THE LAST PLANNER SYSTEM AS A DRIVER FOR KNOWLEDGE CREATION

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ABSTRACT

Successful companies consistently create new knowledge, skills and competences. In this paper a knowledge building process is viewed in light of the expertise needed in carrying out construction projects successfully. The way knowledge building is processed will have a direct impact on how the building project is brought forward.

The question raised in this paper is how the Last Planner system (LPS) may contribute to the process of building knowledge on the project level. This paper suggests the following hypothesis: The Last Planner system is capable of contributing to the process of creating knowledge in construction projects.

The structure, arenas and conditions for collaboration provided by LPS offer a potential to create new knowledge, skills and competences. One such example is the meeting structure, which suggests that a multi-trade collaborative work practice is adopted. The paper discusses these interactions from a knowledge building process perspective, and point to necessary premises to create new knowledge.

The theory is tested empirically through the examination of transcripts of interview data concerning LPS implementation in a search of evidence of such processes taking place, and the extraction of understanding of how such processes develop. Learning occurs when new routines, processes, procedures or behaviour patterns are established in the construction project.

KEYWORDS

Last Planner System, dynamic knowledge building, organisational learning, single and double loop learning, tacit and explicit learning

INTRODUCTION

Many existing problems in the construction industry arise because of barriers to organisational learning (Boyd and Robson 1996).The industry is fragmented, and stakeholders tend to pursue their own agendas (Franco et al. 2004), rather than engaging in collaborative efforts to secure win-win situations for all stakeholders. Fragmentation is considered a major factor in the poor communications between project participants (Orange et al. 1999). These characteristics of the construction industry may create limitations to learning. Successful companies consistently create new knowledge (Nonaka and Takeuchi 1995). In this paper we build on the assumption that there is a functional relationship between suboptimal productivity in the construction industry (Egan 1998) and difficulties with learning (Boyd and Robson 1996). We aim to discuss organisational learning in terms of social processes,

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rather than from a technological innovation perspective, and thus meet an identified need to report from empirical studies in construction that address the "people" issues associated with knowledge management (Egbu 2004). We specifically address the Last Planner system, a methodology for production control (Ballard 2000), in light of the theory of learning organisations in general, and Nonaka's (1994) model of knowledge creation in particular. However, organisational learning is discussed in light of ongoing social processes rather than the methodology per se. According to Argyris (1977), "organisational learning is a process of detecting and correcting any feature of knowledge or knowing that inhibits learning". How does the Last Planner system contribute to the process of acquiring and creating knowledge in construction projects? The process of building knowledge is seen, in other words, in light of the expertise needed in construction projects. We consider the skills needed in terms of the projects' overall competence, and at the individual level. The working hypothesis in this paper is that *The Last Planner system is capable of contributing to the process of creating knowledge in construction projects.*

THEORETICAL BACKGROUND

Scholars have addressed the issue of learning within the construction industry, particularly stressing the need to learn from past project experiences, to enable capitalising on future projects (Barlow et al. 1997, Franco et al. 2004, Orange et al. 1999), as well as emphasising the technical support needed for such learning to occur. Orange et al. (1999) hold that there is a lack of mechanisms for feedback of ideas to improve current projects. This paper examines learning in ongoing construction projects in Norway, and assesses the Last Planner system (LPS) of production control in terms of whether or not LPS may deliver a framework for continuous learning and the capitalisation of knowledge in ongoing projects. Argyris and Schön (1996) were among the first who described a development towards a learning organisation. A learning organisation is perceived as a process that evolves over time. A learning organisation is an organisation with the skills to create, acquire and transfer knowledge, and to change practice to reflect new knowledge and insights (Garvin 2000). Senge (1990) holds that a learning organisation may be loosely linked to new ways of thinking. Other scholars emphasize shared insight, organizational routines and organizational memory as being essential for organizational learning (Stata 1989). Organizational learning requires both individual and collective learning (Moland 2007), and only when people learn effectively together, may organizations change (Senge and Scharmer 2006). When an organization does not succeed with organizational learning, it may be due to a lack of communication between different cultures (Schein 1985).

