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LEAN CONSTRUCTION AND HEALTH AND SAFETY ON SITE: ANALYSED IN A PLANNING AND EMPOWERMENT PERSPECTIVE

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This paper presents experience gained by using Lean Construction in the construction industry and reveals its present impact on health and safety on site. Lean Construction represents a new way to manage, plan and coordinate construction projects and can be seen as a new management concept. Lean Construction used on site in Denmark was studied with a focus on the importance of, and interaction with, health and safety. The study applied theories of knowledge management and literature dealing with construction safety management. The measurements were carried out by studying two different cases on site. The construction sites were observed over a six-month period by applying the methods: observation, documentation and interviews. Production and health and safety are often seen as two separate areas with different key actors. They are reflected and handled as two different management areas with their own embedded management problems. Common to both areas are the dialectics between respectively, planning and self-governance, infrastructure and culture, and control and empowerment. It is concluded that 1) Lean Construction can support safety infrastructure, 2) Lean Construction needs a construction manager to support empowerment, 3) under-empowerment safety culture can push towards increased self-governance.

Keywords: construction planning, health and safety, lean construction, management, organizational culture.

INTRODUCTION

In the past 10-15 years, attention has been paid to human resources and organizational potential. The ongoing unfavourable criticism of low productivity, a high number of failures, varying quality and cost overruns has led to the development of new concepts of collaboration with the aim of promoting learning and innovation through improved dialogue and collaboration between the stakeholders. Lean Construction is a recently introduced production management concept and represents a new way of managing, planning and coordinating a construction project on site (Howell and Ballard 1999). The aim of Lean Construction is to optimize the building process. In Denmark use of Lean Construction is concentrated around the Last Planner System (LPS) developed by Glenn Ballard. LPS is a planning tool with focus on flows and sound activities. The central actors are all the actors on the construction sites: construction management, subcontractors, and gang / craftsmen. The new centralized operations of the concept are: meeting structure, process programme (agreements), period plan (5-8 weeks

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level), weekly plan (the actual planning – healthy activities) and continuous evaluation. In Denmark the concept primarily has been developed and tried out in development programmes and implemented by some of the major contractors.

The concept of Lean Construction has been criticized for being limited to an instrumental rationality, where focus is on only the positive effects of the concept (Green 1999). Green questions the concept's capacity to control and explore the labour in practice, which he believes is a neglected issue in the debate of Lean Construction (Green 2009). However the departure of this paper is not a discussion of the capacity of the concepts but how the concepts are constituted through the situational interaction between structural preconditions and specific, local interaction between site management and craftsmen.

The focus is on contractors' implementation and use of LPS on construction sites and the importance of – and interaction with health and safety (H&S) and H&S work. Production and H&S are often seen as two separate areas with different key actors. They are reflected and handled as two different management areas with their own embedded management problems. Common to both areas are the dialectics between planning and self-governance, infrastructure and culture, and control and empowerment. This paper argues that in a local context – in this case the construction site – the two management areas would interfere at all levels. The aim is to explore:

- Specific contextual conditions on a construction site and the site-specific challenges for management, for support of the production and H&S
- The impact of Lean Construction on H&S and H&S work in construction
- The role that H&S work could play in the organizational renewal and performance improvements

THEORETICAL PERSPECTIVES

The next section outlines four theoretical issues. The first focus is on specific contextual conditions on a construction site and the site-specific challenges to management. The second is on knowledge management and the interaction between specific features of leadership and knowledge resources. The third highlights H&S and looks at the relation between safety infrastructure and safety culture. The fourth is empowerment of employees as a development strategy and barriers that often occur in connection with implementation of the empowerment strategy.

