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EXPLORING THE IMPLEMENTATION OF THE LAST PLANNER® SYSTEM THROUGH IGLC COMMUNITY: TWENTY ONE YEARS OF EXPERIENCE

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ABSTRACT

There is robust evidence that the level of implementation of the Last Planner® System (LPS) is increasing geographically and geometrically in construction. The International Group for Lean Construction (IGLC) community has reported this growth at IGLC conferences over this period. However, no study has explored how the LPS and its implementation has developed or improved.

This study explored developments in the LPS from the review of IGLC conference papers. Qualitative research design utilising content analysis was adopted for this study comprising 57 IGLC reports on LPS implementation across 16 countries. The study reveals components of LPS implemented, with measuring of PPC, Weekly Work Planning meeting and recording reasons for non-completion the most reported. The study developed a timeline for the LPS development and revealed that some of the papers reviewed have no defined methodology.

The study concludes that the LPS has developed in terms of its level of implementation, theory development, and as a vehicle to improve construction management practice across the major continents of the world, with elements that had little presence at the onset now prominent. The study recommends that more attention should be given to the relationship between practical applications and research methods to aid the establishment of sound theory to improve practice.

KEYWORDS

Last Planner® System, implementation, lean construction, IGLC, production control.

INTRODUCTION

The Last Planner® System (LPS) of production control was formally introduced in the construction industry over 21 years ago. Its implementation has gained prominence in recent times and its influence on the production system seems magical

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(LCI, 2015). The LPS developed by Ballard and Howell in 1992 focuses on reducing the uncertainty in workflow overlooked in traditional project management (Ballard and Howell, 2003). Uncertainty or variability in workflow has been identified as a contributory factor to the poor performance of construction projects (Howell and Ballard, 1998; Ballard and Howell, 2003). However, the LPS is an integrated and comprehensive approach that intends to increase predictability and reliability of planned construction activities at the implementation stage on construction site (Mossman, 2014). It is worth noting that its application is not limited to the construction stage alone, as it is also effective at the design stage. More importantly, there are robust evidences that the level of implementation of the LPS is increasing geographically and geometrically in construction (LCI, 2015). Previous studies have reported the implementation of the LPS in building construction, heavy civil engineering construction, highway and infrastructure projects, including ship building and pit mining (Liu and Ballard, 2008; Ballard, 1993) with enormous benefits (Alarcón et al., 2005). However, no study has explored how the LPS and its implementation has developed or improved. Consequently, this study seeks to answer the research question; *"How has the LPS been implemented and developed over its 21 year life?"* The study highlights the major timeline in the LPS development, and examines the trend in the elements of the LPS. The study also reviews the methodologies adopted in LPS implementation.

THE LAST PLANNER SYSTEM

The underlying theories of the LPS revolve around planning, execution, and control. Ballard and Howell (2003) observed that the LPS focuses on planning and production control as opposed to directing and adjusting (cybernetic model) in the traditional project management approach. There are 5 key principles in the LPS which are; (1) ensure tasks are planned in increasing detail the closer the task execution approaches. (2) ensure tasks are planned with those who are to execute them (3) identify constraints to be removed on the planned task beforehand (4) ensure promises made are secure and reliable and (5) continuously learn from failures that occur when executing tasks to prevent future reoccurrence. LPS integrated components include; master plan, collaborative programming or phases planning, make-ready process, production planning, production management and learning (Ballard, 2000; Mossman, 2014). Its implementation supports the development of collaborative relationships among project stakeholders.

RESEARCH METHODOLOGY AND FRAMEWORK

Qualitative research design based on literature review and content analysis was adopted. The framework for the review is based on the approach recommended for content analysis by Berg and Lune (2011) and Robson (2002) as shown in Figure 1. Berg and Lune (2011) assert that content analysis is applicable in any field of human communication such as written documents, audio and video information, and it has been used in various field of learning for research, including construction management research (Jacob, 2010). Content analysis is used in research to achieve the following: (1) identify cultural trend in a group, institution or society (2) show trend in communication contents (3) identify response to communication (4) identify propaganda in information content and (5) show focus in communication by group, institution or society (Weber, 1985). Again, this shows that the choice of content

analysis for this study is not only appropriate, but also robust. For instance, in this study, content analysis was used to show trends in the content of communication on the LPS implementation in construction as published by the IGLC between 1993 and 2014. Content analysis enables study to ascertain data reliability when the documents analysed spans over a period of time (Weber, 1985). This implies that the findings from this review would be reliable since the cases analysed span a 21 year period.

