An Integrated Methodology for Construction BIM & ERP by Using UML Tool

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Abstract –

In order to improve the efficiency of construction management, a new methodology is presented to develop translatability for construction BIM (Building Information Modeling) and ERP (Enterprise Resource Planning) by using UML (Unified Modeling Language) tool. The method includes a new rational operation process can be developed to improve efficiency. Besides, the competitive ability of a construction company is also increased. The major contribution of the method is to understand and confirm what needed and correct process in the enterprise is before running the construction ERP system. Enterprise will know how to use BIM to improve some processes in each part/each module of ERP correctly and efficiency. The research possibilities are identified and tested based on the implementation of the method. To some extent, this research also establishes a new agenda of process conflict solving for future research.

Keywords –

Enterprise Resource Planning (ERP); Building Information Modeling (BIM); Unified Modeling Language (UML)

1 Introduction

The concept of ERP is presented to integrate all enterprise systems because multi-roles joining and working in different projects will lead to the problem of information integration between projects in construction enterprises. In the past, enterprise information systems usually focus on a single department or organization. All kinds of information systems in the enterprise usually come apart each other. That will occur a situation each information system likes an island. However, all of information islands become independent respectively. When each department implements individual information system, each department will become individual information island. This situation will lead information flows, working flows and other flows to run between departments unsmooth. It will cause barrier and hurdle to integrate these flows each other. How to integrate correct flows between departments is becoming a new planning aspect by ERP system planners. Averagely, the actual cost increased more than 1.78 times and the implementation duration increased more than 1.5 times when enterprises implement ERP system [1]. Another investigation points out the cases of enterprise implementation ERP system had 96.4% failure in the past [2]. The most serious problem will lead enterprise to close down. Productivity in construction industry is project-based. When construction enterprise starts to implement ERP system. Production line belongs to the project-based way because of construction characteristic.

BIM is a concept that use digitalize and parametric form design to build a integrate module. It offers various forms and information help control conflict/resource/schedule/cost between project designs and construct period.

We want to make the implementation ERP system and BIM more match and enhance the performance of ERP system. In ERP implementation process, there is serious problem existing for a long time. The problem is that enterprise employees usually know how business processes operate individually in organization/department/enterprise, but they don't know how to develop system planning; In other words, ERP system planners know how system planning is developed, but they don't know how business processed in their customers (enterprise) run. Another big problem is that processes conflict between different organization/department/enterprise. That will be why we combine BIM and ERP system, try to solve the conflict problem. Therefore, when both roles cooperate to implement ERP system enterprise will not match enterprise processes conflict and system planning. This research will try to solve this problem to avoid implementing ERP system failure. Because enterprise implementation ERP system is time-wasted and cost-expensively, we expect to implement ERP system more successfully.

2 Research Objectives

This paper focus on how to construct a transformation method between BIM and ERP system for the implementation of construction enterprise resource planning. In order to improve the efficiency of construction management, a new methodology is presented to develop translatability for BIM and ERP by using UML tool. It can become a consideration method when enterprise starts to implement ERP system. Figure 1 illustrates the framework of research objective. In Figure 2, a whole procedure of implementation ERP system will include "BIM", "Integration" and "build up ERP system" three parts. Because of page limitation, the "build up ERP system" part won't illustrate. So we use duck color to show in Figure 2. We just can illustrate "BIM" and "Integration" two parts in this paper.

3 Problem statements

Via the above mention about feature of construction industry, the most important purpose in this research is how to improve information advancement in construction enterprise by implementing ERP system. In Table 1, we compile problem definition, description and solution of information apart in construction industry.

Combining BIM and ERP regards as a new solution of enterprise information apart. In sum, BIM is a one of concepts and tools to assist running ERP system more effectively and successfully. In Table 1, it classifies about the concepts of ERP and the practices of ERP. The following is classified:

Regarding the concept of ERP

1. Confirm goals of enterprise.
2. Analyze and define needs of enterprise.
3. Evaluate main business processes.
4. Analyze original business processes.
5. Design better business processes.

Regarding the practice of ERP

1. Match business processes with ERP system modules.
2. Develop system implementation planning.
3. Start system planning.

