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Abstract: Abstract
The construction of road infrastructure is often a difficult issue for many countries. While many developing countries do not have public funds available, other developed countries experience public budget restrictions that limit the country's infrastructure development. Public Private Partnership (PPP) appears to be an adequate mechanism for empowering those countries, both developing and developed, to bring together the public and the private sector and to find efficient ways for public funding and public services provision
Public Private Partnership is not however a panacea, instead mean a limited approach that is valid for feasible projects, and given the current economic context it may be the only solution for road provision in some cases. Moreover, affordability limitations and viability conditions become key factors to make projects financially sustainable.
From a case study analysis carried out on many projects in Europe, COST Action TU1001, Public Private Partnerships in Transport: Trends & Theory P3T3 , it may show evidence of key factors (or key performance indicators) that might drive to success or failure. The idea of this paper, therefore, is to identify the elements for assessing sustainability in transport projects against these KPIs. A comparative analysis using 04 case studies (road projects) from Greece, Portugal, Spain and UK were chosen to achieve the main purpose of the paper.
The findings and implications may be of interest at the time of implementing and designing a sustainable and efficient policy for road infrastructure. These results may be considered in many countries which are preparing a master program of national roads.

**Sustainable PPPs: a comparative approach for road infrastructure (cover letter).**

This work was supported by the EU COST programme under Grant COST Action TU1001on "Public Private Partnerships in Transport: Trends and Theory". The findings presented in the paper are taken from the case study database developed as part of the aforementioned project. The case study methodology used a template that included questions ranging from actors, project specifics to performance monitoring. Primary data for this study are basically obtained from these filled case templates. Semi-structured interviews were conducted and secondary data was also collected to fill in the templates. Four toll road case studies from different four very active countries in PPP, were used in this research. The results show elements for assessing sustainability in transport projects.

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# Sustainable PPPs: a comparative approach for road infrastructure

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# Sustainable PPPs: a comparative approach for road infrastructure

**Highlights:**

- This paper shows a basic methodology to evaluate transport infrastructure project success.
- Selected case studies from 04 different countries are used to carry out the research.
- The research considers both the pillar of sustainability performance (social, environmental and economical) and the classical project management components (time, cost and quality).
- Results emphasise the importance of a balanced performance in many aspects (construction, renegotiations, financing, etc) for the project to be sustainable.

# Sustainable PPPs: a comparative approach for road infrastructure


## Abstract

The construction of road infrastructure is often a difficult issue for many countries. While many developing countries do not have public funds available, other developed countries experience public budget restrictions that limit the country's infrastructure development. Public Private Partnership (PPP) appears to be an adequate mechanism for empowering those countries, both developing and developed, to bring together the public and the private sector and to find efficient ways for public funding and public services provision

Public Private Partnership is not however a panacea, instead mean a limited approach that is valid for feasible projects, and given the current economic context it may be the only solution for road provision in some cases. Moreover, affordability limitations and viability conditions become key factors to make projects financially sustainable.

From a case study analysis carried out on many projects in Europe, COST Action TU1001, Public Private Partnerships in Transport: Trends & Theory P3T3[1], it may show evidence of key factors (or key performance indicators) that might drive to success or failure. The idea of this paper, therefore, is to identify the elements for assessing sustainability in transport projects against these KPIs. A comparative analysis using 04 case studies (road projects) from Greece, Portugal, Spain and UK were chosen to achieve the main purpose of the paper.

The findings and implications may be of interest at the time of implementing and designing a sustainable and efficient policy for road infrastructure. These results may be considered in many countries which are preparing a master program of national roads.


**Key words:** Key Performance Indicators (KPI), Critical Success Factors (CSFs), Toll Roads, PPP, Sustainability, Case studies.

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[1] For more info see http://www.cost.eu/domains_actions/tud/Actions/TU1001

- The research considers both the pillar of sustainability performance (social, environmental and economical) and the classical project management components (time, cost and quality).

- Results emphasise the importance of a balanced performance in many aspects (construction, renegotiations, financing, etc) for the project to be sustainable.

