Public Policy and Industry Views on Innovation in Construction

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Abstract
In several countries, governmental agencies have long expressed their concerns about the construction industry's performance, its low productivity and inability to innovate. At the same time public funding of construction-related research and development (R&D) has been reduced, and the responsibility for improving performance transferred to the industry. Drawing on a study on the Swedish and Norwegian construction industries, this paper investigates public policy and industry views on construction innovation, and compares these views with recent theoretical conceptions of innovation, from a network perspective. The findings reveal that the governmental bodies facilitating and funding construction R&D, and the construction industry itself, display partly different views on innovation, both in terms of what innovation actually means and what spurs innovation in this particular setting. The contribution of the paper is twofold: firstly, it reveals different views and discusses their implications for innovative behaviour, and secondly, it suggests some key policy and managerial implications of the study from a network perspective of the business landscape.
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Keywords: Innovation, construction industry, public policy, views, network perspective

1. Introduction

In this paper the focus is on innovation in the construction industry in Sweden and Norway, where in both cases there is a tendency towards the state holding the industry responsible for not being productive and innovative, while at the same time public funds for renewal efforts and research projects have been reduced (SoU, 2002:115; Ørstavik et al., 2003; Bröchner, 2006). This indicates a liability shift in terms of which actors or which forces are seen as the main triggers of technological and economic development; the state through its active involvement or the industry through the influence of 'market forces' and competition. In the beginning of the 1990s, a series of political reforms within housing politics were carried out in Sweden, which essentially shifted the responsibility for industrial renewal and residential property-building from state to market, i.e. the industry (Lind & Lundström, 2007). The new reforms, in combination with a continuous reduction of government funding of the construction sector, have placed the main responsibility for industrial renewal upon the industry itself, and not the state. In addition, this is a position that has become strengthened all the more through subsequent EU regulations (Lind & Lundström, 2011). The Norwegian case presents a similar tendency with the deregulation of the housing market in the 1980s. In addition, the state's involvement in the construction industry is relatively low and fragmented. Several Ministries share the responsibility for the various issues relevant for the industry and little attention has been paid to the industry beyond using it as an important means to sustain the employee rates during the financial crisis. Furthermore, the funding of construction-related research is directed only through open programs in the Research Council of Norway, making it difficult to measure how much is actually spent on this type of research. However, it is argued that the funding has been reduced (See e.g. Ørstavik et al., 2003).

Investment in R&D is a well-known indicator of the degree of an industry's innovativeness. Previous research in the UK (Fairclough, 2002), Sweden (Bröchner & Grandinsson, 1992; Bröchner, 2006) and Norway (Ørstavik et al., 2003; Espelien & Reve, 2007) alike show that the construction industry is lagging behind when it comes to R&D investment. This means that both the public and private funding of construction-related

research are low. Furthermore, previous research also finds that the industry is characterised by adversarial relationships and weak ties between the different actors, particularly when it concerns the establishment of long-term relationships. This is attributed to the tradition of competitive tendering and the industry's focus on the lowest price (Dubois & Gadde, 2002). The lack of interaction provides poor conditions for innovation, according to a network perspective of product development and innovation. From this perspective, any new solution needs to fit into a network of established solutions, which makes innovation an interactive phenomenon involving several different actors and resources. Thus the innovation process is spurred by interaction between actors and resources, and between producers and users (Håkansson et al., 2009).

The aim of this paper is to scrutinise the apparent lack of innovation, R&D investment, and relationships in construction, by using empirical findings from a study of the Swedish and Norwegian construction industries. Public policy and industry views on construction innovation are identified, and there is discussion of the gap between these views and recent theoretical conceptions of innovation from a network perspective. The study draws on the following sources: (1) A review of public documents on government policies and behaviour with regard to construction innovation and R&D funding, (2) questionnaires completed by the construction industry in both Sweden and in Norway, and (3) CEO interviews in both countries (ten in each country), where the focus is to reveal how innovation is viewed by the industry itself and how it actually takes place.

In the following sections, the paper presents a conceptualisation of innovation from a network perspective, and then applies this theoretical basis to discuss and compare the findings from the empirical study. The final section suggests some key policy and managerial implications of the study.

2. A network perspective on innovation

2.1 Innovation – a matter of use

For the last decade or so, innovation has been a buzzword in both the theoretical and empirical worlds. Much management literature points to different strategies of how to manage the innovation process in the pursuit of commercial success, and companies (as well as industries) are using it to demonstrate their progressive forward thinking. The view of innovation, as a spurring force of technological development and economic growth, has also made the concept popular in public policy, regarding mainly the potential advantages of innovation for actors such as companies and universities (See e.g. Eklund, 2007; Widmalm, 2008). From this perspective, there are three factors of particular value in fostering successful innovation: novelty of the new solution, financing of the commercialisation process and, if the new solution is developed outside a commercial setting, transfer support (Ingemansson, 2010). However, this type of reasoning is more in line with the promotion of invention rather than innovation. An invention represents novelty of some sort, it needs to be financed in order to move from just being an idea to being something more concrete, and for this reason it also needs to be commercially produced somewhere. However, in order to become an innovation, i.e. a widely used solution, the new solution does not only need to be transferred from one context to another, it actually needs to fit in within these different contexts (Håkansson & Waluszewski, eds., 2007). A view of the innovation process that does not consider the actual use of the new solution results in a misguided understanding of how to promote innovation. First, if focus is directed to the achievement of novelty itself (invention) and not on its actual use (innovation), financing and transfer support are put before a deeper understanding of the using environment. Second, it will suggest competition rather than interaction as a promoter of innovation. This formulation is anchored in an economic orthodoxy, which in turn is based on models of the business landscape as a market in which innovation is instigated by either suppliers or users, with price and demand as the only driving forces of renewal[1] (See e.g. Solow, 1956; Mankiw, 1998). From this perspective, innovation is not a reciprocal development process between producers and users, but rather a linear procedure of new solutions being 'pushed out' by technology providers or 'pulled out' by users with specific demands. In spite of its simplified view of the organisation of business life, this neoclassical market model still dominates much economic thinking or, as put by Snehota (2004, p. 16):

"The neoclassical conception of market as the price determination mechanism is attractive. It has support of much of the theorizing in economics, is parsimonious and coherent and has gained a special status as the dominant perspective. The problem is that the neoclassical perspective on the market often provides only limited guidance for how to act within a market."

