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Ex post analysis of road projects: resilience to crisis

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This investigation aimed to reveal a mechanism of how different road projects' settings respond to macro-economic crisis. Qualitative and quantitative analyses were performed over a sample of 31 European road projects, in various funding arrangements and life cycle phases, all extracted from the Horizon 2020 BENEFIT project cases database. The project setting is described through a specific combination of project features and/or values of developed indicators. The analysis was applied to identify factors that contributed to projects' performance regarding the resilience to the global financial crisis of 2007–2008. By doing this, it became possible to determine potential liabilities of projects that are already in their implementation or use phases. The analysis showed there are equally strong contributors to a project's success within country-specific, as well as project-specific features. In order to boost resilience toward sudden and unpredicted disruptions, several factors have emerged, such as long term planning, investing in top priority projects (preferably medium size investments), with realistic traffic projections and experienced and responsible concessionaires, but also having in place strong regulatory bodies and government support.The identified mechanism of enhancing the resilience to crisis caused by a specific project setting can be beneficial to multiple stakeholders.

Keywords: *crisis, financing, funding, PPP, road project.*

1. Introduction

The delivery of transport infrastructure is characterised by considerable complexity, including multiple factors that interrelate positively or negatively, leading to specific evidenced performance. These projects usually involve high capital costs followed by many years of operational costs and require a stable financial environment and constant revenue streams (FIDIC, 2012). In addition, multiple actors make decisions that consequently influence the course of project development and later, of its operation. Infrastructure projects are also vulnerable to

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external micro and macroeconomic influences (FIDIC, 2012; Flyvbjerg et al., 2003), and require adequate legislation to be in place (Daito et al., .2013; Ponti et al., 2013).

However, a great deal of research has been conducted in project pre-construction phases regarding the prediction of projects' outcomes based on a set of assessed influencing drivers (Vickerman, 2000; Zhang, 2005). Those drivers include projects' internal and external characteristics, contractual arrangements, projects' participants, and their interaction (Chua et al, 1999). Zhang (2005) found that the most influential among these factors are the socio-economic, investment and political environment of a project. But, in many cases, a change in these parameters may occur during a project's life cycle, requiring the project to adapt to change and develop resilience to sudden and unpredicted disruptions.

The Global Financial Crisis (GFC) that occurred in 2007/08 was the latest of the big international crises that hit the global economy. The GFC was followed by the European sovereign debt crisis that began at the end of 2009 and lasted till 2012, when the peripheral Eurozone member states of Greece, Spain, Ireland, Portugal and Cyprus were unable to repay or refinance their government debt, without the assistance of third-party financial institutions (Mladenovic, 2016).

The European Investment Bank (EIB) report (Kappeler et al., 2010) showed that the Public Private Partnership (PPP) market contracted in most European countries during the financial crisis. According to Burger et al., (2009) the IMF (International Monetary Fund) also reported a shift in preferences of financial institutions from long term loans to short term loans. A review carried out by the Public-Private Infrastructure Advisory Facility (PPIAF) showed that the financial crisis significantly affected the rate of new PPP project closures in the second half of 2008 (Izaguirre, 2010). The review states that projects reaching financial closure after the crisis are facing lower debt-equity ratios, higher fees, shorter debt maturities and embedded mechanisms for refinancing.

The GFC had far-reaching implications on the financing and revenue generation of infrastructure projects (FIDIC, 2012). A higher cost of financing was a significant implication as well as increasing costs and delays on projects (e.g. in implementation, in reaching financial closure) and even project cancellations. The reasons for most of the delays were uncertainty regarding future demand, access to financial resources and the cost of financing.

The influence of the GFC was reported in recent years, as one of the most common drivers of project performance, beyond any doubt. Therefore, the objective of this paper is to determine what are the consequences of the GFC on road infrastructure projects, or more precisely, what are the specific characteristics that contribute to the overall project performance and lead to improved resilience in times of sudden and unexpected disruptions (e.g. GFC).

Resilience as a term does not have a unique meaning in academic literature. Commonly used, resilience is "an ability of an entity to bounce back" (Henry and Ramirez-Marquez 2012). Bocchini, et al. (2014) explained that resilience of civil infrastructure is usually associated with the ability to deliver a certain level of service, even after the occurrence of an extreme event, and to recover the desired functionality as fast as possible. However, some definitions of resilience overlap significantly with other well known concepts such as robustness, fault-tolerance, flexibility, survivability and agility (Henry and Ramirez-Marquez 2012).

In the context of the BENEFIT (Business Models for Enhancing Funding and Enabling Financing for Infrastructure in Transport) project, resilience is defined as "the ability of a transport infrastructure project to withstand changes within its structural elements with respect to its ability to deliver specific outcomes (such as cost and time to completion, expected traffic and expected revenue targets)" (Roumboutsos, 2016). Resilience was also defined as the likelihood of achieving pre-specified outcomes and expresses the level of vulnerability of the project to adverse external implementation conditions (Mladenovic, 2016).

Due to the evident complexity of predicting project performance, the first stage was to establish a methodology suitable for assessing a project in all phases of its life cycle (i.e. feasibility study, pre-award, award, construction, operation and maintenance, renegotiations and reporting).

Developed indicators that served the objectives of this research were based on the project-specific data that involve the assessment of projects' governance and institutions, funding, financing and applied business model. In this approach, no particular stakeholder view is considered.

The analysis was conducted in two steps, through a qualitative assessment of road infrastructure projects and through a quantitative analysis. The developed methodology was applied on 31 real road infrastructure projects in 14 European countries. The impact of the GFC was evaluated on project outcomes, in particular on cost and time to completion, and actual vs. expected traffic and revenues.

The quantitative analysis explored how adequately developed indicators tackle the change in project characteristics and performance during (or after) the GFC, and if they were able to adequately address the crisis' influence on project outcomes. In the context of this research, the influence of the GFC was assessed through evaluating changes in projects' characteristics and performance before the crisis (before 2008), and during and after the crisis (after 2008). The duration of GFC was not the same for all countries in the sample, therefore it was not considered separately.

2. Methodology

This investigation relies on the research conducted within the BENEFIT project. It considers transport infrastructure delivery, implementation, operation and maintenance as a system (Pantelias et al., 2015) that, based on specific inputs, produces outputs (or outcomes) considered as the "performance" of the infrastructure investment. In this sense, the complex project mechanism is presented with nine indicators which become elements of the respective system: the Matching Framework. This research relied on the methodology presented in Figure 1.