# 1. Sustainability in road infrastructure

## 1.1 Sustainability vs. sustainable development – definitions

O'Riordan (1988) distinguishes sustainability as a concept with primary focus on the environment and Sustainable Development (SD) with primary focus on the aspect of development. Taking this view further, Robinson (2004) explains that SD seems to follow a conservationists' approach to natural area management and seems to rely on technology and efficiency improvements to address the problems of pollution and resource scarcities. On the other hand, the concept of 'sustainability' tends to prefer approaches that preserve the natural areas and advocates changes in the individual lifestyles and values as solutions to pollution and resource scarcity issues. Robinson (2004) further observes that while governments and private sector organisations prefer to use the term SD, academic and NGOs seem more inclined towards the term sustainability. He attributes this to the fact that development is often seen as synonymous with growth. Thus, the term SD is generally associated as supportive of continuous economic growth, which is not that favoured by the environmentalists, whereas, sustainability is seen to demonstrate attention towards environmental constraints (Robinson, 2004).

In his report to the Balaton group, Bossel (1999) refers to the Webster Dictionary definition of 'sustain', which means, "to maintain; keep in existence; keep going; prolong". Bossel (1999) states that taken strictly in this sense, human society cannot be maintained at a particular rate forever. The human society is a complex system that evolves and adapts itself to its surroundings that is placed within the natural environment. The latter is a dynamic and possibly, an even more complex system. Hence, Bossel states that "change and evolution is permanent... and must be maintained if the systems are to remain viable and sustainable". He describes this as SD.

According to Bell and Morse (2008) the 'sustainable' part of SD paradigm is both a descriptor of something and a target to achieve. It describes, in its broadest sense, that our actions today should not harm the future generations to come. In sustainability literature this is often expressed as 'don't cheat on your kids' (Bell and Morse, 2008). A similar explanation is provided by Laloe (2007), who states that 'sustainability' is something that is 'dependent on an object which must be described'. Thus, SD could be viewed as the process through which the end goals of 'sustainability' are achieved. This view of sustainability and SD is further supported by Laloe (2007), Bhamra and Lofthouse (2007) and Lutzkendorf and Lorenz (2007). Accordingly, Kiewiet and Vos (2007) stress the importance of asking 'sustainability of what?' question as an essential step in bringing about sustainability. Similarly, Laloe (2007) states that no unique definition to sustainability alone can be proposed, as it is dependent upon the 'object' being described. Thus, it appears acceptable to use the term 'sustainability' in a generic sense. Such an approach makes it plausible to apply any discussions on 'sustainability' to anything that has the term sustainable as an adjective (Bell and Morse, 2008), such as, SD,

sustainable cities, sustainable communities, sustainable construction, sustainable institutions, etc. This enables the comparing and contrasting of the application of the concept across sectors, as well as, applying lessons learnt from one sector to another. The concept of sustainability could be therefore seen as transcending the concept of SD cutting across various cultural and professional barriers. As a result, adopting a similar view of 'sustainability'/'SD' seems appropriate for this research.

Moving forward, this paper will use the term 'sustainability' in a broad, generic sense and terms such as, 'SD' will be used to describe its applicability in the respective arenas (in this case, development and construction in the transport sector).

## 1.2 Achieving and measuring Sustainability in Transport Infrastructure Projects

The demand for sustainable transport projects has increased significantly during the last decade of the twentieth century; when industries experienced a shift in stakeholder pressures from environmental discourse to social-related concern, where new development in the form of projects and technology are undertaken (Labuschagne and Brent, 2006). The shifts were driven by a variety of factors, e.g. achievement of a more integrated and holistic approach to transportation decision-making. However, researches have been shedding light on the complex interrelationships between the built and natural environments; hence encourage need to research the multifaceted implications of transport systems changes.

For transport project planning and planning of other infrastructure systems, several agencies has adopted sustainability within their mission statements, however, it seems that there is a lack of frameworks for assessing/measuring sustainability in transport projects. Measuring sustainability usually involves some sort of index creation, which itself has a long and evolving history. To support this claim, over the past two decades, worldwide efforts to identify indicators of sustainability have resulted in the creation of many indicators, that are either more biased towards environmental sustainability, or have lack of focus towards project life cycle evaluation, i.e. "cradle to cradle" approach (design, construction, operation, decommissioning, reused, demolished, recycled and backfill to nature).

In addition, sustainability with respect to transport is in principal focused on *serving* development, on the one hand, and minimizing the *effects* on the environment, on the other. The 1993 EU White Paper on Growth, Competitiveness and Employment clearly stated this need (EC, 1993). Ever since, the emphasis has been on rational and optimal use of resources (EC, 2001), in order to avoid over- or under-utilisation and meet the demands of sustainable development (conclusions of the Gothenburg European Council, 2001). Therefore, the need to achieve "competitiveness" and "complementarity" and pricing of transport services (EU White Paper on Transport, 2001). Introducing the private sector in public undertakings has supported "competitiveness". Hence, PPP as an infrastructure delivery model is very relevant,

as are tolling practices (EC, 2011). However, little emphasis has been given as to the sustainability of the infrastructure per se.

