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A CASE STUDY OF CLIENT DRIVEN EARLY BIM COLLABORATION

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Abstract: This paper presents a case study of client-driven early BIM collaboration, where the client mandated the BIM and employed an independent BIM consultant to ensure successful implementation of BIM throughout all project stages. The case study demonstrates the idea of achieving maximum benefits of BIM by initiating a coordinated modelling process, in early project stages, using a partnering approach in a traditional procurement process. This approach also encouraged early involvement of the contractor in the design process and ensured interoperable modelling & collaboration process in a structured common data environment that continued throughout the project stages supporting several BIM applications. The author was part of the client's BIM consultancy team that was tasked to ensure that an integrated and coordinated BIM process is successfully developed at the early design stage that would continue throughout the construction and facility management stages.

1 PROJECT OVERVIEW

The project is a mixed-use development, with commercial and residential spaces on the podium and 2 towers with 21 floor each above the podium floors. The project consists of three basements for parking spaces. There are four podium floors which house additional parking as well as a mechanical floor. The fourth podium has a gymnasium, pool and kids play area exclusively for residents. There are two towers with 21 floors (each) above the podiums and offer one, two- and three-bedroom apartments with views of the city of Abu Dhabi.

The project team was challenged with a highly accelerated schedule, aggressive cost target and implementation of new tool and process, i.e. BIM, to meet the client expectations and set new standards of construction in the region. The project is owned by a semi-government real estate developer, having a strong portfolio of properties in the region and internationally. The client decided to implement BIM on this pilot project to explore opportunities offered by BIM, especially in reducing capital cost and enhanced digital facility management and was committed to extending the BIM initiative across all future projects. The client has an in-house construction team that conducted the feasibility study and initial project briefing. The client engaged a project management consultant with the additional responsibility of BIM management throughout the project stages on behalf of the client. The role of the client's BIM consultant was strategic and managerial, which did not include modelling at any stage of the project. The project management consultant was also responsible for traditional project management responsibilities (i.e. Contract administration, Commercial management, design and planning oversee etc).

2 BIM IMPLEMENTATION

2.1 Creating a BIM implementation Team

The first challenge in implementing BIM on the project was creating an eligible team to work in a collaborative environment, breaking the traditional status quo boundaries among the construction disciplines. This was done by creating a BIM Implementation Team (BIT) at the start, including a clear definition of roles and responsibilities, key performance indicators, BIM collaboration protocols and

procedures for project management and document management. In addition to the client's own in-house team, the following stakeholders formed the early project alliance to steer the BIM implementation on the project

- Client's Project management and BIM consultant, consisting of separate but collocated teams for Project management and BIM management tasks. The BIM consultant was not responsible for model development at any stage of the project.
- Design consultants, who were responsible for project design and development of BIM models.
- A preferred contract and sub-contractor, advising onthe constructability of the proposed design in BIM models and collaborating on value engineering of the project design.

A BIM capability assessment was conducted that the project team to set realistic BIM application targets, identified the need for training and agreed to a comprehensive set of client requirements, which form the basis of contract documents for the project (i.e. Project BIM brief, EIR and post contract BEP).

2.2 Innovative Procurement Strategy

A central issue for construction clients in adopting BIM is to use procurement strategies, which can deliver the best value of using BIM for project owners, with minimum disruption to existing work practices. Therefore, the case study project adopted an initiative procurement strategy that allowed the main contractor to participate in the early design stages yet requires the main contractor to enter in the competitive bidding process, as per the client's procurement policy. The collaborative procurement strategy for this project is highlighted in figure 1.