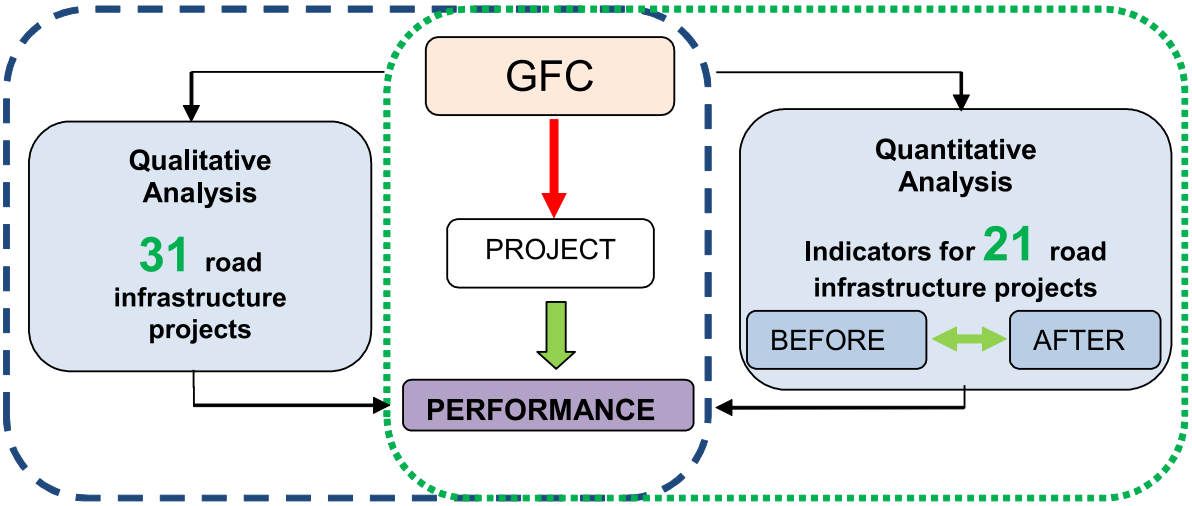

Figure 1. Methodology scheme (Source: Authors' own)

Based on a review of the information on 31 road projects through the case narratives included in the BENEFIT wiki, 2016 and the BENEFIT Cases Studies in Transport Infrastructure e-book (E-BOOK, 2016), it was possible to qualitatively determine what was the influence of the GFC. Moreover, it was possible to extract influences that lead to a specific outcome, whether it is a characteristic of a project or entire setting, i.e. a combination of influences. Case narratives were prepared by BENEFIT partners, and included project descriptions and self-assessments of

projects' performance and key success factors. In terms of the BENEFIT project, success is perceived as delivering infrastructure compliant with given performance criteria.

Secondly, the values of the respective indicators for each case before and after the crisis were analysed with respect to their outcomes quantitatively, based on their case study information. Lastly, obtained findings were systematically compared with those of qualitative analyses allowing for an improved understanding and an enriched discussion.

The BENEFIT case studies (E-BOOK, 2016) were described over time through the values of respective indicators (Vanelslander et al., 2015; Mitusch et al, 2015; Voordijk et al., 2015 and Pantelias et al., 2015) and outcome variables. As they describe key characteristics of the case at specific times in the project life cycle, each set of indicators and outcome values is termed a "snapshot". Every project was assessed in six contexts, each represented with respective indicators, namely:

- Implementation context:
    - Institutional Indicator [*InI*] takes into account political, regulatory and administrative stability of a country through several indexes: Political stability & absence of violence index, Control of corruption index, Democracy index, Rule of law index, Regulatory quality index, Liberalization of transport markets, Government effectiveness index and Government efficiency score.
    - Financial Macroeconomic Indicator [*FEI*] represents the assessment of macroeconomic and financial conditions in a country through a Macroeconomic environment score and a Financial market development score (both indices are part of Global Competitiveness Index).
- Transport mode context:
    - Reliability/Availability Indicator [*IRA*] – self explanatory
- Business model context:
    - Cost Saving Indicator [*CSI*] is comprised of the capability to construct/monitor through the Level of civil works/technical difficulty, Capability to construct, Construction risk allocation, Capability in planning and monitoring, application of Innovation (binary), Life cycle planning and Ability to operate.
    - Revenue Support Indicator [*RSI*] presents the ability of projects to generate revenues through business scope, Project exclusivity, Network integration, Share of greenfield/brownfield/other transport infrastructure, Demand/revenue risk allocation, Capability to operate, Operation risk allocation and Share of non-transport activities.
- Governance:
    - Governance Indicator [*GI*] was calculated from the Number of bidders, Contract type, Design/construction/commercial/revenue & financial risk allocation, Existence of quality performance payments, Exploitation, Existence of renegotiation clauses and Occurrence of early contract termination.
- Funding scheme:
    - Remuneration Attractiveness Indicator [*RMI*] represents the ability to pay the concessionaire, estimated from the Expected revenues as a percentage of total project costs, Share of each income stream on total revenues and Type/risk of each income source.

- Revenue Robustness Indicator [*RVI*] consists of the Share of each revenue stream on total revenues and the Type/risk of each revenue source.

- Financing scheme:
  - Financing Indicator [*FI*] represents the capability of projects to attract private financing, calculated from government support in funding through Debt capital/loans, Equity capital and Type of financiers.

All indicator values were defined in the range of [0, 1], with the exception of the Cost Saving Indicator, which may take values in the range of [–0.33, 1]. In general, if the value of an indicator is closer to "1", it is considered to be stronger and more favourable in terms of better project performance. However, in case of the Financing Scheme indicator, a value closer to "1" means a larger proportion of public financing.

In the context of this research, four outcomes are 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 project construction phase, whereas the latter two are linked to the operational phase. The outcomes may take values [–2, –1, 0, 1, 2], where "0" stands for "in line with expectations", negative values represent outcomes below expectations, and vice versa:

$$\begin{bmatrix} -2 \\ -1 \\ 0 \\ 1 \\ 2 \end{bmatrix} = \begin{bmatrix} \textbf{far below forecast} \\ \textbf{below forecast} \\ \textbf{in line with expectations} \\ \textbf{above forecast} \\ \textbf{well above forecast} \end{bmatrix} \quad (1)$$

Alongside with case narratives and case studies, there was also a set of snapshots available for most of the analysed projects. Snapshots were prepared by the BENEFIT consortium partners, and represent the calculated values of all indicators in several moments of a project's life: award, construction, inauguration (start of operation), operation, crisis, renegotiations and reporting (in most cases 2014 or 2015). Based on the information provided, in many cases it was possible to capture changes in projects' performance before and after the crisis. The projects that had commenced during or after the beginning of the GFC were excluded from the analysis (A2 motorway, Koper – Isola, M25, M80 and three projects in Serbia). Indicators were not available for four projects: Istrian Y motorway, Bundesautobahn 20, E8 Grimstad – Kristiansand, and Horgos – Pozega. Also, the *IRA* indicator was not analysed in this paper, since availability and reliability of the roads in the majority of cases was not connected to the changes in macroeconomic conditions, influenced by the GFC, but rather to maintenance activities on the section.