Specific contextual conditions on a construction site and site-specific challenges for management

Is management on a construction site implementation of a plan or is there a need for employees on site to be self-governed? Construction sites can be viewed from several angles. The following introduces the two dominant understandings. The first angle is based on the phase model. A phase model of a construction project has long existed as an assumption of how a construction project evolves in stages and it is implicit in this understanding that the previous phases determine the subsequent ones. In this understanding the execution phase is a phase where design and engineering are implemented as plan. This understanding helps to maintain an understanding of the execution phase as a phase in which design and project are implemented i.e. as a phase about following an existing plan. Managerial issues tend to act to develop better planning models. The second understanding is based on the construction site as being characterized by being subject to constant change. When construction is in progress,

the physical surroundings change over time. At the same time the employees must be ready to respond rapidly to changes in the environment resulting from changes for example in design and weather conditions, or unexpected events such as pollution. A managerial challenge has to cope with large uncertainties associated with the process and the dependence that employees on site are themselves able to constantly assess the situation. Across the two understandings the management dilemma is how the interface is between the ability to implement plans on one side and the need for employee self-governance on the other.

Specific features of leadership and knowledge resources

Kreiner discusses knowledge resources in new product development processes in relation to two different qualities: "one being that knowledge resources are constituted by explicit knowledge and information allocated to particular ventures, the other one being that knowledge becomes resourceful by particular tacit processes of mobilization and interpretation." (Kreiner 2002: 114). This differs from the more general understanding and application of tacit knowledge, where tacit knowledge and explicit knowledge are often understood as two different forms of knowledge. Often the understanding of the correlation between the two forms of knowledge is that tacit knowledge can be transformed into explicit knowledge, and efforts can be directed towards promoting the process of making tacit knowledge generalized, so that it can be communicated and disseminated. Kreiner places himself at a different starting point. He does not want to distinguish between two different types of knowledge, but wants instead to distinguish between two different types of knowledge resource. He describes the relationship between explicit knowledge and tacit knowledge in the following way: "In mobilizing resources, ascription of meaning, significance and implication is done. Such ascriptions by which explicit knowledge and information are made resourceful are themselves tacit, i.e. implied and impossible to define, but nonetheless very important." (Kreiner 2002: 115). He continues: "Information that is mobilized and made relevant and resourceful by some actor becomes knowledge resources. Knowledge management can focus more or less on the two 'ingredients' in knowledge resources – the informational inputs and explicit knowledge, or the tacit process of mobilization, interpretation and use. The former part may be owned and possessed stocked as knowledge and information and distributed or allocated by central, authority. The latter cannot be separated from its behavioural expression, and could not be managed in conventional terms" (Kreiner 2002: 115). What he suggests is that different management styles depending on their focus on respectively "knowledge allocated for specific purposes" and "mobilization, interpretation and use of knowledge in the situation" promote the use of planning and self-governance respectively.

H&S between safety infrastructure and safety culture

Regulating the H&S on construction sites are marked by a focus on establishing a safety infrastructure for the provision of planning and managing H&S. Safety infrastructure is for example: preparation of a plan for H&S, requirements on the implementation of workplace assessment, requirements for the organization of work safety, etc. It has long been known that H&S on a construction site is dependent on both a working infrastructure and the existing safety culture. Peckitt expresses it in this way: "The precursors of effective occupational health and safety risk management are both functional – e.g. involving formal management systems, and interpretative – e.g. involving social issues such as trust, blame, risk perception, learning, commitment and motivation."(Peckitt *et al.* 2004: 22).

The explanation for H&S dependence on both an adequate and effective safety infrastructure, and a "positive" safety culture has to be found in specific conditions on the construction site. Rowlinson express it this way: "It is important to realize that the construction site is a highly autonomous organization. As such it is very difficult for the head office to control what goes on the site on a day-to-day basis. In fact, on large construction site, it is often difficult for the site agent to control what goes on a day-to-day or even hour-to-hour basis. Consequently, constructions workers are expected to operate with a high degree of independence and initiative" (Rowlinson 2004: 5)

H&S is therefore dependent on forms of management that respect both aspects of knowledge resources i.e., both the informational input and the explicit knowledge, and tacit processes that support mobilization, interpretation and use of knowledge in this specific situation. Rowlinson expresses for example: "Workers progress around the site as the building works progress and each worker is expected to use his own judgement to ensure work proceeds in new and continually changing surroundings." (Rowlinson 2004: 9).

H&S efforts have long been dominated by a mindset of prevention through better planning, but in recent years the discussion has highlighted the importance of safety culture. The problem with safety culture has been to define and operationalize it in a way that it could be used as a tool in a practical context. Peckitt (2004) among others concludes that a safety culture paradigm can, despite its lack of precise quantifiable parameters, contribute to the understanding of accidents, since it involves aspects that have been overlooked by other paradigms. Generally it is found that both managements' action and employee perception are important in determining safety culture.

