ASPECTS OF APPLICATION OF THE BIM IN ORGANIZATION AND MANAGEMENT OF CONSTRUCTION PROJECT FOR STRENGTHENING AND REHABILITATION

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ABSTRACT

Building Information Modelling (BIM) can be presented as the next generation solutions for the organization, implementation and management of construction projects throughout its life cycle. BIM covers all aspects of project management, rights and duties of the project manager at all stages / phases of realization of the investment project. The presented paper deals on application of Building Information Modelling (BIM) in the realization of the project for strengthening and rehabilitation of construction structures

1. Introduction

Rehabilitation and strengthening of existing civil engineering structure has been of great importance during the last decades. There are number of situations where the bearing capacity of a structure in service needs to be increased. On another hand, due to global environment changing and energy crises in the world, for saving the planet need to look forward more about sustainable environment in all aspects and in this circumstance the construction industries and every year this industry is booming in the world. A big proportion of this succeed is coming from the renovation and reconstruction of buildings. In addition due to increase of sustainable initiatives in all fields of the world wide obviously affected in construction fields. Systematic processes of rehabilitation/ strengthening/
renovation/reconstruction for a building are quite complicated and there is high risk of inadequate activities for Engineering, Architectural, and social value, loss of large amounts of money and energy efficiency. Therefore for an excellent systematic rehabilitation and strengthening, renovation and reconstruction process it is necessary to have tools to make correct measurement and design as a result of that to can make proper decision for the rehabilitation/strengthening/renovation/reconstruction measures however the final goal of this determination is to achieve sustainable renovation. The goal of this paper is trying to illustrate the tools and methods which are available in construction industry, and to determine the most adequate from them for renovation purpose. Regarding to complexity of this purpose have the constitutive rehabilitation/strengthening/renovation/reconstruction processes have to be explained and presented clearly, and to be illustrated all the details for successful and valuable progress. (Baoping, C., 2011)

The Building Information Modelling (BIM) can be presented as the next generation solutions for the organization, implementation and management of construction projects throughout its life cycle as for design and implementation of new civil engineering structures, as for rehabilitation/strengthening/renovation/reconstruction of existing one. BIM covers all aspects of project management, rights and duties of the project manager at all stages/ phases of realization of the investment project. The resulting model, a Building Information Model as “smart object”, is a data-rich, object-oriented, intelligent and parametric digital representation of the structures, from which views and data appropriate to various users’ needs can be extracted and analysed to generate information that can be used to make right decisions and to improve the process of delivering the structures (AGC, 2005).

2. Understanding the bim

There is no definite definition of BIM. Rather there are many ways of interpreting what BIM is. The National Building Information Modelling Standards define the BIM as:

“... a digital representation of physical and functional characteristics of a facility. A BIM is a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle; defined as existing from earliest conception to demolition. A basic premise of BIM is collaboration by different stakeholders at different phases of the life cycle of a facility to insert, extract, update or modify information in the BIM to support and reflect the roles of that stakeholder (NBIMS, 2007, p. 21).”

The building information model refers to the combined model where the models from the different disciplines have been merged. According to the BIM handbook the Building Information Model is characterised by the following features:

- Building components that are represented with intelligent digital representations (objects) that “know” what they are, and can be associated with comparable graphic and data attributes and parametric rules;
- Components that include data that describe how they behave, as needed for analyses and work processes, e.g., takeoff, specification, and energy analysis;
o Consistent and non-redundant data such that changes to component data are represented in all views of that component;
o Coordinated data such that all views of a model are represented in a coordinated way (Eastman, et al., 2008, p. 1).

A BIM can be used for different kind of purposes as, visualization, fabrication drawings, code reviews, forensic analysis, facilities management, cost estimating, construction sequencing, conflict, interference and collision detection.

3. BIM and project management

When talking about the BIM application on project management has to think for the project management knowledge areas (Figure 2), as: scope, time, cost, resources, risk, communications, procurement and quality. (Yalcinkaya1, M. and Arditi, D, 2013)

Figure 2 Project management knowledge areas
Budget Management

Budget management comprises the project-related cost of Construction Management (CM) practice. The CM has the responsibility to confirm, generate, track, report, and substantiate all budgeted costs from the first estimate to the final accounting. BIM models can be used for cost estimating to generate a bill of quantities. It is possible to establish and a direct link between the BIM model and the estimating software. With this link, the changes in the BIM model are automatically propagated through the whole estimating cycle, and the CM can get cost-related or expenditure-related evaluation for any activity. Cost budgeting includes and controlling the cost of the changes to the project budget. BIM interconnects structural design, time, and cost effectively. In case of realization of project for strengthening and rehabilitation of the civil engineering structures, this interconnection gives great opportunities to analyze in all aspect the different constructive solutions, and to choose the most effective one.