The BENEFIT dataset of cases includes 31 cases concerning the delivery of road infrastructure. Twenty-four cases have been delivered through a PPP arrangement and the rest were delivered by the public sector, through traditional procurement. This is a sample of projects located in 14 European countries, awarded in the period from 1987 to 2012 and collected by the 14 partners of the BENEFIT consortium. Snapshots were available for 21 projects. Annex 1 presents the detailed list of road projects included in the BENEFIT Case Study database.

2.1 Clustering of countries in light of their resilience to crisis:

There is, in general, substantial difference in performance between projects in North-Western European countries, and projects in Southern European countries. For example, projects in Belgium, Croatia, Finland, Germany, Norway and Poland are, according to all four outcomes, performing in line with expectations or better. Out of four projects in the UK, only one had a delay, and only one project has actual traffic below forecast. On the other hand, most projects that

experienced cost and time overrun and traffic overestimation are located in Southern European countries.

The change of *FEI* from the BENEFIT Implementation context was used as an indicator to identify the severity of the impact of the GFC in the countries included in the BENEFIT database. The use of two derived indicators, namely

$$\frac{\text{Max } FEI}{\text{Min } FEI} \tag{2}$$

and

$$\frac{2014\ FEI}{\text{Max } FEI} \tag{3}$$

resulted in an identical division of clusters, which was applied in further analysis, as presented in Figure 2. The maximum *FEI* value has been defined as the highest *FEI* value in the period from 2006 to 2008. The value of the *FEI* indicator in 2014 was assumed to be significant, as it was the year of reporting for the majority of the projects.

Table 1. Clustering of countries according to impact of crisis

Cluster	Country	Min *FEI*/ Max *FEI*	Country	2014 *FEI*/ Max *FEI*
High impact of crisis	Greece	0.522	Slovenia	0.634
	Slovenia	0.634	Greece	0.642
	Portugal	0.662	Portugal	0.662
	Spain	0.667	Spain	0.667
	United Kingdom	0.722	United Kingdom	0.742
	Serbia	0.742	Serbia	0.758
Medium impact of crisis	Italy	0.806	Italy	0.806
	Denmark	0.806	Croatia	0.840
	Croatia	0.840	Netherlands	0.849
	Netherlands	0.849	Belgium	0.867
	Belgium	0.867	Denmark	0.898
	France	0.878	France	0.902
Low impact of crisis	Czech Republic	0.900	Finland	0.926
	Norway	0.907	Poland	0.974
	Germany	0.908	Sweden	0.979
	Sweden	0.916	Czech Republic	0.988
	Finland	0.926	Germany	0.989
	Poland	0.947	Norway	1.041

source: Mladenovic et al, 2016

Six projects are located in countries with a low impact of the GFC (Norway, Finland, Germany and Poland), four more in countries with a moderate impact of the GFC (Croatia, Belgium, Italy and the Netherlands), and the remaining 20 projects in countries that were severely hit by the GFC (Greece, Portugal, Serbia, Slovenia, Spain and the UK).

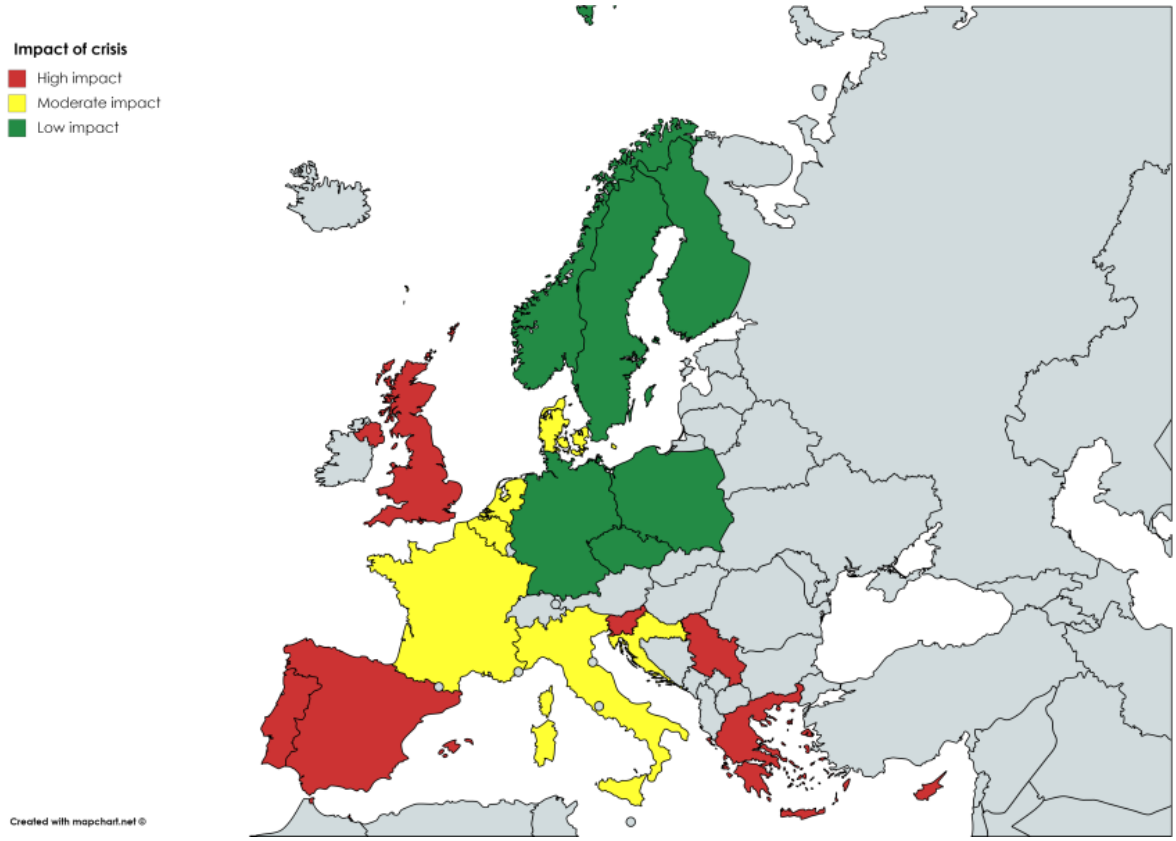

Figure 2. The clusters of countries represented in BENEFIT cases (source: Mladenovic et al, 2016)

One project (Horgos– Pozega) is excluded from the analysis, since the project never reached financial closure, and part of it was later realized as a public project (Horgos – Novi Sad) that is included in the database.

