

# APPLYING LEAN CONSTRUCTION TO DESIGN PHASE

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**ABSTRACT** : The design phase has a great influence on the success of subsequent phases in the project which can be connected with the success of the overall project. Several studies have focused on the effective design management. However, it is too complicated and difficult to manage the design process for the reason that it has a lot of participants and design information and consists of thousands of decisions by an architect alone. Accordingly, it is the main issue for the success of the project how well the design phase be organized and managed. In recent, even in domestic, the importance of design phase has begun to be referred in the conferences. Lean Construction also has a close look at those issues and makes ready to apply specific management methods, called to Lean Design & Construction. Managers can consider a variety of uncertainties to be under control through making the overall process effectively from the early stage. By establishing the efficient process from the design phase before the construction phase, managers can result in a desirable productivity. The aim of this study is to bring the concept (Lean Design & Construction) in domestic design circumstances and verifies the possibility how to apply the concept to the design phase.

*Key words* : Waste, Productivity, Lean design & construction

## 1. INTRODUCTION

### 1.1 Introduction

In the construction project, the design phase can be regarded as the most important process because of the fact that the process not only has a lot of participants who are in charge with the project and provide the technical supports, but needs to carry out with considerable interaction between the designers and contractors. In actuality, however, only little interaction between the design information and communication with contractors is one of main problems which obstruct the progress in the project. In addition, the facts mentioned may cause many problems during the period of the project such as change orders, omission, incomplete designs, and construction delays which can be defined as waste factors. Although several studies in domestic has focused on establishing the design process after recognizing that the design phase have to be under effective control, they have approached with only design information which is meant to identify respective characters in design, and then choose the most proper alternatives in order to prevent the losses caused by waste. However, the flow management in design phase has to be achieved by focusing on the customer's requirements and reducing waste factors. In other words, on the TFV(Transformation-Flow-Value)<sup>1</sup> view, the

design process accommodating customer's values throughout all the project phases and reflecting the specificities in nature that the design phase has needs to be developed.

The main purpose in this study is to suggest LDMP(Lean Design Management Process) based on lean construction principles and consider distinctive features in the design step.

### 1.2 Research Methodology

For applying the concept of lean construction in design phase, it is necessary to turn out the main non-value adding factors to affect the design. Such main factors may decrease construction productivity during the project; therefore they must be identified as waste that should be eliminated. Especially, in the LDMP model, those factors are the main elements to control the process efficiently.

(1) Identifying the main non-value adding factors in design process by taking a look on the studies published in foreign and domestic.

(2) Setting up the direction to manage those waste factors in the design process based on lean construction.

(3) Suggesting LDMP model to resolve problems caused by a current ineffective process in design phase

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<sup>1</sup> TFV(Transformation-Flow-Value) : one of two major lines of thinking to govern the work on lean construction. This concept belongs to the way

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to consider the overall project as a flow production system.

## 2. LITERAL REVIEW ABOUT LEAN CONSTRUCTION

### 2.1 Design Process and TFV Concept

In the construction project, the design phase has traditionally thought of as a single stage to develop a creative idea from nothing. However, the design phase in lean tends to be the essential and considerable step to decide the design quality. According to the lean principles, distinctive features in design phase are described as below.

#### (1) Transformation

The design phase can be divided into subsequent activities respectively and independently, and there are several participants who are willing to resolve problems in their particular way. Therefore, requirements obtained from customers are able to be omitted, which might be in the non-value adding categories.

In addition, there are various types of waste factors like insufficient information caused by the lack of communication among the involved parties, the time to figure out design defects, and rework that must be separated from the iterative activities that occur in the progress to choose alternatives.

#### (2) Flow

Design is considered as a flow of materials and information. Especially, Information is the main key which should be under control. Through delivering the right information at the right time, waste will be reduced, and the process can achieve the reliability in work.

#### (3) Value

In order to bring out the value into design process as a whole, as considering from two points of view, the first one is to attain the value from customers which should be on either the checklist or tools used in lean construction specially during initial stages.

Secondly, the work conditions for the design teams can generate value. Even if all necessary information and resources are provided on time, value generation can't be taken unless barriers to obstacle creative work are eliminated and managed properly.