Nonaka (1994) offers a dynamic theory of learning which shows a connection between concepts of teamwork, creativity and innovation. It explains how knowledge, taken for granted, may be available to others through collaborative activities. Furthermore, it explains how teamwork and creativity help to test and further develop knowledge. Nonaka's theory shows how learning occurs in collaboration with others who may have slightly different knowledge and experience. Co-partners can be both internal and external to the organisation, but it is essential that they have a different knowledge or experience.

People behave in certain ways – some oppose changes while others acknowledge change and adapt to new routines and values accordingly. Single loop learning (Argyris and Schon 1974) is a form of instrumental learning which happens when detecting and correcting errors while nevertheless allowing the organisation to carry on as usual. No new learning takes place under single loop learning, which inhibits free exchange of opinions. In circumstances of single loop learning employees are focused on stability and predictability (Lillebø 2005), whereas in double loop learning employees are required to make decisions and question underlying objectives (Argyris 1977). In double-loop learning procedures and practices are questioned critically. This is radically different from single-loop learning where procedures and practices are operationalised rather than questioned (Argyris and Schon 1974, Lillebø 2005). Argyris (1990) found that double loop learning is difficult. He did not acknowledge the dynamic process that Nonaka (1994) describes, since errors are covered in organisations. Nonaka (1994) holds that people learn all the time. However, the knowledge that we are aware of only represents the tip of the iceberg of our knowledge. This is our explicit knowledge, which we are aware of and are able to express and articulate. In addition, there is tacit knowledge. This knowledge is far more personal, rooted in the individual's experiences, norms, values and feelings. Tacit knowledge is much more difficult to formalise and express. Often, this knowledge stays tacit, because we are not challenged to explain it.

TACIT VS. EXPLICIT KNOWLEDGE

Nonaka (1994) presents a spiral model (Figure 1) for creating organisational knowledge, a dynamic theory with a continuous dialogue between explicit and tacit knowledge. Organisational learning occurs in interaction between tacit and explicit knowledge, when the individual's tacit knowledge is made available, tested and developed, and turned into practical use. Explicit knowledge is articulated and codified objective knowledge, which can be captured, communicated, stored and readily transmitted to others (Nonaka 1994, Polanyi 1966). Nonaka's model consists of four separate patterns of interaction between tacit and explicit knowledge. These are patterns showing how existing knowledge may be converted into new knowledge. Organisations continually create new knowledge by reconstructing existing perspectives. In this way, double-loop learning is built into the model. The dynamics between the four patterns in Nonaka's model are essential in creating new knowledge.

Figure 1: Nonaka's Knowledge Creation Model.

	Tacit knowledge	**Explicit knowledge**
Tacit knowledge	**Socialisation** →	**Externalisation**
	(By observing and imitating, in meetings and group discussions)	(Articulation of ideas, use of metaphors in dialogue) ↓
Explicit knowledge	**Internalisation**	← **Communication**
	(Translating explicit knowledge to new practice)	(Combining new contexts and categories)

Nonaka suggests that creation of knowledge may be described as a spiral which starts with the individual, then continues to the group level and ultimately moves on to the organisational level. The utilisation and sharing of tacit knowledge with others in the organisation is a challenge. Knowledge that remains tacit cannot be benefited from. An individual's knowledge develops in interaction between tacit and explicit knowledge as it expands through experience and rationalisation, the sum of which, together with individual values and beliefs, becomes the individual's original perspective (Nonaka 1994). This knowledge is then taken back to the organisation. Knowledge development in an organisation starts with individuals expanding their knowledge. Individual knowledge will remain private until discussed in a social context. New ideas are formed based on new constellations of people. Work or personal life experiences trigger ideas, which in turn may trigger new ideas when exposed to and discussed with other members of the group. Trust is essential and is developed when experiences are shared, which enhances the understanding of other's situations, which in turn results in a matured common perspective in an ongoing socialisation process (Nonaka 1994). Individual tacit knowledge, accepted at the group level, is conceptualised and tested in the rest of the organisation. The socialisation process starts with developing opportunities for interaction, which enables sharing and transfer of individual experience and mental models. The externalisation process is triggered by meaningful dialogue or collective reflection of tacit knowledge usually found difficult to express. Individual concepts can be combined in a search of more concrete and sharable specifications (Nonaka 1994). This combination mode is facilitated by such triggers as "coordination" between team members. Concepts are articulated and developed until they emerge in a concrete form. This "experimentation" can trigger internalisation through a process of "learning by doing." Internalisation occurs when explicit knowledge is translated into new practice, by adopting new knowledge, thus closing the individual circle of knowledge development (Nonaka 1994).

