THE ROLE OF CIVIL ENGINEERS IN THE PROCUREMENT PROCESS OF PUBLIC PRIVATE PARTNERSHIPS
Carlos A. Arboleda¹ and Jorge L. Ricaurte²

ABSTRACT
The deterioration of existing infrastructure systems and the lack of public funding to maintain and renovate these facilities have promoted the interest of private investors and public officials to implement Public Private Partnerships (PPP). The procurement process of PPPs requires a multidisciplinary team to address all the complexities associated with a fair and transparent awarding process. Hence, both public officials and private bidders require mastering a set of skills and specific knowledge in order to succeed during the bidding process, so the most value-added proposal will be selected as the winner. This paper analyzes and suggests the skills and knowledge attributes that are required by civil engineers when involved in the procurement phase of PPP projects. We argue that civil engineers should have a prominent role as master planners and leaders in these procurement processes due to the importance of the engineering input in the financial viability and analysis of alternatives when preparing the bid. Input from industry practitioners was gathered in order to know their role in these transactions and to inquire about the essential skills that civil engineers ought to have regarding successful procurement of PPPs.

KEYWORDS: Civil Engineer, Procurement Process, Public Private Partnerships

BACKGROUND
The condition of the existing infrastructure systems in the U.S. has been graded by the American Society of Civil Engineers (ASCE) as “D”. The ASCE estimates that $1.6 trillion is needed over a five-year period to bring the nation's infrastructure to a good condition (ASCE 2008c). As the need to upgrade facilities and services increases, public-private partnerships (PPP) are gaining favor (Water 2005) because more resources from private investments can be allocated for operating the infrastructure. Traditionally in these PPPs, a private partner provides the services specified through a contract with the public partner and these services can include the operation, maintenance, and management of water and wastewater facilities systems. The assets (equipment, facilities) in a PPP are operated by the private partner while the public partner owns the assets, has control of these assets, and establishes user rates for services. The rational for the current interest in PPPs can be explained by the following factors:

- Lack of public funding for new infrastructure developments (Reid 2008)
- Renovated interest in private participation in infrastructure (Thornton 2007)

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• Local governments need new sources of funding for operation and maintenance of existing infrastructure (Reid 2008)

• Infrastructure assets such as utilities, toll roads and airports are attractive to financial bidders like banks and pension funds because of their stable cash flow despite having lower growth rates than other private equity opportunities (Desmond 2008)

An important challenge for Civil Engineers (CE) is that the development of new infrastructure projects has to consider new factors such as sustainability, life cycle analysis, risk, public agreement, and delivery scheme (European Commission 2003, Dahl et al. 2005, ASCE 2006). Hence, CE should be knowledgeable about those topics. In addition, if the projects are to be delivered by PPPs, CE will require knowing other domains such as finance, accounting, public policy, which have not been traditionally included in the existing curriculum at the undergrad level. The main purpose of this paper is to describe the major components of the procurement process in PPPs, its participants, and the role that CE can have as master planners for infrastructure development. This paper is organized as follows (1) brief description of the different approaches for PPP, (2) major participants in the procurement process and their interaction with CE, (3) major components of the procurement process, highlighting the processes where CE should have a leadership role, and (4) recommendations for a new set of skills and knowledge required for CE involved in the procurement process of PPPs.

APPROACHES FOR PPPS

Depending upon the participation, involvement, and risk allocation for each party (i.e., public and private), the PPP arrangement can take different names. Typically finance, design, build, maintain, operate and transfer are the principal stages of PPPs (Jeffers 2006, UGÃO 1999). For instance, build operate and transfer (BOT) is one of the most used approaches for PPPs (Abdel Aziz 2007) and has been used extensively in road projects in Latin America (Guasch 2004). In this agreement, the private sector makes a significant investment at the beginning of the project and operates the facilities for a given period of time. As a return of that investment, the private sector collects tolls or tariffs from the users. When the operating period ends, the public sector will assume the responsibility of this facility and can issue a new bid process or renegotiate the contract with the previous concessionaire. Generally, the financing for these types of projects is provided by the private sector through equity contributions and debt from financial institutions (Cartlidge 2006).

