THE ROLE OF THE INDIVIDUAL IN SHARING OF KNOWLEDGE IN PROJECT-BASED ORGANISATIONS

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ABSTRACT

This paper explores how individuals develop and create activities that facilitate social interaction and knowledge sharing across professional and organisational boundaries within a project based settings. Data was collected through a case study approach in the setting of the highly projectifyed construction industry. By applying Wenger's conceptual framework of communities of practice the role of the individual as a knowledge mediator was highlighted. Findings showed sharing of knowledge in this setting to be dependent on individuals' possibility to act as translators of knowledge though creation of trust, allocation of time and money and the freedom to innovate.

Key words: *communities of practice, energy efficiency of housing, translators, construction industry, standardised building systems*

1. INTRODUCTION

Although knowledge is seen as the property of the individual, it is also a product of social interaction within groups. Since the turn of the millennium, researchers and practitioners within the field of knowledge management have begun to focus on these tightly knit groups called community of practice, and how they interact and share their knowledge (e.g. Brown and Duguid, 1998; Wenger, 1998) across organisational boundaries (Wenger *et al*, 2002). Although Wenger's concept of community of practice describes the sharing of knowledge and learning as a social process that takes place when people meet and interact around a shared interest and/or task, the concept has in recent years been proposed by researchers and practitioners as a tool to facilitate and manage these communities. Scholars have described this perspective on the concept of communities of practice as the *new generation of knowledge management*, and it is explored as a means of creating competitive advantage (e.g. Wenger and Snyder, 2000; Wenger *et al*, 2002; Koch, 2002; Grisham and Walker, 2006; Bishop *et al*, 2008; Probst and Borzillo, 2008). This new generation of knowledge management notion highlights the role of the individual within the community of practice (Fontaine, 2001; Borzillo *et al*, 2011) and his/her possibilities to share knowledge across boundaries (e.g. Handley *et al*, 2006; Kimbel *et al*, 2010). However, the need to understand what happens inside as well as outside these communities and what part individuals' play in the sharing of knowledge across community boundaries still exists.

Using the example of the highly-projectified construction industry, researchers in organisational learning have explored the learning possibilities in these settings, focusing on social practices (e.g. Scarborough *et al*, 2004; Bresnen *et al*, 2005). Scholars have found that firms in the construction industry operate on the basis of a

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high degree of tacit knowledge (e.g. Bishop *et al*, 2008; Styhre, 2009) and are therefore highly dependent on face-to-face interaction in their endeavours to create and sustain knowledge sharing and learning (e.g. Styhre *et al*, 2004; Grisham and Walker, 2006). Though strong learning capabilities have been found within projects (e.g. Anheim, 2003; Schenkel and Teigland, 2008), mechanisms of knowledge sharing between project settings are lacking (e.g. Prencipe and Tell, 2001; Styhre *et al* 2004; Sense, 2011). Several studies within construction organisations indicate that communities of practice should be nurtured and supported in order to achieve best practice and competitive advantage (Scarbrough *et al*, 2004; Bresnen *et al*, 2005; Bishop *et al*, 2008; Elmualim and Govender, 2008). However, few studies have focused on how individuals share and mediate knowledge between communities in project-based settings.

Facing the challenges presented by energy efficiency of buildings as well as increased standardisation within the industry opens up research opportunities into how knowledge is shared and mediated within and between such communities in form of professional groupings and organisations. By applying the theoretical lens of Wenger's communities of practice this paper contributes to research on knowledge sharing and learning in a project-based settings. Using a case study approach, knowledge sharing is explored during the development process of a standardised building system for energy-efficient housing within a construction group based in Sweden. The aim of the paper is to explore how individuals development and creation of activities may facilitate social interaction and knowledge sharing across professional and organisational boundaries.

The paper begins by giving an introduction to the concept of communities of practice and its application in research on project-based organisations. Next, the research approach taken and tools used for collecting data are outlined. The subsequent sections present the results, i.e. the organisational setting of the case study, the development process of the standardised building system and how individuals belonging to different professional groups interacted during this process. The paper concludes with a discussion and conclusions on how individuals' may facilitate social interaction and knowledge sharing across professional and organisational boundaries.

2. KNOWLEDGE SHARING AND LEARNING

For the individual, learning takes place when she/he engages in and contributes to a community's practice. For the community, learning occurs when a group of individuals negotiate meaning, and by doing so develop their common practice (Brown and Duguid, 2001). Learning in organisations entails sustaining the connections between the communities of practice that exist within the organisation. These social groups constitute and encompass what the organisation knows and how it is perceived since individual and environment cannot be separated (Brown and Duguid, 2001; Wenger *et al*, 2002).

2.1 The conceptual framework of communities of practice

Communities of practice are as diverse as the situations they accommodate: they can vary in size; have short or long lifespans; consist of members situated in close proximity or widely distributed over organisational and/or geographical boundaries; and consist of

people from the same or multiple disciplines. They may coalesce from spontaneous interaction or be formed intentionally and they may be institutionalised or organic (Wenger *et al*, 2002). In short, communities of practice are everywhere and, just by participating in everyday life: e.g. at work, through family and sports, we belong to several simultaneously (Wenger, 1998; Wenger *et al*, 2002). Most formal organisations can be seen as a hybrid of groups, organisational entities and official and unofficial networks, overlapping each other as interdependent communities (Brown and Duguid, 1998).

