LEAN CONSTRUCTION FACILITATES LEARNING ON ALL ORGANISATIONAL LEVELS?

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ABSTRACT

The construction industry is in need of interdisciplinary learning and development in order to meet customers' needs. However, interdisciplinary learning can be difficult to facilitate, particularly in the construction industry due to organizational structures based on separation of professions, and due to traditions for relying on tacit and practice based knowledge. To meet this challenge, Lean Construction has shown great potential in initiating and facilitating learning, and particularly interdisciplinary learning, throughout the design and construction phases. In order to be able to deliberately facilitate this interdisciplinary learning, a general understanding of why Lean Construction leads to learning is developed. For this both practice based theories as well as a case study are presented. Finally, the authors call for more research on the topic of learning at higher organizational levels, particularly with focus on the early phases. The aim is to include the entire supply chain on a construction project in increasing the value of the end product.

KEY WORDS

Practice based learning, Interdisciplinary learning, Lean Construction.

INTRODUCTION

Exceeded deadlines and budgets as well as poor quality in the construction industry have been discussed for several years (Egan, 1998; Task Force, 2000). It is widely agreed that some of the main causes for delays in construction projects are insufficient communication and unreliable planning (Alpegren et al., 2005). Also poor reuse of experience from project to project in the construction industry limits development of the construction process (Schindler and Eppler, 2003). So, lack in communication and poor reuse of knowledge seem to be among the key factors for developing the construction process.

Much knowledge at construction projects is embedded in practice and context dependent. This is also called know-how and is not easily codified and inscribed in documents (DeFillippi, 2001; Scarbrough et al., 2004; Styhre et al., 2006). Thereby, much communication and knowledge transfer between professions rely on face-to-face communication. However, much knowledge is embedded in the culture of the

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profession in which it is based. This makes knowledge transfer and interdisciplinary learning difficult, as different professions distinguish in syntax (language), semantics (meaning) and pragmatism (motivation) (Carlile, 2004). And as social networks across professional demarcations often disperse after the end of a project and diffusion of knowledge beyond professions is inhibited (Bresnen et al., 2004; Brown and Duguid, 2001), it could be said that the organizational structures of project based work inhibit long term learning and development in the construction industry, e.g. (DeFillippi and Arthur, 1998), (Bresnen et al., 2005).

At the same time projects are enablers of organizational learning (Scarbrough et al., 2004). Projects often consist of several more or less organizationally independent professions. The division of practice allows the project team members to be specialists in their own profession and accumulate knowledge through experience. This learning is directed at developing the single profession's practice, and could lead to sub-optimisation if a broader perspective is not considered. Division of practice is a barrier to flow of knowledge between professions and projects but at the same time it is perceived as an enabler of organizational learning based on practical experience within the single profession.

In order for the different professions to reach out and communicate across demarcation lines and avoid sub-optimisation, it is helpful to have something specific as a basis for the discussion. Such a phenomenon causing people from different groups to cooperate could be called a boundary object (Carlile, 2004). Boundary objects could for example be shared tools, documents, discourses or processes (Wenger, 2003) that lead to an understanding between different groups, or in this case different professions. Thereby, the groups are able to communicate and make common decisions based on several knowledge bases.

The authors, as many other practitioners, have experienced development based on interdisciplinary cooperation by participating in Lean Construction during the construction phase. Extended communication across demarcation lines has enabled innovative solutions regarding both process and product development. This paper seeks a deductive explanation as to why Lean Construction leads to an increase in development and learning. This explanation could help facilitate interdisciplinary learning up-stream in the supply chain to also include the client's organization. The primary focus on how to facilitate learning in the early phases is based on the authors' practical experience showing that project related decisions made during these phases have a major impact on a low cost for the outcome of a project. Despite this, the client is often perceived as merely an initiator of the project and disregarded as an important member of the professional construction team.

The hypothesis to be examined in this paper is: Lean Construction is a tool for interdisciplinary learning and could be used as such throughout the project organization.

