Diffusion of Information and Communication Technology: A Community of Practice Perspective

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ABSTRACT:

This chapter explains the community of practice (COP) concept from the perspective of three major Australian construction contractors. It also describes and provides an analysis of their COPs from the perspective of the individual, work group and organisation. We provide maps of these COPs for each of the three contractors studied. The intention of using this approach is to offer readers insights into how these COPs can be developed and supported.

The study we base this chapter upon focussed on groupware as an ICT initiative being rolled out using COPs as an integral part of the innovation diffusion strategy. Case study findings relating to these COPs reveal that they are not only supported by ICT but also that ICT itself supports these COPs in a self referential and synergistic way. The important contribution that this chapter makes to our understanding of the studied phenomenon was not only the ‘what’ or descriptive nature of these COPs but also insights that help us understand the ‘how’ of the process, so that lessons learned may be absorbed and diffused more widely in the construction industry.

Key words: Knowledge Management, Communities of Practice, Innovation diffusion.

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INTRODUCTION:

Construction organisations comprise geographically dispersed virtually-linked sub-organisations that work together to realise projects. They increasingly do so using information and communication technology (ICT) to communicate, coordinate their activities and to solve complex problems. One salient problem they face is how to effectively use requisite ICT tools. Communities of practice (COPs) generate knowledge networks that enhance and sustain competitive advantage and they are also used to help COP members actually use ICT tools. Etienne Wenger defines communities of practice as “groups of people informally bound together by shared expertise and passion for a joint enterprise” (Wenger and Snyder 2000, p139). This ‘chicken-or-egg’ issue about needing a COP to use the tools that are needed to effective broaden COPs (beyond co-located these groups) led us to explore how best to improve the process of ICT diffusion through construction organisations—primarily using people supported by technology that improves knowledge sharing.

We present insights gained from recent PhD research results in this area. A semi-structured interview approach was used to collect data from ICT strategists and users in the three large Australian construction organisations that are among the 10 or so first tier companies by annual dollar turnover in Australia. The interviewees were categorised into five organisational levels: IT strategist, implementer, project or engineering manager, site engineer and foreman. The focus of the study was on the organisation and the way that it implements ICT diffusion of a groupware ICT diffusion initiative.

From the three Australian cases, several types of COP networks emerge: within-organisation COP; institutional, implementer or technical support; project manager/engineer focussed; and collegial support. Also, there are cross-organisational COPs that organically emerge as a result of people sharing an interest or experience in something significant. Firstly, an institutional network is defined as a strategic group, interested in development of technology innovation within an organisation. This COP principally links business process domain experts with an ICT strategist.

We have structured this chapter as follows. First we provide some background to ICT diffusion in general and how COPs can use groupware ICT applications. We follow this with a discussion of theory underpinning the research project reported upon in this chapter and we explain the differences between teams and COPs. We then report research findings from three case studies and present our analysis. We conclude the chapter and close it with some helpful tips and hints for readers wishing to make practical use of our findings.

LEARNING OBJECTIVES:

- Readers should gain a sound understand of how ICT is diffused through construction organisations using a human infrastructure supported by ICT—specifically from the way that COPs influence how their members actually diffuse ICT.
- While we cannot generalise from our research findings, presentation of our findings resulted in comments that the concepts presented may be more generally applicable to any emerging technology introduced to a business...
entity. Thus, an additional learning objective is to trigger in readers a measure
of reflection of how our findings and arguments may be applied more broadly.

BACKGROUND

Innovation and its effective diffusion and deployment is an essential competitive
driver in the construction industry (Slaughter 1998, 2000). It provides the capacity for
delivering two process improvement or product development benefits. Process
innovation is focused on the ‘how to’ capacity that leads to an improvement or change
in traditional work processes by introducing smarter or more effective ways to do
things—this in turn can lead to construction management process productivity
improvements. Product innovation is focussed upon developing new products in
response to market forces (Meyers et al. 1999).

