DOI: 10.20472/IAC.2015.018.044

HASNANYWATI HASSAN
Universiti Sains Malaysia, Malaysia

VIRTUAL DESIGN AND CONSTRUCTION IN BIDDING PROCESS

Abstract:

Construction projects involve a high degree of complex procurement processes. One essential stage is the bidding process, during which the amount of profit level is critically determined. Within this context, not only the profit is important but technical, human and conceptual skills are critical for bidders. The bidding process in the construction industry is characterized by the involvement of many different parties including the client, architectural and engineering firms, general contractors, specialized contractors, material suppliers, manufacturers, etc. Faced with the challenge of global competition, business leaders serious about running ethical and responsible businesses often have to be strategic and creative in the way they address bid responses and with a clear destination in mind for their organisation. This is especially the case for construction companies that aspire to be competitive and well-regarded players in the global economy beyond their own borders. These companies have to understand and effectively manage not just business risk, but need to demonstrate the willingness to advance industry innovation, aid in nation-building and deliver greater community capacity. Virtual Design and Construction (VDC) which is a visual representation of data, is increasingly being used to more effectively communicate complex or technical information to busy readers in a clear and concise way. Many benefits have been identified in implementing VDC and its uses of virtual models of product, organization and process to simulate the complexities of the construction project delivery. VDC understands the pitfalls the project teams are likely to encounter, to analyze these pitfalls and address them in a virtual world before any of the construction work ever takes place in the real world. The implementation of VDC in bidding process is expected to reduce these demands by improving the efficiency, speed and accuracy. It uses to integrate product, process and resource models of construction projects to support the construction planning in virtual environment. This paper explores strengths of VDC based on its usage in many countries, its execution through during bidding as well as suggestions on how VDC be able to act as an imperative tool in bidding practice in Malaysian construction industry's stakeholders.

Keywords:

Virtual Design and Construction, construction industry, bidding

JEL Classification: O31

Introduction

Construction projects involve a high degree of complex procurement processes. One essential stage is the bidding process, during which the amount of profit level is critically determined. Within this context, not only the profit is important but technical, human and conceptual skills are critical for bidders. The bidding process in the construction industry is characterized by the involvement of many different parties including the client, architectural and engineering firms, general contractors, specialized contractors, material suppliers, manufacturers, etc. (Halaris, et. al, 2001). The bidding process requires a great deal of time and effort. Construction companies should make realistic bid proposals to win the bid. Clearly, success does not mean simply winning the bid, but rather completing the project with the highest possible profit. Therefore, the bid proposal step should be perceived as the most important phase in the bidding process (Arslan, et. al, 2006). Furthermore, Wang and Yang (2004), in their study carried out using electronically facilitated bidding resulted in most construction disputes be prevented or at least mitigated.

The way bidding proposal preparation is operating currently via hardcopy documentation shows Malaysia way of bidding needs to be revamped tremendously. E-Tender which was introduced in 2004 by Construction Industry Development Board (CIDB) and the Public Works Department (JKR) on a project that is expected to revolutionise the tendering process of the construction industry in Malaysia. CIDB's role under this project is to develop, implement, operate and maintain the National e-Tender System. The objective is to develop greater corporate governance in the public construction tendering process. This involves tendering information management, specific tender distribution and the selection of services for all construction works undertaken by the government. But the system however did not incur many process changes from the traditional construction tendering process. Much of the traditional processes were retained and technology was used to control and manage processes for the various parties involved (Lou & Alshawi, 2009).

Based on extensive literature reviews carried out, Virtual Design and Construction (VDC) perceived to reduce these demands by improving the efficiency, speed and accuracy of the bidding process. VDC, which is a visual representation of data, is increasingly being used to more effectively communicate complex or technical information to busy readers in a clear and concise way. This type of visual communication technology has been regarded as a cost-effective way of envisaging real circumstances that enhance effective communication of designs and ideas. This is because the brain processes pictures at once, whereas text is processed in a linear fashion, which takes longer. The bidder and its product of VDC must know how to effectively convey the meaning and context of a particular set of information in graphical form that readers can understand.

Since the use of VDC technologies has been proven to significantly decrease project time and cost by reducing errors and omissions, improving project coordination, enabling more effective communication of the project scope and site safety throughput the whole project life cycle, this research will focus on how a scientific approach can facilitate the industry towards the implementation of VDC in bidding process.

