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Planning, Designing and Scheduling New Transport Infrastructure in Recession Times: The Greek Case

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Abstract
The recent financial crisis in Europe has led the economies of many countries at its periphery into recession, which results in tight budgetary constraints and large reduction of public investment in infrastructure. It is therefore imperative for the State Decision Makers and Public Clients in these countries to review their approach, attitude and policy and compromise the planning, designing and scheduling of new infrastructure projects to the stringent reality of today's and to the fuzzy future of tomorrow. In this paper, the authors discuss critically the current approach to planning, designing and scheduling of infrastructure projects in Greece, i.e. in an economy being in recession for six consecutive years. A number of transport infrastructure projects under tendering or construction are presented and analyzed; these include urban express roads, urban development projects, cruise port, metropolitan rail and airport. The authors review the methodologies and practices implemented worldwide in similar infrastructure development to reduce the required investment, i.e. to tackle capital scarcity, and present on that basis more economical technical solutions for each of the above projects. Finally, the authors develop recommendations regarding the necessary policy and good practices that the Greek State and Public Clients should implement during recession times.

Keywords
Transport Infrastructure, Transport Planning, Infrastructure Design, Recession

1. Introduction

The recession across the world has led to ongoing transformations within the state and the market, brought active development projects to a grinding halt and forced countries and cities to question the very ways in which, sometimes for more than 50 years, the built environment has been managed (Bertolini *et al.*, 2011). Particularly in Greece, the size of the economy has declined by over 23 per cent in 2007–2013 (Matsaganis and Leventi, 2014) and therefore the scarcity of capital obliges to make well-informed and efficient investment decisions, duly justified through the appropriate processes of Cost - Benefit Analysis (CBA) and value appraisal.

Flyvbjerg (2008) aptly observes that when cost and demand forecasts are combined, for instance in the CBAs typically used to justify large infrastructure investments, the consequence is inaccuracy to the second degree. Furthermore, there is a tendency in the Public Clients to keep adopting technical and financial solutions by ignoring the stringent reality of today. Ford *et al.* (2002) observe that managers currently do not exploit real options fully so as to capture the value of strategic flexibility, largely because they do not use a decision-making framework to recognize or quantify the value of options.

Value is a central concept in a project management context as it encompasses its life-cycle cost, as well as organizational, social and environmental aspects associated with the design, construction, operation and decommissioning of the project. The maximization of public projects' "value for money" is a constant goal of the design process. It is assumed to be reached when the same functions are provided at a lower cost and also when more value-adding functions are provided for the same or a lower cost. Value management (VM) is the name given to a process in which the functional benefits of a project are made explicit and appraised as consistent with a value system determined by the client (Kelly *et al.*, 2004), while Value engineering (VE) is defined as an organized approach for the provision of the necessary functions at the lowest cost (Kelly and Male, 1993). Short *et al.* (2007) provide a detailed analysis for the practice of VE and support that a progressive, client-driven use of VE, which relates back to a common sound understanding of the client's vision, offers some basis for success. The attitudes and experiences of VM facilitators within major UK cost consultancies have been investigated by Ellis *et al.* (2005).

This paper aims to present infrastructure development practices able to tackle capital scarcity, critically discuss the current approach to planning, design and scheduling of infrastructure projects in Greece, i.e. in an economy being in recession for six consecutive years, and make recommendations regarding the necessary policy and good practices that the Greek State and Public Clients should implement during recession. In the light of the concepts previously introduced, a number of transport infrastructure projects under design or tendering are presented and analyzed; these include urban express roads, urban development projects, a cruise port, metropolitan rail and an airport. The authors review the methodologies and practices implemented worldwide in similar infrastructure development to reduce the required investment, i.e. to tackle capital scarcity, and present on that basis a more economical technical solution for each project.

2. Thessaloniki ring road

Thessaloniki metropolitan area has a population of approximately 1 million. It is built in a crescent shape, squeezed between Thermaikos Bay in its south and the nearby mountains in its north. The main motorway linking Athens with the northern border of Greece as well as the city's industrial zone lie in its west side, while the international airport, the main residential areas and the touristic destinations lie in the east. Therefore, the proper operation of its ring road is a must for the city's everyday life. The ring road was progressively built from the 1980s and it became saturated in 2005.

