Unification as a standardization tool in the design of information systems and a unified project model: MITOS

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ABSTRACT: Building production process has a complex nature and fragmented structure due to the characteristics of project type productions, i.e., number of participants, various organizational patterns, multi-phased production etc. Some of the currently available information system solutions and models in both conceptual and practical dimensions try to provide an *integration* through the phases of building production process in terms of various management-related functions by integrating the components that correspond to these functions. Due to the fragmented structure stated above, research projects that focuses on *integration* in IS solutions are encouraged in construction industry. However integration is not the only tool to use for defragmentation; *unification*, which can be defined as the combination of more than one models into one unique model fulfilling the functions of each model combined, is another conceptual tool. This paper presents an *integrated* design of a *unified* information system, MITOS (**M**ulti-phase **I**ntegrated Au**to**mation **S**ystem for construction industry), and unification concept as a standardization tool in the design process of information system models.

1 INTRODUCTION

The idea of managing efficiently the functional components of a construction company or a design firm by means of computer applications is not new. Various studies that attempt to solve the integration problem can be located in the literature. Examples include reference or application models such as RATAS (Björk, 1994), SPACE (Underwood & Alshawi, 1997), I3CON (Brandon et al., 1994), COMMIT (Rezgui et al., 1998), COMBINE (Dubois et al., 1995), IRMA (Luiten et al., 1993), etc. The majority of the outputs of the stated projects are reference models.

There are also many efforts to develop standards at different levels for product, process, and project models. Industry Foundation Classes has been one of the main areas in standardization efforts for defining standardized data structures for the exchange of intelligent A/E/C-related objects among CAD systems. ISO STEP (10303) is another international standardization effort and is being developed by the ISO TC184/SC4 committee.

1.1 *Definition of the problem*

As always stated, construction industry has a fragmented structure due to its characteristics. Fragmentation is one of the main reasons of failures in construction projects. Efforts may have two dimensions; in *physical* dimension, some organizational patterns or strategic approaches, e.g., design/build or partnering, and in *virtual* dimension, integration of information systems may contribute to solution.

Information systems (IS) utilizing the facilities provided by information technology (IT) are used as tools to integrate the phases of building production process and to solve the problems that stems from the fragmented structure of construction industry. Integration may be achieved in *horizontal* or *vertical* direction. Horizontal integration deals with the management-related functions within organization and is based on intranet applications mostly. Vertical integration aims to establish relationships among the components of information systems used by various participants in the various phases of building production process. Due to the fragmented structure stated above, research projects that focuses on *integration* in IS solutions are encouraged in construction industry but integration is not the only tool to use for defragmentation. *Unification*, that can be defined as the combination of more than one models into one unique model fulfilling the functions of each model combined, is another conceptual tool.

Unification studies should be extended to IS models. This tool that must be considered and focused in development of IS models does not seem to receive the attention it deserves yet. In order to de-

termine the possibility of unification of models used in different phases of building production process, the similarity of the information organized in different models must be determined first.

1.2 *The aim of the study*

This paper presents a relational database model (MITOS) that tries to achieve *unification* along with *integration* in development of the information systems of different participants, i.e., architectural offices and construction firms undertaking the roles at different parts of building production process and unification concept as a standardization tool in the design process of information system models. If it can be seen that the architecture of any IS model for the construction industry allows to achieve *unification* of information systems of different type organizations in a fragmented industry such as construction, this would support and serve to the *standardization* efforts that contains *unifying* and s*implifying* (in the meaning of reducing the number of types of the entities) dimensions in terms of IS solutions for the industry. MITOS aims to show that in a relational database environment, *unification* is also possible beyond the integration of IS models.

Combining the models developed for these organizations that seems to be different at first sight regarding to their basic functions, i.e., *design* and *construction*, begins to make sense when the management-related functions in both type organizations and in both levels, i.e., *project* and *corporate* levels, are explored to be extremely similar with some minor exceptions. One of these approaches, i.e., *integration* and *unification* for the architecture of basic components of an automation system may be preferable in certain organizational patterns.

