Research on Design Management Process Based on BIM - Taking the New Phnom Penh Airport Project in Cambodia as an Example

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Abstract. With the rapid development of international engineering quantity and scale, traditional project management methods have shortcomings such as relative separation of project design, construction, and operation, and loose connection of project management links. However, BIM technology can effectively integrate various stages of project management. This article combines the new Phnom Penh Airport project in Cambodia and establishes a BIM design management process based on existing management experience. By analyzing the changes in organizational management, team management, technical processes, and management points brought about by BIM, and addressing the problems in project practice, it summarizes and innovates the project design management process under DB mode, achieving a reasonable connection between design and construction management links.

Keywords: BIM technology, Design management, Construction management, DB mode, New Phnom Penh Airport.

1. Introduction

With the rapid advancement of information technology in the international construction industry, the requirements for integrated project management by homeowners are also increasing. At present, the integration of construction design has become a development trend in project construction management.

The emergence of the EPC (Engineering, Procurement, and Construction) and DB mode, while overcoming the shortcomings of traditional contracting models, is still not ideal in terms of work integration and information transfer. BIM (Building Information Modeling) is a collaborative tool for creating, managing, and exchanging information throughout a project [1].

To achieve accurate and efficient design management results and improve the overall quality of construction projects, an information-based BIM design management process can be established, summarizing the key points of BIM project management in the design management process, strengthening the collaborative work of all parties in the engineering project, achieving integrated management, and reducing many procedural work that traditional construction modes cannot avoid, The adoption of BIM design management workflow has become a clear direction for the development of the construction industry [2].

2. Project Background

The New Phnom Penh International Airport in Cambodia is located in the southern part of the

capital city of Phnom Penh, Kampuchea. It has a flight zone level of 4F and will be one of the largest airports in the world with a land area of approximately 2600 hectares. It is the airport with the largest passenger flow in Cambodia and will also drive the rise of the surrounding 1900 hectares of "airport cities". The building area is approximately 210000 square meters, including the terminal building, North Corridor, energy center, elevated bridge, outdoor roads, and parking lot. The overall architectural effect of the project is shown in Fig 1.

Figure 1. Overall Effect of Cambodia's New Phnom Penh Airport Project

3. BIM Design Management Process

3.1. Design Management Architecture "Two Units and One Hub"

(1) “Unified Center”

The design technical person leads the front desk, drives the backend, efficiently collaborates, and forms a trapezoidal management structure with a clear hierarchy and clear responsibilities, becoming the first person responsible for project design technical management.

(2) “Strong Knowledge Back Office”

After receiving the LOA, the professional responsible person immediately conducts an integrity check of the responsible professional drawings, ensuring the N+6 drawing requirements in the form of RFI (N is the structural floor under construction). Collect issues related to the drawings from the responsible person of the building number, communicate with the consultant, and ensure the quality of the drawings through RFI. It is also necessary to complete the deepening design of the architectural structure discipline verify the deepening design of professional subcontracting (referred to as subcontracting by Party A), and coordinate multiple disciplines. In addition, the professional leader should also be responsible for material approval management and construction plan management, helping to solve other professional problems within the architecture and structure disciplines.

(3) “Front Office”

After receiving the LOA, the person in charge of the building number immediately checks the integrity of the drawings for the responsible building and area, writes an RFI, submits it to the professional person in charge, and communicates with the consultant. In terms of design verification, it is necessary to investigate the differences between the floor plan and the detailed drawing in the architectural profession, the differences between the floor plan and the detailed drawing in the structural profession, and the differences between the floor plan in the structural profession and the floor plan in the architectural profession. After identifying the differences, the Structural Discipline Detail Plan (CBP) and the Architectural Discipline Detail Plan (BBP) should be drawn.

After the weekly technical briefing, the person in charge of the building number issues technical documents such as building structural drawings, approved deepening drawings, RFI replies from consultants, approved construction plans, and material submissions. At the same time, the draftsman modifies various professional BIM models such as building models, structural models, and

electromechanical models based on the drawings, RFI, deepening drawings, and other documents issued by the consultant. The overall design management organizational structure of the project is shown in Fig 2.

