DEVELOPMENT OF AN INFORMATION MODEL TO ENHANCE INTEGRATION AND COORDINATION IN THE CONSTRUCTION PROJECTS

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ABSTRACT: Construction is generally believed to be a fragmented industry and increased integration and coordination among different processes and parties is considered by many experts as one of the ways that can resolve most of the problems created by fragmentation. Process inefficiency and a lack of effective quality control in the products of construction are often attributed to fragmentation. The recent developments in information and communication technology (ICT) have provided an opportunity to increase the level of integration among different construction processes by improving the flow of information. This paper examines the possibilities of increasing integration in the construction industry by integrating the planning, design, and construction processes. In addition, an information model is proposed to integrate the different phases in the construction operations and to increase interaction among the stakeholders.

KEY WORDS: Construction, Information Technology, Coordination, Integration, Modeling

1. INTRODUCTION

The construction industry is highly fragmented as compared to other industries. This may have caused significant low productivity, cost and time overruns, conflicts and disputes, resulting in claims and time consuming litigation. (Latham 1994).

The fragmentation problem is further compounded by the fact that the construction process typically involves several disciplines, e.g. architects, structural engineers, building services (HVAC) engineers, quantity surveyors, contractors, sub-contractors, material suppliers etc., collaborating for relatively short periods in the design and construction of a facility. Until fairly recently, these disciplines tended to work independently, while making decisions that affect the others (Anumba, 2000).

Another facet of the fragmentation problem is the fact that the construction projects whether they be buildings, bridges, dams, or offshore structures usually involve many stages, starting from the establishment of the client's requirements through to design, construction, utilization and eventual disposal of the facility. These stages of the project's life cycle and the associated activities and tasks are often undertaken as discrete processes, with only limited integration of data/information, participants, tools and procedures etc (Anumba, 2000).

Some of the consequences of the fragmentation problem include (Amor and Anumba, 1999):

- Inadequate capture, structuring, prioritization and implementation of client needs.
- The fragmentation of design, fabrication and construction data, with data generated at one project not being readily re-used downstream.
- Lack of integration, coordination and collaboration between the various functional disciplines involved in the life-cycle aspects of the project.
- Lack of true life cycle analysis of projects (including costing, maintenance etc.).
- Poor communication and design intent and rationale, which leads to unwarranted design changes, unnecessary liability claims, increase

in design time and cost, and inadequate pre- and post-design specifications.

To achieve the benefits obtained from a good information system, it will be necessary to clarify:

- What information is needed, in which form and during which project stage?
- What decisions will be made and when?
- Who should contribute to these decisions?
- Who should communicate to whom?

The purpose of this research was to find the answers to these questions and present them in the form of a graphical model, which could integrate the different construction stages. A number of research projects have addressed aspects of integration among two or more stages in the building project life cycle. However, there are presently no integration models available that are applicable to the whole project life cycle from conception to demolition. Nevertheless the feasibility and desirability of fully integrated lifecycle models has been restricted to small models. There is a gap in research particularly into the development of appropriate integrated models for the planning, conceptual design, and demolition stages of the project lifecycle. An important challenge in lifecycle integration is ensuring that the models are consistent, persistent, and able to convey data as well as the underlying design intent and rationale. (Amor, 1999; Anumba, 2000).

Important opportunities for improving performance of engineering and construction projects may be obtained through the integration of planning, design, and construction phases. With the construction integration process, suppliers have a growing influence on the design, which results in designs that better fit the construction needs. This process has been defined as the continuous and interdisciplinary sharing of goals, knowledge, and information among all project participants (Gilbertus, 1997).

The recent efforts of rationalizing the industry reached the point to integrate planning, design, fabricating, and assembly process like manufacturing industry. The previously separated design information and construction process planning are combined and integrated as a big construction system. That conceptual progress is considered (Hasegawa, 2000) as the trigger of construction automation.

