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INTERPLAY OF LEAN THINKING AND SOCIAL DYNAMICS IN CONSTRUCTION

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ABSTRACT

Production, commercial, technical, organizational and social aspects must be managed simultaneously for a construction project to be successfully delivered. However, most management approaches in construction are technically-oriented methodologies that largely neglect central social aspects related to people's behaviour. Lean construction research has likewise focused more on technical and commercial aspects than on social aspects. Recent research in the domain has aroused interest in various social aspects, such as the language-action-perspective, people development, culture and transformation, and integral theory. Yet little research has been pursued to understand the interactions between lean construction thinking and the social dynamics within construction project organizations. To begin to bridge this gap, the latent synergy and feedback loops between lean construction practices and social dynamics variables such as trust, goal setting and power distance in construction are discussed in this paper. The interplay between lean construction tools and the social dynamics variables is illustrated through an example based on the Last Planner System (LPS). We argue that lean tools work better when the environment is less autocratic, the team is more integrated, and the levels of trust between project team members are higher. In this organizational environment power-distance is decreased. Lean and goal setting also seem to interact positively and motivate the team.

KEYWORDS

Goal Setting, Last Planner System, Power Distance, Social Dynamics, Trust.

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INTRODUCTION

Projects in construction take place under dynamic and unsteady site conditions, with considerable levels of uncertainty. They are conducted by temporary organizations and executed in provisional production facilities (Koskela, 2000; González and Alarcón, 2010). Two different, but symbiotic aspects emerge from this characterization. Construction can be understood as: (i) a production process (Koskela, 2000), and (ii) a social process (Hill, 1995). Thus, both production and social aspects should be managed simultaneously for a project to be successfully delivered. However, most management approaches in construction are technically-oriented methodologies focused on project and contract management, neglecting central social aspects related to peoples' behaviour both in individual and collective domains (Pavez and Alarcón, 2007). Disputes and conflicts (Cheung and Yiu, 2006), industry fragmentation, highly hierarchical organizations (Emmitt and Gorse, 2009), and lack of communication and trust (Palacios, Gonzalez and Alarcón, 2013), among others, are symptoms that construction does not account much for its social issues, which in turn negatively affect its production performance.

On the other hand, a shift towards people-based managerial approaches has been widely acknowledged by new management philosophies and every type of innovation involving changes in organizational practices (Kofman, 2008). Lean thinking has been an influential force to shape modern manufacturing organizations towards value and people-centred organizations (Womack and Jones, 1996). As a management philosophy, lean thinking has proved capable of improving the performance of firms and organizations, via a suitable implementation of tools and processes (Womack and Jones, 1996). In order to achieve excellent results, lean organizations require not only effective implementation of business purposes and processes, but also teams led by responsible people to carry them out (Womack, 2006). Lean thinking pays much attention to the social mechanisms of organizations, which help develop and empower people, promoting understanding of people's motivations (Liker, 2004).

Lean thinking has been applied systematically to construction over 20 years (Alarcón et al., 2005), but implementation has largely focused on technical aspects rather than on the human and social aspects of projects (Pavez and Alarcón, 2007). Notwithstanding research of various social issues, such as the language-action perspective (Macomber and Howell, 2003), people development (Pavez and Alarcón, 2007), culture and transformation (Alarcón et al., 2006), and integral theory (Pavez, González and Alarcón, 2010), little research has been undertaken to understand the interactions between lean thinking and the social behaviour in a construction organization. A better understanding of the interplay between lean thinking and social dynamics in construction is needed.

Social dynamics refers to the resulting behaviour of groups from the interactions of its individual members and the analysis of the connections between individual interactions and group level behaviours. Social dynamics assumes that individuals are influenced by one another's behaviour and is concerned with changes over time emphasizing the role of feedbacks (Durlauf and Young, 2001). A better understanding on how lean thinking and social dynamics interact within construction organizations is required to identify what are the most influential social drivers to support smooth implementation of lean thinking. In turn, more effective strategies can be designed to help construction organizations to become lean organizations.

