MODELLING THE NETWORK OF COMMITMENTS IN THE LAST PLANNER SYSTEM

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ABSTRACT

Since the Last Planner System (LPS) was devised in the early Nineties, a number of studies have pointed out the need to understand the underlying theory in which it is based on. The Language-Action Perspective (LAP) has been suggested as a suitable approach to understand the management of commitments in the LPS. However, none of the previous studies have provided empirical evidence on the utility of LAP as a theoretical approach for explaining the LPS. This paper reports the results of a research project that aimed to investigate some benefit the utility of the LAP for evaluating the effectiveness of planning and control systems, emphasizing medium and short term planning.

Two case studies were carried out in different construction companies, both of them highly experienced on the use of LPS. In each company, the production planning and control system of one project was assessed, based on the mapping of the network of commitments regarding the medium and short term planning levels. Besides, an in-depth analysis of planning meetings was made, describing how they were carried out, who effectively participated in decision-making, and how the commitments were managed. In both studies, it was possible to track down how the commitments were initiated, and in some cases to analyse the integrity of the workflow loops in the network of commitments, and the consequences of failures in those loops for the planning and control system.

KEY WORDS

Last Planner System, Language-Action Perspective, Network of Commitments, Production planning and control

INTRODUCTION

The Last Planner System™ (LPS)[4] The Last Planner System (LPS) has been successfully applied in construction industry since the early Nineties in different parts of the world, such as Chile (González et al. 2007), Korea (Kim and Jang 2005), Middle East (AlSehaimi et al. 2009) and others. In Brazil, the number of companies that have adopted Last Planner is fairly high, although the level of implementation

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[4] Last Planner System is a trademark from Lean Construction Institute

varies to a great extend among them (Bortolazza and Formoso 2006; Formoso and Moura 2009).

The worldwide success of the Last Planner System has called the attention of the research community regarding the need to understand its underlying ideas, since this system has been developed through a series of industrial experiments. Koskela and Howell (2002) pointed out a strong connection that exists between Last Planner commitment planning and the Language-Action Perspective (LAP). According to those authors, LAP seems to be suitable to explain the two-way communication mechanism that exists at short term planning meetings, when representatives of production crews meet in order to assess the performance in the previous week and negotiate the work packages for the following week. Moreover, Koskela and Howell (2002) pointed out that this theoretical approach could contribute to build a more robust theory for project management.

The Language-Action Perspective considers human work as a network of commitments, therefore the work coordination should be based on the appropriate management of commitment flows (Winograd and F. Flores 1986). The trigger to start a commitment is a request made by one person and needs that another person promises to perform it. For Slivon et al. (2010), at short term planning meetings, the participants usually make promises in public, risking their reputations or personal identities when a commitment is established. According to those authors, this fact increases the likelihood the working crews to fulfil their promises, enabling the participants to develop trust on each other.

Although several papers from the Lean Construction community have suggested the strong connection between the Last Planner System and LAP (Koskela and Howell 2002; Macomber and Howell 2003; Howell, Macomber, et al. 2004; Howell and Macomber 2006; Slivon et al. 2010), none of them are founded on empirical studies. This paper describes two case studies in which the Language-Action Perspective has been used for assessing the effectiveness of planning and control systems, emphasizing medium and short-term planning. The aim of this investigation was to devise a method for modelling the network of commitments, and analysing planning meetings.

LANGUAGE/ACTION PERSPECTIVE

The Language/Action Perspective (LAP) is a way of representing the network of commitments of an organization. This approach was originated in Fernando Flores thesis (Flores 1981). LAP emphasizes what people do while communicating, how the language is used to create a common reality and how activities are coordinated through language (Kethers and Schoop 2000).

One important underlying theory of LAP is the Speech Act Theory. Searle (1969) structured some rules to systematize the context conditions that make the speech acts appropriate to any utterance. Based on this theory, Winograd and Flores (1986) suggested that the Language-Action Perspective can guide organization design according to what they named a "conversation-for-action model" that would be developed through the performance of some specific speech acts.

According to Medina-Mora et al. (1992), one of the methods to model LAP is the Action Workflow. They state that it is necessary two people to establish a commitment. The first one acts as a customer and the second as a performer. The

commitment loop that is proposed by those authors has four phases (requesting, negotiating, performing and accepting). An action starts with a request and is only considered done after the acceptance by the customer. The negotiation phase aims to establish the conditions of satisfaction of the action. Some authors (Cleary et al. 2008; Cleary et al. 2010; Slivon et al. 2010) stress that this phase regards a mutual promise between customer and performer.