However, empirically-based research provides strong support for the belief that new solutions need to fit within both a using and a producing environment in order to become innovations. Firstly, the research indicates that a large number of product development projects fail because the resulting product does not sell as well as anticipated. This means that potential customers have been unable to make use of the new product (See e.g. Cooper, 1979; Dougherty, 1992; Pavitt, 1991). Secondly, when successful innovation does occur, which means that the new product eventually becomes a widely used solution, it often takes place in established producer-user relationships. (Harrison & Waluszewski, 2008; Håkansson et al., 2009) This suggests that

1. For further elaboration on this issue, see e.g. von Hippel 1976, Mowery & Rosenberg 1979, Dosi 1982, Lundvall 1985 and Verspagen, 2005.

mutual knowledge of each other's requirements, and earlier investments that accompany long-term relationships, create a high degree of relatedness between producers and users. This in turn increases the opportunity of producing something new and useful, and which thus facilitates innovation. When this mutual knowledge does not exist, and a new solution is developed and produced outside such established relationship structures, the achievement of innovation becomes more difficult.

The interactive nature of the business landscape, where long-term relationships between business actors influence the achievement of innovation, was acknowledged already in the mid-1970s within what later became known as the industrial network approach. Here the main issue of technological and organisational development is what is happening between actors and their resources or, between producers and users (See e.g. Mattsson, 1978; Håkansson, ed., 1982). The effect of interaction between actors in regard to innovation has also been picked up by others. In the late 1980s, Lundvall (See e.g. 1985; 1988) (together with other scholars), insisted upon a systemic approach to innovation, in what nowadays is referred to as the "national systems of innovation" direction. As opposed to the "push-and-pull" paradigm, in which the empirical mechanisms of innovation were assumed away in favour of simple inputs and outputs, Lundvall considered in-depth understanding of producer-user relationships to be of great importance for the understanding of innovation processes:

"The supply school concentrates upon the bottom of the black box where R&D is introduced and expects beneficial effects to come out at the top of the box. The demand school assumes that changes at the top of the box - changes in demand - will have beneficial effects at the bottom. A user-producer approach might be regarded as one revealing the content of the black box."(Lundvall, 1985, p. 28)

According to Van de Ven (1986, p. 604), also focusing on the interactive and process dependent aspects of innovation, realising innovation means the new solution has become "an implemented reality" and "incorporated into the taken-for-granted assumptions and thought structure of organizational practice". The new solution, whether material or immaterial, thus needs to become embedded in the established organisational and technical structures within its implementing contexts. For this to take place, the various parties involved in developing, producing and using the new solution all have to be able to derive benefit from engaging in the innovation process (Håkansson & Waluszewski, eds., 2007). It is not enough that a single manufacturer sees potential in a certain solution if the prospective users cannot implement it; or that a user sees great benefits in developing a new solution if the investment required to manufacture it exceeds any future returns. Rather, the developing setting must see some kind of benefit in developing the new solution, the using setting needs to embed the resulting product in its existing activities, and the producing setting must be able to support its production based on that use (Ibid.). This implies that, in order to become an innovation, any new solution must combine and fit within established structures and within very different types of settings and, by extension, the different economic rationalities encompassing its development, production and use. It further implies that this requires stable producer-user relationships (Ibid.; Ingemansson, 2010). The next section will examine more closely what it means to create new solutions in an interdependent business landscape characterised by different rationalities.

2.2 The effect of the network

Today, a great number of the activities needed to complete a single product or service are carried out across the organisational borders of a single company, encompassing suppliers, suppliers' suppliers, customers and so on (See e.g. Gudeman, 2001; Håkansson & Waluszewski, 2002; Håkansson et al., 2009). This interdependence creates the need for companies to interact in order to facilitate daily operations and long-term effectiveness. From an interactive perspective, companies are thus embedded in a network-like structure in which they interact in order to ease the constraints of their interdependency (Håkansson et al., 2009). This interaction entails a process of adjustment in which companies (both producers and users) make investments with the purpose of creating a better fit between them. In this process particular solutions, or combinations of resources, are created through repeated investment. Eventually this results in a network of interdependent solutions connected to continual investment, thus making these solutions difficult to replace or to combine with any solution developed outside this network (Gadde & Håkansson, 2001). The implementation of a particular type of solution or technology which is not in accordance with the network will not only affect the solution or technology it replaces, but the entire pattern of surrounding solutions, which makes it a very difficult and costly task (Dosi, 1982; Rosenberg, 1994; Håkansson & Waluszewski, 2002).

A new solution will always, in some regard, bear the hallmarks of the network in which it was developed. As any solution is rarely completely new in the sense that all its elements are "new to the world", it is always connected to the past, and to the established knowledge, conceptions or technical systems of its developing setting (Lundgren, 1991; Van de Ven et al., 1999; Håkansson & Waluszewski, eds., 2007). Also, as previously stated, to become an innovation or an 'implemented reality', the solution has to be applicable to the contexts in which it currently exists, which means that it needs to be adjusted to fit the surrounding conditions (Ibid.). In turn, these contexts have a heritage of their own, consisting of specific knowledge and material and immaterial solutions from which the current state has emerged. This suggests that innovation is a historical product, bearing the

hallmarks of its developing setting (in terms of which actors, resources and activities were present in that network) and which, in order to become successful, has to be adjusted to an implementing network with a history of its own (Ibid.). This is also implied by Stinchcombe (1990), who describes innovation as a "social system" that puts demands on both the developing and implementing settings in terms of technical and organisational adaptation; the more that the new solution deviates from earlier solutions the more extensive the changes need to be, which increases costs. As stated earlier, in much economic literature, innovation is primarily seen as a spurring force of economic growth, and as such an inherently positive economic phenomenon. However, in the empirical world, any change to the current pattern of investment equals increased costs as well as uncertain returns. It is also a matter of creating benefits for very different settings, which are driven by different rationalities (in terms of their historical and present situations). This means that renewal, in an interdependent business landscape involving different rationalities, is difficult as well as costly.

Even if the single company is but one component in a wider network, or system, of business actors, each company must function in order to contribute to, and benefit from, the system as a whole. From an inter-organisational perspective, for producers or users to benefit from the introduction of new solutions, these actors need to have the ability to actually create such benefits, by using both internal and external resources (Håkansson et al., 1993). According to the "absorptive capacity" view proposed by Cohen and Levinthal (1989), this is highly connected to a firm's investments in R&D. From this perspective there are two sides of R&D. Firstly, it can generate new internal knowledge leading to the development of new solutions. Secondly, it can enhance the firm's ability to assimilate knowledge in the surrounding environment, which then can be put to commercial use. From an interactive perspective, however, there are no clear boundaries between the activities and resources of the single firm and those made available through long-term relationships with other actors (Håkansson et al., 1993). This means that any firm needs not only to be able to assimilate new knowledge (through relationships and from 'outside'), but also to be able to combine it with established knowledge and existing solutions within the surrounding network. Thus, in order to have a positive effect on innovation–i.e. the achievement of a widely used solution–a firm's investments in R&D need to be combined with an understanding of how knowledge is transferred throughout the network to suppliers and customers, and how it is put into use. The next section deals with innovation specifically as defined in the construction literature.