3. Qualitative assessment of road cases

The main reasons for cost overrun in analysed cases are typically related to scope changes, expropriation and archaeology problems and sometimes to other technical issues. The most typical reasons for delays in the projects are economic crisis, expropriation problems, design changes, technical and archaeology issues, but also bankruptcy of the contractor (Koper – Izola Motorway). However, reasons for underestimated traffic levels, and consequential drops in project revenues are more than once directly linked to the influence of the GFC.

3.1 Projects in countries with a low impact of the GFC

The cluster is represented by projects with medium to high investment sizes, that are either greenfield, or both greenfield and brownfield. Five of these projects are delivered as PPPs, while only Bundesautobahn 20 in Germany was delivered as a public project. Three of these projects were in the operation phase, and two were in the construction phase during the crisis (Figure 3). The construction of the A2 motorway in Poland commenced after the crisis.

The impact of the GFC in these countries was minimal, and all projects that were analysed showed a very strong resilience to the crisis.

The common factor that was underlined throughout the cases was the capability of legal bodies for introducing and regulating PPP contracts, through laws and legislation and stable

macroeconomic surroundings. In all cases, it was clearly stated that projects involved the construction of very important and long-needed infrastructure that serves many users, both local and regional. Most of the projects had been planned for a long period of time, since they represent important national and regional connections. For example, the E4 motorway project in Finland, 70 km-long, that included the construction of 88 bridges, had been planned since 1996.

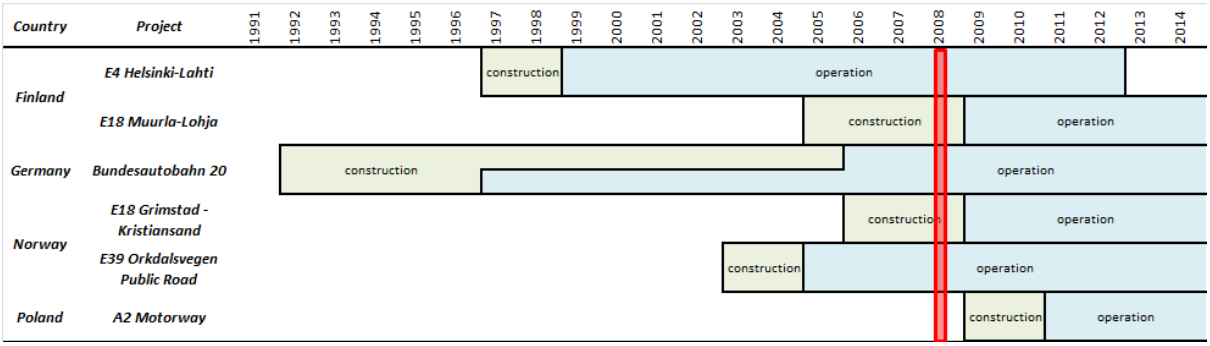

Figure 3. The timeline of road projects in countries with low impact of crisis (source: Mladenovic et al, 2016)

The projects were rather exclusive, allowing for physical network integration and represent an important link between major conglomerations, which also gave them additional resistance to any changes in the economic environment.

3.2 Projects in countries with a moderate impact of the GFC

Four road projects in countries that were moderately hit by the GFC include medium to high investment size projects in four different countries that are both greenfield and brownfield projects, as well as a mix of these two. Three of these projects are PPPs with contract duration between 20 and 30 years. Two projects were integrated with railway projects (Via Zeventem and Combiplan Nijverdal).

The first phase of only one of these projects was in operation (Istrian Y motorway in Croatia) before the crisis; Via Zeventem in Belgium was under construction, while projects in Italy and the Netherlands started with construction after the crisis (Figure 4).

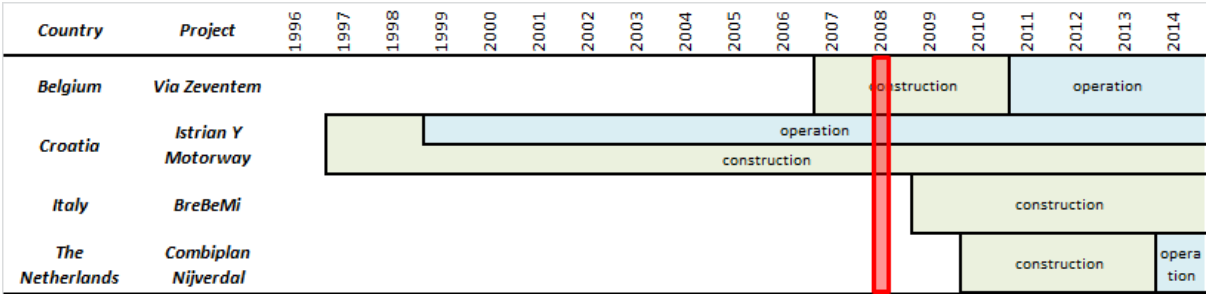

Figure 4. The timeline of road projects in the countries with moderate impact of crisis (source: Mladenovic et al, 2016)

The main purpose of the Via Zeventem project was to improve access and reduce congestion north of Brussels' Zeventem airport. The project was delivered on time and almost to budget. However, traffic declined, since both passenger and cargo traffic at the Zeventem airport dropped as a result of crisis; nonetheless, the project managed to recover in the meantime.

The Istrian Y motorway connects the Istrian Peninsula, one of main tourist regions in Croatia, to the A8 and A9 international motorways. The actual traffic growth was higher than anticipated, especially for passenger cars, indicating that the impact of the crisis on this project was very limited.

In case of the BreBeMi motorway, the financial crisis came immediately after the commitment was signed with the lenders. Despite the crisis, the Italian Government decided to continue with all the priority projects included in the three-year General Transport Plan, considering these projects, and especially those developed under a PPP model, as drivers for economic growth.

The Combiplan Nijverdal included both motorway and railway lines across the city of Nijverdal, including the tunnel, with the main objective to remove congestion. The project experienced cost overrun and delay, primarily due to scope change and introduction of new regulations for tunnels. However, there is no reference to the crisis; the GDP (Gross Domestic Product) growth rate increased and the unemployment rate dropped in the region after the contract was signed.

In case of the cluster of countries with a moderate impact of the crisis, the outcomes of the projects were generally not associated with the financial crisis. One of the reasons for this resilience was that these projects were highly supported by the Government, and considered as top-priority projects. In only one project the crisis caused a drop in the actual traffic level due to dependence on the usage of the road to the number of passengers and transportation of goods on the connecting airport. However, exclusivity of this link enabled the fast recovery of projected revenues.

3.3 Projects in countries with a high impact of the GFC

The time frame for project implementation in countries with a high impact of the GFC is presented in Figure 5.

All projects in Portugal and Spain, two out of four UK projects and Attiki Odos in Greece were in the operation phase before the crisis. All remaining Greek projects were under construction, as well as two projects in Slovenia. The two remaining UK projects and all projects in Serbia commenced just after the crisis.