Communities of practice can be characterised by how new members are admitted. Membership can be open to anyone who is interested in the community's area of interest, or it can be limited to those who the community wants as members (Wenger and Snyder, 2000; Dubé *et al*, 2006). Open membership, then, corresponds to the thought of sharing knowledge in organisations. Dubé *et al* (2006) argue that admitting only those who match a certain profile allows for more control of the community of practice and thus facilitates its management. Further, enrolment in a community of practice can take various forms: voluntary (open membership), management induced (encouraged by management) or compulsory (Dubé *et al*, 2006; Borzillo *et al*, 2011) In any case, individuals may themselves select which communities of practice they wish to join. The choice may be based on what knowledge the individual desires to gain and on their need for the knowledge.

2.2 Sharing knowledge across community and organisational boundaries

Communities of practice are not isolated. To thrive they need outside influence. As communities of practice focus on their interests and/or tasks, they inevitably create boundaries (Wenger, 1998; Wenger *et al*, 2002). The boundaries of a practice are informal, and often even unarticulated. Nevertheless, they are real and can be identified through variations in use of language, vocabulary, artefacts, sets of experiences and ways of performing a task. However, knowledge both 'sticks' within as well as 'leaks' across boundaries (Brown and Duguid, 1998).

The 'leaking' of knowledge across boundaries requires mediators. Brown and Duguid (1998) called these persons translators or knowledge brokers depending on the context, Wenger (1998; 2000) simply called them brokers whereas Sverrisson (2001) saw them as entrepreneurs. The individuals referred to are 'importers-exporters' of knowledge between communities of practice. These knowledge brokers or mediators have central roles at the interface between different communities of practice facilitating the dialogue between them as translators of vocabulary, symbols and tools (Wenger, 1998; Wenger *et al*, 2002; Yanow, 2004; Meyer, 2010). As the role of these persons is to mediate knowledge they should not erect walls or create boundaries around their own practice (Meyer, 2010).

One distinction between translators and knowledge brokers is how they mediate knowledge under different circumstances, i.e. between organisations seen as communities (translator) or within a firm (broker) (Brown and Duguid, 1998). A translator has to be knowledgeable about both communities' practices in order to be able to negotiate meaning and gain trust within and between the two. Gaining the trust of both communities of practice as s/he negotiates meaning within both communities while simultaneously taking into consideration the interest of the other community was

found to be essential (Brown and Duguid, 1998). The role of the knowledge broker on the other hand is that she/he belongs to the communities of practice she/he in turn mediates knowledge between, e.g. this person is a member of an organisation (as a community of practice) and also several sub-communities in the form of workgroups or projects (Wenger, 1998). This type of brokering of knowledge requires concurrent membership in the communities of practice between which knowledge is shared. As a consequence, trust is here of a lesser importance (Brown and Duguid, 1998).

Supporting tools and communication technologies are usually used to mediate knowledge between professional and organisational groups. Scholars investigating the use of these mediating objects in the construction industry context have found that these need to be aligned with the organisation and its social groups in order for knowledge to be effectively mediated (Bishop *et al*, 2008; Styhre and Gluch, 2010). Similar, capturing knowledge and mediating it across organisational boundaries has been found to be dependent on roles that support and connect projects and organisations (Bresnen *et al*, 2003; Gluch *et al*, forthcoming). These roles could even themselves be seen as knowledge management mechanisms in these project-based organisational settings (Bresnen *et al*, 2003). Moreover, mediating knowledge is often associated with support functions and domain experts who have been found to rely heavily on personal contacts within and across organisational boundaries in order to be able to do their work (Bresnen *et al*, 2003; 2005).

3. CONDITIONS FOR SOCIAL INTERACTION AND SHARING OF KNOWELDGE IN THE CONSTRUCTION INDUSTRY

The construction industry is a project-based industry relying on a variety of professional groups such as private or public builders, contractors, architects and several specialised technical consultants. Being project based, the construction process is often described as a loosely connected chain of activities, a relay race, where each phase of realising a building system is de-coupled from the previous and the following (Prencipe and Tell, 2001; Dubois and Gadde, 2002; Kamara *et al*, 2002). Each project is seen as unique (Bresnen *et al*, 2003) where human resources from various professional groups are coordinated by artefacts such as drawings and other documents to attain a common goal (Ruuska and Teigland, 2009). This demands a high degree of social interaction which is dependent on face-to-face communication (e.g. Styhre, 2008; Gluch and Räisänen, 2009)to create a tight coupling within the project environment (Dubois and Gadde, 2002).