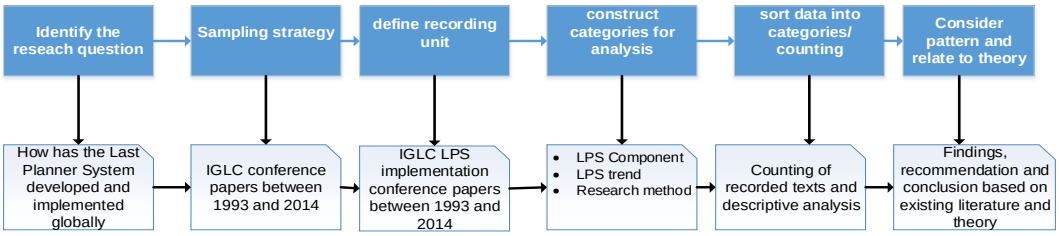

Figure 1: The Review Framework, Adapted after Berg and Lune (2011) and Robson (2002)

The data analysed are the publications of the IGLC annual conferences available at (www.iglc.net), although they are limited to publications that capture LPS implementation in construction between 1993 and 2014. Nevertheless, the study considers the sample appropriate as it has been reported that the IGLC database hosts the majority of publications on the application of lean in construction globally (Jacobs, 2010). The sample was arrived at through reading of the topic and abstracts of various sections and using keyword searches. These include publications from the production planning and control section; the case study and implementation section among others. Keyword searches on the database such as Last Planner System and case study were made in each publication year. This approach was used to avoid omission of papers on LPS implementation. Based on this, a total of 57 publications from 16 countries that reported LPS implementation were retrieved from (www.iglc.net) as shown in Table 1. Of these, 42 reports contained implementation on sites, 4 in design while 11 show no actual implementation. The 42 studies that reported LPS implementation on construction sites were analysed. The selected papers were read thrice, with a focus on obtaining information on the stated objectives. (See link to the reviewed papers https://www.dropbox.com/s/e26b47m4721ren3/IGLC%20LPS%20implementation%20papers%20reviewed.pdf?dl=0). The findings are discussed below.

RESULTS AND DISCUSSIONS

LAST PLANNER SYSTEM IMPLEMENTATION ACROSS COUNTRIES

Table 1 presents a glossary view of the LPS implementation in construction across the globe. The result indicates that the USA recorded the highest number of LPS implementation cases; this is not surprising since the initial concept and its pioneers, Howell and Ballard are based there. This, in addition to the collaboration between the construction industry and centres in institutions of higher learning such as Project Production Systems Laboratory, University of Berkeley (http://p2sl.berkeley.edu/), Lean Construction Institute's (LCI) partnership with contractors and clients in the USA could also have contributed. The study reveals that the uptake of the LPS is not limited to North America alone, as implementation has been reported in almost all the

continents of the world. This shows the universal applicability of the LPS; overcoming language and geographical barriers. However, it is worth noting that cultural barriers such as attitude to work could influence the LPS implementation (Johansen and Porter, 2003).

Table 1: Last Planner System implementation across countries

Country	Number of cases
USA	15
Brazil	10
Norway	5
Venezuela	5
UK	4
Chile	4
Korea	3
Nigeria	2
Finland	2
Lebanon	1
Peru	1
Mexico	1
Ecuador	1
India	1
Saudi Arabia	1
New Zealand	1
Total	57

To be specific, Johansen and Porter (2003) reveal from their study that cultural and structural issues among the barriers to LPS implementation in the UK construction industry. These issues include; the blame culture between subcontractors and main contractors, the deep rooted culture that the main contractor should bear all responsibilities. A further examination of the data reveals that South America recorded the highest number of cases of LPS implementation. This could be due to the collaboration between construction companies and research institutions in the area, cum support from active lean construction researchers such as Carlos Formoso (Brazil) and Luis Alarcón (Chile) (Formoso, Tzortzopoulos and Liedtke, 2002; Alarcón et al, 2005).