Construction Industry and Bidding

The construction industry is a multi-disciplinary, multi-national, and multi-billion economy involving many actors working concurrently at different locations and using heterogeneous technologies. Lack of network connectivity and poor skills in handling network tools will result in a diminished market share or lost opportunities in the competitive business environment (Bridges, 1997). Moreover, the industry is facing widespread criticism of its low efficiency and poor performance (Heng, et. al, 2009). This has led to a rethink of contemporary procurement

delivery. However, current critical perspectives have failed to diagnose the practical problems existing in current delivery, and as a consequence, no promising solutions have been proposed.

Construction industry have undergone series of changes in the past two decades. Design and construction practices and project delivery systems have moved into the direction of integration. This has strongly encouraged many practitioners to consider design processes and construction processes concurrently in consecutive phases. By narrowing the gap between design and construction, through integration via bidding process, project constructability can be greatly improved (Thabet, 2000). The project procurement phase is the time when the project formally transitions from design preparation into construction preparation. This phase includes the bidding process. The project's schedule and budget are finalized in this phase. This is because, winning a major contract is not just great for business stability but it can create a pipeline of work in uncertain times by assisting with client and employee retention, improving internal business processes and boosting the bottom line.

The successful completion of a construction project requires a thorough understanding of all stages and phases of the project, and can be enhanced through integration of design and construction during the pre-construction stage (Thabet, 2000). There is no doubt that VDC help make sense of large amounts of data to make content more engaging, and to visually tell a story. VDC is not only a dynamic way to show information but they also depict a higher level of visual thinking that can help guide, focus and structure the content and the process of mapping ideas towards carefully targeted outcomes.

In addition, it is extremely timely as there is opening up a whole debate upon the sustainability and technological advancement issues. Preparation of bid documents in construction industry requires tonnes of papers and obviously the delivery is not sustainable and create wastage which involves volumes of documented books and cost of tender escalated, cause during bidding process. These problems can be then scrutinized by referring to VDC as a potential solution.

This rapid and unparalleled change has also transformed the construction industry. Today's construction industry sectors (both public and private) are following a definite and increasing trend towards adapting traditional business method and processes to the new electronic ways of doing business (E-Business), resulting in many divides being created: paper to electronic media; local to global commerce; management to a leadership focus; and reactive to more proactive state (Russell, 2000; NOIE, 2002; Murray, 2003).

Consequently, through increased knowledge, awareness and successful implementation of innovative systems and processes - such as electronic tendering (E-Tender) - raises great expectations regarding their contribution towards 'stimulating' the globalisation of electronic procurement activities, and improving overall business and project performances throughout the construction industry sectors and overall marketplace (NSW Government 2002; Harty, 2003; Murray, 2003; Pietroforte, 2003).

Bid however is often used interchangeably with tender, an approach to a client in order to gain significant new or repeat business. The term "bid" or "bidding" can also relate to the documented offer submitted in response to a request or invitation to tender.

Bids, by their nature, involve staff from across the whole breadth of one or more organisations. The Bid Manager, the person involve in bid needs to be able to interact with many types of specialists – from technical to legal, finance, human resource and senior management, and will need to know their roles, responsibilities, and what they can and cannot be asked to deliver. The 'bid' will then be evaluated against a set of criteria that are described in the request or invitation to tender. Tender on the other hand, to the term bid. "Bid" is increasingly being

used by the Offerer (the supply side) and the term “tender” used on the procurement side (the buyer).

Moving forward and faced with the challenge of global competition, construction companies are serious about running ethical and responsible businesses to be strategic and creative in the way they address bid responses. This is to aspire them to be competitive and well-regarded players in the global economy beyond their own borders. These companies have to understand and effectively manage not just business risk, but need to demonstrate the willingness to advance industry innovation, aid in nation-building and deliver greater community capacity.

What is Virtual Design & Construction?

Virtual Design & Construction (VDC)“is the management of integrated multi-disciplinary performance models of design-construction projects, including the product (i.e. facilities), work process and organization of design-construction-operational team in order to support explicit and public business objectives” (Fischer et. al, 2004).