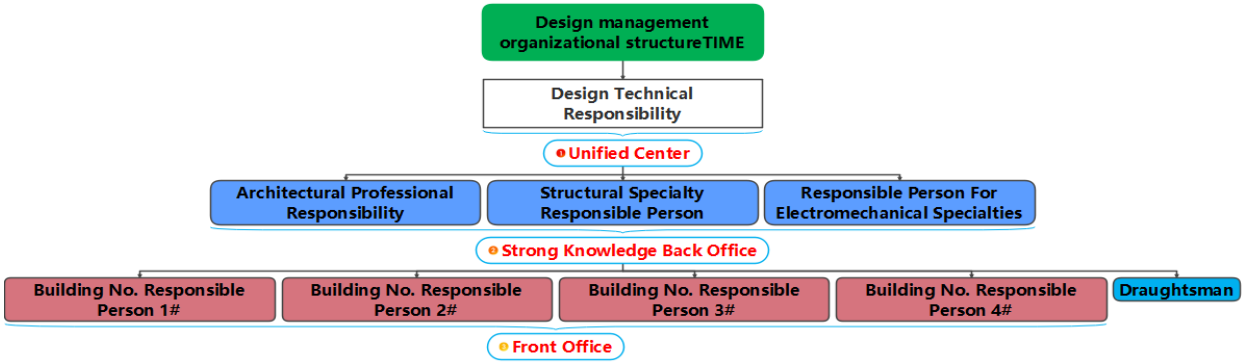

Figure 2. Organizational Structure of Design Management

3.2. Technical Management Process

(1) Drawing Management

The person in charge of the building number and the professionally responsible person should immediately conduct a completeness inspection of the drawings within their scope of responsibility, form a "Drawing Integrity Inspection Status Table", and update it monthly.

(2) Design verification

The person in charge of the building number checks the drawings for errors and conflicts layer by layer, component by component, and across all disciplines: Finds differences between the floor plans and detailed drawings of each discipline.

(3) Single Discipline Deepening

The general contractor-labor subcontractor is responsible for deepening their design (CBP, BBP). Professional subcontracting (referred to as subcontracting by Party A) is responsible for deepening the design of its single discipline.

(4) Multi-disciplinary coordination

The products designed by the consultant sometimes cannot meet the installation and operation requirements of the M&E system. It is necessary to update the design based on the NSC's detailed design drawing and the general contractor's pipeline comprehensive drawing, and reasonably arrange the spatial requirements of the M&E system to ensure no interference with each other. During this process, the responsibility of the general contractor lies in raising issues and updating, while design is the responsibility of the consultant.

(5) Drawing of three-color diagrams

The draftsman annotates the changes in the building and structure using a three-color diagram, submits it to the responsible person of the building number, and uses the approved RFI as an attachment to prove the changes in the building structure in the three-color diagram. The design management process is shown in Fig 3.

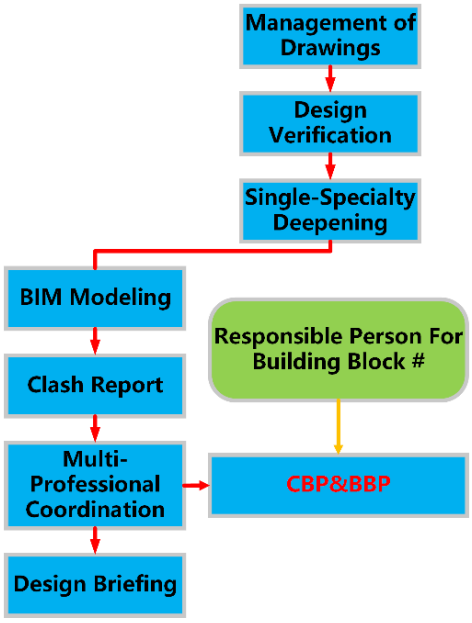

Figure 3. Design Management Process

3.3. BIM Collaborative Management Platform

(1) Lightweight building model display

Familiarizing oneself with building structures, locating component positions, and verifying component elevations and distances through roaming and slicing methods is beneficial for building quality control.

(2) Intelligent classification

Add collision report submission and design consultant approval processes, intelligently monitor the approval status of collision reports, and automatically generate weekly and monthly reports.