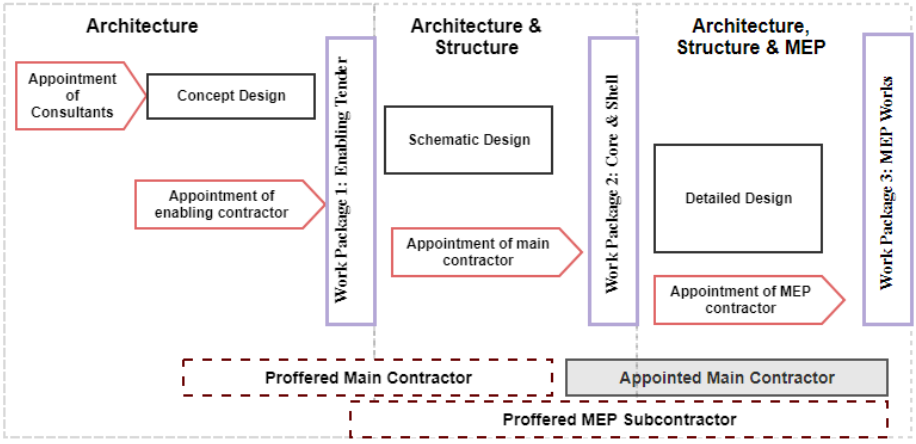

Figure 1: The project Procurement Strategy

The adopted procurement strategy was based on developing a special relationship between the projects' partners based on partnering principles. Preferred suppliers were nominated and approved by the Client based on "strategic partnership" agreement with the Client. The procurement strategy was built upon (1) Strategic relationships; (2) Partnering and collaborative legal framework; and (3) Phased procurement & competitive tendering. A "preferred" contractor was nominated at the early design stage, e.g. at the Concept Design Stage, so that the collaboration with the Consultant could start with the aim of producing a highly coordinated and planned design leading to minimum design errors, value engineering opportunities and minimum RFIs (Request for Information) during the construction phase. The "preferred" contractor and sub-contractor contributed in the design process by using 3D BIM models produced at the different level of details (LOD) during the design development process, yet they were required to bid at the tender stage along with other pre-qualified bidders in a traditional procurement process. However, being involved in the design development stages, the preferred contractor and subcontractors were at an advantage, having in-depth knowledge of the project, in comparison to their competitors at the bidding stage.

2.3 One Integrated Model

The success of producing a consistent and fully coordinated design for the project relied on creating a single and integrated BIM model for the project that allowed for the simultaneous exploration of complex architectural spaces and the coordination of intricate building systems through 3D modelling, rapid prototyping of details and extraction of 2-D documentation from a comprehensive BIM model. To minimise the interoperability issues, the project used a single software platform, Autodesk Revit Suite to develop discipline-specific BIM models (Architecture, Structure, and MEP), which were coordinated & shared through Bentley' ProjectWise using it as a common data environment (CDE).

The structure of the CDE is built upon the recommendations of the PAS1192-2; 2013 and AIA-E202 suit of documents were used to define the legal aspects of model sharing and exchange. It was agreed by all the project participants NOT to over model at any stage, and thus the design progression followed the implementation of the Levels of Development (LOD) as defined by AIA BIM Protocol-E202. The model was progressively developed from LOD 100 to LOD 300 at the design stage, which was used to generate collaborative design reviews, clash detection, constructability reviews and clash detection. The methodology and nomenclature of PASS1192-2;2013 was used to control information sharing and collaboration tasks (i.e. Work in Progress, Shared, Published and Archived). The framework of the CDE is presented in Figure 2.

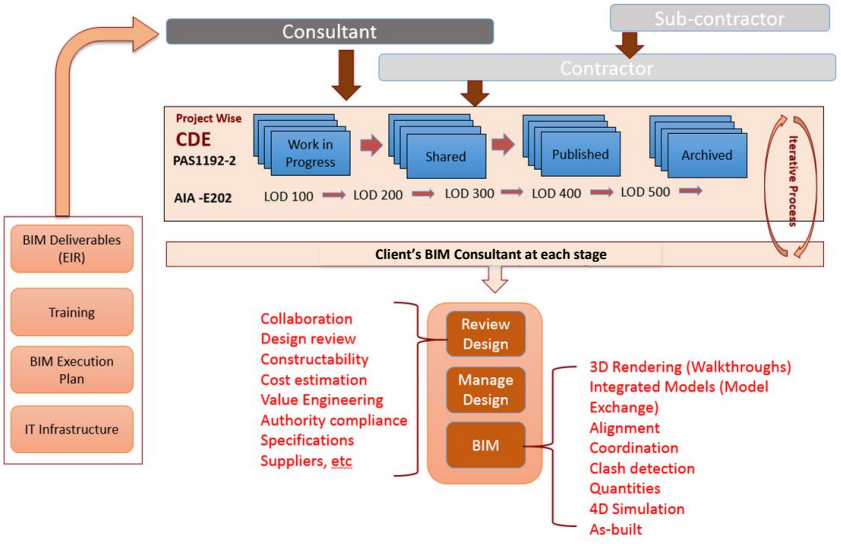

Figure 2: The structure of the project common data environment (CDE)

The fully coordinated-Clash free BIM model (LOD 300) was handed over to the successful bidder at the tender stage to develop further into LOD 400 model. The LOD 400 model was used to perform construction clash detection (e.g. clearances etc) and fourth dimension (4D) simulations to support the planning process. The LOD 400 model was used to track the contractor's progress and report it digitally to the client using the CDE. It was the contractor's responsibility to update the LOD 400 model with as-built information (floor by floor) and submit to the client with the required information needed for facility management tasks, thus delivering an as-built model (LOD 500) at the project handover.

