Building Information Modeling in Public Private Partnership Projects – Perspectives and hurdles

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Abstract

Building Information Modeling (BIM) has received widespread attention in the management of built environment with the potential to change the traditional construction practices. BIM promotes an integrated project delivery approach that encourages collaboration amongst the various stakeholders to the project over its lifecycle. The perceived benefits from collaboration such as improved profitability, reduced costs, better time management and improved customer/contractor relationships have been amongst the factors driving the paradigm shift towards BIM. However, there are various barriers affecting the implementation of BIM in construction projects. Legal pitfalls, besides the technological issues, have been amongst the barriers to efficient implementation of BIM. The legal risks assume a bigger hurdle in BIM adoption for construction projects procured through public private partnership (PPP) route such as build-operate-transfer (BOT) on account of the highly complex contractual relationships amongst the various stakeholders to the project. PPP projects have additional confidentiality, commercial, financial, and legal complexities besides the technical and managerial issues of traditional design-build projects. The paper discusses the hurdles in the implementation of BIM to manage the construction projects procured through PPP route, which has become one of the preferred routes for procurement of projects in developed and developing countries in view of the budgetary constraints faced by the governments. The paper concludes with additional legal and contractual measures that should be included in contractual package of PPP projects in order to facilitate BIM for management of the projects.

Keywords: BIM, PPP, BOT, Concession Agreement, Legal Risk.

1. INTRODUCTION

Traditional mode of project delivery utilises the services of the designers, architects, constructors, and operation and maintenance operators not in an integrated manner. The designers and architects prepare the design. Based on the design, the contractors build the facility which will be operated and maintained by the operators once the constructed facility is handed over to the owner. This traditional construction practice is characterised with separation of design and construction by time and relationship, limited information sharing by participants for other's use in order to limit risk exposure, and tendency to promote participants to do less and bill more. These lead to huge wastage of resources on account of the inefficiencies, mistakes and delays. In fact, as per a study by CII (1986) it has been documented that mismanagement caused by the division between design and construction has resulted in waste of 30% of project costs.

Integrated project delivery approach has been suggested as an alternative to the traditional process which will help in reducing the waste and improve productivity of construction process through integration of people, systems, business structures, practices into a process that collaboratively harness the talents and insights of all the participants (AIA 2007). Building information modeling plays a key role in the integrated project delivery approach by facilitating full collaboration and information sharing amongst the participants of construction projects throughout its lifecycle.

Building Information Modeling (BIM) has brought a different perspective on the business of conducting construction process. The advancements in information and communication technologies and computing facilities have enabled the transformation from 2 dimensional to a virtual world, where BIM plays a key role in the transformation. BIM allows development and use of computer generated n-dimensional model in the simulation of planning, design, construction, operation and maintenance of a facility. BIM facilitates to replicate traditional ways of representing information: two-dimensional drawings, engineering calculations, networks and costs and allows integration of stakeholders involved in the process.

Besides the changes brought about in the construction process by BIM approach, the construction industry has to face additional challenges of executing construction projects in the new business environment created on account of introduction of innovative procurement systems such as public private partnerships (PPPs) by the governments in view of budgetary constraints faced by the public authorities. Most of the studies on implementation of BIM in construction industry have focussed on construction projects procured through traditional route such as design-build. In PPP models such as Build-Operate-Transfer (BOT), the stakeholders who have contributed the private investments are very much concerned about getting the returns on their investments. This result in greater involvement of the stakeholders and adoption of appropriate contractual measures to limit their exposures to high level of risks associated with such projects. The paper discusses the different perspectives on the applicability and hurdles that will be faced in implementing BIM in such projects. The salient features and benefits of adopting BIM approach in construction projects is the focus of the second section. The third section deals with the various legal considerations encountered during implementation of BIM in construction projects. The basic characteristics of PPP, the benefits of PPP route and the risks that could negate the benefits are discussed in fourth section. This is followed by the discussion on the different perspectives on how BIM can add value to PPP projects and hurdles

that could be encountered while adopting BIM in PPP projects. In addition, the legal and contractual measures that should be included in contractual package of PPP projects in order to facilitate BIM for management of the projects are also included in this section.

