INDUSTRIAL RENEWAL WITHIN THE CONSTRUCTION NETWORK

Abstract

The construction business network is generally seen as conservative and non-innovative. A number of reasons for this have also been identified. One major reason is claimed to be related to the way the business is organized – that all important activities are taking place within time limited projects. This makes it difficult to develop long term relationships with customers and/or suppliers which in turn complicate development issues. Another often mentioned reason is the local character of the business – business networks related to construction is limited in space – dominated by local actors and that international actors therefore are lacking. From a governmental point of view this is seen as a problem as the construction sector is an important economic activity in most countries – not least in Sweden.

A first question is if the construction network is as non-innovative as claimed in the Swedish public discussion. One reason for its bad reputation can be that the way in which innovation in general is defined and measured is not suitable for the construction business. Another interesting and complicating factor might be that there is an important variation within the total network – that all parts of it are not so conservative. There are examples of innovations within the area that gives reason to at least investigate this aspect. Thus a first research question has to do with identifying both *the degree and the variation of innovativeness within the construction network.*

The second issue has to do with factors making it possible/necessary to innovative and factors acting as obstacles to innovate. Put differently, what are the *reasons* for why the degree of innovativeness is on the level identified in the first question, as well as for why there is a variation (if this is the case)? The ambition is to identify *a set of factors acting as driving forces and a set of factors hindering innovations to take place.*

In order to identify both the degree of innovativeness as well as the factors affecting it, we have conducted a survey to managers in Swedish construction companies. We have asked business managers (CEOs and managers being responsible for a division or local region in the four largest companies) to give their picture of what has happened during the last five years and also what they think is necessary or possible to change within the next five years. This investigation is the first study in the larger program where also a number of specific innovations later will be studied using a case methodology.

The analysis reveals that we have found an interesting variation among the companies. We have found some very distinct influencing variables to the variation in renewal. The most significant one is the network position and especially the existence of an internal network. It is more common for units within larger companies to have a high degree of renewal compared to independent companies.

Looking closer into renewal we have found that it involves both the internal and external network and concerns partnering with customers as well as use of foreign suppliers/subcontractors. It also concerns resources and activities in terms of for example the use of technical platforms, virtual construction models, and foreign labor. Both platforms and virtual construction are also important tools to handle customer and supplier relationships.

INTRODUCTION

The construction business network is in general seen as conservative and non-innovative. (See e.g. Koskela & Vrijhoef 2001; Seaden & Manseau 2001). A number of reasons for this have also been identified. One of these has been said to be related to the way the business is organized – that all important activities are taking place within time limited projects. This makes it difficult to develop long term relationships with customers and/or suppliers which in turn make it difficult to handle development issues. Another often mentioned reason is the local character of the business – business networks related to construction is limited in space – dominated by local actors and that international actors therefore are lacking. This is said to reduce the competition and thereby also the forces for renewal. From a governmental point of view this lack of renewal is seen as a problem as the construction sector is an important economic activity in most countries, not least in Sweden. (SoU 2002:115; SFD 2009:6) This characterization as well as the causes can be correct but an alternative view is that the picture is more complicated and multifaceted. This is at least the starting point for a large research program initiated by the Swedish construction companies and where the ambition is to investigate how the business landscape look like for the construction companies and what can be done in improving their innovativeness.

A first question is if the construction network is so non-innovative that is claimed in the Swedish public discussion. One reasons for the bad reputation can be that the way innovation in general is defined and measured is not suitable for the construction business. Another interesting complicating factor might be that there is an important variation within the total network – that all parts of it are not so conservative. There are examples of innovations within the area that give reasons to at least investigate this aspect. Thus a first research question has to do with identifying both *the degree and the variation of innovativeness within the construction network.*

The second issue has to do with what are the most important influencing factors. There might be factors making it possible/necessary to innovative and there might be factors acting as obstacles to innovate. What are in other terms the reasons why the degree of innovativeness is on the level identified in the first question as why do we have a variation (if this is the case)? The ambition is to identify *which set of factors are acting as driving forces and which set of factors are hindering innovations to take place.*

In order to identify both the degree of innovativeness as well as the factors affecting it we have conducted a survey to the Swedish construction companies. We have asked business managers (CEOs and managers being responsible for a division or local region in the four largest companies) to give their picture of what has happened during the last five years and also what they think is necessary or possible to change within the next five years. This study is also the first study in a larger program where also a number of specific innovations later will be studied using a case methodology.