2.3 Innovation in construction

In the construction literature, a great deal of attention has been paid to the issue of innovation. Common to all these descriptions is their view of the apparent lack of innovation and productivity in the construction industry, which is considered to have a negative effect on the industry's performance (Egan, 1998; Koskela & Vrijhoef, 2001). A general observation in several countries is that the construction industry scores low on R&D expenditure and that few construction firms take advantage of R&D or innovation programmes offered by governments (Seaden & Manseau, 2001; Miozzo & Dewick, 2004)[2]. Several explanations are offered for why the construction industry is weak on innovation. A key issue is that construction is a low-margin industry, with many small companies that lack the resources to invest in R&D, and consequently innovation. Further impediments are improper reporting of R&D expenses, clients being resistant to change, and governmental policies unsuitable for facilitating innovation.

The literature recognises that the traditional conceptualisation of innovation, measured R&D expenditures, and the number of patents and/or new products is not necessarily applicable in this particular setting, or in any other for that matter. Seaden and Manseau (2001) argue that innovation in organisational processes should also be considered. Organisational processes are very important in construction, as assembly methods and contracting arrangements are the core activities in this industry. That innovation is both product- and process-related is reflected in the many definitions of innovation in construction; for example, Slaughter (2000, p. 1466) defines innovation as "a non-trivial improvement in a product, process, or system that is actually used and which is novel to the company developing it". Early studies focusing on the technological and organisational interdependencies within the construction industry also demonstrate the complexity and difficulty of introducing new solutions within construction. For instance, in an empirical investigation of purchasing of new materials, Hammarkvist (1976) proposes that the use of a product, new or established, is dependent on a surrounding system of norms and regulations, different actors (e.g. contractors, architects, clients etc.), other products as well as processes. This in turn complicates the introduction of new solutions. (Ibid.)

Based on a review of construction literature, Blayse and Manley (2004) identify six factors driving or hindering innovation in construction: firstly, clients and manufacturers are important drivers of innovation. The key role of clients in promoting innovation is emphasised in the literature (see e.g. Winch, 1998; Hartmann et al., 2008), as their demands for a higher standard of work is likely to trigger innovative behaviour among their suppliers. Manufacturing firms are also key drivers of innovation. They can provide

2. R&D expenditures range between 0.01–0.4% of construction value-added for OECD countries (statistically limited to contractors and sub-trades) compared to 3–4% in manufacturing or 2–3% for all industries. (Seaden & Manseau, 2001)

innovative components, due to the fact that they operate in a more stable market, which means that they can maintain R&D programmes, learn from experiences and, from that, build knowledge bases. The second factor is the structure of production, which in construction is temporary and characterised by one-off projects. The scope for use of innovative solutions across multiple projects is limited, reducing the benefits of innovations and therefore the incentives to innovate. The third factor is the relationships between individuals and firms within the industry, and those between the industry and external parties. Industry relationships are 'loose', meaning that there are few benefits obtained from interaction and integration between parties – this is in line with Dubois and Gadde (2002), who found that because of the loose couplings in the permanent construction network, great opportunities for productivity and innovation are missed. Blayse and Manley (2004) also mention the benefits from building relationships with "innovation brokers", such as professional institutions, universities and construction research bodies, who can act as repositories of knowledge and actively disseminate knowledge. The fourth factor is the procurement systems in construction; instead of conservative procurement methods, such as lump sum contracts that hinder innovation, methods facilitating team integration (such as partnering) are likely to enhance innovative behaviour. The fifth factor affecting innovation in construction is regulations/standards. While prescriptive regulations are believed to hamper innovation, many recognise that performance-based regulations can in fact facilitate innovation. This requires, however, that the regulators and policy makers possess sector-specific knowledge. In other words, the design of regulations and standards must be approached strategically. The last factor is the nature and quality of organisational resources as related to the internal attitudes and processes conducive to innovation. Such resources include: a culture of innovation, absorptive capacity, innovation champions, knowledge codification systems, and an innovation strategy. These factors are important both to policy makers and industry participants in developing innovation strategies that are applicable to the construction industry.

3. Research design and methods

This paper aims to investigate innovation in the construction industry from a network perspective. As we learned above, such a view indicates that innovation depends on a strong relationship between producers and users. However, previous literature on construction identifies a lack of such relationships in the construction industry, holding it as a key reason for the industry's low innovativeness. We take these findings as a starting point, delving deeper into possible reasons for these inabilities. Considering innovation as a network phenomenon has implications for the research design and the methods applied. A cross-sectional study of innovation in the Swedish and Norwegian construction industries was conducted between June 2010 and February 2011, combining quantitative and qualitative methods. The use of mixed methods research allows for triangulation and to study different aspects of a phenomenon (Bryman & Bell, 2007). Such a complementary design was suitable for the problem at hand. In this study it was necessary to identify the different views of governmental bodies/public agencies and practitioners in the construction industry on innovation, and to discuss reasons for these differences and their implications for innovative behaviour. Both Sweden and Norway were studied, since the construction industries of both countries face similar challenges. This allowed for some comparisons, revealing interesting similarities and differences between the two countries, through which to better understand the complex nature of innovation in construction.

In 2009, the Norwegian construction industry (including real estate companies [both service and finance], contractors, consultants, architects, rental companies, producers and trade companies that deliver to the construction industry) had a total turnover of 590 billion NOK and employed approximately 250,000 people. The industry is characterised by some large contractors (e.g. Veidekke, Skanska, NCC, AF Group, etc.), even if 97 percent of the construction companies in Norway have 20 employees or less. This high percentage is also true for Sweden. In total, there are about 500,000 people working in the Swedish construction industry, which includes organisations involved in administration, architecture, technical consultation, construction, installation and manufacturing of materials. This represents 10 percent of employment in Sweden. As three of the largest contractors, PEAB, NCC and Skanska, represent more than half of the industry's total turnover (which in 2008 was approximately 250 billion SEK), similarly to Norway the industry is dominated by a few big actors and a large number of small and midsized companies.

