargo Transport	1	1	1		1	4
	Safety	1	1				2
	Technology: high	1					1
	Type of traffic: low cost and charter				1		1
Total		***23***	***16***	***32***	***20***	***18***	***109***

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Table A.3.2 2 – BENEFIT database

Project Title	Athens International Airport				Berlin Brandenburg Airport (BER)		Larnaca and Paphos International Airports				Modlin Regional Airport			
Country	Greece				Germany		Cyprus				Poland			
MATCHING FRAMEWORK INPUT	**Snapshot 1- AWARD (1995)**	**Snapshot 2 - inauguration (2001)**	**Snapshot 3- (2009)**	**Snapshot 4-- reporting period (2014)**	**Snapshot 1: Award (2004)**	**Snapshot 2: Reporting time (2015)**	**Snapshot 1- AWARD (2005)**	**Snapshot 2- opening of Paphos (2008)**	**Snapshot 3- opening of Larnaka (2009)**	**Snapshot 4- reporting (2014)**	**Snapshot 1 - award time 2010**	**Snapshot 2 - opening time 2012**	**Snapshot 3 - reopening time - 2013**	**Snapshot 4 - reporting 2015**
Principle Mode	Airport	Airport	Airport	Airport	airport	airport	Airport	Airport	Airport	Airport	Airport	Airport	Airport	Airport
Use	Mix	Mix	Mix	Mix	mix	mix	Mix	Mix	Mix	Mix	mix	Passenger	Passenger	Passenger
Investment size (sample normalised)	High	High	High	High	High	High	Medium	Medium	Medium	Medium	Low	Low	Low	Low
Investment size (mode normalised)	High	High	High	High	High	High	Medium	Medium	Medium	Medium	Low	Low	Low	Low
Delivery Mode	PPP	PPP	PPP	PPP	public	public	PPP	PPP	PPP	PPP	Public	Public	Public	Public
Transport Network Configuration	Node	Node	Node	Node	node	node	Node	Node	Node	Node	Node	Node	Node	Node
MATCHING FRAMEWORK: TYPOLOGY / DIMENSION/ INDICATORS	**Snapshot 1**	**Snapshot 2**	**Snapshot 3**	**Snapshot 4**	**Snapshot 1**	**Snapshot 2**	**Snapshot 1**	**Snapshot 2**	**Snapshot 3**	**Snapshot 4**	**Snapshot 1**	**Snapshot 2**	**Snapshot 3**	**Snapshot 4**
Institutional indicator	0.59	0.60	0.59	0.57	0.78	0.80	0.70	0.75	0.73	0.71	0.64	0.65	0.66	0.66
Financial Economic	0.543	0.543	0.500	0.358	0.628	0.717	0.555	0.700	0.683	0.425	0.617	0.600	0.617	0.617
Overall Reliability/Availability Indicator IRA	100%	100%	100%	100%	1.00	1.00	100%	100%	100%	100%	100%	56%	25%	75%
Governance Overall Composite Indicator	0.813	0.813	0.813	0.813	0.625	0.250	0.875	0.875	0.875	0.875	0.438	0.438	0.438	0.438
Cost Saving	0.533	0.533	0.500	0.500	0.272	-0.144	0.821	0.821	0.821	0.828	-0.222	-0.222	-0.333	0.167

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Project Title	Athens International Airport				Berlin Brandenburg Airport (BER)		Larnaca and Paphos International Airports				Modlin Regional Airport			
Revenue support	0.252	0.252	0.252	0.250	0.121	0.126	0.205	0.205	0.205	0.205	0.039	0.022	0.000	0.007
Remuneration Scheme	0.295	0.295	0.295	0.297	0.667	0.667	0.333	0.333	0.333	0.333	0.500	0.667	0.000	0.025
Revenue Scheme	0.771	0.815	0.815	0.815	0.687	0.690	0.800	0.800	0.800	0.800	0.600	0.667	0.533	0.540
Financing Normalised Indicator	0.368	0.368	0.368	0.368	0.125	0.125	0.773	0.773	0.773	0.000	0.165	0.165	0.165	0.165
OUTCOMES	**Snapshot 1**	**Snapshot 2**	**Snapshot 3**	**Snapshot 4**	**Snapshot 1**	**Snapshot 2**	**Snapshot 1**	**Snapshot 2**	**Snapshot 3**	**Snapshot 4**	**Snapshot 1**	**Snapshot 2**	**Snapshot 3**	**Snapshot 4**
COST OVERRRUN	0	0	0	0	0	-1	0	0	0	0	0	0	0	-1
TIME OVERRUN	0	0	0	0	0	-1	0	0	0	0	0	-1	-1	-1
ACTUAL VS FORECASTED TRAFFIC	0	0	-1	-1	0	1	0	-1	-1	-1	0	0	-2	-2
TRANSPORT GOALS	0	0	1	1	0	0	0	0	0	1	0	0	-2	-2
OTHER ECONOMIC OUTCOMES	0	1	1	1	0	0	0	0	0	1	0	-1	-2	-1
SOCIAL OUTCOMES	0	1	1	1	0	0	0	0	0	1	0	-1	-2	-1
ENVIRONMENTAL OUTCOMES	0	-1	1	1	0	0	0	0	0	0	0	0	0	0
INSTITUTIONALS OUTCOMES	0	0	0	0	0	0	0	0	0	0	0	0	-2	-1

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A.4 Implementation context typology

A.4.1 Cluster analysis for institutional index

Two sets of analyses were conducted as follows.

Set of analyses 1:
CLUSTERING 21 EU COUNTRIES WITH LIBERALIZATION INDEX (5 missed Liberalization Index: Serbia, Albania, Cyprus, Croatia & Montenegro)

YEAR 2013

CLUSTER	COUNTRIES		
	No	Name	Tot. Score
1	1	Finland	0.85
	2	Netherlands	0.83
	3	Sweden	0.85
	4	Norway	0.84
	5	Denmark	0.85
	6	Switzerland	0.82
2	1	Belgium	0.77
	2	Germany	0.80
	3	United Kingdom	0.79
	4	Austria	0.80
3	1	France	0.73
	2	Portugal	0.70
	3	Spain	0.69
	4	Estonia	0.70
	5	Slovenia	0.66
4	1	Greece	0.57
	2	Italy	0.60
	3	Poland	0.66
	4	Czech Rep	0.65
	5	Hungary	0.64
	6	Slovak	0.65

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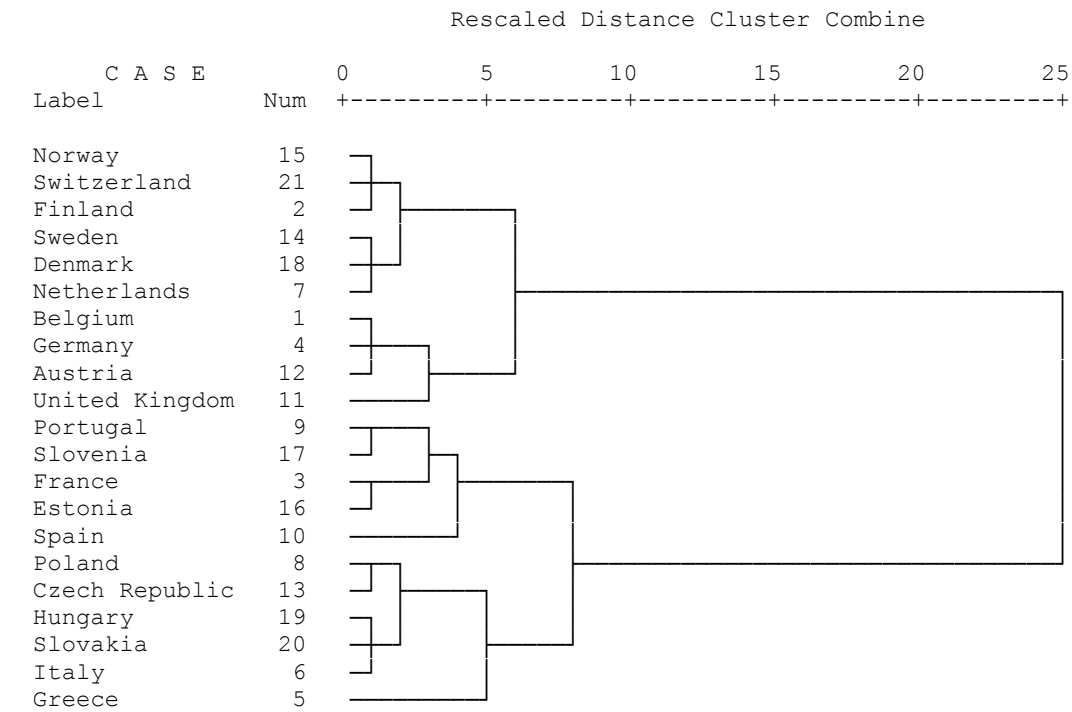
Dendrogram using Complete Linkage



Year 2007

CLUSTER	COUNTRIES		
	No	Name	Tot. Score
1	1	Finland	0.84
	2	Germany	0.80
	3	Netherlands	0.82
	4	United Kingdom	0.80
	5	Austria	0.83
	6	Sweden	0.84
	7	Norway	0.82
	8	Denmark	0.88
	9	Switzerlands	0.83
2	1	Belgium	0.76
	2	France	0.74
	3	Spain	0.68
	4	Portugal	0.68
	5	Estonia	0.69
3	1	Slovenia	0.65
4	1	Greece	0.61
	2	Italy	0.60
	3	Poland	0.59
	4	Czech Rep	0.66
	5	Hungary	0.66
	6	SLovak	0.65

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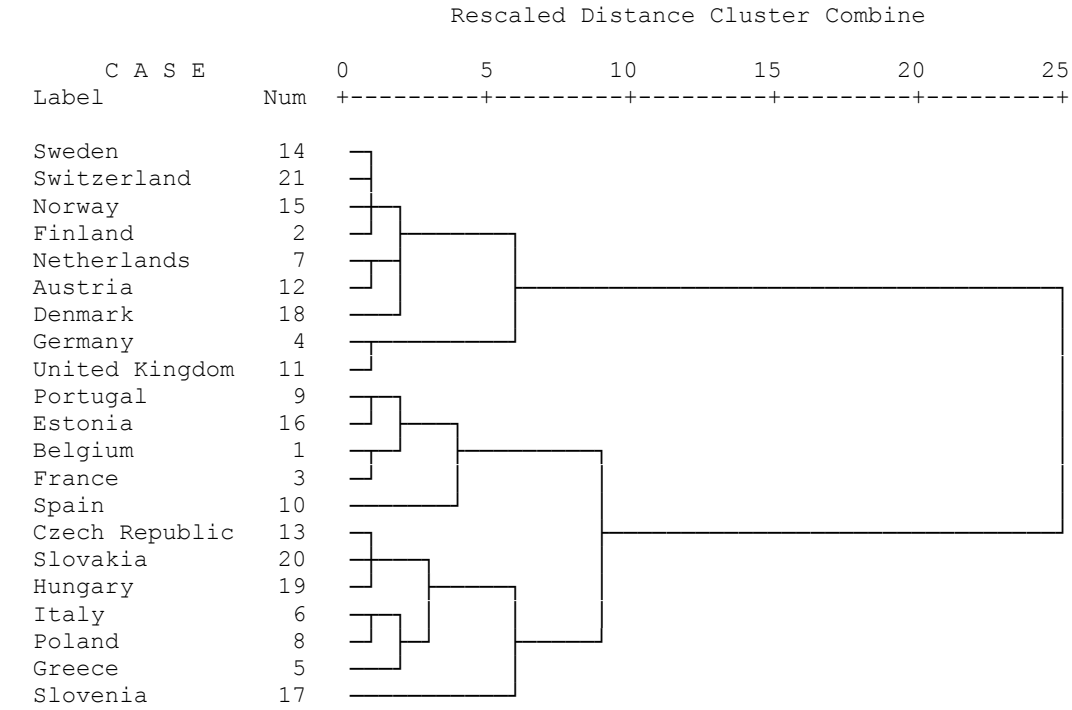
Dendrogram using Complete Linkage



Year 2001

CLUSTER	COUNTRIES		
	No	Name	Tot. Score
1	1	Finland	0.86
	2	Germany	0.81
	3	Netherlands	0.86
	4	United Kingdom	0.83
	5	Austria	0.80
	6	Sweden	0.83
	7	Norway	0.81
	8	Denmark	0.85
	9	Switzerlands	0.83
2	1	Belgium	0.77
	2	France	0.72
	3	Portugal	0.70
	4	Spain	0.75
3	1	Poland	0.60
	2	Italy	0.64
	3	Czech Rep	0.59
	4	Estonia	0.63
	5	Hungary	0.65
	6	Slovak	0.57
4	1	Greece	0.60
	2	Slovenia	0.60

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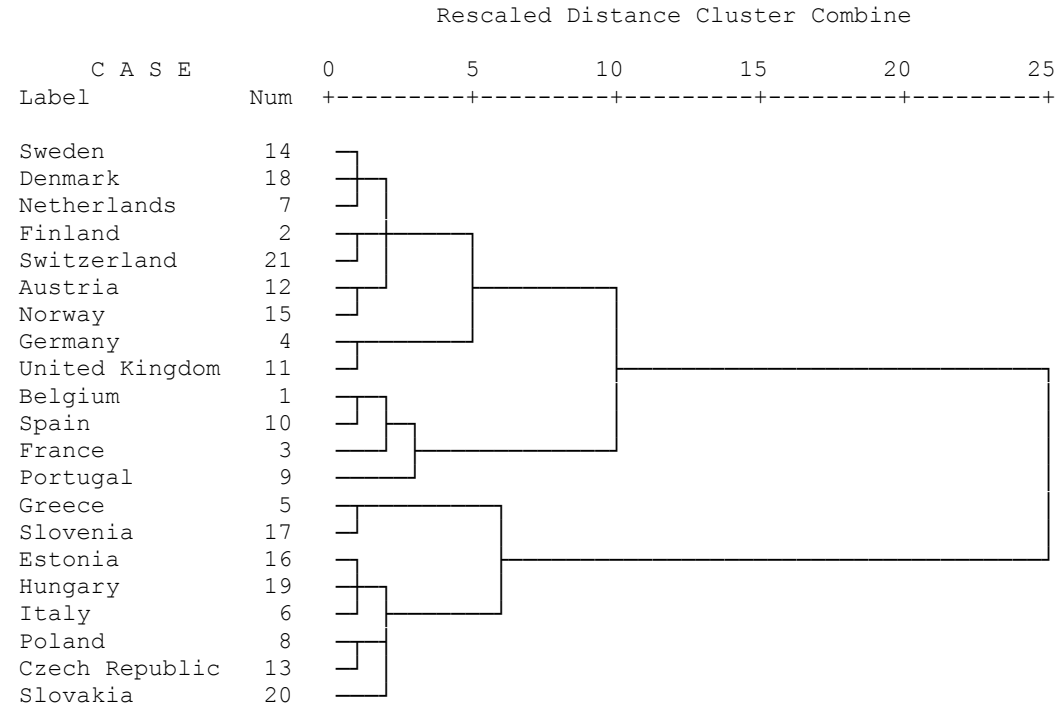
Dendrogram using Complete Linkage



Set of analyses 2:
CLUSTERING 26 EU COUNTRIES WITHOUT LIBERALIZATION INDEX

Year 2013

CLUSTER	COUNTRIES		
	No	Name	Tot. Score
1	1	Belgium	0.77
	2	Finland	0.85
	3	Germany	0.80
	4	Netherlands	0.83
	5	United Kingdom	0.79
	6	Austria	0.80
	7	Sweden	0.85
	8	Norway	0.84
	9	Denmark	0.85
	10	Switzerland	0.82
2	1	France	0.73
	2	Portugal	0.70
	3	Spain	0.69
	4	Cyprus	0.71
	5	Estonia	0.70
	6	Slovenia	0.66
3	1	Greece	0.57
	2	Italy	0.60
	3	Poland	0.66
	4	Czech Rep	0.65
	5	Croatia	0.60