THEORETICAL APPROACH

The classical market model is used in most studies of the construction companies and their innovativeness. (See e.g. Winch 1989; Love et al 2002) However, in order to find some alternative views we will in this study apply an industrial network approach. It means that we look for renewal as well as driving and hindering forces in the interfaces between involved companies. One important reason is that a construction company is using a set of suppliers of both materials and services (sub-contractors) who often are representing 60-70% of the total

volume (Dubois & Gadde 2002). Another reason is that the constructions - houses, office buildings, roads or dams – are mainly done for professional customers. A construction company is in this way acting in a B2B situation both on the input and output side. It is in other words a very typical industrial market/network situation. Earlier studies of such situations should therefore be of interest (Håkansson et al 2009). Thus, an industrial network approach seems to be a reasonable approach and should give interesting, complementary and useful insights both in terms of the identification of the degree and type of renewal as well as finding factors driving or hindering such a renewal. Therefore we will use the ARA-model (Håkansson & Johanson 1992) both as a starting point for discussing how to form the dependent variable – how to identify and define innovations - and also for the identification of factors – the independent variables - affecting the renewal activities.

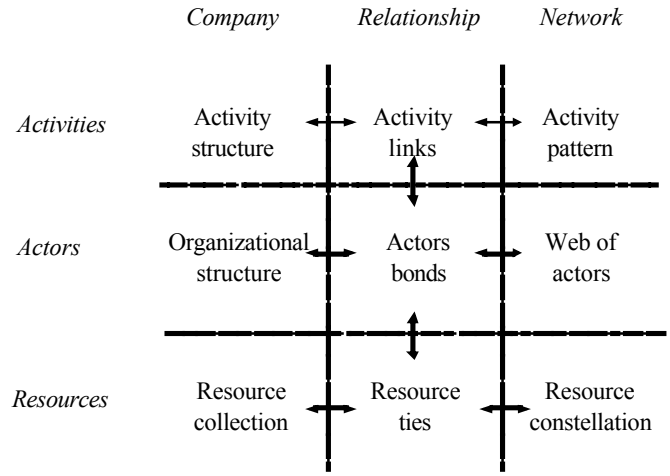

Figure 1. The ARA-model from Håkansson & Johanson 1992

The effect of an innovation in the ARA-perspective must be possible to identify in the relationship to important counterparts – in the interface toward the counterparts and thus affecting ties, links and bonds (Figure 1). It means that a renewal requires that at least one of these components is changed in such a way that it affects the other components or that they are combined in a new way. Thus, if we want to start to look for renewal of an actor – such as the construction company – we could for example try to identify this in relation to important counterparts such as the main customers. Furthermore, we would also look into the ties, links and bonds. It can be a new way to work with the counterpart (new type of bonds), it can be that the activities are designed and related to the counterparts' activities in a new way or it can be that the resources used are different or related to the resources of the counterpart in a new way. Thus, there is a need to cover a number of different dimensions within the relationship in order to identify a number of very different types of renewal. We will need a set of variables to describe and characterize the dependent variable.

On the influencing side there seems to be reasons to identify three types of factors. One has to do with the general network situation the company (business unit) has. Another has to do with the existence of some driving forces, i.e. factors that in a positive way affects the renewal activities. Finally, a third type has to do with factors hindering the renewal work.