2. BUILDING INFORMATION MODELING

A building information modeling (BIM) is a digital representation of physical and functional characteristics of a facility. As such it serves a shared knowledge resource for information about a facility forming a reliable basis for decisions during its lifecycle from inception onward (NIBS 2011). BIM contains information needed in various phases of the project lifecycle providing an object oriented parametric model where information structures of the design are presented as objects with attributes and relationships between facility elements.

The pressure to provide value for money, sustainable design and construction has propelled the adoption of BIM in construction industry. BIM plays a key role in response to the increased pressure of the construction practices of greater complexity, faster development, improved sustainability, reduced cost and efficient operation and maintenance of the constructed facilities. BIM enables simulation of a construction project in a virtual environment, thereby making it possible to practice construction, to experiment and to make adjustments in the project before it is realized.

BIM approach has the potential to provide a truly innovative medium to the collaborative working environment over all the key phases of the project life cycle: from planning (e.g. where planners interact with public authorities for infrastructure planning); to design (e.g. architect interact with engineers and owners to develop the construction project); to construction (e.g. contractors cooperate toward the goal of building the structure); to facilities management (e.g. O&M personnel rely on information made available after project conclusion) (Eastman et al. 2011). The collaborative working environment enables: (a) the owner to develop an accurate understanding of the nature and needs of the purpose for the project; (b) the design, development and analysis of the project; (c) the management of the construction of the project; and (d) the management of the operations of the project during its operation and decommissioning (Grilo and Jardim-Goncalves 2010).

Adoption of BIM in real projects is very slow with a few examples of real world projects. Some of the reasons for the slow adoption include: lack of initiative and training; fragmented nature of the AEC industry; varied market readiness across geographies, and industry's reluctance to change existing work practice (Gu and London 2010). Johnson and Laepple (2003) have also highlighted that one of the most important inhibiting factors in adoption of BIM is lack of clarity on roles, responsibilities and distribution of benefits in adopting BIM approach. Similarly, studies in UK construction industry have documented the following challenges in implementing BIM (Arayici et al. 2011):

- Overcoming the resistance to change, and getting people to understand the potential and value of BIM over 2D drafting
- Adapting existing workflows to lean oriented processes
- Training people in BIM, or finding employees who understand BIM

- The understanding of the required high-end hardware resources and networking facilities to run BIM applications and tools efficiently
- The required collaboration, integration and interoperability between the structural and MEP designers/engineers
- Clear understanding of the responsibilities of different stakeholders in the new process by construction lawyers and insurers.

3. BIM – LEGAL ASPECT

BIM provide a collaborative platform amongst the various stakeholders to the project over the various phases of the project lifecycle. The perceived benefits of adopting BIM in construction practice will be realized when all the stakeholders participate in the collaborative process from the initial stage. In fact, the usefulness of BIM is unlocked when BIM is treated as a shared resource for the facility from the earliest design conception through construction, during the years it is operated and maintained, through any alterations, additions and adaptive re-use, all the way through to the end of its useful operating life.

BIM approach demands a paradigm shift in the nature of the relationships that existed between the stakeholders in the case of traditional practice. In traditional practice, the contractors do not get involved in the design process but rely on the drawings and design provided by designer for building the facility. But, BIM allows contractors to get actively involved in the design process and it becomes more difficult for the contractor to claim against designer for the errors and omissions in the design and drawings and reduce the ability of contractor to disclaim responsibility for design errors. As a result, BIM can create potential risk for contractors to unwittingly assume responsibility for the design and lead the design professionals to become entangled with responsibility for the contractor's means and methods. From the owner's perspective, in case of traditional practice if there is a defect in design, the owner looks to the designer. If there is a defect in the BIM model which is a collaborative work, fixing the responsibility for the liability is not straightforward. As BIM model allows subsequent modifications by others, it also presents liability exposure to the creator of the model, as well as to the parties making the modifications. The question about intellectual property of each of the end users of the model will arise and potentially of the overall model on account of the multiple parties' access to modification of the model.

BIM allows free flow of information exchange amongst the stakeholders to the project. The stakeholder who inputs information into the BIM model wants to maintain right to the information even when the project is over. This is because the proprietary information could find it way to a competitor upon completion of the project since data is now part of the model used by the owner (Ireland 2009). In case of inadvertent sharing of proprietary information, trade secrets, or patented processes, confidentiality may be compromised. Besides the right to the input information, the ownership of the BIM model and modeling information is another legal challenge affecting the implementation of the model in practice. There are different arguments on who should have the right to ownership of the model. For instance, the owner is paying for the model then the owner may feel entitled to own it, but the other stakeholders who have provided proprietary information for use on the project, their proprietary information needs to be protected as well. Bedrick (2006) argued that BIM

is a product of collaboration, ownership of the model belongs to client rather than designer. However, such a stand could results in unsatisfactory consequences to the client. Designer include disclaimer notes in design in order to indicate that designers no longer want to bear to the risks of design errors, rather use this as excuse to transfer risks due to them to clients.