2. OBJECTIVES

The main objective of this paper is to present a model that integrates the project through the construction stages in a building. This is not a feasibility study nor is it a software architecture. The authors propose a framework for the flow of information between the different construction process participants. It is basically a logic diagram (Figures 1 and 2) that can be used to develop an architecture. These stages are clearly defined in previous works. For any building it is possible to identify four construction stages and one operation stage. The construction stages are defined as: (Eastman, 1993):

1. Feasibility study
2. Design
3. Construction planning
4. Construction

3. METHODOLOGY

The model has been improved during two years with the help of the Construction Management Program graduate students working in the construction industry. All of our graduate students are working full-time in the local construction industry in responsible managerial positions and have an average of over 10 years of experience in the construction industry. The authors believe their input is therefore, very relevant to real construction projects. The goal was to receive feedback from them that could help us to refine it. The following guidelines were included to help in the graduate students work.

1. All the parties will work on the product from the early stages up to the production stage like a team. The previously separated design information and construction process planning stages have to be combined and integrated as a fully integrated construction system.

2. The process will be changed interactively and according to the needs.

3. All the information should be in a standard format recognized by all the professionals.

The data flow diagram for each stage in a construction project is shown in Figure 1, and the interaction between the different parties is shown in figure 2. The data model exhaustively defines the construction project through its entire construction cycle. The data includes graphic representation in four dimensions, technical and cost calculations, scheduling, etc. The ultimate goal of this model is to form a software bridge between mathematical coding - the language that computers read - and the characters and pictures that human can see and understand.

4. MODEL DISCUSSION

The first stage in any construction project is the feasibility study. The feasibility study is the generator of the building model and thus influences the design and later stages. This stage also plans and sets goals at a general level for all the other stages. It defines the purposes of the building project and assesses if the resources are appropriately matched with the project scope. At this stage, the costs are balanced with the function of the building. The planning at this level of the building model often involves developing many different feasibility models and comparing them in different dimensions.

The design stage involves the translation of functional criteria developed in the feasibility stage into detailed descriptions of the building project, including the preparation of detailed drawings and specifications. The advantage of this model is that since all the parties are involved in this process, different design alternatives could be easily evaluated and the bets and optimized design can be selected,

In the construction planning stage the bidding, the impact on cost/schedule, and the construction plan are completed. The construction stage executes the construction plan. During this stage, if there is any change in the design or specifications, it could be easily incorporated by the consultation of the owner and the designer.

Due to the cheap availability of the information technology, this model could be easily converted into a software system, which can store and manage all the information. Such software could be coupled with the state-of-the-art web-based technologies. In this way, all the information will be available on-line and accessible to all the project parties regardless of time and space limitations.

5. CONCLUSIONS

A model to increase interaction among stakeholders in the construction process has been presented. The proposed model attempts to deal with all the involved parties from the onset of the project in a manner similar to a construction team. This is a great advantage for the project itself because all changes can be discussed among the different parts of the team before these have to be implemented. This is also very helpful to the management in making better decisions about any upgrade of the project. The model may also contribute to reducing the level of risks during the construction stage.

One effect of the construction integration process is that the suppliers will have more influence on the design process, which results in designs that better fit the construction needs. The recent efforts of rationalizing the industry has reached the stage where it is necessary to integrate planning, design, fabricating, and assembly process like the manufacturing industry. Managerial functions like engineering, management control, contract administration, and others, move towards the integration.

One limitation of this study could be that the feedback was generated only from graduate students. It is recommended that future studies could be expanded to include more diverse participants from the construction industry.