Empowerment of employees

Empowerment of employees is often discussed as a development strategy in the sector due to industry-specific management challenges such as complex products and processes, many actors, fragmented processes and tasks etc. Bryman *et al.* explored the employee perceptions of empowerment. They found that employees indicate two main ways that empowerment can be achieved. "through the demonstration of trust; and by allowing operatives to make their own decisions in relation to their work" (Bryman *et al.* 2005: 362). They also found that employees are very aware of the relation between their competences (experience, knowledge, previous actions and training) and the work they are doing. They recognize that there are limits to their decision-making, and they will ask for assistance from a senior source if they consider that a decision transcends their experience. The consequences are described by the authors in this way: "they considered that by being empowered, they can be able to show themselves as individuals and their individual achievements could then be recognized. Without the opportunity of empowerment, they feel that they are treated like robots…" (Bryman *et al.* 2005: 364).

When management choose to use empowerment of employees as part of a management strategy, it is rarely easy. A number of barriers are identified in the companies' implementation process of empowerment of employees. The roles of middle management are often mentioned as being a major barrier to empowerment of employees due to an unclear definition of the role and middle management's tendency to do as they used to do. Power relations between middle management and employees and lack of insight and skills by the middle management to changing their roles are frequently mentioned explanations (Forman *et al.* 2001, Bryman *et al.* 2005). It is an often forgotten fact that the empowerment of employees requires not only new tasks,

responsibilities, competencies etc. for employees, but also organizational changes (Dainty *et al.* 2002, Forman *et al.* 2001). In the construction sector this trend is even stronger. The distance both geographically and in the mindset between senior management at the company and the employee on site can hinder company strategies about empowerment in being followed up by local management/supervisors on site. (Bryman *et al.* 2005). Health and Safety regulations are also mentioned as a barrier. The employees on the construction site experience that H&S regulation can slow down processes and do not always provide safer working conditions (Bryman *et al.* 2005)

METHOD

The research was based on two case studies. Case studies are relevant in situations where there is a need for exploring phenomena as they appear in reality. The case study is a research method where a single, or a few, cases is studied in depth, and outlines the specifics of a more general character and interest. By choosing the case method, the choice of case becomes an important methodology question. Flyvbjerg (1991) defines different strategies for selecting cases:

1. The paradigmatic case is chosen when the wish is that the case can work as a metaphor or establish a new way of dealing with an issue dealt with in this study.
2. Extreme and deviant cases are cases where you look for example for the specifically problematic or the specifically successful.
3. A critical case concerns a superior aspect and makes it possible to generalize within this superior aspect.
4. Maximum variation cases are cases where we involve various different cases to examine the problem and where the cases are different concerning one dimension.

These strategies cannot be considered as separate strategies, but can be used to specify limits and possibilities of the case you are working with. For this research, strategies numbers 1, 3 and 4 were especially relevant.

Strategy number 1: focus was on the possibilities for using the two cases as a metaphor for correlations between Lean Construction and health and safety conditions on the construction site.

Strategy number 2: two well-reputed major contractors in Denmark were investigated. They both implemented Lean Construction as a management tool on the construction site and they both had H&S as an important company theme. In both construction projects studied, the contractors played the role of main contractor, which made it possible for the contractors to set their own norms for collaboration and H&S on site. This established the cases as examples of best practice, and it should be expected that dilemmas in this context would also be dilemmas in other similar contexts or contexts with fewer preconditions.

Strategy number 4: even though the cases were similar in many ways, there were also some differences. Both contractors grew out of strong craftsman traditions, but as they grew they chose different organizational solutions. Company A recruited many salaried employees with medium length or long educations and in this manner built up an intermediate layer of middle managers. In this way they professionalized the management of production as well as the management of health and safety. Recently

they implemented a certified H&S management system. Due to the growing intermediate layer of middle management in the company, the management of the building site referred to project leaders at the company, who was financially accountable. Company B had to a higher degree recruited middle management from the layer of craftsmen and the company had chosen that both a large group of craftsmen and staff were salaried employees. The company had established management teams that worked together continually on different building sites and they referred directly to the director. The difference between the contractors made it possible to see the differences between the two types of management styles concerning practice and problems on site. The two construction sites were observed over a six-month period using the methods: observation, documentation and interviews.

