

# A Study on the Requirement Information Management Model and Process Linked to Space Planning in the Early Design Stage

Jae Ho, Cho<sup>1</sup>, Sang Woo, Kim<sup>2</sup>, Bo Sik, Son<sup>3</sup> and Jae Youl, Chun<sup>4</sup>

<sup>1</sup> Post-Doc, Department of Architectural Engineering, School of Architecture, Dankook University, Korea

<sup>2</sup> Master's course, Department of Architectural Engineering, School of Architecture, Dankook University, Korea

<sup>3</sup> Professor, Department of Architectural Engineering, Namseoul University, Korea

<sup>4</sup> Professor, Department of Architectural Engineering, School of Architecture, Dankook University, Korea

Correspond to [jaeyoul@dankook.ac.kr](mailto:jaeyoul@dankook.ac.kr)

**ABSTRACT:** The purpose of this research is to develop the technology to meet the requirements of the design content, and to build a 'Requirement Information Management Model' for the design project. The model that should be used in the early design stage will undergo the following process: First, basic requirements would be defined by extracting the design content in the form of a reusable library of space units. At the next stage, requirement information should be modified after considering unique characteristics for the project and conflict problems between function and performance.

*Keywords: requirements, design change, customizing, space unit planning*

## 1. Backgrounds and Purpose of the Study

In advanced countries, importance of 'Pre-Design Services' in early design stage (schematic design, design development) has increasingly been emphasized, but the current design technology base is still insufficient to support this change.

In the early design stage, the process in setting the system 'type' of facilities, including schematic structure design, building envelop, energy, HVAC, lighting, and vertical circulation, is included in addition to the conceptual design. 'Facility Composer' and 'Trelligence' are software that are utilized in the early design stage in other countries, but none of these programs have offered features that manage or integrate a broad range of information required in the early stage.

Despite the presence of various kinds of quality management systems, it is difficult to maintain commissioning<sup>1</sup> for the design solutions and requirement information between clients, designers, and engineers, especially in the event of design changes. The main cause arises from discontinuous connection problems in

requirement information and design solutions, and the discontinuity in design process leads to the occurrence of waste factors, such as design changes, rework, and design errors in the design work.

In this regard, this study attempted to present technical solutions for the connection between requirement information and design solutions(alternatives) in the 'pre-design' process. The 'pre-design' can be defined as a process of supporting collaborative design to discuss major decisions in advance and solve interference problems by sharing requirement information on functions and performance with project stakeholder. Thus, this study presents the concept of design content library on 'space planning unit' and proposes its efficient management process.

## 2. Research Methods

This study seeks technical solutions on issues regarding the definition of requirement information and linkages with design alternatives by investigating the current status of domestic and international research. In addition, the direction of the requirement information library based on space planning unit will be established by identifying the technical problems and limitations of existing studies, and based on this, a management process is finally proposed.

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1) Commissioning is a process of verifying that the operational maintenance is possible so that each system can exert the performance that meets the design intent. Performance verification starts from the planning stage, and it can be applied to each stage of the design process, construction, and trial operation. (U.S. Refrigeration and Air Conditioning Engineers Association, ASHRAE Guideline 1-1996)

### 3. Status of Existing Domestic Research

The matter of client requirements is a critical factor in determining the direction of the design guideline and its functionality. To fully reflect client requirements in the design works, a clear understanding and definition on the requirements must be supported in the early design process. The requirements from clients have not been adequately reflected on the design solutions due to a vague and subjective description specified in the design criteria. Until now, numerous studies have proposed various solutions and frameworks to connect client requirements with design objectives, focusing on the process to define, classification, and manage the requirements systematically. However, insightful research in systematizing the requirements to convert into 'requirement information' is lacking in Korea. In addition, an empirical model that can be applied in BIM(Building Information Model)-based design processes must be formulated.

#### A. <Representative research practice-1>

In response to the trends in information oriented construction management, basic studies on design management have been conducted to prevent design changes and reduce waste factors in the domestic lean construction research (2006 through 2009).<sup>2</sup> In this research, a basic information model of design management, in which a lean concept is applied, was proposed, and a 'system prototype on client requirements' was presented, targeting design objects as a case study. In this research, client requirement information is managed at the level of detail design objects (entities).

#### B. <Representative research practice-2>

As a basic research to achieve information technology innovation in the domestic construction sector, a study on collaborative design was conducted by Jeon Jun-gi (2008). Based on the major achievements of this study, client requirements were shared through narrative-style document information system, which has been utilized in the design phase. A follow-up study must be conducted to convert the narrative-style document information into specific requirement information for design subject.