(3) Submit BIM design deepening drawings

The workflow for updating construction drawings by the draftsman consultant is shown in Fig 4. The process of updating detailed drawings for each professional subcontractor is shown in Fig 5.

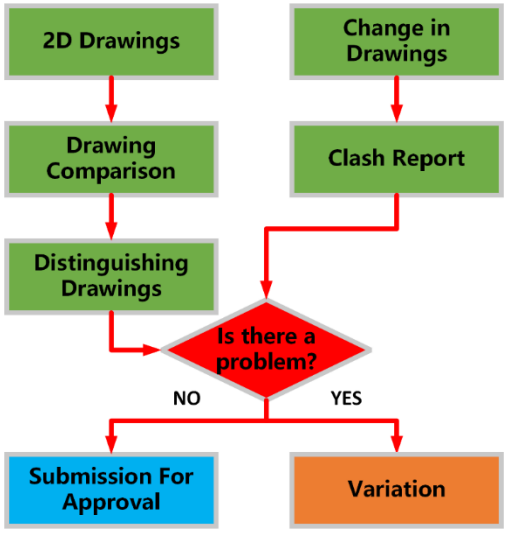

Figure 4. Construction Drawing Update Process

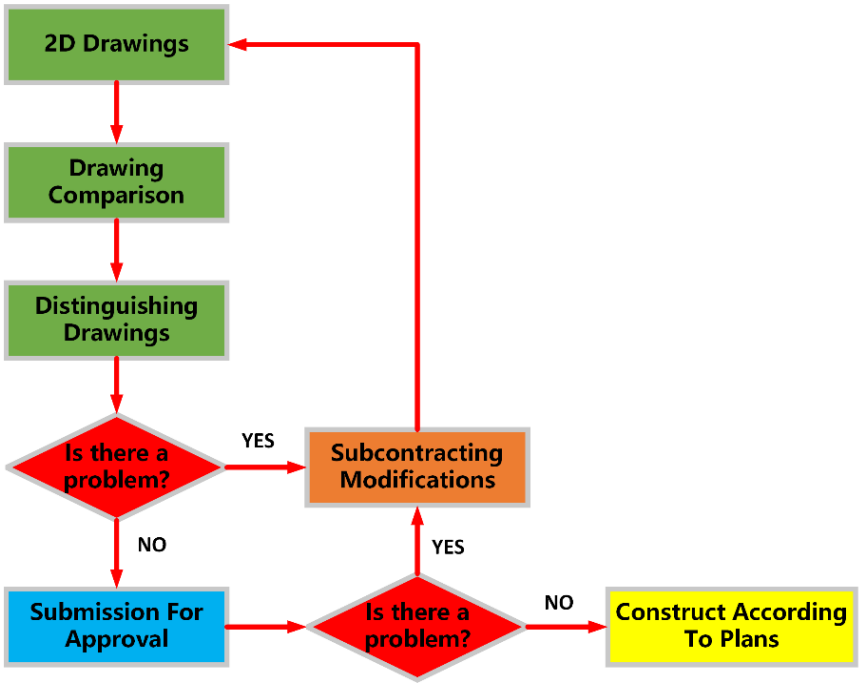

Figure 5. Deepening the Drawing Update Process

In complex projects, using BIM technology can improve understanding of project design and construction; It is very helpful for coordination between clients, consultants, engineering contractors, project visualization, and collaboration among project team members [3].

BIM also helps to reduce the chances of conflicts between project participants. Through BIM, they can intuitively see the situation of different construction stages and how their progress plans will affect each other. In addition, the key role of BIM in achieving project success is to improve scheduling, project coordination, and work quality. Therefore, it is crucial to develop a BIM implementation strategy to better integrate project elements using BIM [4]. The BIM team management process is shown in Fig 6.