2.4 BIM benefits achieved

The client's BIM consultant conducted independent design reviews using 3D visualization and virtual mockups to identify alternative design solutions and to evaluate their impact on the performance of the building and the surrounding environment. This process significantly aided the client in the design reviews, to approve the design intent, analyse the logistical and environmental impacts, identify cost implication and take upfront decisions leading to "no design changes" during the construction stage. Typical BIM applications, such as clash detection etc, were performed by the design consultant and were reviewed by

the client's BIM consultant, ensuring that the final design model is fully coordinated and clash-free. A fully coordinated and clash-free BIM (LOD300 model, i.e. detailed design) allowed the client to produce accurate tender documents, which only received negligible tender queries from all project bidders. Due to the quality of information produced by BIM, the tender prices received from the bidders were within only 5% difference. The completeness of the tender documents and quality of information resulted in initial cost savings of 5 Million AED, with an estimated life cost saving of 10 Million AED for the client. The BOQ analysis and cost estimation using BIM enabled the client to negotiate the prices for major building elements at the rates of 2010 (in 2014) in a region that is witnessing at least 5% annual increase in cost. BIM applications at the design stage also saved significant project time due to early identification and resolution of design clashes, quality of tender documents and low number of RFI (Request for information) from other project stakeholders.

The BIM development and coordination process continued in the construction stage, as the contractor & MEP sub-contracted were asked to develop the same LOD 300 model to LOD 400 model, to eliminate construction clashes and generating project shop drawings. The project construction team used on the fly coordination in a "BIG BIM ROOM" where all project stakeholders reviewed BIM models and provided instant approvals in the weekly project meetings. This helped the project team in resolving constructability issues early in the process, the results of which have informed the progression of the construction model (floor by floor) and helped in accelerating the production of an effective and efficient delivery schedule. In addition to their constructability evaluation, the first-tier subcontractors (e.g. MEP) could get an early start on their detailing models, participate in the Navisworks coordination and did early project planning for their relevant work packages. Due to this closely collaborative work environment and ready access to design information, the result was a highly coordinated construction model (LOD400) that resulted in fewer RFI's and change orders that would normally have been obtained, thus saved significant time in the project delivery for the client. The urban location of the project site-imposed material delivery and management challenges in the construction phase. The development of 4D models, not only allowed the project team to streamline the proposed project plan by the contractor, but also helped in material delivery and management. The main utilization of 4D modelling included the (1) clarifying the "week by week" and "day by day" scope of work; (2) On-time involvement of subcontractor "when we require them"; and (3) "Just-In-Time" material submittals and delivery. The BIM model was continuously updated by adding as-built information and by linking it with the asset management related documents/manuals.

2.4 Lessons Learned

The paper has described a client-driven approach to strategically introduce BIM within a low BIM maturity market, create partnering relationships, empower the supply chain partners and achieve significant BIM benefits with minimum disruption to existing work practices. This case study highlights that although BIM requires a step-change in the work practices of the construction industry, yet it is possible to successfully implement BIM with traditional procurement settings, which may be a critical feature in a certain market or a client requirement. Using BIM as technology may not deliver the BIM benefits to the project, or to the client, therefore a client-driven structured approach must be employed to facilitate a collaborative environment. Construction clients should find innovative practices, such as partnering or preferred contractor approach used in this project, to incorporate BIM processes into the existing business practices.

This paper also suggests that the client organisations are at a low BIM maturity, especially in developing countries, and require services of specialised BIM consultants or an in-house BIM team to oversee BIM development, coordination and management processes. The presented case study has successfully trailed and used BIM documents produced in the UK and USA (such as PAS1192-2, AIA BIM Protocol-E202) to address legal, technical and BIM management aspects. However, it took an extensive effort in training the supply chain partners to build trust and confidence in BIM processes and procedures. The case study has demonstrated that client organisations need a BIM implementation strategy at the early stage to define accurate and reliable Employer's Information Requirements (EIR) for the project. This can subsequently help in identifying the required level of collaboration, legal frameworks, critical process maps and information exchange flows, etc.