Material and Equipment Management

Materials and equipment constitute a large portion of a project’s total cost and must therefore be subject to strict analyze and control. Material/equipment management encompasses all activities relating to the acquisition of materials and systems, and equipment from specification to installation, technology and warranty for the accepted rehabilitation and strengthening solutions. The BIM models can be used to analyze the time and cost impacts of the selected materials and systems. When design rehabilitation and strengthening of structures can be decided to apply conventional or advanced methods which suggest the use of quite different construction materials and technological solutions. Construction planters can use 4D simulations to select the appropriate construction equipment for the project and to check the safety conditions in its construction work. Currently, 4D BIM models are used to optimize construction site layouts, and improve site logistics and space work execution. It is very important opportunity in realization of one rehabilitation and strengthening project. The situation and condition usually for existing building and structural facilities is so difficult and complex.

Value Management

Value management addresses a project's cost versus its value, and has three value components: design-ability, constructability, and contractibility. Design-ability relates value to overall project design. BIM models allow designers to design a building with respect to the required specifications. Constructability relates value to construction materials band systems, details, means, methods, and technologies. BIM models allow the designers and the CM to virtually review the conflicts and resolve them previously. Contractibility relates value to contracting options, contractual assignments, and contracting procedures. The CM is expected to extract maximum value for the owner/investor with respect to design-ability, constructability and contractibility.
Resource Management

Resource management includes the selection, organization, direction and use of all project resources, both human and physical. The construction management delivery system places all design, consulting, contracting, management, and construction services in a team environment coordinated by the CM. The BIM technology is used for visualization purposes by most construction professionals. But this technology has moved far beyond its original visualization stage. BIM-based system integrates dynamic resource management and the decision support system.

Schedule Management

Construction planners typically use CPM-based networks and Critical Path (CP) charts to describe the proposed schedule of a project. The CPM schedule does not provide any spatial information and any information about the complexities of the project components. In addition, the current CPM methods do not allow to explicitly describing the constraints of a construction project, such as availability of resources, the site conditions, and the availability of capital, which are very important factors for making decisions. Besides, it is very difficult to integrate the time and cost information in the current CPM scheduling framework, one of the reasons being that schedules generated by the CPM method are activity-based, whereas in the construction process, the project is executed according to work items as the cost and resource data of the project but are not well connected to the activities of the project schedule. In case of renovation projects typically the object of the project is in the exploitation condition, and it is very important to organize construction work in at the right time and on the right place. BIM 4D models integrate 3D geometry with time as the fourth dimension. Any building component in a 4D model contains geometric attributes that describe its 3D shape, as well as a time attribute that indicates the start and finish times of the construction of this element. The BIM 4D model of a structure can be used to simulate the sequence of construction operations, thereby providing the operator with a virtual, visual understanding of the construction process for the project life cycle management.

Decision Management

Decision management comprises the development and handling of the interrelationships between the project and the construction team, and the relationship between the members of the construction team. The BIM includes all of the design and management source data of the building and the CM can support the construction team by using BIM applications in the decision making process. Each phase of a project requires a unique decision-making process as specially as in case of rehabilitation and strengthening project. The CM can use BIM to generate drawings, reports, design analysis, cost estimates, schedule simulation, facilities management, and ultimately enabling the designers and project managers to make informed decisions.

Project Management
Project management encompasses all of the operational aspects of project delivery, including determining, formulating, developing, installing, coordinating and administering the necessary elements from the beginning of design to the termination of the warranty period. The CM has the responsibility to coordinate the efforts of the team in achieving a basic goal. The BIM models increasingly used to minimize the potential for design and construction errors, to identify critical space and time during construction, to determine the most suitable rehabilitation and strengthening methods and sequence, and to monitor construction progress. Different researchers talk about that the visual representations and interaction technologies support a range of project management functions and enhance the understanding of project status. They use an integrated building information system and digital images captured on-site to semi-automate the calculation of progress measurements and project status.

Quality Management

Quality management ensures that the project will satisfy the needs for which it was undertaken. It includes all activities that determine the quality policy, objectives and responsibilities and implements them by means such as quality planning, quality assurance, quality control, and quality improvement. By the BIM the owner/investors and the designers have a first impression of the overall project from the 3D model. In the traditional approach, it is difficult to compose the different designs. The BIM models allow the designers and the CM to virtually review the conflicts and resolve them during coordination meetings. Therefore, the quality of the project is substantially enhanced before actual construction begins. During the construction process, quality can be controlled with traditional methods such as benchmarking the process against quality standards, but the construction process can be captured and integrated to the BIM environment too. It is very important for execution of one rehabilitation and strengthening building project that the BIM 3D models using data from laser scanners can rapidly generate the existing construction sites and inspected it. The captured construction processes can be used to ensure that the quality requirements of the contract are satisfied.

Risk Management

Risk management encompasses the dynamic risks that are directly tied to team decisions and static risks that are simply inherent to construction. The CM can use the BIM to reduce safety risks and as a starting point for safety planning and communication. The utilization of BIM can result in improved occupational safety by connecting safety issues more closely to construction planning, providing more illustrative site layout and safety plans, managing and visualizing up-to-date plans and site status information, as well as by supporting safety communication in various situations. The BIM can reduce and the risks associated with cost and time management.