To succeed with knowledge development, Nonaka (1994) holds that creative chaos is needed. This means an abundance of information, i.e., more information than strictly needed and a necessary variety in knowledge. Reflection may then occur, which results in new combinations of knowledge; people are linked together by sharing their knowledge, which further helps individuals become aware of their own role, and opens up opportunities to notice new perspectives (Nonaka 1994).

LPS PRACTICE AND KNOWLEDGE CREATION

Both single- and double-loop learning may be appropriate learning mechanisms in construction projects, at certain times and phases. Single-loop learning may be appropriate to increase efficiency with what already works. However, if project managers are loyal to top level decisions alone, without really understanding why and how LPS may contribute to useful project level learning, then only single-loop learning will continue to take place.

Single loop learning will prevail until project managers are challenged to move towards double loop learning. In some projects a state of single loop learning was challenged by early positive experiences of implementing LPS structures, which made project managers conscious about the processes taking place (Skinnarland and Yndesdal 2010).

Nonaka (1994) finds that interaction between tacit and explicit knowledge provides the greatest potential and scope for learning. How may LPS practices be understood in terms of Nonaka's spiral model? This paper argues that a LPS structure may facilitate continuous learning, by facilitating opportunities for exchanges between tacit and explicit knowledge, according to the four processes described in figure 1. In the following we describe how these processes may take place in construction projects implementing LPS, and outline necessary premises found.

METHODOLOGICAL CONSIDERATIONS

The paper builds on an ongoing DBA research project, with a total of 24 unique construction projects represented in the data. All projects are within a large family-owned Norwegian construction company, with a large geographical spread. The duration of the construction projects reported from in this paper varied from 1 to 48 months, ranging from short-term rehabilitation work to large scale construction projects. Mostly the projects consisted of new commercial buildings and apartment buildings. Essentially, the projects were contracted as turnkey contracts.

The construction company has since 2008 carried out a number of construction projects based on the Last Planner system for production control. This entails the involvement of employees and subcontractors, to a greater extent than in previous projects, in the planning process of the projects. The company's top management, although not specifically focusing on becoming a learning organisation per se, has supported learning in their projects by establishing expert positions to support project managers in implementing the Last Planner system.

A study was conducted with the intention of investigating the experiences of project managers and foremen with using LPS in carrying out their construction projects. Altogether, 34 project managers and foremen participated in the study which took place in the fall of 2011. The informants were organised in groups of project managers and foremen respectively. Approximately two-thirds of the respondents have been employed by the construction company for 11 years or more. Two-thirds of the respondents have experienced only one construction project in which Last Planner system has been used.

The research method employed structured group interviews, lasting up to two hours. Group interview as a research method has been in use since the 1940s. Group discussions may reflect internal group processes and can be used to generate information on collective views (Bloor 2001). By describing their experiences with the use of LPS and the outcomes resulting from the use of LPS for controlling their production, the respondents provided valuable insight into the change and learning process taking place. In addition, a survey questionnaire was carried out. This paper focuses mainly on the learning process and specifically on how LPS may contribute to create learning within a construction process.

TRADITIONAL APPROACH TO PLANNING VS. LPS

The traditional approach to project scheduling is based on what should be done and not what can be done (Choo et al. 1999). According to Choo et al. (1999) the traditional scheduling prohibits learning in that reasons for the lack of completion of assignments are not identified. The Last Planner System is a methodology designed to help minimize plan failures and to avoid unnecessary execution failures. An

important feature is to let people closest to the work to be performed, make up the final step in the planning process (Ballard and Howell 1998). A measurement system (Percent Plan Complete, or PPC) has been suggested to track task completion status, and to motivate explanation of deviations from work plans, thus enabling learning (Ballard and Howell 1994). Learning in terms of the concept of Last Planner has often been linked to the process of a PPC status check and finding reasons for non-compliance, hence learning (Choo et al. 1999). In this paper, learning is viewed as an ongoing process throughout the interaction taking place within the LPS framework, and not restricted to PPC measurement.