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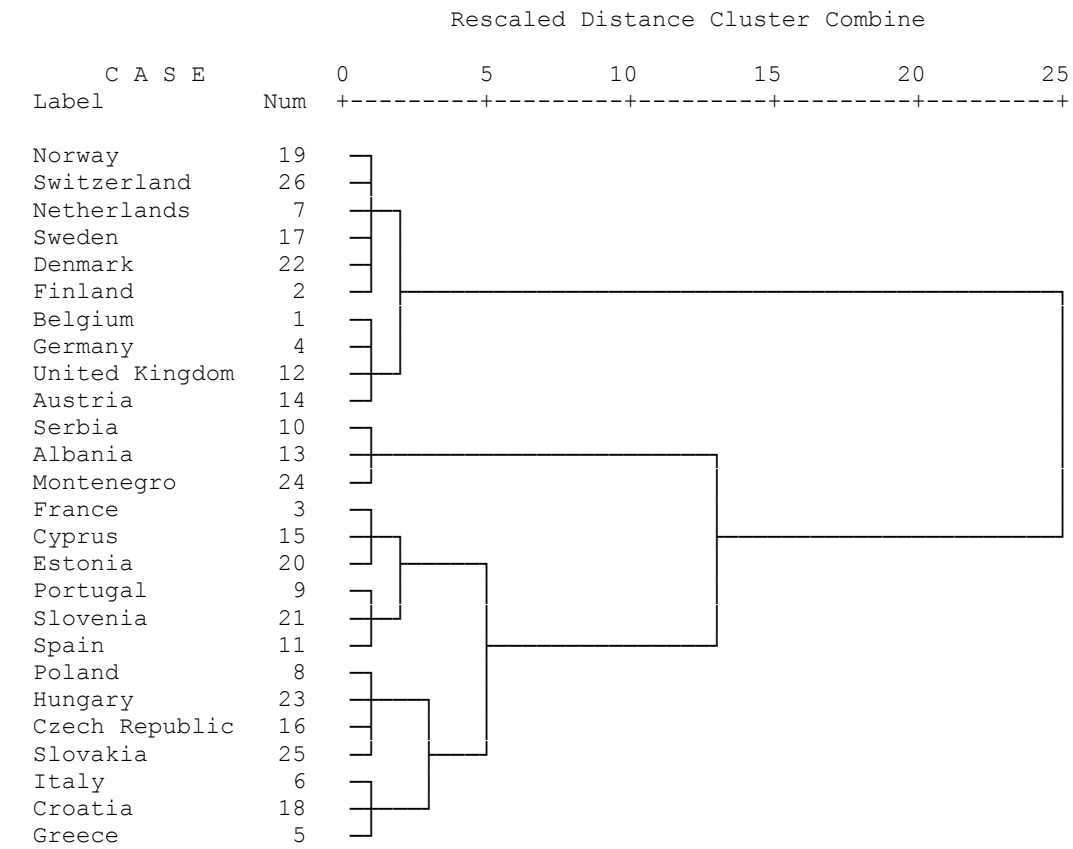
CLUSTER	COUNTRIES		
	No	Name	Tot. Score
	6	Hungary	0.64
	7	Slovak	0.65
4	1	Serbia	0.40
	2	Albania	0.45
	3	Montenegro	0.52

Dendrogram using Complete Linkage



YEAR 2007

CLUSTER	COUNTRIES		
	No	Name	Tot. Score
1	1	Finland	0.84
	2	Germany	0.80
	3	Netherlands	0.82
	4	United Kingdom	0.80
	5	Austria	0.83
	6	Sweden	0.84
	7	Norway	0.82
	8	Denmark	0.88
	9	Switzerlands	0.83
2	1	Belgium	0.76

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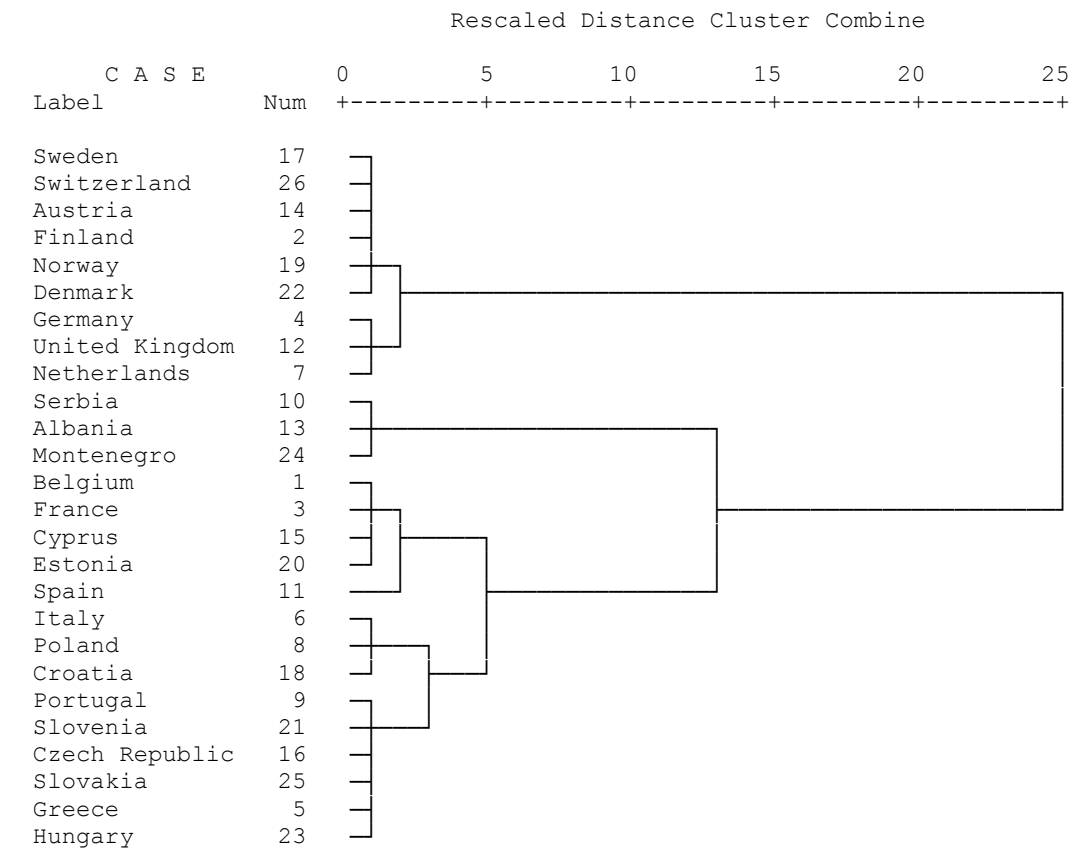
CLUSTER	COUNTRIES		
	No	Name	Tot. Score
	2	France	0.74
	3	Spain	0.68
	4	Cyprus	0.74
	5	Estonia	0.69
3	1	Greece	0.61
	2	Italy	0.60
	3	Poland	0.59
	4	Portugal	0.68
	5	Czech Rep	0.66
	6	Croatia	0.57
	7	Slovenia	0.65
	8	Hungary	0.66
	9	SLovak	0.65
4	1	Serbia	0.44
	2	Albania	0.44
	3	Montenegro	0.48

Dendrogram using Complete Linkage



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YEAR 2001

CLUSTER	COUNTRIES		
	No	Name	Tot. Score
1	1	Finland	0.86
	2	Germany	0.81
	3	Netherlands	0.86
	4	United Kingdom	0.83
	5	Austria	0.80
	6	Sweden	0.83
	7	Norway	0.81
	8	Denmark	0.85
	9	Switzerlands	0.83
2	1	Belgium	0.77
	2	France	0.72
	3	Greece	0.60
	4	Italy	0.64
	5	Portugal	0.70
	7	Spain	0.75
	8	Cyprus	0.70
	9	Estonia	0.63
	10	Slovenia	0.60
	11	Hungary	0.65
3	1	Poland	0.60
	2	Czech Rep	0.59
	3	Croatia	0.53
	4	Montenegro	0.49
	5	Slovak	0.57
4	1	Serbia	0.29
	2	Albania	0.29

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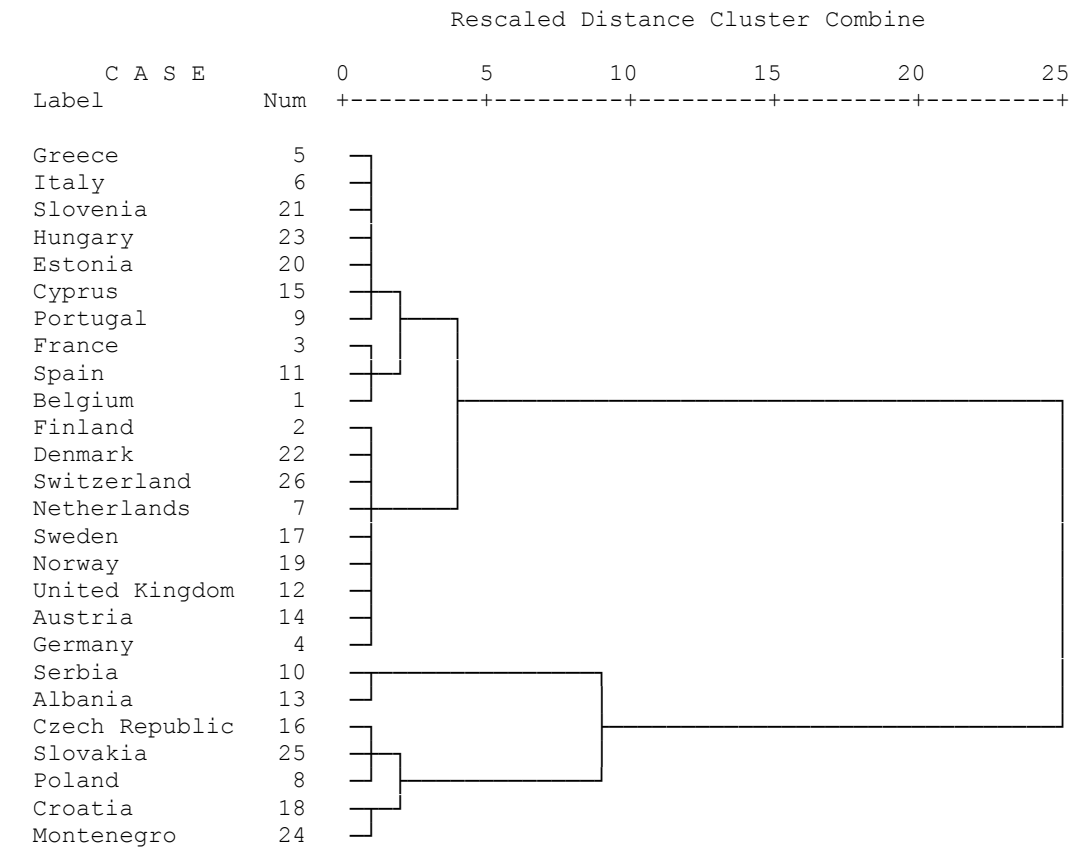
Dendrogram using Complete Linkage



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A.4.2. Correlation for institutional index

Two sets of analyses were conducted as follows.

Set of analyses 1:
CORRELATION AMONG TOTAL INDEX & SUB INDICATOR WITH LIBERALIZATION INDEX

Year 2001
There is a strong correlation among the total index and its sub indicators, including the liberalization index. In addition, all sub-indicators have an almost perfect correlation (approach to 1). Liberalization index also has a correlation with the institutional index, albeit moderate in strength. There is also a strong correlation among the sub-indicators. The liberalization index mostly has moderate to strong correlations with the other dimensions, including the dimension political stability.

Correlations

			Institution_ Index	Pol_stab	Control_ corruption	Voice_ accountability	Rule_Law	Reg_Quality	Liberalization	Gov_ effectiveness
Spearman's rho	Institution_Index	Correlation Coefficient	1.000	.831**	.952**	.915**	.918**	.912**	.759**	.955**
		Sig. (2-tailed)	.	.000	.000	.000	.000	.000	.000	.000
		N	21	21	21	21	21	21	21	21
	Pol_stab	Correlation Coefficient	.831**	1.000	.801**	.834**	.753**	.715**	.515*	.828**
		Sig. (2-tailed)	.000	.	.000	.000	.000	.000	.017	.000
		N	21	21	21	21	21	21	21	21
	Control_corruption	Correlation Coefficient	.952**	.801**	1.000	.935**	.946**	.802**	.694**	.925**
		Sig. (2-tailed)	.000	.000	.	.000	.000	.000	.000	.000
		N	21	21	21	21	21	21	21	21
	Voice_accountability	Correlation Coefficient	.915**	.834**	.935**	1.000	.902**	.740**	.644**	.918**
		Sig. (2-tailed)	.000	.000	.000	.	.000	.000	.002	.000
		N	21	21	21	21	21	21	21	21
	Rule_Law	Correlation Coefficient	.918**	.753**	.946**	.902**	1.000	.789**	.614**	.931**
		Sig. (2-tailed)	.000	.000	.000	.000	.	.000	.003	.000
		N	21	21	21	21	21	21	21	21
	Reg_Quality	Correlation Coefficient	.912**	.715**	.802**	.740**	.789**	1.000	.731**	.862**
		Sig. (2-tailed)	.000	.000	.000	.000	.000	.	.000	.000
		N	21	21	21	21	21	21	21	21
	Liberalization	Correlation Coefficient	.759**	.515*	.694**	.644**	.614**	.731**	1.000	.664**
		Sig. (2-tailed)	.000	.017	.000	.002	.003	.000	.	.001
		N	21	21	21	21	21	21	21	21
	Gov_effectiveness	Correlation Coefficient	.955**	.828**	.925**	.918**	.931**	.862**	.664**	1.000
		Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.001	.
		N	21	21	21	21	21	21	21	21

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Year 2007
There is a strong correlation among the total index and its sub indicators, except for the liberalization index. In addition, all-sub indicators have an almost perfect correlation (approach to 1). Liberalization index also has correlation with the institutional index, albeit moderate in strength. There was also strong correlation among the sub indicators. The liberalization index mostly has moderate correlations with the other dimensions, except for political stability which has no correlation with the liberalization index.

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Correlations

			Institution_ Index	Pol_stab	Control_ corruption	Voice_ accountability	Rule_Law	Reg_Quality	Liberalization	Gov_ effectiveness
Spearman's rho	Institution_Index	Correlation Coefficient	1.000	.640**	.956**	.884**	.973**	.904**	.488*	.964**
		Sig. (2-tailed)	.	.002	.000	.000	.000	.000	.025	.000
		N	21	21	21	21	21	21	21	21
	Pol_stab	Correlation Coefficient	.640**	1.000	.611**	.523*	.609**	.400	.095	.656**
		Sig. (2-tailed)	.002	.	.003	.015	.003	.072	.681	.001
		N	21	21	21	21	21	21	21	21
	Control_corruption	Correlation Coefficient	.956**	.611**	1.000	.914**	.953**	.853**	.453*	.941**
		Sig. (2-tailed)	.000	.003	.	.000	.000	.000	.039	.000
		N	21	21	21	21	21	21	21	21
	Voice_accountability	Correlation Coefficient	.884**	.523*	.914**	1.000	.883**	.793**	.479*	.884**
		Sig. (2-tailed)	.000	.015	.000	.	.000	.000	.028	.000
		N	21	21	21	21	21	21	21	21
	Rule_Law	Correlation Coefficient	.973**	.609**	.953**	.883**	1.000	.869**	.478*	.959**
		Sig. (2-tailed)	.000	.003	.000	.000	.	.000	.028	.000
		N	21	21	21	21	21	21	21	21
	Reg_Quality	Correlation Coefficient	.904**	.400	.853**	.793**	.869**	1.000	.710**	.856**
		Sig. (2-tailed)	.000	.072	.000	.000	.000	.	.000	.000
		N	21	21	21	21	21	21	21	21
	Liberalization	Correlation Coefficient	.488*	.095	.453*	.479*	.478*	.710**	1.000	.431
		Sig. (2-tailed)	.025	.681	.039	.028	.028	.000	.	.051
		N	21	21	21	21	21	21	21	21
	Gov_effectiveness	Correlation Coefficient	.964**	.656**	.941**	.884**	.959**	.856**	.431	1.000
		Sig. (2-tailed)	.000	.001	.000	.000	.000	.000	.051	.
		N	21	21	21	21	21	21	21	21

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Year 2013

There is a strong correlation among the total index and its sub-indicators, except for the liberalization index. The dimension political stability has a somewhat lower correlation. In addition, all sub-indicators have an almost perfect correlation (approach to 1). However, the liberalization index tends to have a low correlation with the institutional index. There is also a strong correlation (between 0.50 and 1; mostly above 0.6) among sub-indicators, except for the liberalization index.

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Correlations

			Institution_ Index	Pol_stab	Control_ corruption	Voice_ accountability	Rule_Law	Reg_Quality	Liberalization	Gov_ effectiveness
Spearman's rho	Institution_Index	Correlation Coefficient	1.000	.611**	.983**	.963**	.970**	.917**	.224	.974**
		Sig. (2-tailed)	.	.003	.000	.000	.000	.000	.328	.000
		N	21	21	21	21	21	21	21	21
	Pol_stab	Correlation Coefficient	.611**	1.000	.549**	.646**	.624**	.585**	.069	.607**
		Sig. (2-tailed)	.003	.	.010	.002	.002	.005	.766	.004
		N	21	21	21	21	21	21	21	21
	Control_corruption	Correlation Coefficient	.983**	.549**	1.000	.963**	.951**	.904**	.220	.962**
		Sig. (2-tailed)	.000	.010	.	.000	.000	.000	.338	.000
		N	21	21	21	21	21	21	21	21
	Voice_accountability	Correlation Coefficient	.963**	.646**	.963**	1.000	.941**	.859**	.153	.945**
		Sig. (2-tailed)	.000	.002	.000	.	.000	.000	.507	.000
		N	21	21	21	21	21	21	21	21
	Rule_Law	Correlation Coefficient	.970**	.624**	.951**	.941**	1.000	.908**	.191	.954**
		Sig. (2-tailed)	.000	.002	.000	.000	.	.000	.408	.000
		N	21	21	21	21	21	21	21	21
	Reg_Quality	Correlation Coefficient	.917**	.585**	.904**	.859**	.908**	1.000	.345	.865**
		Sig. (2-tailed)	.000	.005	.000	.000	.000	.	.126	.000
		N	21	21	21	21	21	21	21	21
	Liberalization	Correlation Coefficient	.224	.069	.220	.153	.191	.345	1.000	.184
		Sig. (2-tailed)	.328	.766	.338	.507	.408	.126	.	.424
		N	21	21	21	21	21	21	21	21
	Gov_effectiveness	Correlation Coefficient	.974**	.607**	.962**	.945**	.954**	.865**	.184	1.000
		Sig. (2-tailed)	.000	.004	.000	.000	.000	.000	.424	.
		N	21	21	21	21	21	21	21	21

**. Correlation is significant at the 0.01 level (2-tailed).

Set of analyses 2:
CORRELATION AMONG TOTAL INDEX & SUB INDICATOR WITHOUT LIBERALIZATION INDEX

Year 2001
There is a strong correlation between the total index and its sub-indicators. All sub-indicators have an almost perfect correlation (approach to 1). There is also a strong correlation (above 0.6) among all sub-indicators.