Integration between these components is a common solution. What is new here is not *integration* but *unification* that means *combination* of the components into a unique model. Thus, same sort of information is possible to be recorded in one relational database object (table) instead of two, for *design* and *construction projects,* and the same computational models or processes and the same interfaces can be used by different functional modules.

2 MITOS - MULTI-PHASE INTEGRATED AUTOMATION SYSTEM

MITOS - **M**ulti-phase **I**ntegrated Au**to**mation **S**ystem for Construction Industry was designed for solving the problem stated above especially in design/build organizations that allows unifying the information systems of the design and construction groups. The initial structure of the model that suggests integration of the components is given in Figure 1. The basic components of **MITOS** are:

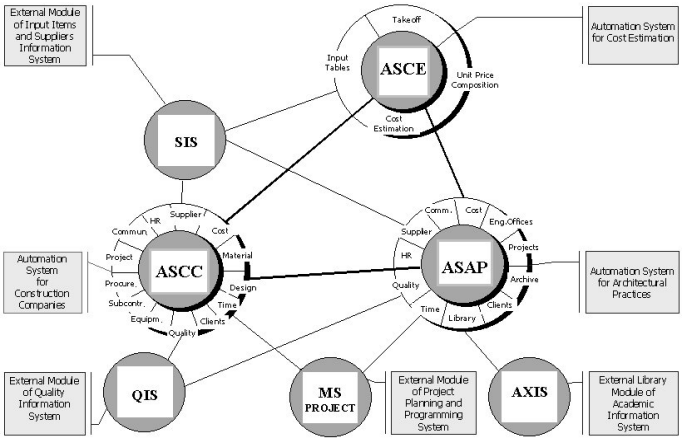

Figure 1 Initial conceptual structure of MITOS (integration of components)

- ASAP - **A**utomation **S**ystem for **A**rchitectural **P**ractices (Kanoglu & Arditi, 2001).
- ASCC - **A**utomation **S**ystem for **Co**nstruction **C**ompanies (Kanoglu, 1999)
- ASCE - **A**utomation **S**ystem for **C**ost **E**stimation (Kanoglu, 2000)

3 UNIFICATION AS A STANDARDIZATION TOOL AND MITOS

Integration efforts focus on standardization of the *form* of information. Whereas, unification tries to find uniformity in the *content* of information needed by different functions, modules or organizations to reduce the number of the objects in IS and thus to simplify the structure of the IS model.

In most cases it is obviously seen that the professionals in construction industry do not know enough about the production processes in other industries. They mostly have an *impression* and *prejudices* that construction is the subject of a highly specialized production and there is no similarity or uniformity between the functions of the organizations in various industries.

This sort of impressions and prejudices effects the design of the IS solutions directly since these professionals are expected to describe the characteristics of the functional components of the information system in their organizations at the system analysis stage of IS development process. Whereas, IS professionals may have the look of the persons who knows about various industries and can foreseen the uniformity.

3.1 *Unification of database functions of different type of organizations*

As it can be seen in Figure 1, the initial structure of the conceptual model of MITOS was containing basically three integrated components at the beginning of development studies. Through the development process it was explored that the functional modules in ASCC that does not exist in ASAP can also be

used by ASAP and the models developed for the architectural offices (ASAP) and construction companies (ASCC) may have almost the same internal modules to organize the same sort of information; so they can be *combined* into one unique model that provides *unification* with minor changes and additions in detail.

Although this sort of exceptions makes it difficult to use the same database objects and to *simplify* and *unify* the structure of combined model, most of the functions that exist in both models match each other. For example, ASAP contains *Engineering Offices Module* to organize the information related to engineering offices undertaking design of various subsystems of projects. As for ASCC, *Subcontractor Module* is one of the basic modules in the model. These two modules are completely similar to each other since engineering offices (consultancy firms) can be accepted as subcontractors of design projects. These two models were combined into one unique model as it can be seen in Figure 2.