Some of the PPP advantages for the public sector include the reallocation of funds for other infrastructure investments, transferring of commercial risk to the private party, minimization of construction, operation and maintenance risk, preservation of the ownership of the facility, and a shorter delivery time. On the other hand, some of the disadvantages include the replacement of the private partner if it ran out of business, the public perception of loss of ownership of public infrastructure, erosion of working conditions for some workers, and political opposition (BCMMA 1999; Yescombe 2007).
PARTICIPANTS IN THE PROCUREMENT PROCESS OF PPP

Traditionally, a multidisciplinary team is responsible for preparing and submitting a bid to the public entity in a PPP processes. This team is led by a “sponsor organization” which can have a group of people from diverse background and expertise involved in the process. Sometimes, these sponsors are led by construction companies interested in entering the PPP market, where they can be the subcontractors for the construction activities. Other sponsors are led by the financial sector and private investors interested in obtaining a good and safe return from their equity. Figure 1 shows the major participants in the procurement process of PPPs. We argue in this paper that civil engineers (CEs) should have a prominent role as leaders in these transactions due to their engineering knowledge and the long term implications of the engineering decisions when preparing the economic offer in a PPP transaction. For this reason, CEs are represented at the intersection of the different participants. This means that they should be able to communicate and understand the positions and arguments from the other team members.

![Figure 1. Participants in the Procurement Process of PPPs](image)

The proposition of having CEs as leaders in a PPP transaction is in accordance to the framework developed by Vision of Civil Engineering stated by the American Society of Civil Engineers (ASCE 2006), the Civil Engineering Body of Knowledge (BOK) for the 21th century (ASCE 2008a), The 21st Century Engineer by Galloway (2008), the future of construction engineering and management research by Levitt (2007), and discussions with practitioners in PPPs. It is not expected that CE will be experts in all the domains involved with PPPs, however, CE should be knowledgeable and proficient when interacting with the participants from the other disciplines. Table 1 summarizes the major topics that CEs need to be familiar with when preparing a PPP as leaders of the multidisciplinary team responsible for the technical and financial proposal to be submitted to the public entity. For example, CE should be able to discuss and make contributions to the definition of the terms for the loans from the financial institutions based on the project risks and guarantees as a representative of the Special Purpose Vehicle (SPV) to be created to manage the PPP.
<table>
<thead>
<tr>
<th>Participant</th>
<th>Major Role</th>
<th>Interaction with Civil Engineers</th>
</tr>
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</table>
| Financial Institutions | Definition of the credit terms to fund capital investments | • Estimation of the loan amount  
• Interest rates  
• Debt term  
• Credit guarantees  
• Loan and security documentations  
• Credit syndication  
• Service fees |
| Lawyers            | Assessment of the legal framework for the development of the PPP            | • Memorandum of understanding among project sponsors  
• Contract revision and guarantees  
• Risk allocation between the private and public parties  
• Dispute resolution |
| Accountants        | Definition of the rules for depreciation, asset valuation, and taxes      | • Tax calculations  
• Depreciation methodologies  
• Dividend distribution policies  
• Reporting to the public entity |
| Investors          | Assessment of the risk and return for equity investments from private investors | • Due diligence  
• Dividend distribution policies  
• Schedule of equity payments |
| Policy Makers      | Definition of the project’s motivation and the regulatory framework for PPPs | • Understanding of the motivations and background of the public entity for the PPP transaction  
• Users/public perception of the PPP  
• Role of the regulatory agencies in the long term operation of the PPP  
• Safety and environmental regulations |
| Contractors        | Definition of the awarding process and risk allocation between subcontractors and SPV company | • Capital investments  
• Quality assurance / Quality control  
• Bond and insurance  
• Operation and maintenance operations |
| Public / Users     | Definition of public expectations for the private participation in infrastructure development | • Users/public perception of the PPP  
• Socio-economical conditions of the project users |

Table 1. Interaction of Civil Engineers with other participants in PPP transactions
MAJOR COMPONENTS OF THE PROCUREMENT PROCESS

Figure 2 describes the major phases involved in PPPs, from project identification until project transfer to the public sector once the concession period ends. Even though all the phases are important for the success of the PPP, this paper focuses mainly in the procurement phase, which is shown within the square in Figure 1.

The procurement phase was chosen due to its importance for a successful PPP. If either the finance process or the bidding processes are not successful, there are long term implications for both public and private sectors during the concession period. For instance, if the financial analysis does not consider the uncertainty in the demand for the infrastructure (i.e., traffic flow on the road) it is possible to overestimate the revenues for the project. If these revenues are below the original estimation, the special purpose vehicle (SPV) company may be not able to repay its debt commitments to the financial institutions and hence, it will enter on default compromising the project success and the public confidence in the project.