In order to address criticism of being an inefficient and fragmented industry (the Strategic Forum for Construction, 1998; SOU 2002:115) and to avoid ‘reinventing the wheel’ in each project, several construction companies in Sweden have chosen to develop standardised building systems (Gerth, 2008). These building systems address the one-off nature of construction projects, and in doing so challenges the traditional construction process and the way professional and organisational groups are used to interact when realising construction projects. Another challenge that the industry currently faces is the increased focus on energy efficiency of buildings (Thuvander *et al*, 2011). This originates from the raised awareness of the ongoing debate on climate change and the strengthening of legislative measures regarding the energy efficiency of buildings. To meet this new demand for new knowledge on environmental performance,

organisations have introduced new support functions in the form of environmental specialists (Gluch, 2009).

4. RESEARCH APPROACH

Over a three year period, data were collected from a Swedish construction group using such case study methods as: interviews, document studies, observations and informal conversations. The data were collected in two cases: the first case in 2009 (7 interviews) exploring knowledge management in the construction industry by focusing on knowledge brokering related to standardised building systems and processes, and the second case in 2011 (12 interviews) focusing on the individuals' role in facilitating interaction and knowledge sharing between organisations and professional groupings in project-based settings. Data for the two cases were collected in the same organisation and one person, the manager of division for technical innovations, was interviewed in both cases. Both studies investigated the intersection between knowledge management and increased standardisation of building systems.

The interviews were carried out face-to-face, the one exception was the first case where the interview was carried out as a telephone conference. All interviews lasted between 1-2 hours and were all recorded except for one in the second case where notes were taken. The number of interviewees, their position and organisational belonging within the construction group and when they were interviewed (first or second case) can be seen in *Table 1*. Each interviewee has been given a reference number (C1-9; H1-3; TC1-4 and A1-2) to facilitate indexing in the result section.

The first case, interviewees were selected to provide a broad picture of how knowledge sharing within the company impacted the development and usage of standardised building systems. The second case was done in two stages, where interviewees in the first stage (7 interviewees) were selected to allow an investigation of the development process of the standardised building system. After an initial analysis of these interviews, the researcher decided to conduct 5 more interviews with persons identified in the first stage as furthering the understanding of individuals' actions to facilitate knowledge sharing. Out of the 5 interviews done in the second stage, 2 interviewees worked in an external architecture firm (see *Table 1*).

The interview guide used in the first case focused on how knowledge was shared within the organisation; how standardised building systems were developed; for what purpose and how they were used within the organisation; and what barriers the interviewees perceived in knowledge sharing within the organisation. Questions were designed so that the interviewees could elaborate to some extent.

For the second case, the interview guide was designed to focus on preferred ways of individual learning and sharing of knowledge; with whom knowledge was shared and how; how the development process of the standardised building system proceed; who had participated in this process; what their contributions were and how these were made.

Case	Position (interview no)/ Area of expertise	Organisation (no interviews)
First case	**Environmental manager** (C1)/ structuring of environmental issues	Construction organisation (10 interviews)
	Head of R&D organisation (C2)/risk management	
	Manager of division for technical innovations (C3)/market strategy	
	Manager at division for purchase and competence division (C4)/property development, international purchasing	
	Head of division for product development (C5)/ property development	
	Manager at division of production of buildings (C6)/ utilise standardised building systems	
Second case	**Manager at division for standardised building systems** (C7)/ structuring of quality issues, Life Cycle Costing, Life Cycle Analysis	
	Manager of division for technical innovations (C3)/market strategy	
	Planning manager (for the pilot project) (C8)/civil engineer, production of buildings, economy, project management	
	Site manager for the pilot project (C9)/ carpenter, production of buildings, project management	
Second case	**Environmental coordinator** (H1)/ environmentally adapted product development, structuring of environmental issues	Housing development organisation (3 interviews)
	Project manager for pilot project (pilot project) (H2)/ standardisation of the building process, project management	
	Manager of a geographic housing development division (H3)/ market strategies	
First case	**Consultant on structural engineering** (hired to develop standardised building system) (TC1)/ civil engineer	Technical consultancy firm (4 interviews)
Second case	**Consultant on energy efficiency of buildings** (hired to develop standardises building system) (TC2)/ civil engineer, energy efficiency of buildings	
	Consultant on structural engineering and production efficiency in construction (project leader of the development project of the standardised building system for energy efficient housing) (TC3)/ civil engineer, production of buildings, project management	
	Consultant on energy efficiency of buildings (TC4)/ energy and environmental engineer, environmental communication	
Second case	**Architect** (A1)/ architect, utilise standardised building systems	Architectural office (2 interviews)
	Planning manager (A2)/ civil engineer, project management	

Table 1 show the number of interviewees, where in the construction group they worked, their role/position in the company and during which part of the study they were interviewed. Each interviewee has been given a reference number to facilitate citation indexing in the results section.

In the first case, recorded interviews were listened to and summarised iteratively, resulting in a detailed list of quotes, phrases, concepts and key words pertaining to the themes in focus. Findings in this case were validated through two workshops held with

representatives from two different R&D committees in The Swedish Construction Federation. The data collected through the interviews in the second case were transcribed and then analysed by iteratively listening to the interviews and reading the transcripts, drawing charts of interaction patterns and making detailed lists of quotes and phrases highlighting the themes in focus. All interviews were first analysed on their own and later in different combinations (e.g. organisational belonging, project participation, according to expressed interests, and/or profession) to map individual actions facilitating the forming of social groups and patterns for sharing/retaining knowledge. Findings in the interviews were compared with the collected documents, such as meeting protocols, information leaflets and the descriptions and blueprints that the standardised building system consisted of.