The goal of this work was to explore the latent synergy and feedback loops between lean thinking and social dynamics variables such as trust, goal setting and power distance in construction. To do so, we theoretically characterize the relationship between different organizational, decision-making and management structures, and social dynamics. An example with the Last Planner System (LPS) was modelled to illustrate the theoretical interplay between lean tools in construction and the social dynamics variables. The next sections will discuss the social dynamics variables studied, the characterization of social dynamics in traditional and lean organizations, and the conceptual modelling framework using the LPS example.

SOCIAL DYNAMICS VARIABLES

Numerous social dynamic variables of construction organization are affected when lean tools are used (Pavez and González, 2012). We focus on three specific social dynamics variables: trust, goal setting and power distance.

People depend on others in various ways to accomplish their personal and organizational goals. There is an inherent risk that could be reduced if people trusted each other. Based on the relationship between risk and trust, Mayer, Davis and Schoorman (1995) proposed one of the most used operational definitions of trust in management research: *"the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party"* (p. 712). In general, a trustor will be willing to be vulnerable to another party based both on the trustor's propensity to trust other people in general, and on the trustor's perception that the particular trustee is trustworthy. In this regard, Mayer, Davis and Schoorman (1995) posed that: trustworthiness is comprised by three factors: ability, benevolence, and integrity.

The goal setting theory is one of the most widely used motivational theories. There is an underlying assumption that as behaviour reflects conscious goals and intentions, employees' efforts and performance in organizations will be influenced by the goals assigned to, or selected by, these employees. Therefore, goal setting theory states that the performance of a team will be high if the related goals are difficult, specific and attainable (Steel and König, 2006).

Power distance refers to how power is distributed in organizations and how people pertaining to a specific culture perceive power relationships (superior – subordinate). It also can be understood as an opposite force to trust and defined as the degree of centralization of authority and autocratic leadership (Hofstede et al., 1990). People belonging to high power distance cultures easily accept that power is distributed unequally and believe that the relationship between superior – subordinate is one of dependence. In contrast, people in low power distance cultures question authority, expect at least some level of participation in decisions, and perceive the relationship between superior – subordinate as one of interdependence (Hofstede et al., 1990).

THEORETICAL CHARACTERIZATION OF SOCIAL DYNAMICS IN TRADITIONAL AND LEAN CONSTRUCTION ORGANIZATIONS

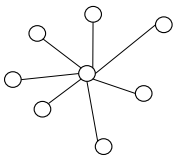
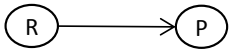
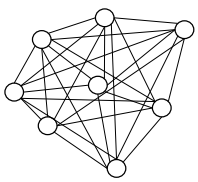
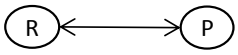
It is argued that the structural features of an organization can shape its social

dynamics and vice versa. Therefore, a theoretical characterization of this relationship can shed light about what these factors are and how they help to enhance the social performance of construction organizations. In this section, the relationship between different aspects of traditional and lean construction organizations and social dynamics is theoretically characterized using their typical project delivery system, decision-making structure, action workflow and operating system, which are in turn related to the social dynamics variables.

RELATIONSHIP AMONG PROJECT DELIVERY, ORGANIZATIONAL STRUCTURE AND OPERATING SYSTEMS

In Table 1, project delivery system, organizational structure and operating system are characterized for both traditional and lean construction organizations.

Table 1: Project Delivery, Organization Structure, and Operating System Characterization.

Project Delivery System	Decision-Making Structure	Action Workflow	Operating System
Traditional Construction Organization			
Silos of responsibility that prevents capability to collaborate (Smith and Rybkowski, 2012). Centralized decision-making, command and control (Alarcón, Harrison and Howell, 2013). Motivating approach: Pressure participants along the critical path to complete work timely and under budget (Alarcón, Harrison and Howell, 2013) and communicate urgency to motivate them to take action (Macomber and Howell, 2003).	 *Centralized* (Malone, 2003)	 R requests the completion of a task "x" to P. Hence, P promises the completion of x. Roles R and P are fixed as conversations become essentially directives between R and P. Thus, coordination and negotiations capabilities between agents (R and P) are very limited (Macomber and Howell, 2003; Lichtig, 2006).	*Activity-centered/* Critical Path Method (CPM) (Alarcón, Harrison and Howell, 2013)
Lean Construction Organization			
High levels of organizational integration and collaboration. Highly shared decision-making (Alarcón, Harrison and Howell, 2013) and decisions by consensus (Lichtig, 2006) Motivating approach: LPD builds on trust and collaboration (Alarcón, Harrison and Howell, 2013).	 *Decentralized-Networked* (Malone, 2003)	 R requests the completion of a task "x" to P or vice versa. Coordination and negotiations usually take place in a highly collaborative environment, in which conversations between R and P represent the basis for the action. Also, roles can be interchangeable, i.e sometimes R can be P and vice versa (Ballard, 2000; Macomber and Howell, 2003; Lichtig, 2006).	*Flow-centered/* Last Planner System (LPS) (Alarcón, Harrison and Howell, 2013)

