

## Improvement and progress of Construction Management by employing Last Planner System in Malaysia

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### Abstract

*Assessing the efficacy of executing the Last Planar System is the goal of present investigation to boost and promote construction planning as well as site administration in the Malaysia construction sector. The Diction investigation process was applied to carryout LPS in two huge public construction planning and projects. Related Data were gathered based on observations, interviews and questionnaire. Advantages such as enhanced site management improved construction planning and better communication and coordination among the parties involved were identified in this research. The main and major success factors in Last Planar System execution were explained in it. Constraints in the way of using of last planar system were underlined in the related paper. The present paper work is encircled to two case studies. This research investigation enhances and improves management and develops a base for more research on construction field. Results can support practitioners in executing varied management methods and underlines advantages, opportunities and challenges. Practical suggestions will be given to help reaching full potential of lean and Last Planar System in the country Malaysia. The present study engages with the use of lean construction techniques in Malaysia construction industry. Present study has roles in the area of lean construction and helps companies and organizations to outline a fresh strategy and enhance and improve their administrative process and actions. Results can be applied as a reference for progressing management.*

**Keywords:** Construction planning; Last Planner System, Last Planar System

### Introduction

Despite this belief that construction management has many problems, descriptive and explanatory research in this field cannot solve the managerial problems (Koskela, 2008). Delay is a common problem in construction projects. Studied literature about delay in construction projects in Malaysia and found that factors of delay are common in most studies but their importance is different. Delay stems from two factors: management and project environment. Managerial factors are ineffective planning and control, poor site management, poor communication between the parties involved and unreliable availability of materials. According to authors, these factors can be controlled and their impact should be minimized. Conversely, environmental factors relate to economy and financial institutions in a developing country which is external factors. In order to promote performance; influence of delay causes should be minimized. But this control is possible with better management practice.

Application of lean construction is an action with direct effects. Lean construction has developed as a new method for efficient management of construction since 1990s. Various techniques have been used to enhance project management through eliminating

waste, improving planning efficiency and reliability, improving productivity and maximizing value (Ballard et al., 2002).

Last Planner System (LPS) is a well-known construction method and useful instrument for managing construction processes (Ballard and Howell, 2003). This method has been tested and revised with numerous advantages. Fiallo and Revelo (2002) reports LPS implementation in Equator; Johansen and Porter (2003) in the UK; Thomassen et al. (2003) in Denmark; Koskenvesa and Koskela (2005) in Finland; Kim and Yang (2005) and Lim et al. (2006) in Korea; Alarcón et al. (2008) in Chile; and Junior et al. (1998) and Formoso and Moura (2009) in Brazil.

But literature shows no sign of practical applications within Malaysia. This study deals with the application of existing principles (LPS) in a different working environment. This study aims to improve performance management by practical attempts. The LPS was tested to examine the utility of the technique in improving planning practice, thus enhancing management practice.

The organization of this paper is as follows: literature of LPS is reviewed and action research method was used in this research. Strategy of conducting LPS in public projects was studied. Discussion and conclusions are offered.

### **Literature review**

Responsible individual or group for production unit control is the "Last Planner" which means completion of work at the operational level (Ballard, 1994). LPS develops collective management to ensure program coordination, planning and delivery. It improves prediction of project delivery time (Ballard, 2000). This system enhances reliability in 3 ways: future planning and prepared plan by ensuring that materials, information and equipment are available; filtering activities to ensure their timely completion; commitment of team's leaders to work. Based on Ballard and Howell (1994), focus of this model is on qualitative features of plans and selecting right work consequence and time and individuals.

LPs has consisted of 5 elements: master planning, phase planning, future planning, and weekly work planning; percent plan complete (PPC) and analysis of reasons for incomplete assignments. These elements have great for construction planning (Howell, 2003).

Many projects in different countries have been done using LPS since 1992. Reports have verified that this method makes significant progress in control, reliability, safety and etc and has decreased projects' cost and time (Kim and Yang, 2005).

It has proven as a robust instrument for managing and planning construction by different trials. Johansen and Porter (2003) studied the application of LPS in the UK and found that LPS added value by structuring the planning process. In their study, engaging many subcontractors was considered part that industry's culture which creates problems. In Chile, Alarcón et al. (2008) acknowledged that the benefits of LPS include improvements in management and control, enhancement of plan reliability, reduction of urgent procurement requests and reductions in project schedule. The authors attribute improvements in PPC to factors including top management support, involvement and understanding of the implementation process. Another study by Fiallo and Revelo (2002) in Equator, have concluded that LPS improved the reliability of work flow, thus reducing cost and duration. The study observed that the incremental improvement is the general tendency in PPC.