The first type of factors that the network theory signals should affect the single company is the type of network position it has (Johanson & Mattsson 1992; Henders 1992). Here we have

a network that for some business units have both an "internal" and external part. Construction companies are decentralized in the same time as there are some major companies dominating the total network. A consequence is that many projects are handled in a local unit within a large decentralized company. All of the business units within large companies have in this way a network that consists both of what can be depicted as an internal network – all the units in the own company – in addition to the external network that all units have. The external network consists mainly of customers, suppliers and competitors. Furthermore, the local character of the network also necessitates consideration to the local network position. For example, there are quite big differences for units existing in the large cities compared to more local cities or regions both in terms of customers but also in terms of sub-contractors and suppliers. Type of customers and suppliers differs due to what type of projects the business unit is specializing in.

Looking for driving and hindering factors we can use Figure 1 to identify a number of possible types. Firstly, we can use the columns and identify factors related to the single actor, to relationships with counterparts and to the larger network. Within each of these broad categories we can look for factors related to the organization, to specific resources or specific activities. If we start in the relationships and identify renewal in the customer relationships we can find driving or hindering factors in relationships to suppliers, sub-contractors, technical specialists including architects and/or governmental bodies. Starting in the network we can identify driving or hindering forces in the way the network works in terms of how the web of actors are functioning (type of relationships applied), changes in how the resource constellation is brought together or the wider activity pattern is formed. Finally, in the single company it can be new ways to plan projects or new way to organize the labor force that can be examples of factors that affect how the relationships to customers will function.

METHODOLOGY

The theoretical approach presented in Figure 1 was used to identify a number of empirical parameters that could be used in an investigation of the renewal of the construction companies. By starting out from the renewal of the construction company we got an important fixed reference point. A first general measure of renewal could then be identified in relation to the customers. The existence of positive changes for the customers could be a general way to identify renewal. But then we needed to map specific changes in the ties, links and bonds. For each of these we identified some typical type of changes that also has been observed or discussed in general in the industry. By asking about the degree to which changes has taken place during the last five years we could identify at least how key persons within the companies perceived the degree of renewal.

The network position was measured with a set of variables indicating size, unit within a larger company, type of local environment (large city etc.) and international purchasing.

	Counterpart				
Activity/resource	Customers	Suppliers	Sub-contractors	Other constr.	Comp.
Projects					
Planning					
Platforms					
Technical problems					
Competence					
Courses					
Cooperation					
Ideas/Information					

Figure 2. Examples of activity/resources (rows) and type of counterparts (columns) that were used to identify driving and hindering factors.

In order to identify driving and hindering factors we identified suitable questions/parameters using matrices of which we show one part in Figure 2. In total we identified 11 types of counterparts (customers, suppliers of materials, suppliers of equipment, sub-contractors, foreign materials suppliers, foreign sub-contractors, other construction companies, other foreign construction companies, technical consultants (incl. architects), research institutes, university departments). In the same way we identified a set of activities and/or resources that could be related to the interfaces with different counterparts. With the help of these matrices it was possible to design a large set of factors which we could ask the mangers to evaluate and compare in terms of driving or hindering factors for renewal. In the appendices the different groups of variables are listed.

In order to get a first picture of the renewal situation and influencing factors we choose to make a survey to 2000 managers in the Swedish construction companies. In each of the four large companies we identified 80-100 business managers and in the rest of the companies the survey was sent to the CEO. A web based tool (Questback) was used to distribute and collect the surveys, which also facilitated further use and analysis of the material. In total we received 440 completed questionnaires with a good spread in terms of different types of construction companies. We got a good variation in relation to size, to different locations, between units within larger companies and independent companies, level of international purchasing (in terms of share of total purchasing) and to variation in what they were producing (in terms of main share of total turnover). (See Table 1)