The development of construction projects typically embraces three fundamental areas: commercial terms, organizations and an operating system, which are shaped by the cultural and technological attributes of the organization (Thomsen et al., 2009).

Commercial terms are usually characterized by a project delivery system (PDS) (Alarcón, Harrison and Howell, 2013), which represents how participants or "agents" interact at organizational level, converting owner's goals into finished buildings (Chen et al., 2011). The most common traditional project delivery systems (PDS) are Design-Bid-Build (DBB), Design-Build (DB) and Construction Management at Risk (CMR) (Konchar and Sanvido, 1998; Alarcón, Harrison and Howell, 2013). In contrast, Integrated Project Delivery and Lean Project Delivery (LPD) have emerged as alternatives to traditional PDS (Lichtig, 2006). LPD in particular is based on lean thinking principles and tools, early involvement of parties and a collaborative work environment (Lichtig, 2006). In Table 1, the traditional and lean cases are illustrated by DBB and LPD respectively.

Construction organizations are also characterized by their decision-making structure and their action workflow (Table 1). The decision-making structure describes how decisions and communications are distributed within an organization (Malone, 2003). In this regard, organizations can be characterized as independent-decentralized (agents have low needs for communication and interaction as they make decisions independently and are not necessarily connected), centralized (agents have significantly higher communication and interaction needs to make decisions, they are connected to one or few "key" decision-makers, and there is command and control), and decentralized-networked (agents generally require even more communication to make decision than centralized ones, they are fully connected to one another, and they tend to collaborate) (Malone, 2003). Action workflow is an approach based on the language-action perspective (LAP) that helps to understand how agents are coordinated through language in an organization and define what exactly flows between them. Action workflow focuses not on tasks but on the speech acts that constitute these tasks (Kethers and Schoop, 2000). Thus, an organization can be described as a network of commitments (promises) between requestors (R) and performers (P) which also represent the parties or agents of an organization (Macomber and Howell, 2003). The operating system shown in Table 1 can be understood as the way work is managed in a project (Howell, 2010). The traditional operating system is activity-centred, in which the project plan is seen as a network of tasks executed by trades. The main goal is to optimize the project by optimizing the pieces, i.e. each activity (Howell, 2010). The Critical Path Method (CPM) is typically used to plan and control the work under this operating system (Alarcón, Harrison and Howell, 2013). In the lean operating system, a flow-based strategy is used in which predictable and fast-paced workflow is typically achieved through a project conceived as a production system. The main goal is to optimize the project, not the pieces, by making workflow predictable (Howell, 2010). The Last Planner System (LPS), a popular lean production planning and control system, is used by this operating system (Alarcón, Harrison and Howell, 2013).

SOCIAL DYNAMICS IN TRADITIONAL AND LEAN ORGANIZATIONS IN CONSTRUCTION

Table 2 shows the relationship between traditional and lean organizations in construction and the different social dynamics variables studied. As suggested in Table 1, a traditional construction organization can have a DBB as PDS, a centralized decision-making structure, an action workflow between R and P agents represented

