

ADAPTING LEAN CONSTRUCTION TECHNIQUES IN NIGERIAN CONSTRUCTION INDUSTRY

BY

SAMAILA ADAMU¹ GREGORY A HOWELL [LCI]² RAZALI ABDULHAMID³

FACULTY OF BUILT ENVIRONMENT
UNIVERSITI TEKNOLOGI MALAYSIA.

i-adam@live.com ghowell@leanconstruction.org b-razali@utm.my

ABSTRACT

The major problem of Nigerian construction industry is that the industry fails to adapt modern techniques to eliminate or minimize waste and improve value of its product. This makes shelter, which is a necessity to become too expensive and unaffordable to many of the citizens that are mostly low income earners. This paper is to evaluate the effectiveness of implementing lean Construction Techniques in Nigerian Construction Industry by comparing Last Planner System with traditional method in construction of 300 housing unit in Damaturu by Yobe State Government of Nigeria. A field study was conducted to analyse the effectiveness of Last Planner System compared with traditional method on the production of these housing units, and to assess the progress so far in tackling the problem of waste and increase value at the end. The data are collected by direct participation in the production management and interview. The effectiveness of Last Planner System is measured base on performance criteria. Best on the Last Planner implementation result so far give significant improvement even though most of the party's involve are not quite familiar with it. With the cooperation of the top management staffs of Ministry of Housing, people have started developing interest on lean construction technique in Yobe State of Nigeria. It was concluded that with effective training and implementation of lean construction technique, from planning and design stage to production stage, waste and non value adding steps will be reduced and eliminated gradually, and will increase the value and cut down exorbitant cost of structures.

Keywords; Lean construction, Last Planner System, Traditional method, value adding steps, material and time waste, Planning, Production, Improvement, exorbitant cost.

Introduction

The Nigerian construction industry is facing continues decline in profit margin and corresponding increase in demand for houses and other infrastructures. And construction contractors are declining to accept new construction contracts due to uncertainty in price of building materials and lack of good profit which rise to serious request for variation that leads to a lot of disputes in the industry. The Yobe State Government lunch the construction of 500 units of low cost houses that will be affordable to low income earners. The late Executive Governor throw the challenge to the Ministry of Housing, to come up with design and proper management planning for construction of low cost houses that will be affordable to junior civil servants and low income earners in the state. In a round table discussion of the stake holders on how to improve the efficiency and effectiveness of the construction process, lean construction techniques were implemented to illuminate or reduce non value adding activities. The idea of applying lean production to construction was analyzed by construction research community since early 1990s (*Salem et al, 2005*). A significant contribution for the formulation of

theoretical base for lean construction was made by International Group for Lean Construction (IGLC) by applying the concept of lean production to the management of construction process. *Kokela (1992)* started understanding the construction as production. The different between manufacturing and construction is the nature of operation, planning and the execution process. (*Paez et al, 1995*). The tool of lean production cannot be used directly to manage construction process, because of these differences some new set of tools are required. The most developed lean construction tool which stresses the relationship between scheduling and production control is the Last Planner system of production control which was introduced in 1992. (*Ballard 2000*). It was indicated by *Howell (1999)* that lean construction is similar to normal present practice in construction industry, as both are targeted towards customer satisfaction and reduction of resources and time waste. Lean construction differs from present practice, because is generally base on production management principles, and it gives better result in complex, uncertain and quick projects. *Salem et al (2005)*. The Nigerian construction industry fails to invest in research and development to improve its productivity. The main limitation to implementation of lean construction tools in Nigeria lack of knowledge and research, as in United State is lack of research in the construction industry. *Salem et al (2005)*. It was stated by *Banik (1999)* that the construction industry is hesitant to invest in research and development to improve its productivity. Lean construction is in stage of development and some of its tool are tested in the field and refine over last decade, such as Last Planner, but some tools such as daily huddle meetings, visualization and 5s are in testing stage and all procedures for their implementation are being developed. *Salem et al (2005)*

This research will assess the effectiveness of implementing Last Planner in Nigeria, compared with traditional method of management in the construction of housing units in Damaturu by the Yobe State Government.

Part one of this paper reviews the Last Planner System and part two will assess the implementation of Last Planner System in Nigeria base on the case study. The result will be evaluated and compared with the traditional method of management and future research to be carried out will be highlighted.