Another important underlying idea was based on the studies of the philosopher Heidegger about the breakdowns. Heidegger argued that the existence of a thing depends on the individual perception about it (Winograd and F. Flores 1986). According to the referred authors a breakdown is not necessarily something to be avoided, since it is a non obvious situation in which the acknowledgment of how something went wrong may aware people involved about a different aspect of doing so. Regarding a hypothetical network of commitment of an organization, a breakdown in one of the loops can be the trigger to start new commitments apart from the common network.

METHOD

The case studies were undertaken in two different companies. Both of them were selected due to their willingness to participate in this investigation, and also because they had previously used the Last Planner System in several projects. Company A is a medium size construction company that have used Last Planner since the 1999. Differently from other construction companies in Brazil, most labour was directly hired by the company – only 20% were subcontracted. Company B is a large sized construction company, with operates in most Brazilian states. This firm has used a planning and control system based on Last Planner since 2007. In contrast to company A, the majority of its work force was subcontracted.

The main evidence sources were participant observation in planning meetings, interviews with meeting participants, and document analysis. Eight short-term planning meetings were observed in each company. The meetings of company A were chaired by the site manager, being usually attended by eight people, including crew leaders, foreman, and engineering interns. The subcontractors did not participate on that meeting. The meetings of company B were led by an engineering technical assistant and by a health and safety specialist, depending on the stage of the meeting. All subcontractors should have a representative at the meetings, although this was not always observed. On average, only 23.9% of the subcontractors attended the meetings. Altogether, around twelve people attended weekly meetings.

The focus of analysis was the understanding of how the commitments were managed during the meetings, and how each company created a trust environment to make promises. The meetings were recorded and transcribed. Each speech was classified according to the type of activity that had been performed, as show in **Error! Reference source not found.**. Although there is a holistic analysis through the interviews, the problems that were pointed out in the networks of commitments were based on the problems that came out during the planning meetings. Moreover, the networks shown in this paper are simplified in order to underline the specific problems that are discussed.

The network of commitments was mapped using the action workflow method. However, the preliminary analysis revealed some limitations of this method: it was

not possible to map activities that were started and performed by the same person, based on the assumption that a commitment needs two people. For that reason, some symbols were developed for individual activities in order to indicate triggers for subsequent commitments. Also, the relationship proposed by Van Reisjwoud and Dietz (1999) was used to understand some loop phase interactions. This study adopted, as well, a differentiation between a failure on the loop phase and a breakdown on it. The former represents a critical problem during the establishment of one commitment that the process is not able to deal with. The latter, in turn represents a problem that the process had created some mechanism to deal with. These symbols are shown in figure 2.

ACTIVITY	DEFINITION	SOURCE
INFORMATION SHARING	Informative discussion that does not propose the performance of an action.	-
REQUESTS	A customer request an action, or the performer offers, according to a condition of satisfaction.	MEDINA-MORA *et al.* (1992)
NEGOTIATIONS	Discussions that intend to change the conditions of satisfaction to perform the action.	MEDINA-MORA *et al.* (1992)
IDENTIFICATIONS	Discussions about a specific execution matter, without requesting an action.	-
RECOMMENDATIONS	Can be understood as an advice. It refers to the way an action should be performed, but it is just a suggestion, instead of an order.	SEARLE (1969)
VERIFICATION	Refers to declaration about the execution of the action, that can be satisfactory or not.	MEDINA-MORA *et al.* (1992)

Figure 1 - Types of activities performed in the speeches, during the planning meetings.

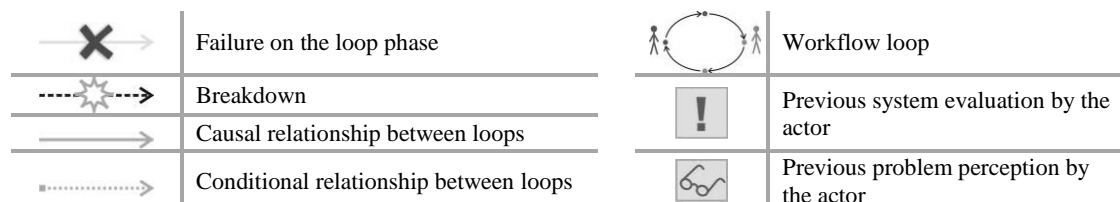|			
	Failure on the loop phase		Workflow loop
	Breakdown		Previous system evaluation by the actor
	Causal relationship between loops		Previous problem perception by the actor
	Conditional relationship between loops		