LPS AS PRACTICED IN THE COMPANY

Construction projects in this data adhered to all or parts of meeting structures suggested by LPS, including phase schedule planning meetings, weekly planning meetings for the team supervisors, and look-ahead planning meetings. The purpose of these meetings was to discuss planning and to remove obstacles for execution of tasks ahead. The various meetings related planning to different time-horizons, with teams planning for the near future, and project management for several weeks ahead. In kick-off meetings the construction company's own employees and subcontractors were involved in phase planning. Some project managers involved all subcontractors, while others only involved the technical trades in planning meetings. Most projects were set up with a systematic approach to planning.

Socialisation Process

The role of the project manager is to create arenas for project participants to develop enough trust and confidence in each other to share knowledge, and create common perspectives. A strict interpretation of Nonaka would state that fragmentation in the construction industry constitutes an obstacle to the achievement of the knowledge creation process suggested by Nonaka. However, it is evident from current and earlier research that learning do occur, when initiated by project management' facilitation of a socialisation process in construction (Skinnarland and Yndesdal 2010). This was done by establishing proper arenas, such as regular planning meetings, and by deploying collaborative behaviour, rather than simply utilizing forms and procedures. This constitutes a change in which actors entering late in the project are socialised. They adhere to established behaviour, by observing and imitating ongoing group discussions (Nonaka 1994). An example of an initiated socialisation process was the kick-off meeting, in which a collaborative structure in the construction project was presented along with the purpose of new collaborative routines. By creating arenas for socialisation, it was made clear that conducting the project was a mutual responsibility to which all participants needed to commit. In kick-off meetings the project management also demonstrated the interdependencies and why building trust and a common perspective are imperative to succeed.

Externalisation Process

The process of externalisation refers to a transfer of tacit knowledge into explicit knowledge. When project participants were challenged to explain why things were the way they perceived them to be, there was a shift in thinking, from "everyone knows that" to explaining why they thought this was the correct way to proceed. For

example, "I have to erect this wall first because..." When participants were challenged to express in words what were previously truisms, their knowledge became explicit. As suggested by Nonaka, ideas were articulated in discussions and dialogues. In planning meetings, conversations were structured such that they enabled participants to explore the best options for ordering activities; participants asked "shouldn't I do this before you do that?" In such conversations, other people's perspectives were displayed. Project management motivated conversations by asking open ended and non-judgemental questions, thus challenging tacit knowledge to become explicit. Also, some project managers were aware of the importance of challenging the truisms. Only when participants realize and understand why they do it their way, can they relate to alternative ways. This process enabled them to realize and take account of their own actions, to question whether a particular action is appropriate, and to decide whether they wanted to question their embedded actions. New collaborative practices may challenge original beliefs and perceived ways of interacting, thus enabling double-loop learning.

Communication Process

When participants together understand that they can challenge their mindset and combine their explicit knowledge, then this knowledge can be taken advantage of. Once a platform is established, such as regular planning meetings, for mutual exchange of explicit knowledge, participants can challenge each other by asking why they do things this way, why are they carrying out their tasks in this order. How are activities connected to each other? How can this particular situation be solved? This process refers to the combination of contexts and categories in Nonaka's model. In order to make tacit knowledge explicit, variance in knowledge is needed (Nonaka 1994). In construction projects different trades constitute this variance. Then questions are asked from different perspectives. Participants consider options and need to explain their views to make themselves understood by other participants. There are certain premises for this combination process to succeed: variance in knowledge and the participants' desire to make the process a joint process, instead of competing against each other. This is constructive communication taking place according to Nonaka's knowledge creation model. When the plumber explains why he wants to assemble the pipes before a different trade carries out a certain task, a response is triggered in return. Several situations may serve as examples of communication processes in projects using LPS. Within the Last Planner system, joint planning of the optimal order of activities may trigger communication processes. A second example that triggers communication of explicit knowledge is the analysis of obstacles in terms of the seven flows[3] (Koskela 2000) of activities. This process also motivates the search for root causes (Bertelsen and Koskela 2002). A third example is discussing unproductive use of time.

Within LPS structures, participants may become aware of what they know, and participants may be enabled to combine knowledge that had not previously been articulated. This may happen for two reasons. First, LPS suggests a systematic approach to collaborative arenas, and defines purposes in terms of planning horizons

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[3]   A work package (task) has seven preconditions in order to be 'sound,' that is, that it can be undertaken without any delay, which is an important issue in the Last Planner System.

and roles. Second, this may happen if project management establishes a trusting, collaborative environment. Participants have not been aware of tacit knowledge because traditionally embedded patterns of operations had not been challenged or questioned. The purpose of the combination of knowledge is not only to follow suggested forms and procedures, but to combine existing expertise. Combination here means transfer of competence, or linking expertise.