The main purpose of this paper is to assess the performance of transport infrastructure projects in terms of achievement of sustainability principles. This will be fulfilled by developing a simple measurement matrix for assessing sustainability in transport projects. The paper will not only assess the performance of projects in terms of sustainability, but it will also be compared against the common indicators that determine project success.

## 2. Methodology and data collection

A case study methodology was used to achieve the aforementioned purpose of this paper. The case study methodology used a template developed with the COST Action TU1001 (P3T3). The template included questions ranging from actors, project specifics to performance monitoring (Roumboutsos and Liyanage, 2013). Herein, actors are the participants in the project, i.e. the public contracting agency and sponsors, the private participants and the users who benefit from the project. Secondly, the specifications of the project are described, mostly with regard to what the project is all about (what), project timelines (when), location (where), why the PPP option was selected for the project, the tendering procedure (which way), etc. Finally, the template focused on identifying the key performance indicators (KPI) and also the critical success factors (CSF) to evaluate the success criteria of the project.

Primary data for this study are basically obtained from these filled case templates (which were then transferred to a case database). Semi-structured interviews were conducted and secondary data was also collected to fill in the templates. The templates were filled for different projects (from different transport modes within many EU countries) by members of COST Action TU1001. All these projects were procured through Public Private Partnership (PPP) form, as the primary focus of the COST TU1001 was on 'sustainable PPPs'. The need for the study was identified due to the heavy use of PPP within transport projects within the EU, due to several reasons ranging from risk transfer/sharing, financing, private sector expertise, etc. The secondary data was widely available on the web and some information was collected from related project organisation/s. The templates were then analysed using Qualitative Content Analysis (QCA). A manual method of content analysis was used for the above. The main purpose of the manual analysis was to somehow quantify the qualitative data for easy comparison and analysis between and within cases. This involved a process of development of indicators using different codes. A 3-stage Delphi study was then conducted to refine the selection of indicators and prioritise them in accordance to their level of importance (on a likert scale basis). The set of indicators developed consisted of 35 questions and the answers follow three predefined likert scales and a binary option (yes or no) to better capture the varied responses in accordance with a set success/failure criteria (Liyanage and Villalba, 2014). The Delphi study was conducted with four experts who have in-depth knowledge and experience in the transport sector.

Of the 50+ projects in the COST Action TU1001 database, overall, four road projects were chosen to achieve the purpose of this paper. The main reason for the choice of roads are, in terms of application of PPPs, road projects have a higher percentage of usage of PPP compared to other transport modes (e.g. rail, airports, ports and urban transit). This was also evident from the number of PPP projects on the case study database. Of the road project, toll roads from Greece, Portugal, Spain and UK were selected for cross case analysis. These four countries are no stranger to the application of PPPs for their infrastructure projects; also the countries themselves and many PPP projects in these countries have been affected heavily following the financial crisis in 2007/08. These similar characteristics make a basis for easy comparison of success/failure of these projects to some extent. The chosen toll road projects are; the M6 toll road, which is the only recent toll road developed in the UK; the R-2, which is one of the well-known Radiales de Madrid projects; the A-23, one of the Portuguese SCUT (shadow toll) roads, whose payment model has shifted from shadow to direct toll; and the Attica Ring Road, a high-speed toll motorway in Greece.

# 3. Case study description

## 3.1 Birmingham Northern Relief Road (BNRR) A6 Toll Road (M6 UK)

The M6 Toll road, originally called as the Birmingham North Relief Road / BNRR, is a greenfield project that connects M6 Junction 4 at the NEC to M6 Junction 11A at Wolverhampton in the area of Birmingham, U.K., with 27 miles (43 km) of six-lane motorway. The agreement is a Design, Build, Finance and Operate (DBFO) contract and was of the main new project in the country. This model is more commonly referred to as the Private Finance Initiative (PFI) in the UK. Constructions costs of the project were about £ 485 Million and the duration of the PPP contract is 53 years. At the end of this period, the infrastructure would be returned to the Government. The M6 UK project is operational since December 2003, after a three-year construction period. The private partner of the project is Midland Expressway Ltd (MEL) and the current equity holder within the SPV is Macquarie Infrastructure Group (MIG). MEL contracted out the construction of the road to a consortium of major contractors, i.e. Carillion, Alfred McAlpine, Balfour Beatty and AMEC. In 2010, the MIG was split into two, and the current the M6 Toll management was assigned to Macquarie Atlas Roads. The value of the project is estimated at £ 900 million. Toll rates for the project are set at the discretion of the operator at six-monthly intervals and there is no cap on the rates charged. For this reason, prices have been multiplied, depending on the type of vehicle by two or three times. This is mostly applied to popular light vehicles, whereas for heavy vehicles, in order to capture additional traffic, the prices have been lowered (compared to the initial toll set) for several years. There is a 5% discount for using a TAG (small self-contained electronic device for toll payment). The repayment method is, therefore, based mainly on user fees. In addition, the UK Government, to enable a smooth connection and operation of the project to the M42, provided sums (to the value of £18 million) and pays a small availability fee to the private partner.

