NEW WAYS OF ORGANISING CONSTRUCTION DUE TO USER DEMANDS

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This paper investigates how client demands affect organisational renewal in construction, more specifically how the combining of technical and organisational resources are directly and indirectly affected by demands from the user. We adopt an industrial network perspective and focus on inter-organisational interaction between the actors involved in two specific healthcare construction projects in Sweden. The findings show that user demands affect organisational renewal with regard to both onsite and off-site operations and that effects due to user demands can be spread outside the 'temporary' network to the 'permanent' network. Hence, user demands create direct and indirect effects on both the combining of organisational and technical resources across individual projects and organisational boundaries. These findings imply that in order to understand innovation in construction it is necessary to study how technical and organisational resources are combined across organisational boundaries and across projects.

Keywords: industrial networks, innovation, interaction, organising construction, resources, client demands.

INTRODUCTION

Several studies state that the construction industry suffers from low efficiency (Vrijhoef and Koskela 2000), and it has been suggested that structural changes are needed (Egan 1998). In particular, the industry faces challenges in the improvement of performance through innovation (Slaughter 1998). Nevertheless, there are many empirical examples of how the industry innovates in various ways, and the most relevant type of renewal appears to lie in the organisation of actors, resources and activities within and across projects (Slaughter 2000). For that reason, it is highly interesting to investigate drivers of organisational renewal within construction, and in this paper we do so by focusing on the role of the client. As the client places direct, as well as indirect, demands on the project and the final product, this actor is often identified as one of the most important drivers of construction innovation (Håkansson and Ingemansson 2013). We focus on how the demands of the client can influence new ways of organising projects in relation to how technical and organisational resources are combined in new ways, and the direct and indirect effects this has on project activities and actors. Due to the features of the construction industry, including

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for example its fragmentation, project-based character, and focus on arms-length relationships, we find an inter-organisational and interactive approach suitable for an analysis of how and why organisational renewal appears in the construction industry. Thus, we apply the industrial network approach (Håkansson *et al*. 2009), which views the single firm and its resources and activities as embedded in an interdependent business network of other firms' resources and activities. According to this view, firms are dependent on the network for their routine operations, development and innovation (Håkansson and Waluszewski 2002). Therefore, the most central activity of the firm is to interact with other firms, which enables access to resources such as knowledge and technology. More specifically, it is the combining of resources across firm boundaries that creates value for firms and enables them to find new valuable combinations, but at the same time it also locks them into specific investment and operation patterns. For the investigation of what makes construction actors organise in specific ways and how these ways may change, we find this perspective a highly useful theoretical and methodological approach. By the use of two in-depth case studies demonstrating different types of client demands, we investigate how clients can enforce new ways of organising construction projects.

THEORY

An industrial network perspective on construction

By adopting the industrial network perspective the emphasis is on inter-organisational interaction (Sundquist 2014) in which firms are viewed not only as relating occasionally through separate transactions, but also through continuous interaction processes in which resources and activities are adjusted in relation to each other (Håkansson *et al*. 2009). Through the interaction processes, the network of resources and activities of the single firm becomes embedded in a larger business network of other actors, resources and activities. This has implications for how firms are assumed to be able to use its resources as well as to develop new ones. More specifically, by interacting, existing resources (such as organisational knowledge, routines, production equipment etc.) can obtain new features depending on which other resources they are combined with (Håkansson and Waluszewski 2002). Many studies using an industrial network perspective have pointed to the construction industry as a *"special case"* (Håkansson and Ingemansson 2013). The project-based character hinders long-term commitment and inter-firm collaboration which differs from for instance the manufacturing industry. Analysing the effects that a project-based industry has on the couplings between firms Dubois and Gadde (2002) suggested that construction actors relate to 'temporary' and 'permanent' networks. The temporary networks refer to the inter-organisational interaction taking place within projects, which can be intense. The permanent networks refer to the interaction that takes place between or across projects, which generally is characterised by 'loose couplings' and little inter-firm collaboration.[2] It has been suggested that this has direct implications for how innovation can (or cannot) occur, and hence most adaptations take place within projects. Consequently, change and innovation is often project-related (Gann and Salter 2000), which makes the driving forces of change within projects highly interesting. Earlier studies have shown that within projects, changes need to be negotiated among the project actors (Winch 2003) and thus involve interaction

[2] There are however exceptions, showing how construction actors, when possible interact intensively across several projects resulting in both technological and organisational innovation (e.g. Crespin-Mazet and Ghauri, 2007; Crespin-Mazet *et al*,. forthcoming 2015).

processes. This paper investigates interaction in projects, and the following section outlines our theoretical perspective to do so.

