LAST PLANNER SYSTEM – A STEP TOWARDS IMPROVING THE PRODUCTIVITY OF NEW ZEALAND CONSTRUCTION

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ABSTRACT

Productivity of New Zealand's construction sector is declining compared with other countries and with most other sectors of the New Zealand economy. In response, the New Zealand government has set a target to lift construction sector productivity by 20% from the year 2010 to 2020. Development and use of new tools is seen as part of the solution, as is the adoption of international construction best practice. Lean Construction approaches are among those considered international best practice; construction industry experience with Lean is widely used and reported around the world in North America, Europe and Asia, but adoption has been very limited in New Zealand to date.

The basis of the research was the low level of implementation of Lean methods, more accurately Last Planner System (LPS) in New Zealand commercial construction. The focus of the research was on the perceived benefits and challenges of LPS and the factors which hinder its implementation in New Zealand companies. While the findings indicate that benefits and challenges are generally perceived to be the same as those reported internationally, procurement methods have been raised as a key issue when considering the obstacles to implementation in the New Zealand context.

KEYWORDS

Planning, Production Control, Last Planner System, Productivity, Impact, Perceptions.

INTRODUCTION

Productivity in the New Zealand (NZ) construction industry is clearly an issue that needs to be addressed, as illustrated by a number of indicators demonstrating that not only is productivity low by international standards, it is also declining. The construction sector in NZ employs 8 % of the workforce, but generates only 4 % of the national GDP (PriceWaterhouseCoopers, 2011). This would put NZ in 43rd place with the Republic of Moldova and Hungary in the United Nations 'Share of construction in Gross Domestic Product' list. (UNECE, 2011) Labour productivity rate in NZ is about 30% lower than near neighbour Australia. (Department of

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Building and Housing, 2012). According to the NZ Government Statistician, a fall in productivity in the NZ economy between 2006 and 2009 was largely attributable to the construction and manufacturing sectors. (Bascand, 2011)

The New Zealand Building and Construction Sector Taskforce (2009) concluded that the key factors implicit in the NZ Construction sector's poor productivity are innovation, regulation, procurement practice, management capability, skills and job churn. To address these issues, the sector and the NZ Government (through the Department of Building and Housing) established the Building and Construction Sector Productivity Partnership in November 2010. The goal of the Partnership is to increase productivity by 20% by 2020. Development and use of new tools is seen as part of the solution, as is the adoption of international construction best practice (Kane, 2012).

The basis of the research was the low level of implementation of Lean methods, more accurately Last Planner System in New Zealand commercial construction. The focus of the research was on the perceived benefits and challenges of LPS and the factors which hinder its implementation in NZ companies. Data collection was done through interviews in large New Zealand construction companies which use LPS in their commercial construction projects.

NEW ZEALAND CONSTRUCTION IN CONTEXT

New Zealand consists of two main islands with a combined length of 1600 km. Both islands have a spine of mountains and additional individual ranges, increasing the time and length of transportation routes. Most of the country is rural and the 4.4 million population is spread across many small population centres (Statistics New Zealand, 2012). This scattered distribution restricts the number of large construction projects and companies that the market can support. The vast majority of construction companies are very small, with sole traders accounting for 21% of companies, and fewer than 10% of companies having more than five employees (Kane, 2012).

The closest neighbour and biggest trading partner Australia lies 2,250 km northwest. Main centres of Asia and the United States are approximately 10,000 km away. Largely due to this geographical isolation and small market scale, the New Zealand construction industry has not been strongly influenced by many of the trends and innovation in construction internationally. Construction and procurement methods remain mainly traditional.

DRIVERS OF LOW PRODUCTIVITY IN NEW ZEALAND

The NZ Building and Construction Sector Productivity Taskforce (2009) identified six factors as key to the issues around low productivity:

- *Innovation:* Construction methods tend to be relatively traditional, with little innovation or use of new methods. Where there has been innovation, for example in building materials, this has largely acted to improve quality rather than to enhance efficiency. The New Zealand Construction Industry Council (2004) identified the lack of innovation in the industry as a pervasive factor that is strongly connected to procurement practice: "The lowest-bid approach compromises health and safety, quality, training, environment and education, all of which constrain innovation." (p10)