LAST PLANNER SYSTEM OF PRODUCTION

A project objective is best achieved by governing its execution by management process, i.e. planning is followed by control. As indicated by Ballard (2000) Last Planner is a technique that shapes work flow and addresses project variables. Individual or groups that are responsible for operational planning are the Last Planners. They are responsible for structuring the product design to facilitate an improved work flow, and also the completion of individual assignment at operational level. The sequence of implementation of Last Planner system set up a frame work for efficient schedule planning which shapes work flow, sequence and rate, match work flow and capacity, develop method of executing work and improves communication between trades. Schedule and budget specify *should*, production control translate *should* in to *can* by making schedule activities ready for assignment and eliciting a specific commitment to what *will* be done during next near term plan period. Therefore *should*, *can*, *will* are going to be achieved, which is the key term of weekly work plan. Work flow is improved by contribution of two way

communication, constrain analysis process in six weeks look ahead before assignment is executed, analysis of reason for variance after assignment are completed, the effort of each planner and the training of project team. The difference between what *should*, *can* and *will* be done is not considered at the traditional practice. It is assumed that better result will be achieved by pushing more resources. *Salem et al (2005)*.

The Last Planner tool evaluates the performance of workers base on their ability to meet a reliable commitment, this replace optimistic planning with realistic planning. The goal of Last Planner is pulling the activities using reverse phase scheduling through team planning and optimizes resources in long term, just as in production levelling tools in lean manufacturing. *Salem et al (2005)*.

SCHEDULES

Master schedule is the overall project schedule. In application of lean construction principle to schedules, master schedule is limited to phase milestone, special milestone, and long lead items. Phase schedule is produce with the team that will carry out the work, using a backward pass, making float explicit, and deciding as a group how to float a buffer uncertain activities. This is produced base on master schedule. And said to be Reverse Phase Schedule (RPS).

The Reverse Phase Schedule is developed from completion time of a project to planning time. To achieve proper plan that will integrate and coordinate different specialist operation, phase schedule is being developed. It also provides linkage between work structuring and production control. *Ballad and Howell (2003)*.

The Last Planner team is responsible to develop reverse phase schedule. It is more accurate than master schedule. Weekly Work Plan (WWP) is also more accurate than reverse phase schedule if the actual field factor is not considered. *Salem et al (2005)*.

Look ahead planning is the process under take to achieve possible constraints, free assignment and cut down uncertainty. *Koskela et al (2000)*. The function of look ahead planning is to shape work flow sequence and rate, match work flow and capacity, maintain a back log of ready work (workable back log), develop detail plan for how work is to be done, (operation design). *Ballad et al (2000)*. Look ahead specifies the activity require to be executed in future time. In look ahead of time and schedule was estimated base on the result of reverse phase scheduling. All constraints are indicated, so that problems will be solve before production is started. (*Ballad,2000*).

Base on site condition and actual schedule weekly work plan is developed, man power requirement for each trade will be adjusted to need. The materials requirement for the period in question will be drawn in early warning chart, so that they will be delivered on the time required for work. The issue of weekly schedule, safety and quality requirement, construction methodology and any expected problem that may arise on the site will be addressed in weekly work plan meeting. Information is disseminated effectively and accurately on the project within the team. Thus, there is great improvement in productivity due to relationship of the team members. Safety, quality and resources flow are also improved. Weekly work program is reviewed to determine what assignment are completed, and if not why? The reasons are

periodically analysed to their root course, and action are taken to prevent future occurrence. It should be taken as learning process than pointing fingers to team members. The cause of failure will be refer back to look ahead process for improvement of planning system. (*Ballard and Howell, 2003*)

A percentage plan completed value is the number of activity completed as planned divided by the total number of planned activities. (*Ballad, 2000*). If the production plan is reliable there will be positive upward slope value of percentage plan completed.

BACKGROUND OF THE STUDY

The study is based on the on the construction of 500 housing unit by Yobe state Government of North Eastern part of Nigeria. A state seriously encroached by desert, that make some part of it not easily assessable except with strong four wheel drive Lorries and jibs. The housing project was splited all over the state in 17 local government areas as follows; State capital 300 units, 17 Local Government Areas 170 units, that is 10 units in each LGA and 2 zonal Headquarters 30 units, i.e. 15units in each zone.