VDC is a form of visual communications allows a practitioner to build symbolic models of the product, organization and process (P-O-P) early before a large commitment of time or money is made to a project. Thus VDC supports the description, explanation, evaluation, prediction, alternative formulation, negotiation and decisions about a project’s scope, organization and schedule with virtual methods. The objective of VDC therefore is to use these virtual models of product, organization and process to simulate the complexities of the construction project delivery, to understand the pitfalls the project teams are likely to encounter, to analyze these pitfalls and address them in a virtual world before any of the construction work ever takes place in the real world.

VDC are simply visual representations of data, is increasingly being used to more effectively communicate complex or technical information to busy readers in a clear and concise way. It is ‘visualising the invisible’. By developing virtual design and data visualisation, it helps construction companies discover and articulate an array of ways to communicate their systems, processes, research outcomes, and even their offerings. With length words or pages now common in tender documents, VDC can greatly reduce the word count of a response. They are especially effective in condensing a procedure into a flow diagram, to explain a service delivery model or communicating timelines and/or project delivery milestones in tenders, bids and submissions.

General practices of VDC and in bidding process

Although there has been some active discussion in the research community over the measures of construction productivity it is hard to ignore the fact that other industries clearly have made some rapid strides in productivity improvement compared to the construction industry in general. Some of these productivity improvements have been attributed to the use of information technology and a rethinking of the processes in other industries (Drucker, 2006).

Virtual design and construction (VDC) is becoming an important part of architecture, engineering, and construction (AEC) practice and research. Kunz and Fischer (2009) define VDC as the use of integrated multi-disciplinary performance models of design-construction projects to support explicit and public business objectives. Existing VDC methods have demonstrated the benefits of visualization, integration, and automation of AEC tasks, in particular to predict project outcomes and manage towards the desired performance (Eastman et al. 2009; Hagan et al. 2009; Haymaker and Fischer 2001; Jongeling et al. 2008; Khanzode et al. 2008).

VDC has been used in many countries i.e. USA, Hong Kong, Britain, Germany in their projects delivery process and a number of recent research studies have focused on documenting the benefits of using these VDC to support these processes. These tools and techniques have been applied in a variety of projects and to accomplish the objectives which includes visualization of construction activities to identify time-space constraints (Haymaker et al, 2001), photo-realistic representation of the built spaces for effective communication (Fischer, 2003), 3D modeling used for coordination of various disciplines like Mechanical, Electrical, Plumbing and Fire Protection (MEP / FP) (Staub-French et al, 2001), constructability analysis of various construction methods (Akinci et al, 2002), evaluation of site logistics plans (Heesom et al, 2004), evaluation and analysis of various project sequences early on in the design phases of the project (Heesom et al, 2004), prediction of time-space conflicts or constraints (lay down areas) during the entire project duration (Haymaker et al, 2001) and use of shared product models to extract quantities and reduce the time for creating estimates (Staub-French et al, 2003).

When it comes to VDC in bidding process, Kunz stated that the first “rule” is to model early and often. Build integrated product-process-organization models as part of the bid process (most companies start applying the method at this stage because it leads to higher hit rates on their bids). Build models for the initial designer-contractor meetings to clarify who does what and when. Update models frequently during the design and construction process both to support identification and resolution of design conflicts and to support clear assignment of responsibility, schedule and level of effort for coordination

The second “rule” is to build visualizations that support multiple stakeholders, and to build computer-based models that support useful visualization. The owner can build and show models that clarify its design intent. The architect can build models that show how its designs relate to owner functional requirements and details that the contractor needs to understand to successfully realize the design. The contractor can build and show models that clarify its understanding of design details

The third “rule” is to get started with multi-perspective visualizations for multiple stakeholders.

VDC in Malaysia

Currently in Malaysian practice, open tendering is applied for procurements above RM200,000.00. For tenders that target for local suppliers, the bidding period is 21 days and if the required goods or services are not available locally, the bidding will be opened to international tenderers for 56 days. As mentioned by Hui, et al. (2011), tendering system is always involved with issues of accountability, transparency, corruption, integrity and cronyism. As example in cronyism and corruption, there are occurrence of information leakage to closely relative or friend as a hint to win a tender competition. There tenders were mostly carried out by E-Tender, a process is very familiar with the traditional tender process, but the procedure of tendering for particular system may vary. However, the existing e-tendering system is still lack in addressing integrity, confidentiality, authentication and non-repudiation in e-tendering requirements Hui, et al. (2011).