(a)Bang-Na Expressway, Thailand (b) Thessaloniki Ring Road (photo-realism)

Figure 1: The fly-over design option

In 2008 an integrated programme was developed for the upgrading of the ring and the connection to the airport. The initial design for the 8-km central section forsaw a new motorway parallel to the existing one and comprised a series of twin tunnels covering almost all of its length; the environmental terms were approved and the design was completed.

However, an alternative design option based on fly-over could significantly reduce both the construction cost and the environmental impact as well. This kind of design has been used for instance in the Bang-Na Expressway in Bangkok, Thailand (Figure 1a), which is a 55km long six-lane highway completed in January 2000. Inspired by similar projects and in line wih the international experience, a new design was proposed and adopted for the ring. It inluded a fly-over with its piers founded on the one side of the existing motorway, i.e. half of the width of the fly-over would be on the top of the existing motorway (Figure1b); the new environmental terms were approved and the design was completed. The construction cost of the fly-over solution was estimated to the 60% of the tunnel one; furthermore, the operation and maintenance cost and the environmental impact would be much lower. Construction would take place without traffic interruption using state-of-the-art prefabrication techniques (transport of segments to be placed on the constructed section of fly-over) as shown in Figure 2. As Walker and Shen (2002) argue, ability supported by organizational and team competence and commitment to explore construction method options in a flexible manner are necessary to facilitate good construction performance.

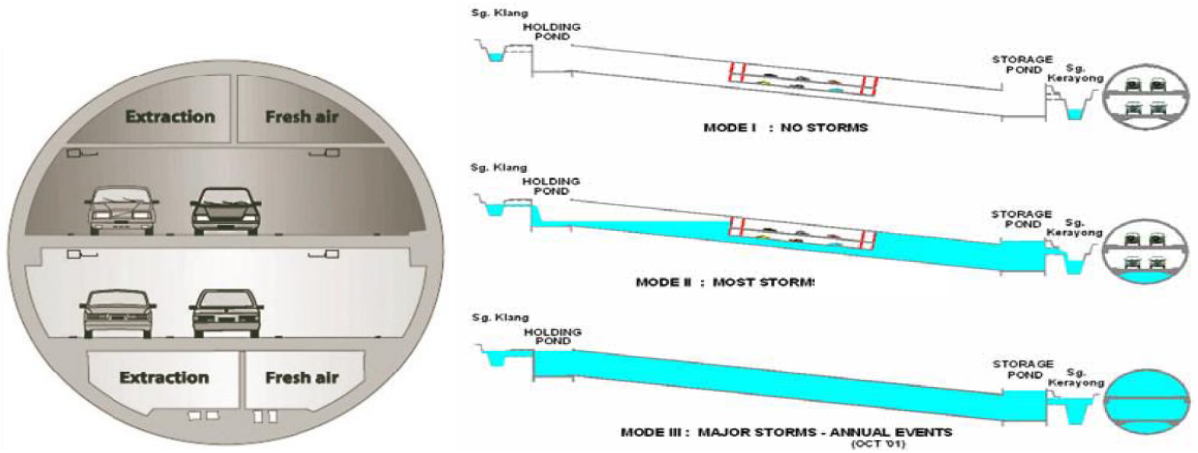
Figure 2: Prefabrication method with transport of the segments on the section constructed

3. Imittos Peripheral Road in Athens

The Athens metropolitan area has a population of approximately 4 million inhabitants. The city is compacted between the seafront and a semi-circular series of mountains. Therefore, the peripheral roads across the mountains are of vital importance. The peripheral road of Imittos mountain is only partially constructed according to motorway standards (west section). Existing roads serve for the missing eastern section. The initial design of the 10-km east section included a new motorway consisting of a series of twin tunnels covering almost all of its length; the environmental terms were approved and the design was completed.

