Last planner system: Experiences from pilot implementation in the Middle East

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LAST PLANNER SYSTEM: EXPERIENCES FROM PILOT IMPLEMENTATION IN THE MIDDLE EAST

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ABSTRACT

The work described in this paper is devoted to evaluate the effectiveness of implementing Last Planner to improve construction planning practice in Saudi construction industry. Firstly, the primary results of implementing Last Planner System (LPS) in two construction projects in Saudi Arabia are presented. Action research strategy was undertaken with different data collection methods employed included interviews, observation and survey questionnaire. Secondly, benefits gained in terms of improving construction management practice are presented, the critical success factors for LPS implementation are discussed, and potential barriers for implementing LPS revealed from the studies are presented. The results demonstrated numerous benefits were gained in terms of improving construction planning and site management. The fact that the structural work in one of the sites finished two weeks ahead of schedule is a clear evident of this improvement. However, there are some potential barriers reported which hindered the achievement of full potentials of LPS. Finally, a comparison between the outcome of this study and some previous studies on Last Planner in other countries is briefly carried out.

KEY WORDS

Action Research, Construction Industry in Saudi Arabia, Construction Planning, Critical Success Factors and Barriers, Last Planner System.

INTRODUCTION

Construction management suffers from many problems and the majority are practical which need to be solved or better understood (Love et al., 2002; Wing et al. 1998). As a result, the construction industry is overwhelmed by delay and often has suffered cost and time overrun. In their critical evaluation of previous studies on construction delay, Alsehaimi and Koskela (2008a) reported that the poor project management was a dominant and common reason for delay in construction projects. The authors criticised the previous studies as they fell short to provide clear recommendations demonstrating how project management practice could be improved since the majority of recommendations where made are general in nature and do not lead to a focus on a specific area (Alsehaimi and Koskela, 2008b). Consequently, these problems associated with management in particular, should be understood and efforts need to be directed towards developing solutions and more efficient methods of operation (Alsehaimi and Koskela, 2008b). In (Koskela 2008), it is contended that typical research in the field of construction

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management tends to be description and explanation driven, which is insufficient to solve the persistent managerial problems. Instead the solution to many difficulties in construction seems to require certain other research approaches. In this context, Alsehaimi and Koskela (2008c) proposed that rather than solely explanatory studies, novel management techniques could be developed and practically implemented in non-traditional research approaches such as constructive and action research. This may help to tackle some of the persistent managerial difficulties, enhance the performance, and contribute to knowledge in construction management.

Research on Lean and LPS shows no evidence into its practical application within construction industries in the Middle East and Saudi Arabia. Therefore, to the best knowledge of the authors, the research here reported is the first application of Lean construction aiming to improve the construction planning practice and provide a basis for the development of research in the area of Lean construction in Saudi Arabia.

This paper seeks to describe the process of implementing LPS via an action research strategy aimed to improve construction planning within two construction projects in Saudi Arabia. This paper is organized as follows. Firstly, literature in Lean and Last Planner is briefly addressed. Secondly, the research method described where the two studied projects introduced, along with descriptions of the ways that the LPS was applied. Thirdly, benefits gained in terms of improving construction management practice are presented, the critical success factors for LPS implementation are examined, and the identified potential barriers for implementing LPS are discussed. Finally, a comparison between the outcome of this study and some previous studies on LPS is briefly undertaken.

LEAN CONSTRUCTION AND LAST PLANNER

According to Ballard (1994), one of the most effective ways to increase productivity is to plan more efficiently, improving production by reducing delays, getting the work done in the best constructability sequence, matching manpower to available work, coordinating multiple interdependent activities, etc. In Lean Construction, planning and control are considered to be complementary and dynamic processes maintained during the course of the project. Planning defines the criteria and creates the strategies required to reach the project objectives. At the same time, control makes sure that each event will occur following the planned sequence. Re-planning must be done when the previously established sequences are no longer applicable or convenient. Feedback facilitates learning when the events do not occur as planned (Ballard 2000; Howell 1999). Howell (1999) argued that control is redefined from "monitoring results" to "making things happen". Planning system performance is measured and improved to assure reliable workflow and predictable project outcomes. In Lean Construction as in much of manufacturing, planning and control are two sides of a coin that revolves throughout a project:

- Planning**:** defining criteria for success and producing strategies for achieving objectives.
- Control: causing events to conform to plan and promoting learning and re-planning.