The effects of combining resources

A well-used tool within the industrial network approach to study inter-organisational interactions and the effects thereof is the ARA model (see Håkansson and Waluszewski, 2002). This model outlines three different but highly interconnected layers of business networks, Actors-Resources-Activities. Resources are defined as being technological (e.g. products and production facilities) or organisational (e.g. knowledge, routines and relationships). One of the basic assumptions is that resources are heterogeneous and thus obtain specific features depending on which other resources they are combined with (ibid.). Thus, depending on how resources are combined across firm boundaries as firms interact, they obtain specific features and values. This can be expressed as it is the combination of resources that determines the use and services of resources (Ingemansson 2010). For instance, a product can result in one type of use and value for one client while for another client it results in another type of use and value depending on the specific set of resources and activities of the respective actors. Another basic assumption of the effects of resource interaction is that the interaction that takes place between technical and organisational resources affects how they can be changed, i.e. what is possible to change depends on how technical and organisational resources can be (re-) combined. Consequently, new ways of organising often depend on and/or affect technological solutions, and technological innovation often requires and/or results in organisational change (Håkansson and Waluszewski 2002). Due to the centrality of organisation in construction, in this paper we take particular interest in new resource combinations and how this relates to organisational renewal. More specifically we want to show how clients intentionally and/or unintentionally put certain demands on the construction which creates direct and/or indirect effects on the involved construction actors in combining resources in new ways.

METHOD

In the paper we focus on healthcare construction projects as they involve active clients with specific demands in order to provide efficient healthcare. Hence, healthcare is a suitable empirical arena when investigating user demands and their effects on organising construction. The paper is a multiple case study, involving two healthcare projects in Sweden; the university hospital in Linköping and the Skandion Clinic in Uppsala. Case studies are particularly useful for studying a contemporary phenomenon (Yin 1984) and for studies of complex systems, and events where broad conceptual frameworks are used (Dubois and Gadde 2014). The university hospital in Linköping is a refurbishment project of an existing hospital offering all kind of healthcare services, while the Skandion Clinic is a new clinic offering specialised cancer treatment with proton radiation. In both cases the construction projects are organised and directed by user demands. The Linköping case reveals user demands related to ongoing healthcare operations while the Skandion case reveals user demands related to future healthcare services. The cases complement each other by illustrating different kinds of demands. For each case three specific examples on how user demands create direct and indirect effects on organising construction are presented. To identify user demands' effects on organising construction we need to investigate the network of actors related to the construction projects. The main data of the paper is based on interviews with a variety of actors involved in the two projects, such as the client, the main contractor, subcontractors, engineering companies and architects. A total of 20 interviews along with site visits including two guided tours were conducted in the Skandion Clinic case. In the Linköping University Hospital case, 10 interviews have been performed with actors such as the main contractor, subcontractors, the logistics specialist, the project manager and suppliers related to the project. This study also includes three on-site visits covering logistics and construction operations.

EMPIRICAL PRESENTATION

Case 1: Linköping University Hospital

The FUS-project involves new buildings and refurbishment of existing buildings at the university hospital in Linköping, Sweden. The total budget is 3850 million SEK and the project phases stretching from 2011-2019. The FUS-project involves new construction of nursing wards, emergency entrance, delivery ward, helipad, teaching facilities, and a psychiatric clinic. In addition, a major part of the main building is reconstructed to create a new entrance and reception area as well as various services such as pharmacy etc. The project also involves a new parking facility and new infrastructure to separate ambulance traffic from other traffic. The client, Östergötland County Council (ÖCC), had specific requirements regarding the organisation of the project owing to the fact that the hospital is fully operative during the construction project. Consequently, high demands were set on the coordination among construction processes and ongoing hospital operations, which include large amount of health care personnel, patients and visitors. By no means should health care provision be jeopardised by the construction processes.