However, international practice reveals design solutions of greater value. Such an example is the A86 Duplex Tunnel (2011), part of the 80km A86 ring-road around Greater Paris (Paris Super-Peripherique), completed in January 2011 at a cost of €2.2bn. The project consists of two toll tunnels; the east one is an innovative 10km tunnel, with a diameter of 10.4 m, for the exclusive use of light vehicles (with 2m-clearance height) and features two decks, each with two traffic lanes and an emergency one. Each level is independent of the other, watertight and with individual air ventilation systems (Figure 3a). The west tunnel of 5.5 km is built according to more traditional construction with just a single deck carrying all vehicles, including HGVs.

Another example of project built in line with the Value engineering approach is the Stormwater Management and Road Tunnel (SMART, 2007), a multi-purpose single-bore two-level road tunnel constructed in Kuala Lumpur, Malaysia. The project was incepted primarily to mitigate the recurring floods in the city of Kuala Lumpur, the financial, business and commercial hub of Malaysia. However, at the design stage of SMART, the dual purpose concept was born from the ingenuity of the project proponents by integrating the motorway tunnel into the system to relieve traffic congestion at the main Southern Gateway to the city center. Depending on the rain, the tunnel (diameter 13.2 m) may alternatively operate (Figure 3b) as a road tunnel when weather is fair with little or no rain (Mode I), as a road tunnel and flood flow conveyor from the lower drains of tunnel when moderate rainfalls occur (Mode II) or as a passage of flood when prolonged heavy rain storms occur (Mode III).



(a) Paris ring-road A86 Tunnel cross section (b)The alternative operation modes of SMART

Figure 3: Innovative Road Tunnels

Regarding Athens, based on the above examples and taking into account the international experience, a new design approach was proposed for Imittos Peripheral Road. A 3-km two-level single bore tunnel was studied at a preliminary level to connect the west Imittos peripheral road with Vouliagmeni Avenue, an existing avenue heading east; this would serve only light vehicles, while the existing road network would serve the heavier ones. The total cost of the two-level tunnel construction and of Vouliagmeni Avenue upgrading to free-flow standards was estimated to be half of the cost of the initial design solution.

Similar duplex tunnel solutions could be adopted in Athens in order to create express urban roads, e.g. a north-south by-pass of the historical center (Syngrou Avenue-duplex tunnel-Kifisias Avenue), a connector of Athens ring road (Attiki Odos) to the city center (Katehaki Avenue-duplex tunnel –Patission Avenue).

4. Urban Development Projects in Greater Athens

The Greek Ministry of Infrastructure submitted recently to the European Commission (EC) for co-financing two major urban projects. The EC refused their approval, claiming that they were decorative in nature and Greece's priority should be the completion of the Trans European Transport Network (TEN-T). The first project aims at the revitalization of the wider historical center of Athens and its market. It foresees the center's pedestrianization, the banning of private cars and the construction of tramways, gardens, fountains etc. at a cost of €110 million. The project has been criticized from various experts on the following grounds: first, it does not form part of an integrated city master plan; second, the necessary traffic studies were not fully completed; and third, the policies required for the successful regeneration of the market area were neither completed nor agreed with the residents, local retailers etc.

As Priemus (2010) and De Jong *et al.* (2013) note, the world changes while the project is being constructed; important changes relate to traffic demand, governments, policies and regulations, human and financial resources and technical developments. One way of dealing with such changes is by dividing the project into smaller parts. In light of this observation, the proper way to implement the project would be to split it in two distinct stages. First, the implementation, at a small part of the total budget, of the pedestrianization, traffic arrangements (placement of barriers on the streets, rearrangements of traffic lights, new traffic signs, preservation of existing bus lanes, painting of lanes etc.) together with the necessary exploitation policies; this stage can be easily reversed. Second, the expensive construction of tramways, gardens, fountains etc., if and when the first stage proves to be successful.