The schedules of the contract are very prescriptive including levels of management to be employed and the monitoring procedures for compliance throughout the concession period. However, the contract makes reference to the ability of the concessionaire to vary and make changes to the technical aspects. This suggests some renegotiation possibilities established in the contract. It has been reported that some type of negotiation may be going on considering the low level of traffic achieved. Regarding the risks analysis, given that this is a DBFO type of the contract, the concessionaire takes most risks for design, construction, commercial, financial and other elements, except for regulatory issues, force majeure and some exploitation considerations.

## 3.2 Madrid Radial 2 Toll Road (R-2 Spain)

The R-2 is a greenfield project for the construction and operation of a toll motorway in the north east area of Madrid in Spain. The PPP option of the project is Built, Operate and Transfer (BOT) contract. The final project cost has been around 500 million Euros and the total duration of the project is 25 years. The project is in operation since October 2003, after a period of tendering and construction for 3 ½ years. The concessionaire, named as HENARSA, S.A., is responsible for the construction and financing of the road, is entitled to receive revenues for the services provided and finally hand-over to the grantor at contract termination. The repayment method is mainly based on user fees in the form of direct toll during the concession period and other revenues may be obtained from the exploitation of the service areas either from direct operations or from renting the space to different services providers, such as gas stations, car cleaning and repair, restaurants and other services to users. The tolls are established in the contract and are indexed to inflation in accordance with a general update procedure. These are fixed tariffs and, therefore, are regulated. However, there are some contract provisions for discounts to be granted for only frequent users adopting the electronic payment devices on a monthly basis (i.e. TAG). This requires a previous agreement with a bank, which manages all the payment procedure.

The contract does not include renegotiation clauses. However, there are some provisions in general law applicable for exceptional cases, mainly named as Financial and Economic Re-equilibrium. Under this principle, the grantor has to make the necessary modification to compensate any damages occurred as a result of actions by the Public Administration. This provision allows for contract modifications and enhancements in order to generate the required increase in revenues to pay for additional costs and/or compensate possible negative impacts. This has already been occurred in the R2 Spain as a consequence of additional works required by the grantor and deviation in the price of the land use. The grantor has also provided additional financing to pay part of the excess prices to land owners. In addition, due to the dramatic negative traffic impact as a result of the economic downturn, the grantor has provided a minimum revenue guarantee for a period of three years. Thus, the grantor has allowed some modifications in the contract regarding the tariffs. However, this measure has proven to be insufficient as the minimum amount has not been paid due to strict public budget restrictions. With regard to risk analysis, most of the risks are assumed by the concessionaire: construction (except for design that has to follow the pre project that is prepared by the grantor),

maintenance, exploitation, commercial/revenue generation and financial. However, some other typical risks are taken by the grantor, mainly force majeure, regulatory, etc.

## 3.3 Beira Interior A-23 Toll Road (A-23 Portugal)

The A-23 Beira project, is a combination of some existing infrastructure and a new construction of a toll road in the centre of Portugal, linking the north-south axis A1, near the Spanish border. The contract is Built, Operate and Transfer (BOT) and the duration of the project is 30 years. The initial construction cost was estimated at Euro 628 million, but the total amount of payments made by the State at the end of the concession period would be about 2,280 million. The construction works ended in July 2003, nearly six years after the date of call for tender. The concessionaire is SCUTVIAS– Auto Estradas da Beira Interior, S.A. for most of the length of the project (178 out of 217 km) and is responsible for the design, construction, operation and maintenance during the concession period, after which the road will be delivered to the grantor. The remaining section is managed by the national road institute, Instituto das Estradas de Portugal - IEP. The repayment method is a combination of two models, shadow toll and availability fee. During the first stage of operation (first five-years), the Government paid the concessionaire an annual payment depending on the length of the existing road in operations; in the second stage, the payment is composed of an availability payment and a shadow toll. Shadow toll prices are fixed in three different intervals. The idea behind this model is that the first interval will pay for fixed operation and maintenance costs and the senior debt; the middle interval will pay for variable operation and maintenance costs and the subordinate debt; the latter interval will pay dividends and the stockholders debt.