Ballard (1994) states that better planning results from overcoming several obstacles common in the construction industry, including: 1) Management focus is on control, which prevents bad changes; and neglects breakthrough, which causes good changes. 2) Planning is not conceived as a system, but is rather understood in terms of the skills and talents of the individuals who are in charge of planning. 3) Planning is considered to consist of scheduling, not taking crew level planning into equal consideration. 4) Planning system performance is not measured. 5) Planning failures are not analyzed to identify and act on root causes.

One of the best known Lean techniques is the Last Planner System which has been demonstrated to be a very useful tool for the management of the construction process, and continuous monitoring of the planning efficiency. The Last Planner integrated components are; master plan, phase planning, look ahead planning, weekly planning, PPC and reasons for incomplete, when systematically implemented can bring many advantages and add major benefits to construction management practice in general and planning practice in particular.

RESERCH METHOD

Two case studies on an action research mode were conducted to examine the impact of LPS on improving construction planning practice in two governmental facilities. An action research project emerges from and has to contribute to the practical concern of people and the solution of existing practical problems (Järvinen, 2007). Dick (2002) argued that action research is a flexible spiral process which allows action (change, improvement and research (understanding, knowledge) to be achieved at the same time.

Data was collected by conducting (a) interviews aimed to evaluate the current management practices, (b) attending the weekly meetings as a facilitator of LPS application over a period of eighteen weeks, (c) interviews with participants during the implementation process, (d) participant and non participant observation and (e) finally conducting survey questionnaire to assess the stakeholders' perceptions on implementation of LPS. Justifying the adoption of action research, the main aim of the study is to contribute to practice, bring improvement to the managerial practice which could not be achieved by means of other research approaches. In addition, action research provides a richness of insight which could not be gained in other ways (Gummesson, 2000). Moreover, authors believe that organisations should benefit from knowledge and research advancements rather than just being subjects in the research.

LAST PLANNER IMPLEMENTATION STRATEGY

1. DESCRIPTION OF THE STUDIED PROJECTS

Table 1 summarises some general details about the studied projects (type, contract size and duration). As can be seen from the table (in the fifth column), there was only one subcontractor in the first project for electrical work. However, there were four in the second project working in the structural, architectural, mechanical and electrical work. The last column of the table shows the contractors' classification. The first contractor is class 1 in buildings work according to the Saudi contractor's classification (Ministry of Public works, 2006). Based on the degree of this classification, the organisation is allowed to bid for projects over SR 200 Million ($53 Million). The second contractor is classified in class 2, which means that the organisation can tender for projects worth up to SR 200 Million ($53 Million).

2. LAST PLANNER IMPLEMENTATION PROCESS

The LPS was only implemented half-way through the projects. The research plan was to undertake the implementation process (facilitated by the first author) in four phases with an evaluation being made at the end of each phase. This incremental implementation is believed to gradually stabilise the elements of LPS, minimise resistance to change, and have the additional advantage of providing an opportunity to evaluate each phase and take the lessons learned to the next one. Figure 1 shows the implementation strategy of LPS in the studied cases.

Table 1: Description of the Studied Projects

Project	Contract	Duration	% time elapsed when LPS starts	Subcontract -ors	Organisation classification
(1) Faculty of Business and administrative sciences	$21Million	17 Months	50%	Electrical	Class 1
(2) General classrooms and Laboratories	$10 Million	17 Months	50%	Structural Architectural Mechanical Electrical	Class 2