Example 1.1: A logistics specialist appointed - securing onsite logistics
In order to handle the complex situation described above ÖCC emphasised a need for a sophisticated on-site logistics solution as to secure hospital operations. Conditions at the site are challenging, for instance, in the construction of two new buildings the entrance to the construction site is located next to the emergency entrance with ambulance traffic. Thus, ÖCC demanded in the tendering phase that a logistics specialist should be appointed, and Svensk Bygglogistik (SB), specialising in onsite logistic operations, was selected. Positioned under the main contractor, NCC, SB is responsible for the planning and monitoring of all deliveries to the site; for materials handling from the point of arrival to the site and to the assembly point on the site, and the organising of resources such as cranes, elevators and scaffolds, including updates of site disposition plans. This set-up was hence decided early on by ÖCC and clearly stated in the procurement process, thereby known to all contractors entering the project. Before the first delivery to the FUS-project each subcontractor needs to take part in an introduction arranged by SB concerning the logistics aspects of the project as the main contractor and all subcontractors are required to use SB for all logistics and materials handling operations. This arrangement was new to these actors, and required them to adapt their operations in several ways.

SB has a team of people stationed at the site. This team works regular working hours. The actual materials handling takes place after regular working hours (between 4 p.m. and midnight) by SB personnel to minimise disturbances of production flows and enable efficient use of cranes and elevators for construction work during daytime. Contractors pay a fee per unit materials handled by SB depending on the size and weight of the goods. Preferably, goods should be delivered on pallets that can be handled by pallet lifts and transported in elevators rather than using the tower crane, to allow for more efficient materials handling at the site.

This logistical arrangement creates several effects both on-site and off-site. On site, the contractors' construction workers are no longer involved in materials handling and can focus on construction operations, which improves efficiency. At the same time, construction workers must plan ahead to a greater extent as they can no longer themselves bring in additional materials on short notice. Construction workers and managers thus interact more intensively regarding progress of work and requirements of deliveries of materials. This, in turn, results in increased planning by managers towards suppliers and call-offs of materials to the site. Also, managers tend to plan for excess delivery of materials to avoid a situation where workers are out of materials. Off-site the material suppliers, such as distributors, have to adapt their operations to be able to deliver off-hours. In one case a distributor and a carrier, who supply three subcontractors in the project, had to set up an intermediate storage facility some kilometres from the construction site from where off-hours deliveries could be made. For the material manufacturers, this way of working generated stricter rules for delivery times, and requirements on keeping the order together, not allowing residue deliveries.

Example 1.2: Required side-contractor partnering agreements: increased interaction to improve construction processes
The client ÖCC also had requirements on how the project should be organised with regard to collaboration forms and ÖCC demanded that for the frame complement the project should be permeated with cooperation among contractors and subcontractors in the formation of groups. Thus, for frame complement the project organisation consists of three side-contractor groups (each including a construction contractor, plumbing contractor, electricity contractor, and ventilation contractor) who took part in the tendering process as a group and work tightly together in the construction process. To support this work ÖCC sets up standards for formal meetings on various levels but also many informal meetings take place. Also, a common project office was set up by ÖCC where all cooperating firms within each side-contractor group have their working space in close proximity to one another.

The requirements of side-contractor groups created a more thorough recruitment process with regard to individuals that had to apply with an extensive cv, and also personally meet with the human resource function. Before the project started there was a three day long team building course with the respective side-contractor group, representatives from ÖCC and construction engineers. This was initiated and paid for by ÖCC. For the involved subcontractors, the arrangement created new management effects. Commonly, the building contractor manages and controls to a large extent all work and adapts this to its operations, and subcontractors have to adapt. In the case with side-contracting all involved actors in the group plan together to decide upon 'when to do what' to obtain the best result in all operations and avoid sub-optimisation.

Example 1.3: LogNet - a web portal for coordination of deliveries to site
LogNet is a web portal for deliveries to the site and is developed by SB and used in all projects in which SB is involved. Contractors have to book all material deliveries at least five days in advance in LogNet. Available time slots are visible for the contractors when planning for the deliveries. Deliveries are scheduled in LogNet in time slots of 30 minutes. Required resources for materials handling, e.g. cranes, are

also booked in LogNet. Personnel at SB confirm or deny the requested time slot and the required resources. All deliveries must pass through a *"checkpoint"* located at the entrance of the hospital area in order to get the delivery to the site approved. The area for unloading at the site is very small and only has room for one truck at the time. Trucks cannot wait outside the gate as this area has to be cleared for ambulances.

The use of LogNet has implications for the contractors as well as for their partners. Contractors get goods in neatly packed pallets delivered to the correct assembly area marked 'house X, floor, Y, coordinates ZW. As no materials are stored outdoors at the site waste is reduced. However, it requires deliveries to the site to be booked at least five days in advance in LogNet, thus, contractors must apply more advance planning of deliveries to the site and ordering in comparison to what they are used to. This planning takes place in two steps: first a request is sent to LogNet, and second, after approval, the contractor sends the confirmation to the supplier.