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Correlations

			Institution_ Index	Pol_stab	Control_ corruption	Voice_ accountability	Rule_Law	Reg_Quality	Gov_ effectiveness
Spearman's rho	Institution_Index	Correlation Coefficient	1.000	.880**	.974**	.945**	.954**	.943**	.976**
		Sig. (2-tailed)	.	.000	.000	.000	.000	.000	.000
		N	26	26	26	26	26	26	26
	Pol_stab	Correlation Coefficient	.880**	1.000	.860**	.891**	.845**	.809**	.879**
		Sig. (2-tailed)	.000	.	.000	.000	.000	.000	.000
		N	26	26	26	26	26	26	26
	Control_corruption	Correlation Coefficient	.974**	.860**	1.000	.952**	.970**	.884**	.959**
		Sig. (2-tailed)	.000	.000	.	.000	.000	.000	.000
		N	26	26	26	26	26	26	26
	Voice_accountability	Correlation Coefficient	.945**	.891**	.952**	1.000	.944**	.835**	.948**
		Sig. (2-tailed)	.000	.000	.000	.	.000	.000	.000
		N	26	26	26	26	26	26	26
	Rule_Law	Correlation Coefficient	.954**	.845**	.970**	.944**	1.000	.871**	.962**
		Sig. (2-tailed)	.000	.000	.000	.000	.	.000	.000
		N	26	26	26	26	26	26	26
	Reg_Quality	Correlation Coefficient	.943**	.809**	.884**	.835**	.871**	1.000	.916**
		Sig. (2-tailed)	.000	.000	.000	.000	.000	.	.000
		N	26	26	26	26	26	26	26
	Gov_effectiveness	Correlation Coefficient	.976**	.879**	.959**	.948**	.962**	.916**	1.000
		Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.
		N	26	26	26	26	26	26	26

**. Correlation is significant at the 0.01 level (2-tailed).

Year 2007

There is a strong correlation between the total index and its sub-indicators. By exception of the dimension political stability, all sub-indicators have an almost perfect correlation (approach to 1). There is also a strong correlation (above 0.6) among all sub-indicators.

Correlations

			Institution_ Index	Pol_stab	Control_ corruption	Voice_ accountability	Rule_Law	Reg_Quality	Gov_ effectiveness
Spearman's rho	Institution_Index	Correlation Coefficient	1.000	.714**	.976**	.923**	.983**	.946**	.978**
		Sig. (2-tailed)	.	.000	.000	.000	.000	.000	.000
		N	26	26	26	26	26	26	26
	Pol_stab	Correlation Coefficient	.714**	1.000	.692**	.651**	.688**	.575**	.724**
		Sig. (2-tailed)	.000	.	.000	.000	.000	.002	.000
		N	26	26	26	26	26	26	26
	Control_corruption	Correlation Coefficient	.976**	.692**	1.000	.944**	.973**	.916**	.965**
		Sig. (2-tailed)	.000	.000	.	.000	.000	.000	.000
		N	26	26	26	26	26	26	26
	Voice_accountability	Correlation Coefficient	.923**	.651**	.944**	1.000	.928**	.866**	.917**
		Sig. (2-tailed)	.000	.000	.000	.	.000	.000	.000
		N	26	26	26	26	26	26	26
	Rule_Law	Correlation Coefficient	.983**	.688**	.973**	.928**	1.000	.921**	.974**
		Sig. (2-tailed)	.000	.000	.000	.000	.	.000	.000
		N	26	26	26	26	26	26	26
	Reg_Quality	Correlation Coefficient	.946**	.575**	.916**	.866**	.921**	1.000	.914**
		Sig. (2-tailed)	.000	.002	.000	.000	.000	.	.000
		N	26	26	26	26	26	26	26
	Gov_effectiveness	Correlation Coefficient	.978**	.724**	.965**	.917**	.974**	.914**	1.000
		Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.
		N	26	26	26	26	26	26	26

**. Correlation is significant at the 0.01 level (2-tailed).

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Year 2013

There is a strong correlation between the total index and its sub-indicators. By exception of the dimension political stability, all-sub indicators have an almost perfect correlation (approach to 1). There is also a strong correlation (above 0.6) among all sub-indicators.

Correlations

			Institution_ Index	Pol_stab	Control_ corruption	Voice_ accountability	Rule_Law	Reg_Quality	Gov_ effectiveness
Spearman's rho	Institution_Index	Correlation Coefficient	1.000	.687**	.989**	.965**	.978**	.936**	.981**
		Sig. (2-tailed)	.	.000	.000	.000	.000	.000	.000
		N	26	26	26	26	26	26	26
	Pol_stab	Correlation Coefficient	.687**	1.000	.645**	.723**	.691**	.682**	.676**
		Sig. (2-tailed)	.000	.	.000	.000	.000	.000	.000
		N	26	26	26	26	26	26	26
	Control_corruption	Correlation Coefficient	.989**	.645**	1.000	.959**	.965**	.924**	.975**
		Sig. (2-tailed)	.000	.000	.	.000	.000	.000	.000
		N	26	26	26	26	26	26	26
	Voice_accountability	Correlation Coefficient	.965**	.723**	.959**	1.000	.962**	.909**	.948**
		Sig. (2-tailed)	.000	.000	.000	.	.000	.000	.000
		N	26	26	26	26	26	26	26
	Rule_Law	Correlation Coefficient	.978**	.691**	.965**	.962**	1.000	.940**	.962**
		Sig. (2-tailed)	.000	.000	.000	.000	.	.000	.000
		N	26	26	26	26	26	26	26
	Reg_Quality	Correlation Coefficient	.936**	.682**	.924**	.909**	.940**	1.000	.895**
		Sig. (2-tailed)	.000	.000	.000	.000	.000	.	.000
		N	26	26	26	26	26	26	26
	Gov_effectiveness	Correlation Coefficient	.981**	.676**	.975**	.948**	.962**	.895**	1.000
		Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.
		N	26	26	26	26	26	26	26

**. Correlation is significant at the 0.01 level (2-tailed).

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A.5 Business Model Typology

A.5.1 Key factor: Level of Control vs Allocation of Traffic Demand

Table A.5.1.1: Assessment of PPP case studies

Project Title	Level of Control (Normalised Score)	Demand Risk Allocation	Level of Control - Demand Risk Allocation	Revenue Support (mitigation)	Restrictions on pricing (reduction of control)	Revenue source	Concessionaire Repayment (=Project revenues)	Incentives (yes/no)	Influence of other factors
More risk passed on to the Private Sector									
EJE Aeropuerto (M-12). Airport Axis Toll Motorway	0,8	6	-5,3	0	2	3	3	0	+
BNRR (M6 Toll)	1,1	6	-4,9	0	0	3	3	0	-
BreBeMi	0,4	5	-4,6	2	2	3	3	0	-
Radial 2 Toll Motorway	1,5	6	-4,5	0	2	3	3	0	+
M-45	1,5	6	-4,5	0	N/A	1	1	0	-
A19 Dishforth to Tyne Tunnel	0,8	5	-4,3	0	N/A	1	1	0	+
Central Greece (E65) Motorway	2,3	6	-3,8	2	2	2	2	0	+
Ionia Odos Motorway	3,0	6	-3,0	2	2	2	2	0	+
AttikiOdos (Athens Ring Road)	3,0	6	-3,0	1	1	3	3	0	-
E18 Muurla-Lohja	3,0	6	-3,0	0	N/A	1	1	1	+
Elefsina Korinthos Patra Pyrgos Tsakona Motorway	3,4	6	-2,6	1	2	3	3	1	-
Rio-Antirio Bridge	3,4	6	-2,6	1	2	3	3	0	-
Millau Viaduct	3,4	6	-2,6	0	2	3	3	0	-
M80 Haggs	1,5	4	-2,5	0	N/A	1	1	1	+
Port of Agaete*	3,8	6	-2,3	0	3	3	3	0	+
E4 Helsinki-Lahti	3,0	5	-2,0	0	0	1	1	1	+
Port of Leixoes	3,4	5	-1,6	0	2	3	3	0	-
Piraeus Container Terminal	4,5	6	-1,5	0	0	3	3	0	-
Terminal Muelle Costa at the port of Barcelona	4,5	6	-1,5	0	0	3	3	1	+
Istrian Y	3,8	5	-1,3	0	3	2	2	0	-
Reims tramway	3,8	5	-1,3	2	2	2	2	1	+
Approximately Appropriate Risk Allocation									
Moreas Motorway	3,0	4	-1,0	2	2	3	3	0	+
Metrolink LRT, Manchester	3,0	4	-1,0	2	2	3	3	0	+

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Project Title	Level of Control (Normalised Score)	Demand Risk Allocation	Level of Control - Demand Risk Allocation	Revenue Support (mitigation)	Restrictions on pricing (reduction of control)	Revenue source	Concessionaire Repayment (=Project revenues)	Incentives (yes/no)	Influence of other factors
Caen-TVR	4,1	5	-0,9	2	2	2	2	0	+
Brabo 1	1,5	2	-0,5	2	1	2	2	1	+
Lusoponte - Vasco da Gama Bridge	3,8	4	-0,3	2	3	3	3	1	+
Athens International Airport 'Eleftherios Venizelos'	5,3	5	0,3	0	0	2	2	0	-
Larnaca and Paphos International Airports	5,3	5	0,3	0	0	2	2	0	-
Via-Invest Zaventem	2.3	2	0.3	1	N/A	1	1	1	+
M-25 Motorway London Orbital	3,4	3	0,4	0	0	1	1	1	+
Liefkenshoekspoorverbinding - Liefkenshoek Rail Link	1,5	1	0,5	2	N/A	1	1	0	+
E39 Orkdalsvegen Public Road	2,6	2	0,6	0	3	3	3	1	-
Adriatic Gateway Container Terminal	4,9	4	0,9	0	0	3	3	0	+
Coen Tunnel	3,0	2	1,0	0	N/A	1	1	1	+
Metro de Malaga	3,0	2	1,0	2	2	2	2	0	+
E18 Grimstad - Kristiansand	3,0	2	1,0	0	N/A	1	1	1	+
More risk retained by the Public Sector									
Deurganckdoksluis-Deurganckdock lock	3,4	2	1,4	2	N/A	3	3	0	-
The Oresund Link**	3,4	2	1,4	N/A	1	3	3	0	+
A2 Motorway Poland	2,6	1	1,6	0	3	3	1	0	+

*N/A = not applicable; * The port of Agaete was constructed by the Public sector and is operated by a concessionaire; ** The Oresund Link is marginally consider here as a PPP as it is a joint venture between the public sector of Denmark and Sweden.*

Table A.5.1.2: Assessment of Public case studies

Project Title	Level of Control Normalised Score	Demand Risk Allocation	Level of control - Demand risk allocation	Revenue Support (mitigation)	Restrictions on pricing (reduction of control)	Revenue source	Incentives (yes/no)	Influence of other factors
More risk passed on to the operator								
Modlin Regional Airport	0,4	2	-1,6	0	3	2	0	-

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Project Title	Level of Control Normalised Score	Demand Risk Allocation	Level of control - Demand risk allocation	Revenue Support (mitigation)	Restrictions on pricing (reduction of control)	Revenue source	Incentives (yes/no)	Influence of other factors
Approximately appropriate risk allocation								
Météor	3,0	4	-1,0	2	3	2	0	+
Tram T4 (Line 4 of Lyon Tramway)	3,8	4	-0,3	1	3	2	1	+
Koper - Izola Expressway	2.3	2	0.3	0	3	2	0	-
Athens Tramway	1,9	1	0,9	0	3	2	0	+
A5 Maribor - Pince Motorway	1,9	1	0,9	0	3	3	0	-
More risk retained by the central public sector								
TGV Mediterranean	2,3	1	1,3	0	N/A	1	0	+
Attiko Metro (Athens Metro Base Project)	3,4	2	1,4	0	2	2	0	+
Warsaw's Metro 2nd line	2,6	1	1,6	0	3	2	0	-
Motorway E-75, Section DonjiNeradovac - Srpskakuca	2,6	1	1,6	1	3	2	0	+
Belgrade By-pass Project, Section A: Batajnica-Dobanovci	3,0	1	2,0	0	N/A	1	0	+
Motorway E-75, Section Horgos - Novi Sad (second phase)	3,4	1	2,4	0	3	2	0	-
Berlin Tiergarten Tunnel	3,4	1	2,4	0	N/A	1	0	+
London Underground Jubilee Line Extension (JLE)	3,4	1	2,4	0	N/A	1	0	+
Bundesautobahn 20	3,4	1	2,4	0	3	1	0	+
SodraLanken (The southern Link)	3,4	1	2,4	0	N/A	1	0	+
Gardermobanen (Airport Exprestrain)	3,8	1	2,8	0	3	2	0	+
Tram-Train "Kombilösung" Karlsruhe	3,8	1	2,8	0	N/A	1	0	+
CombiplanNijverdal	3.8	1	2.8	0	N/A	1	0	+
The Hague New Central Train Station	4,1	1	3,1	0	N/A	1	0	+
Berlin Brandenburg Airport (BER)	4,1	1	3,1	0	3	2	0	-
RandstadRail	4,1	1	3,1	0	3	1	0	+
NBS Köln-Rhein/Main	4,1	1	3,1	0	N/A	1	0	+

N/A = not applicable

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Table A.5.1.3: Assessment of performance of PPP cases

Project Title	Level of Control - Demand Risk Allocation	Influence of other factors	Traffic demand indicator	Renegotiations indicator
More risk passed on to the Private Sector				
EJE Aeropuerto (M-12). Airport Axis Toll Motorway	-5,3	+	-2	1
BNRR (M6 Toll)	-4,9	-	-1	0
BreBeMi	-4,6	-	-1	0
Radial 2 Toll Motorway	-4,5	+	-2	1
M-45	-4,5	-	1	0
A19 Dishforth to Tyne Tunnel	-4,3	+	0	0
Central Greece (E65) Motorway	-3,8	+	-2	1
Ionia Odos Motorway	-3,0	+	-2	1
Attiki Odos (Athens Ring Road)	-3,0	-	-1	0
E18 Muurla-Lohja	-3,0	+	0	0
Elefsina Korinthos PatraPyrgosTsakona Motorway	-2,6	-	-2	1
Rio-Antirio Bridge	-2,6	-	-1	0
Millau Viaduct	-2,6	-	1	0
M80 Haggs	-2,5	+	0	0
Port of Agaete*	-2,3	+	1	0
E4 Helsinki-Lahti	-2,0	+	1	0
Port of Leixoes	-1,6	-	0	0
Piraeus Container Terminal	-1,5	-	1	0
Terminal Muelle Costa at the port of Barcelona	-1,5	+	0	0
Istrian Y	-1,3	-	1	0
Reims tramway	-1,3	+	-1	1
Approximately Appropriate Risk Allocation				
Moreas Motorway	-1,0	+	-1	1
Metrolink LRT, Manchester	-1,0	+	1	0
Caen-TVR	-0,9	+	0	0
Brabo 1	-0,5	+	0	0
Lusoponte - Vasco da Gama Bridge	-0,3	+	0	0
Athens International Airport 'Eleftherios Venizelos'	0,3	-	-1	0
Larnaca and Paphos International Airports	0,3	-	-1	0
Via-Invest Zaventem	0.3	+	0	0
M-25 Motorway London Orbital	0,4	+	0	0
Liefkenshoekspoorverbinding - Liefkenshoek Rail Link	0,5	+	0	0
E39 Orkdalsvegen Public Road	0,6	-	1	0
Adriatic Gateway Container Terminal	0,9	+	-1	0

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Project Title	Level of Control - Demand Risk Allocation	Influence of other factors	Traffic demand indicator	Renegotiations indicator
Coen Tunnel	1,0	+	-1	0
Metro de Malaga	1,0	+	0	0
E18 Grimstad – Kristiansand	1,0	+	0	0
More risk retained by the Public Sector				
Deurganckdoksluis-Deurganckdock lock	1,4	-	0	0
The Oresund Link**	1,4	+	1	0
A2 Motorway Poland	1,6	+	1	0

Table A.5.1.4: Assessment of performance of Public cases

Project Title	Level of control - Demand risk allocation	Influence of other factors	Traffic demand indicator
More risk passed on to the operator			
Modlin Regional Airport	-1,6	-	-2
Approximately appropriate risk allocation			
Météor	-1,0	+	1
Tram T4 (Line 4 of Lyon Tramway)	-0,3	+	1
Koper - Izola Expressway	0.3	-	0
Athens Tramway	0,9	+	-2
A5 Maribor - Pince Motorway	0,9	-	1
More risk retained by the central public sector			
TGV Mediterranean	1,3	+	1
Attiko Metro (Athens Metro Base Project)	1,4	+	1
Warsaw's Metro 2nd line	1,6	-	0
Motorway E-75, Section DonjiNeradovac – Srpskakuca	1,6	+	0
Belgrade By-pass Project, Section A: Batajnica-Dobanovci	2,0	+	-2
Motorway E-75, Section Horgos - Novi Sad (second phase)	2,4	-	-1
Berlin Tiergarten Tunnel	2,4	+	1
London Underground Jubilee Line Extension (JLE)	2,4	+	1
Bundesautobahn 20	2,4	+	-1
SodraLanken (The southern Link)	2,4	+	1
Gardermobanen (Airport Exprestrain)	2,8	+	1
Tram-Train "Kombilösung" Karlsruhe	2,8	+	1