	Share of companies in regard to being unit/indep.	Share of companies in regard to number of employees	Share of companies in regard to different localizations	Share of companies in regard to international purchasing	Share of companies in regard to main type of production *(50-100% of total turnover)*
Business Unit	26.1%	-	-	-	-
Independent company	73.9%	-	-	-	-
5-50 employees	-	70.3%	-	-	-
51-200 employees	-	22.5%	-	-	-
201 or more employees	-	8.2%		-	-
Larger city (Stockholm, Gothenburg, Malmoe)	-	-	41.4%	-	-
University city	-	-	25.1%	-	-
Country side	-	-	33.6%	-	-
0-2% of total purchase	-	-	-	67.4%	
3-4% of total purchase	-	-	-	5.5%	
5% or more of total purchase	-	-	-	27.1%	
Housing -new production	-	-	-	-	15%
Housing – rebuilding	-	-	-	-	19.1%
Property building (offices, schools etc.)	-	-	-	-	35.6%
Large infrastructure	-	-	-	-	12.8%
Escavation and foundation work	-	-	-	-	25.2%

Table 1. The response frequency within five different groups; unit/independent company, number of employees, localization, level of international purchasing in terms of share of total purchasing and main type of production in terms of share of total turnover (50-100%).

Analytical model

One problem we have is that the respondents have different experience of renewal activities. Some have been highly involved and have themselves been driving forces while others probably have done very little or sometimes even been functioning as a hinder. In order to handle this basic problem we have designed a statistical model where the degree of perceived renewal was linked to different potentially influencing factors. In practice, this meant that we tested the covariance between particular questions representing renewal, potential driving forces and hinders as well as the network position. This was done by using confirmatory

structural equation modeling in LISREL[1]. The model was based on renewal (R) as a function of network position (N), driving forces (D) and hinders (H) in the following manner:

$$R = coeff*N + coeff*D + coeff*H$$

This means that the model is not designed to demonstrate which type of renewal that has been the most frequent in the industry, or which type of driving forces or hinders that are considered most common (this is instead straightforwardly presented by the percentages in the data material). Rather, it measures the *variation* of conceived driving forces and hinders among the companies that have scored high on renewal and those that have scored low. This means that if a variable, for instance a potential hinder, is considered equally important by companies that engage in renewal as by those who don't, it will not have a high impact in the model. However, if a variable is considered very important by the companies that engage in renewal it will have a high impact in the model and thus affect the latent variable "renewal". It is also important to emphasize that what has been measured in the survey and thus in our model, is the managers' conception of these different enabling or hindering factors, and not their actual effect. Not only does the model disclose which enabling factors, hinders or network effects that have the most significant impact (in terms of the managers' opinions), it also reveals to which degree these three influencing factors matter among themselves. Throughout the paper these results are compared and discussed in reference to the more general results of the survey.

RESULTS

The renewal model –the importance of the network position

The results show that the model has an approximate fit and a fairly high R^2 value of 0.71, which means that the equation accounts for a large part of the variation in the latent variable renewal (see below).[2] All variables of the equation are statistically significant except for the variable representing driving forces, which means that this variable doesn't have a statistically assured coefficient. In turn this suggests that there is little systematic variation in the data material for how the factors representing driving forces are perceived by respondents in relation to perceived degree of renewal. Put differently, regardless if the company is renewed or not, the managers still think that it is the same type of driving forces that are important. Network position and hinders are however statistically significant, which means that for these variables there is a significant difference between renewed and not renewed companies, in terms of their network position as well as their managers' perception of hinders of renewal.

$$R = 0.69*N + 0.24*D + 0.073*H$$

As can be observed in the equation above, the model shows that the strongest variation in reference to renewal is connected to the network position of the company, which means that in comparison with conditions identified as potential driving forces or hinders, the general network position of the companies has the most significant impact on their renewal.[3] The

[1] Jöreskog & Sörbom 1993

[2] Root Mean Square Error of Approximation (RMSEA) is 0.071 which equals an "approximate fit" of the model. A "close fit" requires an RMSEA value below 0.05.

[3] What might be confusing about the equation is that "hinders" have a positive effect on "renewal" but what it demonstrates is rather the way that the questions were scaled in the survey; high scores on renewal and high scores on hinders were positively correlated.

single two most important factors determining this position are related to whether the company is an independent firm or a unit within a larger company, and to the size of the company in terms of number of employees. It is also significantly related to the educational level of the staff and the degree of international purchases. More specifically, the material demonstrates that the companies that have engaged in renewal are generally units within larger companies, they have a larger and more educated staff, and a higher degree of international purchases.[4] This demonstrates the impact of both the internal and the external network; it makes a difference if the company has an extensive internal network in terms of other units within the same corporation, and a larger staff as well as an external network, which in this case is partly represented by international suppliers.