Case 2: The Skandion Clinic

The Skandion Clinic is the first clinic in Northern Europe specialized on cancer treatment by using proton radiation. The construction started in June 2011 and the first treatment is planned to October 2015. The cost of the clinic is estimated to around 1 billion SEK (cost for construction: 500 MSEK, cost for medical tech: 500 MSEK). The client of Skandion Clinic, Kommunalförbundet Avancerad Strålbehandling (KAS), is an organisation established in 2006 with the aim to run and manage proton therapy at the clinic. KAS is a national organisation set up by seven Swedish county councils.[3] As a client KAS has special requirements in relation to how the working areas in the clinic will be organised along with special requirements concerning the use of medical technology. KAS is the main user of the clinic but rent the clinic from the owner and property manager, Akademiska Hus (AH). Hence, it was AH that contracted a construction company, NCC Construction to set up the clinic, while KAS is the tenant.

Example 2:1: The partnering agreement between Akademiska Hus and NCC - increased interaction and spread to other projects
When KAS issued a contractor inquiry for construction and management of the Skandion Clinic, AH realised that in order to manage the construction of this unique building outside of its core business (normally the company manages buildings for higher education such as auditoriums, laboratories and offices) a capable collaboration partner was needed. Therefore, the company contacted NCC Construction, a construction company that they have worked with extensively in the Uppsala region for the past 20 years and asked if they would send in a joint partnering bid for the construction of the clinic. NCC accepted and this was the first partnering agreement between the two parties. The partnering agreement affected the whole construction process. To begin with, the parties organised procurement in another way compared to traditional contracting. AH decided to jointly manage the procurement process. As a consequence, more time was put on identifying suitable suppliers. Central suppliers of both parties were used along with new suppliers. In order to make the partnering agreement work this required increased interaction between the parties, hence more meetings and workshops were initiated during the Skandion Clinic project. For instance, a new type of meeting was introduced, the NAV-meeting, a meeting forum mainly used to facilitate the information and communication between the planning and the production of the clinic. Since the Skandion Clinic was the first partnering

[3] All Councils with university hospitals

agreement between the two parties the project required investments in increased interaction, however in the subsequent project, the Uadm-project, the parties once again used the same type of partnering contract and NCC supplies a similar project organisation with partly the same managers. Once again, joint procurement along with the same meeting forums was used including some developments such as including more participants in workshops throughout the project.

Example 2.2: BIM as a coordination tool during the construction process - resulting in a manual and in new processes
A new technical resource, Building Information Modelling (BIM), was introduced in handling the construction of the Skandion Clinic. BIM is a software technology that can be used to manage the design, production and maintenance of the building. The reason for implementing BIM was due to the complexity of the building, especially due to the complexity of canalisations and installations that needed to be integrated in walls and ceilings. When awaiting the decision by KAS in which med-tech supplier to use, AH decided with the support from the partnering entrepreneur, NCC, to use the Skandion Clinic as a pilot project for BIM. The intention was to use BIM more as a coordinated work process stretching planning, production and maintenance. This meant that engineering firms in charge of supplying drawings needed to have BIM-experience. The planning coordinator, Sweco, instructed all consultants to connect the drawings to one BIM-model. This model could be used for coordinating planning meetings and visualise the building while planning. Therefore installation collisions could be identified early on, especially important for a building that contains extreme amount of canalisations and installations. Moreover, in production NCC used the model to extract quantities of materials needed and thereby minimise time on measuring quantities and hence facilitate planning and ordering of materials. New type of meetings between several of the actors using the model were also initiated. In order to be able to work in relation to the BIM-model, AH appointed an architect firm, Link, to coordinate and update the BIM-model continuously throughout the project. The use of the BIM model thus resulted in organisational and processual changes; new ways of handling the coordination among actors across the construction process were put in effect. Working with BIM in the Skandion Clinic project also resulted in a technical resource, a BIM-manual that AH could use for future projects. The manual can be seen as a technical resource since it is a new physical resource with codified information on how to manage BIM in projects. The BIM-manual is also used for the second partnering project between AH and NCC, the Uadm-project.