The project was initiated by Yobe state government as pilot project of low cost houses to tackle the problem of housing accommodation in the state. The project include 200 blocks of two bed room bungalow, 100 blocks of two bedroom duplex semi detached, and 100 blocks of three bedroom bungalow, using hydra form block making machine to produced clay bricks for the project. The vision of this project is “Building in value”. The professional staffs of ministry of housing were to plan the production management of the 300 housing units in the state capital. Six teams were formed, each to construct 50 houses, with responsibility of managing the production and materials schedule. This is aimed at achieving maximum value of the end products. My team used Last Planner System to manage the production process. Yobe state Aluminum Company is the roofing and window subcontractor only. The rest were executed by the remaining five teams using traditional method of production management. The management staff led the supervision of the project teams and assessment of performance of each team. The Last Planner is used as planning tool in the implementation of the project. The Leader is to monitor the application of the tool, implement the guidelines and give feedback. The 50 houses managed with Last Planner System of management had shown a significant impact in the project in general. Only average of 7 to 10 people are attached to each block of a house in order to cut down idleness. The master schedule of the project is done in three stages; main structure, roofing, finishing and services. The duration of the project was measured base on five working days in a week. The total duration of the project was 120 days in master plan and 90 days in reverse phase schedule per each unit, going in the same time. All implemented using Last Planner System of management were completed in 65 to 72 days. And the remaining houses handle by the remaining team using traditional method of production management; none was completed in less than 120 days. And number of workers attached to each house daily was not less than 15 persons. Even some of uncompleted blocks and handed over to Last Planner team for immediate completion. The Last Planner team was lead by project manager on general planning and operational control.

Schedules	Last Planner System	Traditional method
-----------	---------------------	--------------------

Master schedule	120 days	120days
RPS	79 days	-
Actual completion period	65 to 72 days	Not in less than 120 days



Figure 1 50 blocks fully completed within 65 to 72 days using LPS.



Figure 2 250 blocks not completed after 120 days expired

METHOD STATEMENT

As a pilot project was used, to achieve the objective of the project, intensive study and training on Last Planner System implementations was conducted. The Last Planner System was selected by the team for implementation in the construction of 50 houses allocated to the team in 300 housing unit projects. A comparative analysis is also made with progress of other teams using traditional method. The data were collected through direct observation and interview only in the process of operation and labour utilization. The data was compiled directly from schedules and huddle meetings in the construction process. The researcher is the head of implementation term. The data collection starts from beginning to the end of the project.

The data compile on the implementation of each is base the following;

Last Planner System	Minutes of meeting, schedules, activity and its duration, completion date as per schedule, date completed, constraints and reason for failure to complete the assignment as planned, labour employed to each activity and result of interview.
Traditional method	Schedules, activity and its duration, completion date as per schedule, date completed, labour employed to each activity and result of interview.

CONSTRAINTS AND THEIR SOLUTION

The interest is to get low-cost houses, the researcher is the team leader and the project manager, and therefore the interest of the project and the implementation Last Planner System were matched together. And the aim is achieved, but the members of the team are not familiar with lean techniques (LPS). Therefore it became a tedious job to the project manager to monitor all activities. The team members become fed up with the new techniques during the project, but appreciated at the end. Initially the project manager has to maintain all

documentation of result, including the subcontractors work, as they do not appreciated the tedious planning work and recordings. The team members expected that additional management tools are not important to the project objective, as it make their work more tedious. The project manager proposes an incentive to be given to committed staffs. This improves the participation of the project team to record keeping. Even though daily meeting were held daily, interviews are conducted on courses of failure to meet up with schedule. Little constraints were compiled and variance were identified and addressed. The result was generally satisfactory.

FIELD SURVEY ON 50 BLOCKS OF LOW-COST HOUSING UNIT

To achieve the objective of the project, waste and non value adding activities must be eliminated, a functional two way communication must also be provided. With regard to this issue, the traditional scheduling method was replaced with new scheduling technique and proffer team planning Last Planner system as shown in Figure 3.0 below.