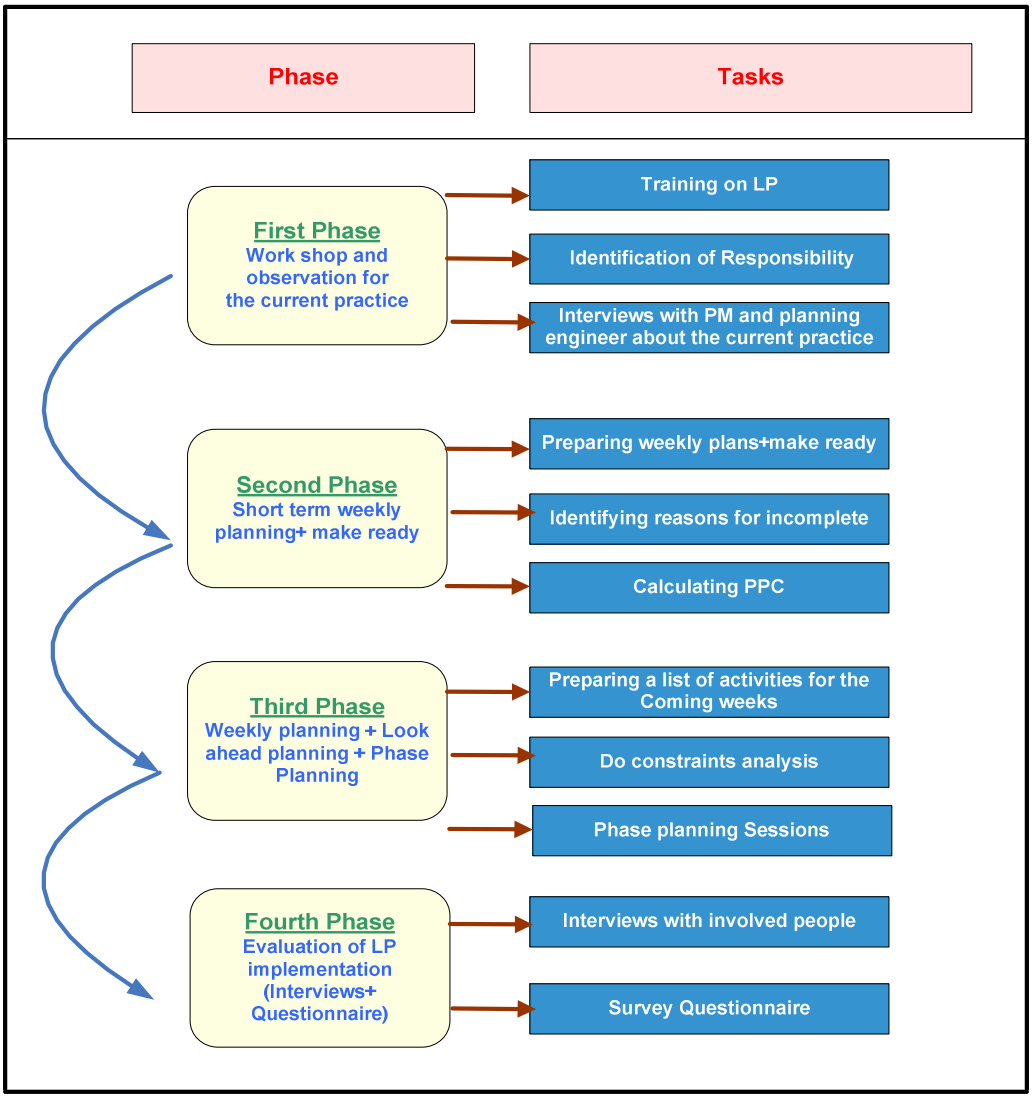

Figure 1: LPS Implementation Strategy in the Studied Projects

FIRST PHASE

In the first phase, a workshop on Lean and training on the use of LPS were provided to highlight the benefits and discuss the perceived advantages of Lean and LPS, after which there was two-weeks observation period to monitor the current planning practice, interviewed the participants and to make notes. In addition, this phase aimed to train the team how to calculate the PPC, identifying reasons for failure during these two weeks, but this is not included in the data as LPS was not implemented during this phase. Further, during this phase, PPC was calculated, and reasons for non incomplete assignments were traced and recorded.

SECOND PHASE

Implementing LPS on site was facilitated by the first author and it was agreed that PPC and reasons for incomplete assignments would be traced and recorded on a weekly basis for a period of five weeks. It was an attempt to help the team in driving improvement to see how the LPS improve the planning practice. In this phase, the focus was on short-term planning and make ready only and little attention was directed to Look Ahead planning. Two weekly meetings were held with involvement of all project parties (contractor's team, client representatives, consultant engineers). In this phase, data (PPC and reasons for incomplete tasks) were collected during the summer season in the country. At this time of the year, the highest temperature is usually recorded, and this year it reached 52 degrees in the day-time. Furthermore, it was the month of Ramadan in Muslim countries where people have to fast the whole day. Taken together, these factors significantly affected labour productivity, and hence, assignments completion.