There are also issue with respect to lifecycle use of BIM (Hurtado and O'Connor 2008). Traditionally, a design remains the property of the designer following completion of the project but BIM offers possibilities for utilisation in the management of the constructed facilities, and hence the owner may wish to continue to use and develop the model. BIM, therefore, can create new legal risk for the stakeholders who had created or managed the model if the model is treated as a deliverable and used as a tool in the operation and maintenance of the facility during its lifecycle. If BIM model is considered to be a product transferable to the owner, then potential product liability and warranty exposures could change the legal environment significantly for those BIM project participants(Haynes 2009). This raises more concerns regarding the design professional relinquishing possession and control of an instrument that could serve as a basis for future liability (Simonian 2010).

4. PPP – CONTRACTUAL RELATIONSHIPS

Public Private Partnerships (PPP) has been one of the preferred modes of delivery system of construction projects in developed and developing countries. As per the National Council for Public-Private Partnerships (2011) "a Public-Private Partnership (PPP) is a contractual agreement between a public agency (federal, state or local) and a private sector entity. Through this agreement, the skills and assets of each sector (public and private) are shared in delivering a service or facility for the use of the general public. In addition to the sharing of resources, each party shares in the risks and rewards potential in the delivery of the service and/or facility." PPP is thus designed to combine the best capabilities of the public and private sectors for mutual benefit. Some of the benefits of PPP to governments include: improve service delivery, improve cost-effectiveness, increase investment in public infrastructure; reduce public sector risk, deliver capital projects faster, improve budget certainty, and efficient use of assets (Partnerships British Columbia 2003).

There has been a paradigm shift in the procurement of construction projects. PPP route for infrastructure development has become a preferred route over the traditional models such as Design-Build and Design-Bid-Build models. PPP models such as Build-Operate-Transfer and its variants are amongst the models predominantly adopted by the governments in view of the investments from the private sector in development of infrastructure projects. Governments have invited private sector in financing infrastructure projects on account of the need for allocating the scarce budgetary resources in building the social infrastructure such as education and medical facilities, resulting in funding gap for infrastructure creation and rehabilitation. Besides the investments, the techno-managerial efficiencies of the private sector have been perceived to be amongst the driving factors for the preference of PPP over the traditional models. In PPP models, the private sector is incentivised to innovate in order to provide a cost effective solution and complete the projects ahead of time and within budget.

Adopting PPP models for infrastructure development leads to benefits of faster delivery of projects and reducing the burden on the scarce budgetary resources. However, the PPP models are very

complex in nature and involve huge transaction costs. PPP models have a complex network of contractual relationships in order to allocate the responsibilities and risks amongst the various stakeholders to the projects. The stakeholders in a PPP projects include the project sponsors, lending institutions, EPC contractor, O&M contractor, insurance agencies and the public entity granting concession to the private sector. Figure 1 shows the relationships between the stakeholders to the projects. The concession agreement between the project sponsor and the public entity (the granting authority) is the most important contractual agreement that clearly defines the rights and obligations of the parties of the concession, and establishes the framework for allocation of risks and rewards between them. Other contractual provisions of agreements such as EPC and O&M contracts signed between project sponsor and EPC contractor and O&M contractor, respectively are derived from concession agreement.