MAJOR COMPONENTS OF LAST PLANNER SYSTEM IMPLEMENTED

As shown in Figure 2, measuring Percentage Plan Completed (PPC), Weekly Work Planning (WWP) meeting, and recording reasons for non-completion (RNC) are among the commonly implemented components of the LPS in the IGLC papers reviewed. This finding aligns with recent empirical findings such as Dave, Hämäläinen and Koskela (2015) where they observed that WWP was the most commonly implemented LPS element from the evaluation of five projects and a

detailed case study. Daniel, Pasquire and Dickens (2015) also observed that phase planning/collaborative programming, PPC measurement and WWP meetings were the most fully implemented LPS elements from their evaluation of 15 construction projects in the UK. The frequent reporting of the measurement of PPC in the studies reviewed seems to show PPC measurement is among the early indicators of LPS implementation in construction.

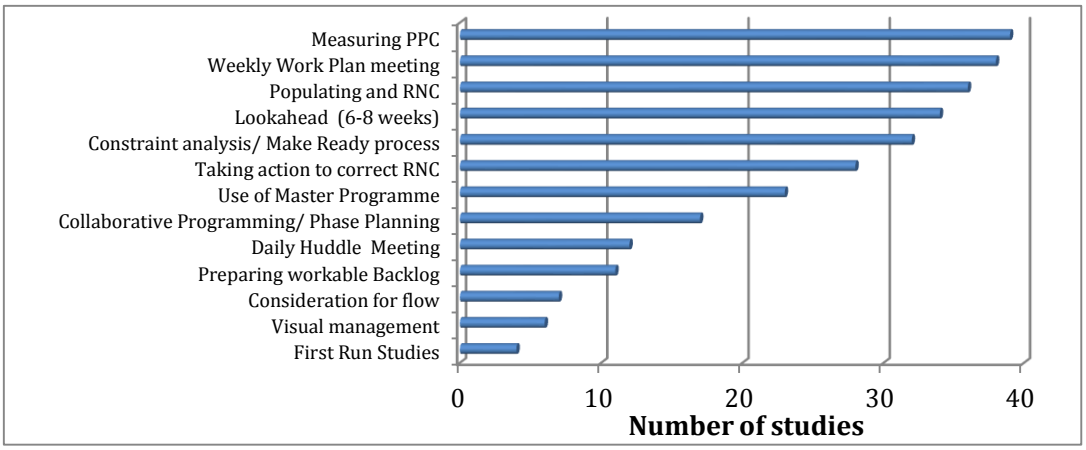

Figure 2: Components of LPS reported in the review

Ballard (2000) asserts that PPC measurement supports continuous improvement as it allows the team to learn from the reasons for non-completion. These are collected at the WWP meetings which is part of the PPC measurement process. This implies that the PPC measurement does not only show plan reliability, but also other project performance indicators such productivity (Liu and Ballard, 2008).

The use of First Run Studies (FRS) and Visual Management (VM) were less reported in the IGLC papers reviewed, even though FRS was among the LPS components implemented as stated in the earlier reports, see Ballard (1993). However, visual management was never described in detail, in the earliest studies on LPS implementation. This could be the reason why VM was less mentioned in the LPS implementation studies reviewed and why lean construction practitioners in the UK construction industry claim that VM is not part of the LPS (Daniel, Pasquire and Dickens, in press). However, when considering the meaning of VM it would seem to be clearly embedded in the LPS system. According to Liff and Posey (2004, pp.1-5), VM is a management approach used to align an organisation's goal, vision, value, and culture in the workplace through visual stimulation of the stakeholders on the project for continuous process improvement. It can be argued that the display of PPC, RNC, magnet planning board, phase scheduling/collaborative planning board and the use of coloured stickies are all part of a visual management system and also part of the LPS.

TRENDS IN THE IMPLEMENTATION OF LPS COMPONENTS

The study reveals that LPS elements reported were not consistent across the years. This could be due to the evolution of the LPS over this time. For instance, phase scheduling/collaborative programming became prominent after year 2000. This could be due to the publication of a white paper by LCI in 2000 to back its use (Ballard, 2000). Furthermore, the study reveals a progressive increase in the use of most of the elements in recent years, as shown in Figure 3, with few exceptions such as workable

backlog and FRS. This confirms that the implementation LPS element is growing (LCI, 2015).