### **Research methodology**

It is suggested that some research methods like design science research or action research can be alternative methods for promoting practical performance. Organizations should enjoy developments in knowledge not being merely topic of subject. Researchers examine their theories in real world to make them relevant (Avisonet al., 1999).

Reviewing the process and identifying problems and changing the situation are allowed by action research to evaluate and generate new knowledge (Baskerville, 1999;

Naoum, 2001). Distinction of action research with traditional methods is in the role the researcher has in study (Naoum, 2001; Herr and Anderson, 2005).

In order to consider practical concerns of people and solving problems, this study has used action research (Järvinen, 2007). Data gathering and feedback emphasize on dimensions which are difficult to capture by descriptive methods (Eden and Huxham, 1996).

#### **Research carried out**

Two case studies with action research methods were conducted in Malaysia for investigating effect of LPS on improvement of public projects. Contractors were selected based on their experience in the market. Based on the classification of Malaysia contractors, firms are classified based on their bids to government for public projects. The two construction organizations were mostly active in building projects. However, they also worked on other types of construction including roads, water and drainage networks. Two ongoing projects were selected for the motivation of their staff with this research, the firm commitment of executive management and the cooperation of clients in providing access to data.

#### **Data were gathered by different tools:**

1. Two to three hour semi-structured interviews: conducted with two project managers, two site managers and one planning engineer working in each of the projects under study to evaluate the existing planning practices. Questions included the planning techniques being used, the level of involvement of other parties in the planning process, frequency of meetings, the facilitation of medium term planning and means of communication adopted.

2. Non-participant observation: lasted for two weeks, and aimed to help in the identification of existing planning practices, prior to LPS implementation.

3. Facilitation of LPS implementation, through participant observation: the researcher attended weekly meetings over 18 weeks with the project teams. In these meetings, PPC figures were recorded and reasons for incomplete assignments were tracked and analyzed.

4. Unstructured interviews: including project managers, site engineers, client representatives and consultant engineers. It tried to seek their views of LPS as a planning system and its benefits. The aim was to seek its advantages and the benefits gained during its implementation. Additionally, these allowed reporting difficulties so that potential solutions could be examined.

5. Survey questionnaire: assessing stakeholders' perceptions of the LPS with these purposes: evaluating the implementation process and investigating the extent to which the LPS were perceived to improve planning practice; identifying benefits and barriers to LPS adoption; and identify the critical success factors (CSFs). In the first project, 32 questionnaires were distributed and 26 responses received. In the second, 40 questionnaires were distributed and 32 responses received.

Table I indicates the type, contract size and duration of studied projects. There was only one subcontractor in the first project, for electrical work, while all other work was done by the contractor's personnel. Four subcontractors were in the second project with structural, architectural, mechanical and electrical work. The last column of the table shows the contractors' classification. The first contractor was assessed as class 1 in building work (Ministry of Public Works, 2006), meaning that it was able to bid for projects over SR 200 millions (USD 53 millions), while the second was placed in class 2, allowing it to tender for building projects worth up to SR 200 millions. In both case studies, LPS was implemented half way through the project.

#### **LPS implementation**

**Existing planning practices:** In first step, interviews and non-participant observation were conducted to examine the current planning practice (Figure 1). According to findings, planning was based on master plan prepared at the outset. Beginning of construction was in the meeting of two parties in which they set regulations. There is no systematic study about project planning. Most interviewees said they don't want to mention previous works because they were inadequate. It also showed the lack of comprehensive short-term planning and improvement meetings to discuss project progress. Most of the interviewees stated that their firms used the critical path method.

After the interviews, the application of LPS was discussed in detail and examples from previous studies were considered. The weaknesses of the current planning practices were observed and thought was given to how the LPS could enhance practice. This also included training on LPS implementation.

**LPS implementation:** For each case study company, an implementation strategy was developed in which main components of LPS were implemented in four phases and evaluation was done at the end of each phase. In this project, implementation was from weekly planning, despite starting it from up stages in other LPS studies. Parties involved agreed upon study after great discussions. Strategy of LPS implementation started with the short-term planning in both project. Figure 1 shows the LPS implementation strategy used in both cases, followed by a description of the phases. In the first phase, a workshop was held to show the use of LPS and highlight its benefits. Then, there was a two-week observation period to monitor the current practices, to interview the participants and to make notes.