Figure 2 – Symbols adopted for mapping the network of commitments

RESULTS

COMPANY A

In Company A, the production manager is in charge of producing a master plan, which is represented by a Gantt bar chart. When construction starts, the site manager analyses all long-term constraints that cannot be removed within the look-ahead planning horizon. He is also in charge of updating the master plan and producing a four-week look-ahead plan. No formal medium-term planning meeting is carried out: electronic messages are sent to different company departments requesting the removal of constraints. Regarding short-term planning, weekly meetings are carried out for assessing the performance of the previous week and negotiating the plan for the following week.

The Network of Commitments

The analysis of the network of commitments indicates how complex the networks have become, mainly due to the lack of medium-term planning meetings. For example, the network of commitments for removing materials and equipment constraints is presented in figure 3, which shows that many commitment loops had to be created, making the management of constraints very complex. There were frequent failures along the loops at the medium-term planning level – for instance, the site manager sometimes was not aware of the status of materials delivery, resulting in planning errors, such as the assignment of tasks that did not have their constraints removed.

The network of commitments for removing equipment constraints shows an example of breakdown. In order to remove equipment constraints, such as renting scaffolds, the inventory chief manager is in charge of the negotiation with the rental companies. He contacts other sites of the company to see whether the equipment needed can be made available shortly. If this workflow loop cannot be completed, due to the lack of equipment available, this manager has to contact the rental company and rent what is needed.
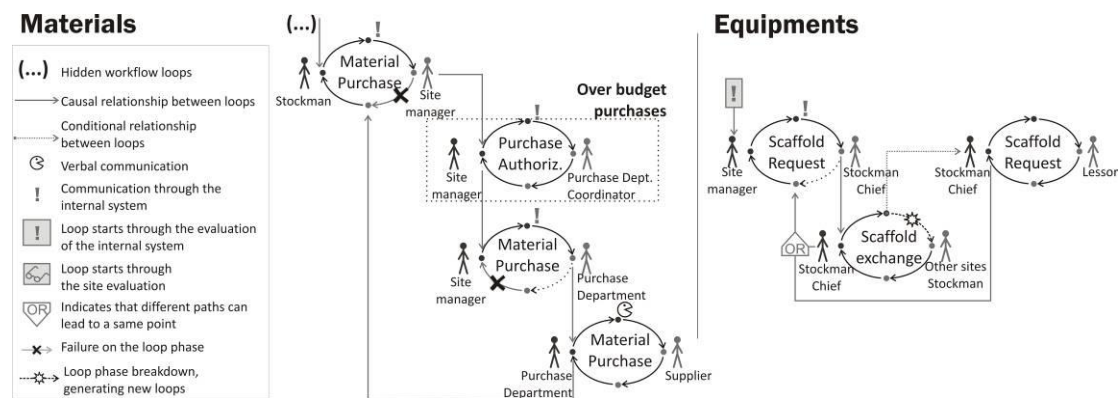

Figure 3 – Networks of commitments to remove material and equipment constraints

In the short-term planning, the control of the completion and of the quality of each work package was undertaken separately, since the trigger to perform each control was different. The former depends on the short-term planning horizon, which is one week. The quality control depends on the completion of production stages. Thereby, different people carried out those controls at different times, as shown in figure 4. This separation resulted in the possibility of considering completed work packages that have not had their quality checked, which may distort PPC results or cause the need of rework packages in the following week.

Analysis of the meetings

The short-term planning meetings were divided into two main stages. In the first stage, named verification, the site manager looks for the causes for the non-completion of work packages from the previous week. The second stage, named new packages, is when new assignments are discussed with crew leaders. The meetings also have moments in which the discussions are not related to any package - these moments were classified as discussions. Those stages of the meetings are not necessarily carried out sequentially, as shown in figure 5.