The impact of the GFC was particularly significant in Greece. The construction of three Greek projects was interrupted from 2010 to 2013 and they were subjected to lengthy renegotiations, caused mainly by the steep decrease in actual traffic due to the GFC. Renegotiated terms, for all three projects, included an increased government participation in the project's funding, a significant reduction of the project size and the payment of claims to the Construction Joint Venture. The Moreas Motorway project had a cost overrun of 10% and was delayed for 2.5 years due to slow payments on behalf of the state (explained by the GFC) and archaeological findings. It was reported that the economic crisis had a severe impact on traffic levels, which affected the primary source of income, i.e. cost recovery through tolls. Consequently, the project went through several renegotiations, requesting additional capital support from the Greek state and payment of claims to the concessionaire. However, unlike three other projects, there was no pause in construction. Only the Attiki Odos project (Athens ring road) was in its operation phase when the crisis occurred, and has experienced for the first time in 2012 that the actual traffic was lower than the predicted one, but has managed to sustain itself despite the crisis.

The revenue scheme for both projects in Portugal was initially based on shadow tolls. The traffic on the A22 motorway dropped in 2008, but was still above expectations, which was explained by the touristic nature of the region. Contrary to A22, on A23, the actual traffic and revenues were 50% below forecast. It was stated that the funding scheme failed during the economic crisis due to the non-availability of state subsidies, leading to the need for introducing tolls in previously non-tolled infrastructure, which caused major traffic reductions and inefficiencies.

Cases for projects in Spain also had significant drops in traffic levels. In other countries from this cluster, the crisis has reportedly influenced the macroeconomic environment, causing a rise in unemployment, a drop in GDP, etc., which all may have caused drops in mobility and influenced traffic levels. However, the projects did not go through renegotiations or cancelations.

The consequences of the GFC on the poorly performing projects are reflected through the fact that many projects have entered renegotiations, which in most cases involved reducing the scope of projects and significant reduction of the project size in terms of investment as well as an increase in government participation in the funding scheme (e.g. projects in Greece) and introduction of user paid tolls or increase in toll prices (e.g. in Portugal). Consequently, the distribution of risks shared between the public and private partner has changed substantially (e.g. in Greece).

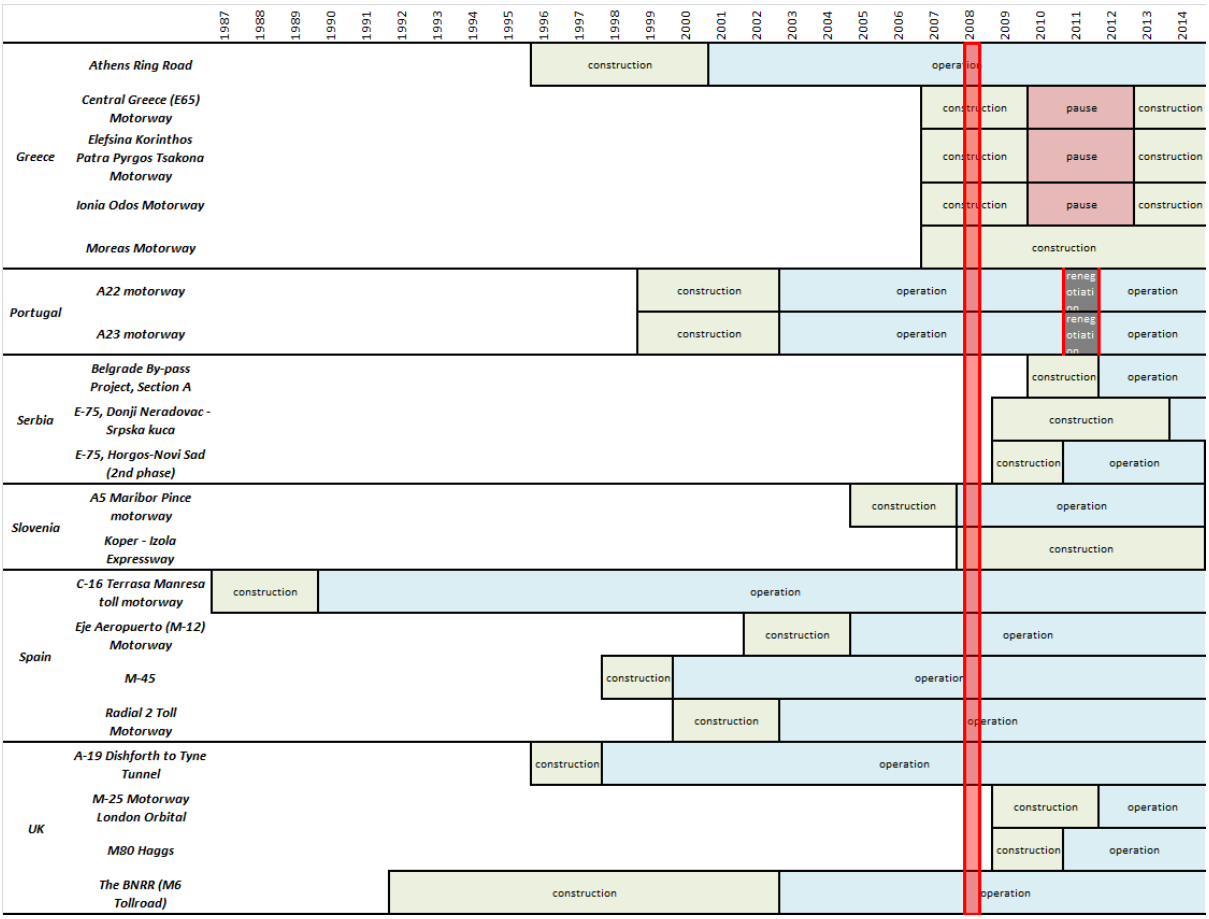

Figure 5. Projects' timeline for the cluster of countries with high impact of crisis (source: Mladenovic et al, 2016)

A common trait of the projects in Greece was their size: they were very large projects (all five projects required budgets close to or above one billion euro). This was an unfavourable factor since the funding was structured so that part of it had to be covered from user paid tolls on already constructed sections. In other words, risk was doubled since revenue risk heavily impacted construction risk. Also, in almost all mentioned cases the traffic projections were overly optimistic (optimism bias in demand forecasts). One of the additional reasons behind "low success" was reportedly related to the political environment (political cycles and budgetary purposes).

4. Quantitative analysis of road projects before and after the crisis

Both Implementation context indicators, Institutional indicator (*InI*) and Financial Macroeconomic indicator (*FEI*) are much lower for Southern European countries. The lower values of *InI* show weaknesses in the political, regulatory and administrative stability of these countries compared with North-Western European countries, while generally lower values of *FEI* may suggest greater impacts of the GFC in these countries.