5. CASE DESCRIPTION

The organisation studied is a large construction group based in Sweden, but also active on an international market. Being a typical actor within the Swedish construction industry, the construction group offers services ranging from production of housing to R&D in projects. (See *Figure 1* showing organisational chart.) Parts of the organisation under study are the construction organisation (contractor), the housing development organisation (builder) and the technical consultants (in-house consultancy firm). The R&D, process development and standardised building systems divisions all belong to the construction organisation.

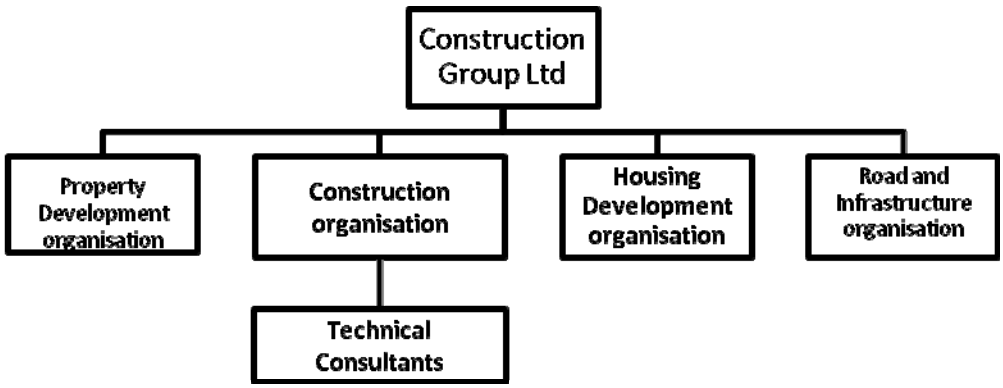

Figure 1: Structure of the Swedish organisation in the Construction group.

The construction group has recently refocused from considering time, cost and efficiency to include environmental considerations such as energy efficiency. To meet this new demand for knowledge on environmental performance, the construction group has introduced new support functions and in-house consultants on environmental issues and energy efficiency.

The construction group has previously worked with standardised building systems which have been managed by the standardised building systems division in the construction organisation aided by the technical consultants (henceforward, when appropriate, referred to as in-house consultants). Seen as a competitive advantage, theses standardised systems were developed to coordinate purchases and collect best practice in order to raise the efficiency and quality of the production of housing and infrastructure (Gerth, 2008). Sharing knowledge between projects was not the primary reason for introducing these standardised building systems.

Since parts of the development process of the standardised building system took place during the pilot project, other relevant professional groups, such as the architects were included in the study.

6. KNOWLEDGE SHARING IN THE DEVELOPMENT OF A STANDARDISED BUILDING SYSTEM

Focus in this section will be on how knowledge and knowledge sharing was viewed and took place within the project-based settings of the construction group. How individuals' actions influenced the development process, and what their contributions were towards the developed standardised building system for energy efficient multi-family housing.

6.1 Knowledge and skills

The term competence was frequently used by members of the construction group when describing an individual's knowledge, when they assessed whether someone was knowledgeable. Competence was considered to be dependent on the social environment, i.e. to be skilled in a particular context. Competence was described as knowledge obtained through practical experience.

In this context, when required by the projects, specialists' knowledge could be mediated by individuals employed within and/or outside the organisation. In this sense, specialists were seen as individuals with a certain type of knowledge that did not exist, but was acquired from outside the social setting of the project group. Curiosity was seen as a prerequisite in the construction group for retrieving knowledge. Resistance could be detected against seeking or incorporating the knowledge provided by specialists or a professional group that the receiver did not belong to nor had had a previous personal relationship with.

6.2 Knowledge sharing in project-based settings

Within the construction group it was seen as important to know whom to contact to resolve problems that may arise in projects. Therefore, continuous efforts were made to connect employees to create knowledge capital in the construction group, as the quote below describes.

> *The collective wisdom of the company is entirely dependent on how good we are at connecting people's knowledge. The knowledge of each individual is worth a lot, but we must ensure that we can build a network and a [knowledge] capital in the company.*
>
> Interviewee C3

To facilitate exchange of experience, formal horizontal networks were established in the organisation between different specialists and for the planning and staff functions. One

example of this was the environmental coordinator's network led by the environmental manager of the construction company, within which participants from the housing development and construction organisations and in-house consultants on environmental issues of the technical consultancy firm were members.

The large flow of information within the construction group caused the employees to only take in and process information that was provided exactly at the time they felt they needed it. Time constraints were seen to have a large impact on information processing and also seen as the main reason for not seeking knowledge, for example in databases, including documents, or by contacting subject specialists or support functions.

Barriers to sharing knowledge were associated with time constraints and the fact that personnel left the project in various phases of the construction process and did not follow the project to its completion. In addition leadership was found to influence knowledge sharing as it guided, allowed for, or hindered the time-consuming social process of knowledge sharing.