ICT innovation is a major potential innovation improvement that can deliver real
benefits to the construction industry and its participants (Duyshart et al. 2003). Much
of the paper-based information exchange process that takes place during the
construction phase that underpins decision making involves duplication, continual
translation and transcription from one medium or form to another, as well as loss of
information (Duyshart 1997). ICT has not only been used to decrease integration
problems but also can be used as an effective way for experts to share knowledge and
jointly solve problems. For example, the BP virtual office facilitated complex
problems to be solved using the expertise of a global network of virtually linked
experts (Prokesch 1997). A case study of a knowledge-intensive firm of people
familiar with e-mail has been shown to be more effective as a tool for low-level
knowledge than expected (Robertson et al. 2001). Thus collaborative enabling ICT is
a relevant and important tool for improving productivity and so effective ICT
diffusion becomes even more important in this context. A paradox that has been
emerging is that groupware and ICT applications that effectively connect
geographically dispersed people are self-referential. Benefits from the very
technology that is used to allow people to collaborate are best achieved by effective
ICT diffusion, yet these very applications require an effective ICT diffusion process.

Our discussion in this chapter focuses upon the roles of COPs that support the
diffusion of innovation within three construction organisations. The literature argues
that the COP concept has an essential role in knowledge-sharing and in turn can
develop a more knowledge-productive culture of learning in construction management

THEORY UNDERPINNING THE RESEARCH PROJECT

Much has been written on the need for firms to develop core competencies (Prahalad
and Hamel 1990) that provide sustainable competitive advantage either from cost or
product/service differentiation (Porter 1990). ICT innovation can be argued to support
both a cost competitive advantage (through management efficiency reducing wasted
management and administrative energy) as well as providing sophisticated clients
with service level improvements that deliver a distinctive and differentiated
qualitative competitive advantage. Many firms develop their own competitive
advantage through initiating innovation. This can be achieved and may be optimised
by effective ICT diffusion occurring at both the individual and organisational levels.
At the organisational level, diffusion of innovation depends on how well organisations can absorb external sources of innovation as well as develop their internal capacity through trial and error experimentation and piloting, research and development and supporting learning systems (Cohen and Levinthal 1990). Absorptive capacity is one of the essential factors that sustain innovation and its diffusion through building up an experience and knowledge base that can be drawn upon when needed to develop or diffuse innovation. This infrastructure capacity helps provide not only the technical and knowledge enablers of innovation and its diffusion, but also can be used to help to build an organic organisation, often unofficial, that utilises external and internal sources of knowledge to enhance the internal innovative process or product. Due to the individual features of an organisation’s business processes, the adoption of external innovation needs to be modified to suit its specific business objective.

At the individual level, innovation diffusion depends upon information or knowledge gatekeepers who help transfer innovative knowledge from external and internal sources to the internal unit of organisation. These gatekeepers interpret or transform knowledge into simple language to fit the environmental context of known target groups (Rogers 1995). Diffusion could not be achieved if individuals within an organisational unit do not accept the innovation and convince others to use it.

At the group level, people naturally tend to form knowledge networks to share and re-frame knowledge that they routinely or occasionally use. History provides many such examples of learning communities. Trades and guilds of Europe are one medieval example with more recent cases of COPs being documented in many organisations. One example from the Daimler Chrysler Corporation reports groups of people being clustered around a particular skill to form ‘tech clubs’ (Wenger et al. 2002). The power of people forming small groups to learn from each other has triggered a great deal of interest and led to the concept of communities of practice (COP). Lave and Wenger (1991) first introduced this term when studying forms of apprenticeship and social groups and studied how these communities shared not only knowledge but also the culture of access to knowledge and its use to diffuse complex tacit knowledge. A COP, shares knowledge and skills and sustains its members through obligation to exchange knowledge, providing access and accessibility to shared insights and knowledge about the practice of work (Wenger et al. 2002, p4).

An ICT diffusion study of 117 people from three large Australian construction organisations reveals 11 broad factors affecting ICT diffusion. These 11 factors were grouped into four clusters of influencing characteristics: management, individual, technology, and environment. ICT diffusion is impacted by management, individual and technology characteristics that affect each other. All these are nurtured or inhibited by organisational culture environmental characteristics (Peansupap et al. 2003b). One of the more interesting findings from this ICT innovation diffusion study was that people-support, in terms of COPs, was an evident element of the four clusters of characteristics. Thus human capital infrastructure appeared to provide a pivotal role supporting ICT innovation diffusion. Therefore, a fruitful way forward in developing improved ICT diffusion is to map, facilitate, build and support the development and maintenance of an effective mechanism for people to form groups that help each other by sharing knowledge (particularly about how to best use ICT applications that support knowledge management).
People helping each other by sharing knowledge can occur within the context of 1-2-1 relationships as either isolated or continued instances and indeed this is a normal feature of working on joint problem solving activities. More often people are working in groups so that there is a many-2-many, 1-2-many or many-2-1 communication patterns. Groups can become teams but they are distinguishable. A team is defined as “a small number of people with complementary skills who are committed to a common purpose, performance goals, and approach for which they hold themselves mutually accountable” (Katzenbach and Smith 1993, p45). However, as they argue (1993, p89), “a working group uses its purpose solely to delineate individual roles, tasks, and responsibilities. Those roles typically match formal organisational positions. To get their assigned tasks done, working group members, especially at senior levels, usually delegate the real work to others beyond the group.” Groups exchange information, knowledge perspectives and insights as well as act as a point of further reference, however, there is unlikely to be the depth of focus that is evident in teams working toward realising a particular project.