THIRD PHASE

This phase was the longest of all the phases. During this phase, in the two projects, in addition to the weekly planning and make ready that already introduced, two main components of LPS applied; Look Ahead planning was undertaken, and the phase planning was introduced. In the first project, look ahead incorporated two sub-phases, one covering the four-week Look ahead window, and the other the six-week Look Ahead window. However, in the second case, it included only one phase since only four look ahead was generated. Perhaps the reason here is due to the involvement of many subcontractors, it was difficult to produce six week Look ahead plan. Look ahead planning was extracted from the Master Plan of a zone-by- zone then coordinated in the Last Planner sheets. In the two sites, phase planning sessions carried out through the project various phases aiming to provide certain goals in each phase and then work backward from the target completion date to achieve the proposed milestones. Each session was dedicated to certain type of activities (structural, architectural and mechanical).

FOURTH PHASE

This phase focused on a survey questionnaire administered to evaluate the process of LPS implementation aimed to allow all participants to self-report the achieved benefits, CSFs, and barriers to LPS implementation in the projects. The respondents were given sufficient time to read the questionnaire, think about it and ask any questions they wished. Most participants answered in group interviews (informal friendly discussion manner) in the presence of the first author, the author explained the questions, provided any clarification necessary, and asked the participants to choose the answers they believed to be the most appropriate.

RESEARCH FINDINGS AND RESULTS

1. WEEKLY PERCENT PLANNED COMPLETED (PPC)

The first author played the role of facilitator of implementing LPS over the period of approximately eighteen weeks in the two sites. In the first project, PPC rose from 69% in the first week to a level of 86% in the last week, peaked at 100% in the first week after introducing look ahead planning and then stabilised at the level of 86% for the last two weeks of the project as shown in Figure 2. In the second project and over the same period, PPC rose from 56% in the first week to a level of 82% in the last week, it reached the peak (84%) at the middle of the period and then stabilised above 80% for the last five weeks of the project, as indicated in Figure 2. In the figure, the PPC for the two projects combined together to allow for some comparison.