A survey was conducted in both Norway and Sweden. In Norway, the study of the construction industry was part of a larger research project on knowledge and innovation in Norwegian industry generally, A Knowledge-based Norway (Reve and Sasson, forthcoming in 2012). A standard questionnaire was developed for 13 different industries to cover topics relevant to innovation. The questions included: type of firm (independent, or part of a national or international corporation), the size of the firm (turnover, workforce), employees' education, and level of investment in competence development and R&D. Furthermore, the questionnaire contained questions about characteristics of each company's customer and supplier bases, as well as about interaction with other actors including public authorities, competitors, alliance partners, customers and suppliers, and R&D organisations. In Sweden, the questionnaire focused specifically on the construction industry with questions

concerning the key barriers to, and driving forces of, innovation. More specifically, this included aspects of educational level, methods of knowledge generation and transfer, organisational and technical progress during the last five-year period, key relationships within the construction network, and identified barriers to industrial renewal. The primary aim of the surveys was to collect data relevant to the focus on innovation, competence development and R&D, as well as to the degree of interaction and the dynamics between actors in the industry as a whole, which was perceived as being difficult to access through secondary sources and single interviews.

In Norway, the questionnaire was sent to 4,500 e-mail addresses covering the whole construction industry. The addresses were collected from the various industry organisations. Eight hundred and forty answers were received, approximately an 18 percent response rate. In Sweden, the questionnaire was sent to all registered member companies of the national trade association with five employees or more, covering 2,160 companies (almost exclusively contractors). This number also included around 200 group units for three of the largest corporations (PEAB, NCC and Skanska) spread across the entire country. Four hundred and forty answers were received, which gave a response rate of 20 percent. Seventy-five percent of the answers were from independent companies, while the remaining 25 percent came from group units belonging to the large corporations. This provided the opportunity to compare the differences in innovation between independent companies and group units within a larger corporation.

In conjunction with the surveys, qualitative studies were conducted to gather up-to-date and in-depth data about current business challenges, current views on and behaviour in the field of innovation, and interaction in the industry. Qualitative methods are useful to gain rich descriptions of interesting issues (Bryman & Bell, 2007), which in this study were questions relating to the barriers and drivers of innovation, inter-firm interactions, competition, and the role of different actors such as the firms, governmental agencies, and knowledge providers. For this purpose two data-gathering methods were utilised: in both Norway and Sweden, ten semi-structured interviews lasting about two hours were conducted, which yielded direct quotations from top managers in various parts of the industry. The questions concerned their experiences, opinions, feelings and knowledge (Patton, 2002) of technical and organisational development within their companies and the industry as a whole. In Norway, seven short case studies were also conducted, which provided an in-depth and contemporary understanding of innovation (Yin, 2009).

In addition to the primary data sources, secondary data were gathered and analysed. These included what were considered as relevant policy documents and other reports about construction R&D and innovation, as well as public statistics (e.g. Statistics Norway's innovation statistics). Archive data from both governments was used, as well as data from commissions, statistics agencies, public funding agencies, and R&D organisations. While there are two recent formal investigations in Sweden, and subsequent reports of R&D and innovation in construction (which were of immense relevance for this paper), there have been no similar initiatives in Norway. There is a forthcoming white paper to the Norwegian Parliament on building politics in general, which is the first in its kind. The paper has been delayed, but is expected in 2012. It has as such not been used in this analysis. Nevertheless, there are two official reports of R&D and innovation in Norway and also construction statistics, which have been used in the analysis. The analysis of the documents focused on views about construction innovation, definitions of innovation, perceived problems and suggested solutions, and public innovation behaviour such as funding of construction-related R&D over the years. No formal interviews were conducted with public policy makers or public agencies, besides informal discussions with representatives from the Research Council in Norway. Nevertheless, the views represented in the documents and statistics over funding were interpreted as public policy views and subsequent funding behaviour.

Both the quantitative and qualitative data were analysed in a qualitative way, based on theoretical insights focusing on drivers of, and barriers to, innovation and the role of interaction between actors. A concurrent triangulation approach was therefore applied (Creswell, 2009), which means that two or more data sources are compared to identify similarities and differences between the sources. Hence, even if the response rates of the surveys were low in both countries, the purpose was not to generalise statistically from these. Instead, several sources were combined to gain insight and increase understanding of the views on innovation within the construction industry (Bryman & Bell, 2007).

4. The public policy view on innovation in the construction industry

4.1. The Swedish case

In the 1940s the Swedish government took a first step towards governmental funding for construction research by forming The Governmental Committee for Construction Research (SKB). Two decades later, a debate on whether construction research should be organised together with the existing scientific disciplines or be run within a particular research institute, resulted in the establishment of two organisations; one of these would be in charge of distributing funds to universities and various institutes (The Swedish Construction Research Council) and the other would conduct research and development (The Swedish Institute for Building Research – SIB). This system remained intact for more than thirty years,

until SIB was terminated in 1994 (even though parts of the organisation still exist at the University of Gävle) (Landin et al., 2011). This was part of a series of political reforms in the beginning of the 1990s, which drastically changed Swedish housing politics into what has been called "one of the most market liberally controlled housing markets of the western world" (Lind & Lundström, 2007, p. 129). Before these reforms, the Swedish construction sector was subsidised in various ways, making residential building primarily a state affair and not a market-driven one. Furthermore, in 2000, the Swedish Construction Research Council, which had had the construction industry as its sole area of responsibility since 1960, was reorganised into Formas, which became the new Swedish governmental authority for handling research and development issues within the industry. Since then, several research authorities and institutes dealing with questions relating to research and innovation within construction have been created, such as BIC (the Swedish construction industry's research centre), the SP Technical Research Institute of Sweden, Boverket (the governmental authority for community planning, construction and housing), and SBUF (the construction industry's organisation for research and development) just to mention a few.

The great number of different research institutes, foundations and authorities connected to the construction industry might suggest that there is a strong and definite focus on construction research in the Swedish innovation system. However, upon examination of governmental investigations scrutinising the role and contribution of these institutes, another picture comes into view. From these investigations it can be concluded that construction is not treated as a so-called 'strategic research area' from a political standpoint, and that research efforts are very fragmented as well as often divided into broader areas such as 'technology' and 'society' (Bröchner, 2006; Prop, 2008:09:50; SFD, 2009:6). It is not a given that these broader themes are negative for the industry from a development standpoint (as they might offer some collaboration opportunities between different industries and research areas). However, not only does it make it difficult to assess how much research funding is actually put into construction and the direction and total scope of the different research efforts, but also how this research is used (or not used) by the industry.

Even the main governmental authority in command of research and development within the industry, Formas, has other responsibility areas such as environmental issues and agriculture. In the hope of fostering a more concentrated and rigorous approach in the industry, since the restructuring of The Swedish Construction Research Council in 2000, many mergers and collaborations between different research institutes and authorities have taken place. There have been several formal collaborations between Formas and BIC, and in 2010 BIC merged with BQR (The Council for Constructing Excellence) to form IQ Samhällsbyggnad (The Swedish Centre for Innovation and Quality in the Built Environment) (www.bic.se). Also, by order of the government in 2007, Formas started a formal collaboration with Vinnova (a Swedish governmental body responsible for funding and facilitating innovation in various industries) regarding environmental technology where "sustainable construction" was part of the programme (VP 2007:02). However, besides this effort, the overall focus on the construction industry has more or less been non-existent within Vinnova's research programmes (Bröchner, 2006; SFD, 2009:6).