- *Regulation:* Regulation is seen to limit construction activity, increase costs and stifle innovation.
- *Management capability*: The small organisational scale of the NZ industry means that very few companies are able to invest in management and leadership development. Moreover, firms are generally forced to train their own managers through work experience, often struggling to find skilled managers when there are not enough construction management graduates to fill the roles. Twelve per cent of the managers had a bachelor's degree or higher, while in other occupations the number is 19 %. (Department of Labour, 2009)
- *Skills:* Trade skills also need improvement. The economic upswing brought a lot of unskilled labour into the sector and apprenticeship levels are low.
- *Job churn:* This level of reactivity to the market makes it difficult for workers to envisage a career in the sector or see the advantages of developing trade or professional skills, when there is so little continuity.
- *Procurement practice:* The most widely used procurement method in the NZ industry is the traditional, Lowest Price Conforming, despite the many disadvantages recognised in using this method: "high risk of cost time and quality blow-outs dues to unforeseen design errors, client changes, contractor quality. It limits innovation opportunities and can be adversarial." (Building and Construction Sector Productivity Taskforce, 2009, p. 20). Because of these disadvantages, the Working Group recommended that the traditional procurement method be used "…only for simple, repeatable projects which can be fully pre-designed with few or no client changes. The method is not generally recommended." (p.20) Current procurement practice does not allow early collaboration in projects or encourage collaboration during the construction stage, but maintains an unhealthy culture of claims (Building and Construction Sector Productivity Taskforce, 2009). In addition, the New Zealand Construction Industry Council (2004) has identified that there is too great a focus on term costs, and not enough attention to life cycle or long term costs. The concept of value, as opposed to cost, is poorly understood, and risk allocation is frequently managed purely by requiring fixed price contracts, rather than more sustainable risk management practices.

PRODUCTIVITY AND LEAN CONSTRUCTION

A wide body of literature (Ballard & Howell, 2004; Howell, 1999; Wood, 2004) supports the view that Lean Construction provides a new paradigm for project management, a cognitive way of thinking and planning. Such a planning approach may better meet customer needs while reducing waste and using less of everything. New project delivery systems can be applied to all construction projects, but are particularly suited for complicated, uncertain projects requiring completion within a quick timeframe. Lean Construction has three main focuses that distinguish it from traditional construction management. The first focus is on waste and the minimisation of waste (internal, physical); the second focus is on productivity and how it can be

maximised to its full potential by managing flows; the third one is maximising value. (Ballard & Howell, 1994; Howell, 1999)

Last Planner is one of the main Lean Construction tools. In contrast to traditional planning systems, which use a push system, LPS is based on a pull system. Pulling allows resources into a production process only if the process is capable of doing that work. It can be understood as a mechanism for transforming what should be done into what can be done (Ballard, 2000).

The benefits of Lean Construction methods and LPS in construction production have been widely reported for some time. Ballard (2000) measured productivity increases on three case study projects with results ranging from 10% to 40 %, with 30 % as a median. Mader (2003) studied 50 projects from one company and found that the LPS process saved an average of 17% of the projects' labour budgets, while another company was able to shorten the programmes by as much as 20%. Horman, Minchin, and Chen (2003) proved that effective flow management can improve construction labour performance. Alarcón, Diethelm, Rojo and Calderon (2005) reported project performance improvements of between 7-48% and up to 86% productivity improvements in individual projects when using LPS in production. Evidence is quite clear that LPS, when used appropriately, improves project performance and increases productivity. Despite this evidence, the adoption of LPS in New Zealand has been very limited to date. Implementation of Lean Construction and more specifically the Last Planner System is potentially an answer to the question of how to improve productivity in the New Zealand construction sector.

RESEARCH METHOD

In order to explore the poor uptake of LPS in New Zealand commercial construction, this research sought to examine the perceived benefits and disadvantages of LPS implementation, and through that to identify the reasons behind the slow.

The first step in the research was to identify companies in the Auckland area which use LPS in their production. Focus was on the large main contractors in the area. Through an enquiry process, three large main contracting companies were identified. The chosen research approach was qualitative, using semi-structured interviews as a method to focus on industry perceptions. Six interviews were conducted, two with site managers and four with project managers. Each of the managers had an average of 5 years' experience with LPS, both in New Zealand and overseas companies. On average, they had implemented LPS in seven projects.

The interview was conducted in two parts: the first part identified the level of understanding that participants had of LPS. This was done to ensure there were no misunderstandings of the key focus of the study. All six participants had at least a fair amount of knowledge about the LPS processes and tools. The second part of the interview investigated the participants' perceptions of the benefits and challenges that LPS presents. All of the participants also had experience in conventional push-planning methods, which allowed comparisons to be discussed between conventional planning and LPS. The pre-planning and planning during construction stages were investigated separately to explore what effect the procurement method had on the success of LPS in use.

FINDINGS AND DISCUSSION

UNDERSTANDING AND USE OF LPS

One of the participants was very experienced in the use of LPS, having used it in 25 projects both in NZ and overseas. At the other end of the scale was a project manager who had used LPS only once, but he had very good theoretical knowledge of LPS through his education. The implementation of LPS also varied; some managers were more orthodox than others, but this did not directly correlate with their experience with LPS. All had a good understanding of the pull mechanism of the system, the importance of the structured meetings and the measurement metrics.