Safety Management

Construction is one of the most hazardous industries in the world due to its unique nature including frequent work team rotations, exposure to weather conditions, and high proportions of unskilled and temporary workers. Safety management includes the processes required to
assure that the construction project is executed with appropriate care to prevent accidents that cause personal injury, death, or property damage. Traditionally, the safety is achieved through periodic meetings and training. Virtualization of the projects before the actual construction phase allows safety managers and CMs to simulate their safety precautions and identify potential safety problems. The BIM's visualization technologies have a central role in safety training. The BIM are using to analyze and anticipate unsafe conditions. The BIM models incorporate safety related activities into construction schedules; The BIM technology can defined the analytical procedures based on 4D simulations to reveal potential safety threats.

Information Management

The information management encompasses the collection, documentation, dissemination, safe keeping, and disposal of verbal and graphic project-related information. The volume of the information generated for project accountability purposes requires a multilevel, need-to-know reporting structure and an efficient information storage and retrieval system. The BIM can be used as a communication platform established the information management. The BIM is like a shared information backbone through the lifecycle of the project. The BIM approach is essentially a conceptual way of managing project information.

4. Benefits of bim application

One of the major benefits of BIM is its accurate geometrical representation of the parts of a building in an integrated data environment (CRC Construction Innovation, 2007). But BIM has and other important benefits, as: 1) faster and effective processes (information is more easily shared, can be value-added and reused) (Figure 1). 2) Better design (construction design proposals can be rigorously analyzed, simulations can be performed faster and performance benchmarked, there possibility for enabling improved and innovative solutions). 3) Controlled whole life costs (better understood). 4) Better production quality (documentation, presented the design solutions - output is flexible and exploits automation). 5) Automated assembly (digital product data can be exploited in downstream processes and be used for manufacturing/assembling of structural systems). 6) Better customer service (proposed design solutions are better understood through accurate visualization). 7) Lifecycle data (requirements, design, construction and operational information can be used in civil engineering structure management).
The literature review data shows the follow BIM indicates benefits such as: Up to 40% elimination of unbudgeted change; Cost estimation accuracy within 3%; Up to 80% reduction in time taken to generate a cost estimate; Savings of up to 10% of the contract value through clash detections; Up to 7% reduction in project time.

The Architectural, Engineering and Construction (AEC) professionals determine that the most important requirements of BIM solutions satisfy are:

1) Full support for producing construction project documents so that another drafting application need not be used;
2) Smart objects, which maintain associatively, connectivity, and relationships with other objects;
3) Availability of object libraries;
4) Ability to support distributed work processes, with multiple team members working on the same project;
5) Quality of help and supporting documentation, tutorials, and other learning resources;
6) Ability to work on large projects;
7) Multi-disciplinary capability that serves architecture, structural engineering, and MEP;
8) Ability to support preliminary conceptual design modelling;
9) Direct integration with structural analysis and project management applications;
10) Industry foundation classes (IFC) compatibility.
5. The bim improves the process of rehabilitation and strengthening of buildings

If we can add all the BIM processes to the rehabilitation and strengthening project, the benefits that we can derive from it, are greater for all stakeholders involved in this process and will surely improve project outcomes and demands.

The ability to create a complete BIM model and the use of this to help to analyse the costs and benefits trade-offs of proposed rehabilitation and strengthening projects within a building is the key to building performance analysis. Innovative design products that support BIM, making it a cost-effective way to evaluate, prioritize, and audit proposed building rehabilitation and strengthening are essential for the success of BIM in this specific projects. Figure 2 presents a BIM process in rehabilitation and strengthening project:

Figure 2 BIM process in rehabilitation and strengthening project

The benefits of using BIM for rehabilitation and strengthening projects are huge, but some of them are:

1. Enhanced information exchange and added document control, including sharing models, meetings, project images, etc.;
2. Interoperability, i.e. the ability to share data across applications;
3. Elimination of unbudgeted changes on projects;
4. Cost estimation accuracy to within 3%;
5. Up to 80% reduction of time taken to generate a cost estimate;
6. Clash detections, particularly services, providing time and cost savings (avoid potential requirement of re-design);
7. Reduction in project delivery time;
8. Reduction in remedial works due to enhanced quality control and design coordination;
9. Reuse and remodel instead of building new;
10. Prevent over-ordering, i.e. materials, equipment, etc.;
11. Beneficial occupancy and reduce period of disuse, improving profits and client demands.

CONCLUSION

The future of the design and construction industry lies in the use of technology and BIM is expected to shape this future effectively. The introduction to BIM into design and construction practice in erection for new buildings and facility structures, and as for the rehabilitation and strengthening of existing one has brought along new duties and responsibilities for the CM. BIM is effective in every phase of a project’s lifecycle as it covers several CM functions in the most critical phases. BIM has big potential to be used alongside many construction management applications. Future CMs must be trained to be effective in a BIM environment.

REFERENCES