The final purpose of the procurement phase is to select the best-value bid from the private sector competitors. This bid traditionally has two major steps: a technical and an economical component (Kerf et al 1998). The technical proposal evaluates the expertise and operational capabilities of the SPV to manage the PPP for the concession period. The economical component focuses on quantitative metrics to select the best value offer. Some
of these metrics are: the highest concession fee paid to the government, the lowest tariff to the charged to consumers, the lowest economical warranties from the government, or the lowest net present value of the future revenue stream (Guasch 2004).

The whole procurement phase is time consuming, expensive, and has been considered a critical factor for success by practitioners and researchers as well (Miller et al. 2000, Abdel-Aziz 2001, Zhang 2001, Cartlidge 2006). For example, Jefferies (2006) addressed the procurement phase as the key success factor for the SuperDome facility in Australia. Also, during this phase the scope of the PPP or performance requirements must be clearly defined (Zhang 2005). Besides, the sharing of risks and rewards for both sectors have to be established within this step as well. Abdel-Aziz (2001) stated that PPP procurements have three dimensions that have to be entirely discussed in order to avoid pitfalls during the implementation phase. These dimensions are: rights (possession, revenues), obligations (operation, financing, reward scheme, specifications), and liabilities (taxes, risk, liabilities). In order to provide more details of the activities and decisions that need to be made by CE in the preparation of the bid during the procurement process, Figure 3 shows the processes associated with the elaboration of the economical proposal by the private sponsor.

![Diagram of the economic proposal process]

**Figure 3. Preparation of the Economic Proposal as part of the Procurement Process**
We emphasize the preparation of the economic proposal because this is the latest step in the bid preparation and it involves the active participation of most of the team members involved in the procurement process and it may require significant number of iterations, so the best offer can be made to the public sector without compromising the return to the investors. As previously described, CE should have a leadership role in this process due to the importance of the final decisions being made and their understanding of the long term implications of these decisions. A brief description of the major processes involved in the preparation of the economic proposal is as follows:

**Revenue estimation.** This implies the estimation of the project revenues based on the demand for the infrastructure and the tariffs (tolls) to be charged to the users. Demand estimation and forecasting is a complex endeavor because there are many variables to be considered such as economic growth, demand elasticity, macroeconomic variables, alternative routes, population and activity levels, and user’s choices. All these variables increase the uncertainty in the revenue estimation (Arboleda 2006). The SPV usually hires consultants to estimate the future demand, but CE should be participative of this process due to the importance of accurate and reliable revenue estimation.

**Cost estimation.** The major costs are associated with three major items: a) the cost of construction and/or renovation of the infrastructure (i.e., capital investments), b) the operation and maintenance of the infrastructure once the assets are transferred to the private sector, and c) the SPV’s operational costs. The input from CEs is pivotal in the construction cost estimation, including Life Cycle Assessment (LCA) considerations. LCA is needed in the cost estimation for PPPs because the SPV will be operating the facility for a long period of time (traditionally longer than 25 years).

**Estimation of pro-forma financial documents.** The Balance Sheet, Income Statement, and Free Cash Flow are the major financial documents required to estimate the project’s economic feasibility (Benninga 2006). These statements are mostly created by investment bankers firms affiliated with the project sponsors to evaluate the project. These investment bankers can later become either equity contributors (stakeholders) or lenders to the SPV. Although CEs are not directly involved in the creation of these financial models, they should understand the link between the different financial reports and the effect of changes in items such as depreciation, taxes, revenue uncertainty, capital investments, maintenance routines, etc.

**Estimation of metrics for financial evaluation.** Once the free cash flow has been estimated, it is possible to determine the project general financial viability without taking account of its financial structure utilizing metrics such as Net Present Value (NPV) and Internal Rate of Return. In both cases, it is necessary to have an estimation of the discount rate for the project, which is a major decision factor that should account for the project risk perception (Yescombe 2007). If the resultant NPV is less than zero, some of the assumptions need to be reviewed or the project can be discharged because it does not provide marginal economic benefit.

**Definition of debt conditions.** As part of the preparation of the economic proposal, CEs as leaders of the multidisciplinary team, should deal with financial institutions in the
negotiation of the terms of the loans required to fund the capital investments. This process traditionally involves the participation of investment bankers, who are in charge of the due diligence process.

Estimation of metrics for return to investors. After the terms of the debt from the financial institutions have been defined, the return to the investors can be estimated. This return considers the financial structure for the project and the main measure for investors is the return on equity (i.e., Equity IRR). This metric considers the equity cash flows distributions (dividends) versus the original equity investment by the investors (Yescombe 2007).