No incentives to sharing knowledge or bridging these barriers were in place within the construction group. Instead, sharing knowledge with peers could be seen as a disadvantage when unique, prestigious and complex projects, where for instance new technique was tested, were to be manned.

6.3 The pilot project for energy efficient housing

In the autumn of 2007, to meet market demand, the housing development organisation made the strategic decision to set up one energy-efficient housing project in each of its four geographic regions. The decision was a result of the lobbying by the environmental coordinator in the housing development organisation.

The environmental coordinator, also a member of the cross-organisational environmental coordinator's network, saw the change in market demands and decided to lobby from the inside of her own organisation in order to drive the strategic decision for energy efficient housing. To facilitate the strategic decision made by the management of the housing development organisation she had data collated by in-house specialists on energy efficient housing, who could calculate energy savings and monetary expenditures for the different geographic areas and climates. She also had a market survey made by an institute of public opinion investigating clients' interest in energy efficient products and what these would be willing to pay for this type of housing. The environmental coordinators efforts to get the strategic decision in place is illustrated in the quote below.

> *To make decisions about the levels for energy use in housing, I took the help of [in-house specialists] to investigate where do we stand today. What kinds of measures are necessary for us to take in order to upgrade our standards? So, with the groundwork from [the consultancy firm], [like] the cost estimates on what better windows cost, and that, [then] the management team was ready to take a decision like that, so to speak. But, it was I who pushed [it] through and presented the groundwork to the housing management team.*
>
> Interviewee H1

Her actions made the initiation of the pilot project possible. F*igure 2* shows the timeline of pilot project where activities and development of artefacts, such as drawings, descriptive documents and information leaflets can be seen.

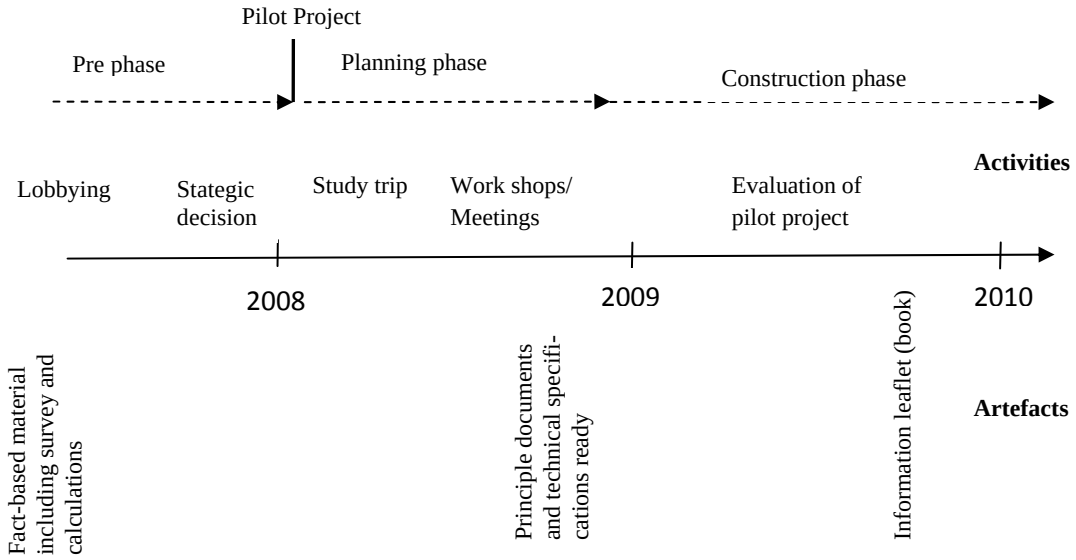

Figure 2. The timeline of the pilot project where activities and artefacts created are shown.

The pilot project itself was initiated by a manager of one of the geographical housing development divisions with the purpose to learn how to construct these types of buildings. He saw the potential of obtaining market advantages over competitors by learning more about constructing these types of housing. In his decision of creating a pilot project, the manager of the housing development division made two things: he appointed a project manager with previous experience in using standardised building systems and he contacted the environmental coordinator in order to get knowledge on how to design and build an energy efficient building. The contact with the environmental coordinator was taken by the manager as he thought it a part of her role to mediate knowledge to projects within the housing development organisation concerning these issues. Being contacted in expectation to help out in designing an energy efficient building, the environmental coordinator realised she had limited knowledge herself on how to design an energy efficient housing. She therefore put the manager of the housing development division in contact with the in-house consultant she previously used for putting together the lobbying material.

The architect was included in the planning group as he showed interest in the energy efficiency of buildings. Together the group planned and arranged a study trip to ongoing and completed energy efficient housing projects. The trip took place early in 2008 and was made in order to learn and create a common view within the planning group on how to plan and design energy efficient housing. The planning group had by this time grown to include an external planning manager from the same architectural firm as the architect with the responsibility to coordinate the consultants, two external consultants on installations and electricity, two in-house consultants on installations and structural engineering, and a contract manager from the construction organisation. The project manager of the planning group facilitated interaction between the different professional

groups. Her actions as project manager enhanced negotiation of meaning among planning-group members. How the members of the planning group viewed this process can be seen in the quote below from an information leaflet co-written by the architect, the environmental coordinator and the manager of the housing development division.