6. REFERENCES

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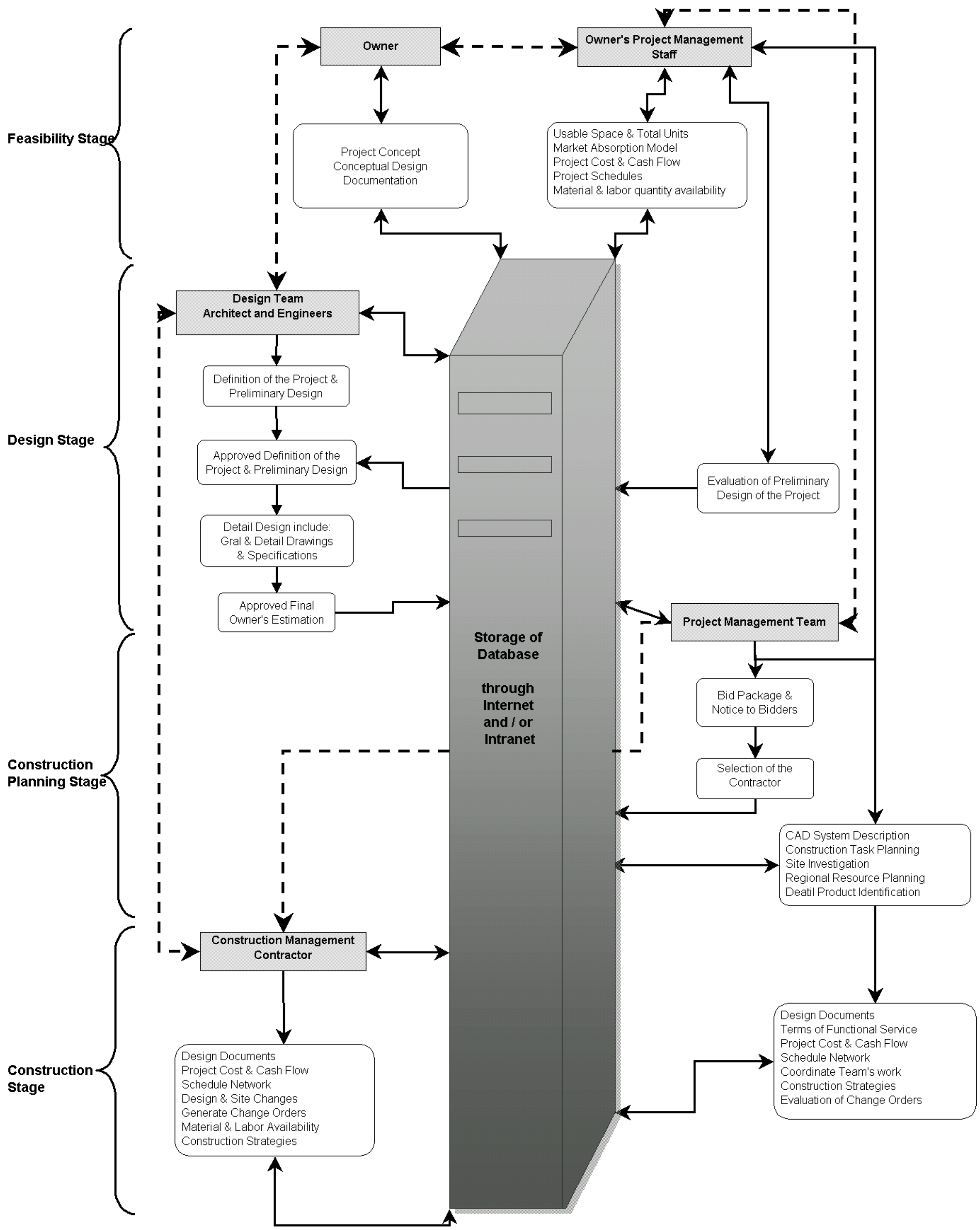