The second project foresees the upgrading of a 3-km sea-front strip at Faliro Bay in Athens (Figure 4a). It includes the construction of the Underground Avenue, anti-flooding technical works, low buildings, marinas, gardens etc. at a cost of €320 million. Following the same reasoning, the proper way to implement the project would be to split it in two distinct stages. First, the construction, at a small part of the total budget, of the absolutely necessary anti-flooding technical works, small earthworks, pedestrian and cyclist paths along the shore etc.; the completion of this stage would enable the citizens to enjoy the sea-front. The remaining costly works would be implemented at a later stage, when full financing will be available.

Figure 4: Faliro sea-front strip and alternative locations for the new Cruise Port in Piraeus

5. New Cruise Port in Piraeus

Tourism by cruise ships is developing quickly in the Mediterranean Sea. This is particularly evident in the case of Piraeus and the increasing demand creates the need for a new cruise port. The initial plan of the Port Authority foresaw the construction of six new piers in the mouth of the main port (Figure 4b), to be founded at the depth of 60 meters; further to the elevated construction cost due to the depth, the high ship traffic in that area (there is also a big container port nearby) increases safety risk. According to another proposal, an equivalent cruise port could be constructed at short distance in the Faliro Bay, founded at the depth of 14 meters, at half the cost (Figure 4c). Furthermore, from that location there is easy access to existing metro, tramway and express road leading to the Acropolis and museums.

6. Metropolitan Railway

During the past years, the metropolitan railway network in Athens was significantly expanded. This was accompanied by the creation of an urban railway network using existing railway lines and a new urban 40km railway line in the central reserve of the Attiki Odos (Athens Ring Road). This line is not fully

exploited nowadays, since there is no regular bus connection to most of its stations. Fortunately, there are expropriated old construction sites which belong to the State and could be used as bus stations or for park and ride. Unfortunately, the State intends to sell them, rendering thus the combined use of transport modes impossible.

Also in urban transportation, the solution of monorail (Figure 5) could lead to reduced construction cost and time and expropriation cost, while achieving an increased level of service and safety. A monorail is a railway system in which the track consists of a single rail, typically elevated and with the trains suspended from it. Monorail systems have been built in many countries around the world, many of them on elevated tracks through crowded areas that would otherwise require the construction of expensive underground lines or have the disadvantages of surface lines. They are particularly suitable for medium traffic sections in the periphery, e.g. Kalamaria – Airport – Perea in Thessaloniki, Kifisias Ave in Athens.

Figure 5: The monorail design solution

7. New International Airport in Crete

The island of Crete, one of the biggest in the Mediterannean Sea, requires a new airport to serve the needs of both its population (about 600,000) and the millions of tourists visiting the island every year, mainly by air. The existing international airport is the 2nd busiest in Greece, after Athens International Airport, with 5 million passengers annually using over 50 airlines. It presents a 5-month very high seasonality and it is over-saturated. As it is built within the boundaries of the capital city of Crete, Heraklion, at the sea-side, it is impossible to expand it; therefore, the construction of a new international airport is being planned on Minoa plain at a distance of 30 km.

The new International Airport initially foresaw a runway of 3,800m with its taxiway, buildings, access roads etc. at an estimated cost of €800 million. It was tendered as a concession in 2012 with a State contribution of €200 million; the State will also pay for the expropriation cost which is estimated to €80 million. According to Garvin and Cheah (2004), facilities delivered through project financing arrangements supported from private capital sources can assist public infrastructure owners in their search for strategies to meet society's needs amidst funding constraints. In the same line, De Jong *et al.* (2013) argue that the private capital can improve the performance of projects as the private parties involved are expected to make a better evaluation of the expected cost, schedule and benefit performance of projects. These private parties would be expected to make their own forecasts, aiming solely at getting profit from the projects, without serving any political goals. Indeed, there was an interest from specialised consortia, but due to the Greek financial crisis there were no offers. The interested consortia had suggested reduction of technical characteristics in order to reduce investment. Currently, the project is under tendering again; the only substantial change in its technical characteristics is the reduction of the runway length to 3,200 m with the option to increase it to 3,800 later, if necessary. Almost the same specialized consortia scrutinize the project; since the interest rates remain very high, either there will be no offer again or it will be of no benefit for the State.