Via the above mention about the concept of ERP and the practice of ERP, we can comprehend and find out the problem solutions below:

1. Processes modeling and conflicts finding.
2. Processes and system planning integration.
3. System planning.

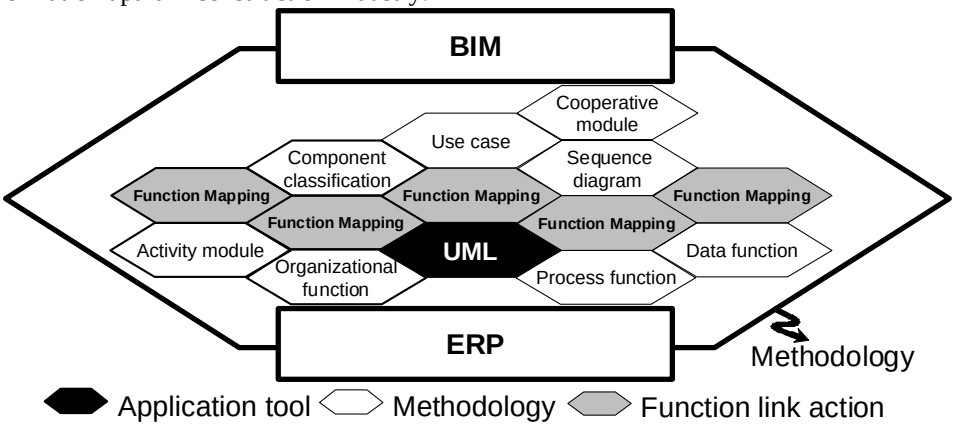

Figure 1. Honeycomb structure diagram of research objectives

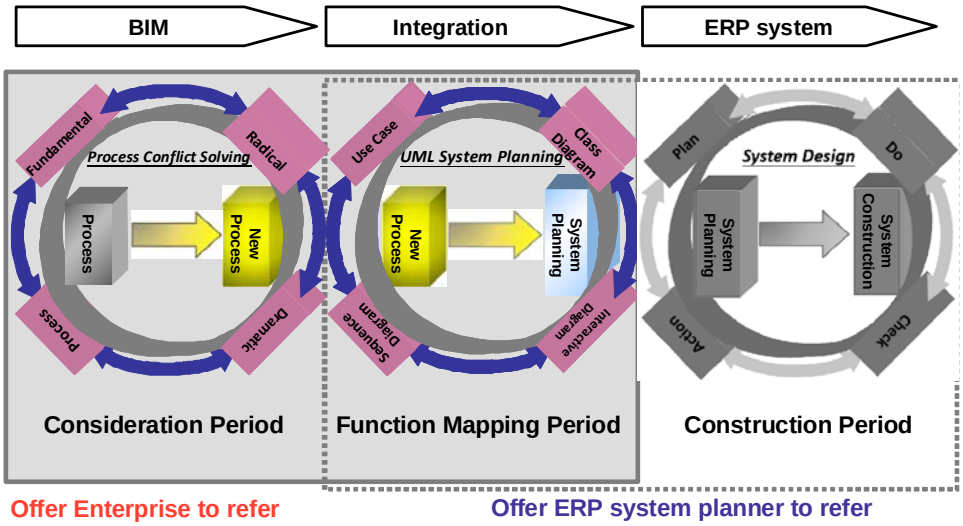

Figure 2. Research Scope Diagram

Table 1. Problem definition, description & solution

Problem	Problem Definition	Problem Description		Solution
Information Aspect	How to improve Information advancement in Construction enterprise by Implementation ERP system?	Regarding the concept of ERP	■ Confirm conflict problems of enterprise ■ Analyze & define needs of enterprise ■ Evaluate main business processes ■ Analyze original business processes ■ Concern conflict to design better Processes flows	Business processes conflicts finding from BIM Business processes & system planning integration System planning
		Regarding the practice of ERP	■ Match business processes with ERP system modules ■ Develop system implementation planning ■ Start to system planning	

4 ERP implementation

The main purpose of method is to make the smooth integration for translation between processes (avoid conflicts) and ERP system planning. The left dotted block includes BIM phases (see Figure 2). This phase is to apply BIM tool to proceed process discussion and conflicts. The middle dotted block belongs function-mapping phase. The phase primarily processes the translatability between process conflict solving and system planning. The right dotted block includes system-planning phase. The phase apply UML tool to proceed to system planning. Actually, the function-mapping is the kernel part in method because it plays the road of the translatability. In the other words, the functionality of method is like a bridge between processes conflicts and ERP system planning.