Much negotiation is carried out between crew leaders and the site manager in the new packages stage. During the discussions, the site manager informs the crew leaders about the activities that are expected to be carried out, thus making the teams aware about possible interferences among tasks. This would enable the group to find a solution together. Besides, at this stage the site manager discusses with the crew leaders whether their labour teams are performing satisfactory.
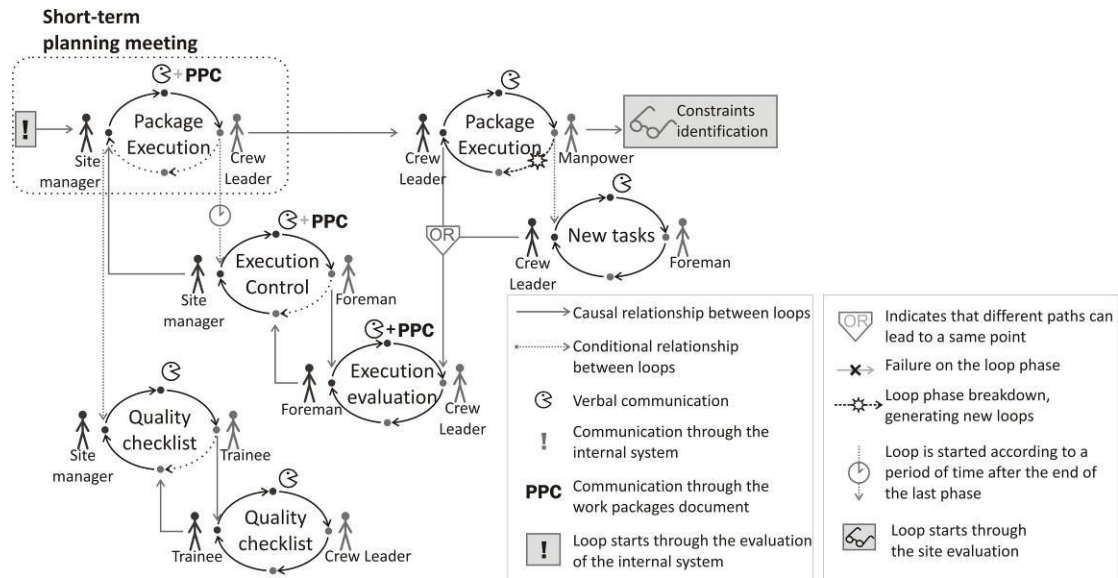

Figure 4 – Network of commitments of the short term planning

An analysis was made on the kind of activities performed during the meetings, resulting in a profile, as shown in figure 5. Although information-sharing represents the most frequent activity, since it takes 74.33% of the meeting time, the two main stages have a clearly different patterns according to the phase of the workflow loop that is performed: the acceptance phase in the verification stage (24% of the time of this stage) and the requesting and negotiations phases in the new packages stage (30% of the time of this stage).
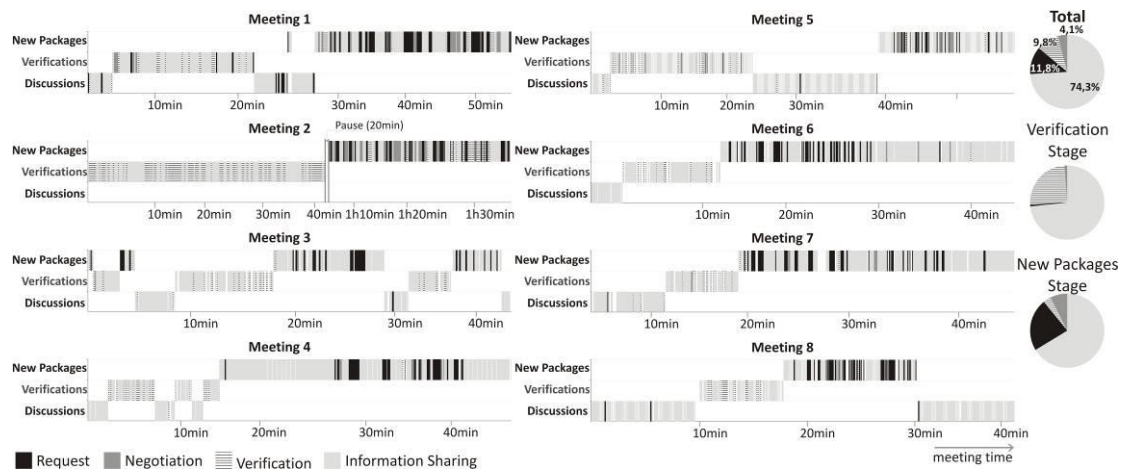

Figure 5 – Activities performed along the meetings steps, Company A

It is also possible to identify the impact of the lack of look-ahead planning meetings in the short-term planning. Much time was spent on discussions about tasks constraints, (21.8% of the meetings duration). The time spent in those discussions could be reduced if there were a meeting to deal with the constraints issues, which would also provide more transparency on the process, avoiding the communication problem pointed out in the networks of commitments to remove material constraints.