The positive effect of being part of a larger corporation is also confirmed by the general results in the survey. On the general question of what degree of development that has taken place in the companies' activities during the last five years, leading to a more valuable product for the client, 61% of the companies state that considerable changes have been carried out and that this has added significant value for the client. Thus, almost two thirds of the companies claim that they have developed their business to the degree where it leads to their clients getting a more valuable product. However, while this is claimed by 82% of the units belonging to a larger company, the same is true for only 54% of the independent companies. For a unit within a larger company there is both the external network in terms of the unit's local network and the one which becomes available through the other units in the company. This access offers a different type of network position than for independent companies, which seems to make renewal more plausible. The next question is what type of renewal which this kind of network position correlates to. As will be dealt with in the next section it is mainly changes which require both human and capital resources, and relate both to the internal and external company network.

Renewal

Besides the broad question on which degree of development that has taken place in relation to customers on a more general level, a set of questions addressing specific organizational and technical changes was also specified in the survey (see appendices). According to the model, the changes which stand out among the companies which have engaged in renewal, and therefore also have a strong connection to a beneficial network position, are:

- International purchasing of materials/International purchasing of subcontractors
- The development and use of technical platforms
- The use of virtual construction models[5]
- Partnering relationships with customers
- Foreign labor force

As can be observed, these are changes which concern both the internal and the external network of the company. International purchasing clearly concerns the companies' external network, in the shape of relationships with foreign suppliers. As it requires competent staff and investments, particularly in the case of materials, not all companies can engage in this type of activity. International purchasing therefore presupposes a certain size of the company,

[4] As can be suspected there is a correlation between these four factors. In general, units within big corporations are larger in terms of number of employees, have a more educated staff and a higher degree of international purchases.

[5] Virtual construction, also often referred to as BIM, is an umbrella term for 3D-modelling programs used for construction design and planning.

both in terms of number of employees and turnover. This is also true for the use of technical platforms and virtual construction models.

Technical platforms refer mainly to a standardization of the construction elements and materials, which are combined into fixed modules, but can also lead to a homogenization of the construction process; when using standardized modules, errors or inefficiencies in the working methods and in the process are more easily discovered and can thus be put right and even standardized. Usually the modules are assembled in-house by the construction companies. The different components and prefabricated materials are however delivered by various suppliers and can be adjusted for the particular purpose of fitting into the module, which suggest that the suppliers are highly involved in the development and production of the platforms. The implementation of platforms also entails the relationship with the customer as it usually means that due to earlier experience of producing and using the platform there is a fixed time plan and little surprises along the way. Thus, renewal in reference to technical platforms involves both the internal network of the construction company, in terms of in-house processes of developing and producing the platforms, and the external network in terms of suppliers and customers. In the survey, more than two fifths of the companies state that there has been an increase in standardization through technical platforms which suggests that it can be considered a trend, but that it does not apply to the majority of the construction network. In order to engage in this type of technical and organizational development a construction company needs both the human and capital resources to invest in a production facility and in its supplier relationships. This type of capacity does not apply to the larger part of the Swedish construction industry.

The use of virtual construction models simplifies the project work as well as the planning process as it in detail can display the construction object in three dimensions and how the construction work should progress over time. The idea is that this eliminates many errors, such as cross-wiring of electrical cables or water pipes, which before were discovered during production and thus led to improvised solutions and delays. It is however a rather new technology within the construction industry, which means that many companies are still learning how to implement it and about the different consequences of its use. Also, to purchase the program and to train the entire company staff in how to make use of it, from both a planning and a production perspective, requires investments. Since it offers the opportunity of improving the planning level of the projects, its implementation not only affects the relationship between planning and production, it can also highly affect how the company works with its suppliers, subcontractors, consultants/architects and customers in a more provident and integrated way.