Table 1 - Differences Between Teams and COPs (adapted from Wenger et.al (2002, p42 and Bourne (2003, p14)

<table>
<thead>
<tr>
<th></th>
<th>Teams</th>
<th>COPs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nature of formation</td>
<td>Selected through resourcing processes</td>
<td>Generally formed through voluntary and informal processes</td>
</tr>
<tr>
<td>Term</td>
<td>Temporary and finite: until the project is complete</td>
<td>It depends: the COP will remain as long as its members consider its has a purpose</td>
</tr>
<tr>
<td>Duration</td>
<td>Set up a specific time period for team joining Team member will be desegregated after finish the project.</td>
<td>Don’t specific time The member COPs will be finished if the members feel that it is not their interest.</td>
</tr>
<tr>
<td>Structure</td>
<td>Each team member will have a specific role and ‘place’ in the team</td>
<td>Peers with a common purpose.</td>
</tr>
<tr>
<td>Purpose</td>
<td>Deliver the ‘result’ (building, system, change) Organisation determines a specific goal and time framework to achieve a goal.</td>
<td>Sharing of knowledge Members determine group interest and share their knowledge in natural manner.</td>
</tr>
<tr>
<td>Operating principle</td>
<td>Command and control</td>
<td>Collaboration and commitment</td>
</tr>
<tr>
<td>“Legitimation” (power+authority relations)</td>
<td>Formal hierarchy /leadership</td>
<td>Informal and dynamic/ fluctuating membership Status in COPs must be earned</td>
</tr>
<tr>
<td>Essential success ingredients</td>
<td>Trust, shared ‘vision’ and purpose Commitment</td>
<td>Trust, shared ‘vision’ and purpose. Commitment</td>
</tr>
<tr>
<td>Type of knowledge</td>
<td>Explicit knowledge and information (documentation, processes, report)</td>
<td>Tacit knowledge (stories practical experience, lessen- learn, tips)</td>
</tr>
<tr>
<td>Communication mode</td>
<td>Formal (formal meeting)</td>
<td>Informal (social activity and peer group, conference) Ad hoc and informal meeting</td>
</tr>
</tbody>
</table>

The distinction between teams and COP is palpable and relevant because there is often a different purpose for the two though our research indicated that there can be a designed development of integrating COPs and teams in helping realise team goals and objectives. As Wenger et al (2002) have demonstrated, companies that creatively engage with COPs realise a significant set of knowledge assets and competencies that would otherwise be unobtainable.
Table 1 assists us to understand the differences between teams and COPs. It has been developed from ideas offered by (Wenger et al. 2002, p42) and Bourne (2003, p14). It highlights the difficulty in assuming that teams naturally are COPs or that they can naturally become a COP where sharing knowledge becomes the cultural foundation that distinguishes them from other forms of associations of people solving complex problems. The informality and self-referential nature of COPs versus teams is an important distinguisher as is the term of the association and duration of their activities. Motivation also differs between these groups as does operating principals, legitimacy and ingredients of success. The type of knowledge exchanged is generally different and the communication mode also different between teams and COPs.

This begs the question how can organisations harness the power of COPs in engaging with teams to solve complex problems? Part of the answer lies in the levels of formality as indicated by the study results cites earlier of ICT innovation diffusion by Peansupap et al (2003b). These stressed the importance of cultural factors and a management style that facilitates learning and professional development as well as actively supports interaction, questioning the status quo in order that a full repertoire of potential problem solutions can be explored and examined in an atmosphere of open and honest discussion. This can be further explained with reference to Figure 1.

