

MANAGEMENT INNOVATION BROKERS

- The Story of Lean Construction Entering Denmark.

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ABSTRACT

Lean Construction is a relative new management approach in Danish construction. This paper describes the journey of Lean Construction into the Danish construction sector.

Lean Construction is viewed as a management concept and this paper will focus on the role of innovation brokers in the innovation process. Our intention is to show that brokers - and in this case: Lean Construction brokers - have a profound influence on how, where and when a new management concept will penetrate the construction industry.

The story of Lean Construction entering Denmark is told - from the first ideas in public funded development programmes through the ongoing development in a few, leading edge construction companies and through the work of a network of brokers to the recent launch of a Danish Lean Construction Institute (Lean Construction-DK). The case is matched against established theories on the innovation process and the role of brokers.

It is concluded that the innovation process in this case has been multi-levelled and emergent and has depended on several different types of brokers at different stages and with different roles. Also the case indicates that Lean Construction is well on the way to institutionalisation in the Danish construction sector.

KEYWORDS

Lean Construction, management concept, innovation brokers, innovation process, network

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INTRODUCTION

In recent years the construction sectors in the OECD countries have been focussing on productivity, processes and management. The Danish construction sector has been dominated by a debate on the disappointing development of productivity. The debate has been fuelled by a number of public investigations. One of the identified problems is difficulty with innovating management and organisation (Byggeriets fremtid 2000). In this paper we wish to describe how Lean Construction has entered the Danish construction industry through a journey that started more than 10 years ago. Lean Construction is viewed as a management innovation.

The journey of Lean Construction has not come to an end yet. However, essential characteristics of the process now seem to elucidate. Lean Construction has been supported by a number of individuals, coalitions and general circumstances, which apparently in random combination have been brokering the innovation on its journey towards managerial practice. This paper tells the quite unique story of Lean Construction being institutionalised in a national construction sector.

The paper relates the Lean Construction journey to different theoretical views on innovation processes. We view the innovation process as emergent and complex and use the understandings represented by the Minnesota Innovation Research Programme, Van de Ven and Graham Winch.

The paper first identifies Lean Construction as a concept. Then theories on the emergent innovation process and innovation brokers are presented. The story of Lean Construction entering Denmark is told drawing special attention to the role of the different brokers. The case is analysed by matching it against the theories.

This paper co-exist with the paper "Shaping Lean Construction in Projectbased Organisations" by Simonsen and Koch (Simonsen & Koch 2004), who describe how Lean Construction emerges in a large contracting company and how it is implemented on two projects.

WHAT IS LEAN CONSTRUCTION?

Lean Construction is a production management-based approach to project delivery - a new way to design and build capital facilities. Lean production management has caused a revolution in manufacturing design, supply and assembly. Applied to construction, Lean changes the way work is done throughout the delivery process. Lean Construction extends from the objectives of a lean production system - maximize value and minimize waste - to specific techniques and applies them in a new project delivery process. As a result:

- The facility and its delivery process are designed together to better reveal and support customer purposes. Positive iteration within the process is supported and negative iteration reduced.
- Work is structured throughout the process to maximize value and to reduce waste at the project delivery level.

- Efforts to manage and improve performance are aimed at improving total project performance because it is more important than reducing the cost or increasing the speed of any activity.
- "Control" is redefined from "monitoring results" to "making things happen." The performance of the planning and control systems are measured and improved.

The reliable release of work between specialists in design, supply and assembly assures value is delivered to the customer and waste is reduced. Lean Construction is particularly useful on complex, uncertain and quick projects. It challenges the belief that there must always be a trade between time, cost, and quality (Lean Construction Institute)

DANISH VARIATIONS

In Denmark several experiences with construction logistics started before the thoughts of Lean Construction reached the country. Many of the developed principles and ideas were merged with the original Lean Construction ideas. In Denmark Lean Construction has been translated into 'Trimmet Byggeri' [*trimmed construction*], and the contractor MT Hojgaard Ltd. has evolved its 'personal' variation 'TrimByg'. The main principles are identical with those of Lean Construction, but the national implementation context and its chronology, which will be illustrated in this paper, have generated important variations like the process manager.