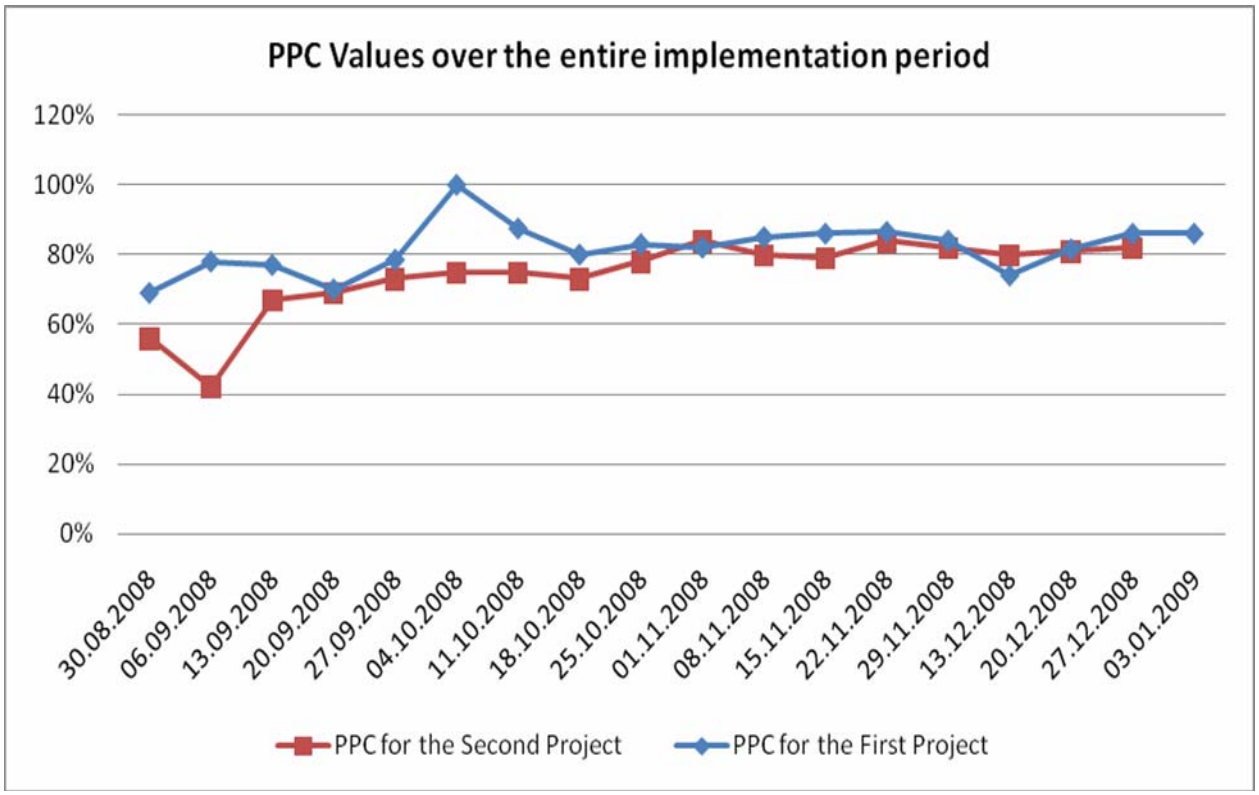

Figure 2: Weekly PPC Values Over the Entire Implementation Period for Both Projects

2. REASONS FOR INCOMPLETE ASSIGNMENTS

Figure 3 presents the various reasons for incomplete assignments reported for the two projects. Pre-requisite work was the main reason for incomplete assignments in the first project. This perhaps, due to the nature of the stage that the project had reached as most activities - including architectural ones - were entirely dependent on structural assignments being completed. Reasons for incomplete assignments were combined in the same figure for the purpose of comparison between the two cases.

For the second project, labour supply was the main reason for incomplete assignments. It was evident that the project was always struggling to keep pace with the weekly plans and look ahead

plans because the available workforce was insufficient to meet the project needs. Most of the subcontractors appear to have exceeded their capabilities in their commitment to labour supply. This is due to a high current demand for skilled labour in the present time where the country is passing through unprecedented construction boom where multi billion dollar projects are under way and many more in the planning stage by both the public and private sectors.

The second main reason in the two projects was the materials availability, which occurred because of several factors. Firstly, the approval procedure required by the client is time-consuming and causes delays. Secondly, suppliers did not always deliver the materials at the agreed time. Sometimes the wrong materials were delivered. This was mostly due to confusion on the supplier side because of the use of different block types (normal, cement, fire-rated) and different sizes being used, and these cases deliveries were made but of the wrong materials. In other instances (specifically during the last phase in relation to some of the mechanical materials) deliveries were simply not made on time.