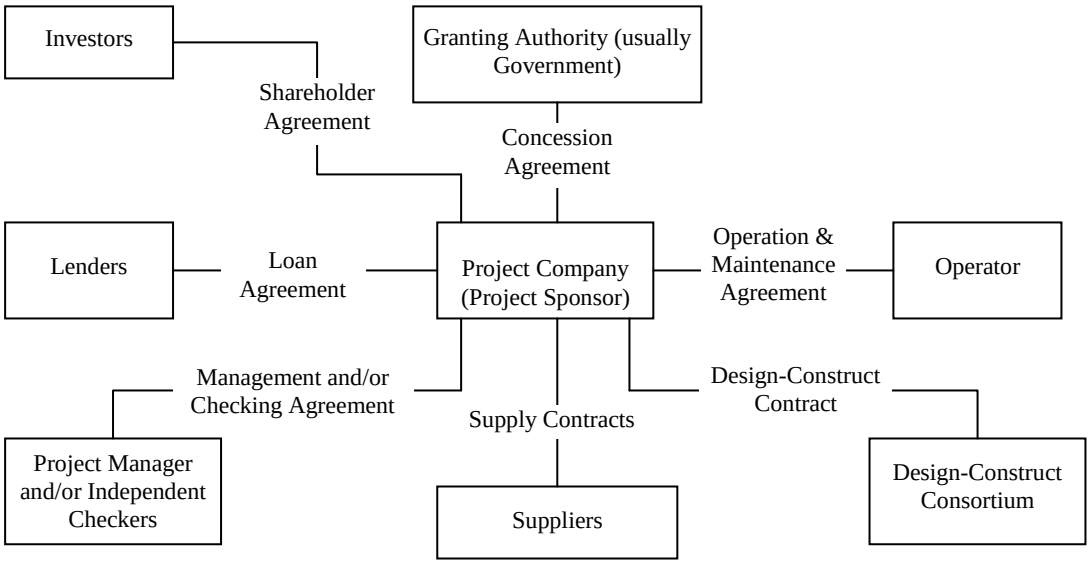

Figure 1 : Contractual Structure of a Typical BOT Projects

The stakeholders have different perspectives regarding the rationale for participation in a PPP project. The project sponsors focus on the infrastructure development business opportunities and the returns on the investment that will be accrued from the project operation. The key motive for the participation of EPC and O&M contractors is the captive construction and operation businesses. The lending institutions get involved in a PPP project for the investment opportunities. Higher returns on investments in PPP projects have been amongst the key factors making PPP projects attractive to financing agencies.

PPP projects are associated with different types of risks that are encountered in the different phases (development, construction and operation phases) of the project lifecycle. The typical risk profile of a PPP project will include risks such as technology risk, time and cost overruns, demand risk, revenue risk, O&M risk, and political risk. For example, time and cost overrun risks are associated with the construction phase while demand risk, revenue risk, and O&M risk are encountered during the operation phase of the project. These risks are allocated to the various stakeholders through the contractual agreements based on the concept of risk management, i.e. risk should be allocated to the party best able to manage the risk. In PPP models such as BOT and Design-Build-Finance-Operate (DBFO) the private sector assumes a greater share of risks in comparison with traditional delivery models. The premium that the private sector charged for assuming the risk is also in accordance with the risk-reward concept. The stakeholders who provide equity capital to the project have higher risk exposure than lenders providing debt financing and as a result equity holders demand higher return than lenders. The involvement of private sector in the development of infrastructure projects is guided by the business principles which are different from the motive of delivering public goods of the government. As a result, issues that could undermine their business interests are of great concern to the private sector in PPP projects.

5. DISCUSSION

BIM can be adopted in construction projects even without collaboration amongst the stakeholders in the creation of the model. However, adopting such kind of an approach will waste the power of BIM and discard the cost and quality advantages of single entry, multiple uses. CURT (2006) mandated integrated project delivery methodologies as an alternative to traditional practice after analyzing the causes of declining productivity in construction industry. Integrated project delivery methodologies prescribe collaboration amongst the various stakeholders that will be associated with the various phases of project lifecycle. As per American Institute of Architects (2007), Integrated Project Delivery is defined as "a project delivery approach that integrates people, systems, business structures and practices into a process that collaboratively harnesses the talents and insights of all participants to optimize project results, increase value to the owner, reduce waste, and maximize efficiency through all phases of design, fabrication, and construction." BIM enables implementation of IPD by providing the technological front for full collaboration and effective information sharing amongst the stakeholders. It has been observed from evaluation of the composition of the project sponsor team in PPP projects that it comprises of members who have the experience of developing infrastructure projects on PPP basis, an EPC contractor who has the experience of construction similar structure and O&M operator who has the experience of operating similar projects. The team is normally formed to submit the bid and hence the collaboration and the information sharing amongst the stakeholders commences from the conceptual stage of the project. BIM can play a big role in supporting the

collaboration and exchange of information amongst the stakeholders even in projects procured through PPP route. It has been, however, observed that most of the studies on BIM have concentrated on projects procured through design/build route. There is a need for evolving appropriate contractual measures to enable implementation of BIM in PPP projects and the conduct studies in similar direction in view of the benefits that BIM could bring in PPP projects.