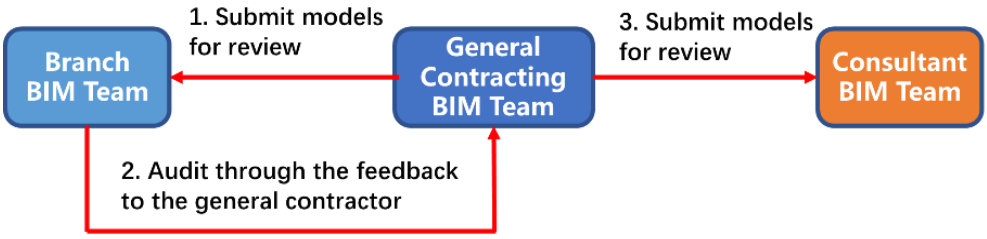

Figure 6. BIM Team Management Process

4. Key points of BIM project management

4.1. Cost Management of Design and Construction

Based on conventional technology and time dimension thinking, technical personnel increase their thinking on the engineering budget, decompose design, technology, procurement, and other work into three parts according to project stages, namely "people, materials, and machinery", through information technology methods such as BIM, and search for optimization space for each part.

Compare the design scheme and material selection. Due to the large amount of project budget work involved in DB or EPC projects, technical personnel need to take on the responsibility of leading the design, assisting, and supervising budget work.

For the optimization of design structure and material replacement, the general contracting technical personnel should know the cost information of the building design structure and related materials. Especially for design "optimization" that saves costs but affects changes in functionality

and effectiveness, the general contracting unit needs to provide timely opinions or instructions, indicate the direction of modification by the design institute, and discuss with the owner and consultant to persuade the owner or determine whether a consensus can be reached.

For the general contracting unit, design and construction management include optimizing construction plans, reducing project costs, focusing on decomposing the "personnel, materials, and machinery" components of sub-projects, analyzing the input costs of the plans, and making production safety, construction quality, and construction efficiency easy to control.

4.2. Time management of the schedule

The preparation of the overall schedule plan is a high workload preparation and organizational work, mainly including the following tasks: organizing various disciplines and departments, collecting plan information, summarizing and arranging, coordinating and integrating, analyzing and optimizing, publishing disclosure, collecting progress data, tracking records, analyzing and publishing report reports, preparing EOT documents, timely reorganizing and collecting plan adjustment opinions and adjusting and updating plans.

The New Phnom Penh International Airport project is a highly systematic and complex project that involves multiple interdisciplinary disciplines, such as civil engineering (architecture, roads, and landscape); Installation (electromechanical, drainage, BHS, and ICT); Decoration, exterior walls, etc[5].

During the project construction process, the planning and layout of the site are the core links. By using BIM to develop a schedule, 3D modeling can be carried out using BIM professional software such as Revit. The layout of tower cranes, equipment, materials, and living areas is reasonably planned, ensuring that the construction progress is arranged reasonably in terms of time, space, and resources, avoiding conflicts between construction steps and deployment, as well as unreasonable resource distribution. The project BIM plan and floor plan are shown in Fig 7.