> *All parties in the formed [planning group] had just as much - or rather as little - experience of building energy efficient housing and together we explored what it would mean for the buildings we were designing to meet the criteria [of energy efficient housing]. The group was imprinted by a common understanding and curiosity [for energy efficiency of housing] and worked in the first phase under workshop-like forms to find the appropriate solutions for both the system selection as well as the design. [...] This gave the group a common frame of reference and objectives to strive towards.*

As the quote demonstrates, the planning group together took on the challenge of designing and constructing something that was new to them.

As the economic recession hit in the autumn of 2008 the project was delayed four months allowing the group time to reach a common understanding of energy efficient technology and its implications for the construction of these types of buildings during joint evaluations of solutions at meetings and workshops. The knowledge they gained during these meetings and workshops was used to draw up the principle documents and technical specifications for the project.

On moving into the construction phase, the project was handed over to the construction organisation and a hand-over to an internal planning manager was made. This procedure was in line with the construction group's policy for constructing buildings when using the housing development organisation as builder. In addition, the architect's services were no longer needed so he left the planning group, but kept in contact with the project and site managers through jointly arranging guided tours and seminars on site. On these occasions the project and site managers as well as the architect described how they devised technical solutions and designed for energy efficiency in order to comply with the official demands on energy efficiency of housing.

As the pilot project moved into the construction phase, the decision was made by the environmental manager of the construction organisation to classify the pilot project according to a Swedish environmental classification system. Although the decision was taken by the construction organisation, the environmental coordinator had raised the possibility of classification during the planning phase, as the subject of environmental classification had been discussed for some time in the environmental coordinators network.

The construction organisation needed the help of the environmental coordinator of the housing organisation to manage the classification process. As the quotes below illustrates, the environmental coordinator engaged the some of the members in the planning group in the classification process during workshops. Negotiation of how to classify the pilot project became a part of the discussions during these occasions. Moreover, the site manager of the pilot project chose to gather a group on site in order to handle the new demands regarding choice of material and technical solutions needed to meet the demands of the classification system. The planning group considered that

the dedication of one person, a true enthusiast, was necessary to drive development and innovation; the site manager considered that the power of individuals joining together in solving a problem to be more compelling.

> *But, it came up, we talked about it, during our workshops on environmental classification in [the pilot project], that a person is needed who pursues issues in projects, which will exhilarate and drive [things forward].*
>
> Interviewee H1

> *We were supposed to environmentally classify these houses and I had no idea how to do this, so I formed a small group [on site]. It's important to pick the right people. It is not easy. Sometimes I have to tell someone 'you have to, for it must have the right composition. That when you get a giant motor! We solved a lot of problems in this environmental group.*
>
> Interviewee C9

Even though the site manager emphasised the advantage of working in a group, he also highlighted the importance of appointing the right individuals to that group. During these on-site group meetings where the negotiations on how to interpret and accommodate the classification system were carried out, the site manager made frequent use of both the environmental coordinator's and the in-house consultant on energy efficiency's knowledge. The site manager's practical experience was an additional asset to the planning group in the discussions on, for example, the architect's design of fitted sun screens for the windows and the project manager on different technical, installation and structural solutions. The site manager became an asset to the in-house consultant leading the development project of the standardised building system as this project leader made frequent visits on site to discuss issues related to construction practice. These projects ran in parallel during the construction phase, which made it possible for the in-house specialist to document the structural and installation solutions used in the pilot project. Many of the solutions utilised in the pilot project ended up in the standardised building system as the quote below indicates.

> *[The standardised building system] is a copy of what we planned and constructed in [the pilot project] as there was no [standardised building system], or yes, it was under construction, but a lot of what is incorporated we planned and constructed in the [the pilot project].*
>
> Interviewee C8

As the concept of constructing energy-efficient housing was new to all the members of the pilot project, the initial lack of knowledge on how to construct such a building made its participants more open to collaboration. Working together in projects was a way of learning and developing individually as the quote below indicates.

> *The people who worked on this project continued on to new projects, talking about what they had done [in the previous project], [...]We*

are constantly trying to summarise projects after they are completed, what we had been good at, what we missed, what was less good, what customers told us, and we try to absorb it. It's hard, everything is very bounded to the person. All the people who worked in the projects learned from it. That's where the knowledge is.

Interviewee H2

As indicated above, when the pilot project was handed over to the construction organisation, the architect felt a need to write down experiences made in the pilot project in an information leaflet in form of a book. He contacted the environmental coordinator and the manager of the geographic housing development division proposing a joint writing of the book. The book was thus co-authored by the architect, the environmental coordinator and the manager of the housing division in order to share their experiences and lessons learned outside their respective organisations.

6.4 The development project of a standardised building system

Early in 2008, after the strategic decisions to realise one energy efficient housing project per geographical region had been taken, the housing development organisation initiated cooperation with the construction organisation through a cross-organisational interest group. As the construction organisation was predominantly interested in the technical aspects of construction and in making the production of housing as cost and time-efficient as possible, the initiative to cooperate on energy efficiency of housing resulted in a decision to develop a standardised building system for this type of buildings.