5 Case study

5.1 Building Information Modeling (BIM)

BIM is a concept that combines digital information products and engineering application technologies to develop / estimate / maintain project or engineering in its lifecycle. In the other way, BIM uses virtual space in computer to simulate a real environment or situation. That will help include starting from plan, design, constructing, operating and maintaining how to manage by this new concept, new technology or new method. BIM emphasizes lifecycle information gathering and sustainable use of engineering, 3D visualization and cross-disciplinary collaboration, geometric and non-geometric information Knot, static and dynamic process information of the immediate grasp of micro and macro space information integration [3][4].

The concept of BIM has been the beginning and BIM from 2D planar technology to 3D graphics development process (see Figure 3 & Figure 4).

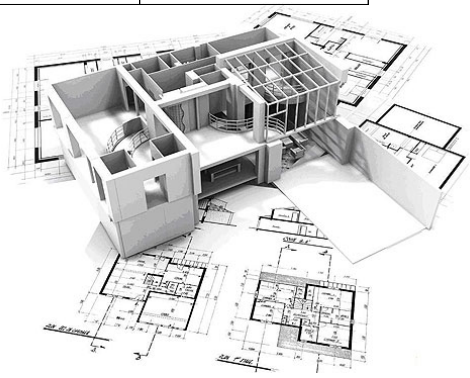

Figure 3. 2D and 3D model conversion diagram

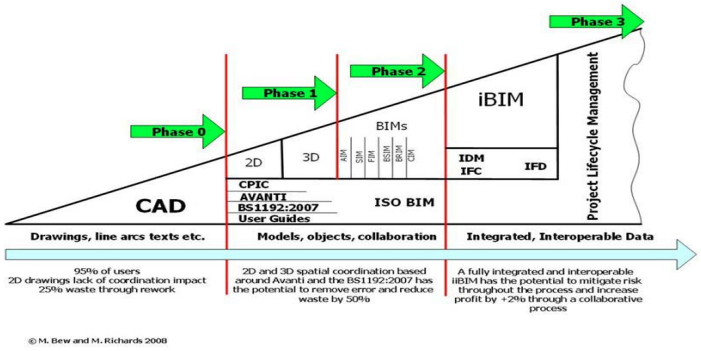

Figure 4. BIM development process

5.2 BIM for the improvement of the conflict

Here we discuss BIM is used in engineering quantity estimation. Engineering quantity estimates in traditional, we mainly use 2D drawings. The engineer must calculate the number of components from the 2D drawing and obtain the information needed to estimate the number of projects when we estimate the number of templates. There is a practice in this part is to define each of the components of a combination of its order, and then use the writing program to retrieve its surface area information, which may have some increase in the account. So through the BIM with the writing program, you can estimate the number of templates out, and can

make the results very accurate there will be no error. This is the BIM project quantity estimation and conflict application.

As shown in the following figure, the 3D model we made is a geometric shape of the more complex triangle angle of the template configuration, this problem will occur mainly in the triangle angle of the intersection, because itself will have thickness, in the overlap when the combination may be because of this place Resulting in the possibility of repeated calculations, which form a conflict in the calculation of the number of templates.