#### C. <Representative research practice-3>

In Yoo Seung-yeon's (2008) research, the information management system model for the systematic management of client requirements was proposed. Its main contents include the deduction of direction on ordering guidelines through analysis of the client's order

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2) Development of web-based distributed lean construction information system (2006, 4 consecutive years of the project): Development of design and optimization technology, completed in 2009, Ministry of Land, Transport, and Maritime Affairs.

environment at home and abroad. As an improvement direction, a method of documenting the requirements was suggested. Through this method, mutual information documentation based on the categorized items of 'design requirements' and 'revised content of requirements' is shared. The method of materializing the requirements allows clients, whose ordering capacities and experiences are lacking, to set new requirements by using the specific cases of design guideline. However, the methodology used in materializing the initial requirements into requirement information was not suggested even in this research.

### 4. Overseas Research Status

In overseas cases, the CCT (Change Control Tool)<sup>3</sup> model was suggested that it is connecting client requirements with design objects. This is the object-based computational concept that is connections between requirements and the space program as well as design products. It could be utilized in the business of design changes. These researches are more systematized compared to the results of domestic research, but prototype models must be developed by connecting them with real project practices to be applicable in domestic conditions. In foreign countries, research on the integration of design information and information interface have been widely carried out, and active research activities have been performed to develop knowledge representation/extraction information models by using 3D object-oriented approach, semantic approach, ontology approach, EXPRESS-G, etc.

#### A. <Representative research practice-1>

As an information model for the management of design changes, the CCT model is a conceptual, computerized model designed to solve problems automatically by delivering revised information to participants concerned in advance. The change control tool CCT will identify implications of a change as soon as it is proposed. The tool will ensure that the stakeholders involved in the decision process in which change proposals are evaluated will know in advance if a change could cause the project to stray from its original goals, as expressed in the requirements. The proposed CCT uses the building program as a link between client requirements and the building design and traces the different relationships that exist between the requirements in the project. The relationships are traced using requirement traceability capabilities on the level of a specific space in the project and on the level of the entire project. From this relationship, the performance of system is determined by how effectively and clearly the requirements information is defined in the entire project and specific areas.(See [Figure-1])

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3) Shabtai Isaac (2008) proposed the CCT (Change Control Tool) model to cope with design changes effectively.

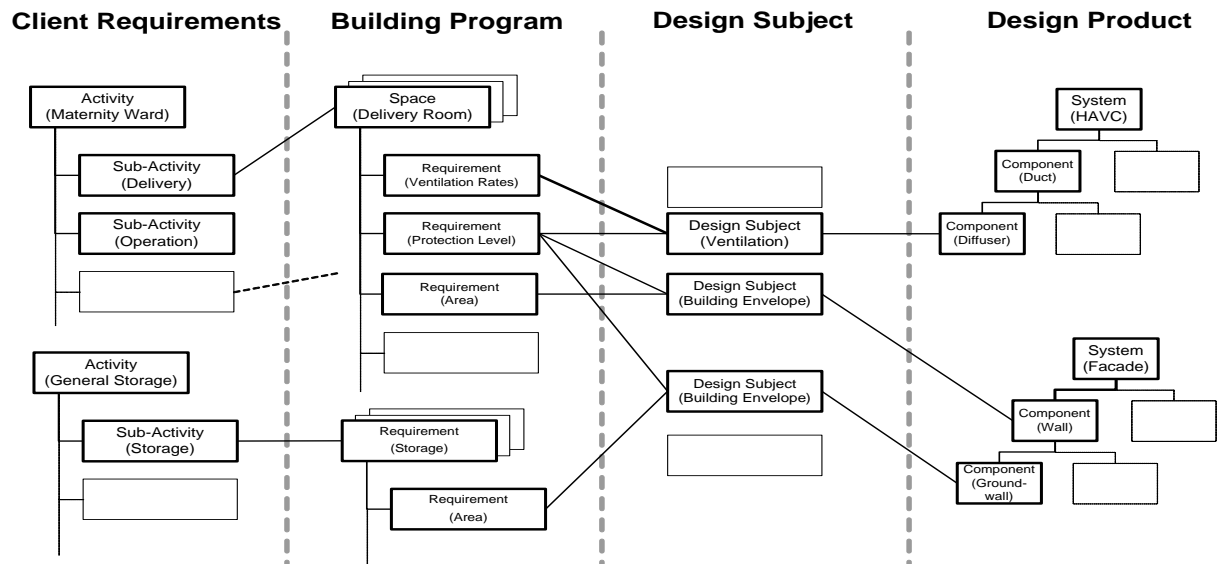


Figure-1. The concepts of CCT (Change Control Tool) and connection with design product (Shabtai Isaac(2008))

## 5. Suggestion of Improvement Direction

The specified requirement information plays a role on design guidelines for designers in the subsequent design stages, and helps them to make decisions on various design alternatives. The performance requirements of the design collectively consider performance conditions, such as electricity, interior design, and equipment for related systems, starting from predicting the performance of the space unit and the area of the space required. Accordingly, to represent the design performance, the conditions related to the performance required by the space unit must be preferentially clarified, and systematic information management on various performance specifications is required in the applicable space unit.