In a debate article published in early 2011, the director of the SP Technical Research Institute suggested that the construction industry should once again appoint its very own research council, so that funding to the industry would not be affected by other research areas considered of greater strategic importance (Ny Teknik, 2011). This tendency has also been addressed in an investigation by SBUF. In a report on construction innovation, it was concluded that the governmental effort in the early 2000s of appointing specific strategic research areas (also referred to as "strong research environments") has led to less funds being spent on construction research. Instead, due to the strict funding programmes, universities prioritise more basic research areas within the natural sciences, which have been classified as strategically important for Sweden's position as one of the leading nations within research and innovation; this has made it difficult for both construction companies and academia to acquire funding for research efforts related to construction (Bröchner, 2006; Landin et al., 2011).

Governmental investigations evaluating the quality and efficiency of the construction industry in Sweden can be traced back several centuries and, despite the many different subject matters of these investigations, some critiques remain the same. The industry is constantly blamed for increasing housing prices and that it suffers from cartelisation (and thus a low degree of competition), not to mention accusations of its low quality and low efficiency (Bröchner, 2011). At the beginning of the 21st century the Swedish government once again appointed a commission to investigate the lack of industrial renewal in the construction sector. The commission was to examine and propose suitable measurements of how to "promote the competition as well as counteract competition-inhibiting behaviour…and increase the quality within the construction sector" (SoU 2002:115, preface). In the resulting report, the commission suggested that many of the industry's problems were due to lack of competition, which was the cause of high prices, low productivity, bad quality and little inducement for transformation. Another major concern was the role and position held by the developer, i.e., the clients. The commission suggested that the clients needed to become more knowledgeable and put themselves in a better position to put more demands on the final product. This was partly related to the law of public procurement and the legal question of which party was responsible for any construction

errors or negligence once the product is finished. Concerning companies' expenditure on research and development, little was said. The only conclusion that was drawn was that the larger firms had the greatest ability and sophistication to provide the new technology that could lead to "important innovations"[3] (SoU 2002:115, p. 230); further, that research, in addition to universities and various research institutes, was channelled mainly through manufacturers of material, components and equipment.

Seven years later, in 2009, the government decided to do a second investigation, as there still did not seem to be any real industrial renewal or development. This time it was the Swedish Agency for Public Management that took charge of the investigation. In spite of the rather nuanced picture of the industry and its problems that was outlined in the report, one of the key recommendations remained increased competition:

"Thus, a generally heightened propensity for change and more competition are according to The Swedish Agency for Public Management the single most important factors in increasing the spread of innovations and consequently the efficiency and quality of construction"[4] (SFD 2009:6, p. 77).

Thus, the overall picture that emerges of the governmental support structure for research and innovation within the Swedish construction industry is that the large number of actors has created disunity and confusion as to what is being done and how the industry in turn makes use of it. It can also be concluded that the public policy image of the industry that emerges from the two investigations is that the construction industry mainly suffers from a low degree of competition, and that has adversely affected innovation.

4.2 The Norwegian case

In contrast to Sweden, there have not yet been any governmental investigations of industrial renewal and innovation in the Norwegian construction industry. However, there is a general concern over the Norwegian industry's low score on standard indicators of innovation and R&D. In 2008, The Ministry of Trade and Industry presented Norway's first white paper on innovation: Report No. 7 (2008-2009) to The Norwegian Parliament - An Innovative and Sustainable Norway.[5] Innovation is defined in the white paper as "to do something new in order to create value". It has been continually emphasised in this paper that a new idea or invention cannot become an innovation before it has been applied and commercialised. It has also been emphasised that moderate market competition provides a pressure on existing companies to improve and innovate. Too strong or too weak competition, on the other hand, will hamper innovation. Furthermore, the importance of collaboration is acknowledged, as increased innovation occurs as a result of interaction between suppliers and users.

In A More Open Research System[6] , (Official Norwegian Report 2011:6), the commission appointed by the Ministry of Education and Research, expresses concerns over Norway lagging behind the other Scandinavian countries in production of research. One proposal is to restructure the public funding system. Instead of focusing too much on specific topics, funding to the open research arena must be increased, thereby making it possible for more researchers to compete for a share of the money. However, whilst arguing that competition in general promotes quality and efficiency gains, it is also acknowledged that competition may have negative effects. As the commission puts it:

"Competition may counteract the willingness of long-term thinking and to invest in where the output is uncertain. Competition may also be resource-consuming" (Official Norwegian Report 2011:6, pp. 19)[7] .

Furthermore, the commission argues that collaboration is important for knowledge sharing in the research system, and that it is important to create mechanisms for this. A balance between collaboration and competition is therefore seen as vital for the research system.

The construction industry is not specifically mentioned in the two governmental reports on innovation and research. However, the report on innovation refers to examples of construction-related innovation. These include the use of innovative materials and designs in the new opera house in Oslo, the value of applying building information models in construction projects, and allowing for effective information sharing. Nevertheless, when the report considers different areas that are important for innovation in general, such as demographic development and environmental challenges, it does not mention the obvious role of the construction industry in helping to overcome them. Neither is the construction industry mentioned in the report on research, when considering the traditional strategic areas for research in Norway.

Even if there is apparently little attention paid to construction-related research and innovation in Norwegian public policy documents, the debate over this topic has been intense at certain times. The key dispute relates to the seemingly reduced funding for construction-related research over the last 15 years (as illustrated in Ørstavik et al., 2003) and to the lack of domestic construction research programmes by the Research Council in Norway. Industry organisations and construction companies interpret this situation as governmental bodies' lack of interest in construction, and as their failure to understand its importance to Norwegian society. The reply to this accusation, particularly from the Research Council, is that the situation is a result of the industry's failure to apply for funding. It argues that there are other, even if general, programmes suitable for funding

3. Translated from Swedish by the authors
4. Translated from Swedish by the authors
5. Translated from Norwegian by the authors
6. Translated from Norwegian by the authors
7. Translated from Norwegian by the authors

research on construction-related issues (Hallèn, 2010)[8]. There are in particular two such programmes for which the construction industry is encouraged to apply. The first programme is The SkatteFUNN tax deduction scheme for R&D in Norwegian companies. According to the Council (www.forskningsradet.no), "the scheme is linked primarily to the individual company's ongoing needs in development and innovation". The main idea is that companies engaged in R&D activity on their own or in collaboration with others may apply for a tax deduction. The second programme is the User-driven Research-based Innovation (Norwegian abbreviation: BIA). This programme is not dedicated to any pre-determined theme and applicants must "compete for funding on the basis of how well their proposed projects can contribute to research-based innovation and value creation" (www.forskningsradet.no).