by directives, and an activity-centred operating system. A traditional PDS does not necessarily encourage communication and collaboration between the project parties as it defines a contractual and relational framework that is adversarial in nature (Alarcón, Harrison and Howell, 2013; Palacios, Gonzalez and Alarcón, 2013). Conversations within the organization are reduced to requests and directives from R to P. Also, commitments between them are not built up on a reliable basis as an appropriate coordination and negotiation process does not take place (Priven and Sacks, 2015a). In addition, traditional construction organizations commonly have a business environment plagued with claims and litigation (Cheung and Yiu, 2006), which is an indication of a low degree of organizational trust as shown in Table 2. In this type of organization, the centralized authority and decision-making structure along with a low degree of organizational trust suggest unequally distributed power (Priven and Sacks, 2015a), which implies a high degree of power distance. Under a traditional PDS, construction organizations are usually highly disintegrated, hence work related to the development of a project is difficult to coordinate due to existing organizational silos (Alarcón, Harrison and Howell, 2013; Palacios, Gonzalez and Alarcón, 2013). Also, the way in which the operating system works is not very efficient as the trade work typically is planned and controlled using CPM tools (Alarcón, Harrison and Howell, 2013). Thus, they are unable to effectively coordinate different trades and provide clear directives to them of what can be done on-site (Ballard, 2000). Table 2 suggests that the goal setting degree is low as production goals are not very specific, clear or challenging for trades.

Table 2: Characterization of Social Dynamics Variables in Traditional and Lean Construction Organizations

	Trust Degree	**Power Distance Degree**	**Goal Setting Degree**
Traditional	Low Adversarial relationships. Limited collaboration and communication. Unreliable commitments (Smith and Rybkowski, 2012; Alarcón, Harrison and Howell, 2013; Palacios, Gonzalez and Alarcón, 2013; Priven and Sacks, 2015a).	High Unequally distributed power and centralized authority (Pavez and González, 2012; Alarcón, Harrison and Howell, 2013; Palacios, Gonzalez and Alarcón, 2013; Priven and Sacks, 2015a).	Low Less clear and/or challenging goals (Pavez and González, 2012).
Lean	*High* Highly collaborative and integrated relationships. Enhanced communication Reliable commitments (Smith and Rybkowski, 2012; Alarcón, Harrison and Howell, 2013; Palacios, Gonzalez and Alarcón, 2013; Priven and Sacks, 2015a).	*Low* More evenly distributed power and descentralized-networked organization (Pavez and González, 2012; Alarcón, Harrison and Howell, 2013; Priven and Sacks, 2015a).	*High* Specific and clearly defined goals. More challenging, but achievable goals (Pavez and González, 2012).

The lean construction organization defined in Table 1 has the LPD as PDS, a decentralized-networked decision making structure, an action workflow between R and P agents represented by two-sided conversations and reliable commitments and a flow-centred operating system. A lean PDS tends to integrate more tightly the different parties of a project, where trust and collaboration are the basis of their relationships (Alarcón, Harrison and Howell, 2013; Palacios, Gonzalez and Alarcón,

2013). Conversations between R and P are made in a highly collaborative environment that engenders reliable commitments as an appropriate coordination and negotiation process take place (Priven and Sacks, 2015a). Accordingly, Table 2 shows that the degree of organizational trust is high. Decentralized-networked decision-making structures and higher degrees of trust have been observed in lean organizations, which suggests a low degree of power distance (Priven and Sacks, 2015a). In addition, LPS has proven to be an efficient operating system to plan and control trade work in construction organizations willing to become lean organizations (Alarcón, Harrison and Howell, 2013). LPS is able to control the workflow between trades and provide a reliable and clear basis to define what can be done on-site (Ballard, 2000). Thus, Table 2 proposes that the goal setting degree is high as production goals are specific, clear and challenging for trades.

CONCEPTUAL MODELING FRAMEWORK OF SOCIAL DYNAMICS WHEN IMPLEMENTING LEAN TOOLS

In this section, the conceptual modelling framework of the interplay between social dynamics and lean thinking in construction is illustrated using an example with the LPS. The synergy and feedback loops between LPS and social dynamics are theoretically modelled. In Table 1, LPS falls into the "pure" lean category. However, a traditional organization in the process of becoming lean may have some of the lean elements shown in Table 1. For instance, a traditional/lean organization may have a DBB contract as PDS, LPS as operating system, and a partially decentralized organization.