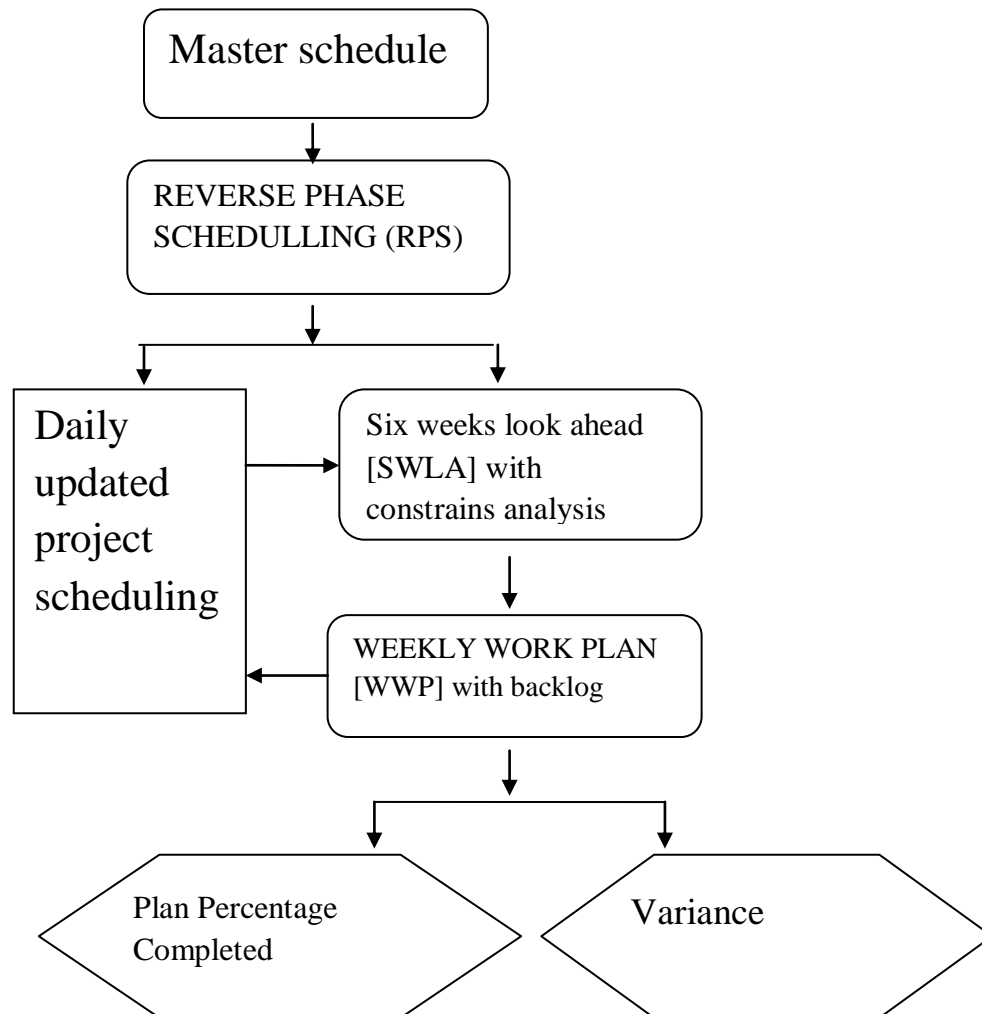


FIGURE 3.0: THE SQUENCE OF LAST PLANNER [Salem et al, 2005]

The process steps are as follows;-Master schedule was developed by the project manager base on time given to the team and previously executed projects. The schedule, drawings, early warning chart, and construction methodology were all distributed to the team members before the reverse phase schedule meeting is conducted. The LPS concept was link to the objective of the project, and the procedure was explained to the team before the RPS meeting. All the team members participated in developing the RPS activity program. The logic of the activities is identified and the sequence is adjusted to requirement. Activities that dominate the critical path are identified, and the floats provided are added to activities with uncertainty in the critical path. The master schedule is the guide for RPS production. Finally a detail schedule is produced with constrains appearing. The process was observed and new detail schedule is produced.

Six week look ahead is developed by the project manager base on the result of RPS and master schedule. Constraints are recorded and analysed. SWLA is distributed to weekly work program meeting members. All members of the team participate in WWP meeting every Monday including the Honourable Commissioner of the ministry of Housing. The WWP is compiled from the submission by different trades before the meeting. The meetings usually addresses the issue of planning process such as schedules, manpower, safety, construction, early warning chart and all other problems. The meetings are open and integrate two way communications.

Every week the project manager compile the actual schedule of activities executed, and update the WWP schedule and variance control table and analyzed them. Percentage Program Completed [PPC] is calculated base on start and finished time of activity and circulated to members.

RESULT AND DISCUSSION

LAST PLANNER SYSTEM

It is verified that the validation of early warning schedule for materials and labour, all the activities will be completed within schedule. Each activity that is schedule to start within next six weeks is examined, and a look ahead window is design shorter. As all parties the will provide the necessary information required are within the project team. This gives a greater control over the work flow. All activities maintain their schedule as all constraints are removed in time. Problems are identified earlier and solved to at least maintain the look ahead schedule, and are imposed in the production level of the project.