In the second phase, there was an agreement to record PPC and reasons for incomplete assignments weekly for five weeks. The focus was on short-term planning and make ready, while little attention was directed to forward planning. Two weekly meetings were held with the involvement of all project parties (contractor's team, client representatives, consultant engineers). Starting with short-term planning aimed to gradually introduce the other elements of LPS (look ahead planning, phase planning and stabilize production planning at the ground level. Specific requirements such as definition, soundness, sequence, size and learning (Ballard and Howell, 1994) was introduced to achieve quality assignments.

Causes for incomplete tasks were identified, analyzed and acted upon, together with the PPC calculation in the weekly meetings. Limitations were documented based on indications given by the project team and constraints analysis was performed jointly by all project members. Data were gathered during the summer, which is a very hot season in Malaysia. Furthermore, data collection coincided with the month of Ramadan, when Muslims fast during daylight hours. These factors had significant influence on labor productivity and assignment completion.

Third phase lasted 11 weeks in each project and two LPS components were introduced during it: Forward planning and phase planning. Phase planning allowed activities to be done through by reverse team planning and for resources to be optimized in the long term. There were two look-ahead windows in the first project, one for four weeks and the other six weeks, and in the second case, the four-week look-ahead window was feasible. It is justified with difficulty of producing six-week plans for subcontractors. Future planning was extracted from the master plan zone by zone and harmonized in the Last Planner (weekly) sheets. All planning levels were linked.

Sticky notes were used to show the names, durations, prerequisites and locations of individual tasks on the project map. Each session was dedicated to a certain type of activity with the purpose of providing goals in each phase and work backwards from the target completion date to achieve the proposed milestones. Phase planning creates a detailed plan covering the respective project phase and allows better visualization of the work flow helping all parties to negotiate deadlines for the planned work. Survey questionnaire was administered to evaluate the LPS implementation in the fourth phase. It

aims to allow participants to self-report benefits and barriers in implementing LPS. The questionnaire contained ten questions, but only the questions related to the achieved benefits, CSFs and barriers for LPS implementation are covered here. Questions were formulated using a five-point Likert scale that asked participants to indicate their degree of agreement or disagreement with a series of statements. The respondents were given sufficient time to read the questionnaire, think about it and ask any questions they wished. Most participants answered in group sessions in the presence of the first author. The key findings obtained through the questionnaire are discussed in more detail below.

### **Research findings**

**Weekly PPC:** PPC is an instrument to measure of promises about timely delivery and it is calculated as the number of activities that are completed as planned divided by the total number of planned activities, presented as a percentage. When the LPS implementation started, most of the work carried out consisted of structural activities. However, architectural activities started after week five and later after week 11, mechanical and electrical activities started.

Weekly PPC was gradually increased in the implementation period which is shown in Figure 2, showing promotion of the planning practices. In the first project, PPC increased from 69 per cent in the first week to 86 per cent in the last week which shows at 100 per cent in the first week after introducing future planning; then it was stabilized at 86 per cent for the last two weeks of the project. In the second project, PPC rose from 56 per cent in the first week to 82 per cent in the last week, reaching a peak of 84 per cent and stabilizing above 80 per cent for the last five weeks.

There are different reasons for PPC stabilizing in this project. The project team enhanced its professional practice and continuously assessed results. The gradual improvement in PPC over the period of the LPS implementation indicates that planning reliability improved over this period.

**Reasons for incomplete assignments:** Reasons of inadequate work are shown in figure 3 for both projects. The numbers in the figure is the accumulative number of occurrence for each cause during implementation period. Prerequisite work was the main reason for incomplete assignments in the first project, which is caused by nature of stage that most activities were dependent on completion of structural assignments. The main reason for incomplete assignments was lack of labor. It was evident that the project was struggling to keep pace with the weekly and future plans, because workforce was not sufficient to meet the needs.

Limited availability of materials was the second important reason in inadequate progress which had several causes. The approval process was time-consuming and caused delays. Suppliers did not always deliver the materials on time. Quality of materials was not good in some cases.