The contract also includes financial rebalancing payments in the following situations: changes on concession activities introduced unilaterally by the State which imply increased costs or reduced revenue for the private partner; force majeure events; legislative changes which imply increased costs or reduced revenue for the private partner; other situations which the contract allows. After a renegotiation process and following a Government decision in December 2011 to introduce user fees as tolls, the contract has been modified although details are not accessible to the public. According to the Directorate-General of Treasury and Finance (DGTF), repayments are now based on availability and direct tolls. However, the new risk matrix has been published later, keeping the public sector the commercial risk, most part of the regulatory, force majeure risk; and sharing the exploitation risk with the private sector. The design, construction, maintenance and financial risks have already been transferred to the private sector.

## 3.4 Attica Tollway, The Athens Ring Road (Attica, Greece)

Attica Tollway is a greenfield project, consisting of three-lane ring road around the city of Athens. This is part of the Trans European network. The construction of the project was performed in parallel with flood protection works, as it passes through three large hydrographic basins. It is a hybrid structure of a PPP project under a Build, Operate and Transfer (BOT) contract with strong public financial support. The concessionaire is Attiki Odos. They are

responsible for the construction and operation of the road. It has established back to back contracts with the concession agreement, with "Attiki Odos Construction Joint Venture" for the project construction and with "Attikes Diadromes, S.A." for the operation and maintenance of the project. The total project cost is Euro 1,300 million and the concession period will end in a maximum period of 25 years or earlier, in the case that the maximum Return on Equity (13.1%) has been reached. The project is in operation since 2001, five years after the contract was granted, though final completion was in August 2004. The project financing included State contributions, EC Structural Cohesion Funds, private equity and loans. The financing was covered as follows: 33% Greek State contribution; 16% private equity and 51% loans (9% Commercial Banks loans and 42% EIB loans). The financial close was delayed, mainly because of uncertainties surrounding the project. Finally an agreement was reached in March 2000. There were many delays, but solutions were found after extensive negotiations between all parties involved; and amendments to the concession contract were introduced, leading to the satisfaction of the banks and reaching a financial close.

The risk allocation was a BOT typical matrix, where design, construction, maintenance and exploitation, commercial and financial risks are mostly or totally private, and regulatory, force majeure and others were mainly public.

# 4. Findings and implications

As mentioned earlier in section 2, comparative analysis was adopted to analyse the 04 cases above. The comparative analysis consists of the following steps.

- Manual QCA to develop KPIs (these consisted of 35 questions – refer Table 1)
- Quantify the KPIs with a set of likert scale/binary option (refer Table 1).
- 3-stage Delphi study to refine the selection of indicators and the scale/s used (likert scale or binary option).
- The 35 KPIs were considered according to two perspectives: i.e. according to the project management perspective (to assess success or failure of the project); as well as, sustainability perspective (to assess the level of achieving sustainability within the projects).
- The aforementioned two perspectives were further categorised as follows:
    - Time, cost and quality for assessing project performance (as these three are the most commonly used indicators for project success); and
    - Environmental, social and economic pillars to assess sustainability performance. Sustainability is widely characterised as composites of three

pillars, namely: environmental, economic and social, otherwise known as the three "Ps" (people, planet and profit) or the three "Es" (environment, economy and equity) (Magnus, 2012). It is argued that sustainability could not be implemented without the integration of all three pillars, hence achieving sustainability requires holistic thinking to consider the complex inter-relationships between these different elements (Du Plessis, 2005; Atkinson et al. 2009, Kiewiet and Vos, 2007). Therefore, for both normative and substantive reasons (Magnus, 2012), the relationships among these pillars are generally assumed to be compatible and mutually supportive (Littig and GrieBler 2005).

The consideration of these 35 KPIs within both these perspectives and division of the KPIs within their respective categories were made according to the content and meaning of the discussions given in the filled case templates and their major areas of impact on these categories (Liyanage and Villalba, 2014). Initially the researchers carried out the division of KPIs and subsequently they were refined using views of 11 experts in the area of PPP transport (this was fulfilled during a COST Action TU1001 meeting at the University of Twente, Netherlands in July 2013).

The final findings were then presented in a matrix analysis as follows (see Table 1). The number of KPIs come under each category are given within brackets.