Fourth on the list is partnering relationships with customers which signifies close collaboration between the construction company and the customer and includes an open policy on financial issues. Various forms of such customer relationships, even though not always referred to as “partnering”, have been practiced in the industry for several decades but according to the survey it also seems to have increased during the last few years. Further it seems like a general trend in the industry as 61% of the respondents claim that the share of partnering relationships with customers has increased during the last five years. A closer look reveals that 80% of the units in larger corporations have stated an increase while this is true for only 55% of the independent companies. Thus, there is an apparent variation in terms of which type of company that increasingly applies partnering relationships.

In regard to foreign labor force this also appears to be an issue related to the network position of the company, and thus among other things to company size and whether the company is a

unit within a larger corporation or if it is independent. While only 26% of the independent companies with less than 50 employees have increased their use of foreign labor during the last five years, this is true for 56% of the midsized units with 50-150 employees. Once again there is clear variation in the data material. This is a type of renewal which involves interaction in the external network of the construction company, in this case with foreign employment agencies, but also highly affects the internal network of the company as it introduces new staff and thus new skills and working methods.

What is indicated is that there are various forms of renewal taking place in the construction network. There are not only changes in the processes concerning purchasing, customer management, planning, project work and production but also technological development in terms of standardized technical solutions and methods. It is also taking place in interaction with suppliers and customers. We now turn to the perceived driving forces of these types of changes.

Driving forces

Despite the relationship between driving forces and renewal not being statistically significant in the model, the factors with the highest impact are quite different from the general results of the survey and seem to have a clear connection to the network position of the company. Therefore we find them highly relevant for discussion. The two factors with the highest impact are:

- Visiting ongoing projects within the larger corporation
- Common efforts within the larger corporation

The result indicates that the variation in the material, and the companies which engage in the addressed renewal, is represented largely by business units belonging to a larger corporation. Visiting ongoing projects within the corporation is appointed the most important source for learning and skills development, and common efforts within the corporation the most important source for inspiration to develop and use new methods, processes and products or services. The subsequent factors are internal courses and further education for employees, which also point to size and financial resources of the company. These factors scored rather low in the survey in general, particularly further education (see appendices). This further indicates that it is the own company and the resources made available through the larger corporation which are seen as the main driving forces for renewal, and only secondarily the external network. However, commonly for almost all companies in the survey is that customers are considered a very important driving force. Also, they are considered more important than suppliers and subcontractors. However, as this doesn't represent a variation in relation to the degree of renewal it is not shown by the model.

The two subsequent factors nevertheless indicate that also suppliers and customers are involved in renewal processes, even if only indirectly. The first factor concerns routines for exchanging experiences after finished projects and depending on how the routines are designed within the specific company this can also concern suppliers, subcontractors, consultant/architects, and customers. Either way, it does concern an evaluation of the company's relationships with these different actors within the project and therefore has an effect on both the internal and the external network. The second and almost equally influencing factor concerns visiting earlier or ongoing customer projects which suggests that customer interaction and learning from their projects is seen as an important part of developing the company.

What is indicated is that while it is the internal organization, through an extended internal network within the larger corporation, which is seen as the most important driver of renewal, external actors such as customers, suppliers and subcontractors, are too regarded as important influencers. In addition it can be argued that through the extended internal network there is also a comprehensive *external* network consisting of various relationships also playing a part in the renewal process. What is then considered counteracting forces of these positively influencing factors? In the next section we turn to the perceived hinders of renewal.