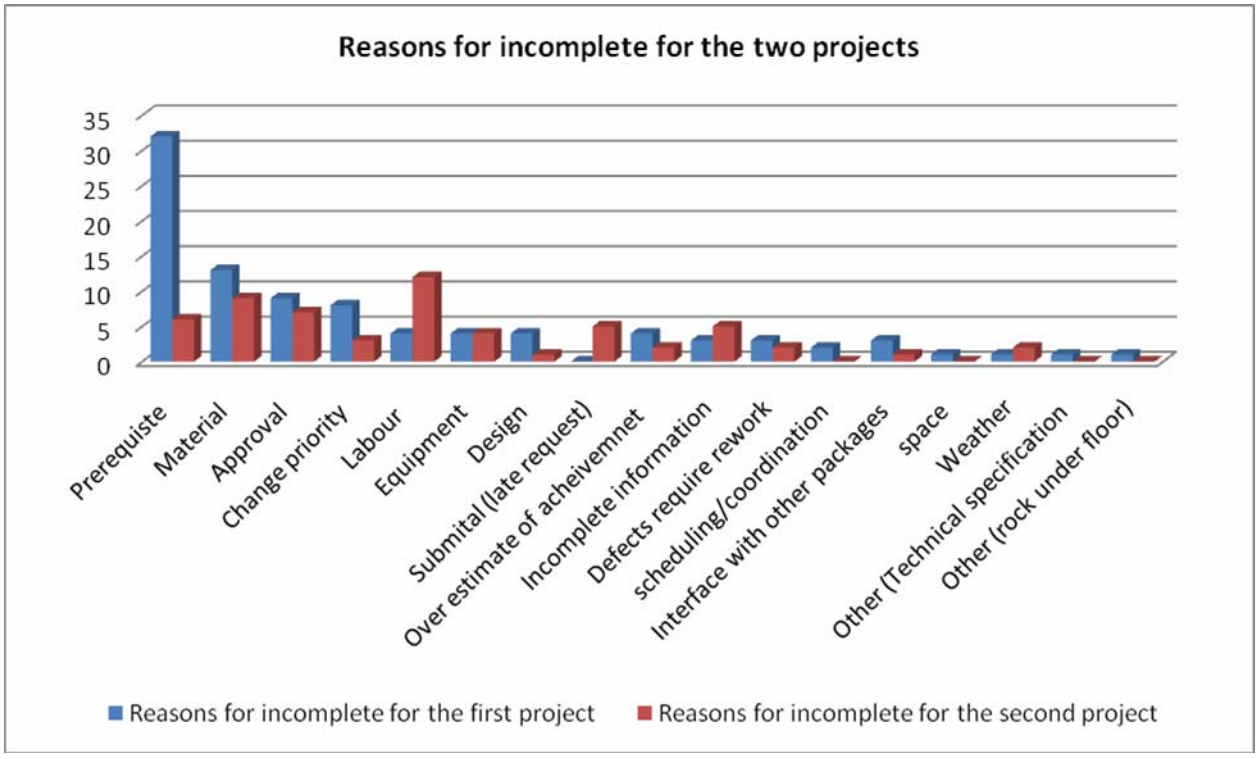

Figure 3: Reasons for Incomplete Assignments Over the Whole Period in the Two Projects

The third reason for the two cases related to approval, since whilst the approval system from client itself caused delays (due to bureaucracy and the usage of vast amount of paper work as exclusive means of communication) in agreeing the purchase of materials, there was also an issue with requests being submitted too late for decisions to be made that enabled particular activities to start on time.

The fourth reason was change priorities, which appeared mostly in the architectural activities that were not always sequence-dependent. However, in some cases there was a need to change priority because of distribution of labour between zones, confusion in sharing resources,

availability of professionals such as builders, and carpenters, and there may also have been other reasons. In the second project, the fourth reason for incomplete assignments was the prerequisite work, which again appeared mostly in the structure and architectural activities.

The fifth important reasons for the first case were labour and equipment but for the second case were late or incomplete information and late submittal of requests as they were equally happened five times over the entire period of LPS implementation.

3. OUTCOME OF THE SURVEY QUESTIONNAIRE

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 requested opinion about different attributes gathered from the outcome of previous studies in LPS, from the literature in LPS and Lean construction, and from observation and notes taken during the involvement of the researcher in the implementation. In the first project, the sample is 26 respondents; from all parties involved. In the second project, 32 respondents from all involved parties contributed to the questionnaire.

4. THE PERCEIVED BENEFITS, CRITICAL SUCCESS FACTORS (CSFS) AND BARRIERS

One of the major conclusions that can be drawn from the questionnaire findings is that the experience was very successful, had a positive impact on performance as reflected by the main achievements and the outcome of the implementation. Benefits, CSFs and barriers revealed from interviews and survey questionnaire are briefly presented in table 2. In both cases, the benefits and CSFs are similar to a large extent with differences only in the degree of agreement between respondents. The most identified important CSFs are top management support, commitment to promises, involvement of all stakeholders and communication and coordination between parties. Also, most of the identified barriers are common with disparities only in the degree of importance from one study to another. These include: lengthy approval process by the client due to enormous amount of paperwork routinely involved between employees, cultural issues, commitment and attitude to time. The last two factors are probably what differentiates Arab culture from others, since in Arab societies, one or two hours delay and maybe days in some cases, is usual. It is normal to start meetings an hour late and most people accept this. However, this comes as a surprise for people with no experience in Arab countries. Such attitudes to time can have an impact on the implementation of techniques that are time-dependent and a commitment to this is crucial. Except one factor (the involvement of many subcontractors) it was given the highest agreement in the second project but was not applicable for the first case.

5. KEY SUPPORTIVE FACTORS

The LP discipline consists of inter-related elements, and provides major benefits that are properly appreciated when all these integrated features are systematically implemented by an entire project team over a period of time. This fact was realised by all the parties involved in the project after a period of time, and although it was well before the implementation period was over, it did not happen overnight. The implementation process in the first project was very successful as indicated by the gradual improvements in PPC, and the other benefits that were gained. Since the first author served as a facilitator in the process of LPS implementation thus from his perception, supportive factors contributed to the success which may have resulted from:

- The company's standing in the industry. As it is ranked at the sixth top construction contractors in the country (Meed, 2007) and one of the best 100 companies in the country, its culture was one where improvement initiatives are appreciated and very welcomed.