Firstly, a theoretical framework for examining the learning at construction projects is presented. This is based on well known theories of practice based learning. Secondly, a case will demonstrate how this learning model has been tested and conclude that Lean Construction could be used as a tool for interdisciplinary learning among skilled workers in the construction phase. Thirdly, these findings call for further research as learning and innovation need to include the whole supply chain, starting with the cooperation between the client and his advisors and designers.

METHODS

This paper originates from a research project, which has examined the learning among skilled workers at construction projects. The results are supplemented by practical experience and professional discussions. The case was a construction project where the client decided to facilitate better learning and cooperation at a housing project containing a high level block for housing and service. The client took several initiatives to promote a better construction process. In order to facilitate at better informal communication, the client insisted on setting up a common workmen's shed for the skilled workers for breaks and meetings. Furthermore, the client supported implementation of elements of Lean Construction including Last Planner™ System, stop the line, and Lean Design principles.

During the research project, qualitative research methods were used to understand learning among the skilled workers at a construction site. The case study was monitored for more than three years (Ebbesen et al., 2006). As a part of the case study formal and informal interviews were conducted with several representatives from the client's organization, the project manager, and the skilled workers at the construction site. Furthermore, observations and action research were carried out in order to understand and support learning activities at the site (Kristiansen and Krogstrup, 1999; Nielsen, 2004).

By being a part of the field and deliberately interacting with the subjects, the researcher could influence the results. Nevertheless, this is actually the point of Action Research: to help the subjects make socially constructed innovations through dialogical processes, (Nielsen, 2004). During the study, the researcher first observed, then made interviews, and at the same time constructed an understanding of learning and innovation through literature study. Later this understanding was tested and further refined through action research. This constructive approach correlates with Koskela's call for more action research in construction management research (Koskela, L., 2008). The outcome of this research is a model (artefact) that could be used to describe learning in practice, and how Lean Construction initiates and facilitates such learning across demarcation lines.

Later on the findings were brought into new contexts as the researcher changed focus from the construction phase to the very first phases where the client decides on his needs for a project and starts to cooperate with other professionals in order to determine values and scopes for the project.

A LEARNING MODEL

People who have participated in Lean Construction projects are often aware that learning happens within the field of tension between different professions. This learning also points to a broader perspective of interdisciplinary constraints and understanding of different cultures within the different trades. This paragraph seeks an explanation to why Lean Construction has such potential.

Theories of practice based learning state that all learning stems from practice and being part of the world is a constant source of knowledge creation. According to John Dewey, an American pragmatist, (1859 – 1952), experience does not deal with how to obtain knowledge, but instead experience is about being in the world, and thereby Dewey has an ontological approach to experience. Humans, as well as all other living

creatures, are in the world and transact with each other. Dewey uses the term transaction to emphasize that subjects constantly change each other, and these transactions continuously transact with other transactions. Nothing exists separately, and thereby there exists no single truth, but several. Pedagogically, he focuses on encouraging the learner to become a reflective thinker, which leads to continuously more qualified actions, and thereby the person becomes able to deal with more and more complex problems in a movement towards growth. However, not all growth is desirable, and a direction has to be defined (Dewey, 1974). According to the work of Dewey and interpretations of this made by Bente Elkjær, (Elkjær, 2000; Elkjær, 2004; Elkjær, 2005), learning cannot be separated from practice. When experience and expectations do not comply in a specific situation, an uncertain situation occurs. To make the situation certain or "safe" one can either re-construct his expectations or his practice through inquisition. Based on this perception of learning, a model has been developed:

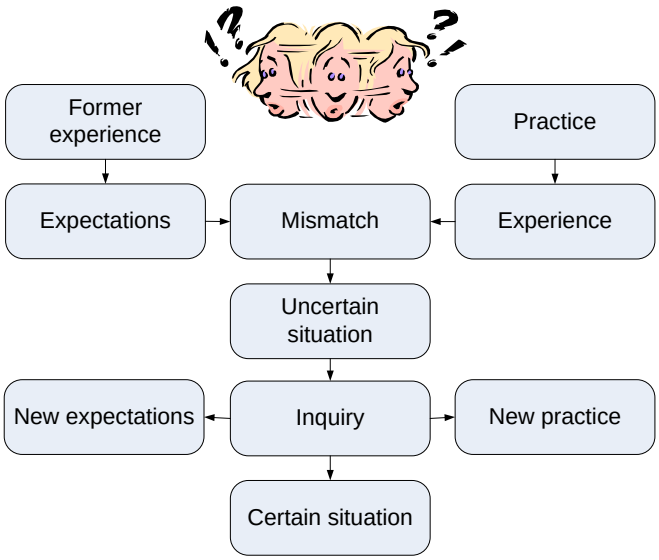

Figure 1: Illustrating the process of learning (Ebbesen R., 2006)

The model leaves three possible outcomes of an uncertain situation that would effect future learning situations: Either a new expectation, a new practice, or possibly a mix. New expectations lead the learner to expect the situation to occur again, but this time he knows how to deal with the situation. This could be called reactive learning. The other possible outcome is a changed practice, trying to avoid the situation to re-occur. The learner takes action to avoid the same situation to occur again. This could be perceived as the learning happening during stop-the-line process, where a fault should not occur more than once. Thereby, learning can either be a reactive or an active process, or single-loop and double-loop learning, (Argyris and Schön, 1978; Dick and Dalmau, 2000). Single-loop learning is perceived as merely problem-solving which is mostly tacit, while double-loop learning is persisting and touching nature of the problem (Argyris, 1992).

Lean construction relies on professionals, designers as well as construction workers transacting across demarcation lines in order to reach the best possible product as well

as process. These transactions form the professional actions within the project. So despite specialization within each profession, each profession is dependent on the others to perform. Through this perception of learning, Lean Construction leads to learn by guiding individuals to transact across demarcation, e.g. by interacting in planning meetings. They are also guided to be reflective thinkers by constantly questioning own practice in order to evolve. To develop the construction process the involved people have to become active learners who can change their practice to be more effective seen from both the single profession's point of view and in a broader perspective.

LEAN CONSTRUCTION AS BOUNDARY OBJECT

Lean Construction has shown to be a tool for interdisciplinary learning by bridging the different specialists. Lean Construction focuses on using the involved team members' knowledge no matter profession or level of management responsibility. Thereby, the different professions are obliged to cooperate and to be aware of the dependencies between the different professions.

In the case examined, the weekly planning-meetings showed to be excellent boundary objects as the agenda made the workers express their knowledge and expectations to their work process. They were gathered to make a joint work-plan for the week to come, as specified in Last Planner System of Production Control (Ballard, 2000) and thereby, they had something specific as a base for the discussion, a boundary object that all involved could relate to. Because planning became more specific than usual, and because the people involved were directly involved with practice, it became visible where the different trades had different perceptions on both blueprints and process planning. According to the learning model, such disagreements lead to an inquiry into the situation, and the perception of the construction process could thereby be discussed, and agreements reached of how to proceed. Normally, the disagreements would visualize during the construction process at the construction site, and not during meetings.

It also showed that this kind of learning process appealed to construction workers, as the meetings committed different professions to the construction process, thereby learning got linked directly to practice. They did not feel like being put in a class-room situation, because the content of the meeting was of immediate relevance for their practice.

Therefore, the outcome of the planning meetings became more than just a plan for the following week's work and an evaluation of the former weeks' work progress. It became a forum for discussion and knowledge sharing as the workers brought in their own histories and experience and used these to solve problems and to develop the process. Thereby everyone became more aware of each others' professions and the constraints between the different professions. They got to know each other as persons and could more easily coordinate smaller things directly without managers and project managers. Instead of being passive, the workers could positively affect their work conditions and change practice. If a problem occurred, they solved it together by changing practice, and thereby they created new knowledge which they could afterwards bring on to the next project.

Thereby, Lean Construction has shown to be an initiator of interdisciplinary learning linked directly to practice. Lean Construction bridges the different practices

and allows transactions directly between practitioners. Thereby disagreements become visible, and agreements of how to proceed can be made leading to knowledge on how to meet future challenges.