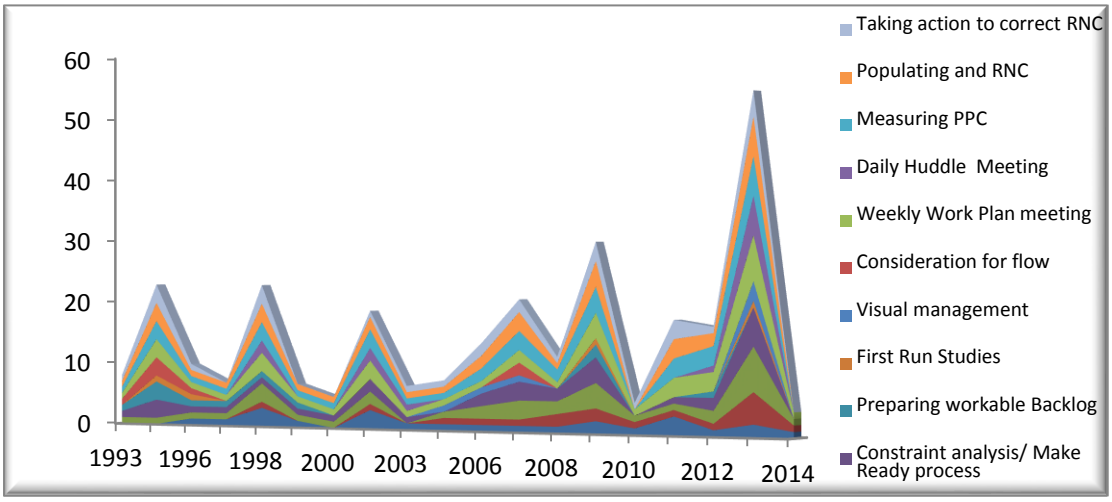

Figure 3: Trend in LPS Elements implemented across the years

However, the extent of the implementation of these reported elements (i.e. in terms of partial or full implementation) still remains an issue to contend as recent empirical studies have shown some of these elements are not fully implemented as claimed. For instance, Dave, Hämäläinen and Koskela (2015) observed from the evaluation of the LPS on five construction projects that lookahead planning was only fully implemented on one out of the five projects. Daniel, Pasquire and Dickens (2015) also observed partial and in some case no evidence of LPS element implementation from their study in the UK. The study also reveals the trend in the use of master programme in developing the phase scheduling or collaborative programme was on the increase over this time. This shows that the LPS has not been totally liberated from the traditional approach of managing construction project. Koskela, Stratton and Koskenvesa (2010) in their attempt to compare the LPS and Critical Chain method (CCM) concluded that both the LPS and CCM were still trading on the traditional critical path method (CPM). However, with the current application of the LPS in design and the emerging concept of Target Value Design (TVD) this can be improved.

EVALUATION OF RESEARCH METHODS USED IN LPS IMPLEMENTATION

Figure 4 indicates that only 35.7% of IGLC papers reviewed have defined research methods. This may be due to the practical application nature of IGLC publications on LPS, coupled with industry papers that merely report case studies with less attention on the scientific methods used in the process. Nevertheless, this should be a point of concern to the IGLC research community that is seeking to build lean construction on sound theories and principles for better practice. Sound theories can only be developed from sound methods and methodologies. Additionally, the review indicates that case study approach was commonly used in the LPS implementation. The use of case study in LPS implementation is inevitable because of the practical nature of the implementation on the construction process. However, case study alone may not be sufficient to generate the needed learning from implementing the process in construction. In view of this, lean construction researchers have called for the use of

other forms of proactive research methods such as action and design science research alongside case study (Koskela, 2008).

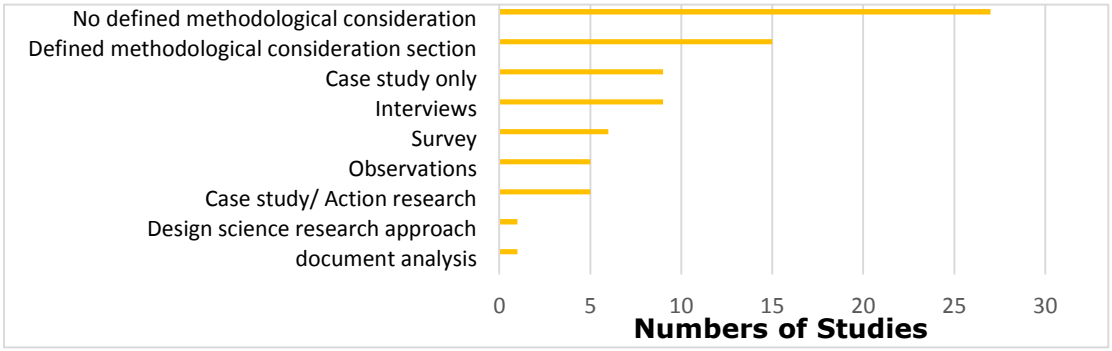

Figure 4: Research methods used in LPS implementation reported in IGLC Conference Papers

THE DEVELOPMENT OF THE LAST PLANNER SYSTEM

The timeline reveals that the concept of the LPS was developed out of consulting work in the industrial construction sector by Glenn Ballard and Gregory Howell (Ballard, 1993; Ballard and Howell, 1998).