The subject of E-Tender is not the focal point in this research but rather a supplementary aspect that would be taken into account when discussing VDC as how E-Tender entered the Malaysian tendering process in 2004 by placing a technology to increase productivity and cost efficiency of tender. VDC is perceived to facilitate the delivery of information and the submittal of prices in an electronic format by a construction companies and the main aspects of VDC that may appear in a construction project are dissemination of information related to project, construction phases, project cost, preparation and submittal of bid.

However, the information of usage of VDC during bidding process is limited although some of the perceived benefits using VDC in bidding are identified in SAP, 2013.

- Increased bid accuracy level
- Reduction of design and construction rework
- Minimized paper
- Driven tasks
- Early detection of potential design clashes
- Increased asset uptime; higher mean time between repairs (MTBR)
- Reduction of data reconciliation work
- Increase in repair response time
- Decrease in costs to create operations and maintenance information

LaNear (2002) identified some of the functions identified and perceived to be used in bidding are:

- Drafting Automation
- Sections, Elevations
- Perspectives
- Drawing Coordination
- Visualization
- Presentation Materials
- Interactive Design Review
- Schedule Automation
- Specification Data
- Cost & Performance Analysis
- Construction Sequencing
- Simplified Processes
- Consolidating of Applications
- Reduced File Management

The perceived importance of VDC in Malaysia

This is a new research embark in hope to change the Malaysian bid delivery landscape. With VDC used for bidding proposals, it is perceived to benefit many parties namely:

General

- Streamlines the whole bidding process
- Brings about innovative business processes
- Initiates greater opportunities for small and regionally based businesses
- Makes it easier for businesses to obtain tender documentation and to submit an offer on time.

Industry perspective:

- Increased bid opportunities
- Improved access for geographically isolated industry organisations
- Increased market share and competitiveness; and
- Reduces the cost of printing - saving time and resources.
- The creation, analysis and optimization of construction schedules
- Effective constructability analysis.
- Elimination of construction risks through digital mockup of processes.
- Clearer understanding of project scope and better work instruction from main contractor to subcontractors.
- Effective communication between the client and contractors.
- Effective management of design changes and
- Better capture and re-use of knowledge

Government perspective:

- Increased efficiency and effectiveness;
- Consistent bidding practice across Government;
- Promotes overall e-Commerce initiative; and
- Environmentally friendly due to a predominantly 'paperless' process

Summary and Conclusion

VDC claims to improve efficiency, speed and accuracy of the bidding process. The VDC process applies the performance-based engineering method to the design-construction process. The E-Tender that being used by most of the government projects in Malaysia will have to revamp to make way for VDC to take place for better coordination, supervision, value added to the whole bidding process among the stakeholders. In addition, the use of VDC may enable the industry to remove bottleneck issues. This is because VDC requires designers to modularize design into BIM (Building Information Management) models which are 3D models with information for performance evaluation of the models and this encourages standardization and prefabrication. Prefabrication indirectly introduces a production line into the construction industry. VDC can realistically simulate construction processes and effectively capture design and construction knowledge which can be re-used in future projects.

The researcher attempts to use digital construction as a way of rethinking some fundamental rules of the contracting game certainly looks impressive. However, that this is still a work in progress, and some important issues still need to be tackled, such as working out exactly what effect the new system will have on productivity, and exactly how that target of to win the bid is to be attained.

References

Akinci, Burcu, Fischer Martin, Levitt, Raymond and Carlson, Robert (2002). Formalization and Automation of Time-Space Conflict Analysis. *Journal of Computing in Civil Engineering*, *Vol.16 (2)*, 124-134.

Arslan. G, Tuncana. M., Birgonul T. and Dikmen. I. (2006). E-bidding proposal preparation system for construction projects. *Building and Environment 41,* 1406–1413

Atlas, I., Pitney, A., Curtis, J., Greenham, P., Hanly, G., Glodstein, D., Mansfield, J. & Grace, T., eds (1993). The Tendering Process. Blec Business Law Education Centre from the training division of Longman Cheshire.

Bridges AH (1997). Implications of the internet for the construction industry. *Automation in Construction*: 6:45–9.

Drucker, P. (2006). Innovation and Entrepreneurship, Practice and Principles. Harper Collins, Reprint edition, May 9.

Eastman, C., Lee, J.-m., Jeong, Y.-s., and Lee, J.-k. (2009). Automatic rule-based checking of building designs. *Automation in Construction, 18(8),* 1011-1033.