LEAN CONSTRUCTION IN THE EARLY PHASES

Lean Construction has proved to be an excellent initiator for interdisciplinary learning between different trades working at the construction site (Ebbesen, R., 2008). While the Lean Construction toolbox including, e.g. The Last Planner system of Control (Ballard, G, 2000) by many practitioners is seen as an integrated performance enhancement within the construction phase, the applicability towards the early phases is still debatable among practitioners. Utilizing The Last Planner system in the design phase is apparently still not widely perceived as an efficiency improvement.

As described in (Hamzeh et. Al, 2009) the empirical data gathered from a case study reveals insufficiencies regarding the implementation of the Last Planner system of Control in its current form on a specific health care project. However, the preliminary results indicate that altering the elements of Lean Construction to suit the specific requirements in the design phase, enable the project participants (architects, designers and owners) to become more comfortable in planning their work on a weekly basis.

The interdisciplinary learning facilitated by Lean Construction on the construction site as documented in (Ebbesen, 2008) is a prerequisite for developing the construction processes in general, and for adding value to the specific project and to subsequent projects. Existing tools for adding value to a construction project, e.g. Value engineering designers. Both tools are applicable during the design phase. As mentioned, the tools mostly focus on the designers' work, and the client is perceived as peripheral (Loveless, Barry K. 1986), and Designing to Target Cost (Ballard and Reiser, 2004) focuses on the design phase and the inter correlation between premise, whose development and learning are not regarded as highly beneficial for the specific project and therefore often discarded.

However, professional clients will most likely benefit from a closer correlation with the other project participants, specifically in the early phases of value determination and design. The client, as well as other professions in the construction industry, have internal constraints and interested parties that should be involved at the right times to achieve a reliable planning base. The inter-organizational learning facilitated between the client and the client advisory consultant (designer) could create an understanding of the constraints within the specific organizations. This will create a common knowledge enabling the parties to increase the reliability of the project plans. Nevertheless, the client's ability to make the appropriate decisions at the right time is perceived as a necessary prerequisite for the entire construction project.

In this context, should this early phase of a construction project not be as detailed planned as the design or the actual construction phase?

According to the developed learning model (Ebbesen R., 2006) and the before mentioned case study, boundary objects such as planning methods in Lean Construction have the ability to initiate interdisciplinary learning between parties with different professional perspectives and hereby initiate further development of the construction process. Hence to improve the process of determining client

requirements and hereby increasing the value of the end product, elements of Lean Construction could be altered to suit the problems and difficulties related to the early phases of a construction project.

CONCLUSIONS

Lean Construction projects have showed great potential by initiating interdisciplinary learning. This paper has interpreted Lean Construction into a theoretical framework of practice based learning. This pointed to the fact that by making different professions cooperate in, e.g. shared planning leads to shared learning and understanding of the construction process as a whole. However, these possibilities for initiating learning seem to have been primarily focusing on the construction phase and partly the design phase. Therefore, this paper discusses the possibilities for implementing more Lean Construction and specifically Last Planner System of Control tools within the early phases of value determination, in order to make professional clients a part of the construction team, and thereby ensuring that project planning is as reliable as possible in the early phase, and furthermore to increase the potential for innovation and learning throughout the project period. By facilitating interdisciplinary learning throughout the supply chain, focusing on making every link as strong as possible, development of the construction process could be moved to a higher level.

FURTHER RESEARCH

As proposals for further research, this paper points towards examination of two specific elements:

Firstly, a further interpretation of Lean Construction into a theoretical framework of practice based learning, e.g. by monitoring more cases. These findings could also benefit from a thorough project evaluation after the handing over process in order to determine the level of long term learning initiated.

Secondly, the early phases of a construction project – including the client's decision-making and initial cooperation with advisors and designers could be examined further. Specially, the questions of how to implement a better planning including internal and external factors should be researched in order to create usable tools for both interdisciplinary planning and learning in the early phases.

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