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Project Title	Level of control - Demand risk allocation	Influence of other factors	Traffic demand indicator
The Hague New Central Train Station	3,1	+	0
Berlin Brandenburg Airport (BER)	3,1	-	1
RandstadRail	3,1	+	-1
Combiplan Nijverdal	2.8	+	-1
NBS Köln-Rhein/Main	3,1	+	1

N/A: not applicable – inauguration expected in 2016. Currently figures are lower than expected

Table A.5.1.5: Cases in line with the Hypothesis

Project title	Delivery Type	Appropriate Risk Transfer	Actual vs Forecast Traffic
GDP proxy = 0			
A19 Dishforth to Tyne Tunnel	PPP	More	0
E18 Muurla-Lohja	PPP	More	0
M80 Haggs	PPP	More	0
Port of Leixoes	PPP	More	0
Caen-TVR	PPP	Appropriate	0
Liefkenshoekspoorverbinding-Liefkenshoek Rail Link	PPP	Appropriate	0
Lusoponte - Vasco da Gama Bridge	PPP	Appropriate	0
Deurganckdoksluis-Deurganckdock lock	PPP	Less	0
Motorway E-75, Section DonjiNeradovac – Srpskakuca	Public	Less	0
Warsaw's Metro II-nd line	Public	Less	0
GDP proxy = 1			
Météor	Public	Appropriate	1
A5 Maribor – Pince Motorway	Public	Appropriate	1
TGV Mediterranean	Public	Less	1
Attiko Metro (Athens Metro Base Project)	Public	Less	1
Sodra Lanken (The southern Link)	Public	Less	1
Tram-Train ”Kombilösung” Karlsruhe	Public	Less	1
NBS Köln-Rhein/Main	Public	Less	1
E39 Orkdalsvegen Public Road	PPP	Appropriate	1
Millau Viaduct	PPP	More	1
Port of Agaete	PPP	More	1
Istrian Y	PPP	More	1
GDP proxy = -1			
EJE Aeropuerto (M-12). Airport Axis Toll Motorway	PPP	More	-2
Radial 2 Toll Motorway	PPP	More	-2
Central Greece (E65) Motorway	PPP	More	-2
Ionia Odos Motorway	PPP	More	-2
Elefsina Korinthos PatraPyrgosTsakona Motorway	PPP	More	-2

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Project title	Delivery Type	Appropriate Risk Transfer	Actual vs Forecast Traffic
BreBeMi	PPP	More	-1
Attiki Odos (Athens Ring Road)	PPP	More	-1
Rio-Antirio Bridge	PPP	More	-1
Moreas Motorway	PPP	Appropriate	-1
Athens International Airport 'Eleftherios Venizelos'	PPP	Appropriate	-1
Larnaca and Paphos International Airports	PPP	Appropriate	-1
Coen Tunnel	PPP	Appropriate	-1
Athens Tramway	Public	Appropriate	-2
Motorway-75, Section Horgos Novi Sad (second phase)	Public	Less	-1

Table A.5.1.6 Hypothesis not valid – Pessimistic forecast

Project title	Delivery Type	Appropriate Risk Transfer	Actual vs Forecast Traffic
GDP proxy = 0			
E4 Helsinki-Lahti	PPP	More	1
Metrolink LRT, Manchester	PPP	Appropriate	1
The Oresund Link	PPP	Appropriate	1
Berlin Tiergarten Tunnel	Public	Less	1
London Underground Jubilee Line Extension (JLE)	Public	Less	1
Gardermobanen (Airport Exprestrain)	Public	Less	1
RandstadRail	Public	Less	1
Berlin Brandenburg Airport (BER)	Public	Less	1
GDP proxy = -1			
M-45	PPP	More	1
Piraeus Container Terminal	PPP	More	1
Metro De Malaga	PPP	Appropriate	0
A2 Motorway Poland	PPP	Less	1
Tram T4 (Line 4 of Lyon Tramway)	Public	Appropriate	1
Koper - Izola Expressway	Public	Appropriate	0
The Hague New Central Train Station	Public	Less	0

Table A.5.1.7: H1 not valid – Optimistic forecast

Project title	Delivery Type	Appropriate Risk Transfer	Actual vs Forecast Traffic
GDP proxy = 0			
Reims tramway	PPP	More	-1
GDP proxy = 1			
E18 Grimstad – Kristiansand	PPP	More	0
Terminal Muelle Costa at the port of Barcelona	PPP	More	0
Brabo 1	PPP	Appropriate	0

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Project title	Delivery Type	Appropriate Risk Transfer	Actual vs Forecast Traffic
M-25 Motorway London Orbital	PPP	Appropriate	0
Via-Invest Zaventem	PPP	Appropriate	0
BNRR (M6 Toll)	PPP	More	-1
Adriatic Gateway Container Terminal	PPP	Appropriate	-1
Modlin Regional Airport	Public	More	-2
Belgrade By-pass Project, Section A: Batajnica-Dobanovci	Public	Less	-2
Bundesautobahn 20	Public	Less	-1
Combiplan Nijverdal	Public	Less	-1

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A.5.2 Key factor: Capability to Operate

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Table A.5.2.1: Cases Tested for H1

Project Name	Delivery Type	Year Awarded	Contract duration years	Construction Budget MEuros (2013)	% public contribu-tion	Level of Control [1, 6]	Actual vs Fore-casted Traffic [-2, 1]	GDP [-1, 1]	Constr. Cost Overrun	Constr. Time to com-pletion
Piraeus CT	PPP	2008	30 (option for additional 5)	151.63	0	4.50	1	-1	0	0
Port of Sines Terminal XXI	PPP	1999	30 (with option for additional 30)	216.58	30.8	4.13	0	0	n.a.	1
Barcelona Europe South Terminal	PPP	2006	30	706.38	n.a.	4.50	n.a.	1	n.a.	n.a.
Adriatic Gateway Container Terminal	PPP	2009	30	135.48	n.a.	4.90	-1	1	n.a.	n.a.
Terminal Muelle Costa at the port of Barcelona	PPP	2013	15 (with option for additional 7.5)	20.00	n.a.	4.50	0	1	n.a.	n.a.
Quadrante Europa Terminal Gate	PPP	2005	?	33.43	n.a.	4.13	0	-1	-1	0
BNRR (M6 TOLL)	PPP	1992	53	1,711.97	2.00	1.13	-1	1	1	0
Liefkenshoekspoorverbinding-Liefkenshoek Rail Link	PPP	2008	43	690	n.a.	1.50	0	0	n.a.	0

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Table A.5.2.2: Spearman's non-parametric test for the sample of H1

Spearman's Coefficient rho	Level of Control	Actual vs Forecasted Traffic	GDP	Constr. Cost Overrun	Constr. Time to completion
Level of Control	1.000	.783	-.033	-.500	.181
Actual vs Forecasted Traffic	.783	1.000	-.767	-.500	0.000
GDP	-.033	-.767	1.000	.866	
Constr. Cost Overrun	-.500	-.500	.866	1.000	
Constr.Time to completion	.181	0.000			1.000

**. Correlation is significant at the 0.01 level (2-tailed).

Table A.5.2.3. Cases tested for H2

ID	Project title	Delivery Type	Capability to Operate Index	Level of Control	Traffic Demand vs Forecasted	GDP variation
7	PIRAEUS CONTAINER TERMINAL	Private	1.000	4.50	1	-1
20	RADIAL 2 TOLL MOTORWAY	Private	1.000	1.50	-2	-1
22	M-45	Private	1.000	1.50	1	-1
28	A2 Motorway Poland	Private	1.000	2.63	1	0
33	Reims tramway	Private	1.000	2.25	-1	0
34	Caen-TVR	Private	1.000	2.63	0	0
37	E39 Orkdalsvegen Public Road	Private	1.000	2.63	1	1
40	Via-Invest Zaventem	Private	1.000	2.25	0	0
44	Deurganckdoksluis-Deurganckdock lock	Private	1.000	3.38	0	0
45	Liefkenshoekspoorverbinding-Liefkenshoek Rail Link	Private	1.000	1.50	0	0
62	Terminal Muelle Costa at the port of Barcelona	Private	1.000	4.50	0	1
66	The Oresund Link	Private	1.000	3.38	1	0
73	E18 Muurla-Lohja	Private	1.000	3.00	0	0
49	M-25 Motorway LONDON ORBITAL	Private	0.967	3.38	0	1
21	EJE AEROPUERTO (M-12). AIRPORT AXIS TOLL MOTORWAY	Private	0.933	0.75	-2	-1
14	BNRR (M6 TOLL)	Private	0.917	1.13	-1	1
24	Lusoponte - Vasco da Gama Bridge	Private	0.880	3.75	0	0
15	M80 Haggs	Private	0.867	1.50	0	0
67	Adriatic Gateway Container Terminal	Private	0.837	4.88	-1	1
42	E18 Grimstad - Kristiansand	Private	0.833	3.00	0	1
11	Central Greece (E65) Motorway	Private	0.778	2.25	-2	-1
10	Ionia Odos Motorway	Private	0.778	3.00	-2	-1

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ID	Project title	Delivery Type	Capability to Operate Index	Level of Control	Traffic Demand vs Forecasted	GDP variation
38	Elefsina Korinthos Patra Pyrgos Tsakona Motorway	Private	0.760	3.38	-2	-1
31	Istrian Y	Private	0.720	3.75	1	1
2	Rion-Antirion Bridge	Private	0.717	3.38	-1	-1
16	A19 Dishforth to Tyne Tunnel	Private	0.667	0.75	0	0
52	Moreas Motorway	Private	0.667	3.00	-1	-1
61	SERVICI	Private	0.667	2.63	0	0
68	QUADRANTE EUROPA TERMINAL GATE	Private	0.667	4.13	0	-1
69	E4 Helsinki-Lahti	Private	0.667	3.00	1	0
56	Larnaca and Paphos (Cyprus) International Airports	Private	0.656	5.25	-1	-1
48	METRO DE MALAGA	Private	0.505	3.00	0	-1
43	Athens International Airport Eleftherios Venizelos	Private	0.417	5.25	-1	-1
41	Brabo 1	Private	0.347	1.50	0	0
1	ATTIKI ODOS (ATHENS RING ROAD)	Private	0.330	3.00	-1	-1
24	PORT OF AGAETE	Private	0.333	3.75	1	1
3	BreBeMi	Private	0.167	0.38	-1	-1
34	RandstadRail	Public	0.667	4.13	1	1
32	Sodra Lanken (The southern Link)	Public	0.667	3.38	1	1
31	NBS Köln-Rhein/Main	Public	1.000	4.13	1	1
30	ATTIKO METRO (ATHENS METRO BASE PROJECT)	Public	0.667	3.38	1	1
29	Météor	Public	1.000	3.00	1	1
28	TGV Mediterranean	Public	1.000	2.25	1	0
27	London Underground Jubilee Line Extension (JLE)	Public	1.000	3.38	1	0
18	Berlin Brandenburg Airport (BER)	Public	0.667	4.13	1	1
17	Motorway E-75, Section Donji Neradovac - Srpska kuca	Public	0.667	2.63	0	1
16	Belgrade By-pass Project, Section A: Batajnica-Dobanovci	Public	0.667	3.00	-2	1
15	Motorway E-75, Section Horgos Novi Sad (second phase)	Public	0.667	3.38	-1	1
12	Gardermobanen (Airport Exprestrain)	Public	0.667	3.75	-2	-1
9	Koper - Izola Expressway	Public	0.667	2.25	0	0
8	A5 Maribor - Pince Motorway	Public	0.667	1.88	1	-1
4	Tram T4 (Line 4 of Lyon Tramway)	Public	0.667	3.75	1	1
3	Modlin Regional Airport	Public	0.667	0.38	-2	-1
2	The Hague New Central Train	Public	0.667	0.38	0	1

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ID	Project title	Delivery Type	Capability to Operate Index	Level of Control	Traffic Demand vs Forecasted	GDP variation
	Station					
14	Warsaw's Metro II-nd line	Public	0.333	2.63	0	-1
13	Athens Tramway	Public	0.333	1.88	-2	0

Table A.5.2.4: Spearman's non-parametric test for the sample of H2

Spearman's rho	Delivery Type	Capability to Operate Index	Level of Control	Traffic Demand vs Forecasted	GDP variation
Delivery Type	1.000	-.243	.026	.205	,320*
Capability to Operate Index	-.243	1.000	-.030	.230	.149
Level of Control	.026	-.030	1.000	.234	.207
Traffic Demand vs Forecasted	.205	.230	.234	1.000	,444**
GDPvariation	,320*	.149	.207	,444**	1.000

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table A.5.2.5: Spearman's non-parametric test for the sample of H2 that includes bundling of activities

Spearman's rho	Delivery Type	Capability to Operate Index	Level of Control	Actual vs Forecasted Traffic	GDP
Delivery Type	1.000	-.166	.161	.418	-.091
Capability to Operate Index	-.166	1.000	-.953**	.644	.832*
Level of Control	.161	-.953**	1.000	-.529	-.808*
Actual vs Forecasted Traffic	.418	.644	-.529	1.000	.764*
GDP	-.091	.832*	-.808*	.764*	1.000

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

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A.5.3 Key factor: Capability to Construct

Table A.5.3.1: Cases tested for H1

ID	Project Title	Delivery Type	Construction Capability Index	Level of investment	Cost to complete	Time to Complete
2	Metrolink LRT, Manchester	Private	1.000	3	0	0
4	Millau Viaduct	Private	1.000	1	-2	0
1	Piraeus Container Terminal	Private	1.000	2	0	0
5	Radial 2 Toll Motorway	Private	1.000	2	1	0
3	The Oresund Link	Joint venture	1.000	3	0	0
6	BNRR (M6 Toll)	Private	0.917	3	1	0
7	M80 Haggs	Private	0.867	2	0	0
23	Athens Tramway	Public	0.833	2	1	0
8	E18 Grimstad – Kristiansand	Private	0.833	2	0	0
10	Central Greece (E65) Motorway	Private	0.778	3	0	1
9	Ionia Odos Motorway	Private	0.778	3	0	1
11	Rion-Antirion Bridge	Private	0.717	2	0	-1
15	A19 Dishforth To Tyne Tunnel	Private	0.667	1	0	0
12	Central Public Transport Depot Of The City Of Pilsen	Private	0.667	2	-2	-1
24	Gardermobanen (Airport Exprestrain)	Public S.A.	0.667	2	1	0
14	Larnaka Port & Marina Re-Development	Private	0.667	3	0	1
13	Moreas Motorway	Private	0.667	2	0	1
17	Quadrante Europa Terminal Gate	Private	0.667	1	-2	0
16	Velo'V	Private	0.667		0	0
18	Larnaca And Paphos (Cyprus) International Airports	Private	0.656	2	0	0
19	Metro De Malaga	Private	0.505	1	1	1
26	MXP T2-Railink-Up	Public	0.500	1	0	0
25	Sá Carneiro Airport Expansion	Public	0.500	1	1	1
20	Athens International Airport B€□Eleftherios Venizelosβ€□	Private	0.417	3	0	0
21	Brabo 1	Private	0.347	1	0	0
22	Attiki Odos (Athens Ring Road)	Private	0.330	3	0	0
33	Blanka Tunnel Complex	Public	0.333	2	1	1
32	Bundesautobahn 20	Public	0.333	3	-2	0
28	Modlin Regional Airport	Public	0.333	1	1	1
30	Motorway E-75, Section Donji Neradovac - Srpska Kuca	Public	0.333	1	0	1
31	Port of Agaete	Public	0.333	1	0	1
27	The Hague New Central Train Station	Public	0.333	3	0	1
29	Tram T4 (Line 4 Of Lyon Tramway)	Public	0.333	1	0	0

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Table A.5.3.2: Spearman's non-parametric test for the sample of H1

Spearman's rho	Delivery Type	Construction Capability Index	Level of Investment	Constr Cost Overrun	Constr Time to completion
Delivery Type	1	-0,584**	-0.299	0.301	0.341
Construction Capability Index	-0,584**	1	0.245	-0.014	-0,358*
Level of Investment	-0.299	0.245	1	-0.066	-0.055
Constr Cost Overrun	0.301	-0.014	-0.066	1	0.337
Constr Time to completion	0.341	-0,358*	-0.055	0.337	1

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

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Table A.5.3.3: Spearman's non-parametric test for the sample of H1 with additional variables

Spearman's rho	Delivery Type	Capability to Operate Index	Actual Construction Cost	Level of Control	Actual vs Forecasted Traffic	GDP	Passenger freight mixed	Node Link
Delivery Type	1	-0.243	0.123	0.026	0.147	0,320*	-0.151	0.070
Capability to Operate Index	-0.243	1	0.206	-0.030	0.083	0.149	-0.037	0.119
Actual Construction Cost	0.123	0.206	1	0.126	0.115	-0.066	0.281	0,415**
Level of Control	0.026	-0.030	0.126	1	0.146	0.207	-0.156	-0,399**
Actual vs Forecasted Traffic	0.147	0.083	0.115	0.146	1	0.215	-0.074	0.051
GDP variation	0,320*	0.149	-0.066	0.207	0.215	1	-0.077	0.000
Passenger freight mixed	-0.151	-0.037	0.281	-0.156	-0.074	-0.077	1	0,416**
Node Link	0.070	0.119	0,415**	-0,399**	0.051	0.000	0,416**	1

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A.5.4 Key Factor: Brownfield section improves resilience to macro-economic fluctuations

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Table A.5.4.1: Cases Tested for H1

Project Name	Delivery Type	Year Awarded	Contract duration years	Construction Budget MEuros (2013)	% public contri-bution	Brownfield/ Greenfield length	Level of Control [1, 6]	Actual vs Fore-casted Traffic [-2, 1]	GDP [-1, 1]	Constr. Cost Overrun	Constr. Time to com-pletion
E4 Helsinki-Lahti	PPP	2012	15.33	769.88	n.a.	3.37	3.0	1	0	0	n.a.
BreBeMi	PPP	2003	19.5	944.17	n.a.	0.56	0.4	-1	-1	1	n.a.
Motorway E-75, Section DonjiNeradovac - Srpskakuca	Public	2011	n.a.	26.88	100	1.03	2.6	0	1	0	1
E39 Orkdalsvegen Public Road	PPP	2003	25 (+ 3 construction)	244.04	n.a.	0.37	2.6	1	1	n.a.	0
Horgos-Pozega	PPP	2007	25	1507.48	n.a.	1.18	2.63	n.a.	n.a	n.a.	n.a.
Elefsina Korinthos PatraPyrgosTsakona Motorway	PPP	2007	30 (including design/ construction period)	967.00	22.7	0.28 (After re-neg. 0.78)	3.4	-2	-1	0	1
Central Greece (E65) Motorway	PPP	2007	30	1,746.94	30.65	0.33	2.3	-2	-1	0	1
Moreas Motorway	PPP	2007	32	956.10	30.00	0.4	3.0	-1	-1	0	1
Ionia Odos	PPP	2007	30	1299.29	27.70	0.93	3.0	-2	-1	0	1
M80 Haggs	PPP	2008	30	572.17	n.a.	0.5	1.5	0	0	0	0
A22 – Algarve	PPP	2000	30	253.00	n.a.	2.57	1.88	-2	n.a.	n.a.	n.a.