RESULTS

Although production and H&S were handled as two different management areas, craftsmen on both sites perceived H&S and production as two sides of the same coin. When you perform an activity, you consider which method should be used to achieve a good result and the impact of the methods on H&S.

What impact did Lean Construction have on H&S and H&S work?
In the planning of the construction site, the contractor as part of the legal H&S work had to make a plan for health and safety and conduct a workplace assessment of the various work processes. Both activities helped in identifying a number of H&S conditions that might be taken into account in organizing the construction site and the construction process. Experience gained from both cases showed that LPS could help so that identified H&S problems were addressed and operationalized. This mattered especially concerning the handling of building materials and poor working posture that could be resolved and operationalized through improved logistics and planning of the scaffold. In the one case scaffolding, adjustments were formulated between the various trades as an activity in line with other activities in the construction process so that the activity of adjusting the scaffolding was not something you needed to discuss, but was and perceived as an activity in line with installing windows. Both sites held regular H&S checks on site, H&S meetings and weekly LPS meetings where the experience was that the LPS meeting was also a good forum for addressing H&S problems and operationalization of H&S solutions. Each case therefore showed that Lean Construction, in the form of LPS may open up for new opportunities to involve H&S in production coordination and planning.

The above is about the relation between safety infrastructure and LPS. Looking at the relation between safety culture and LPS, the experience gained was more varied. The experience in both cases was that construction managers became aware that an essential precondition for LPS acting as a planning tool was that gangs were self-governing and took a greater responsibility for production. Increased gang responsibility was formulated as increased responsibility for the coordination of activities and the procurement of materials. The cases showed different construction manager strategies and experience.

Case A: the management team on site consisted mainly of a construction manager with a technical education and a craftsman who had been recruited to be construction manager after many years as a craftsman. The work between the construction managers was divided so that the technically grounded construction manager took care of the planning and the construction manager with a background as a craftsman

took care of communicating and solving practical problems on site. In connection with the use of LPS (which was also a company practice), a practice emerged where the agenda of the meetings was limited to input from the gangs to management about what activities were planned for the following week and to gathering of the gang's input in a common spreadsheet so that everyone could see what everyone else was planning to do. Implementation of LPS was marked by negotiations between construction managers and craftsmen. In the implementation process they had to find a new form of mutual agreement between construction managers and craftsmen. The craftsmen' starting point was: "We want to give you more details so you can make a detailed planning for the building process, but inversely we also want that you do not blame us for what we do not accomplish."

The technical construction manager was also H&S coordinator and therefore responsible for the coordination of H&S work, including conducting the H&S check on site. The construction manager himself conducted the H&S checks together with a H&S representative or craftsmen, but despite a heavy workload he chose to take the responsibility of documenting the checks in a memo, even though he did not have time for it, and consequently the H&S checks were not documented. As an H&S coordinator he did not want to leave responsibility to the H&S representative. He was concerned that the H&S representative would use the situation to formulate the H&S memo to his own advantage. The quest for control of production culture and an understanding of the relation between construction management and the gang as "us and them" was transferred to the H&S work. You can perceive it as if the safety culture is exposed to pressure from the production culture.

Case B: construction management consisted of a team comprising a project manager and two process managers. The process managers were both craftsmen who were recruited to process managers. The process managers were responsible for the weekly LPS meeting. At the meeting both the long and short-term planning was discussed. The agenda was guided by the LPS approach but not clearly defined – excluding economy. If there was a H&S problem, it could be addressed in line with other conditions. There was not a contradiction between the production culture and the safety culture regarding control and empowerment.

The relation between formal and informal coordination?

The use of LPS could affect both the safety culture and safety infrastructure on the construction site. Meanwhile, implementation of LPS and the way the concept was anchored in practice also affected whether the concept promoted the coordination and execution of the construction process. On both sites it was difficult to plan construction processes, and it was made further difficult due to a harder winter in Denmark than usual. Snow and frost meant delays and that certain activities planned at the LPS meeting could not be carried out. There was a great need for informal coordination on the sites between the formal coordination at the weekly meetings. Different experience was gained from the two cases regarding how coordination problems were understood and solved.