At the annual construction conference in 2010, the CEO of the Research Council in Norway addressed the apparent lack of interest from the industry in applying for the different programmes, particularly the BIA. The speech was titled: "Does the construction industry need research – and is it willing to?" (Hallèn, 2010) . He showed that the construction industry (confined to the executing part of the industry, that is, contractors and sub-contractors) has the smallest number of projects within BIA of all industries, and that there has been a substantial decrease in construction-related applications and funding in recent years (from 31 million NOK in 2007 to 24 million NOK in 2010). He also illustrated that the industry does not apply when times are good, showing a correlation between increase in turnover and a reduction in applications. Compared to other industries, construction also participates less in the Skattefunn programme, and overall spends very little of its turnover on R&D (less than 0.2 percent). He concluded that the construction industry simply does not use the public funding system and ended the presentation by outlining some barriers towards R&D in construction: the lack of knowledge sharing, lack of management competence, tendering and contract strategies, too few demanding clients (and therefore too little competition based on quality and customer orientation rather than price), and finally the need for the social sciences to better understand construction.

When looking at the public funding of construction-related research in Norway, the funding seems generally to have decreased over the years and become more fragmented. The most important research institute, SINTEF Building and Infrastructure was established in the late 1940s by the Royal Norwegian Council of Scientific and Industrial Research, which was one of the five original Research Councils in Norway until they were merged into one in 1993. In 1986, the institute became an independent foundation and in 2006 it was merged with the SINTEF research organization's building research activities. From being directly funded by the Research Council system, funding to SINTEF Building and Infrastructure primarily comes from contracts won in open competition. Funding from the Research Council constitutes only 20% of the total funding. The research institute is responsible for two large research centres funded by the Research Council of Norway: COIN Concrete Innovation Centre, which was one of 14 centres for research-based innovation established in 2006 (emphasising Norway's long-term prioritising of R&D for the business sector) and the Research Centre on Zero Emission Buildings (ZEB), which was one of eight national centres for environment-friendly energy research that were established in 2009. These two centres contribute to upholding the amount of public funding to the construction industry. Besides these two centres, the funding has decreased substantially in recent years from an already low level (e.g. in the BIA program there has been a reduction from 31 million NOK in 2007 to 19 million NOK in 2011). The last publically funded research programme for construction was initiated and funded by the Ministry of Local Government and Regional Development and the construction industry itself. The main objective was to reduce building costs. The total budget was 185 million NOK of which the industry paid 105 and the ministry 80. When the programme ended in 2010, there was a discussion between the industry and the Ministry of how to continue the work. The industry suggested establishing its own centre for R&D in construction, funded by the Ministry, however this was not followed up. Instead, the ministry has announced a white paper to the Norwegian Parliament on building politics, where the commission has been asked to comment upon the challenges facing the construction industry, which will include issues relating to productivity, innovation and the need for greater research.

5. The construction industry's view on innovation

As we have seen earlier in this paper, research and development investments are well-known indicators of an industry's innovativeness (Seaden & Manseau, 2001; Fairclough, 2002; Miozzo & Dewick, 2004). In the Norwegian study the focus was therefore on construction firms' investments and participation in research projects. Similar to previous research (e.g. Seaden and Manseau, 2001), the findings show that the construction industry invests little in R&D compared to other industries. According to Statistics Norway (2009), other industries spend on average three percent of their turnover on R&D, while the survey reveals that nearly all of the contractors used less than one percent of their total turnover on R&D in 2009. There are some differences between large and small firms, but still nine out of ten of the large companies in the Norwegian construction industry (annual turnover above 100 million NOK) spent less than two percent. Even if there were no great differences between small and large firms in the Norwegian study with regard to

8. Presentation given on the annual construction conference in March 2010. Translated from Norwegian by the authors.

R&D investment, there are still significant differences as to whether the companies had participated in R&D projects. While few of the companies with a total turnover below 100 million NOK said they had run their own R&D projects in 2009, nearly half of those above 500 million NOK reported that they had. Furthermore, two out of three of these companies said they had participated in collaborative R&D projects.

These numbers give a negative picture of the industry's interest in R&D and subsequent innovation abilities, but it might be explained by the industry's view on innovation. In the interviews with the Norwegian CEOs, they were asked to reflect upon the concept of innovation. Each of the managers described innovation as closely intertwined with the actual work practice of the companies, and as a continuous development process that involved the improvement of existing processes and products and finding new solutions. As one of the managers said:

"I don't have any clear definition of innovation, but innovation occurs in projects. Ideas occur, which are further refined and managed. Innovation is not directed by any research programme as such. Of course we take part in formal research programmes to develop knowledge, but that it something other than innovation".

The low investment in R&D can therefore be explained by the view of innovation as something that occurs through actual practice and not necessarily through formal R&D initiatives. Resources are spent on continuous improvements, and this is reflected in the way the managers talked about innovation as "the small steps", "stone by stone" and "small, but frequent steps".

The Swedish questionnaire did not include questions regarding actual R&D investment numbers, however, it is clear that investment in R&D is generally not perceived as the most important factor in increasing the innovativeness of Swedish industry; only one out of five respondents considered increased investment in R&D a decisive factor in renewing the industry. However, there were some differences between large and smaller companies: more than one out of three companies with a turnover of 140 million SEK or more (which was defined as a large company in the Swedish survey) perceived R&D as important, but only one out of ten of the companies with a turnover of 20 to 80 million SEK (which was defined as a small company in the Swedish survey) said the same. Also, there was a difference between the independent companies (generally smaller firms located outside growth markets) and the group units (generally bigger companies located on growth markets): only one out of seven independent companies considered increased investment in R&D of the highest importance for increased innovation, while this was true for more than one out of three of the group units belonging to larger corporations.

An interesting finding is that when asked about where innovations take place, the Norwegian construction companies reported to a higher extent than companies in other industries that innovations happen in collaboration with others (Statistics Norway, 2009). This finding corresponds with the emphasis on projects as the main source of innovation and, in construction, projects are by definition inter-organisational. In the surveys, respondents were asked more specifically about the importance of different actors for the company's renewal and development of new ideas, processes and products (i.e., innovation). In the Norwegian study, local customers were considered the most important, followed by suppliers, personal networks and industry organisations. Nevertheless, even if suppliers in general were seen as important for innovation, when asked about the strength of relationships with specific industry actors, Norwegian contractors viewed their relationships with suppliers (e.g. technical contractors, trade organisations and producers of materials and products) as weak. This indicates that, even if suppliers are viewed as important for innovation, companies do not have appropriate the relationships to exploit the opportunities.