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Table A.5.4.2: Spearman's non-parametric test for the sample of H1

Spearman's rho	Delivery Type	Brownfield Greenfield length	Level of Control	Actual vs Forecasted Traffic	GDP	Constr. Cost Overrun	Constr. Time to completion
Delivery Type	1.000	.200	-.051	-.312	.530	-.143	.258
Brownfield Greenfield length	.200	1.000	-.087	.150	.360	.082	0.000
Level of Control	-.051	-.087	1.000	-.116	-.170	-.592	.564
Actual vs Forecasted Traffic	-.312	.150	-.116	1.000	.442	.177	-.882**
GDP	.530	.360	-.170	.442	1.000	-.286	-.617
Constr. Cost Overrun	-.143	.082	-.592	.177	-.286	1.000	
Constr. Time to completion	.258	0.000	.564	-.882**	-.617		1.000

** Correlation is significant at the 0.01 level (2-tailed).

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A.5.5 Key Factor: Bundling of Activities

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Table A.5.5.1: Cases Tested for H1

Project Name	Delivery Type	Year Awarded / Construction Start	Con-tract Durat-ion	Const. Budget MEuros (2013)	% public contrib u-tion	Commer-cial Revenue Indicator [1, 3]	Common Operator [0, 1]	Potential Revenue from combined transport operation [1, 3]	Level of Control [1, 6]	Actual vs Fore-casted Traffic [-2, 1]	GDP [-1, 1]	Constr. Cost Overrun	Constr. Time to com-pletion
Athens International Airport	PPP	1995	30	3653	18	2	0		5.25	-1	-1	0	0
Larnaca and Paphos International Airports	PPP	2005	25	749	n.a	1	1		5.25	-1	-1	0	0
Reims Tramway	PPP	2006	34.5 (30 after constr.)	334.32	57.0		1	3	2.25	-1	0	1	n.a.
Caen-TVR	PPP	1994	30	294.95	42.4		1	3	2.63	0	0	n.a.	n.a.
Larnaca Port & Marina re-development	PPP	2012	35 (port & marina) 99 (real estate)	689.16	n.a.	3	1		4.13	n.a.	-1	n.a.	1
Fertagus train	PPP	1999	30 (renego tiated to 6; further renegot iated to 20)	27.36	n.a.	1	0	0	3.0	0	n.a.	n.a.	n.a.

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Project Name	Delivery Type	Year Awarded / Construction Start	Con-tract Durat-ion	Const. Budget MEuros (2013)	% public contrib u-tion	Commer-cial Revenue Indicator [1, 3]	Common Operator [0, 1]	Potential Revenue from combined transport operation [1, 3]	Level of Control [1, 6]	Actual vs Fore-casted Traffic [-2, 1]	GDP [-1, 1]	Constr. Cost Overrun	Constr. Time to com-pletion
Berlin Brandenburg Airport (BER)	Public	2006	n.a.	6110	100	3	1		4.13	1	0	n.a.	1
Tram-Train Kombilosung Karlsruhe	Public	2010	n.a.	897.32	100		1	3	3.75	1	1	n.a.	0
RandstadRail	Public	2003	n.a.	1375.26	n.a.		1	3	4.13	1	0	1	1
Combiplan Nijverdal	Public	2010	n.a.	282.00	100			3	3.75	-1	1	0	0
The Oresund Link	Public Joint venture	1995		2323	19		1	3	3.38	1	0	0	0
Berlin Tiergarten Tunnel	Public	1995	n.a.	7689	100			3	3.38	1	0	1	1
The Hague Central Station	Public	2011	n.a.	112.74	100%	3	1		4.13	0	-1	0	1
Servici	PPP	2000	20	95.5	n.a	3			2.65	0	0	n.a.	n.a.
Velo V	PPP	2004	13	60.68	n.a.	3			3.0	1	n.a.	0	0

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Table A.5.5.2: Spearman's non-parametric test for the sample of H1

Spearman's rho	Delivery Type	Commercial Revenue Indicator	Common Operator	Potential Revenue from combined transport operation	Level of Control	Actual vs Forecasted Traffic	GDP	Constr.Cost Overrun	Constr. Time to completion
Delivery Type	1.000	.436	.430	.488	.266	.529	.479	.158	.311
Commercial Revenue Indicator	.436	1.000	.559		-.385	.685	.490		.693
Common Operator	.430	.559	1.000	1,000**	-.115	.369	.385	.316	.378
Potential Revenue from combined transport operation	.488		1,000**	1.000	.250	.178			
Level of Control	.266	-.385	-.115	.250	1.000	-.052	-,573*	-.370	.149
Actual vs Forecasted Traffic	.529	.685	.369	.178	-.052	1.000	.338	.250	.366
GDP	.479	.490	.385		-,573*	.338	1.000	.370	-.224
Constr. Cost Overrun	.158		.316		-.370	.250	.370	1.000	,745*
Constr. Time to completion	.311	.693	.378		.149	.366	-.224	,745*	1.000

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

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Table A.5.5.3: Maturing period

Project Name	Delivery Type	Year Project Conceived	Year Awarded / Construction Start	Maturing period (years)
Athens International Airport	PPP	1975	1995	20
Larnaca and Paphos International Airports	PPP	1988	2005	17
Reims Tramway	PPP	2003	2006	3
Caen-TVR	PPP	1988	1994	6
Larnaca Port & Marina re-development	PPP	1999	2012	13
Fertagus train	PPP	-	1999	-
Berlin Brandenburg Airport (BER)	Public	1992	2006	14
Tram-Train Kombilosung Karlsruhe	Public	2002	2010	8
RandstadRail	Public	1989	2003	14
CombiplanNijverdal	Public	1970	2010	40
The Oresund Link	Public Joint venture	1973	1995	22
Berlin Tiergarten Tunnel	Public	1992	1995	3
The Hague Central Station	Public	2001	2011	10
Servici	PPP	-	2007	-
Velo V	PPP	2003	2004	1

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A 5.6 Spearman's Non-Parametric Tests & Importance Analysis of Business Model Indicators

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Table A.5.6.1 Spearman's rho

Key Characteristics	Airports			Metros			Tramways			Ports			Rail		
	Cost	Time	Traffic	Cost	Time	Traffic	Cost	Time	Traffic	Cost	Time	Traffic	Cost	Time	Traffic
Cost Saving Potential															
Capability to Construct	0.433	0,866**	0.204	-0.584	-0.584	0,739*	0.526	0.241	0,866**	0.599	0.057	0.095	0.128	-0.338	0.231
Optimal Constr. Risk Allocation	0.500	1,000**	0.354	0.632	0.632	-0,980**	0.091	0.445	0,768**	0.316	-0.100	0.000	-0.683	-0.645	0.088
Capability to Innovate	0.500	1,000**	0.354			-0.612	0,683*	0.168	0.547	0.125	0.316	-0.153	0.408		0.250
Life Cycle Planning	0.500	1,000**	0.354	0.395	0.395	-0.750	0,712**	0.425	0,779**	0.211	-0.267	-0.067	0.500	0.395	0.295
Capability to Operate	-0.498	-0.285	0.134	-0.619	-0.619	0,734*	0,748**	0.278	0,659*	-0.245	-0.207	-0.546	-0.129	-0.342	0.167
Optimal Operation Risk Allocation	-0.250	-0.500	-0.354	-1,000**	-1,000**	0.791	0,559*	0,676**	0.528	-0.125	-0.316	-0.459			
Revenue Stream Support															
% of Greenfield	0.500	1,000**	0.354	0.250	0.250	-0.791	-0,750**	-0.271	-0,815**	-0.375	0.474	-0,765*	0.000	-0.250	0.559
% of secondary infrastructure				-0.141	-0.141	0.493				0.250	-0.316	0.102	-0,904**	-0.342	-0.233
% Brownfield	-0.500	-1,000**	-0.354	0.141	0.141	0.600	0,750**	0.271	0,815**	0.250	0.158	0.510	-0.171	-0.258	-0.176
% non transport revenues	0.270	0,905*	0.554	0.363	0.363	0.229	-0,723**	-0.191	-0.462	0.200	0.316	-0.141	0.500	0.272	0.333
Level of Control	0.488	0,976**	0.499	0.428	0.428	-0.704	0,823**	0.077	0,634*	0.348	-0.352	0.332	-0.433	0.000	-0.447
Optimal Demand Risk Allocation	-0,750*	0.000	-0,707*	0.584	0.584	-0.462	-0.430	0.294	0.390	0.552	0.306	-0.038	0,761*	0.424	0.289
Level of Satisfaction	0.488	0,976**	0.499	0.216	0.216	-0.128	0,607*	0.089	0,590*				0.441	0.167	0.114

**. Correlation is significant at the 0.05 level (2-tailed).*

***. Correlation is significant at the 0.01 level (2-tailed).*

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Table A.5.6.1 Spearman's rho (continued)

	Bridge & Tunnel			Roads including Brownfield sections			Greenfield Roads		
	Cost	Time	Traffic	Cost	Time	Traffic	Cost	Time	Traffic
Cost Saving Potential									
Capability to Construct	0.372	0.372	0.160	-.266	.075	.337	-.204	.270	-.277
Optimal Constr. Risk Allocation	-0.555	0,926**	-0.720	-.146	-.013	-.267	-.509**	.107	-.500**
Capability to Innovate	-0.555	0,926**	-0.720	.615**	.601**	.514**	.076	-.182	-.081
Life Cycle Planning	1,000**	1,000**		-.319	-.118	-.063	-.036	-.018	-.382*
Capability to Operate	0.370	0.370	-0.113	-.515**	-.048	.027	-.054	.490**	.003
Optimal Operation Risk Allocation	-0.555	0,926**	-0.720	.176	.241	.106	-.440*	.017	-.420*
Revenue Support Potential									
% of Greenfield							-.116	.032	-.171
% of secondary infra	1,000**	1,000**							
% Brownfield							-.099	-.016	-.117
% non transport revenues				.249	-.077	.121	-.025	.338	.064
Level of Control	-0.196	0,979**	-0.646	.453*	.472**	.515**	-.554**	-.417*	-.416*
Optimal Demand Risk Allocation	0.080	0.239	0.046	.572**	.493**	.468*	.204	-.410*	.112
Level of Satisfaction				-.319	-.451*	-.282	-.199	-.521**	-.350

**. Correlation is significant at the 0.05 level (2-tailed).*

***. Correlation is significant at the 0.01 level (2-tailed).*

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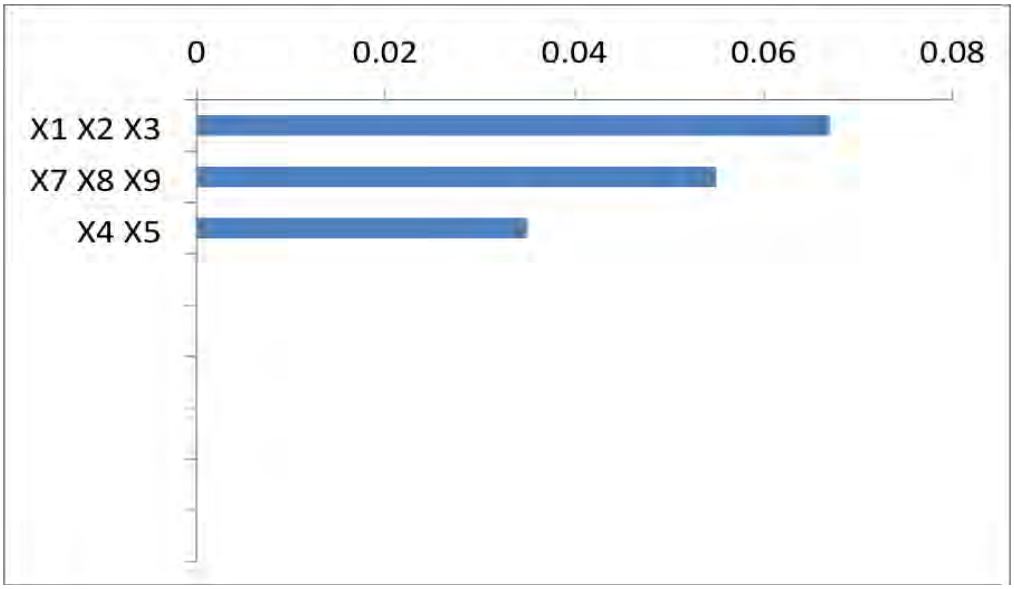

Figure A.5.6.1: Importance of Cost Saving factors with respect to cost overrun

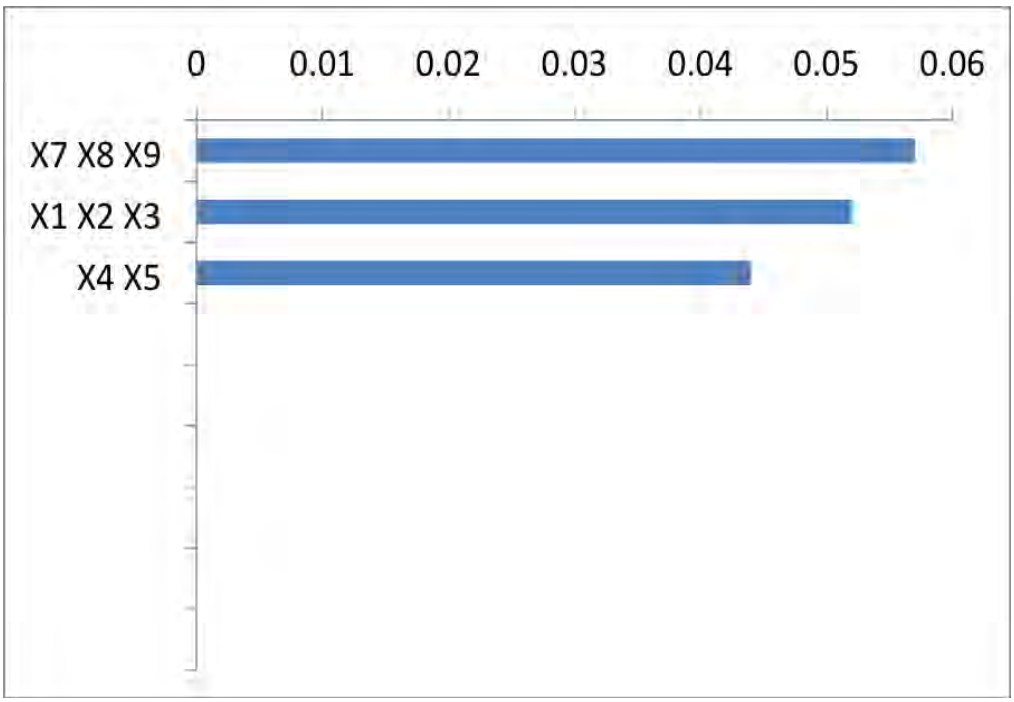

Figure A.5.6.2: Importance of Cost Saving factors with respect to time overrun

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A.6 Governance Typology

A.6.1 Detailed background description of indicators

Table A.6.1: Governance indicators and descriptions

Indicator	Description
G1.The client selected only one service provider [bidder] to participate in the pricing stage	These variables were found to be statistical significant factors of project governance (PG). Note between Project Performance (PP) and PG was found also a significant positive association (see i.e. Chen and Manley, 2014). This couple of indicators is linked to the risk and reward sharing regime component in a project as well as associated with the risk awareness feature of an optimal risk allocation as seen by Ng and Loosemore (2007).
G2.The client and the key service providers [bidders] collectively estimated the expected project cost	
G3.Encouragement of competition between bidders	This variable was found to be a statistical significant factor that ultimately contributes to reduce transaction costs (Li, Arditi and Wang, 2013). This variable favours uncertainty in the transaction environment for a project to be reduced as well as is associated with the risk awareness feature of an optimal risk allocation as seen by Ng and Loosemore (2007).
G4.Integration of design and construction	This variable was found to be a statistical significant factor of PG (Chen and Manley, 2014). This variable was also found to be a statistical significant factor that ultimately contributes to reduce transaction costs (Li, Arditi and Wang, 2013). This variable favours uncertainty in the transaction for a project to be reduced as well as is associated with the risk awareness feature of an optimal risk allocation as seen by Ng and Loosemore (2007).
G5.The key service providers [contractor] to pay a penalty if completion dates were not met	These variables were found to be statistical significant factors of PG (Chen and Manley, 2014). This couple of indicators is linked to the risk and reward sharing regime in a project as well as associated with the incentives component of an optimal risk allocation as seen by Ng and Loosemore (2007).
G6.The key service providers [contractor] solely carried the risk of rising costs	
G7	**NOT TO BE Included**
G8. Bonding requirements	This variable was found to be a statistical significant factor of PG (Chen and Manley, 2014). This variable was also found to be a statistical significant factor that ultimately contributes to reduce transaction costs (Li, Arditi and Wang, 2013). This variable favours uncertainty in the transaction for a project to be reduced as well as is associated with incentives components of an optimal risk allocation as seen by Ng and Loosemore (2007).
G9. Commercial/revenue & financial risks are not	Fair allocation of risk variable was found to be a statistical significant factor that ultimately contributes to reduce transaction costs (Li, Arditi and Wang, 2013). This variable favours uncertainty in the transaction