- Facilitation of phase planning and look ahead planning contributed significantly to the success of LPS since they are considered of the most important components.
- Development of teamwork with duties being properly distributed amongst the team who were most professional in their work, being supported by top management who employed professors and doctors from universities as part-time as advisors and consultants to improve various organisational processes at different levels.
- Given that LPS implementation also relies on good communication skills, as well as the type of management support mentioned, and a general outgoing attitude by staff, it was seen that the researcher's efforts in introducing the meeting structure also improved the culture of communication among project team members. Additionally, all the project engineers and personals were equipped with a personal device (Bravo) and number, working on a particular system that enabled them to be called from anywhere in the country. This communication system helped in saving time and promoting better communication among the project personnel.
- The focus on process evaluation at the end of each phase made significant and continued improvement, and has contributed substantially to the quality of the finished work. Additionally, the researcher's aim was not only the collection of data, but also to benefit the organisation and the project team by the introduction of LPS, which would contribute towards the assurance of a permanent improvement in practice. In this regard, a great deal of effort was made by the researcher over the entire period.

Table 2: The Perceived Benefits, CSFs and Barriers for LPS In the Two Projects

Case	Benefits	CSFs	Barriers
Faculty of Business and Administrative Science	1. Enabling site supervisors to plan their workload. 2. Improving learning process 3. Improving planning and controlling practice 4. Enabling accurate prediction of resources 5. Reducing uncertainty 6. Preparing team members to be in collaboration	1. Top management support. 2. Commitment to promises. 3. Involvement of all stakeholders. 4. Communication between parties to achieve team work 5. Close relationship with suppliers 6. Motivate people to make change	1. Lengthy approval procedure by client 2. Cultural issues 3. Commitment and attitude to time in Arab world 4. Short term vision
Classrooms and Laboratories	1. Enabling accurate prediction of resources 2. Improving planning and controlling 3. Enabling site supervisors to plan their workload 4. Improving site management 5. Improving learning process. 6. Reducing uncertainty 7. Improving productivity	1. Commitment to promises 2. Communication and coordination between parties 3. Involvement of all stakeholders 4. Top management support 5. Close relations with suppliers 6. Manage resistance to change	1. Involvement of many subcontractors 2. Lengthy approval procedure by client 3. Commitment and attitude to time in the Arab region. 4. Cultural issues 5. Short term vision

6. IDENTIFIED BARRIERS HINDERING ACHIEVEMENT OF FULL POTENTIALS OF LPS

In the second project, the vast majority of participants considered the implementation of LPS successful when compared to traditional planning methods. The majority of site team believed that the LPS adds value throughout structuring the planning, giving control to the participants and assisted them to be more disciplined. However, findings from interviews, observation and survey questionnaire revealed that there were some barriers that prevented achievement of full potential of LPS. These obstacles may have resulted from:

- Involvement of many subcontractors made the coordination for weekly programmes among them a difficult process. In addition, the shortage of subcontractor's labour on the site. It was evident that there was a demand for skilled labour to do the finishing work.
- Some subcontractors were not committed which perhaps related to the shortage of the resource they are providing. In addition, there was a lack of understanding of the project needs by some of the subcontractors especially during the second phase of LPS implementation.
- The facilitator endeavored to clearly explain the LPS to the participants which significantly contributed to the process success. However, the existence of full support and commitment from top management was necessary. What was existed is the enthusiasm and willingness of both project manager and client representative which strongly supported the implementation of LPS. Perhaps the author's interpretation here is that such family based construction companies which managed by their owners who do not greatly appreciate such improvement initiative.
- Commitment did not usually met from different sides including suppliers, consultant and some subcontractors. Indeed, commitment and attitude to time has affected the process of LP implementation and this is probably one of the factors that differentiate Arab culture from others, since in Arab societies, one or two hours delay and maybe days in some cases, is usual. In this respect. An example of that is the material delivery which agreed to be delivered on a certain day but it delivered two or three days late. This perhaps calls for a long term relationship with material providers (i.e. partnership), the factor which is vital to support the implementation of Lean principles.
- The site manager and client management generally were open to Lean construction principles and they are good examples of well motivated people who appreciate improvement initiatives. However, they have had limited power to effectively implement LPS on this project because they do not have enough influence over the entire parties involved in project particularly subcontractors.
- Starting implementation of LPS half way through the project where different trades working at the same time and many activities going on simultaneously can be considered to some extent as an obstacle. Hence, bringing all parties working in the project after a while from the start and introducing a different practice technique to them is not an easy task. It is expected that the implementation process would be much easier if it was implemented from the early start of the project.