THE INNOVATION PROCESS

For many years innovation have been treated as a linear process⁴ like an in-firm product development process. We believe that the process is much more complex, both regarding iterations and actors in the process.

The Minnesota Innovation Research Programme (MIRP) has identified five core concepts of innovation (Van de Ven & Angle 1989):

- Ideas (the innovation idea)
- People (project participants)
- Transactions (with knowledge institutions a.o.)
- Outcomes (the results of the innovation)
- Context (institutional and organisational context for the innovation process)

Based on these five components MIRP defines the innovation process as:

"a sequence of events in which new ideas are developed and implemented by people who engage in relationships with others and make adjustments needed to achieve desired outcomes within an institutional and organisational context" (Van de Ven et al. 1999)

⁴ i.e. by people like Rogers and Schumpeter

Miller presents an innovation model for what he calls Complex Product Systems (CoPS) (Miller et al. 1995). The Complex Product Systems are characterised by (Winch 1998):

- Many interconnected and customised elements organised in a hierarchical way;
- Nonlinear and continuously emerging properties where small changes to one element of the system can lead to large changes elsewhere in the system;
- High degree of user involvement in the innovation process.

These characteristics are also seen in many parts of the construction industry. Miller (1995) assigns the following attributions to the system integrator (broker) in the CoPS⁵:

- the skills to integrate interdependent components into a coherent whole
- detailed knowledge of client requirements
- knowledge of the rules and regulations governing the industry

Winch (2003) states that innovation in complex product systems can not be done by one firm without bringing many of its collaborators and clients with it. Innovations are the result of collaboration between firms in clusters or networks. This negotiation process can take place directly between firms in a project coalition, or, more frequently, it is facilitated through network institutions, often set up for this purpose. This is also a fertile field for government intervention in the innovation process. Such network institutions and associations can be considered to be brokers in the innovation process in complex system industries.

TOP-DOWN OR BOTTOM-UP?

Winch has made the model illustrating the Top-down and Bottom-up Modes of Construction Innovation (Figure 1) (Winch 1998 – further developed in 2003). The top-down mode is where the firm adopts new ideas and tries to implement them on projects. The role of the broker in this mode is to review and distribute knowledge and thereby promote awareness and facilitate implementation to the projects. Winch refers to this as broadcasting.

The Bottom-up mode is where the innovation revolves around problem solving on the projects. The firm is learning from these projects and is thereby able to diffuse the innovation to other projects. This requires a different kind of broking where the broker backed with technical expertise acts as consultants to find the best possible solution.

⁵ Miller's work is not based in the construction industry – but aircraft simulators. One very specific point has been omitted from the original list of attributions

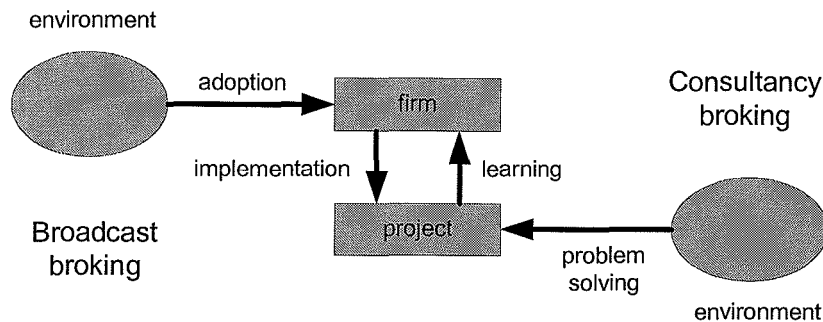


Figure 1 - The Top-down and Bottom-up Modes of Construction Innovation (Winch 1998&2003)

MANAGEMENT INNOVATION BROKERS

Innovation is often defined as developing and implementing a new idea (Van de Ven et al 1999). A classic approach to innovation distinguishes between product and process innovations and further split process innovations into new procedures, policies and organisational forms. In construction there is a tendency towards a focus on process innovation (Bang et al 2000).