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Indicator	Description
concentrated	environment for a project to be reduced as well as indirectly reflects projects capacity to cope with risk as seen by Ng and Loosemore (2007).
G10. Clauses enable updating of service and/or price changes	This variable was found to be associated significantly with Pareto improving amendments. Pareto improving amendments are considered as renegotiations that improve the welfare of one party without worsening the other (e.g., Guasch et al. 2007, 2008) in Susarla (2012). These Pareto improving amendments usually lead to a reduction of transaction costs. This variable is evidently connected with the contractual flexibility component of the governance typology. Flexibility provisions reduce the likelihood of rent seeking by both parties lowering maladaptation and underinvestment (Susarla, 2012).
G11. Clauses indicate that client has an option to terminate the agreement without cause	This variable was found to be associated significantly with Pareto improving amendments. Pareto improving amendments are considered as renegotiations that improve the welfare of one party without worsening the other (e.g., Guasch et al. 2007, 2008) in Susarla (2012). These Pareto improving amendments usually lead to a reduction of transaction costs. This variable is connected with the contractual flexibility component of governance typology. Termination for convenience rights grants unilateral control to the client, reducing the likelihood that a contractor can engage in opportunistic rent seeking. The threat of unilateral termination by the client correspondingly lowers the likelihood of underinvestment by the contractor. Such enhanced performance incentives for a contractor correspondingly lower incentives for a client to force concessions or strategic termination, lowering the likelihood of maladaptation and underinvestment, facilitating smooth adaptation to unfolding contingencies and leading to Pareto improving amendments (Susarla, 2012).

A.6.2 Scoring methodology

This section explains how these variables can be determined from the information that is available from the BENEFIT database. The scoring methodology for each variable is presented in Table A.6.2.

Table A.6.2: Governance indicator scoring methodology

Indicator	Coding into the proposed system model and collection of information
G1.The client selected only one service provider [bidder] to participate in the pricing stage	G1 and G2 are jointly evaluated by one of the two numbers 0.5, or 1. The lumped measure for G1 and G2 is coded as 0,5 if the client selected only one bidder to participate in the pricing stage and 1 if the client and several bidders were involved in the pricing process. The narratives attached to '1.8.1. Procurement/tendering' in the BENEFIT database and templates can provide information to derive the values. Yet it is desirable that this information is collected by a questionnaire addressed to the project management to ensure reliability.
G2.The client and the key service providers [bidders] collectively estimated the expected project cost	
G3.Encouragement of competition between bidders	This variable is to be coded as 1 (0 otherwise) for procurement processes in which more than one bidder was involved. The value to be assigned to this indicator can be directly derived from section '1.8.1. Procurement/tendering' in the BENEFIT database.

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Indicator	Coding into the proposed system model and collection of information
G4.Integration of design and construction	This variable is to be coded as 1 (0 otherwise) for contracts in which design and construction of works is one of the services to provide. The value to be assigned to this indicator can be directly derived from section '1.8.2 Contract' in the BENEFIT database.
G5.The key service providers [contractor] to pay a penalty if completion dates were not met	We suggest coding G5 and G6 measure with values from a three point scale depending on the presence of two contract clauses. The lumped measure for G5 and G6 is coded as 0,5 if the contractor solely carried the risk of rising costs and 1 if contractor is additionally obliged to pay a penalty if completion dates were not met. If none of this is the case, this indicator is zero. For information The narratives see in the BENEFIT database '1.8.1. Procurement/tendering' and '1.8.2. Contract'. Yet, to ensure reliability, it is desirable that this information is collected by either a review of the project contract or a questionnaire addressed to the project management.
G6.The key service providers [contractor] solely carried the risk of rising costs	
G8. Bonding requirements	This variable is to be coded as 1 (0 otherwise) if clauses indicate that guarantees of performance are/were agreed upon. For information see '1.8.3 Revenue Stream' and '1.8.6 Performance' in the BENEFIT database and templates.
G9. Commercial/revenue & financial risks are not concentrated on one party	This variable is to be coded as 0 (1 otherwise) if commercial/revenue & financial risk allocation is (was) rather concentrated in one party. The value to be assigned to this indicator can be directly derived from section '1.8.4. Risks' in the BENEFIT database. Please note that in order to obtain a value for this indicator the assessor must examine only how commercial/revenue and financial risks are distributed. According to Iossa, Spagnolo and Velez (2007), Ke, Wang and Chan (2010) and Chung, Hensher Rose (2010) it is possible to infer that a generic rule to allocate risk cannot be used. Nevertheless, there is somewhat a common agreement that when at least, commercial/revenue and financial risks are shared, this constitutes a more optimal situation in comparison to the situation under which risk is concentrated on one party. Moreover, note that residual risk is ultimately shared over the project life-time in most of the cases. The remainder risks in section '1.8.4. Risks' might have clearer criteria of allocation. For example, Design, construction and maintenance risks are commonly allocated to the party carrying out these activities. Regulatory and force majeure risk are commonly managed by the public party. Any deviation from this distribution can suggest an inappropriate risk allocation and can also be penalized in the system model by setting a value of zero for this variable.
G10. Clauses enable updating of service and/or price changes	We suggest coding this measure as a binary scale depending on the presence of two clauses that specify updating of service terms and enabling price changes. The measure is coded as 1 if EITHER OR BOTH of the clauses are present. The narratives attached to the section '1.8.2 Contract' in the BENEFIT database and templates can

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Indicator	Coding into the proposed system model and collection of information
	provide information to derive the values. Yet, for reliability reasons, it is desirable that this information is collected by either a review of the project contract or a questionnaire addressed to the project management.
G11. Clauses indicate that client has an option to terminate the agreement without cause	This variable is to be coded as 1 (0 otherwise) if clauses indicate that the client has an option to terminate the agreement prematurely without cause. The narratives attached to '1.8. 2 Contract' in the BENEFIT database and templates can provide information to derive the values. However, to reduce bias, it is desirable that this information is collected by either a review of the project contract or a questionnaire addressed to the project management.

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A.7 Financing Scheme Indicator

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		Aggr. Financial Scheme Indicators	Inst. and economic environment		Transport Mode Context	Governance	Business Model		Funding Scheme		Performance Indicators						
		I_normalized_new_all_categories	Institutional Indicator	Financial Economic	Reliability/ Availability. IRA	Overall Composite Indicator	Cost Saving	Revenue support	Remuneration Scheme	Revenue Scheme	ENVIRONMENTAL OUTCOMES	SOCIAL OUTCOMES	OTHER ECONOMIC OUTCOMES	TRANSPORT GOALS	COST OVERRRUN	TIME OVERRUN	ACTUAL VS FORECASTED TRAFFIC
I_normalized_new_all_categorli	Pearson-Korrel	1	,364*	,460**	,444**	0,073	-0,099	-0,07	0,213	-0,235	0,016	0,147	0,045	0,119	0,169	,342*	0,227
	Sig. (2-seitig)		0,021	0,003	0,004	0,663	0,543	0,667	0,186	0,144	0,922	0,37	0,786	0,466	0,297	0,031	0,159
	N	40	40	40	40	38	40	40	40	40	39	39	39	40	40	40	40
Debt A share	Pearson-Korrel	0,237	0,137	,351*	0,107	0,068	-0,091	0,019	0,135	0,217	0,094	0,292	0,237	0,054	0,178	,323*	0,09
	Sig. (2-seitig)	0,141	0,398	0,026	0,509	0,683	0,578	0,906	0,406	0,179	0,567	0,071	0,147	0,742	0,272	0,042	0,581
	N	40	40	40	40	38	40	40	40	40	39	39	39	40	40	40	40
Mixed Debt A-B share	Pearson-Korrel	,653**	0,218	0,208	0,181	0,162	0,179	0,007	-0,142	0,203	0,1	0,238	0,2	0,162	-0,081	-0,05	0,067
	Sig. (2-seitig)	0	0,176	0,199	0,263	0,331	0,269	0,965	0,381	0,208	0,544	0,144	0,222	0,319	0,618	0,759	0,68
	N	40	40	40	40	38	40	40	40	40	39	39	39	40	40	40	40
Debt B share	Pearson-Korrel	0,307	0,166	0,215	0,087	-0,193	-0,128	-0,192	0,159	-,549**	0,105	-0,052	-0,072	0,004	0,117	0,225	0,087
	Sig. (2-seitig)	0,054	0,306	0,182	0,594	0,246	0,432	0,234	0,326	0	0,527	0,754	0,665	0,982	0,472	0,162	0,593
	N	40	40	40	40	38	40	40	40	40	39	39	39	40	40	40	40
Debt C share	Pearson-Korrel	0,139	-0,086	-0,13	0,165	0,028	-0,117	0,099	,332*	-0,244	,361*	-0,242	-,379*	-,323*	0,165	0,241	-0,054
	Sig. (2-seitig)	0,393	0,596	0,424	0,309	0,868	0,471	0,545	0,037	0,129	0,024	0,137	0,017	0,042	0,308	0,135	0,741
	N	40	40	40	40	38	40	40	40	40	39	39	39	40	40	40	40
Debt D share	Pearson-Korrel	-0,257	0,168	0,232	0,146	0,281	-0,213	-0,137	0,146	-0,009	0,18	-0,128	-0,067	-0,016	-0,027	-0,211	0,061
	Sig. (2-seitig)	0,109	0,3	0,15	0,367	0,087	0,187	0,399	0,37	0,954	0,273	0,437	0,684	0,92	0,871	0,192	0,709
	N	40	40	40	40	38	40	40	40	40	39	39	39	40	40	40	40
Debt E share	Pearson-Korrel	0,079	-0,022	-0,058	-0,06	-0,137	-0,289	-0,299	-0,17	0,023	0,013	0,011	-0,047	-0,127	,438**	-,384*	-0,302
	Sig. (2-seitig)	0,628	0,891	0,724	0,712	0,411	0,071	0,061	0,296	0,888	0,938	0,946	0,778	0,435	0,005	0,014	0,059
	N	40	40	40	40	38	40	40	40	40	39	39	39	40	40	40	40
Eq A share	Pearson-Korrel	0,222	0,122	0,094	0,052	-0,123	0,165	-0,041	-0,015	-,325*	0,007	0,006	-0,026	-0,006	,374*	0,301	0,068
	Sig. (2-seitig)	0,168	0,453	0,562	0,749	0,461	0,309	0,802	0,924	0,041	0,965	0,97	0,874	0,972	0,017	0,059	0,676
	N	40	40	40	40	38	40	40	40	40	39	39	39	40	40	40	40
Eq B share	Pearson-Korrel	0,124	-0,129	-0,013	0,028	0,087	-0,086	0,136	0,095	-0,102	0,011	0,01	-0,04	0,175	0,106	0,067	0,103
	Sig. (2-seitig)	0,445	0,428	0,937	0,866	0,605	0,598	0,403	0,558	0,53	0,947	0,954	0,81	0,28	0,517	0,679	0,526
	N	40	40	40	40	38	40	40	40	40	39	39	39	40	40	40	40
Eq C share	Pearson-Korrel	-0,175	0,024	-0,055	0,127	-0,103	-0,137	0,004	-0,089	0,135	-0,132	-0,098	0,049	0,203	-0,056	-0,063	0,172
	Sig. (2-seitig)	0,281	0,882	0,736	0,436	0,54	0,399	0,982	0,586	0,407	0,422	0,554	0,766	0,209	0,732	0,697	0,29
	N	40	40	40	40	38	40	40	40	40	39	39	39	40	40	40	40
Eq D share	Pearson-Korrel	-,540**	-0,007	-0,132	-0,179	0,303	0,274	0,088	0,099	0,203	0,132	0,108	0,027	0,001	0,094	0,017	0,031
	Sig. (2-seitig)	0	0,967	0,418	0,269	0,064	0,087	0,588	0,544	0,208	0,424	0,511	0,872	0,993	0,564	0,916	0,848
	N	40	40	40	40	38	40	40	40	40	39	39	39	40	40	40	40
Gov't guar. Debt share	Pearson-Korrel	-,404**	-,365*	-,389*	-,815**	-0,31	0,231	-0,071	-0,22	0,111	0,011	0,01	-0,04	-,339*	-0,309	-0,292	-,388*
	Sig. (2-seitig)	0,01	0,021	0,013	0	0,058	0,152	0,664	0,172	0,494	0,947	0,953	0,807	0,033	0,053	0,067	0,013
	N	40	40	40	40	38	40	40	40	40	39	39	39	40	40	40	40
Gov't Subsidy share	Pearson-Korrel	-,388*	-,357*	-0,248	-0,244	-0,26	0,135	0,161	-,450**	0,144	0,054	-0,023	0,174	-0,004	-0,073	-0,2	-0,262
	Sig. (2-seitig)	0,013	0,024	0,123	0,13	0,115	0,407	0,322	0,004	0,376	0,745	0,889	0,289	0,98	0,656	0,216	0,102
	N	40	40	40	40	38	40	40	40	40	39	39	39	40	40	40	40

Colours and stars
yellow:
* correlation is significant at 0.05 level (two-sided).
** correlation is significant at 0.01 level (two-sided).
orange:
correlation is significant at level well below 0.1 (two-sided).

Figure A.7.1: Spearman's Non-Parametric Test for Financing Scheme Indicator

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A.8 FsQCA - Reading the results

The results of the fs QCA analysis (in particular the analysis regarding sufficient conditions) are presented in tables in Chapter 6. In order to facilitate the understanding of these tables, key terms will be defined and the two main symbols, which are indicated in the tables will also be explained. In these tables, the rows show each of the conditions composing the model and the columns show the different solution path(s). In each solution path, the signs '+' and ' ~ ' are used.

The sign '+' shows the presence of the condition in the path. For example, '+ cost saving' means the presence of the cost saving in the path; it means that 'high cost saving (+) in combination with otherfactors explains specific cases which are e.g. "on cost" (or "over cost"). The sign ' ~ ' shows the absence of the condition in the path. For example,'~ cost saving' means the absence of the cost saving in the path; this means that 'low cost saving (~) in combination with other factors explains specific cases which are e.g. on cost (or over cost).

Some of these signs (+ and ~) are highlighted in green colour. This means that these conditions are core conditions. Core conditions have a stronger explanatory value than the other conditions. Core conditions are identified in the following way: we take the combinations of conditions appearing in the parsimonious solution and we check if we can find the exact same combinations in the intermediate solution. If these conditions or combinations in the intermediate solution are also included in the parsimonious solution, then they are considered as core conditions.

Apart from the signs, the following terms are mentioned in the tables: 1) Consistency, 2) Raw coverage, 3) Unique coverage and also 4) solution coverage. The respective definitions are presented below:

- **Consistency**: is the degree to which empirical evidence supports the claim that a set-theoretic relation exists. A subset relation may signal a necessary or a sufficient condition, depending on which is the subset, the cause (sufficiency), or the outcome (necessity). In the sufficiency analysis, consistency measures the degree to which the solution is sufficient for the outcome to occur, referring to the percentage of the cases in which this is the case.
- **Raw Coverage**: is the degree of respective terms of specific minimal formula which cover observed cases. When there are more than one solution paths, each path has raw and unique coverage. Raw coverage, hence, reports the proportion of membership in the outcome explained by the solution term, referring to a percentage of the observed cases in which this is the case.
- **Unique Coverage**: is the share of coverage which can be uniquely attributed to one and only one sufficient condition, or net of all other sufficient conditions. By assessing the unique coverage, we also find to what extent the cases within solution paths overlap with each other. These cases are highlighted in yellow colour in the tables.
- **Solution Coverage**: is an assessment of the way the respective terms of all the minimal formulas 'cover' observed cases (in regression model, it might be similar to R^2). While there is often a trade-off between consistency and coverage, it is reasonable to calculate coverage only after establishing that a set relation is consistent (Ragin, 2008). Coverage, hence, reports the proportion of membership in the outcome explained by the overall solution term, referring to a percentage of the observed cases with this outcome explained by the overall solution term.

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It is also important to mention that the solution paths presented in the tables are the paths with consistency cut off > 0.75.