COMPARISON BETWEEN THE OUTCOME OF THIS RESEARCH AND PRIOR STUDIES ON LPS

Pilot experiences from implementing LPS in the Saudi construction industry are to a great extent similar to prior implementations in other countries, but there are novel differences. The outcome

of the pilot implementations indicates that LPS resulted in numerous benefits, significant improvement in the overall project management practice reflecting that LPS is a powerful and generic method applicable in different cultural contexts. This is supported by the outcomes from the survey questionnaire since it was demonstrated and provided clear benefits. In the following, results of some patterns from this study will be compared against some previous experiences.

- In general, the tendency of incremental improvement in PPC agrees with most of the prior studies (Ballard, 2000; Fiallo and Revelo, 2002, Junior et al, 1998; Kim and Jang, 2005).
- The dominant reason for assignments incomplete in the first project is prerequisite work which agrees with prior studies (Koskenvesa and Koskela, 2003; Ballard, 2000).
- There are various benefits gained from implementing LPS in these two studies such as improving planning and controlling practice, improving site management, improving team working and others. This is in full alignment with the literature in Lean and LPS.
- The main critical success factors revealed from the questionnaire were top management support, commitment to promises, involvement of all stakeholders and communication and coordination between parties to achieve team work. This is in agreement with the literature in Lean and LPS since much emphasis was directed towards these factors.
- The main potential barriers to the LPS implementation can be summarised into four factors namely; involvement of various subcontractors, lengthy approval procedure from client (government departments), commitment and attitude to time in Arab world, and cultural issues. Except the first reason, the other three identified reasons have been derived from this study for the first time, which adds to the literature in implementing LPS in governmental projects. The last two factors are probably what differentiate Arab culture from others.
- There are different nationalities working in Saudi construction industry, it was expected that the Multilanguage construction site can be a barrier but surprisingly it was not. The explanation behind this is that the respondents' views and facilitator observation were clearly qualified to answer that. In the management level, it was evident that the majority of engineers and site supervisors speak good English. On labour level, in case of any language-associated difficulties with labour; field engineers and supervisors can talk to senior labour as interpreters and utilize drawings for explanations purposes.
- A different implementation strategy (differ from prior studies on LPS) for the introduction of the technique on site was developed where the main components of LPS were gradually implemented via four phases. This incremental implementation is believed to stabilise and support introducing the components of LPS gradually, minimise and manage resistance to change, and have the additional advantage of providing an opportunity to evaluate each phase and take the lessons learned to the next one. Furthermore, it is believed that participants' confidence in the tool can be gained via such gradual implementation.

CONCLUSION

By means of collaboration between the action researcher and the studied organisations, improvement in quality of work practice, enhancement of managerial practice, knowledge expansion and learning have been achieved via action research process. The LPS technique proved that it could enhance construction management practice in various aspects and bring numerous advantages. An important event that indicates the success of LPS implementation in the first project was the fact that the team were able to shorten the time of structure activities by

about two weeks. Even though, there were some obstacles prevented the achievement of full potentials, the implementation process in the two projects was successful as demonstrated by the studies' results and the outcome of the survey questionnaire. Besides its contribution in improving the project management practice in the companies being studied, this study has made a valuable contribution to construction management practice in Saudi Arabia, and added to the theory of Lean construction and LPS, since it has reported the outcomes of implementation of LPS in an environment which differs from places where it has been implemented before. Additionally, the study developed a basis for the development of research in this area in one of the academic establishments in the country. This intended contribution to both theory and practice was the key reason for choosing action research in this study. The study's outcomes suggest the need for improvements in certain areas in the Saudi construction environment. Examples include the need for efficient communication means where implementing an ICT is a suggested solution, deregulation of existing bureaucracy and authority hierarchy to minimise the approval time and more partnerships with key suppliers are necessary. Further, the results can be used as a reference for organisations which look forward to improve their managerial practice and the benefits of this study can be extended from Saudi Arabia to other countries particularly in Arabian Gulf Region and the Middle East in general. The study's outcomes will be translated to the Arabic language and published in local journals and construction magazines.

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