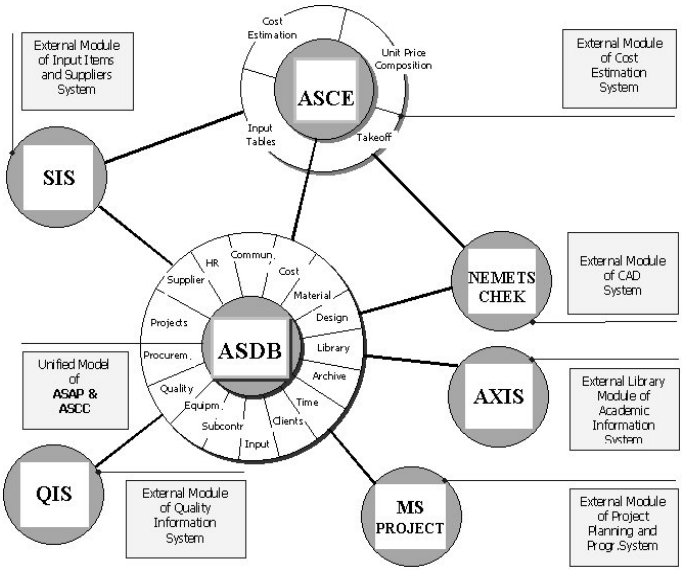

Figure 2 Revised conceptual structure of MITOS (integration and unification of components)

3.2 *Unification of database objects*

The exceptions of some functions of architectural offices and construction firms makes it difficult to use the same database objects and to *simplify* and *unify* the structure of combined model, since most of the functions that exist in both models match each other, the same database objects (tables, queries, forms, reports, macros) can be used to save the same information for different type of projects, i.e., *design* or *construction projects* with few exceptions.

Information related to the tasks in an architectural office is thought to be different from the information of the tasks at the construction site at first sight. However, they both include the production items and can be thought as the take off lists.

Although integration provides facilities of electronic data flow and exchange, it carries the fragmented structure of construction industry to IS solutions. Thus the users of the information system face to hundreds of screens because of unnecessary duplication. Whereas it is possible to reduce the number of screens (forms) and reports at least by half and remove the resistance of personnel to IS that stems from the complexity of IS and volume of procedures to be learned. Reduction of the numbers of database objects will also contribute to diminish the complexity of the reference models.

In addition to unification of IS models, the architecture of the unified model should also be taken into consideration to minimize the number of interfaces and simplify the transitions among them. MITOS tries to achieve this by suggesting a simplified structure for the transitions that is too easy to learn and impossible to get lost in details. The structure of the system are given in the EXPRESS G model in Figure 3. As it can be seen in figure, the modules are grouped into three sequential levels. The modules at the third level can be accessed by one, two or three steps. Second level modules are reached by one or two steps. First level modules can be accessed directly by one step. In each transition, selected entities such as project, personnel, equipment, material, supplier, subcontractor, etc., and their unique IDs are transmitted automatically to the succeeding modules as filter parameters.