In recent years there have been a call for management and organisation innovation in Danish construction (Byggeriets fremtid 2000) (Clausen 2002). According to the definition of innovation, *management innovation* is defined as developing and implementing new ideas in managerial activities and support systems. Managerial activities encompass assignment of tasks, coordination, planning and communication (Koch 2002).

The *Management Innovation Broker* is a person or institution who facilitates the development and implementation of the new managerial ideas.

Winch (2003) distinguishes the innovation broker from the knowledge broker by the fact that the knowledge brokers are a for-profit sub-set of innovation brokers, which include many not-for-profit organisations. In this terminology engineering consultants are knowledge brokers whereas for instance universities are seen as innovation brokers. At the same time there is little difference between the two categories, and they might also periodically vary in relation to the same actor. Both the knowledge and innovation brokers capture and diffuse innovation. Nam & Tatum (1997)⁶ describes the importance of champions in construction by stating, that ideas carried by people are the rallying point around which collective action is mobilized.

There have been many attempts at categorising innovation brokers (Winch 2003, Bang et al. 2000). Winch (2003) suggests the following types of brokering institutions to be central in

⁶ Referred in Winch 1998

relation to construction: National building research institutes, professional associations, universities, trade associations, standards association, state sponsored innovation initiatives.

This work is in progress within the framework of CIB⁷, Task Group 47⁸.

FIVE KEY ROLES IN INNOVATION

Van de Ven (1999) defines five key roles that appear in the innovation process.

The *Entrepreneur* is the role for managing the innovation. The Entrepreneur is dealing with the innovation on a daily basis and making all the key decisions influenced by the other roles.

The *Sponsor* is typically placed high in the organisation and advocates the innovation in the organisation and among investors. The Sponsor is thereby supporting the Entrepreneur by loosening up possible barriers.

The *Mentor* is typically an experienced innovator. The Mentor coaches and advises the Entrepreneur through the innovation process.

The *Critic* is an opposite of the mentor and the sponsor roles. The critic plays the role of the devil's advocate and by asking cunning questions forces the coalition behind the innovation (the sponsor, mentor and entrepreneur) to re-examine the content and course of the innovation and hold it against existing business criteria. Top managers who focus on project investments, goals and progress, often carry out the role of the critic. The effect of the critic is that the entrepreneur and the sponsor/mentor coalition must explain and often rethink the innovation in order to defend it toward the critic. This iteration makes the innovation stronger.

The *Institutional Leader* has the role of balancing the opposite roles of the sponsor/mentor and the critic. The institutional leader is not as directly involved in the innovation process as the other roles.

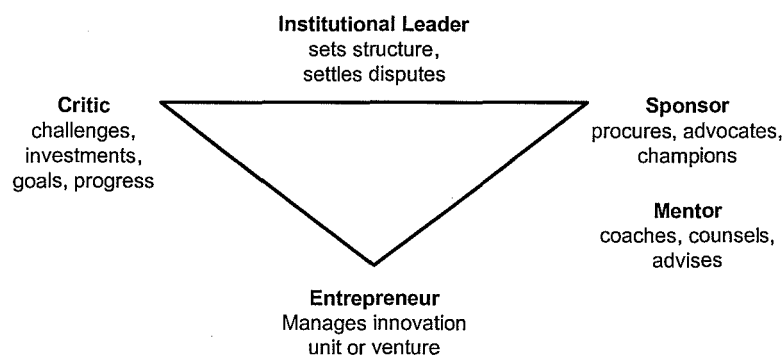


Figure 2 –Five roles in Innovation (Van de Ven 1999)

⁷ International Council for Research and Innovation in Building and Construction.