COMPANY B

The planning and control process in Company B was much more centralized, compared to Company A. The master plan of each construction site is initially produced at the company head office. If necessary, this plan is adapted to the context of a specific region of the country. This is decided in a meeting that involves the site manager, the head-office planning manager and the regional planning manager.

Regarding the look-ahead planning, the company has two different kinds of meetings for identifying and removing constraints. The constraints for short lead-time items are discussed in a weekly meeting, while for items that present a lead-time longer than a week there is a monthly meeting in which the managers from the company's central office also participate.

Regarding the short term planning meetings, it is divided into three stages: safety issues, product quality issues, and the definition of packages. The first part is chaired by the health and safety specialist, who makes a brief presentation of safety problems observed on site. A discussion involving also crew leaders, foremen and the site manager is then undertaken with the aim of defining solutions for those problems.

The second part of the short-term planning meeting is led by the site manager technical assistant (usually a civil engineering intern). He makes a brief presentation of quality problems during the execution of the tasks, and discusses with the crew leaders their causes and how they can be avoided. Finally, the third part of the meeting is focused on planning and control. However, as it is carried out at the end of the meeting, the assignment of packages are made during a very short period, without much discussion.

Network of commitments

The network of commitments maps pointed out again the high degree of complexity of the planning and control process. In figure 6(a), for instance, the network of commitments for removing materials constraints presents several transactions, which are the result of the decomposition of the first task and a series of approvals that need to be given by different instances of decision-making. When there is a break in the loop between the supply department and the supplier, the site manager starts a new loop in order to request the site administrator to remake the material request to the supply department. Figure 6(b) shows the network of commitments related to the health and safety phase. The role of the health and safety specialist is very important, since he is allowed to change task procedures, and to ask directly the crews to perform safety-related tasks.

The failures along the loops were more critical for short-term planning commitments. In figure 6(c), a segment of the complete network is presented, showing that there is a failure in the loop established between technical assistant and the crew leader, at the negotiation phase. It happens because the weekly packages

definition and control that should be a site manager responsibility are assigned to the technical assistant, who has to discuss these packages with the crew leaders. However, this assistant was not allowed to change the weekly plan according to the crew leaders claims. If it was necessary to make a change in the packages definition, the site manager needed to be present at the meeting.
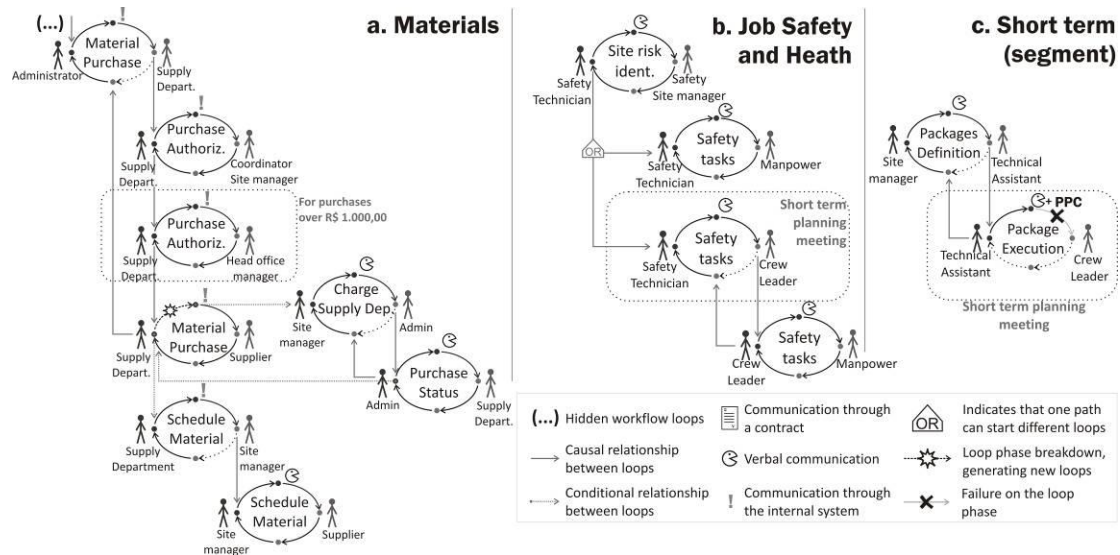