Case A: the increased need for informal coordination was solved by the gangs themselves as they coordinated activities between the gangs on site in collaboration with the construction manager with a background in construction. The construction manager knew both worlds on the construction site: construction management and plans and on the other side gangs and execution. It turned out that the construction manager came to act as an important mediator between the two worlds and thus had

an important role as a link between plans and execution, where his role primarily was to support the gangs' self-governance and ensure overall coherence. The need for informal coordination between the weekly meetings gave rise to criticism of the concept and questions like: do we need the tool, when we still have to coordinate changes throughout the week? At the same time, the craftsmen demanded that the agenda at the meetings included long-term schedules and weather forecasts. This could be interpreted as a desire to take greater responsibility for coordinating at the meetings, but also that the necessary information and time horizons were available, so they were able to do so in a qualified manner.

Case B: the process leaders also had the ongoing contact with the gangs. The process plan was perceived as the plan in force, but only until there was a reason for adjusting it. The project leader asserted himself primarily when he demanded documentation of changes, for example solutions for technical changes that were important with respect to liability and warranty. Therefore the need for informal coordination between meetings was no reason to question the validity of the concept, but problems were continuously resolved through coordination between the process managers and the gang in their daily communication.

What role could H&S play in the organizational renewal and performance improvements?

In Denmark the construction sector is under increased external pressure in relation to H&S due to legislation conferring greater responsibility for H&S on the construction site to the client. This has resulted in new client demands that often have the character of increased requirements to the documentation of the H&S on site and the H&S work. In case A, this was reflected in the circumstance that the contractor must conduct a H&S check on site once a week and document the results. In case B, it was expressed by the client's choosing to use an external consultant as a safety coordinator. This could affect the contractors' safety infrastructure and safety culture.

Case A: the company had to meet the external requirements to establish an H&S function at the company and implement a H&S management system. The company's H&S policy was that H&S was an important area that the company would like to make their responsibility. It was the experience that the H&S management system supported safety infrastructure on site, but also that it gave rise to dilemmas that were significant for the H&S culture. The safety coordinator on site, who was responsible for the H&S checks, found that the H&S checks lost their meaning, because of the requirement for documentation. He believed that it was important to solve the problems immediately instead of spending time on documentation.

The H&S manager at the company conducted self audits on site once a month. The aim was to contribute with an external look at the H&S conditions on site. The target group consisted of both the gangs and the construction management. The audit memos did not reach the entire target group. The gangs subsequently demanded the memos from audit and insisted on easy access to the memos in future. The H&S function faced a challenge. The H&S function had to define the relation between the requirements for documentation and solving problems in practice and they had to decide whether H&S work should be anchored by the construction management or the H&S organization, and what changes should be made to strengthen the H&S organization. If the H&S function wanted to strengthen the H&S culture towards self-governance, there was a series of challenges such as: less focus on evidence and more on problem solving, direct communication with craftsmen and H&S representatives,

focus on the role of H&S coordinator and ensuring follow-up. If the safety culture facilitated increased empowerment of the employees, the safety culture could give a push in the direction of increased gang self-governance, which might affect how LPS were implemented and anchored.

Case B: the company did not separate production and H&S but acted on the understanding that they belonged together. There were not two rationales at play, but only one. The external safety coordinator planned and implemented H&S meetings on site and made H&S checks. The contractors' first reaction was whether they now had to hold two safety meetings instead of one; so they held their own. But soon they decided only to hold one with the external safety coordinator. The meetings were mostly about information, where the contractor informed the external safety coordinator about H&S issues. Apparently it was not very important for the company's H&S work, since a large part of the effort lay with the employees themselves and in the daily communication with process managers, i.e. anchored in the safety culture. Furthermore, the process managers as the craftsmen took up H&S issues when they felt it was needed and did not distinguish between whether it was at a safety meeting or at a weekly meting.