Two of the participants were site managers and therefore had not used LPS earlier than in the construction stage. The other four, who were project managers, had used LPS also in earlier stages; the extent depending on the procurement method used. In construction stage implementation all managers applied LPS in a very similar way. They had weekly meetings with all the subcontractors and trade foremen. Some had designers and clients also participating in these meetings, while others kept LPS meetings separate from designer meetings. In addition the managers held daily meetings closer to milestones and completion dates. Percent Plan Complete values were reviewed in the meetings and once reasons behind the delays were discussed the Weekly Work Plans were looked at. Some of the managers used Five-Week Lookahead programmes, some Six-Week. These were reviewed and updated in each meeting.

PERCEPTIONS OF BENEFITS

The findings indicate that benefits and challenges are generally perceived to be much the same as those reported internationally.

Participants stated that when using conventional planning systems most time spent on-site is unproductive. They saw LPS essentially as a tool that removes wastage and improves productivity while reducing construction time as a result. Time was not used in 'firefighting', but for productive work as planned. This aligns closely with Mader's (2003) views and experiences. The participants highlighted that the reduction of construction time is achieved when more planning is done earlier in the project. This is done by incorporating all project participants in collaborative discussions as early as possible, preferably at the design stage, to discuss the design and how it affects buildability. Changes in design can be used positively, reducing construction time and costs instead of increasing them as changes in the construction stage usually do. Participants reported that 100 % of projects using LPS were finished on time. One manager identified that in their current project construction time has been reduced from 10 to 7 months by using LPS. Another manager had experienced 20-30 per cent savings on time. Reduction of time was also seen as reduction in cost by most of the participants, but some highlighted that when combining design and build the overall cost might stay the same, but more value is provided for the client. Finding the best combination of construction systems and methods at an early stage frees up money for other design aspects such as better functionality and quality.

Other benefits found were closer working relationships, collaborative team building and enhanced communication. The participants stated that "the meetings got everybody communicating and developing stronger relationships between one

another", "LPS opens up the lines of communication" and "why tell one subcontractor what the other is doing, when they can do it themselves". These views are supported by Salem, Solomon, Genaidy & Luegring (2005).

LPS was also perceived to increase planning reliability, which also affects productivity. Participants reported increased reliability of delivery by subcontractors, more relaxed management when subcontractors started to manage themselves, continuous improvement and forward thinking. The improvement in the reliability of delivery was seen to be a result of the high level of communication between the project team prior to construction. Trades and subcontractors were standing by their decisions, because they had made the decisions themselves and committed to them in front of the whole project team.

PERCEPTIONS OF CHALLENGES

Four of the six participants addressed some negative effects of using LPS in production. One participant did not see any downside at all in the use of LPS, while another could not find any negative effects from his own experience, but considered that "LPS is getting a bad representation because it is being misused". This challenge of partial or incorrect implementation is one of 12 challenges identified by Porwal, Fernández-Solís, Lavy and Rybkowski (2010). In this instance, however, the challenge was an industry-level rather than an implementation challenge, in that it was seen as an inhibitor of adoption in the industry as a whole, rather than a problem experienced on a particular project.

Two participants stated that it was difficult to get buy-in from subcontractors who were first time users of LPS. In those cases more effort was required in educating the subcontractors rather than managing them, and the whole process needed more time. LPS meetings were seen as a time consuming process themselves; efficient facilitation was needed to keep everybody focused. A special facilitator was used in some cases to assist the project or site manager to run the meetings.

One of the challenges was to keep everybody scoring their delays during construction. Reviewing past work was not common practice for the trades and subcontractors and although the reliability of delivery improved as a result of LPS, for some it was difficult to admit that the delay was their responsibility. Some subcontractors also found it difficult to present their ideas in front of the whole team. This was either because they were not used to speaking in front of so many people, or they found it difficult to say their part when other team members were dominating the discussion.

It was also noted that it was a struggle to get designers to participate. One view was that in most cases in traditional Design-Bid-Build projects the designers have already used most of their fees by the time the construction stage begins, and they are not willing to put in the additional time required for the meetings. Another view was that designers did not want to confront buildability issues at this stage, when it either meant big changes in the design or big difficulties in the construction.

One of the participants also commented on tender cost, as more work was required for pre-planning using LPS and if the company was not awarded the contract, the money was lost. LPS or Lean Construction principles as a whole were not seen to work well with traditional Design-Bid-Build procurement.