Table 1: Assessing project success vs. achieving sustainability

| **Project Management (35)** | **Achieving Sustainability (35)** | | |
|---|---|---|---|
| | **Environmental (5)** | **Economical (21)** | **Social (9)** |
| **Quality (19)**<br>**Cost (13)**<br>**Time (3)** | Environment (3)<br>Operations (1)<br>Maintenance (1) | Contract specifications (9)<br>Construction (4)<br>Monitoring (1)<br>Finance (4)<br>Performance (2)<br>Downturn impact (1) | Objectives (4)<br>Tendering process (3)<br>Risks (2) |

The aforementioned table was used to analyse and compare the sustainability performance of the 04 case studies. This case study analysis is completed with additional remarks that indicate the success and failure attributes which have been identified within the process of QCA. Since the methodology adopted is more qualitative, subjectivity could be a limitation herein. However, care was taken to avoid researcher bias as much as possible. Table 3 explains success and failure attributes and the likert scale used to quantify the qualitative analysis, i.e. s-S = Success, f-F = Failure, n-N = Neutral, S/F = More Success than Failure and F/S = More Failure than Success. According to this analysis, for example, M-6 project, in social perspective of sustainability, could be considered as a failure but in economic perspective, is a success. It is

worthwhile noting that the number of performance measures allocated to different KPIs, as shown Table 1, is different; and, subsequent division of the performance measures according to the categories in the two different perspectives is also different; as a result, the number of KPIs come under each category is different as well. Accordingly, when the percentage of success is calculated, the performance measures/KPIs, intrinsically, are not treated as equal, as they gain different weightings under each perspective. One limitation that could be identified here is the calculation of this weighting; however, since they are not calculated for the final percentages of success, this was not an issue.

In addition to the aforementioned comparative analysis the results were also presented in bar graphs. The first graph (Figure 1) illustrates raking of the 04 case studies on an overall basis. The second graph (Figure 2) shows the social, environmental and economical performance of the 04 projects. Final graph (Figure 3) indicates the project performance from time, cost, quality perspectives.

According to Table 3 and Figures 1, 2 and 3; it is apparent that the Portuguese project is very successful from both project management perspective and sustainability perspective. In the Portuguese case, the repayment mechanism used is a combination of shadow, availability and direct toll collection. Moreover, demand risk is shared between the public and private sector out of such combination: the public sector is responsible for collecting user fees and pays to the private sector a shadow toll depending on measured traffic intervals, which shows the private partner exposure to the demand risk. However, there are some critical opinions suggesting that this repayment mechanism is biased at the cost of the public, which, therefore, questions the success of the project in social terms. Future progress will show at which extent potential benefits may be shared with the public, either reducing the user fares or smoothing the amount of shadow payments to the private partners.

The Greek project is also, overall, quite successful, except in terms of social perspective; although the project faced with many issues with regard archaeology findings, land expropriations, relocation of public utilities and design variations for environmental reasons. There were also some problems with regard to risk transfer, which had to be modified later especially in terms of guarantees that finally counted with the State support in order to achieve financial close. The consequences were significant delays in the initial phase, but an effective management and the support of the many Greek industries ensured the construction to be completed within budget and on time for the Olympic Games. Other notable matters related to performance are: whilst actual traffic was even higher than expected and the impact of economic downturn impact limited, the success of the output is evident, notably in terms of active traffic management, high level of safety, incidents management plan and response, incentives for promotion of electronic users and customer service satisfaction.

The English and Spanish projects could not be considered clearly successful for different reasons.

On one side, the English case (M-6) resulted in a failure in terms of social aspect because of implementation problems related to the quality of the project and regarding cost and time issues during the tendering process. However, it is successful in the environmental area and more successful that failure in the economical areas. Overall conclusion considers this project more success tha failure.

On the other side, the Spanish case (R-2) is successful in the environment aspects and more successful than failure in social aspect; however, the economical area has resulted a failure, because firstly, there were delays in the construction phase that caused additional costs and delays; and secondly, cost problems were identified in certain elements of finance, traffic and revenue performance were much lower than expected and due to the strong impact of the economic downturn. Therefore overall conclusion is considered neutral.

It is important to make several remarks to describe most of the implications. Firstly, all respective European countries of featured case studies have put in place environment legislation following European directives in order to protect and reduce the negative impact both in construction and operations phases. Indeed, an Environment Assessment and a mitigating Action Plan is due in the European Union before a Public Works is started. This ensures that negative impacts are avoided or minimised to acceptable/reasonable levels in accordance with the construction and technology's current state of the art. This includes strong measures in order to minimise noise and pollution and ensures a proper and environment friendly maintenance of the infrastructure. Two KPI regarding these were included to measure the environmental impact of projects. Finally, the Environment achievements are validated by the high level of success obtained in the environmental area, considering all projects are European based.