In a related focus, this study attempted to connect segmented information between space programming and design product through the construction of a space library as a method to improve requirement information management of the client's narrative-style requirements. The operating process is described as follows.

To generate basic requirement information, the requirement information library of the building zone type unit, story type unit, and room type unit must be constructed for recycling in the 'pre-design' phase, through which designers and clients can predict the performance of the corresponding space in new project.

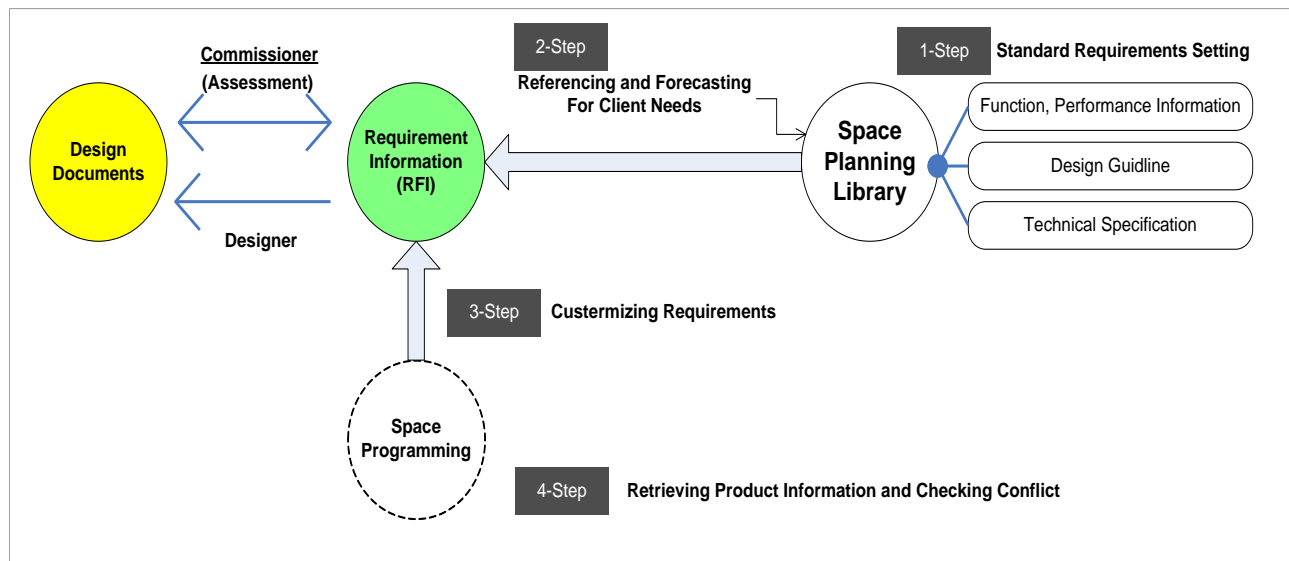


Figure-2. The management process model on the requirements information at the level of space unit (content suggested in this study)

As the first step, users select the initial type from the space library, and generate basic requirement information. Then, the information is assigned to a space program of the project. (See Step 1, Step 2, and Step 3 of [Figure -2].)

As the second step, the completed requirement information is used primarily as the basic design guidelines for design work, and it is re-modified in consideration of the characteristics of the user needs and the new project. In the event of changes in requirements by the clients, the performance, and the specifications, interference problems with adjacent systems can be identified early. (See Step 4 and Step 5 of [Figure -2].)

## 5. Conclusion

In this study, the process model and the requirement information model on client requirements were proposed. The technical solution in converting the clients' narrative-style requirements into requirement information and connecting it with the design product directly and indirectly was also suggested.

A conceptual model that could utilize requirements as specified requirement information in the early design stage by constructing a knowledge-form library in the space planning unit was proposed. With the space library, basic requirement information can be defined, and it is possible to update it through customizing<sup>4</sup> the requirement information in consideration of the unique characteristics of the new project. In the event of changes in client requirements, the detailed requirement information can be redefined, and interference problems with adjacent systems can be identified in advance by direct or indirect changes in the design product.

In this performance approach of space unit, the requirement information model in the form of a library is expected to carry out the 'pre-design' services of the designers effectively through a connection with space programming in the early design stage. In addition, it can be used to support design changes efficiently, and review in advance design defects resulting from design errors and interference problems. In a follow-up study, the system concept of computerization that can be implemented through a case model needs to be suggested.

## 6. Acknowledgement

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4) It refers to a kind of customization service provided by manufacturers and craftsmen who manufacture products according to the requirements of customers. The term is derived from the word, 'customize,' meaning 'made to order.' Recently, its meaning has been expanded to include sales through redesign and reconfiguration of products to meet the needs of customers.

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