IMPACT OF PROCUREMENT METHOD

Procurement method was raised as a key issue when considering the obstacles to implementation. As Heidemann and Gehbauer (2010) state, "Lean Construction enhances the cooperative project delivery with a focus on customer needs and the optimisation of the project as a whole rather than pieces during the design phase, as well as, during construction" (p. 581). This is well reported in the literature. However, there is little exploration of the effect that choice of procurement method has on the use of LPS. During the interviews, it became obvious that the chosen procurement method had a significant impact on achieving a trouble-free and successful implementation of LPS.

The most commonly applied procurement path in the participants' projects was traditional tender such as Design-Bid-Build. This is the most common method used in New Zealand commercial construction, regardless of the fact that it has been identified as "suitable only for simple, repeatable projects which can be fully pre-designed with few or no client changes" (Warren, 2009, p. 17). All participants agreed that Design-Build or Negotiated procurement paths were more successful options to realize the full potential of LPS. When Design-Bid-Build was used it was impossible to start full pre-planning process using LPS early enough, because the identity of the subcontractors involved was unknown until late in the tendering stage. Early involvement with subcontractors and suppliers was seen as a critical success factor by the participants, because it enabled proper pre-planning. Designers were not considered to be strong in their awareness of buildability. Early involvement with the design team even as early as in the feasibility analysis stage was seen as another critical success factor in achieving more detailed planning around methodology and buildability, although this had less to do with LPS directly and more to do with the lean principles that accompanied adoption of LPS. On the other hand one of the project managers suggested that LPS should also be used as a design management tool. This aligns with Ballard's (1999) views of using pull techniques in design management. Overall, Design-Build as a project procurement method brought more control over the whole planning process.

The respondents believed that the importance of early involvement is not always seen so clearly by the client or by subcontractors who are unfamiliar with LPS. Early involvement of the larger project team means that the project requires more significant inputs from the client at an earlier stage. It can be difficult for the client to see that the overall costs of the project might be smaller, or for them to understand the difference between value and cost. As mentioned previously, LPS is still a relatively new system in New Zealand and few clients or subcontractors have been exposed to it. Therefore it is difficult for the client and the subcontractors to understand the full benefits of the system. Respondents considered that understanding the theory behind the practice is a way to gain buy-in from client and subcontractors, and also that gaining that buy-in is essential for the successful implementation of LPS. The client after all is the one who decides the procurement method, and the subcontractors are the Last Planners.

Although Design and Build was preferred by the participants, this procurement method also has its deficiencies. Mathews and Howell (2005) list four major systemic problems with the traditional contractual approach, which also apply to DB:

- Good ideas are held back
- Contracting limits cooperation and innovation
- Inability to coordinate
- The pressure for local optimisation

Mathews and Howell (2005) suggest Integrated Project Delivery (IPD) as a solution for these problems. In IPD the whole team functions as a single company with shared responsibility. With IPD comes a different range of challenges such as insurance, bonding, job costing, job accounting, the formula for distributing gross, project leadership etc. (Mathews and Howell, 2005). This procurement and delivery approach has not yet been used in the NZ market.

CONCLUSIONS

Many technical tools are used in the implementation of LPS, but this study indicates that improved communication inside the project team is the underlying cause of improved productivity using LPS.

- *Design stage:* Improved communication affects the compatibility and buildability of the design, reducing the number of changes needed in the following stages. It also enables better flow of the design process, when pull method is used instead of the traditional push method.
- *Tender stage:* Improved communication increases the accuracy and predictability of planning, which increases the accuracy of the construction time and cost estimates.
- *Construction stage:* Improved communication enables a better flow of resources and affects the stress levels and overall wellbeing of the whole construction team.

LPS can only improve productivity for the stage and team where it is being implemented. If the procurement method does not allow it to be used before construction stage, it can only achieve a limited amount. To fully utilise all the aspects of LPS it should be implemented from the design stage, to coordinate and manage the design process and combine construction information into the design in the form of buildability and construction methods. Sharing knowledge among the project team as early as possible minimises the need for changes later in the project and frees up time and money to give better value for the client in the form of better functionality and quality. LPS, as for Lean Construction methods in general, works best when applied together with integrated procurement practices. As Procurement Workstream states “We know from numerous examples that through upfront planning and engagement of relevant parties, the application of better construction procurement skills and access to smart tools, processes and systems, more productive outcomes will be achieved.” (Kane, 2012). Adopting LPS as a general part of construction projects in New Zealand will improve the productivity of the industry. To what extent the productivity will improve depends on the ability of the construction industry to adopt other Lean methods and integrated procurement methods.

Future research in NZ context could focus on perceptions of a wider range of stakeholders such as clients, designers and subcontractors, including an investigation of why LPS is used more widely in civil construction in NZ rather than commercial construction. There is not yet enough experience in the use of LPS in NZ for a quantitative study addressing the productivity outcomes of LPS projects, but detailed case studies would provide more robust data to support the continuing uptake of LPS and the resulting productivity improvements.

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