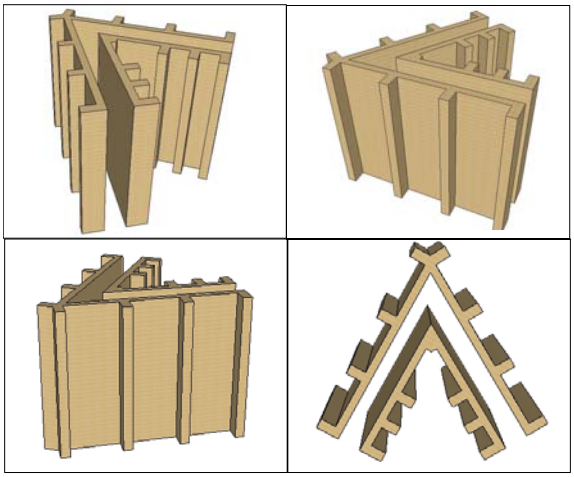

Figure 5. Template conflict example different view

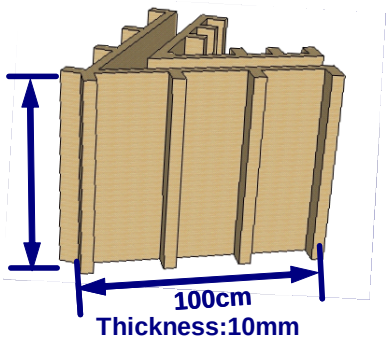

Figure 6. Template conflict example

Outside template:

Traditional estimate A1 = 100 × 100 × 2 = 20000cm^2 (1)

Overlap estimate A2 = 100 * 1 = 100cm^2 (2)

Inside template:

The number of square columns = 4 × 2 = 8 (3)

Overlap estimate of square columns = 8 – 7 = 1 (4)

There is 100cm^2 overlap quantities existed in the calculation of such a unit. And there is 1 overlap quantity existed in the calculation of such a unit. When the estimate is quite large and complex time, the overlap quantities existed will be huge. And that will affect the correct number of estimates and cost estimates. This is the traditional calculation will occur on the error, but through the BIM can solve this problem.

5.3 Function Mapping

There are six steps in function mapping phase. They are confirming processes conflicts solving, developing process function table, drawing process function diagram, building up system planning criteria table, acquiring system planning components and making components category table. The first step is confirming processes conflicts solving. We inherit from the result of BIM phase. We must discuss with related staffs to confirm the correctness of new process that avoid processes conflicts. The second step is that developing process function table. We classify the result of BIM