A.8.1 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: A.8.1 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
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

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ITEMS	SCORING	METHOD		CALIBRATION
		TYPE	Scaling	CS/fs-QCA
• 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

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ITEMS	SCORING	METHOD		CALIBRATION
		TYPE	Scaling	CS/fs-QCA
• 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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A.8.2 Case studies

Table A.8.2.1: Cases included in the cost and time outcome analysis

No	PROJECTS	Case number ID	Delivery mode
1	Athens International Airport	43	PPP
2	Larnaca and Paphos International Airports	56	PPP
3	Modlin Regional Airport	3	Public
4	A-19 Dishforth	16	PPP
5	A2 Motorway	28	PPP
6	A22 motorway	19	PPP
7	A23 motorway	36	PPP
8	Athens Ring Road	1	PPP
9	BNRR (M6 Toll)	14	PPP
10	C-16 Terrasa Manresa toll motorway	64	PPP
11	Combiplan Nijverdal	1	Public
12	E39 Orkdalsvegen Public Road	37	PPP
13	Eje Aeropuerto (M-12) Motorway	21	PPP
14	Koper - Izola Expressway	9	Public
15	Motorway E-75, Section Donji Neradovac - Srpska kuca	17	Public
16	Motorway E-75, Section Horgos-Novi Sad (2nd phase)	15	Public
17	M-80 (Haggs)	15	PPP
18	M-25 Orbital	49	PPP
19	M-45	22	PPP
20	Radial 2 Toll Motorway	20	PPP
21	Via-Invest Zaventem	40	PPP
22	Liefkenshoek Rail Link	45	PPP
23	FERTAGUS Train	25 +70	PPP
24	Metro de Malaga	48	PPP
25	Metro do Porto	71	PPP
26	Warsaw's Metro II-nd line	14	Public
27	Metrolink LRT, Manchester	17	PPP
28	Athens Tramway	13	Public
29	Brabo 1	41	PPP
30	MST-Metro Sul do Tejo	50	PPP
31	Lyon's tramway T4	4	Public
32	Reims tramway	33	PPP

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No	PROJECTS	Case number ID	Delivery mode
33	Lyon's VeloV	35	PPP
34	Barcelona Europe South Terminal	63	PPP
35	Muelle Costa Terminal Barcelona	62	PPP
36	Port of Agaete	24	Public
37	Port of Sines Terminal XXI	23	PPP
38	Central PT Depot of city of Pilsen	74	PPP
39	Lusoponte Vasco da Gama Bridge	24	PPP
40	Rion-Antirion Bridge	2	PPP
41	Blanka Tunnel	39	Public
42	Herrentunnel Lübeck	59	PPP
43	E4 Helsinki-Lahti	69	PPP
44	E18 Muurla-Lohja	73	PPP
45	Port of Leixoes	39	PPP
46	A5 Maribor Pince Motorway	8	Public
47	Belgrade Bybass Project	16	Public
48	Piraeus Container	7	PPP
49	Elefsina Korinthos Patra Pyrgos Tsakona Motorway	38	PPP
50	Moreas Motorway	52	PPP
51	Berlin Brandenburg Airport	25	Public
52	Hague New central station	2	Public

Table A.8.2.2: "PPP- Sub-sample" - Cases included in the cost and time outcome analysis

PROJECTS
1. Athens International Airport
2. Larnaca and Paphos International Airports
3. A-19 Dishforth
4. A2 Motorway
5. A22 motorway
6. A23 motorway
7. Athens Ring Road
8. BNRR (M6 Toll)
9. C-16 Terrasa Manresa toll motorway
10. E39 Orkdalsvegen Public Road
11. Eje Aeropuerto (M-12) Motorway
12. M-80 (Haggs)
13. M-25 Orbital
14. M-45
15. Radial 2 Toll Motorway

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16. Via-Invest Zaventem
17. Liefkenshoek Rail Link
18. FERTAGUS Train
19. Metro de Malaga
20. Metro do Porto
21. Metrolink LRT, Manchester
22. Brabo 1
23. MST-Metro Sul do Tejo
24. Reims tramway
25. Lyon's VeloV
26. Barcelona Europe South Terminal
27. Muelle Costa Terminal Barcelona
28. Port of Agaete
29. Port of Sines Terminal XXI
30. Central PT Depot of city of Pilsen
31. Lusoponte Vasco da Gama Bridge
32. Rion-Antirion Bridge
33. Herrentunnel Lübeck
34. E4 Helsinki-Lahti
35. E18 Muurla-Lohja
36. Port of Leixoes
37. Belgrade Bybass Project
38. Elefsina Korinthos Patra Pyrgos Tsakona Motorway
39. Moreas Motorway

Table A.8.2.3: "Road- Sub-sample" - Cases included in the cost and time outcome analysis

PROJECTS
1. A-19 Dishforth
2. A2 Motorway
3. A22 motorway
4. A23 motorway
5. Athens Ring Road
6. BNRR (M6 Toll)
7. C-16 Terrasa Manresa toll motorway
8. E39 Orkdalsvegen Public Road
9. Eje Aeropuerto (M-12) Motorway
10. Koper - Izola Expressway
11. Motorway E-75, Section Donji Neradovac - Srpska kuca
12. Motorway E-75, Section Horgos-Novi Sad (2nd phase)

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13. M-80 (Haggs)
14. M-25 Orbital
15. M-45
16. Radial 2 Toll Motorway
17. Via-Invest Zaventem
18. E4 Helsinki-Lahti
19. E18 Muurla-Lohja
20. A5 Maribor Pince Motorway
21. Piraeus Container
22. Elefsina Korinthos Patra Pyrgos Tsakona Motorway
23. Moreas Motorway

Table A.8.2.4: Cases included in the traffic and revenues outcome analysis

No	PROJECTS	Case number ID	Delivery mode
1	Athens International Airport	43	PPP
2	Larnaca and Paphos International Airports	56	PPP
3	Modlin Regional Airport	3	Public
4	A-19 Dishforth	16	PPP
5	A2 Motorway	28	PPP
6	A22 motorway	19	PPP
7	A23 motorway	36	PPP
8	BNRR (M6 Toll)	14	PPP
9	E39 Orkdalsvegen Public Road	37	PPP
10	Eje Aeropuerto (M-12) Motorway	21	PPP
11	Koper - Izola Expressway	9	Public
12	Moreas Motorway	52	PPP
13	Motorway E-75, Section Donji Neradovac - Srpska kuca	17	Public
14	Motorway E-75, Section Horgos-Novi Sad (2nd phase)	15	Public
15	M-80 (Haggs)	15	PPP
16	M-25 Orbital	49	PPP
17	M-45	22	PPP
18	Radial 2 Toll Motorway	20	PPP

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No	PROJECTS	Case number ID	Delivery mode
19	Via-Invest Zaventem	40	PPP
20	Liefkenshoek Rail Link	45	PPP
21	FERTAGUS Train	25 +70	PPP
22	Metro de Malaga	48	PPP
23	Metro do Porto	71	PPP
24	Warsaw's Metro II-nd line	14	Public
25	Metrolink LRT, Manchester	17	PPP
26	Athens Tramway	13	Public
27	Brabo 1	41	PPP
28	MST-Metro Sul do Tejo	50	PPP
29	Lyon's tramway T4	4	Public
30	Reims tramway	33	PPP
31	Lyon's VeloV	35	PPP
32	Barcelona Europe South Terminal	63	PPP
33	Muelle Costa Terminal Barcelona	62	PPP
34	Port of Agaete	24	Public
35	Port of Sines Terminal XXI	23	PPP
36	Central PT Depot of city of Pilsen	74	PPP
37	Lusoponte Vasco da Gama Bridge	24	PPP
38	Rion-Antirion Bridge	2	PPP
39	Blanka Tunnel	39	Public
40	Herrentunnel Lübeck	59	PPP
41	E4 Helsinki-Lahti	69	PPP
42	E18 Muurla-Lohja	73	PPP
43	Port of Leixoes	39	PPP
44	Piraeus Container	7	PPP
45	Athens Ring Road	1	PPP
46	C-16 Terassa Manresa toll motorway	64	PPP
47	Combi plan Nijverdal	1	Public

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Table A.8.2.5: "PPP- Sub-sample" - Cases included in the traffic and revenues outcome analysis

No.	PROJECTS
1	Athens International Airport
2	Larnaca and Paphos International Airports
3	A-19 Dishforth
4	A2 Motorway
5	A22 motorway
6	A23 motorway
7	BNRR (M6 Toll)
8	E39 Orkdalsvegen Public Road
9	Eje Aeropuerto (M-12) Motorway
10	Moreas Motorway
11	M-80 (Haggs)
12	M-25 Orbital
13	M-45
14	Radial 2 Toll Motorway
15	Via-Invest Zaventem
16	Liefkenshoek Rail Link
17	FERTAGUS Train
18	Metro de Malaga
19	Metro do Porto
20	Metrolink LRT. Manchester
21	Brabo 1
22	MST-Metro Sul do Tejo
23	Reims tramway
24	Lyon's VeloV
25	Barcelona Europe South Terminal
26	Muelle Costa Terminal Barcelona
27	Port of Agaete
28	Port of Sines Terminal XXI
29	Central PT Depot of city of Pilsen
30	Lusoponte Vasco da Gama Bridge
31	Rion-Antirion Bridge
32	Herrentunnel LÃ¼beck
33	E4 Helsinki-Lahti
34	E18 Muurla-Lohja
35	Port of Leixoes
36	Piraeus Container
37	Athens Ring Road
38	C-16 Terassa Manresa toll motorway

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able A.8.2.6: “Road- Sub-sample” - Cases included in the traffic and revenues outcome analysis

No	PROJECTS
1	A-19 Dishforth
2	A2 Motorway
3	A22 motorway
4	A23 motorway
5	BNRR (M6 Toll)
6	E39 Orkdalsvegen Public Road
7	Eje Aeropuerto (M-12) Motorway
8	Koper - Izola Expressway
9	Moreas Motorway
10	Motorway E-75. Section Donji Neradovac - Srpska kuca
11	Motorway E-75. Section Horgos-Novi Sad (2nd phase)
12	M-80 (Haggs)
13	M-25 Orbital
14	M-45
15	Radial 2 Toll Motorway
16	Via-Invest Zaventem
17	E4 Helsinki-Lahti
18	E18 Muurla-Lohja
19	Athens Ring Road
20	C-16 Terassa Manresa toll motorway

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A.9 Potential of transfer of Lessons Learned

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Entire Sample

Table A.9.1: Testing for H1 over the entire snapshot sample per mode (Average distance <1).

Infrastructure Mode	Number of Snapshots (datasets)	Number of Indicator Clusters formed	Number of Indicator sets not included in clusters	Number of outcome clusters formed	Number of outcome sets not included in clusters	Number of indicator clusters rejecting hypothesis	Share of cases rejecting hypothesis
Average distance <1 for outcome set; Average distance <1 for indicator set							
Airports	10	2	5	1	5	1	20%
Ports	8	1	6	1	5	0	50%
Rail	7	1	5	1	5	n.a.	100%
Bridge & Tunnel	7	2	2	1	5	2	80%
Roads	63	20	17	12	12	10	40%
Urban Transit	24	5	12	5	4	5	50%
Metros	4	1	2	1	1	0	0%
Tram/ LTR	18	4	8	3	8	4	50%
Average distance <1 for outcome set; Average distance <5 for indicator set							
Airports	10	2	2	1	5	2	38%
Ports	8	3	2	1	5	3	83%
Rail	7	1	5	1	5	n.a.	100%
Bridge & Tunnel	7	2	1	1	5	2	66%
Roads	63	13	6	12	12	13	51%
Urban Transit	24	4	7	5	4	4	60%
Metros	4	1	1	1	1	1	33%
Tram/ LTR	18	4	3	3	8	4	46%
Average distance <1 for outcome set; Average distance <10 for indicator set							
Airports	10	3	0	1	5	3	50%
Ports	8	3	2	1	5	3	83%
Rail	7	2	2	1	5	2	80%
Bridge & Tunnel	7	1	1	1	5	1	66%
Roads	63	9	6	12	12	9	70%
Urban Transit	24	5	2	5	4	5	59%
Metros	4	1	1	1	1	1	33%
Tram/LTR	18	4	1	3	8	4	53%

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Roads Only

Table A.9.2: Testing for H1 over the road snapshot sample distinguishing PPP and non-PPP projects

Infrastructure Mode	Number of Snapshots (datasets)	Number of Indicator Clusters formed	Number of Indicator sets not included in clusters	Number of outcome clusters form	Number of outcome sets not included in clusters	Number of indicator clusters rejecting hypothesis	Share of cases rejecting hypothesis
Average distance <1 for outcome set; Average distance <1 for indicator set							
PPP	55	17	18	11	9	13	38%
Public	8	3	2	2	2	2	33%
Average distance <1 for outcome set; Average distance <5 for indicator set							
PPP	55	10	6	11	9	10	55%
Public	8	3	1	2	2	2	29%
Average distance <1 for outcome set; Average distance <10 for indicator set							
PPP	55	7	4	11	9	7	65%
Public	8	2	0	2	2	3	63%

Roads only excluding project with potential traffic forecasts bias

Table A.9.3: Testing for H1 over the road snapshot sample distinguishing PPP and non-PPP projects excluding projects with potential traffic forecast bias

Infrastructure Mode	Number of Snapshots (datasets)	Number of Indicator Clusters formed	Number of Indicator sets not included in clusters	Number of outcome clusters form	Number of outcome sets not included in clusters	Number of indicator clusters rejecting hypothesis	Share of cases rejecting hypothesis
Average distance <1 for outcome set; Average distance <1 for indicator set							
PPP	32	10	8	7	7	5	29%
Public	3	1	1	1	1	1	50%
Average distance <1 for outcome set; Average distance <5 for indicator set							
PPP	32	5	5	7	7	5	55%
Public	3	1	1	1	1	1	50%
Average distance <1 for outcome set; Average distance <10 for indicator set							
PPP	32	5	5	7	7	5	55%
Public	3	1	1	1	1	1	50%

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A.10 Rebuttal

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

REVIEW OF DELIVERABLE D4.2
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
Yves Crozet	Authors' Response
Congratulate the authors. They did a good job especially because they are honest and explain clearly the situations where the results are not clear. Especially when the outcomes are not good.	Thank you
What is interesting is that the report underscores the situations where it is not possible to conclude	Thank you. Special emphasis has been placed in this respect in order to understand how to improve the MF.
A comprehensive approach by using 3 different methodologies in 3 different chapters (6,7,8) to assess the conditions of success or failures - outstanding	Thank you
Outstanding knowledge of the subject	Thank you
Technically sound - Excellent	Thank you
Some findings are more or less trivial: cf 7.3.1 1) relationship between the cost and the construction phase 2) relationship between revenue and the operational phase	The report aimed at a holistic approach. This also includes trivial issues.
Maybe it is necessary to focus on the necessary or sufficient reasons not to be "on cost", or "on revenue" or "on traffic"! Some remarks on PPP, better before the crisis than after lead to a more critical approach on the so called "wider economic benefits"	Findings are registered based on the approach followed. In some analyses methods, it was only possible to identify limiting factors. This is presented in the conclusions.
Coherence and **consistency** – Outstanding	Thank you
Writing – Good: It is difficult to provide outstanding results by listing different approaches	The document has been proof read by three individuals to streamline writing styles.
Cesar Queiroz	Authors' Response
Dr Queiroz made corrections throughout the text.	All suggestions have been included. Thank you
"Peripherical" to "peripheral"	This change was not **made** in chapter 6 as it refers to a term in FsQCA.
	Authors' Response

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Reviewer's Comments	Authors' Response
Dejan Makovsek (Comments based on Chapters 9 & 10 and scattered reading of the report)	
In terms of analytical efforts this is probably the biggest effort I have ever seen.	Thank you
I would therefore recommend, that each analytical approach in the concluding sections be represented separately, as opposed to now where they are compared for each of the performance outcomes (on budget, on time etc).	Each method of analysis ends with conclusions with respect to the funding and financing of transport infrastructure and the MF. Repeating these sections in the conclusions would increase the length of the document. However, respective references have been made.
My general and principal concern is however the identification and interpretation of variables in your typologies.	Typology definitions and structure are presented in detail in D2.2, D2.3, D2.4 and D3.1
You will note, that the design level of a project for a PPP or a traditional procurement will be different in particular, when the traditional procurement does not involve a design & build contract. Accordingly, the design in traditional procurement will be more advanced (normally a »full business case« or a »detailed design«), while in a PPP the design will be of a lower level (»outline business case« or »outline design« or even less). It is well established, that the budget estimates are more inaccurate the more rudimentary the design is. This introduces a bias between the two types of projects. A further complicating measure is, that the point above may not be true for all the PPP projects. There may well be cases, where the PPP was awarded for a detailed design, which was already elaborated by the public side.	These issues are dealt in the Governance indicator see chapter 4.4 and D2.2
Another aspect is, how do you account for the source of cost overruns – did the cost overrun come from the technical problems the contractor had on the project – or did it come from the change of specification by the procurement authority?	This is considered in the qualitative analysis. See Chapters 3 and 5.
As you know, in a PPP, the SPV/lenders transfer the construction risk to the construction contractor for a fixed price/date, agreed at contract award/financial close. If the contractor can do the project for less money – it's his profit, and the SPV nor the public authority get any »savings«. If the project costs more (within the responsibilities of the contractor) – it is his duty to absorb the risk. Accordingly, if the PPP consortium does not completely fall apart due to construction problems, no increase in project construction cost will be recorded. The information on the true construction cost is private. The only way, where a construction cost increase would be recorded, would involve cases like: - The public authority changing the scope/renegotiations; - A risk materializing, that was supposed to be shared between the PPP and the public authority (e.g. some kind of force majeure event); - Failure of the PPP consortia/renegotiations. Intuitively I would expect, that most recorded cost increases in PPPs come from the first point – public authority asking for something more than originally agreed, due to strategic behaviour in the first place or a poor planning process and poor definition of the desired output.	This has been identified in some cases in the qualitative analysis. See Chapters 3 and 5.
The strategic behaviour of one or both parties would also nicely explain the pre and post crisis PPP outcomes. In crisis, governments became even more constrained in terms of budget. Most of the BENEFIT members come from the EUROSTAT zone and the Maastricht criteria, which implicitly incentivized countries to seek off-balance sheet project execution. This exacerbated a	We consider renegotiations as "points of change".