⁸ TG47 - Innovation Brokerage in Construction

The different roles are supposed to appear in the innovation process and all represent a kind of innovation broker. Although not all of them try to facilitate the innovation they are all valuable in the process. In the analysis following the case we will try to identify the carriers of the different roles regarding the development and implementation of Lean Construction.

THE CASE: LEAN CONSTRUCTION ENTERING DENMARK

The story⁹ has its departure in the late 80ies and follows different parallel and interrelated trajectories¹⁰. In 1989 the Consulting Engineers Union carried out an initial and ice-breaking analytical work focussing on the process of the construction supply chain (Dobbelt-Op, 1990). This work represented a clear contrast to the product-orientation, which had been dominating the Danish development agenda. Central actors in the process of making the Double Up report were Sven Bertelsen (Manager at NIRAS consulting engineers) and C.F. Møller (Manager at contractor Hojgaard & Schultz).

At that time a central policy-maker in the Ministry of Housing¹¹ was Marius Kjeldsen, who also pioneered the industrialisation of the Danish construction industry in the 60'ies. In the late 80'ies the Danish Ministry of Housing funded development projects of which two focussed on process aspects – one relating to a construction system of steel and plaster boards, the other aimed at developing construction logistics and was lead by the company NIRAS. This new focus on the process was maintained and upgraded to development programmes on ministry level¹². In the PPB-programme (Process and Product Development in Construction) four consortia worked with different kinds of developments. Hojgaard & Schultz¹³ (H&S) was member of one of the consortia, PPU, working with logistics. The objective of PPU was to develop and reorganize the construction process. This should be done through enhanced vertical collaboration and structuring the design process. Furthermore they worked with 'process units', defined as non-interdependent production units. Another consortium - Habitat - set out to evaluate different product innovations as well as aspects of reorganizing. By coincidence¹⁴ Niras with Sven Bertelsen ended up as partner in Habitat and Bertelsen soon introduced logistics as an important focus area. During the development period from 1995 to 1999 focus shifted towards process organisation matters (Clausen 2002).

In the same period the Danish Building and Urban Research Centre launched their Building Technology and Productivity Division, dedicating a group of people to focus on examining the building process from a theoretical point of view and educating PhDs.

In 1999 the Technical Science Academy (ATV) published a report on Danish construction in the 21st century. The report was written by some of the main innovators in Danish construction. Among these were Bertelsen and Peter Henningsen from H&S.

⁹ The case is partly based on interviews with Dag Sander and Sven Bertelsen in spring/summer 2003.

¹⁰ Which makes it a bit difficult to describe in an orderly fashion

¹¹ The Ministry of Housing has changed names many times in the last decade. Now the function is under the National Agency for Enterprise and Housing.

¹² The Ministry of Business and Industry, wanted to sharpen the competitiveness of the construction industry.

¹³ Large Danish contractor. United in 2001 with other large Danish contractor Monberg & Thorsen to become MT Hojgaard.

¹⁴ NIRAS bought the company originally responsible for the consulting engineering work in Habitat.

Another path leading the Danish construction sector in the direction of Lean Construction is Sven Bertelsens trips around the world meeting likeminded who has inspired his work in Denmark. Among others he worked with people from the University in Melbourne on construction logistics.

Bertelsen regularly wrote papers for different research conferences and hereby discovered the first references to the new concept Lean Construction. A turning point was getting a paper rejected for a conference in 1999. The rejection was argued in lacking references to Lean Construction. After this Bertelsen had to find out what Lean Construction was all about. He searched the internet and found articles by Koskela, Ballard and Howell etc. as well as proceedings from the earlier IGLC conferences. Bertelsen saw Lean Construction as a possible solution to many of the problems the Danish construction industry was facing and a concept that embodied many of the thoughts that he himself had been working on. Bertelsen went to the IGLC conference in Berkeley in 1999. When he got back he was invited by Henningsen to collaborate with 'theme group 4' in Project House and write the part on construction logistics. This is where it took off. At the time there were possibilities to experiment with the new ideas. Both Niras and H&S got experiences through these projects merging their past work and experiences with the principles of Lean Construction. This showed promising results and H&S who became MT Hojgaard (MTH) in 2001 worked hard on implementing the ideas of Lean Construction into what they called TrimByg.