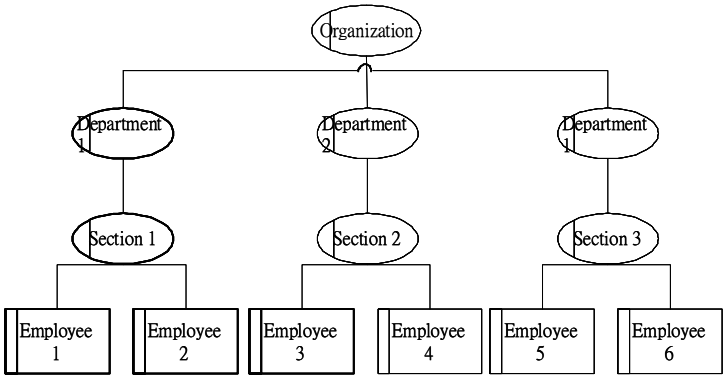

Figure 7. Organizational function diagram

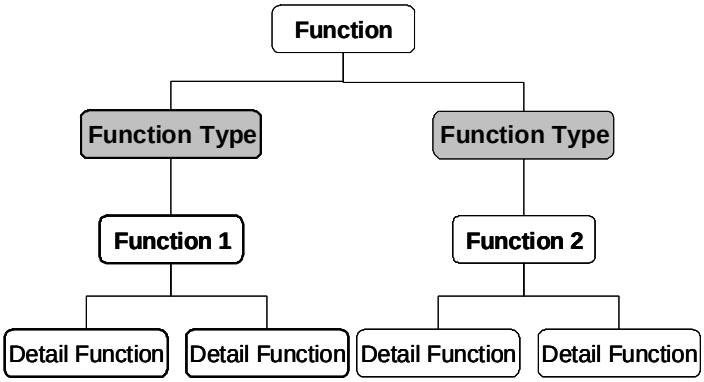

Figure 8. Process function diagram

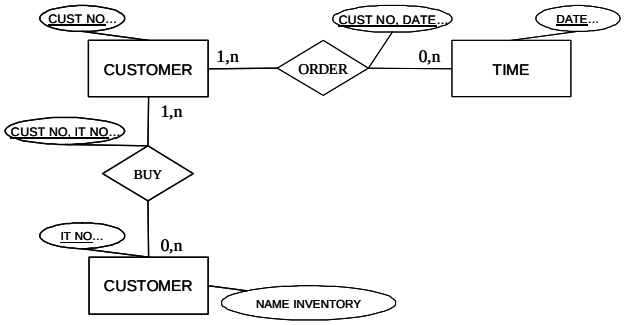

Figure 9. Data function diagram

phase to become “event”, “function”, “organization” and “data” four categories according to organizational function diagram (see Figure 6). When we develop process function at the ready. The third step is that drawing process function diagram. We draw function, data, event and organization four diagrams according to organizational function diagram. For example, fig 8 and fig 9 are function and data models.

The fourth step is building up system planning criteria table. The process function table, event model, function model, organization model and data model are transformed into system planning criteria table. This step is critical point that transmission BIM process into ERP system planning (using UML tool). In the other words, we can say it is important referring to system planning successfully. The fifth step is that acquiring system planning components. Useful components may be acquired from second step to fourth step before UML system planning. After acquisition, components category table at the sixth step can be made to prepare for system planning phase (see Table 2).

Table 2. Component category table

System planning components by UML tool	Outcome of acquisition from BIM
Actor	Department or staff
Use-Case	Process name, event, entity or information
Class Name	Department's name, staff or entity
Attribute	Attribute (eg. Item name, evaluation table's name etc.)
Operation	Attribute (eg. The motion of verify, the motion of calculate etc.)
Message	Information (eg. Item estimate finished a part of project etc.)

5.4 System Planning

There are four steps in system planning phase. They are confirming components category table, static system planning, dynamic system planning and finishing system planning. Confirming components category table belongs first step. The correctness needs to be confirmed with related staffs. The second step is the static system planning.

Static system planning is developed according to rules of UML tool. The core work of static system planning is that develop “Use-Case diagram”, “Use Case description”. A complete static system planning will have a lot of diagrams and descriptions by use-case, object and class planning. For example, Figure 9 and Figure 10 show use-case diagrams and one of class diagrams. The third step is that dynamic system planning. Dynamic system planning is developed based on rules of UML tool. The main work of dynamic system planning can be designed to develop “Collaboration diagram”, “Sequence diagram”, “State diagram” and “Activity diagram” (see Figure 12 & Figure 13). A complete dynamic system planning will include a lot of diagrams by the static system planning and the dynamic system planning steps, hundreds or thousands of tables and diagrams are made. We must discuss with related staffs to confirm the correctness. After confirming the correctness about UML models of static and dynamic system planning, we have finished to translate enterprise business processes into system planning. The result will be taken for the specification by ERP system planning company. In sum, four phases are made to assist the integration implementation between BIM and ERP system more successfully.