Primary categories of constraints are provided in Activity Definition Model (ADM), that is, directives, prerequisite work and resources.

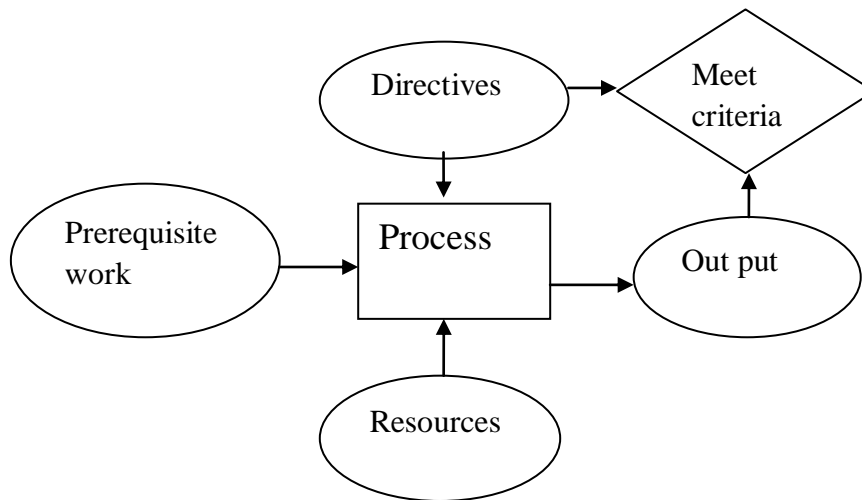


FIGURE 2.0: ACTIVITY DEFINITION MODEL (ADM)

Directives give guide according to which output is to be produced or assessed. Prerequisite work is the substrate on which work is done or added. Resources are the labour. The ADM tool is used to explode phase schedule activities in to greater detail through specification of constraints and further detail process. It was concluded that six weeks look ahead is enough for material and labour flow.

PERCENTAGE PROGRAM COMPLETED (PPC)

The weekly work program meeting is conducted weekly. The work was completed fifteen days before the RPS and four days before the master schedule.