This far we have mentioned MTH as an actor, but Lean Construction as an innovation has been carried by only a handful of people in MTH who believed in the potential of Lean Construction. The innovation has been introduced to MTH at the middle management level. The people who were in the public founded development programmes have taken the ideas back to the company and have been given the possibility to try to follow them. C.F. Møller and Henningsen have been vital forces in MT Hojgaard's success with testing, developing and using the Lean principles. In 1999 project manager Dag Sander got involved in the making of the ATV report and later got the opportunity to work full time implementing the TrimByg concept along with Henningsen and with the help of Bertelsen.

When Bertelsen found the descriptions of this new Lean Construction concept he was eager to try the ideas in real life. Bertelsen wondered if the tools of Lean Construction worked and MT Hojgaard gave him the opportunity to test them. Through his connections with Henningsen, Bertelsen teamed up with him and MT Hojgaard. Bertelsen worked with Henningsen and Sander on developing the concept and educating the site employees in the techniques. Bertelsen left NIRAS in late 2000 to start his own consultancy. He kept working with MT Hojgaard, but less and less involved in the daily implementation and teaching. Other people were found to carry out this task along with Sander.

MT Hojgaard worked with the new principles on their own, closing out competitors in order to get a competitive advantage. This means that MTH only have been working with Bertelsen in their development of the concept. MTH's competitors have known what MTH was doing but MTH has been very closed regarding their methods, implementations and experiences. Bertelsen and Sander have been running courses in MT Hojgaard educating both employees and subcontractors in the new principles like the Last Planner System. The secrecy doesn't concern the Last Planner System or the content of Lean Construction as any of MTH's competitors can read about this elsewhere - the secrecy regards the methods of

implementation. Not that MTH have completed a 100% successful implementation of Lean Construction but they find they have a head start due to their experiences.

According to Dag Sander the presentation of Lean Construction ideas to the management of MTH caused different reactions: a small group of innovative persons, who were very positive, a big group of sceptics and a small group of reactionaries who didn't understand why the traditional ways should be changed. These groupings seem to be normal in social segregation. The site workers reacted in the same way. Many of the ideas were very different from what they were used to. The change didn't come overnight, but many were positive and willing to try.

It is not only (people from) MTH and Bertelsen who have influenced the development and implementation of Lean Construction. The Ministry of Housing and the Ministry of Business and Industry have had a profound influence by funding the large development projects in which many ideas have been born and tested. Also different funds have supported developing new ideas for process improvement in construction. Finally the need for Lean Construction as a tool for improving construction comes from a demand from private and public organisations, building owners, different ministries (economy) and more.

Once MTH displayed positive results by using the Lean Construction principles, the interest in the Danish construction sector increased. As a result a Danish branch of the Lean Construction Institute (Lean Construction Denmark) was founded in Denmark in 2002. Lean Construction-DK is based at the Danish Technological Institute and lead by Pernille Walløe. In 2004 Lean Construction-DK got a board of external companies and organizations and were thereby the main place for Lean Construction activities in Denmark. The aim is to help Danish construction companies implement Lean Construction. Sven Bertelsen is associated with Lean Construction Denmark as Senior Research Advisor. Lean Construction-DK is hosting a discussion network initiated by Bertelsen when he was associated with the Benchmark Centre for the Danish Construction Sector. The network is an open forum for discussing Lean thoughts.

ANALYSIS

The analysis relates the case to the described theories on innovation processes and brokering. First we relate to Winch's work and then identify who play the different brokering roles.