Financial viability of the projects is of paramount importance in case of projects procured through PPP route such as BOT. The BOT projects are structured in such a fashion that the risks relating to technology, demand, financial, political dimensions are appropriately allocated so that the financial viability of the project is not undermined. The stakeholders normally show reluctance to freely share the financial information of the projects. In addition to this, information relating to design, and operation and maintenance are proprietary in nature in case of highly technologically complex projects. If the information that is being shared could lead to weakening of financial competitiveness and technical superiority of the stakeholders, then the stakeholders will not like to exchange the information freely. There is a need to define clearly what information can be freely shared amongst the stakeholders through BIM and design appropriate contractual arrangement to safeguard the financial interests of the stakeholders, if the stakeholders want to realize the benefits of BIM implementation in PPP projects.

In PPP projects, EPC cost accounts for around 80-85 % of the total landed cost of the project. EPC contractors are required to complete the project ahead of time and within budget. Adoption of traditional construction practices even in projects procured through innovative route could face issue of reduced productivities in spite of the contractual incentives and penalties, to prevent cost and time overruns, built into the EPC contract signed between the project sponsor and EPC contractor. BIM can play an important role in improving the financial viability of PPP projects. The return on the investments made by the private investors is directly related with the revenues from project operations and cost incurred in construction, and operation and maintenance of the constructed facilities. The project can improve the financial viability through cost savings from adoption of BIM for the construction, and operation and maintenance of the facility could lead to cost savings. On the other hand, BIM demands a steep learning curve, requires training of personnel and the implementing agency needs to deploy resources for it. The additional time and resources that will be required for adopting BIM in PPP projects could strain the tight schedule and budget of PPP projects. In view of the benefits that could be realized from adoption of BIM, modalities for management of the BIM model should be incorporated in the contractual arrangements of PPP model, taking into consideration the need to align it with the existing responsibilities and obligations of the stakeholders defined in the contractual arrangements of PPP projects.

Different options on how the ownership of the BIM modeling information can be handled have been suggested in literature and reports. Aschraft (2011) has suggested that ownership of BIM modeling information can be through one of the options: (i) owner owns the modeling information; (ii) designer owns the modeling information; (iii) all parties own whatever they create. In case of Design-Build projects, one of these options could be adopted for the ownership of the BIM model. However, in case of PPP models such as BOT, the projects get transferred back to the public entity granting the concession and as a result it raises complex legal issue regarding ownership of the model and modeling information. During the concession period, when the BIM model will be developed,

utilised and managed, the owner of the model is the concessionaire and the stakeholders such as designer, contractor and suppliers provide the necessary trade related input information to the model. Once the constructed facilities have been transferred to the public authority upon completion of the concession period, the public authority becomes the owner of the facility. In case the ownership of BIM model is also to be transferred to the public authority, necessary legal actions will be required to complete the transfer. This will also demand consents from the stakeholders who had provided input information to the model and incorporation of relevant contractual clauses in the contractual agreements. On the other hand, if transfer of constructed facilities does not involved transfer of ownership of the BIM model then future liability of the designers, contractors and operators will cease with the termination of the project concession period.

6. CONCLUSIONS

The A/E/C industry faces new challenges with the introduction of BIM to replace traditional practice and new business environment created on account of adoption of PPP as the preferred route for procurement of construction projects. BIM brings in efficiency in the construction practice and saves time and cost. However, it demands innovative legal measures to facilitate its adoption so as to realize its full potential.

In view of the proactive role played by the private stakeholders in the development, execution and management of PPP projects through collaboration and sharing of information amongst them, the attributes of integrated project delivery approach are clearly visible in the PPP projects. PPP projects have a highly complex contractual arrangement in order to manage the various risks associated with the projects and assign the responsibilities and obligations to the stakeholders involved in the projects. BIM, which is the platform for integrated project delivery approach, can add value to PPP projects by providing an established medium for collaboration and information sharing amongst the stakeholders. This demands incorporation of appropriate contractual measures in the contractual agreements of PPP projects so that it takes care of the legal hurdles of implementation of BIM and maintain the integrity of the contractual structure of PPP projects.

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