The environmental coordinator of the housing organisation was appointed project leader of a pre-phase of the development project by the cross-organisational interest group where information was collected on how to build energy efficient housing. At her disposal she had a work group consisting of seven in-house specialists who helped her calculate costs and identify risks of different technical solutions. The project group used workshops and meetings to coordinate its work, which resulted in drawings, calculations and risk assessments on how to build energy efficient housing. Even though not used later on in the development process, these documents included the knowledge of many individuals.

During the pre-phase, a study trip was made abroad by a selected group consisting of representatives from the housing and construction organisations, the technical consultancy firm and an architectural firm (not part of the actual development process). The purpose of the trip was to collect information on how to build energy efficient housing from countries where these types of buildings had been constructed for some time. The timeline for activities during the development project can be seen in *Figure 3*.

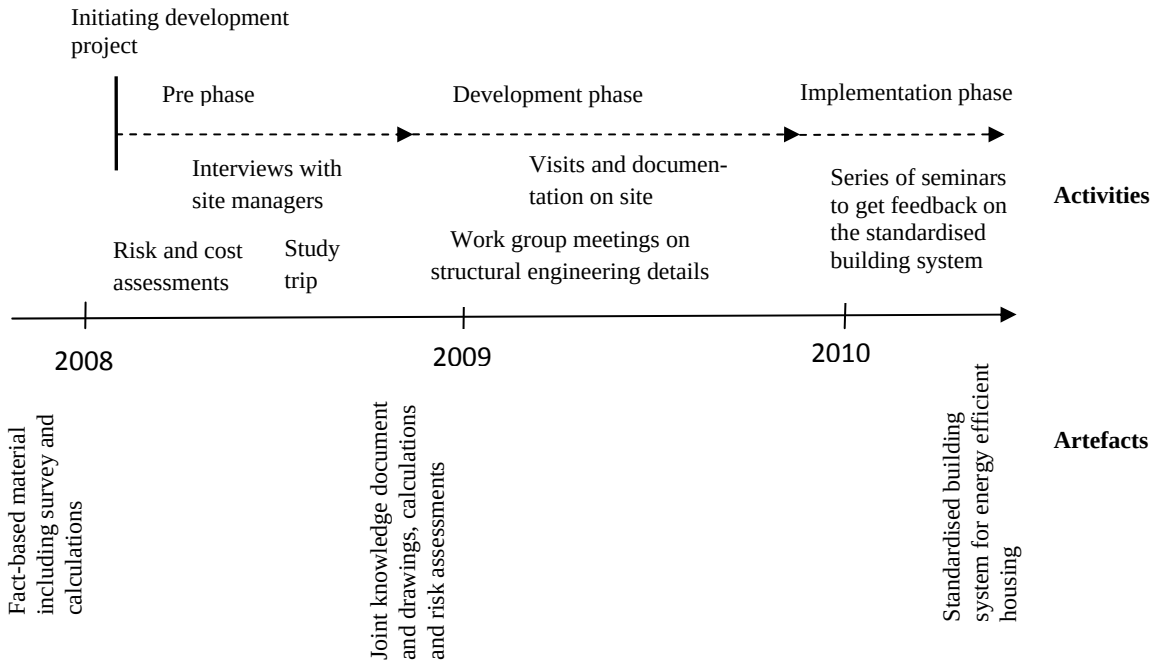

Figure 3. The timeline of the development project where activities and artefacts created are shown.

After the trip, a joint document, called a 'knowledge document' was compiled, where each professional grouping documented their impressions from the trip. The document enabled the group to create a common language around what they had experienced during the study trip. However, this document was not utilised later on in the development process, even though it contained valuable information on the participants' joint experiences. The process of putting it together was in itself perceived as a learning process by the participants in the study trip.

Parallel to the planning of the study trip, an in-house consultant on structural engineering and production efficiency in construction was hired by the construction organisation to perform interviews with site managers. These site managers had previously constructed energy-efficient housing for external clients. Their accounts were used when the development project moved into the next phase and the in-house consultant on structural engineering and production efficiency in construction was appointed as project leader for the development project.

Although the project leader of the development project had participated in the study trip and in compiling the joint 'knowledge document' as well as drawings, calculations and risk assessments, he chose to use an already existing standardised building system for housing when continuing the development process of the standardised building system. Based on this platform the in-house consultant decided to gather a team of in-house consultants on structural engineering. In his choice he left out the in-house consultants on installation as he considered the development process to be of a structural engineering nature. He thought these in-house consultants' contributions to be of less importance at this stage of the development process as is shown in the quote below.

[...] we tried to cover the areas we thought were of concern. Well, we were pressed [...], so, even if I found it a bit wrong, [...] we decided to work on what was new, as the installation part of the [standardised building system] had to undergo limited changes to what we normally build.

Interviewee TC3

The pressure the in-house consultant felt to deliver the project limited his abilities to administer a larger team of in-house specialists. He saw himself and his role as an information seeker, however, the information he sought under these circumstances was related to his interest in structural engineering and standardisation of building systems. As a result, the installation solutions in the standardised building system were instead discussed and developed in the planning group during the planning phase of the pilot project. These solutions ended up in the standardised building system due to the project leader's frequent visits on the construction site of the pilot project. Moreover, as the in-house consultant did not share the environmental coordinator's interest in environmental issues he found the classification system too comprehensive to be included in the documents and descriptions that constituted the standardised building system.