Hinders

Just as routines for exchanging or bringing back experiences after finished projects is considered a very important force of renewal, lack of such routines is seen as a great hinder of renewal. This is tightly connected to the subsequent factor of all projects being "unique" in the sense that the construction company in most projects need to adjust to new conditions in regard to the product, the production team and the local environment of the construction site. This "one-off" nature of the projects, in which new teams constantly are formed and where there are particular local conditions, makes the use of earlier experiences and standardization difficult. In addition, when it's time to evaluate the project, parts of the team are usually already involved in new projects, which complicate their further participation. A third obstacle concerns the relationship with the customer in regard to the amount of time given between ordering the project and start of production. Usually this is too short which means that little time is left for planning. As a consequence the construction company has to plan the project, in terms of logistics, ordering material, hiring subcontractors and so on, during actual production. This increases the risk of building mistakes and thus delays, and leaves little opportunity to try new working methods or materials. In turn this is connected to the external network of the company as it becomes difficult to plan purchases and the need for different products or services.

This means that it is largely in the nature of the building process which the perceived hinders for renewal are found; the uniqueness and locality of the projects, how this is handled in terms of routines for bringing back experiences from each project and the lack of time for well-needed planning. These are problems identified by the managers which companies actually engage in renewal and should thus to a large degree represent actually experienced obstacles of the type of renewal addressed earlier. It should however once again be noted that hinders (as well as driving forces), as defined in the survey, is shown to only have a minor influence on renewal compared to the company's network position. This suggests that even if there are particular driving and hindering conditions in the construction industry, the most influencing factors in regard to renewal seems to be connected to the companies' situation of being involved in a larger corporation or not, and thus the question of having access to an extended internal network, as well as to company size.

DISCUSSION AND CONCLUSIONS

The analysis of the empirical material gives some interesting suggestions. A first one is that the total activity of renewal is considerable even if one third of the companies answer that very little or nothing has happened during the last five years. It means that the total changes probably are smaller and more related to how single companies work. Still two thirds have experienced a substantial renewal. Given that we during these years have had a severe economic crisis, which probably has consumed a lot of attention and activities, we had expected a lower number.

We have also found some very distinct influencing variables to the variation in renewal. The most significant one is the network position and especially the existence of an internal network. It is more common for units within larger companies to have a high degree of renewal compared with independent companies. This is interesting as it goes against the classical myth that innovative behavior is more typical for small companies. In the construction industry in Sweden it seems that the renewal is more apparent in the larger companies than in the smaller ones. As we will see below this can probably be explained by the fact that renewal in technical as well as process aspects requires substantial resources.

If we look closer into renewal we have found that it involves both the internal and external network and concerns partnering with customers as well as use of foreign suppliers/subcontractors. It also concerns resources and activities in terms of for example the use of technical platforms, virtual construction models, and foreign labor. Both platforms and virtual construction are also important tools to handle customer and supplier relationships. They are both requiring quite large resources in order to be applied. This can be an important explanation why we have found the larger companies being more renewal oriented.

An interesting observation is that the driving forces were perceived in the same way independent of degree of engagement in renewal activities. This was an unexpected result as we believed that driving forces would be more apparent to those doing a lot of renewal activities. Instead, these factors seem to be more of a general influencing type and not more important for those engaged in renewal. The driving forces identified in the analysis include variables related both to the internal and external network. In relation to the internal network it includes common efforts within the larger corporation. But it also includes internal courses and exchanging experiences. This indicates that it is largely the extended internal network that is seen as a driving force for renewal, even if this indirectly also involves an external network of suppliers. In direct relation to the external network the most important variable is visits to the own clients' projects. This means that even though construction companies in general are very dependent on suppliers for material and services (e.g. Dubois & Gadde 2002), they are still not considered particularly important by the companies engaging in renewal. In addition, increased international purchasing was the most evident type of renewal for these companies which suggest that even though change is taking place in regard to suppliers they are not considered a resource in renewal efforts.