As shown in Figure 3, two major steps are required in the evaluation process: project feasibility and investment return. Both of them are complementary, but the purpose of each analysis is different. At this point, CEs need to be aware of a potential conflict of interest associated with the procurement process of PPPs when they are representing a construction contractor. In this particular case, the construction contractor may be more interested in the project feasibility than the return of investment to the equity investors. In other words, a very good construction contract can be detrimental of the investment return for the equity investors. A balance between the role of CEs as representatives of construction contractors and investors is required. If possible, CEs should address the PPP procurement process only as representatives of the interests of the SPV.

RECOMMENDATIONS FOR A NEW SET OF SKILLS AND KNOWLEDGE REQUIRED FOR CE INVOLVED IN THE PROCUREMENT PROCESS OF PPPS

Previous sections have described the participants, stages, and complexity of the PPP procurement process. Ricaurte et al. (2008) analyzed and discussed the role of CEs in PPPs, not only in the procurement process, highlighting the areas where CEs can have a prominent role through the entire life cycle of PPPs. Similarly, this section attempts to summarize the major topics that CEs should be knowledgeable at when leading the procurement process of PPPs.

Table 2 summarizes these findings, which are based on the review of the existing literature, interviews with PPP practitioners, and the author’s own experiences in the preparation of PPP bids as representatives of private investors. The industry practitioners interviewed belong to construction companies, investment banking institutions, law firms, government, and consulting companies. It is expected that some of these skills and knowledge areas can be developed through elective courses at the undergraduate level or within the M.S./30 hours framework suggested by the ASCE policy statement 465 (ASCE 2008b).
<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Application in the PPP procurement process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication</td>
<td>Communicate effectively with technical and non-technical individuals.</td>
<td>Presentation of project benefits to the public and financial institutions</td>
</tr>
<tr>
<td>(ASCE 2006)</td>
<td>Group communication. Presentation techniques. Plan, compose, and integrate the verbal, written, virtual, and graphical communication. (ASCE 2008a)</td>
<td>Due-diligence process with potential investors</td>
</tr>
<tr>
<td>Risk/uncertainty</td>
<td>Risk management. Define risk position. Identify, evaluate and respond to risk. Critical thinking</td>
<td>Definition of discount rate Sensitivity analysis for discounted cash flows Value at risk analysis</td>
</tr>
<tr>
<td>Public policy</td>
<td>Involvement and understanding of current and local public policies. Analyze, compare and contrast the economic, environmental, political, and societal impacts of engineering (ASCE 2008a).</td>
<td>Definition of strategies for bid submission based on economic metrics Presentation of the technical component of the proposal, emphasizing solutions for public concerns</td>
</tr>
<tr>
<td>Sustainability</td>
<td>Evaluate the sustainability of complex systems, whether proposed or existing.</td>
<td>Process engineering, green construction, value engineering. Life cost analysis methodologies. Constructability.</td>
</tr>
<tr>
<td>(Levitt 2007)</td>
<td></td>
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</tr>
<tr>
<td>Management</td>
<td>Executive control of design, planning and finance, construction and initial operation phases. Building relationships.</td>
<td>Bid submission strategies for the SPV Management plan for the SPV Human resources policies (hiring, retention) Contract revision Conflict resolution</td>
</tr>
<tr>
<td>Leadership and team work</td>
<td>People motivation. Formulate and articulate environmental, infrastructure and other improvements. Decision making capabilities</td>
<td>Work distribution among team members Bid submission strategies for the SPV Selection and negotiation among SPV partners</td>
</tr>
</tbody>
</table>

Table 2. Skills and knowledge during the PPP Procurement Process (Adapted from Ricaurte et al. 2008)

SUMMARY

The procurement process for PPPs is a complex effort. It involves the participation of multidisciplinary teams with different incentives. As a result of this process, the decision of whether the technical and economical bid would be submitted has to be made. We argue
that CEs should be the team leaders in the procurement process, but they will need a set of new skills and knowledge in order to be successful in this new role. The new set of skills and knowledge is presented within the context of PPP procurement process, highlighting the domains where CEs need to be acquiring expertise so they will be able to communicate with other project participants. Then, it is expected that CEs will be involved not only in the technical definitions, but also in the financial, managerial, and strategic decisions in the PPP procurement process.