Fischer, Martin and Kunz, John (2004). The scope and role of Information Technology in construction. Technical Report # 156, CIFE, Stanford University.

Hagan, S., Ho, P., and Matta, C. (2009). BIM: The GSA Story. *Journal of Building Information Modeling (Spring 2009),* 28-29.

Halaris C, Bafoutsou G, Papavassiliou G, Mentzas G. A System for Virtual Tendering and Bidding (2001). 8th Panhellinic Conference in Informatics, 8–10 November, Cyprus

Harty C. (2003). The Re-Organising of Construction Design Information Technologies and Coordination in Construction Practice. Construction Innovation and Global Competitveness - 10th International Symposium, USA, CRC Press

Haymaker, J., and Fischer, M. (2001). Challenges and benefits of 4D modeling on the Walt Disney Concert Hall project. CIFE Working Paper 64, Center for Integrated Facility Engineering, Stanford University, Stanford.

Heesom, David and Mahdjoubi Lamine (2004). Trends of 4D CAD applications for construction planning, *Construction Management & Economics, Vol 22 (2),* 171-182.

Heng Li, Weisheng Lu & Ting Huang· Rethinking project management and exploring virtual design and construction as a potential solution. *Construction Management and Economics*, *Vol.27 (4)*, 363-371

Hui, W. S., Othman, R., Omar, N. H., Abdul Rahman, R., &Haron, N. H. (2011). Procurement Issues in Malaysia. *International Journal of Public Sector Management, Vol. 24,80. 6* , 567-593.

Jongeling, R., Kim, J., Fischer, M., Mourgues,C., and Olofsson, T. (2008). Quantitative analysis of workflow, temporary structure usage, and productivity using 4D models. *Automation in Construction, 17(6),* 780-791.

Khanzode, A., Fischer, M., and Reed, D. (2008). Benefits and lessons learned of implementing building virtual design and construction (VDC) technologies for coordination of mechanical, electrical, and plumbing (MEP) systems on a large healthcare project. *ITcon, 13 (Special Issue: Case studies of BIM use),* 324-342

Kunz, J., and Fischer, M. (2009). Virtual Design and Construction: Themes, Case Studies and Implementation Suggestions. CIFE Working Paper #097, Stanford University, Stanford.

Kunz, J. (2003). Smoothing out the construction process, accessed via http://www.djc.com/news/co/11143361.html

Lou & Alshawi (2009). Critical Success factor or E-Tendering Implementation in Construction Collaborative Environment: People and Process Issues. *ITcon. Vol. 14,* 98-109.

Murray M., B. D. (2003). The Development of E-Commerce within the Global Construction Industry. Construction Innovation and Global Competitveness - 10th International Symposium, USA, CRC Press.

NOIE (2002). Doing Business Online with Government. A guide for Suppliers to Trade Electronically with Commonwealth Government Agencies. Canberra, Australia, National Office for the Information Economy (NOIE)

NSW Government (2002). Electronic Procurement Implementation Strategy – Guidelines (http://www.cpsc.nsw.gov.au/e-procurement/contents.htm). Sydney, New South

Pietroforte R., C. N. (2003). E-Construction in the USA: A New Research Agenda.Construction Innovation and Global Competitveness - 10th International Symposium, USA, CRC Press.

Russell J.S. (2000). Trends in Our Industry (Editors Letter). *Journal of Management in Engineering (January/February).*

SAP (2013) Solution Summary Engineering, Construction and Operation accessed on May 2015 http://www.sap.com/bin/sapcom/en_us/downloadasset.2015-03-mar-17-15.virtual-design-and-construction-an-engineering-construction-and-operations-solution-pdf.bypassReg.html

Staub-French, Sheryl and Fischer, Martin (2001). Industrial case study of electronic design, cost and schedule integration. CIFE Technical Report #122

Staub-French, Sheryl, Fischer, Martin, Kunz, John and Paulson, Boyd (2003). An Ontology for Relating Features with Activities to Calculate Costs, *Journal of Computing in Civil Engineering, Vol. 17*.

Thabet, W. (2000) Design/Construction Integration thru Virtual Construction for Improved Constructability, Berkley-Stanford CEM Workshop, August, Stanford, CA

Wei-Chih Wang and T, Jyh-Bin Yang. (2005). Applications of electronically facilitated bidding model to preventing construction disputes, *Automation in Construction 14,* 599– 610.