Example 2.3: Medical technology - setting the agenda for construction
As a user of the Skandion Clinic, KAS is in charge of the treatment of patients but this organisation also handle the procurement of medical equipment used for proton radiation treatment. This specific medical technology put specific requirements in relation to the construction process of the clinic, and it meant that KAS had to be approved to perform radiation treatment by the SSM (The Authority for Radiation Safety). In addition, the building needed to be approved as *"radiation safe"*. KAS started the search for suitable technologies already in 2007 but realised that the technique they wanted, 2nd generation proton therapy (spot-scanning), was not available for purchase. Thus, KAS waited two years for the technique to be developed. However, an actual procurement agreement with a supplier was not realised until April 2011 due to two public appeals regarding the public procurement process. Finally, the Belgium med-tech company, IBA, won the bid and was allowed to supply the cyclotron needed to generate the proton beam for treatment of patients.

The choice by KAS to buy equipment from IBA meant that the construction process needed to adhere to specific demands from IBA and especially the integrated building document (IBD), a technical specification from IBA including 30-40 drawings and a 100 page document with detailed instructions of how to construct the rooms used for treatment down to nut and bolts. The IBD secured the quality and the function of the equipment. For instance the document detailed the need for creating safety internally and externally. Consequently, the construction of the clinic entailed walls and ceilings of iron-ore of more than 4 meters in widths. The IBD also emphasised the need for stability of the equipment, which meant that the groundwork of the clinic was of great importance. The heavy clinic and demands on stability resulted in more than 650 steel poles in the ground. In addition, access to electricity and cooling water was detailed along with the requirement of creating humidity of 30% inside the rooms to avoid the creation of static discharge that could affect the med-tech equipment. Hence the construction of the clinic was dependent on the guidelines of the IBD.

CONCLUDING DISCUSSION

The two cases illustrate how the clients' demands gave rise to new ways of interrelating and organising technological and organisational resources within the respective projects. In addition, although such demands targeted either technological or organisation issues, the effects did not only arise in the direct and corresponding type of resource but created various indirect effects across different types of resources and combinations. Some demands were directly related to specific technological solutions, for example, software solutions related to logistics (LogNet in example 1.3) and to design/planning (BIM in example 2.2), and the user related technology (in this case medical technology), but created both technological and organisational effects. Other demands were directly related to organisational aspects such as the need for various forms of partnering agreements (side-contractor partnering in example 1.2 and contractor-client partnering in example 2.1) and specific competences (the logistics specialist in example 1.1) in order to complete the project, which had immediate consequences for how both technological and organisational resources were used and developed. Thus, as the effects of specific demands and subsequent changes involve and re-combine different types of resources, the intended effect is not isolated, easily foreseen nor can it be truly evaluated beforehand. Table 1 illustrates how the client demands target one type of resource and affect either a corresponding or another type of resource. Consequently, four types of combinations appear in the cases: technological-technological, technological-organisational, organisational-technological and organisational-organisational.

Table 1: Technological and organisational client demands and effects on resources

User demands \ Effects	Technological	Organisational
Technological	BIM→BIM manual (2.2) Medical technology→new product supplier (2.3) Medical technology→building (2.3)	BIM→Work processes (2.2) LogNet→Work processes (1.3) BIM→new requirements of suppliers (2.2)
Organisational	SB→intermediate storage (1.1) Particular medical technology supplier→ effects of IBD document (2.3)	SB→suppliers' routines for delivery (1.1) Side-contractor partnering→increased interaction among contractors (1.2) Partnering agreement→use of same set-up in subsequent projects (2.1)

Both client demands related to *ongoing* healthcare operations (the Linköping case) and to *planned* healthcare services (the Skandion case) influence the way of organising the projects not only in relation to onsite operations, but also to procedures related to 'permanent' networks (see Dubois and Gadde 2002) of actors and activities (e.g. offsite or other projects). For instance, the use of a logistics specialist on-site (example 1.1) resulted in the need for an intermediate storage facility to be set up by a supplier, located nearby the site. Hence, inter-organisational renewal is not isolated to the site, but clearly involves, and affects actors in the wider supply chain. These network effects are not distributed equally among the actors: what might be beneficial for actors on site might be less valuable for other actors off-site. Another example is how the partnering contract in the Skandion project (example 2.1) was applied again in a subsequent project. Organisational renewal taking place through inter-organisational interaction within a project can hence be spread among projects, involving a more 'permanent' network (as opposed to the 'temporary' network of the individual project). Consequently, this paper shows that the different ways in which clients and users inspire to innovation with regard to new ways of organising construction can create innovative effects outside individual projects, both technologically and organisationally. Therefore, any understanding of how construction innovation is to be promoted or organised must start from an understanding of how technological and organisational resource combinations are created and changed across organisational boundaries. According to our findings, in this process clients and users appear to have a central role to play.

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