Figure 6 - Networks of commitments to remove material (a); job safety and health constraints (b); and short term planning commitments (c)

The set of medium-term networks of commitments from Company B showed that there are fewer failures in the loops, but breakdowns often happen, caused by the lack of effectiveness of upstream processes, which are managed by the company's head office. Those networks indicated that there is a general awareness in terms of ensuring the integrity of the workflow loops: when a failure is detected, managers apply procedures to deal with them. However, the failures that were pointed out in short-term planning process seem to happen due to the lack of negotiations with crew leaders.

The Meetings Analysis

Company B meetings were very different from the ones carried out in Company A, as shown in figure 7. The number of negotiations and requests during the safety issues stage indicated that this was usually a period for open discussion among the meeting participants. By contrast, in the stage of definition of packages, a large percentage of the time was spent on requests, leaving much less time for negotiations of work packages – in fact, in some of the weeks no negotiation happened. Moreover, as there was not enough time for discussing the causes of the planning failures, the metrics were mostly used to communicate the central office the problems observed on site.

CONCLUSIONS

This paper provided some evidence of the utility of LAP for describing and evaluating production planning and control systems based on the Last Planner system. Although the literature prescribes how the Last Planner system should be carried out, LAP

provides a conceptual framework that can be used for describing and understanding how commitments are managed. The analysis of planning meetings provided additional evidences on how LPS is really implemented, which are not usually provided in other studies on the implementation of this system.

A method for modelling the network of commitments, based on LAP, and analysing planning meetings was devised. Some changes were made in the action workflow method in order to make it possible to map all the interactions and breakdowns that need to be considered. Such method provides a comprehensive description of planning and control processes, and produces evidences on different ways of undertaking the Last Planner System in constructions projects.
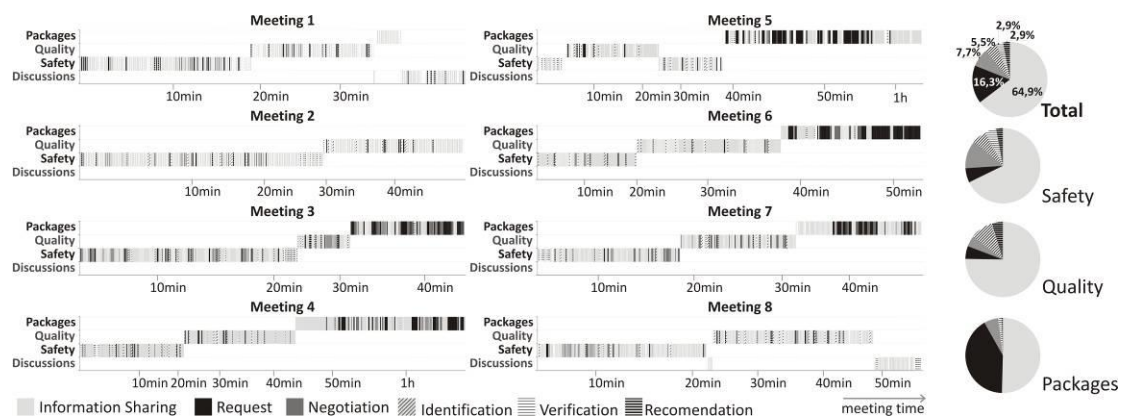

Figure 7 – Activities performed along the meetings steps, Company B

The analysis of the network of commitments revealed the complexity that construction managers have to deal with to achieve a specific goal. In some cases, there are different ways of starting a process, which increases the need for an effective coordination method. Moreover, the maps stressed some failures along the networks that can be seen as improvement opportunities, since these may cause disruptions in the project. Based on patterns found in the meetings, misunderstandings of some underlying ideas of Last Planner were identified in the case studies. For instance, in Company B the technical assistant who chair the short-term planning meeting, should discuss the packages but did not have decision making power to negotiate changes in the plan with crew leaders.

Regarding the LPS underlying ideas, the use of LAP emphasized the importance of ensuring a mutual understanding of each commitment in the network. LAP assumes that an organisation work through the successful management of this small transactions. The studies provided evidences that this two-way communication plays a key role in getting a mutual understanding on the tasks and their constraints. By contrast, the lack of this type of communication results in plans that do not match to the capacity of the work force.

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