In the interviews, we asked the managers to elaborate on the interaction among the different actors. Both Norwegian and the Swedish construction managers noticed that there is too little collaboration in the industry. As one of the Norwegian managers pointed out: "We have ways of relating to each other that hamper innovation and I don't think we work together in a very smart way".

All of the Norwegian managers emphasised that closer collaboration in the supply chain is a key focus area for further improvement. This was also an issue brought up in the Swedish CEO interviews. The view was that if other industries can keep the supply chain together and provide an integrated offering to their clients and end consumers, then why couldn't the construction industry do the same? This would require close upstream interaction between consultants, different contractors, specialists and suppliers. To some degree this type of interaction exists already, and when asked to give examples of innovations in the companies, the managers in the Norwegian study described innovation processes clearly characterised by close collaboration with other actors. The seven short cases of innovation that were included in the Norwegian study show a similar pattern. Nevertheless, the focus on price and arm's length relationships were seen as a main barrier to innovation in the construction industry. Construction is a low-margin industry and the managers reported a strong focus on price in all parts of the industry. According to the managers, this gives few incentives to invest in R&D and innovation; customers primarily choose the lowest bid anyway. As the CEO of one of the main contractors explained: "When price means everything, it is impossible to think about innovation in a low-margin industry".

There was a concern that public clients do not invest in and contribute to supplier development in the industry compared, for example, to the Norwegian gas and oil industries. Some

clients, however, both in the private and public sectors, have started to include other selection criteria than price when contracting, such as competence and construction methods. Together with the development towards larger and financially stronger companies in the industry, the Norwegian managers saw this as an important condition for increasing their investments in R&D and innovation.

Just as in Norway, the Swedish survey showed that customers were considered a very important source for the development of new products, services and processes but also co-workers, which was considered an equally important source. This is in line with the general conditions for the industry – the "one-off nature" of the projects, which in a sense makes every product a prototype, makes the client a central actor in formulating the specifications that often set the frame of the project (the client's role in the preceding process however depends on which type of contract that has been settled). However, even if the survey showed that suppliers were not considered the most important party in renewal efforts, it was clearly shown in the CEO interviews that suppliers were involved in such efforts through the provision of both new products and services. Thus, in both Norway and Sweden there seems to be some inconsistency between the view of suppliers and subcontractors in regard to innovation, and their real involvement in renewal efforts.

In addition to customers and suppliers, both of the surveys also included questions about the importance of other actors for innovation. The results show that R&D institutes and public funding agencies are in general considered least important. Yet, again, in the examples of innovations, several of the managers describe how R&D institutes contribute to the process and some managers, particularly of material producers, consider them as fundamental. A key concern is that the basic funding to such institutes has decreased, meaning that they have to rely on consultancy work instead; as a result, their objectivity has been called into question. Several of the Norwegian managers claim that the industry is ignored by public funding agencies, which may explain why such agencies are considered of little importance. Some also feel that it is far too resource consuming to apply to the Research Council of Norway. There is a general feeling that the Norwegian government pays too little attention to the industry beyond using it as a main tool for fighting recession and avoiding high unemployment rates. The industry does not have its own ministry, but must engage with many different ones, and it does not have its own programmes in the Research Council, as previously described earlier in this paper. An acknowledged exception is the focus on reducing energy consumption and emissions from buildings and building materials (e.g. concrete), which is reflected in new regulations and the funding of COIN and ZEB mentioned in the previous section. In several of the Swedish CEO interviews, another particular reason for why these actors score low was advanced: the barrier lays in not wanting to share with others. If a company develops something internally, or in collaboration with a client or a supplier, it more or less becomes the property of the company and can thus be used as a competitive advantage. However, if a new solution is developed in collaboration with a research institute, such as SBUF, it becomes "public property" and available to every company. There is also the belief that R&D institutes and the governmental support structure need to adopt a more holistic approach to the industry and not just consider specific issues. In general, the focus on environmental issues is considered by the managers as a key driving force of innovation in today's construction industry. It is, however, a concern that the regulations will contribute to innovation initiatives only if accompanied by sufficient funding and focus on competence development.

6. Concluding discussion and conclusions

This study of public policy and industry views on innovation in the Swedish and Norwegian construction industries has revealed interesting issues that might be subjects for further discussion. Firstly, the identified gap between public policy and the industry, particularly in Sweden, in regard to what spurs innovation in the construction sector is not very surprising in itself. It is rather the nature of this gap and the consequences that it has, which requires some thoughtful reflections. What, then, is the policy recipe for increased renewal and innovation? While there seems to be a common picture of innovation as the actual use of new solutions, and that clients matter a great deal in this process, the main recipe of how to achieve innovation is still through competition; particularly in the Swedish context, where this is explicitly advocated in two public investigations carried out in the last decade into the main barriers to industrial renewal in the construction industry. The strong focus on competition as the key to increased innovation indicates that the prevailing policy image in Sweden is influenced by the fact that innovation is seen as being achieved by single actors through a "push-and-pull" mechanism, where the only influencing factors are price and demand (See e.g. Dosi, 1982; Mowery & Rosenberg, 1979; von Hippel, 1976 for further elaboration on this issue). Such a view clearly fails to see the interactive effects occurring within the constructing network that, as stated above, can act to both hinder and drive innovation. It also fails to see that the construction industry is already highly driven by competition-promoting mechanisms, such as the law of public procurement and the strong price focus at every stage of the supply chain. Is, then, an even stronger endorsement of competition the answer? Norway, on the other hand, presents a more nuanced picture where the public policy view of innovation in general is that only moderate competition is beneficial and that competition in regard to quality, rather than price, needs to be emphasised. As for construction, the problem is that the interest in this

industry has been relatively low from governmental bodies. The interest increased as a result of the financial crisis in 2008, where construction was considered as an important means to sustain employment rates. Related to this renewed interest, the Ministry for Local Government and Regional Development has initiated an investigation and the first white paper to the Norwegian Parliament on building politics, where the industry's performance, as well as its challenges and opportunities are likely to be discussed. The report is expected during spring 2012, and it will be interesting to see what views are taken.