GI also 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, e.g. all projects in North-Western European countries have high values of *GI*. This indicator was formulated to represent the features of the contract (for the construction or operation phase) in terms of type, allocation of risks, existence of competition, and features related to revenues and costs. Therefore, *GI* may be influenced by the country context, but not necessarily by country economy, meaning that *GI* may have high values in countries that are experiencing unfavourable macroeconomic conditions in case the contract is adequately formulated. For instance, *GI* in Southern European 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 *GI* was able to show the difference between well-performing and poorly performing projects.

The average value of *CSI* is significantly higher for projects in North-Western European countries compared with Southern European countries, which reflects the maturity of the construction industry. *CSI* shows capabilities of the contractor to construct or to deal with a technically difficult project, but also the capability of the investor to monitor and adequately plan the investment project.

RSI has a wider range (lower minimum and higher maximum values) in Southern European countries, compared with North-Western European countries. *RSI* is generally very low (0.05), almost identical and fairly constant in all cases, which shows a general inability of road projects to generate other revenues. However, this indicator also includes project exclusivity, capability to operate, share of greenfield/brownfield infrastructure and operation risk allocation, meaning that generating revenues is a complex mechanism. Therefore, analysing only the *RSI* indicator, without matching with other indicators, may be misleading. The values of *RMI* for well-performing PPP projects were higher than for poorly performing ones, indicating a higher ability of a project to pay the concessionaire. That shows that the three chosen variables: Expected revenues as a percentage of total project costs, Share of each income stream in total revenues and Type/risk of each income source were able to capture projects' remuneration attractiveness, i.e. ability to pay the concessionaire. On the other side, *RVI* that describes a project's ability to generate revenues is a project-specific variable that depends on the Share of each revenue stream in total revenues and the Type and risk of each revenue source.

4.1 Projects in countries with a low impact of the GFC

It can be argued that all projects in this cluster were highly successful since they have a 100% return on investment, traffic in line or above expected, with no cost or time overruns, and do not show any influence of the GFC on their overall performance, as shown in Table 2.

The only project where some impact of the crisis on project outcomes was seen (although all the outcomes were still in line with expectations), was the E18 project which had lower traffic and revenue outcomes in 2009 compared with 2008 (Table 2). The reason behind this was mainly seen in a moderate change in the overall macroeconomic environment (a drop in *FEI*) and project's ability to generate various sources of revenues (drop in *RVI*). For E18 there was also a drop in *CSI* during the operation phase, which was explained by a change in the ownership structure, which did not influence outcomes.

Table 2. Snapshots for road projects in countries with a low impact of the GFC

Case Study	Snapshot	Indicators								Outcomes			
		InI	***FEI***	***GI***	***CSI***	***RSI***	***RMI***	***RVI***	***FI***	**Cost**	**Time**	**Traffic**	**Revenue**
E4	1997, award	0.81	0.627	0.688	0.489	0.145	1.0	1.0	0.679	-	-	-	-
Helsinki-	1998, inn.	0.83	0.627	0.875	0.489	0.145	1.0	1.0		0	1	0	0
Lahti	1999	0.83	0.637	0.750	0.489	0.145	0.333	1.0		0	1	0	0
	2001	0.86	0.637	0.750	0.467	0.097	0.333	0.947		0	0	1	0
	2008, GFC	0.84	0.792	0.750	0.467	0.097	0.333	1.0		0	0	0	1
	2012	0.86	0.766	0.750	0.467	0.097	0.333	1.0		0	0	1	1
E18	2005, award	0.86	0.753	0.688	0.467	0.121	0.667	1.0	0.773	-	-	-	-
Muurla-	2008, inn.	0.84	0.792	0.750	0.467			1.0		0	1	0	0
Lohja	2008, GFC	0.84	0.792	0.750	0.133			0.967		0	0	1	1
	2009	0.86	0.758	0.750	0.133			0.824		0	0	0	0
E39 Orkda-	2003, award	0.81	0.738	0.563	0.722	0.200	0.333	0.667	0.719	-	-	-	-
lsvegen	2005, inn.	0.82	0.808		0.556					0	0	0	0
Public Road	2014	0.84	0.842		0.667					0	0	1	1
A2	2008, award		0.630	0.688	0.510	0.222	1.0	0.444	0.752	0	0	0	0
Motorway	2009		0.600		0.719	0.216				-	-	-	-
	2011, inn.		0.608		0.719	0.216				0	1	1	1

(Source: Authors' own)

The common trait of these projects was that *InI* took very high values ranging between 0.81 and 0.86. Also, *FEI* was always above 0.63 as well as *GI*, indicating strong institutional and financial-economic projects' surroundings coupled with projects' adequate governance in terms of high capability for planning and monitoring the investment. Values of other indicators, as seen in the Table 2, did not change due to the crisis.

4.2 Projects in countries with a moderate impact of the GFC

Table 3 provides snapshots available for three road project in the moderately impacted cluster of countries. The only indicator that changed during the GFC was the Financial-Macroeconomic indicator (which decreased in all three cases during the crisis), cost-savings and revenue support indicators.

The change in *CSI* for the Via Zeventem project was a result of different formulation of the indicator for construction and operation phases (Table 3), while the increase in the *RSI* was a result of increased capability to manage traffic demand. This project is considered to perform in line with expectation, according to the outcomes.

Table 3. Snapshots for road projects in countries with a moderate impact of the GFC

Case Study	**Snapshot**	**Indicators**								**Outcomes**			
		InI	***FEI***	***GI***	***CSI***	***RSI***	***RMI***	***RVI***	***FI***	**Cost**	**Time**	**Traffic**	**Revenue**
Via	2006, award		0.690	0.688	0.515	0.206	0.667	0.000	0.740	-	-	-	-
Zeventem	2014		0.600		0.449	0.216				1	1	0	0
BreBeMI	2009, beg.works	0.492	0.492	NA	NA	0.142	0.333	0.667	0.735	-	-	-	-
	2014	0.450	0.450							1	1	1	0
Combiplan	2006, award	0.760	0.760		0.148	0.202		0.000	1.000	-	-	-	-
Nijverdal	2007	0.775	0.775	0.479	0.137		1.000			0	0	0	0
	2013, inn.	0.660	0.660		0.245					-1	-1	-1	0
	2014	0.650	0.650	0.375	0.313		0.833			-	-	-	-

(Source: Authors' own)

For the BreBeMI project the only indicator that changed between snapshots is the *FEI*. However, there was only one available snapshot, from 2014, showing that the project performed in line or above expectations.