CONCLUSION

Lean Construction and LPS as production management concepts and tool are often discussed theoretically with regard to their inherent capabilities (Green, 1999 and Howell, 1999). This paper shows that there is a need for paying much more attention to understanding how the concepts are constituted in practice through the situational interaction between structural preconditions and specific, local interaction between site management and craftsmen. This paper explored the relation between Lean Construction and H&S on site. The contractors, who were investigated in the cases, were characterized as examples of best practice as they had both made a major effort regarding implementation of Lean Construction respectively managing H&S conditions. In the conclusions, three aspects are highlighted and these aspects might also be relevant for other contractors who choose to implement Lean Construction as a planning tool on site.

The first aspect was that Lean Construction was able to support the safety infrastructure on site in such a way that identified H&S problems could be addressed and operationalized. LPS could open up for new opportunities to involve H&S issues in production coordination and planning. Concerning safety culture the relation was not that simple. The cases showed two different relations between construction management and craftsmen: a negotiation culture characterized by us and them and focus on control, and a partnership culture characterized by us and focus on self-governance. The type of relation has an impact on the implementation of LPS, and the rationality embedded in the way LPS is anchored organizationally can have an influence on H&S culture.

The second aspect concerned the relation between plans and self-governance. During the implementation of LPS, both contractors had recognized that if LPS should function and better the coordination and planning of the production on site, craftsman self-governance was a central prerequisite. If implementation of Lean Construction is to succeed, there is a need for a construction manager who facilitate empowerment of employees. The experience gained from the cases showed that construction managers who had both craftsmen's competence and construction management competence could play an important role as a mediator between plan and self-governance.

The third conclusion took its departure in H&S. Regulation of H&S was mentioned as a barrier for empowerment of workers. In Denmark there is a long tradition for H&S issues to be handled in collaboration between employer and employee. The legislation requires that companies establish safety organizations with both employer – and employee representatives. The collaboration between employees and employer in the construction sector is under pressure from new tendencies e.g. new regulations that place responsibility for H&S on clients. Unintentionally the new tendencies may move H&S efforts from problem solving to documentation. It was found that the contractors' H&S function can support empowerment of craftsmen, but if so, the professional H&S function has to keep the health and safety work in the safety organization. The function should focus less on evidence and more on problem solving, communicating directly with craftsmen and H&S representatives, focus on the role of H&S coordinators and ensure follow-up. If the safety culture is supported toward increased empowerment of the employees, safety culture may give a push to increased gang self-governance which may affect how LPS is implemented and anchored.

REFERENCES

Bryman, A, Dainty, A R J, Price, A, Soetanto, R and King, N (2005) Employee perceptions of empowerment. *Employee Relations,* **27**(4), 354-368.

Dainty, A R J, Bryman, A and Price, A D F (2002) Empowerment within the UK construction sector. *Leadership and Organization Development Journal,* **23**(6), 333-342.

Green, S D (1999) The dark side of lean construction: exploitation and ideology. *Procs IGLC-7*, 26-28 July 1999, University of California, Berkeley, CA, USA 21-32.

Flyvbjerg, B (1991) *Rationalitet og magt: Volume 1*. Copenhagen: Akademisk Forlag.

Forman, M and Joergensen, M S (2001) The social shaping of the participation of employees in environmental work within enterprises: experiences from a Danish context. *Technology Analysis and Strategic Management*, **13**(1), 71-90.

Holt G D, Love, P E D and Jawahar Nesan, L (2000) Employee empowerment in construction: an implementation model for process improvement. *Team Performance Management,* **6**(3/4), 47-51.

Howell G, Ballard G(1999) Bringing light to the dark side of lean construction, *Procs IGLC-7*, 26-28 July 1999, University of California, Berkeley, CA, USA, 33-38.

Kreiner, K (2002) Tacit knowledge management: the role of artifacts. *Journal of Knowledge Management,* **6**(2), 112-123.

Lingard, H and Rowlinson, S (2005) *Occupational health and safety in construction project management*. London: spon Press.

Peckitt, S J, Glendon, A I and Booth, R T (2004) Societal influences on safety culture in the construction industry. *In:* S. Rowlinson (eds) *Construction safety management systems*. London: Spon Press.

Rowlinson, S (2004) Overview of Construction Site Safety Issues. *In:* S. Rowlinson (eds) *Construction safety management systems*. London: Spon Press.