ACKNOWLEDGEMENT

The authors would like to thank Ernesto Carrasco (Investment Director - Odinsa), John DiCiurcio (Executive Vice-President Turner Construction Company), Joe Seliga (Mayer-Brown LLP), George Papas (URS), Ellen Hamilton (University of Illinois at Chicago), John B. Miller (Patton Boggs LLP), Kathleen K. Mayo (BART), David Horner (U.S. Department of Transportation), and Matt Bidwell (Merrill Lynch Global Infrastructure Fund) for their input and for their valuable and helpful comments.

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Relationship to Other Papers in this Session

The following paragraphs contain a summary of discussion topics that can be related to the other papers to be presented in this session.

Huovinen Paper:

This paper deals with the concept of global project-based business, which has a strong relationship with the idea of Public Private Partnerships, especially when these partnerships require significant capital investments by the private sector and are promoted by multinational construction companies with projects in different locations. We may consider a PPP as a project within a global environment, especially due to the fact that these projects require the participation of multiple disciplines, professionals with different expertise, and global investors looking for investment opportunities. Interestingly, Huovinen considers HOCHTIEF as an example of a global company. This company has been highly involved in PPP overseas. In 2007, Hochtief bought a civil infrastructure company in the US (Flatiron) with the intention of facilitating its entrance to the PPP business. Hence, it is clear that the criteria definition for global project-based business management encompasses PPP projects.

An important relation between Huovinen paper and our paper is the role of civil engineers (CE) in these global projects. CE work mostly in a project-base approach and with the current global environment, these pose significant challenges in order to obtain the expected returns and performance indicators. Then, it can be argued that Civil Engineers may need a new (updated) set of skills to address these global projects, including PPPs. We may attempt to link these two papers using Figure A-1.

![Figure A-1 Relationship between the Global Project-Based Business Management Concept and the role of CE as master planners](image_url)

In Figure A-1 we are showing that PPP are projects that can be defined within the framework of a Global Project-Based Business, having CE as the leaders of these transactions due to their role of master planners.
Katsanis Paper

This paper describes how AEC firms can be organized and coordinated in a challenging business environment, focusing in the areas of structure and organization. Then, we can find a clear connection between Katsanis paper (structure and organization) and Huovinen paper (global project-based business) for AEC companies involved in global projects. In terms of structure and organization, Katsanis provides a good description of the different participants in an engineering firm, their roles, and deliverables. An important discussion presented in the paper relates to the business development team and its role as “procuring” projects. Here, Katsanis argues that engineers are competent for doing this job because they are able to deal with technical issues in their encounters with the clients. We would add that technical skills are necessary, but not sufficient to the business development team. There are clearly negotiation, business management, and marketing skills that are also needed when procuring the next set of projects. At this point, we see a link between Katsanis paper and the main idea in our paper (i.e., providing CE with a new (updated) set of skills to be able to manage complex and multidisciplinary projects), emphasizing the importance of non-technical skills for the development of AEC companies.

Hakan and Taylor Paper

Similarly to the previous authors, Hakan and Taylor are addressing global projects in their paper. However, they consider these global projects from the perspective of understanding and appreciating the cultural differences between project participants and how learning in a project network is affected by these differences. Factors such as conflicts, misunderstandings, participant values, and lack of communication may increase costs and reduce efficiency affecting the project performance. Based on this idea, it can be argued that project participants and its leadership should be aware of the cultural diversity on global projects. Hence, from a management perspective, they should be knowledgeable about working in multicultural environments and be familiar with the specific constraints and challenges of global projects.

Concluding remarks

Based on the previous discussions, it is clear that the growth of global projects will require CE to acquire (update) their skills in order to be successful in the implementation of global projects. Both Katsanis and Huovinen describe the challenges and complexities involved with worldwide projects from the perspective of structure, organization, and strategy. Hakan and Taylor describe the importance of learning in a multi-cultural project environment, highlighting the importance of understanding and appreciating the cultural differences among project participants. However, there is not a clear reference to the individuals or participants that will lead or coordinate such global and multicultural projects. We argue that CE can have a leading role when in order to develop and manage these projects, but they will need a new (updated) set of skills and knowledge that will allow CE to deliver these global projects according to the original client’s expectations. We use PPP as an example of a type of global projects where the interaction with multiple...
disciplines require CE to be familiar with different concepts such as finance, legal aspects, risk, public policy, etc.

Based on the previous summary, some issues that could be discussed during the working session are:

1. What are the major challenges in managing AEC companies in a global environment?
2. What would be the best approach for continuous learning in project-oriented organizations in a global world?
3. What is the role of civil engineers in a global AEC business environment?
4. How can CE students be trained to be leaders in this global environment, not only in projects, but organizations as well?