WINCH AND THE COPS

Winch points out that innovation in a complex product system (CoPS) as construction, must be done by a network of companies working together. In the case of Lean Construction in Denmark MT Hojgaard has taken a rather introvert approach to the innovation of the company. But they have acknowledged the fact that they needed to bring in their subcontractors in order to make Lean Construction operational. The principles of Lean Construction is based on a collaboration between the different trades and contractors on the construction project and MT Hojgaard have invited all their collaborators on projects to participate in kick-off seminars. In this way the principles of Lean Construction are spread to the subcontractors and it has often been seen that these will advocate for the principles on the next project they encounter. Also at some point MT Hojgaard might be using knowledge of

and experience with Lean Construction as criteria for collaborating with them on large construction projects. This will force the subcontractors to be prepared for using Lean Construction if they want contract with MT Hojgaard on large projects. Later it might be used also in the up-stream collaboration with Architects and consulting engineers using Lean Design.

Winch also mentions the possibility for state intervention in the innovation process. The Danish state (The Ministry of Housing and later The National Agency for Enterprise and Housing) has been a very important player in the process. Through the different development programmes – PPB, Project House, Project Urban Renewal a.o. – space was provided for testing and developing new initiatives in the Danish construction industry. The provision of this experimental environment was facilitated by the obliging attitude of key-persons in different departments of ministries and other governmental institutions. High positioned officials like Marius Kjeldsen and Ib Steen Olsen have supported the various attempts to improve the process of construction – like partnering, lean construction, vertical and horizontal collaborations, logistics, IT-integration a.o.

In the governmental funded projects consortia or coalitions of companies have carried out the innovations. It is clear to see that it is the companies who participated in these consortia that have continued working with the innovations afterwards whereas it has not spread widely to companies outside these coalitions. Most visible is the work with logistics and Lean Construction which Hojgaard & Schultz started on in some of these projects and which they have carried through to their other projects. Also Sven Bertelsens work departs from the publicly funded projects. Niras has been working with Lean Construction and using that as a base for working with strategies for client value optimisation.

TOP-DOWN OR BOTTOM-UP OR ?

Referring to Winch's Top-down and Bottom-up Modes of Construction Innovation (figure 1) the story of Lean Construction is obviously representing both modes. Many of the ideas have evolved in the Danish construction sector as solutions to some of the problems of the sector before it was known to be Lean Construction. When Bertelsen discovered Lean Construction companies began adopting Lean Construction as a "packaged" set of tools. Lean Construction was adopted as a possible solution to many of the general problems of low productivity in the construction sector.

Also the case shows that managers placed on the middle management level of MTH carried the innovation working with iterations in the implementation/learning area of Winch's model. Thus, the case is neither a clean top-down nor bottom-up dynamic but has rather entered at a middle level and from there evolved both up and down.

The final innovation goal is to obtain an institutionalised status in the company. Lean Construction has not yet achieved this formal status, but it lies right on the track. The more formal status of Lean Construction-DK as a well-established network and association and the leading consultancy on Lean Construction in Denmark gives the concept a formal status, making it more visible to all in the construction sector and thereby (consultancy-) brokering the innovation more effectively.

On the macro-level the National Agency for Enterprise and Housing are working on a guide for building owners. This guide sets directions for managing the construction process.

Some of the principles of Lean Construction will be presented as new tools. As a result more and more building owners will demand the companies to have these skills in order to be allowed to bid on projects. Hereby the government/ministry is also taking a step toward institutionalising the concept.

THE ROLES OF DIFFERENT ACTORS

Van de Ven's five roles in the innovation journey can also be identified in the case of Lean Construction entering the Danish construction sector. In this section we will identify the different roles (Entrepreneur, Sponsor, Mentor, Critic and Institutional Leader) and discuss the way they influence the process.