Secondly, sustainability usually requires adopting technical innovations and respecting the environment as a mean to procure long term infrastructure available for next generations, instead of the provision of short term public work solutions to cope with current problems. An example of this may be the successful case of Attica Tollway in Greece. In effect, this project introduced a number of innovations during its construction and operations. Some constructing measures such as the use of vibrations recorders to restrict peak particle speed in open-cast mining excavations; the tunnel construction method using Roadheader machinery; the avoidance of explosives in areas of historical interests; the use of utmost road pavements product ensuring higher resistance and durability; were all used in Attica project. During operations, Attica was the first toll road to introduce the electronic toll collection system. In addition, the project was constructed in parallel with flood protection works, considering that the road crossed three large hydrographic basins. The flood protection works constructed were dimensioned to be adequate for the existing and future land use.

Thirdly, the Portuguese project success is highlighted in the table and charts. It must be clarified that the evaluation of the project has considered the long and drastic negotiations between the Portuguese Government and the Operators. Would these negotiations have not been produced, the project will be socially unsustainable due to the payment amounts the

Government had to pay to operators. This suggests how concession renegotiations are important from an economical and social point of view.

Fourthly, the Spanish project is currently in a renegotiation process and positively there are many lessons to be learnt. Cashflow problems, due to lower than expected traffic revenues and cost overruns, require a project redefinition and changes in the concession contract. The absence of renegotiation provisions in the contract has challenged possible agreements and a final decision of the Government to step in the concessions is expected. This also indicates how important it is to include provisions for renegotiation in the contract specifications.

Finally, even if there are no clear conclusions on the repayment mechanism to be followed, it is remarkable that the economic downturn had a high impact on project cashflow when financing is only based on users fees. M-6 and R-2 projects show that projects revenues that depend exclusively on user fees may fail during economic downturns, whilst availability payments act as an economic mattress during support market adverse conditions. It makes perfect sense to combine user fees for the cost of the toll roads with availability payment for the cost of additional works required. However, charging the cost of additional works in free access sections to users of toll sections, as in the case of the R-2, may be excessive and unsustainable from an economical point of view. This suggest that blended repayment mechanisms such as the one for M-6 or even more notable, the one applied for A-23 (even though commercial risk is maintained in the public side, contrary to what most of the PPP are looking for), may be more economically sustainable and some demand risks may be socially accepted.

# 5. Conclusions

This paper proposes a basic approach of assessing sustainability performance using a combination of quantitative and qualitative content analysis (QCA). The proposed approach is applied to four case studies to finally derive at conclusions. The case studies considered were M-6 UK, R-2 Spain, A-23 Portugal and Attica Greece. The sustainability performance is also compared against the 'conventional' project management, in order to see the deviation of results, if any. The three pillars, i.e. economic, social and environmental, are used to measure sustainability; whilst the "iron triangle", i.e. quality, cost and time, are considered to assess the project performance. The findings are populated onto a matrix that consists of 35 performance measures (that belong to 12 KPIs). The results matrix portrays how and why two cases, i.e. A23 Portugal and Attica Greece, are considered successful. The other two cases show different results in different perspectives (project management and sustainability). Overall, M-6 UK is more success than failure and R-2 Spain is considered neutral. The additional ranking shows the best performance order of the four projects. In conclusion, determining success or failure of a project is not a clear cut approach; it needs an in-depth analysis of strengths and weaknesses either enable/hinder a progress of a project and the analysis of their level of impact on the project overall.