The public debate about the construction industry in both Sweden and Norway has focused on the industry's needs for revitalisation and improvement, as well as addressing the lack of research. However, this study shows that, at the same time, the public efforts to support the industry have become fragmented and have declined over the years. Firstly, this relates to a fragmentation and decrease in the public funding of construction-related R&D. Secondly, despite the vital role the industry plays both in regard to sustaining the employment rate and to building communities, a number of different overlapping governmental departments share responsibility for the industry. Furthermore, these departments have several other areas of responsibility that seem to get more attention. This indicates a liability shift in terms of the state taking less responsibility for the construction industry and its situation, and shuffling off the supposed productivity problems to the industry itself. In Sweden this can be seen in a series of political reforms within housing politics that have restructured governmental support during the last two decades; a similar development has been ongoing in Norway, such as the deregulation of the housing market in the 1980s.

Delving further into the R&D issue, this paper's findings suggest, in line with previous construction literature, that R&D spending is low in construction compared to other industries. However, as stated by Seaden and Manseau (2001), R&D expenditure might not be a proper tool to measure industrial innovation within construction. The nature of the industry – being project-based and organised in terms of different activities and processes among a large number of different actors – suggests that much development is organisational rather than technological. Furthermore, both in Sweden and Norway the industry perceives formal research efforts as of less importance for renewal and innovation. Instead, collaboration with clients and the "small steps" of continuous development in the projects are seen as key to the development of profitable and sustainable solutions. However, there is a difference between smaller, independent companies and units within larger corporations. The latter group seems to have a more positive attitude towards R&D and has made substantial investments in research and technological development during the last few years.

Earlier studies on innovation in the construction industry show that a stressing issue in construction is the loose couplings and lack of long-term relationships between the different actors. As a result, opportunities for creating important network effects, and subsequent productivity and innovation gains, are missed (See e.g. Dubois & Gadde, 2002). The results of this study demonstrate that suppliers are generally seen as less important for renewal than clients and, in the Swedish case, as even less important than co-workers, which suggests that there is relatively little upstream interaction in the industry. From an interactive perspective, interaction and relatedness between producers and users are the foremost reasons for achievement of innovation (Håkansson et al., 2009), which suggests that the obvious lack of such interfaces hinders innovation within the construction network. When price means everything, as the managers in the study point out, relationships are hard to establish. This, in turn, reduces both opportunities and incentives to innovate, according to the CEOs that were interviewed. What is interesting to note here is the industry's apparent inability to see that investment in R&D and innovation is in fact a prerequisite for reducing long-term costs. This might be explained by the fact that the industry mainly operates through one-off projects, which in turn induces a short-term perspective on costs and benefits (See e.g. Brown et al. 2001).

Another interesting reflection is that perhaps it is the network structure of the construction industry itself that in fact hinders innovation; there are several interdependencies but, because of the inability to establish proper couplings, the continuous confrontation of different logics and rationalities act as barriers to innovation but as drivers of loose and standardised interfaces. The construction industry is often described as complex, and this complexity stems not necessarily from the large number of actors and interdependencies in the network, but from the lack of integration. However, it is not a given that increased interaction will give the desired effects. There are always particular interests and dominating actors within any network, which direct the creation of couplings towards efficiency and effectiveness gains for specific parties. Hence an important issue for governmental bodies, when intervening in such networks, is to consider what types of efficiency and effectiveness are desired and for what purposes. Here, a decisive factor is which actor or actors have the ability to influence the network, and how governmental policy makers are to gain and make use of such knowledge.

It might also be appropriate in this respect to reflect on the fact that long-term relationships in this particular setting are not necessarily associated with positive outcomes. The construction industry represents a network that has always been criticised for inappropriate networking and interaction. Joint price-setting has been reported, and this type of collaboration might be seen as the main reason why there is so much focus on competition and regulations for the bidding process, especially in public projects. The fact that this type of price setting would have been useless had the

process been based on competence and previous experience instead of price seems to be a fact either ignored or not fully understood.

There seems to be awareness within the industry of the loose couplings and lack of long-term commitments inherent in the construction network. In addition, there seems to be a view of suppliers and subcontractors as less important in renewal efforts than customers (and even co-workers in the Swedish case). This view might be the result of two interacting factors: how public procurement is implemented with price being the only focus, and the unstructured collaborations in terms of new clients, suppliers and subcontractors being involved for each new project. The question is whether this can be adjusted through new regulations, or if the problem lays in the very implementation of the regulations, and thus in the structure of the construction network. As suggested by Gadde and Dubois (2010, p. 261), if the industry is to make use of collaborative efforts and establish more long-term relationships the "dominating course of action applied in construction" might need to change over time. According to them, construction companies will then need to see the benefits of interacting over time and attempt collaboration across projects. Either way, if regulations and standards meant to facilitate renewal and innovation are to fit with the industry, there needs to be an understanding among regulators and policy makers of what drives and hinders innovation in this particular setting. Otherwise, as suggested by Blayes and Manley (2004), they might represent obstacles instead of enablers of renewal opportunities.

What does this mean for regulators, policy makers, and the industry itself – how can the network theory be used to capture what is going on? The lack of an organised structure for construction-related research (and thus indirectly education) seems an obvious problem. As stated by Blayse and Manley (2004), building relationships with professional institutions, universities and research bodies can have a positive effect on innovation. From an interactive perspective these effects come in the shape of indirect benefits such as educated people entering the industry, and of a strong knowledge base being produced over time, eventually and slowly leaking out through interaction to be applied in different industrial applications. This type of knowledge is already embedded in the methods, processes and equipment that the industry uses today. However, which type of research or knowledge they are based on is far from obvious, which makes the downsizing of various research efforts and knowledge production a risky business. The effects are already apparent; the industry is in need of a stronger knowledge and research base. How it is to make use of it is, however, a different question and the answer is far from obvious. Nevertheless, what has become clear in this investigation is that while public funding of research efforts is necessary because of the indirect benefits that they provide over time, the industry itself also needs to shift its focus in order to be able to make use of such knowledge. Awareness and use of external sources of knowledge need to increase, and a more open approach to research and development is required, both in regard to internal and collaborative efforts.

Earlier studies of innovation in construction point to the need for a deeper understanding of the industry in terms of its organisational challenges and how relationships are formed (or not formed) throughout the network. This suggests that a network approach to innovation is a suitable method for trying to capture how different types of renewal and innovation take place. In this study, it was used to understand the relationship between public policy and industry views on innovation, and also how the industry views its relationships with other actors.

As a suggestion for future studies, there seems to be a need for a deeper look into the innovation processes taking place in construction. This assertion is based on the argument that R&D investment and traditional innovation studies do not capture how innovation actually takes place in this industry, and that the processes through which innovation happens are not fully understood. Such a study should find examples of what types of innovations take place, through which types of transactional patterns they are developed and, finally, how they are applied as well as the effects they are likely to create.

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