Internalisation Process

Internalisation takes place when individuals' new behaviour becomes embedded, i.e. explicit knowledge is translated into new practice (Nonaka 1994). The practice of LPS in projects may make internalisation processes observable. New collaborative behaviour and conversations become natural and taken for granted (Skinnarland and Yndesdal 2010). When new knowledge is internalised, participants do not question whether or not to carry out joint planning sessions, or whether or not these plans may serve as a convenient collaborative tool. New practices then are described as "this is the way we do it". At this stage, single-loop learning may be appropriate to increase efficiency. However, in the next project, LPS needs to be adapted to new settings and frameworks, and, e.g., questions concerning the length of lookahead horizons may be raised, in contrast to whether or not to consider lookahead horizons at all. As such LPS offers a framework for continuous learning within the understanding of Nonaka's knowledge creation model.

DISCUSSION AND CONCLUSION

In planning meetings an ongoing mode of resolving problems has been observed to exist. This may constitute on ongoing collaborative process which may accelerate learning within the LPS. This mode of continuous improvement is desired and fruitful in the construction industry. Beside the structures offered by LPS, certain premises must exist, however, to enable learning within construction projects using LPS. The project provides a framework that can support or inhibit the interaction between the individual and organizational learning (Moland 2007).

Projects need slack to reflect (Bygballe 2010). Nonaka (1994) suggests establishing new groups to enable reflection and trigger knowledge creation. This premise is one which the construction industry can easily adhere to. A new project means a new constellation of people, and new phases of a construction project do somewhat the same. Even within projects, groups are established within a LPS framework, in that employees and subcontractors, to a larger extent than in traditional construction management, meet regularly to discuss planning issues.

Another premise for learning is abundance of information (Nonaka 1994). In planning meetings participants meet and reflect about what could be done differently. This triggers additional information (participants are asked what they need instead of simply being told what is needed of them). For example, foremen who attend team supervisor meetings receive and share information, which lead to information overflow, as opposed to foremen who only issue messages and directives.

Some project managers chose to involve only a few subcontractors, e.g. the technical trades. Their argument was that the rest of the trades may just be informed when to arrive at the building site. In terms of learning, this argument is alarming.

Considerations concerning whom to involve and whom not to involve, may prevent reflection and learning.

If project management and other construction project participants are not willing or able to move from single-loop to double-loop learning, then LPS implementation exercises will not achieve the full potential to learn. Thus, this paper concludes that The Last Planner system is capable of contributing to the process of creating knowledge in construction projects. However, a set of premises needs to be fulfilled to take advantage of the structures and tools offered in LPS. Management and leadership skills are highly demanded, to create an atmosphere in which individual tacit knowledge may be translated into explicit knowledge in a socialisation process. If this premise is met, then LPS may contribute to the development of skills characterised by learning organisations (create, acquire and transfer knowledge, and to change practice to reflect new knowledge and insights (Garvin 2000).

It is imperative to establish a project atmosphere and framework which builds confidence, and motivates willingness to change and elicit tacit knowledge. Given the optimal collaborative, collegial and trustworthy atmosphere, knowledge may surface which participants were not even aware of themselves, knowledge under the tip of the iceberg. It must be based on a safety environment, e.g. in terms of reporting errors, mistakes and delays back to the group. When LPS implementation fails, it has been observed to be caused by premises not being fulfilled according to the requirements noted above. In other words, LPS is more than introducing formulas, and spreadsheets, it requires a willingness to change, based on joint reflection, communicating new knowledge and acting upon obtained explicit knowledge.

Project management and participants must acknowledge the need for double loop learning, for Nonaka's spiral model to come into play. Only if most project participants, both management and workers, manage to change their attitude and open up for new learning, may tacit knowledge be made explicit, and new ways of combining knowledge be found. Many project managers in our data, managed to take new ideas and thoughts into consideration, and were able to make tacit knowledge become explicit knowledge, and to capitalize on the combined explicit knowledge.

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