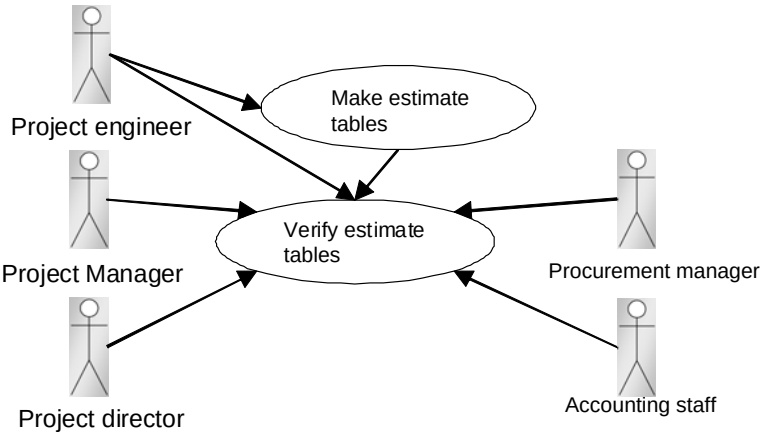

Figure 10. Use-case diagram

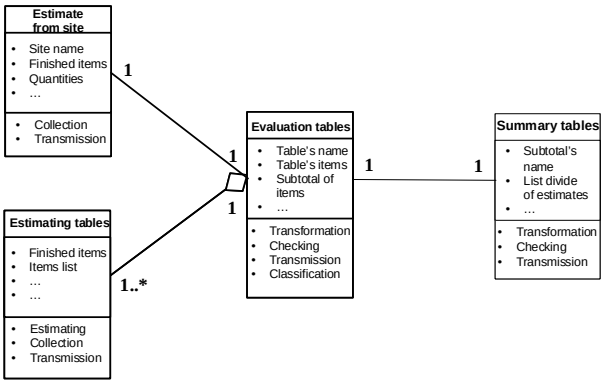

Figure 11. Database table of Use-Case

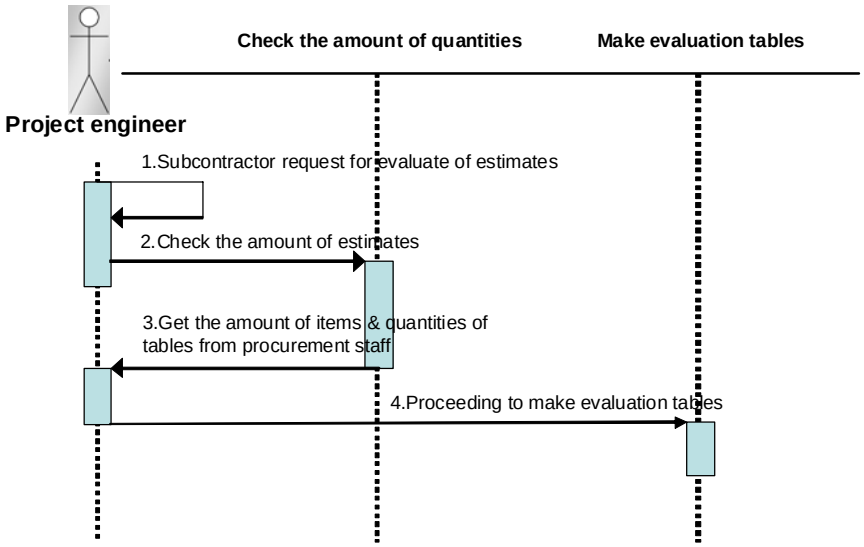

Figure 12. Sequence diagram

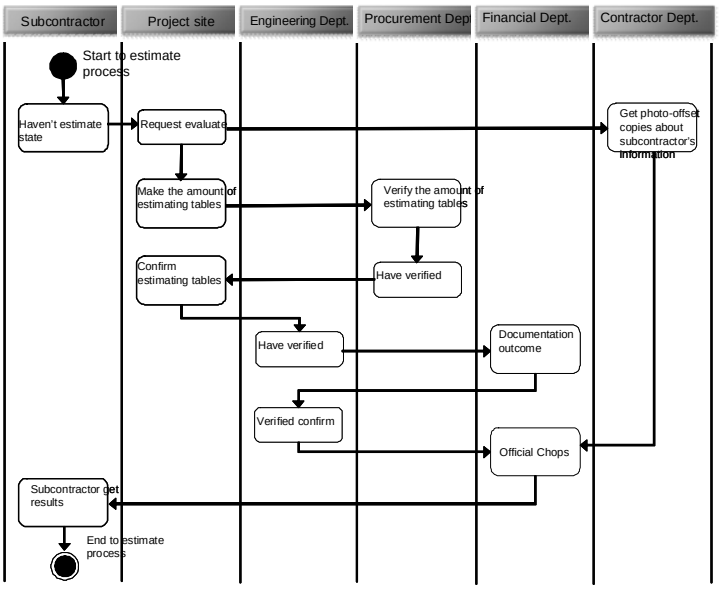

Figure 13. Activity module diagram

6 Conclusion

Enterprise implements ERP system almost failure as a result of existing a gap between processes conflicts and ERP system planners. The gap is that they don't understand the other side affairs each other. Method tried to solve this problem. Enterprise may apply this method for BIM implementation before ERP system implementation to make processes appropriately. Using UML model will help system planner transfer the result of BIM to ERP system implementation easily and effectively. In the future, a system may be developed according to this method to assist system planner for translating processes appropriately into system planning automatically by combining BIM and UML model.

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