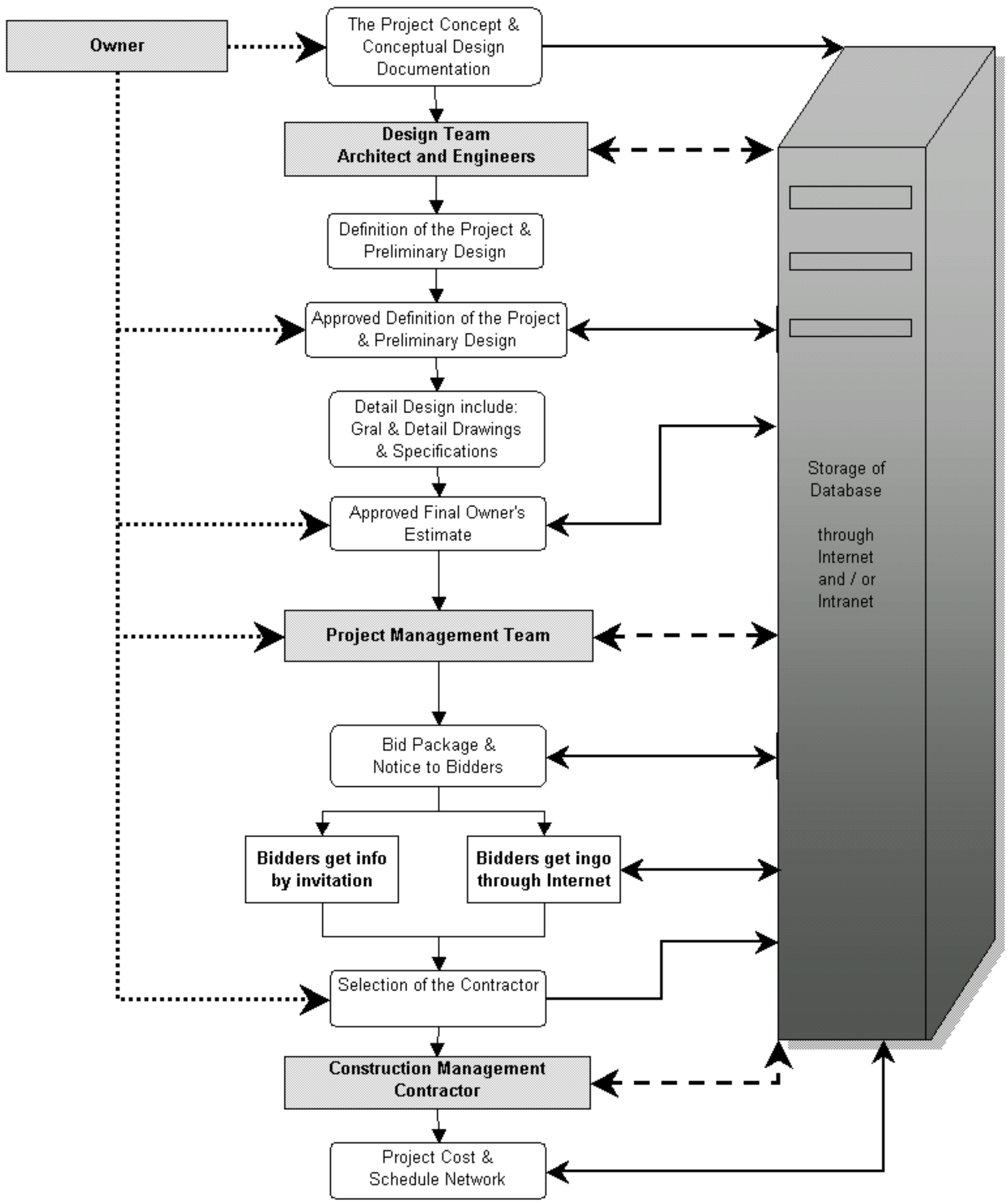
NOTES:

The dashed line represents the interaction between the parties.

The continuous line shows how the data is sent to or received from the database storage.

However, the interconnection between the processes take place in the database.

Figure 1. Data Flow Diagram for each Stage in a Construction Project



NOTE:
The direction of the arrows indicate how the information is flowing through the system.
The doted line represents the owner's actions through the server.
The dashed line indicates the interactions of the parties through the database.
The continuous line shows how the data is sent to or received from the database storage.
We can visualize the proposed management process by using a database storage on Internet and / or Intranet.
The information is available to any party at anytime. Therefore, it would benefit communication between the parties during the bid process.
Bidders can get information easily reglardless of where they are located.
In case of design changes, the Project Management Team can access information instanstaneously.
Because all parties involved have access to the same database, they have the same information source.

Figure 2. Interaction Between Parties