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Reviewer's Comments	Authors' Response
hold-up problem, where the contractors/PPP partners knew this and could use it to extort the public authority (i.e. what mattered was not the cost, but the accounting treatment). Furthermore the tight market conditions may have forced the PPP/construction partners to go in low with the bids as well, hoping to renegotiate later. Note that renegotiation may not always end with bigger remuneration, it may also involve the extension of the concession period or reduction of the scope to be delivered. Thus a renegotiation does not necessarily imply a cost overrun.	
Issues like these should not dishearten your efforts. Much more specialized studies than this one have failed to produce a predictive framework for cost performance in infrastructure. Creedy (2006) in Australia covered more than 600 road projects in one single country and tried to identify causes of cost overruns for traditional projects. He tried to develop a predictive framework with the lead indicator method and failed. Flyvbjerg's reference class forecasting approach in the UK failed (though he would not agree with such an assessment), and the cost performance has recovered through greater institutional maturity. The issues of cost/time performance though is just one area. Challenges probably exist for other metrics as well.	This is the BENEFIT innovation and challenge.
Astrid Molenveld (chapter 6)	Authors' Response
Comments delivered 21 Dec. 2015	All comments included.
Werner Rothengatter	Authors' Response
Comments on Chapter 8 now section 4.3.1	
Section 8.2: Section 8.2 is on testing the influence of allocation for traffic demand risk. This is a most important issue and worthwhile to be studied beyond the cross tabulation exercises in chapter 7. The performance of a project is defined by two indicators: (1) actual traffic greater or equal to forecast for public finance, and (2) no re-negotiation for the case of PPP delivery. Actual traffic greater or equal to forecast is considered an "additional benefit". This is a fuzzy definition for statistical testing. From the political or economic points of view the definitions appear very narrow. One of the key influencing variables is "level of control". This is generated by a scoring procedure for three sub-indicators which again result from scoring procedures and compared with the actual demand risk allocation which is scored between 1 (totally public) and 6 (totally private) such that "level of control" and "actual demand risk" are measured within the same interval. The authors assume that differences between both figures are meaningful although the first is measured as a continuous and the second is measured as a discrete variable. Very strong conclusions are drawn from these differences: if they are smaller than (-1) then too much risk has been allocated on to the private sector, if they are between (-1) and (+1) then risk allocation is appropriate and if they are greater (+1) then too much risk has been allocated to the public sector. While the qualitative reasoning behind this approach is acceptable the quantitative approach includes a number of subjective manipulations of the data set and subjective definitions of thresholds. Together with the uncertainties hidden in the data set (I had mentioned the dependence of cost/time/forecast data on the phase of the life cycle) one can classify the overall approach as an interesting numerical exercise which can be used for an in depth analysis of projects after accomplishing the data base and ensuring that all data are comparable. The conclusions drawn in the assessment section 8.2.3.3 are highly uncertain and should not be over-interpreted with respect to the appropriateness of risk allocations for single projects. Example: On p96 it is concluded from the analysis that two public cases (Tram-Train "Kombilösung" Karlsruhe and Neubaustrecke) could have served as PPPs. First of all the Kombilösung is still under construction such that it is surprising that data for "actual vs. forecasted" figures are available. Secondly both projects were subject to a number of changes in all design phases and even during construction. Thirdly for both projects the planned	The section is now 4.3.1 and is included under the Business Model Indicator validation. This was the original intension of the analysis. The objective of the analysis was not to carry out a statistical analysis. The emphasis was more on ranking. The approach is definitely fuzzy and subjective, however, it is suitable to the type of data available (all given in scaling). Respective corrections and verifications of the cases identified were carried out. Stemming from the respective comment all data was reviewed, checked with the case "owners" and revised accordingly. The reviewer's comments with respect to conclusions were formulated accordingly, stressing also the fact that they should be considered with caution.

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Reviewer's Comments	Authors' Response
construction costs have more than doubled. Fourthly both projects cannot be operated exclusively rather than are essential components of an integrated network. In particular in the case of the Neubaustrecke it would only have been possible to construct an availability based PPP for the construction of the project, which would have separated the construction manager completely from the responsibility for maintenance and operation, i.e. the presumed impacts of PPPs on more efficient management have to be seriously questioned. While I appreciate the numerical exercise I recommend to formulate the conclusions much more carefully and take account of the limited reliability of the data base and the manifold subjective manipulations of these data which were necessary to perform the analysis.	
Comments on chapter 9 – now sections 4.3.2 to 4.3.6	
Typos in 3rd para of section 9.2.	Thank you. Corrected.
Projects: The "Tram-Train Kombilösung Karlsruhe" is still under construction. I don't understand why it is included in the tests on performance variables "actual vs. planned".	The project is scheduled in phased construction. Hence, phased operation is considered
P134: I don't know the term "concessioner", do you mean "concessionaire"?	Thank you. Corrected.
P141, Table 9.16: Typos	Thank you. Corrected.
P149, section 9.4.2, second and fourth bullet para: numbers missing in second and third bullet point	Thank you. Corrected.
P151, Table 9.21. The Table includes projects which are still under construction but get values for traffic and construction time indicators (Berlin, Karlsruhe)	Information by the case "owner" was provided for the phased development of the projects.
P154: maturing period, Table 9.22: The figures for the preparation period have to be interpreted with care. Projects associated with short periods may have passed through a long period of development to achieve an accepted design while only the time after approval enters the statistics. The length of the overall planning period can have various reasons (often missing acceptability or lack of funding) and does not indicate the maturity of the politically approved project design.	Thank you. This consideration was added to the text. This contribution is not included in the section nor other conclusions.
P159, section 9.4.4, bottom page, wording "in 5 in 11 cases"	Thank you. The sums of cases were reviewed throughout the text.
Champika Liyanage	Authors' Response
References to relevant material and literature: This could be improved, especially for Chapters 3 and 4.	Emphasis through the document has been placed on economizing length. Hence references have been extremely limited.
Sufficient knowledge of the subjects: Good - Since a lot has been covered in different angles, perhaps the depth of the issues covered may have been compromised in all chapters. But given the length of the document and the things discussed in the document, I'm sure it is not a major issue as such.	Thank you for your understanding.
Technically sound: Outstanding, especially the findings that have emerged from FsQCA, IA and EA are given in-depth and have been explained clearly.	Thank you
Findings clear and well argued: Good - Findings are clearly presented but, it is not argued well as to what the reasons could be for such findings. This was apparent mostly in Chapter 3. Most of the findings are presented in graphical/tabular form, and those are discussed as well briefly in paragraphs, but in many instances, the reasons are not provided.	The qualitative analysis was based only on the information provided in the narratives and snapshots. Deeper investigation into factors leading to some findings is expected in tasks 4.2 and 4.3 that follow.
Coherenece and constistency: Good - in some sections, especially in chapters 3, 4 and 5, the amount of information covered in different sections and the	This is due to the different volume of material in each

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structure slightly differ.	section. This is explained now in the introduction to the respective chapters.
Writing style: Good- The document could do with a final proof read.	The document has been proof read. Thank you.
Detailed remarks	
Chapter 3	
p.29 – it is quite unclear as to why the 08 dimensions were chosen for the review of cases regarding the outcome. It would be good to provide some reasoning for the choice of 08 dimensions.	The dimensions are those described for the MF in D3.1. This is now explained. Thank you
Airport analysis, although brief, has covered all 08 dimensions above. For road analysis – only 04 dimensions (mentioned in p.29) are considered/analysed. For Urban transits; bridge and tunnel projects; and Ports – only 03 dimensions are analysed. Rail project analysis (section 3.4) does not follow the same structure of analysis, thus, there is a lack of consistency.	In the introduction it was written "The analysis of cases per mode, while focusing on the same outcomes, follows a slightly different approach in order to exploit in the most appropriate way the available cases per mode. The approach followed is described in each respective section of this Chapter". Further clarification is now added.
.P.31 (Table 1) and p.32 first sentence give two different numbers for road cases, i.e. 30 and 31 respectively	The Combiplan Nijverdal (rail and road project) is included here but not in the road projects of section 3.1. This is added as a footnote on page 32
p.33 – Three Greek cases have been excluded for possible bias: what kind of bias are we talking about here? Or were they excluded due to non-completion?	. .. bias due to overweighting of projects in one coutry. Thank you. The above clarification has been added.
Chapter 4	
p.93 2nd para – Unit 1 has been omitted in the equation – is it correct?	Yes- this change has been made since late August 2015
Section 4.7 in p111 – 3rd para 2nd sentence 'the respective indicators may be validated ….' – If it's not validated, are findings be derived for lessons learnt valid?	As noted for 4.7 conclusions the validation did not lead to any conformation nor rejection of hypotheses. In Chapter 10 following all conclusions (all findings) there is a proposal for the restructuring of the financing scheme indicator. This was a conclusion of analyses throughout. So Yes lessons learned are valid.
Typologies (business model, funding and financing) are not validated as yet. They are to be further investigated. How will that inform/affect the subsequent tasks, will be good if that is discussed in chapter 10.	Business model is validated and confirmed through the various analyses. What is being tested now is if it should be weighted. Funding and financing scheme typologies are being reviewed in accordance with suggestions.

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Section 4.7.2, p.113 – why is Governance typology not included in the discussions?	Now included – Thank you
Chapter 5	
Why is implementation context missing in section 5.4 (Rail)?	The implementation section was added in section 5.4 Airports. Rail is not included as snapshots were available for only one case the Liefkenshoekspoorverbinding-Liefkenshoek Rail Link
Chapter 6	
p.150 – 2nd para mentions the threshold used by others as a satisfying consistency, e.g. 0.75 or 0.85 or even higher. In BENEFIT analysis 0.90 has been used, will be good to state it in this para and why?	**The threshold is 0.75. This has been clarified in the text.** Thank you.
Thierry Vaneslander/ Eleni Moschouli	Authors' Response
Chapter 1 - Introduction is good.	Thank you
Chapter 2 - Methodology is very good, well-written and easily understood. It presents in a few pages all the validation steps. It is a very good summary of what is done (validation steps 1-3) and what will be done (validation steps 4-5). Also good English language is used and the structure is cohesive.	Thank you
Chapter 4 - Typology Indicator Validation:	
a) Implementation context: brief, well written	Thank you
b) Business Model- Level of control: well written [4.3.2.3→ very interesting part the conclusions and lessons learned, very useful for policy makers, bullets very good p.83, the "box conclusions" p.83 (before 4.3.3) very good. - Capability to operate: box at the end useful (4.3.3.1) - Capability to construct: p.86 *"No trend…construction targets"*: Wouldn't be good to mention that in chapter 3 (QA) a trend was found? ("most cost overruns were identified in medium size projects"). General comment for BM section: it was indeed a refinement of the work done in D3.1 and also qualitative analysis was added. p.92: The changes made in BM are mentioned, which is very useful: 1) xcor omitted and 2) life cycle planning indicator changed (4.3.8 useful).	Thank you ▪ Box added for Capability to Operate. ▪ Chapter 3 findings have been added in the conclusions.
c) p.95: Governance validation → useful to mention that G7 is removed because it was found irrelevant (but this comment should be also taken into account in chapter 5 where it is written that 11 indicators compose the overall governance indicator (assessing reality fit). It was 11 before removing the G7 but after they are 10, aren't they? (see Chapter 5 comments)	Thank you. Chapter 5 was corrected respectively.
d) Funding scheme: 1. The Dimensions "Remuneration and Revenue scheme" are well defined. The same applies for the indicators composing each dimension (better defined than D3.1) 2. p.99→ not very clear how validation was made (what do we mean when we say that *"validation was conducted through the understanding of the case study authors on the appropriateness and comprehensiveness of the framework"?)* 3. p.100: Why 4.5.4.5 which refers to the overlaps between dimensions is included in the text? Only the overlaps are mentioned but is not explained if a change needs to be done or if these do not create any problem. 4. It is mentioned in p.100 (4.5.4.4) that the weighting of indicators should be adjusted for a given project. Was that the case for BENEFIT? Were the weightings adjusted for each case?	Thank you. The comments are valid. As per the conclusions of D4.2, the funding scheme is re-investigated. Hence, the suggested clarification will be included in the new version.
e) Financing scheme: 1. P.102: in this deliverable it is useful that it is mentioned that *"low*	Thank you

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indicator value must not be interpreted in the same way as a low indicator value in some private projects". But it would be good to mention more explicitly what low and high indicator value means for PPP and public projects. 2. p.102: "new numerical specification of the financing scheme indicator" is introduced and explained. But it is not clear why a "new" one was needed? 3. p.107: Why the validation of the financial indicator is confined to PPP projects? (is it because of the H5 which is confirmed above?) 4. p.108: H8 → It is mentioned that the indicator is correlated with the typology indicators e.g. governance etc. BUT IRA is not mentioned (what relationship is expected)?	1. This is included. 2. This new approach was based on the validation and information from partners. 3. The correlation to IRA is added.
Chapter 5 - Assessing the Reality Fit General comment: it is well written, clear, interesting and it is useful that there is a summary of findings at the end of each subsection. It is a very helpful chapter for the upcoming WP related to the effect of the economic crisis (p.123: "we can see the variation of indicators between different snapshots which shows stronger impact of the 2008 economic crisis). 1. p. 114: 1st paragraph of chapter 5 → It would be useful to add a few more explanations in this introductory part about "how we assess if each typology fits reality" and also to mention why this assessment of the reality fit is important to be conducted. 2. It would be also good at this part to mention that the assessment per typology is presented per project infrastructure category 1) roads, 2) bridges and tunnels. 3. It would be also good to mention that in this chapter comparisons are made between "North Western European Countries and Southern countries". 4. p.115 – 5.1.2 (1st paragraph): it would be good to mention that IRA indicator is always 100% at the award time because at the time of award we expect that the reliability and availability of the infrastructure will be the maximum. p.115 – 5.1.3 (Governance) - Not 11 indicators but 10 indicators compose the overall governance indicator because after the validation process G7 was omitted (see p. 95). - p.123: It would be useful to add a sentence in theintroduction explaining that by "Urban transit projects", we refer to e.g. tram, metro infrastructures etc. - p.123: Repetition: the first two sentences of 5.2.1 are repeated (implementation context). - 5.2.4 (p.125): Repetition - 5.2.5 (p.126): Repetition - 5.2.6 (p.127): 1st sentence Repetition - 5.2.7 (p.128): it would be better to use same title for each subsection presenting the conclusions ("summary of findings" (5.1.7) BUT next title "conclusions across typologies"(5.2.7) - 5.3.1 Repetition (implementation context) - 5.3.2 Repetition (Transportation mode typology) - 5.3.3 Repetition & governance indicators mentioned 11 instead of 10? - 5.3.4 Repetition (BM) - 5.3.4.2 Repetition - 5.3.7 it would be better to use the same title for all "conclusions subsections" of this chapter. - Airports (p.147): Implementation context subsection is not presented - 5.4.2 Governance typology (1st sentence: repetition) p.137 - 5.4.4 Funding scheme (1st sentence repetition)	Thank you Introduction enhanced. Analysis per mode stated. This only applies to road projects. This has been stated. Included. Governance: All governance reference corrected – thank you Repetition of introductory sentences kept, as it is part of the structure. In this way, chapter sections may be read independently. Airports: Implementation context section added – thank you

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- 5.5.1 (Ports): Repetition (Implementation context) p.142 - 5.5.2 Repetition (Transport Mode Typology) p.142 - 5.5.3 Repetition (Governance) p.142 - 5.5.4 Repetition (BM) p.142 - 5.5.4.2 Repetition p.142 - 5.5.5 (p.143): repetition	
Chapter 7: Importance analysis, p.201 repetition of 1st paragraph (same text mentioned in 7.1 (p.197)	Paragraph rephrased – thank you
Chapter 8: Econometric analysis General comments: This chapter is well written, well explained, references are used and there is also a focus on the effect of the economic crisis on PPP projects (by inserting a dummy for the years previous to the economic crisis). This chapter is useful for the upcoming Task 4.3 (Effects of Recent Economic and Financial Crisis). 1. p.208: Outcomes take binary values? Based on the snapshots outcomes take values between -1 and 2 and -2 and 2? 2. It would be useful if a brief definition (if possible) is included for the term " multiplicative dummy". 3. 8.2.1 (p.213) Revenue support provides the highest effect, not the remuneration scheme. 4. P.213: It would be good to mention for the Model M2 (like it was done for M1) which are the variables with the highest weights. In this case, since it seems that all variables are significant, it would be good to present the variables by order of importance like it was done for M5 for example.	Thank you 1. In order to improve the sample, outcomes are "equal and positive" and "negative". 2. There is reference in the footnote. There is a need to economize on report length. 3. Corrected and other variables checked – thank you 4. Influencing factors mentioned – thank you
Chapter 9 and 10: comments/corrections submitted on 21st of December 2015	Comments included in final draft.

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End of report

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