Pavez and González (2012) have discussed how theoretically LPS and the social dynamics variables (trust, goal setting and power distance) could interact. Figure 1 shows a conceptual model of the hypothetical relationship between LPS and the social dynamics variables studied, and the resulting feedback loops and synergies. Note that only some LPS components and aspects have been used in the illustration. Pavez and González (2012) claimed that one of the deepest changes in successful projects using the LPS is the decrease of power distance. LPS helps to lift trust within the project, because the dynamic of the weekly work plan meetings decreases the perceived autocratic leadership and promotes positive exchanges between team members as the manager begins to listen more. This effect has been observed in four projects in which the 'Social Subcontract' was implemented together with the LPS (Priven and Sacks, in press). When this happens, PPC increases and the manager's behaviour during the meeting turns from advocacy to inquiry. Mayer, Davis and Schoorman (1995) stated that the variation of the attribution on trustworthiness varies the perceived level of trust between parties. Accordingly, incidents or actions that prompt a reappraisal of any of the trustee perceptions will impact trustworthiness and hence the perceived level of trust. Pavez and González (2012) argued that this social mechanism takes place within the LPS as the teamwork dynamic allows the perceived ability of the project team to be enhanced.

As a result, the LPS implementation may increase the perceived level of trust among project agents by enhancing their perceptions of their partners' ability, integrity and benevolence. Thus, LPS helps to reduce power distance, by allowing the agents of the project team to pool their own viewpoints with those of the manager in

such a way that the comments made by the manager are no longer perceived as orders, but as a way to understand other's perspectives with the aim of improving project performance (Pavez and González, 2012). As power distance decreases, communication channels are opened and collaboration is encouraged. Thus, the degree of trust shifts from low (traditional) to high (lean) within the organization.

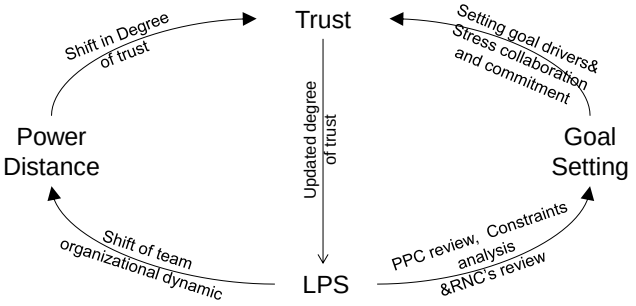


Figure 1: Feedback loops and synergy between LPS and social dynamics variables.

LPS allows the project team to set specific, challenging and achievable goals. Ballard (2000) proposed the definition of these goals through the quality criteria for assignments that are part of the weekly work plan: definition, soundness, sequence, size and learning. In this regard, the constraints analysis process is instrumental, as what will be done is assessed against what can be done. The reliability of the commitment plan is tracked using the percentage of plan completed (PPC). Pavez and González (2012) claimed that PPC was originally created to manage the workflow uncertainty from a purely technical standpoint; however, PPC works as a social agreement that changes team dynamics as well. In particular, they argued that the process to build up the commitment plan and the systematic PPC review increase the commitment and alignment with the team goals (project performance). Pavez and González (2012) pointed out that the PPC evolution (when improved) linked with the Reasons for Non-Completion (RNC) allows the team to assess the perception of the past experience in a positive way, which guides the selection of more challenging and attainable future goals. Thus, the LPS implementation may improve goal-setting for planning project tasks (difficult, specific and attainable).

As mentioned, LPS changes power distance, which in turn influences the level of organizational trust through changes in the organizational dynamics. On the other hand, LPS modifies the organizational goal setting by acting on the PPC review, constraints analysis process and RNC review. The power distance-goal setting interaction allows the levels of trust to be updated and improved, which impacts on LPS, in turn engendering synergies and feedback loops with the social dynamics variables.

CONCLUSIONS

This research has discussed the interplay between lean thinking and social dynamics in construction, through the analysis of a conceptual model representing the implementation of the LPS. From a practical standpoint, the model and the discussion provide guidelines for considering which social aspects are critical in the implementation of lean construction tools and what are the potential impacts and opportunities at both organizational and production levels.

The synergies and feedback loops between LPS and the social dynamics variables are modelled simplistically and several assumptions have been accepted to do so. A more comprehensive characterization of feedback loops and synergies between the studied variables is being developed and a numerical simulation is being prepared to enable research of the phenomena.

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