In both projects, the third reason was related to approvals. Bureaucracy and the overuse of paper-based communication caused significant delays in decision making and purchasing materials. Requests were also being submitted too late for decisions to be made in time for the scheduled start of particular activities. Change of priorities was the fourth reason for incomplete assignments in the first project and influenced architectural activities, although they were not always sequence dependent. However, changing priority was a necessity because of some limiting factors such as the redistribution of labor between zones, confusion in sharing resources and the availability of builders and carpenters. In the second project, the fourth reason for assignments incomplete was prerequisite work, which again applied mostly to structural and architectural activities.

The fifth reason for incomplete assignments in the first project was labor. However, in the case of the second project, the fifth reason was late or incomplete information. The sixth factor in the first project was equipment problems, which occurred with the same frequency in the second project.

### **Questionnaire results (participants' perceptions)**

**The effectiveness of the LPS implementation:** Four questions dealt with effectiveness of the LPS in promoting site management and the benefits of the LPS over traditional planning. Most respondents agreed that the LPS were effective in improving planning after 8<sup>th</sup> week's implementation. In the second project, most of the 32 participants (about 86 per cent) also agreed. Large majority agreed that LPS was effective in site management. Respondents revealed following cases as the advantages of LPS: knowing the requirements of the project and prerequisites of tasks, helping to facilitate planning and control, and ability to better predict the completion date of the project.

**Perceived benefits, CSFs and barriers:** Three questions are answered in this research about implementing LPS, potential barriers and using LPS for future projects. Results showed that LPS implementation was successful in both projects and problems were identified using questionnaires and interviews which are shown in table 2. Similarities between two cases were found and there were slight differences.

Benefits were gathered from this study and other studies and 16 benefits were listed that the most important of them are presented in table. Main advantages were accurate prediction of resources, planning workload better, reducing uncertainty and collaboration. Key CSF advantages management support, commitment to promises, involvement of all stakeholders and communication and coordination between parties.

Questionnaire showed that most barriers are common between two projects including: lengthy approval process, bureaucracy and use of routine paperwork, cultural issues, commitment and attitude to time. 88% of respondents stated that they will use LPS in future and they were satisfied by this system.

**The present study compared to previous implementations of the LPS:** The study by Koskenvesa and Koskela (2005), in Finland, revealed that the PPC rose from 47 to over 80 per cent, but in this study, the PPC stabilized over 80 per cent in the last seven weeks. Other statistics implementing LPS are given by Koskela and Ballard (2006). In another case study set in Korea (Kim and Yang, 2005), PPC rose from 62 to 85 per cent in the eighth week of LPS implementation. The tendency for an incremental improvement in PPCs indicates improvement in construction planning practice.

Causes of non-completing works should also be considered that prerequisite work is the leading cause. This is consistent with other studies and labor was the main cause for incomplete assignments in second projects. Majority of problems were internal and few were of external origin.

Management support was the main CFS in this study and after it commitment to promises, involvement of all stakeholders and communication and coordination were listed. Major barriers in implementing LPS are the involvement of various subcontractors, lengthy approval procedures on the part of the client, commitment and attitude to time in the Arab world and cultural issues. The last two of these are probably what differentiates Arab societies from others. Similar barriers are known in different studies.

### **Discussion**

Increase in implementation of LPS has stabilized its elements and reduced resistance against it and change. Short term planning has brought participation of all sides. Future planning and other elements were enhanced by short-term planning. Majority of team believed that LPS has added value and promotes communication and discipline. Projects were similar according to results. LPS implementation has many advantages which are summarized in table II. This method helped managers and supervisors to analyze mistakes and improve performance. Action research process allowed researcher to influence practice. Researcher worked as a facilitator of the process, but three months after it, the project teams can guide process without the help of researcher.

Results showed that implementation LPS was successful and responses to questionnaires showed positive effect of LPS on management. It enhanced stability and reliability and decreased uncertainty. It is an efficient method in reorganization planning process.

### Conclusion

Action research is a useful way in implementing LPS and can overcome delay in projects which was examined in this study. Improvements were obtained by collaboration of researcher and studied organizations. LPS is promising tool in reorganizing the planning process, assisting in collaborative planning and providing forward information for control. It leads to great improvement in performance and enhanced teamwork.

This is the first comprehensive academic study in the Malaysia construction sector concerning the application of lean construction techniques. Implementing LPS is an initial step in creating competitive companies. This study improved management practice. It needs support of government. The outcomes of the case studies can be used as a reference for organizations seeking to improve their managerial practice.

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