In the case of Lean Construction the Entrepreneurs are the people who work on the daily basis with implementing Lean Construction on the construction sites. Not the site managers or foremen, but the people working on the higher organisational level who can dictate which tools to use on the sites regarding planning and coordination. This level is project managers or centrally placed managers in charge of development. A couple of Danish contractors are beginning to test and implement the principles of Lean Construction and Last Planner System. Each company have one or more Entrepreneurs working with the implementation of the concept. In MTH it is evidently persons like Dag Sander and Kristine Ann Barnes who work as entrepreneurs with implementing and educating.

The sponsor is a very important function in the life of the innovation. The sponsor supports the Entrepreneur from a higher organisational level by removing barriers. In MHT the role of the sponsor is played by Henningsen who as Head of Division can create the possible room for innovation in the projects and empower the Entrepreneurs to be able to try out the different tools and ideas. At sector level the Ministry of Housing can be seen as The Sponsor creating and funding development programmes that make it possible to test different ideas and concepts.

The Mentor is the coach of the Entrepreneur. Sven Bertelsen has had the role of the Mentor for a large part of the work with Lean Construction in Denmark. He has been the consultant and collaborator of MTH and large projects like DR Byen¹⁵. Bertelsen has worked closely with MTH and helped them implement the Lean Construction principles. He has also done several seminars on Lean Construction for all who wished to learn. Bertelsen initially worked as a manager at NIRAS, later as an individual consultant, as part of The Benchmark Centre for the Danish Construction Sector and latest as a strategic partner of the Lean Construction-DK Institute. Lean Construction-DK has taken over the formal role of mentor in Denmark. Lean Construction-DK is also a business-unit that offers consultancy to its company members. Sven Bertelsen worked more independently and treated Lean Construction more as a course than as a field of working. Now, with the strategic alliance between Sven Bertelsen and Lean Construction-DK the formal and informal mentorship of Lean Construction in Denmark have been joined into a single unit.

The Critic is the one questioning the innovation often comparing it to existing way of thinking. In the case of Lean Construction in Denmark, the role of the Critic is often being carried out (as Van de Ven predicts) by a senior manager from the same company as the

¹⁵ Large project building a new area for Danish National Television Company.

Entrepreneur who tries to implement the innovation. The Critic will often be focused on project budgets and time schedules and be critic to why existing practise isn't good enough. In MTH the top management have been quite critical toward the work with Lean Construction as top management typically are people from the "old school". When educating the site employees the concept has also received a lot of criticism. This has been an important part in the process of developing the TrimByg concept. Also the Critic may come from competing companies.

The Institutional Leader is the one balancing the critic against the sponsor/mentor. The Institutional leader may be the government who through legislation and guidelines can institutionalise the concept and decide which parts of the innovation and the critique should be heard. Also top managers in the innovating companies can act as institutional leaders deciding and dictating which ideas and tools to use.

This section has explained some of the different shapes the innovation brokers have in the case of Lean Construction entering Denmark. The important point is that all of these roles are important if you want the journey of the innovation to be important. Also it shows that the different roles of innovation brokers sometimes are maintained by individuals, sometimes by companies and sometimes by public institutions.

CONCLUSION

The match between the case and the presented theories shows that innovation brokering is indeed a multifaceted and widely applied element in the innovation process. And it seems likely that brokering has played a crucial role in the successful implementation of Lean Construction as an innovation.

Thus, the successful innovation process can be characterised as a multi-level innovation. The innovation has followed several parallel and inter-dependent trajectories, and several different brokers have facilitated the development and implementation. The case underlines that the key to success is the interplay between structures and individuals in the Danish construction sector - the large state-financed development programmes, the efforts of MT Hojgaard and the fiery soul of Sven Bertelsen. Some of these events appear to be of an arbitrary character - which underlines our belief in the very nature of the innovation process as being emergent and non-linear.

The strategy of MT Hojgaard, the upcoming guidelines from the National Agency For Enterprise and Housing, and the establishment of Lean Construction-DK are clear indications of Lean Construction being well on the way towards an institutionalised status in the Danish construction sector.

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