**Table 1.** Transformation, Flow, Value in the Design

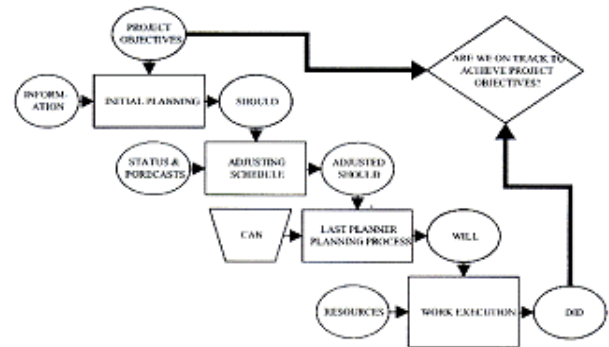
	Transformation	Flow	Value
<b>Definition</b>	Transfer input	A flow of materials and information	Requirements from customers
<b>Goal</b>	Pull Schedule	Minimize unnecessary activities	Fulfill requirements
<b>Principle</b>	-Detailed planning -Structural dismantling	-Reduce work time -decouple redo -Achieve the reliability of work flow	Analyze conditions Coming out the proper alternatives
<b>Tool</b>	WBS CPM ORC	Design Structure Matrix Team Approach	Q.F.D Requirements Management

### 2.2 Last Planner System

The Last Planner System, which consists of 4 levels of Master Schedule, Phase Schedule, Lookahead Plan, and Weekly Work Plan, is one of the methods related to lean construction in order to build up the management planning process in design. Uncertainties (defined as waste factors) can be minimized from the initial stage in design process. The quality criteria of Last Planner allocated to individual activity are represented below.

- (1) Definition : Consider about whether executing the tasks assigned or not
- (2) Soundness : Prepare workable backlog including the contents such as information for the assignment, manpower, and tool and methods before the task starts up
- (3) Sequence : decide the systemic priority in design process in order not to overuse manpower and resources which may cause the interference among activities.
- (4) Size : determine the proper amount of tasks according to the productivity of each crew. That can be evaluated with the form of PPC after completing the activity.

Figure 1 shows the basic concept of Last Planner.



**Figure 1.** Process of Last Planner System

## 3. HOW TO APPLY LEAN CONSTRUCTION TO THE DESIGN PHASE

### 3.1 Identify Non-value Adding Factors in Design

When realizing that, in the design, the flow management needs to be performed on the sequent and detailed information and the value from customers is added to the product, it is inevitable to identify non-value adding activities by researching several papers in foreign and domestic. In both research, the most common design defects are turned out, and that are inconsistencies in design documents, errors and omissions made by crews, lack of communication with special participants like technical experts and construction managers, and change orders and whatnot. However, as compared to the design defects in foreign, the different thing is the fact that the design process in domestic tend to enforce the alternative stage rather than make an efficient and standard process planning.

As a result, those problems caused by discrepancy (lack of

communication) between architecture team and engineer team or change order in construction phase (it usually occur a claim because there is no way to verify who are going to be in charge with, and also no time to check and amend design documents (including drawing and estimation sheet)

According to the fact proved in this research, the LDMP is going to have 3 main control elements (information, verification, communication)

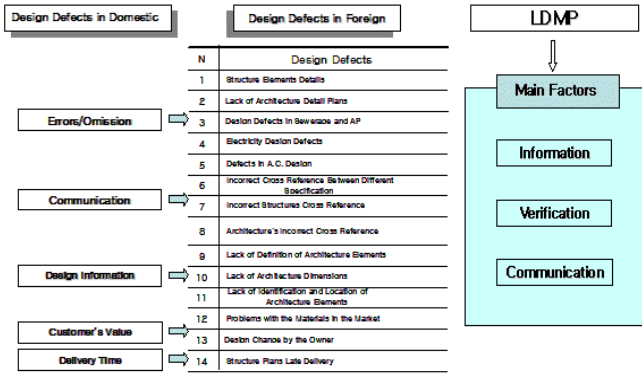


Figure 2. Identification of Design Defects

3.2 LDMP Model

The LDMP model is the flow process to emphasis work reliability during the period of the project, and there are 4 steps to get through with three control factors (information, verification, communication). The next part will explain the direction and methods applied in the LDMP model.

1) Investigation the value of customers and objectives of the project.

By interviewing face-to-face or using survey like QFD matrix, it is possible to confirm the purpose and value in the project. The most important thing is to be able to encourage participation from other specialties and write down that valid information on the standard document in concurrence with keeping the straight focus until the end of the project like a checklist

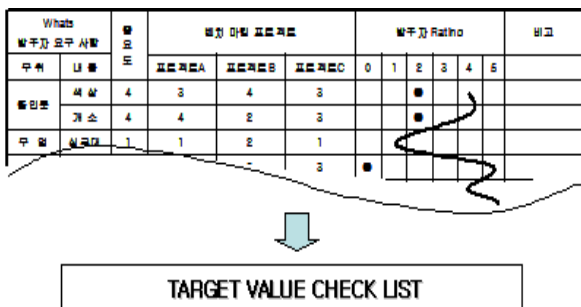


Figure 3. WHATS(QFD Matrix)

2) Rearranging activities in design process – Adept  
In order to improve the planning and management of the

design process, not using traditional way to put in sequence, design activities will be arranged into the way to alleviate the uncertainty and waste caused by insufficient information or incomplete work.