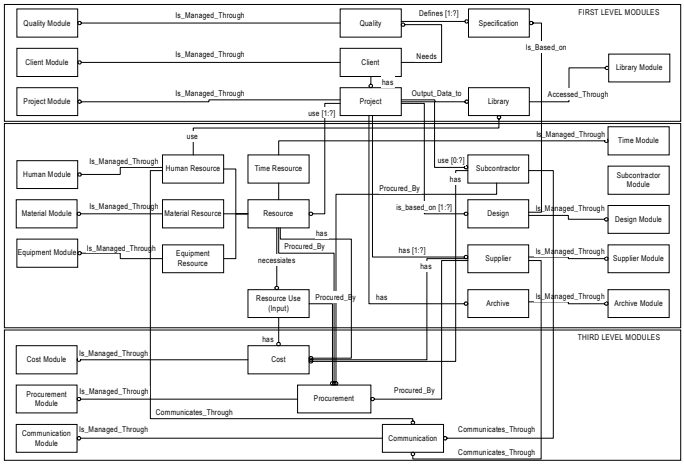

Figure 3 EXPRESS G model of MITOS

3.3 *Unification of computational models*

Unification can also be achieved in terms of some computational processes or algorithms that are needed by different functions in the information system. Use of the same procedures, methods or computational models for different functions is another tool for *unification* at a different level. As an example, the conceptual structure of the procedure of *performance-based cost estimating system* can also be used for the *performance-based duration estimation*

in MITOS. The module and its integration with the other modules are explained in detail in another study (Kanoglu, 2000).

Figure 4 shows how these two functions and computational processes are unified by using the same computational model. The Use Case diagram related to the unified process of cost and duration estimation can be seen in Figure 5.

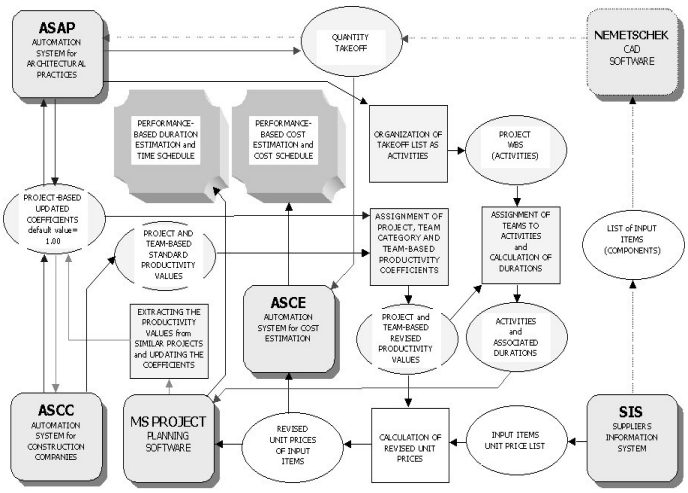

Figure 4 Unified structure of the computational model of cost and duration estimation

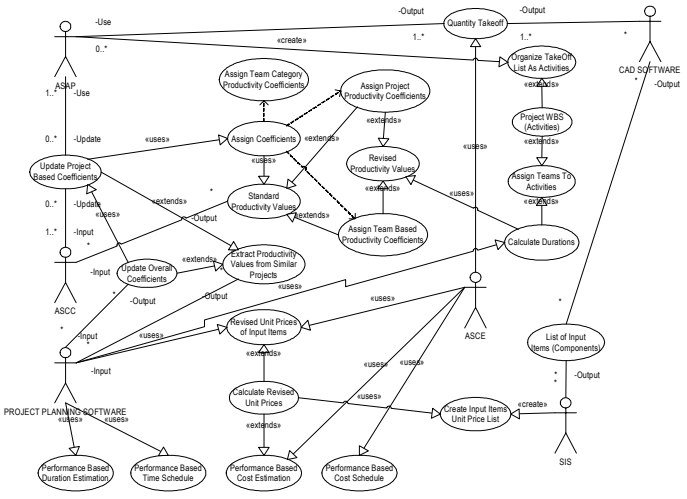

Figure 5 Use Case diagram showing the unified structure of cost and duration estimation model in MITOS

4 CONCLUSIONS

This study and model (MITOS) developed in this research projects shows that the functional components of information systems of architectural offices and construction companies have remarkable uniformity to consider in the design process of an information systems. It is obvious that reducing the number of the objects by considering the uniformity of the functions in an information system helps the standardization efforts. Integration efforts for development of information systems of various types of organizations in construction industry should be supported by other standardization tools such as unification.

5 ACKNOWLEDGEMENTS

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