Some hinders were more clearly seen by those being most involved in renewal and these are obstacles which mainly concern the way construction companies are organized. The projects and that they all are handled in a unique way is one important hindering factor as well as how the experience exchange is handled (or not handled!). Finally, the lack of time between the order and the start of the production makes it difficult for the construction company to plan and to activate all earlier collective experience. Instead they have to start the construction with what they have in terms of their own personal experience. Several of these problems can be stated to hamper renewal in terms hindering standardization or industrialization, which should be a stressing issue for these larger companies. The uniqueness of the projects in combination with not being able to capture good and bad experiences from the different projects reduces the opportunity of developing standardized working methods and processes, which could pose more efficient ways of organizing the building process and production. But perhaps more importantly it reduces the opportunity of building long term relationships with important suppliers and customers. This in turn hinders long term development of new solutions across the organizational borders of the single construction company. Instead most of the development of new solutions is initiated and carried out by single companies, solutions which are then assimilated by other companies if they are found useful.

What we see is that higher degree of renewal is concentrated to particular parts of the construction network in Sweden, particularly in regard to technological development which requires large investments and therefore is a privilege of larger companies. There also seems to be a clear advantage of being a unit within a larger corporation because of the access which this provides to an extended internal and indirectly external network. The industrial network approach has been helpful in understanding that it is the interfaces between the different internal units which are seen as the main driving forces for renewal and only indirectly the external network made available through these. The renewal that is actually taking place however seem to involve both the internal and the external network. Also, clients are regarded a more important driving force than suppliers, even if we can see that renewal clearly is taking place both in regard to customers and suppliers.

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APPENDIX 1

SURVEY RESULTS

The following tables present selected results from the questions that were used to define "renewal", "driving forces" and "hinders".

Questions regarding renewal

Potential development areas	**Share of respondents stating that there has been a slight or a considerable increase during the last five years**	**Share of respondents stating that there has been a considerable increase during the last five years**
Planning level of production	68.6%	13.1%
Partnering relationships with clients	61.3%	20.7%
Quality of projection	59.7%	12.4%
Share of subcontractors and specialists	56.3%	6%
Share of prefabricated materials and construction elements	52.8%	6%
Standardization through technical platforms	42.1%	5%
Share of foreign labor	36.7%	9.2%
Share of international purchases of materials	33.1%	8%
Share of projects involving virtual construction	32%	5.9%
Share of international purchases of subcontractors	21.6%	4%
Average	***46.4%***	***9%***

Questions regarding driving forces

Potential sources of inspiration and driving force for renewal	**Share of respondents stating this is currently a very important driving force for renewal**
Ideas and opinions from co-workers	78.3%
Ideas and opinions from clients	77.3%
Technical problems requiring a solution	45.7%
Ideas and opinions from subcontractors	30.5%
Ideas and opinions from technical consultants and architects	28.3%
Common efforts within the corporation	25.6% *
Ideas and opinions from material suppliers	21.4%
Competition from Swedish construction companies	20%
Courses	16.8%
Ideas and opinions from equipment suppliers	12.9%
Information from governmental authorities	12.5%
Competition from foreign construction companies	11.5%
Information from research institutions	8.6%

Ways of developing competence	**Share of respondents stating this is currently in frequent use**
Learning by doing (through mentorship, coaching, instructions)	89%
Exchanging experiences from finished projects	58.8%
Internal courses	46.4%
Courses and meetings arranged by suppliers	45.3%
External courses	40.2%
Study visits and discussions at clients	38.8%
Study visits at projects within the same corporation	23.2% *
Further education on university level	1%

*These questions were only answered by the companies that are group units within larger corporations

Questions regarding hinders

Potential barriers of renewal	**Share of respondents stating that there is a slight or a considerable hindering effect upon renewal**	**Share of respondents stating that there is a considerable hindering effect upon renewal**
Focus on price in all parts of the process	78.3%	38.7%
Too little time between ordering and starting the project	70.8%	30.8%
Insufficient profitability	63.4%	19.5%
The business cycle of the industry with quick shifts between boom and decline	56.9%	14.5%
Labor contracts for construction workers	53.5%	24%
No time –busy with ongoing projects	53.1%	13.8%
The competence level in the industry	38.9%	8.3%
How exchange of experiences between projects is handled	23.8%	5.4%
The structure of the industry with a few big actors and many small companies	19.6%	3.7
Decentralized management	13.3%	3.1%
Labor contracts for office workers	4%	0.5%