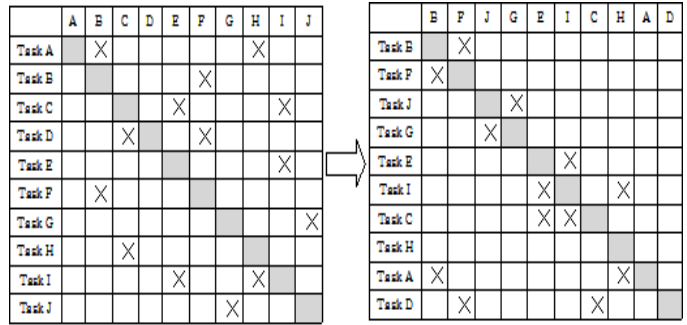


Figure 4. Rearrangement of design activities

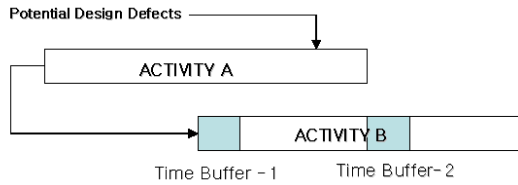
3) Last Planner Process

The Last Planner System gives the opportunity to make the design process become detailed and efficient with the decentralized and collaborative structure. As getting through four level planning like Master Schedule, Lookahead Planning, Workable Backlog, and Weekly Work Plan, the whole process can be proactive not reactive because, in advance, potential waste factors are able to be decoupled by generating "make ready" work.

Figure 5. Last Planner Sheet

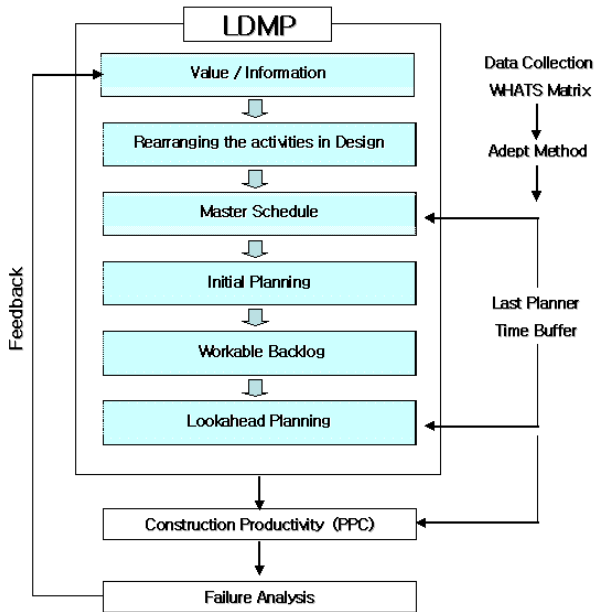
4) Time Buffer for verification

As described before, one of the design defects is late discovery of hidden defects which can generate more serious impact on related work and subsequent activity. In this case, time buffer placed between activities can help prevent this problem before the following activity is executed.



**Figure 6.** Settlement of Time Buffer in Schedule

Figure 7 describes the several steps. Among those steps, the most important stage is the last stage to evaluate the performance based on the construction productivity index, and then perform failure analysis which can provide the additional information through the feedback.



**Figure 7.** LDMP Scheme Draft

#### 4. CONCLUSION

Even on the view of lean construction, design phase is not a single stage to create tangible things from blank sheets but very complicated and difficult to manage; however, if building up detailed planning and management, the whole design process can be improved because non-value adding factors (called waste) more than 50% are controlled. The following is the conclusion drawn from this study.

- (1) After researching and analyzing design defects in domestic and foreign, be able to get three main control factors (Information, Verification, Communication)
- (2) Based on this research, suggest the direction how to employ lean construction in design and the basic LDMP model.
- (3) Through this model, be expected to recover the work reliability as a flow management, minimize non-value adding factors (can be defined as waste), and collaborate with other participants.

Even though putting this LDMP model into the practice at this study, anticipated benefits resulted from operating the

systemic management process in design are below;

- ① The communication among participants in design can be improved, which can also pull out full collaboration through the whole project.
- ② The work activities structured by detailed and effective the management process (LDMP model) can accomplish the reliability which protect overlap between work activities and trades, and also can take off inconsistent works from the work-in-progress (Pull Schedule)
- ③ By reducing waste (non-value adding activities), the desirable productivity which managers want to achieve can be under the control.

Unfortunately, due to the limited recognitions of lean construction in domestic, this study only provides a frame work how to apply the principles and concepts of lean construction in design phase. In the near future, the LDMP model will be assessed with empirical case studies through the project issued by the Ministry of Construction and Transportation.

#### ACKNOWLEDGMENT

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