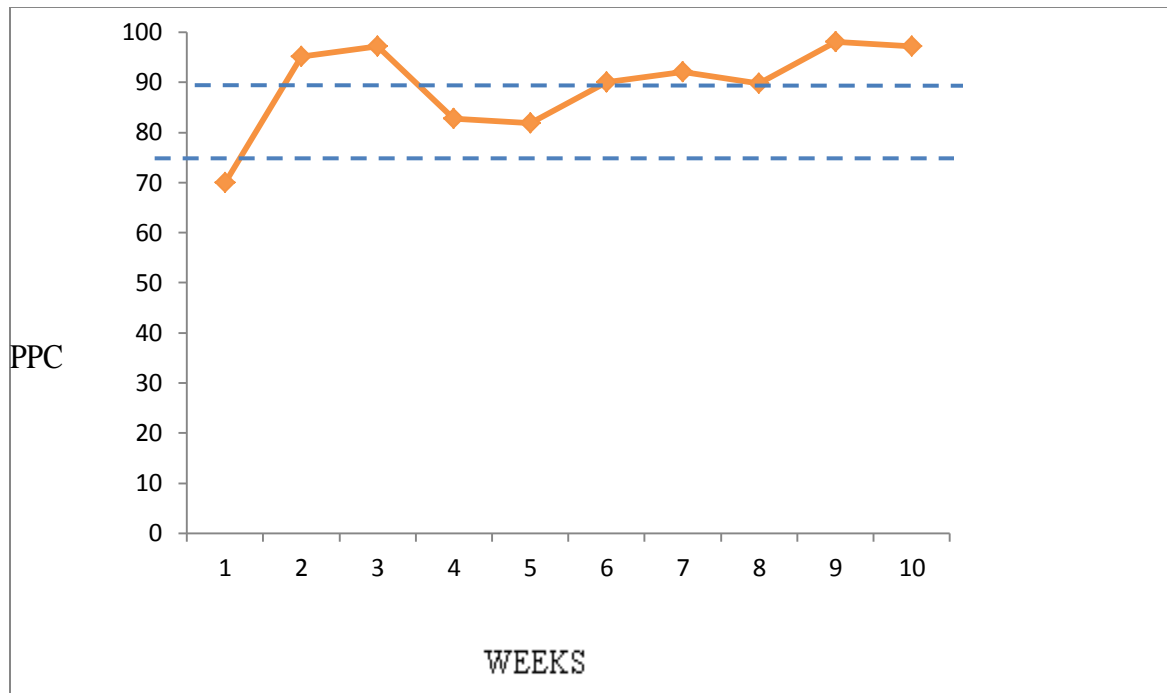


FIGURE 3.0 : PERCENTAGE PROGRAM COMPLETED

All values of PPC are above 70%, as no force majeure that interrupts the schedule. The values are achieved due to incentive created to team members, two way communications, understanding and team work; problems are solved once in WWP meeting. Also the estimated schedule is base on knowledge of traditional project management, which is the main reason that activities are completed before the schedule duration. Training on lean construction technique and production management will eliminate the conservative estimation. Most of the problems that arise are overcome by the project manager. Some constraints due human error are also managed.

FINAL ASSESMENT

The lean construction technique is new in Nigeria, few professionals in the construction industry know about it. The implementation process tends to be tedious. It involves training in both management and production using new materials. Therefore this assessment is pilot assessment cannot be compared with organized implementation process. The Last planner tested was assessed base on its contribution in achieving the objective of the project. The assessment was scaled as highly impressive as compare to initial traditional method. The Last Planner was assessed high due to its impact to the project objective, by maintaining the schedules.

CONCLUSION AND RECOMMENDATIONS

The paper assessed the implementation of Last Planner as Lean construction tool in Nigerian construction industry. The author is the project manager and the Last Planner in this project. The PM is the only one having the knowledge of lean construction techniques, but the support

and commitment of management staff and workers of direct labour unit ministry of housing, lean tools prove to be the solution to down fall of profit margin in Nigerian construction industry. All stakeholders in the industry should took the responsibility of training and enlightening all parties involved on lean construction techniques as a solution to its main problem. The conservative idea of management in production process that makes activities to overlap their schedules must be change for better. The research for implementation of lean techniques now continues, schedules estimation and weekly work program are reviewed, and more tools are going to be tested. It was provided in this year's budget the provision to construct 1000 houses using these techniques. Some institutions have joined the ministry in its effort to eliminate waste and non value adding steps in the industry to get low cost houses for its citizens.

REFERENCE AND BIBLIOGRAPHY

- Ballard, G., and Howell, G. (1997) "Implementing lean construction: improving downstream performance" Lean Construction, Alarcon, L. (ed), A. A. Balkema, Rotterdam, The Netherlands, 111-125.
- Ballard, G. (1999). "Improving work flow reliability" Proc., IGLC-7, 7 Conf. of Int. Group for Lean Construction, Univ. California, Berkeley, CA, 275-286.
- Ballard, G., and Howell, G. (2003) "An update on Last Planner" Proc., IGLC-11, 11 Conf. of Int. Group for Lean Construction, Blacksburg, VA <<http://strobos.cee.vt.edu/IGLC11>> (Mar. 5, 2004)
- Blacksburg, VA. 418-426. <<http://strobos.cee.vt.edu/IGLC11>> (Mar. 5, 2004).
- Schwaber, K. (2002). Agile Software Development with Scrum. Prentice Hall. Upper Saddle River, NJ.
- Banik, G. (1999). "Construction productivity improvement" ASC Proc. 35th Annual Conf. April 7-10 Associated Schools of Construction. San Luis Obispo, CA, 165-178.
- Koskela, K. (1992). "Application of the new production philosophy to construction" CIFE Tech. Rep. No.72, Center for Integrated Facility Engineering, Stanford Univ., Stanford, CA, 4-50.
- Koskela, L., Howell, G., and Dr. Tech. (2000) "Reforming project management: the role of Lean Construction" Proc., IGLC-8th Conf. of Int. Group for Lean Construction, 8 Brighton, Brazil
- Moser, L., and Dos Santos, A. (2003) "Exploring the role of visual controls on mobile cell manufacturing: a case study on drywall technology." Proc., IGLC-11, 11th Conf. of Int. Group for Lean Construction,
- O. Salem, J. Solomon, A. Genaidy, and M. Luegring Lean Construction Journal 2005 Vol 2 # 2 October 2005 Site Implementation and Assessment of Lean Construction Techniques
- Paez, O., Salem, S., Solomon, J., and Genaidy, A. (1995) "Moving from Lean Manufacturing to Lean Construction: Toward a Common Sociotechnological Framework." Human Factors and Ergonomics in Manufacturing, 15(2), 233-245.