Only the Combiplan Nijverdal project had available snapshots for "before" and "after" the crisis and had experienced a decrease in performance, regarding cost, time and traffic project outcomes. However, the initial decrease in *CSI* for Combiplan Nijverdal project was a result of decreased capability to monitor construction, resulting from technical difficulties in the project. *CSI* at the end of the construction phase indicates improved capability to monitor construction. However, the general negative outcome of the project at the end of the construction phase was not related to the impact of the crisis.

4.3 Projects in countries with a high impact of the GFC

Table 4 gives an overview of respective indicators for projects in the cluster of countries with a high impact of the crisis. There is a clear drop in *CSI* and *FEI* "before" and "after" the GFC, based on available snapshots for Greek projects. The sharp decrease in *CSI* after the GFC reflects the pause in construction of three projects. The *CSI* has increased during operation only for the well performing project in Greece, i.e. Attiki Odos.

In addition, a distinctive decrease of *FEI* implied changes in macroeconomic project surroundings. Although all the countries from this group experienced a significant drop in *FEI*, for the success of the project, its initial value was also relevant. For example, in Spain and UK *InI* was above 0.6 and *FEI* above 0.5 (before and after the crisis); in Portugal and Slovenia *InI* was above 0.6, however *FEI* had lower values after the crisis, and finally in Greece *InI* was close to 0.6 and *FEI* was as low as 0.3.

The indicators in available snapshots for Portuguese road projects show a sharp drop in *CSI* as a result of a reduced capability to operate the projects, as well as drop in *FEI*. Both indicators may explain the drop in traffic outcome (traffic below forecast). This was influenced by renegotiations and introduction of tolls. The changes in *RMI* (increase in value) were a consequence of different risk allocation and introduction of tolls, as a result of renegotiation processes.

In Spain, the same pattern was present, i.e. a drop in both *CSI* and *FEI* after the occurrence of the GFC. These projects are particularly interesting from the aspect of the influence of the crisis, since they experienced a drop in traffic and in revenues, as a direct consequence of the crisis, and had managed to recuperate from in the following few years. For example, for both M45 and Radial 2 Motorway, revenues were below the expectation in 2012, and in line with the expectations in 2014. The change in *FEI* shows a general drop in countries' economic power, which influenced a drop in traffic. However, after increased participation of the government, seen in the increase of *FI*, projects managed to sustain and to generate the expected profit.

Finally, in the UK set of projects, a distinct drop in *FEI* was detected, since the UK is also a country severely hit by the crisis. However, the values of other indicators did not change drastically, and revenues, time and cost outcomes were all in line with projections. Unlike other projects from this cluster, these projects had very high values of *GI* and *InI* (ca. 0.8), meaning that institutional frameworks and adequate governance played a major role in fulfilling the projects' expected outcomes.

Table 4. Snapshots for projects in high impact cluster of countries

Case Study	Snapshot	Indicators								Outcomes			
		InI	*FEI*	*GI*	*CSI*	*RSI*	*RMI*	*RVI*	*FI*	Cost	Time	Traffic	Revenue
C-16 Terr-	1987, award	0.7	0.637	0.563	0.511	0.201	0.333	0.667	0.406	-	-	-	-
asa Manre-	1990, inn.	0.70	0.637		0.133				0.300	-1	0	-1	0
sa toll mot.)	2015	0.69	0.467		0.200				0.300	-1	0	-1	0
Eje Aero	2002, award	0.76	0.617	0.500	0.541	0.040	0.333	0.667	0.640	-	-	-	-
puerto	2005, inn.	0.73	0.678		0.541				0.640	-1	-1	-1	0
(M-12)	2008 GFC	0.68	0.700		0.311				0.640	-1	-1	-1	-1
Motorway	2012	0.69	0.508		0.311				0.670	-1	-1	-2	-1
	2014	0.69	0.467		0.311				0.698	-1	-1	-2	0
M-45	1998, award	0.72	0.637	0.563	0.533	0.089	0.667	0.063	0.703	-	-	-	-
	2000, inn.	0.74	0.637		0.583					-1	0	1	1
	2008 GFC	0.68	0.700		0.333					-1	0	1	1
	2012	0.69	0.508		0.333					-1	0	0	0
	2014	0.69	0.467		0.333					-1	0	1	1
Radial 2	2000, award	0.74	0.637	0.500	0.244	0.089	0.333	0.667	0.640	-	-	-	-
Toll	2003, inn.	0.69	0.638		0.244				0.640	-1	-1	-1	0
Motorway	2008 GFC	0.68	0.700		0.333				0.640	-1	-1	-1	-1
	2012	0.69	0.508		0.333				0.669	-2	-1	-2	-1
	2014	0.69	0.467		0.333				0.698	-2	-1	-2	0
Moreas	2007, award	0.61	0.558	0.750	0.561	0.301	0.400	0.679	0.765	-	-	-	-
Motorway	2013,fin.pause	0.57	0.308		0.750				0.816	-1	-1	-1	-1
Ionia	2007, award	0.61	0.558	0.750	0.506	0.269	0.433	0.667	0.554	-	-	-	-
Odos	2010, pause	0.58	0.458		-.011	0.255			0.554	-1	-1	-2	-1
Motorway	2013, restart	0.57	0.308		0.226	0.247			0.622	-1	-1	-2	0
Elefsina	2007, award	0.61	0.558	0.625	0.514	0.255	0.400	0.667	0.796	-	-	-	-
Kor. Patra	2010, pause	0.58	0.458		-.021	0.244			0.796	-1	-1	-2	-1
Pyrgos	2013, restart	0.57	0.308		-.021	0.222			0.644	-1	-1	-2	0
Tsakona													
Central	2007, award	0.61	0.558	0.625	0.510	0.173	0.333	0.667	0.913	-	-	-	-
Greece	2010, pause	0.58	0.458	0.625	0.314	0.173			0.913	-1	-1	-2	-1
(E65) Mot.	2013, restart	0.57	0.308	0.750	0.237	0.186			0.938	-1	-1	-2	0
Attiki	1999, award	0.59	0.543	0.688	0.230	0.224	0.333	0.667	0.561	-	-	-	-
Odos	2001,inn.1sec.	0.60	0.543		0.313	0.224				0	0	1	1
(Athens	2004, compl.	0.62	0.587		0.313	0.229				0	0	1	1
Ring	2009	0.59	0.500		0.427	0.229				0	0	1	1
Road)	2014	0.57	0.358		0.427	0.224				0	0	-1	0
A22	2000, award	0.69	0.540	0.625	0.464	0.188	0.383	0.095	0.779	-	-	-	-
motorway	2011,bef.ren.	0.68	0.517	0.625	0.598	0.188	0.383	0.095		0	0	1	1
	2013	0.70	0.442	0.813	0	0.267	0.667	0.283		0	0	-2	-1
A23	1999, award	0.69	0.540	0.625	0.318	0.200	0.383	0.095	0.779	-	-	-	-
motorway	2011,bef.ren.	0.68	0.517	0.625	0.489	0.200	0.383	0.095		0	0	-1	-1
	2013	0.70	0.442	0.813	0	0.222	0.667	0.283		0	0	-2	-1
A5 Mari-	2005, award	0.64	0.595	0.563	0.097	0.151	1.0	1.0	1.0	-	-	-	-
bor Pince	2008,inn.	0.68	0.683		-0.007					1	-1	1	1
motorway	2014	0.66	0.433		0					1	0	1	1
A-19 Dish-	1996, award	0.82	0.635	0.688	0.411	0.075	0.667	0.063	0.525	-	-	-	-
forth to	1998, inn.	0.83	0.635		0.411					0	0	0	0
Tyne Tunn.	2014	0.79	0.600		0.667					0	0	0	0
The BNRR	1992, award	0.82	0.635	0.813	0.522	0.045	0.347	0.673	0.640	-	-	-	-
(M6	2003, inn.	0.81	0.665		0.172		0.347	0.673	0.640	0	0	-1	0
Tollroad)	2008, GFC	0.80	0.742		0.611		0.333	0.667	0.300	0	0	-1	0
	2012	0.79	0.600		0.611		0.333	0.667	0.300	0	0	-1	0
	2014	0.79	0.600		0.611		0.333	0.667	0.300	0	0	-1	0