7. DISCUSSION AND CONCLUSIONS

The purpose of this paper has been to explore how individuals develop and create activities that facilitate social interaction and knowledge sharing across professional and organisational boundaries. By highlighting the role of the individual as a knowledge mediator in the development process of a standardised building system, this paper adds to the understanding of how knowledge may be shared across organisational and professional boundaries in project-based organisations

Sharing of knowledge has in this paper been found to be highly dependent on personal relationships, where trust in the source of information was of importance for its acceptance and internalisation. By applying Wenger's (1998) conceptual framework of communities of practice and Brown and Duguids' (1998) application of the framework onto organisations, each organisational entity, professional group, project and network discussed can been seen as a community when similarities and differences in strategic goals, focus areas driving work, symbols and language used to communicate are reflected.

What facilitated the development process of a standardised building system possible were the vision and actions of the environmental coordinator on how the housing organisation could accommodate the evolving housing market through environmental and energy-efficient housing. Taking on the role of a trusted translator between the network for environmental coordinators and the management of the housing organisation, as described by Brown and Duguid (1998), she enabled the pilot project. The trust needed to become a translator in this situation was created through the presentation of facts using vocabulary and symbols, such as statistics and calculations that the housing organisation was used to and could digest. Trust was also shown by the cross-organisational interest group by making her the project leader of the pre-phase of

the development project. And trust was displayed by the manager of a geographic housing division when he invited her to participate in the planning of the pilot project.

Similarly, the environmental coordinator guided the pilot project, not just on site, through the environmental classification of the energy-efficient housing by taking on the role of both translator and broker simultaneously at the interface of the different professional groups, i.e. the architect, the housing and construction organisations as well as the in-house and external consultants, as suggested Brown and Duguids' (1998). Also, she made her knowledge available to the personnel on site by accepting the site manager's invitation to participate in group discussions on environmental classification of housing which in itself is a sign of trust in her knowledge and abilities. But, what more than the use of vocabulary and symbols makes an individual a trusted translator or broker within and between communities? Would it be possible for any individual to mediate knowledge outside her/his area of interest and thus body of expertise?

In viewing knowledge as a competence and as being highly dependent on the social context and on personal relationships rather than as knowledge in its own right the construction group risked undervaluing or overlooking it. This was confirmed by the actions taken by individuals during the development process of the standardised building system. By comparing the actions and artefacts produced in the different projects (*Figures 2 and 3*) it becomes evident that social interaction lead to facilitation of knowledge sharing, here manifested in the documentation from the study trip and in the co-authored information leaflet, but also that sharing of knowledge within and between these project communities were dependent on individuals' actions.

The addition of time made available as a result of the recession and the actions of the project manager of the planning group enabled communication and interaction between individuals belonging to various organisational entities and professional groups where they freely negotiated meaning around a shared interest and task in workshops and meetings. Meanwhile, the feeling of operating under scares resources made the project leader in the development project take actions in a way Meyer (2010) refers to as creating boundaries which resulted in limited membership in that project group hampering knowledge sharing across professional groupings.

The limitation in membership in the development project group was found not only to be linked with the feeling of operating under scares resources, but also to the project leaders focus of interest in structural engineering and production efficiency. However, as argued by Dubé *et al* (2006), admitting only those who match a certain profile allows for more control of the group and thus facilitates its management which is convenient during resource constraints. More, the feeling of scares resources may well have affected the sharing of knowledge between the two projects. Here, knowledge was mediated through the interactions between the project leader of the development project and the site manager of the pilot project with whom the project leader shared the interest in structural engineering and production efficiency. The trust to share knowledge was seemingly gained through these individuals' shared interest and vocabulary. However, as little other social interaction took place between the two development projects, the project manager's knowledge of standardisation of the building process was not sought and incorporated into the standardised building system.

The actions taken by individuals having the formal roles of subject experts, support functions and project managers facilitated social interaction and knowledge sharing

across professional and organisational boundaries and can be seen as knowledge management mechanisms as discussed by Bresnen *et al* (2003; 2005). In the study presented in this paper, these individuals were offered the possibility to act as brokers and translators if personal contacts, skills and allocation of resources, such as time, were made available. But, can any member of an organisation take on the role of a broker or translator and become a knowledge management mechanism? And can organisations in this case support and facilitate such actions taken by individuals?

The research approach taken when performing this study has allowed the author to explore how knowledge sharing between professional groups and organisations can be facilitated and stimulated. However, it has been beyond the scope of this study to examine how the developed standardised building system was received and put into practice in other projects, i.e. how these individuals' explicit knowledge was mediated through the use of the standardised building system as previously studied by for instance Styhre and Gluch (2010). It is the conclusion of this paper that further research is needed into the sharing and mediating of knowledge across organisational and professional groups in project-based settings. For instance, what actions and personal traits make an individual trusted as a translator or mediator of knowledge?

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