The European PPP (Public Private Partnership) Expertise Center (EPEC, 2009 and 2010), in which the European Bank participates, suggests, in cases of high interest, the selection of loans and lenders to take place later by the Concessionaire and the Owner jointly. In this line and in order to overcome the current financial situation without significant time loss, it is crucial for the State to adopt an integrated strategy combining the efficient utilization of existing infrastructure after small-scale improvement with the rational planning of new investment according to the following proposals:

- International competitive dialogue in order to award to a private consortium, qualified in airport management and concession: a) the joint operation for ten years of the existing Heraklion Airport and the adjacent and not in use military Tymbaki Airport (if necessary), so that the optimal exploitation of both airports is achieved, b) the completion of the final design and c) the long-term concession of the new International Airport, subject to the approval by the State of the Loan Terms and Financial Model to be submitted by the prospective Concessionaire within seven years.
- Earmarking during the above operation period of the existing Airport's revenues (about €20 million per year) for the realization of the new International Airport: €20 million for existing infrastructure upgrading, €80 million for land expropriation and €50 million for the construction of the access roads.
- Immediate upgrading by the State of the existing airport's capacity to accommodate the demand during summer period. The upgrading will be of low cost (€5 – €10 million) and include extension of the apron and expansion of the building premises with inflated or light construction parts (membrane trusses), aiming to alleviate the waiting times occurring at peak periods.
- Utilization of the military Tymbaki airport during the summer period (April-September) after low – cost upgrading (€5 – €10 million) by the State of the runway (pavement improvement) as well as the expansion of the building premises with inflated or light construction parts (membrane trusses).
- Continuation of the expropriation process and construction of the access roads.
- Preparation of a Master Plan for the New Airport wider area (Minoa plain) as soon as possible and resolution of all the related disputes of the local community to avoid friction.
- Preparation of a Master Plan for the existing Airport wider area as soon as possible. According to initial estimations by the relevant Public Service, a mild urban development of the said littoral area (60% green space, 40% hotels, residential buildings etc.) can bring to the State revenue that suffices to cover the total cost of the new Airport. Nevertheless, it should be noted that in the similar case of the new Athens Airport, the respective land remains unused for fifteen years.

8. Recommendations

The fact that the EC keeps rejecting a considerable number of proposals for co-financing of projects in Greece after four Community Support Programmes lasting for 20 years and the case studies analysed above justify the need for the Greek Ministry of Infrastructure to improve, in short time, its project planning processes. In periods of financial stress, the implementation of projects not only should be prioritized according to the results of in-depth CBA, taking into consideration their rate of return, but furthermore, design and scheduling of projects should be reviewed according to VE and VM principles:

- CBA for all important projects should be obligatory by law and conducted by experienced consultants. They should be based on carefully elaborated traffic studies and cost estimates.
- The Public Clients, before project tendering, should conduct detailed VE and VM appraisals in order to reduce cost and increase value as much as possible.
- The Public Clients should investigate the possibility of project construction in stages in order to achieve best value for money.
- A special purpose Office should be created at the Ministry of Infrastructure. The Office should review the CBA, VE, VM and stage construction of all projects to be tendered. The remit of the Office should not be confined to the infrastructure projects of the various Ministries but also cover the important projects to be implemented by all Regions.

- Emphasis should be placed in the development of knowhow and personnel training.
- The State should give priority to the promotion of integrated programmes, e.g. TEN-T, and to coherent policies of national importance, e.g. road safety enhancement.

9. Conclusions

It is undisputable that the recession in Greece has had a profound adverse impact on projects' planning and has been a significant challenge for the prioritization of public investment. Nevertheless, current investment choices and the design options being selected reveal that there is still much room for improvement in the allocation of public resources in different infrastructure projects, so that public investments achieve a greater value for money and the consequences of inaccurate demand and cost forecasts are minimized. In this direction, the proper implementation of the relevant methodologies of VM, VE and CBA as well as an increased degree of flexibility in construction scheduling are required.

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