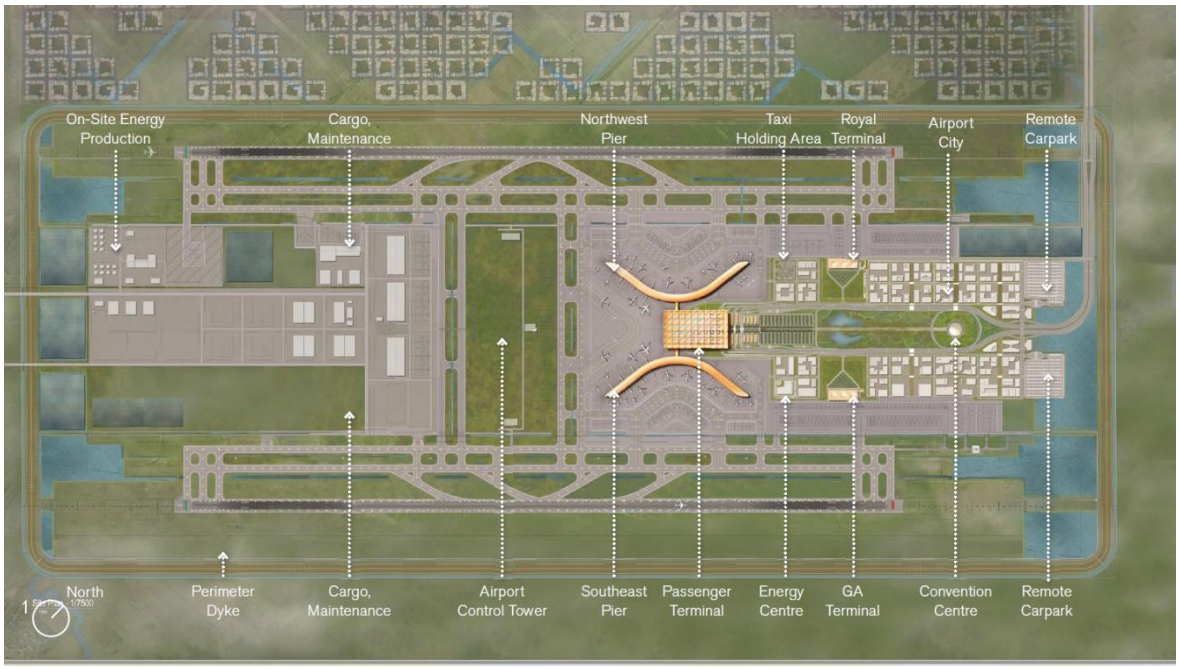

Figure 7. Project Planning and Layout

The New Phnom Penh International Airport project not only involves ordinary installation work such as equipment, electromechanical, and water supply and drainage, but also involves professional installation work such as luggage system, security system, and airport control system. The general contracting unit must coordinate the drawings of multiple disciplines before carrying out construction in all disciplines. After the coordination of professional drawings is completed, it is also necessary to coordinate various professional subcontractors for orderly construction. By using the BIM refinement

model, it is possible to grasp the overall construction progress of the project. The project BIM refinement model is shown in Fig 8.

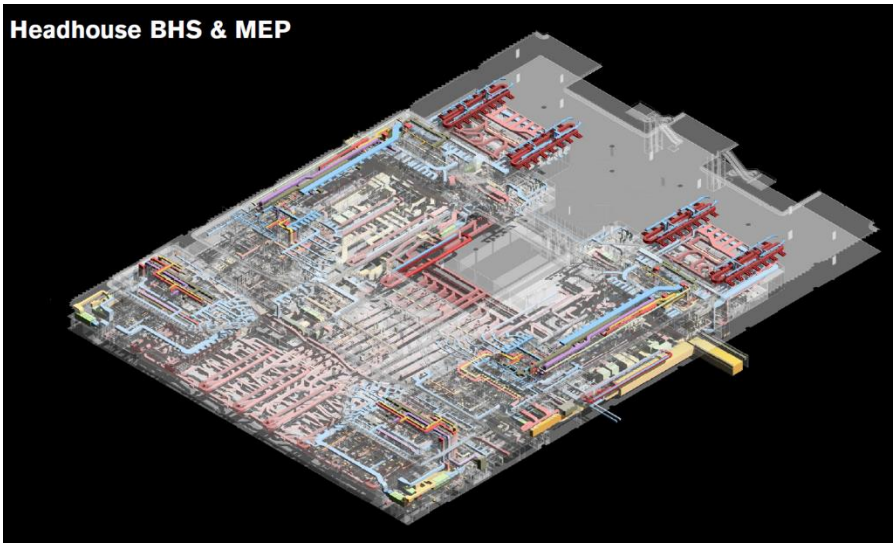

Figure 8. Project Refinement Model

During the design and construction process, the progress plan established using BIM is only a data model that needs to be dynamically adjusted based on actual situations. There is no perfect BIM plan model, nor is there a perfect plan model (Primavera P6 or Project). Therefore, technical personnel should attach importance to enhancing their professional knowledge and experience during the project implementation process, to improve their technical organization and management capabilities.

4.3. Communication Management of Project Informatization

Construction personnel with professional knowledge and relevant experience, as well as designers themselves, are generally able to correctly understand the construction drawings provided by the design institute, as these technical personnel have a professional foundation in interpreting the drawings. Personnel without professional knowledge, such as foreign workers, consultants, supervisors, etc., may not be able to use this type of drawing for design and construction management in the short term.

Therefore, the project needs to establish a BIM information model, deepen the professional drawings, and deepen the interpretation of construction drawing design and construction data information. At the same time, simplifying the process of drawing identification reduces the requirement for professional basic knowledge, reduces the understanding deviation of the owner, design party, and construction party towards the construction drawings, and leads to the suspension of normal construction processes on site. BIM technology coordinates the structural and electromechanical disciplines of the energy center as shown in Fig 9.