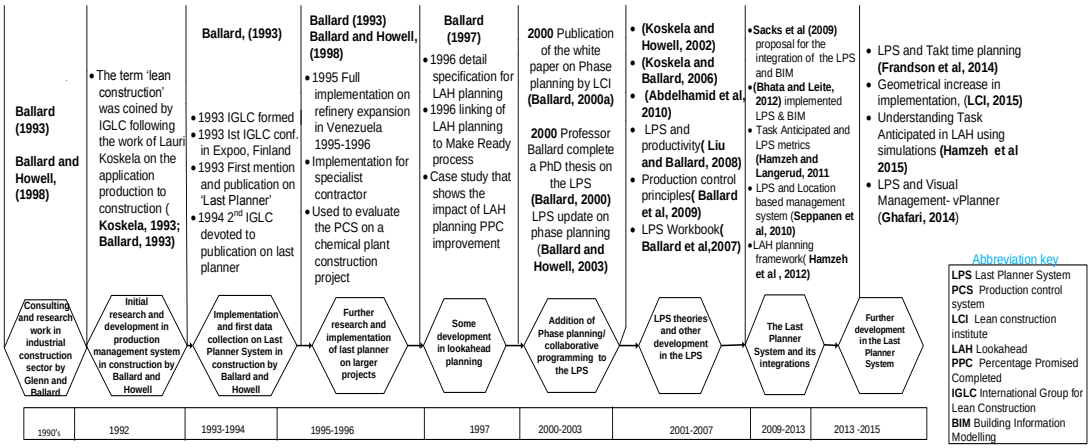

Figure 5: Time line highlighting major developments in the Last Planner System

This shows that the LPS does not originate from the Toyota Production System (TPS) as viewed in some quarters, though its principles align with the TPS. According to Mossman (2014, pp.1-5) the LPS is the production planning and control system developed for the construction industry by construction professionals. The timeline reveals that the initial principles of the LPS are to; improve workflow, improve plan reliability and predictability (Ballard, 1993; Ballard and Howell, 1998; Ballard, 2000). These principles have not changed but have greatly improved through research and practice. Another highpoint in the development of the LPS was Glenn Ballard's PhD thesis on the LPS of production control which happened to be the most referred publication on the LPS. A most recent google scholar search reveals that the publication has been cited 714 times (Google scholar, 13/05/ 2015 at 14:29 hrs). This has initiated various academic researches into the LPS both at masters and PhD levels in various parts of the world. This shows the development of the LPS in terms of

research. The further exposition on the underlying theory of the LPS by prominent lean construction scholar such as Koskela, Howell, and Ballard among others brought much understanding on how the LPS works in construction. It is worth to note that the IGLC as a body is committed to developing sound theories for better practice and performance of the construction industry. The LPS is has been evolving, as seen in its integration with other systems such as BIM among others. This is made possible through its robust theory development. Koskela, (2000, pp. 3) state that "*our efforts to develop construction, say through industrialization or information technology, have been hindered by the lack of a theory*". This further magnifies the importance of development of theories for the LPS and lean construction in general.

CONCLUSIONS

The aim of this study is to explore the developments and implementations of the LPS from the IGLC community. The study established that the LPS was developed out of consulting work in the industrial construction sector. The system was specifically developed for the construction industry by construction practitioners to minimise uncertainty in the production process and not from the TPS concept as claimed in some quarters. The study confirms that the LPS is not static, but rather dynamic and has evolved positively over the last 21 years. It reflects this in its ongoing researches in different parts of the world, development of theory to explain current practice and its successful integration with other systems such as BIM, Takt time planning, and Visual Management planning software such as vplanner®.

The study reveals that measuring of PPC, having WWP meeting and populating RNC were among the common components of the LPS reported in the papers reviewed. However, practices such as developing workable backlog and FRS were less reported even though they were part of the initial element of the LPS. The study concludes that the LPS has developed in terms of its level of implementation, theory development, and as a vehicle to improve construction management practice across the major continents of the world.

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