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Table 2: Success Matrix

| Project Mngmt / Output | KPI | QUALITY | COST | TIME | M6 U.K. | QUALITY | COST | TIME | R-2 Spain | QUALITY | COST | TIME | A-23 Portugal | QUALITY | COST | TIME | Attika Greece | QUALITY | COST | TIME |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **OVERALL** | **35** | **19** | **13** | **3** | **S/F** | **S/F** | **F/S** | **S/F** | **N** | **S/F** | **F** | **S/F** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **N** |
| **SOCIAL** | **9** | **3** | **5** | **1** | **F/S** | **N** | **N** | **F** | **S/F** | **F/S** | **S/F** | **S** | **S** | **S** | **S** | **S** | **S/F** | **S** | **S** | **F** |
| Objectives | 4 | 2 | 2 | | **F/S** | f | n | | **F** | f | f | | **S** | s | s | | **S** | s | s | |
| Tendering Process | 3 | 1 | 1 | 1 | **F/S** | s | f | f | **S** | s | s | s | **S** | n | s | s | **S/F** | s | s | f |
| Risks | 2 | | 2 | | **S** | | s | | **S** | | s | | **S** | | s | | **S/F** | | s/f | |
| **ENVIRONMENTAL** | **5** | **5** | **0** | **0** | **S** | **S** | | | **S** | **S** | | | **S** | **S** | | | **S** | **S** | | |
| Environment | 3 | 3 | | | **S** | s | | | **S** | s | | | **S** | s | | | **S** | s | | |
| Operations | 1 | 1 | | | **S** | s | | | **S** | s | | | **S** | s | | | **S** | s | | |
| Maintenance | 1 | 1 | | | **S** | s | | | **S** | s | | | **S** | s | | | **S** | s | | |
| | | | | | | | | | | | | | | | | | s | s | | |
| **ECONOMICAL** | **21** | **11** | **8** | **2** | **S/F** | **S** | **F** | **S** | **F** | **S** | **F** | **N** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** |
| Contract Specifications | 9 | 9 | | | **S** | s | | | **S** | s | | | **S** | s | | | **S/F** | s/f | | |
| Construction Phase | 4 | 2 | 1 | 1 | **S** | s | s | s | **N** | s | f | f | **S** | s | s | s | **S** | s | s | s |
| Monitoring | 1 | | 1 | | **F** | | f | | **N** | | n | | **S** | | s | | **S** | | s | |
| Finance | 4 | | 3 | 1 | **N** | | f | s | **F** | | f | s | **S** | | s | s | **S/F** | | s | n |
| Performance | 2 | | 2 | | **F** | | f | | **F** | | f | | **S** | | s | | **S** | | s | |
| Downturn impact | 1 | | 1 | | **F** | | f | | **F** | | f | | **S** | | s | | **N** | | n | |

Values: s - S -> Success f - F -> Failure n -N -> Neutral S/F -> More Success than Failure F/S -> More Failure than Success

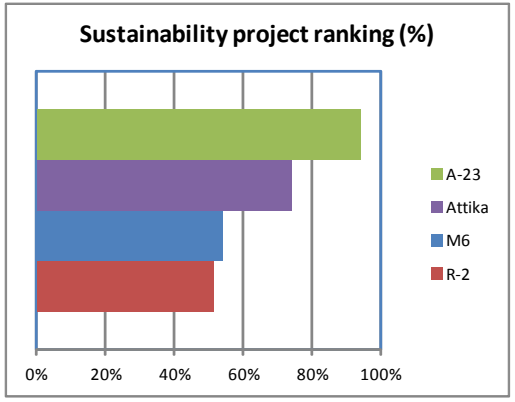


Figure 1: Sustainability project ranking

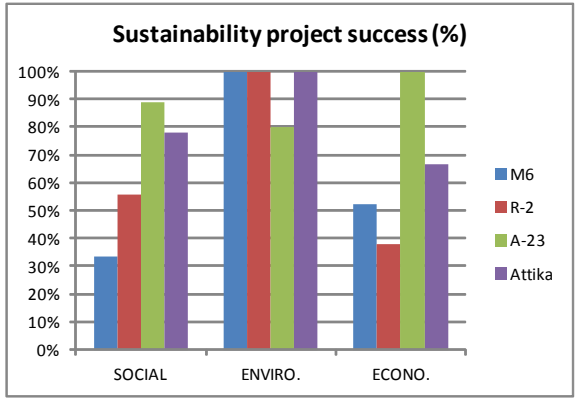


Figure 2: Sustainability project success

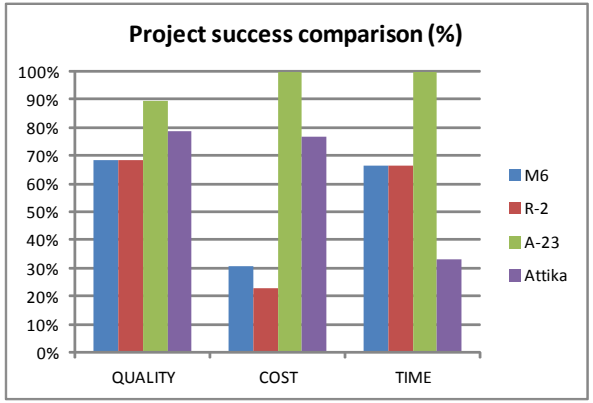


Figure 3: Project success comparison