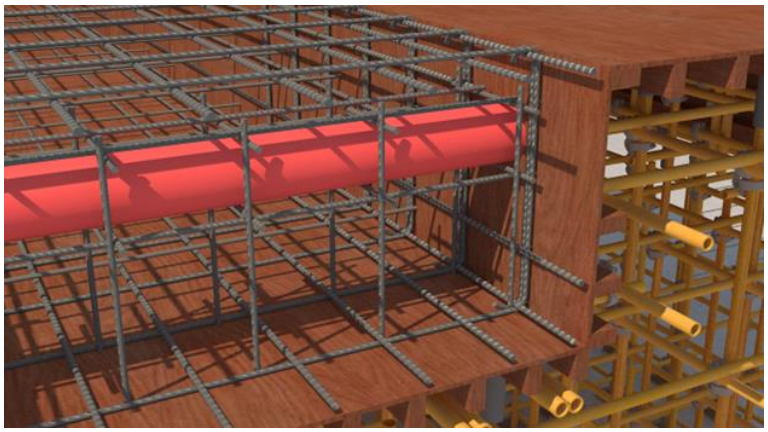

Figure 9. Energy Center Structure and Mechatronics Discipline Coordination

BIM is an information platform based on 3D models, while the common project management information platform (PMIS) is a file management platform, but it belongs to the field of informatization.

In international engineering, if the owner unit does not specifically purchase and use a professional information platform, it is necessary to use some manual information processing methods to form an information platform to complete the submission, approval, archiving, organization, and query of project documents and drawings.

Performing manual information processing requires a high level of effort and time from file administrators; Using a dedicated information platform can improve the efficiency of document control work. In the case where the owner provides a dedicated platform for the project, considering the confidentiality of construction materials, some internal information communication still requires the general contractor to establish an internal information platform to complete. In response to the above situation, our technical department has developed and maintained the CCYR-BIM information platform, which is used to store important data such as project accounts and building information models.

In summary, the information-based application of BIM can ensure that the delivery of construction projects is completed within time, quality, and budget. Secondly, it also helps to improve the productivity of construction projects, especially during the design, execution, construction, operation, and management stages of the building [6]. BIM is very suitable for simplifying project communication, especially among project professionals, for design improvement and building performance analysis, thereby improving the production efficiency of construction projects [7].

5. Conclusion

Through research on the BIM design management process, a design management architecture of "two machines and one center" has been systematically established. The technical management process of the project has been clarified, and the key points of design and construction cost management, schedule planning, and communication management have been summarized through a collaborative management platform and the use of BIM information technology. The following conclusions were drawn:

(1) Reduce work disputes

Traditionally, architects and homeowners discuss architectural design plans based on design drawings, which may lead to blind spots in communication and understanding. As for the 3D information model generated by BIM, parameterizes all design conditions and makes work communication clearer.

(2) Crossing the work area

Architecture, structural, and electromechanical engineers can use BIM technology to communicate on the same platform, using the same model and common language for two-way discussions. This work style is like working in the same team, which can achieve good communication effects and reduce the phenomenon of conflicting design content.

(3) Consistent integration of building information

The information is all within the same model. If there is a design change, all information will change with the change, and subsequent plans, elevations, and structural diagrams will also change together, saving a lot of communication and correction time, and of course, reducing the possibility of errors and omissions.

(4) Real-time update of information

The use of information platform interfaces is more convenient for updating information. Supervision units can directly use tablets or mobile phones to compare whether the project is constructed according to the drawings. If there are discrepancies, they will mark them and the information will be transmitted to the BIM integration interface. The structural engineer checks whether the construction error affects the safety of the building and considers whether to modify the

design, reducing communication time.

(5) Avoiding visual dead spots

Using two-dimensional graphics to describe design drawings can make it difficult to communicate with some visual dead corners, resulting in discrepancies between the on-site situation and the drawing design after construction. If the BIM three-dimensional building information model is applied in the architectural design process, the content of the design drawings can be clearly explained, reducing the difficulty of communication between design and construction. Professional coordination issues such as pipeline conflicts and steel bar conflicts can be easily identified on the drawings and should be improved during the deepening design to avoid problems being discovered only after construction, which can clarify responsibilities.

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