(Source: Authors' own)

5. Conclusions

A strong influence of the GFC was reported in a number of case studies causing significant time and cost overruns for projects that were in the construction phase, as well as a drop in traffic for projects in the operation phase, particularly for those in Southern European countries.

The GFC caused a drop in AADT (Average Annual Daily Traffic) which was a direct consequence of the drop in economic power and overall activity (Spain, Portugal and Greece). As a result of the crisis, GDP was also lower than expected in a number of countries (Slovenia, Portugal and Greece), which led to cash flow difficulties as a consequence of public budget restrictions (Spain, Greece and Portugal). Finally, as a consequence, a drop in revenues was witnessed in projects in Spain, Portugal and Greece.

The GFC also had an indirect impact on road infrastructure projects by causing renegotiations of contracts (examples were found in Portugal, Greece and the UK). New, renegotiated terms of contract, included reducing the scope of projects and significant reductions of the project size (e.g. in Greece), increased government participation (Greece), payment of claims (Greece), introduction of tolls on previously non-tolled sections (Portugal) and rebalance of risks shared between public and private partners (Greece).

With respect to the four basic performance outcomes studied (cost and time to completion, traffic and revenue forecasts), no single combination of factors was identified having a positive effect on all four targets. However, one factor that was identified to have an impact on all outcomes was the implementation context and its indicators *InI* and *FEI*. This has been confirmed by analyzing the case studies qualitatively, as well as matching the values of respective indicators "before" and "after" the crisis. Almost all cases confirmed the importance of a strong regulatory body in the country, as well as the importance of government support.

The critical success factors that led to successful projects, most resilient to sudden and unpredictable changes in project surroundings included long term planning regarding project funding and choice of top priority projects which are long-needed infrastructures with a high level of exclusivity and which allow network integration, i.e. more efficient routes in comparison with existing ones. Long-term planning was even more efficient if project design was of good quality, and traffic projections were realistic and adequate.

The capability to construct, i.e. the choice of a responsible and experienced contractor, was also pointed out as a very influential characteristic. Although the project success depends on the importance of the project to the overall users, this analysis also showed that projects that were medium in size (or divided into several stages) outperformed really large project and were less sensitive to changes caused by the crisis. In case of PPP projects, one of the essential common characteristics for success and resilience of projects was a responsible and well experienced concessionaire.

Finally, both qualitative and quantitative investigations revealed the significance of good governance (expressed through *GI*) which in combination with other indicators substantially improves the potential for achieving cost and time projections. This involves effective administration, competitive tendering and contracting arrangements, good communication and management between project participants, adequate and timely changes in laws and the potential for timely reorganizations of public bodies (i.e. ministries). This points out the significance of public authority competence and good institutions. The cases showed that good governance, strong institutions, and capable participants are the core characteristics that determine a project's resilience and have the potential to overcome changes in a project's surroundings.

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Appendix A: List of case studies included in the analysis

Case study	Country	Year of award	PPP/ Public	Duration of PPP contract	Project type	Budget size[1]
Via Zeventem	Belgium	2007	PPP	30 years	Brownfield	Low
Istrian Y Motorway	Croatia	1997	PPP	28 years	Brownfield	High
E4 Helsinki– Lahti	Finland	2012	PPP	15 years	Both GF&BF	Medium
E18 Muurla– Lohja	Finland	2005	PPP	24 years	Greenfield	Medium
Bundesautobahn 20	Germany	1992	Public	–	Greenfield	High
Athens Ring Road	Greece	1996	PPP	25 years	Greenfield	High
Central Greece (E65) Motorway	Greece	2007	PPP	30 years	Both GF&BF	High
Elefsina Korinthos Patra Pyrgos Tsakona Motorway	Greece	2007	PPP	30 years	Both GF&BF	Medium
Ionia Odos Motorway	Greece	2007	PPP	30 years	Brownfield	High
Moreas Motorway	Greece	2007	PPP	30 years	Both GF&BF	Medium
BreBeMi	Italy	2003	PPP	20 years	Both GF&BF	Medium
Combiplan Nijverdal	The Netherlands	2010	Public	–	Brownfield	Medium
E18 Grimstad–Kristiansand	Norway	2005	PPP	25 years	Greenfield	Medium
E39 Orkdalsvegen Public Road	Norway	2003	PPP	25 years	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	50	Greenfield	Low
Eje Aeropuerto (M-12) Motorway	Spain	2002	PPP	25	Greenfield	Medium
M-45	Spain	1999	PPP	25+ext.	Greenfield	Medium
Radial 2 Toll Motorway	Spain	2001	PPP	25+ext.	Greenfield	Medium
A2 Motorway	Poland	2009	PPP	25 years	Greenfield	High
A22 Motorway	Portugal	2000	PPP	30 years	Both GF&BF	Low
A23 Motorway	Portugal	1999	PPP	30 years	Greenfield	Medium
A-19 Dishforth	UK	1996	PPP	30 years	Brownfield	Low
BNRR (M6 Toll)	UK	1992	PPP	30 years	Greenfield	High
M-25 Orbital	UK	2009	PPP	30 years	Brownfield	High
M-80 (Haggs)	UK	2008	PPP	30 years	Both GF&BF	Medium

Note: [1]Low (<400 Million Euros), Medium (400–1000 Million Euros), High (>1000 Million Euros)