![Figure 1- Formal/Informal Organisation Structure for Teams and COPs](image)

This idea may help to explain the relationship between team and COP differences by level of formal and informal structure/style of management of organisations. The two groups (teams and COPs) in a formal organisation may be more separated than those in informal organisations. If an organisation can inject a combination of informality as well as its formal team governance arrangements then it has an opportunity to integrate the potential knowledge assets of COPs with that of any given team. The formal-informal requirement also has another interesting dimension—trust. In one sense formal team governance can engender trust because it establishes a set of rules that everyone knows should be adhered to and so there is an element of predictability and near-certainly about the way that activities take place. Also Wenger et al (2002, p51) argue that a set of guiding principles needs to be addressed when developing or nurturing COPs and they promote 7 principles for cultivating COPs that is akin to a formal team working on a project. Their principles do appear to engender trust from rules and principles that apply namely:

1. Designing the community of practice for evolution;
2. Having an open dialogue between inside and outside perspectives;
3. Inviting different levels and intensity of participation;
4. Developing both public and private community spaces;
5. Having a focus on value; combining familiarity and excitement; and
6. Creating a rhythm for the community—where activities fall into a natural flow that supports relationship building and knowledge exchange and where people’s contribution ebbs and flows. People enter various levels of a COP, from core participants who actively participate and share knowledge through to ‘lurkers’ whose contribution ebbs and flows with their engagement.

An interesting case study of a project spawning a community of practice is the Xerox Transition Alliance reported by John Storck and Patricia Hill (2000). This was an example of a strategic community of practice of 50 IT specialists responsible for maintaining 70,000 workstations and 1,200 servers in which Xerox top management deliberately established the Alliance to serve as a vehicle for diffusing new ICT. The interesting aspect of this case that is relevant to our discussion in this chapter is that this community of practice was designed and developed for ICT diffusion and that it was judged a success that endured as a more recognisable community of practice after the project aim of ICT diffusion was achieved. It was facilitated and formally enacted and recognised many of the informal imperatives that characterise COPs, however, it has been termed as a STRATEGIC COP. Six principles were highlighted:

1. Design an interaction format that promotes openness and allows for serendipity;
2. Build upon a common organisational culture;
3. Demonstrate the existence of mutual interests after initial success at resolving issues and achieving corporate goals;
4. Leverage those aspects of the organisational culture that respect the value of collective learning;
5. Embed knowledge-sharing practices into the work processes of the group; and
6. Establish an environment in which knowledge sharing is based upon processes and cultural norms defined by the community rather than on other parts of the organisation (Storck and Hill 2000, p73-74).

The implications of the theory proposed by (Wenger et al. 2002) and (Storck and Hill 2000) for the construction industry is that a COP approach to encouraging ICT diffusion in particular, and knowledge sharing in general, is both valid and to be encouraged.

AUSTRALIAN CASE STUDIES—METHODOLOGY

A semi-structured interview approach was used to collect qualitative data from ICT strategists and professional users in the three large Australian constructors at several organisational levels using a case study approach (Yin 1994). Key contact people within the IT department who understood the research aims nominated interviewees who were asked to identify ICT users already using ICT in their work so that a better understanding of how these organisations approached ICT diffusion can be found. Thus the sample is not a random sample but a purposeful one drawn from ICT professional users, in major construction companies that principally operate in Australia but also do so as global construction contractors.
The focus of the study was on the organisation and the way that it implements ICT diffusion of a groupware ICT diffusion initiative. The research question is directed at understanding how and why observed behaviours took place in diffusing an ICT groupware initiative. It concentrated upon the ‘latest wave’ of ICT innovation facing major construction contractors and the aim was to gain a better insight into how several of the major global players in this industry sector approached ICT innovation. It was anticipated that the study would allow, through comparing and contrasting the organisations applied to ICT diffusion, identification of better business practices and deeper mechanisms underpinning these so that they can be unearthed and better understood. Lessons learned may be offered for general acceptance or adaptation, results are not intended to be seen as a general factual status (audit) either within the organisations concerned or as being representative of all the top tier contractors under study. The sample used was too small to generalise from, but the study does enable findings to be used to shed light on ICT diffusion best business practice elsewhere.

AUSTRALIAN CASE STUDIES—RESEARCH FINDINGS

Interviewees presented in Table 2, can be grouped into five levels: IT strategists (senior level management champion and initiative driver) implementers (given the task of encouraging diffusion of the ICT groupware initiative), project managers (responsible for construction teams on projects using this technology), site engineers, and site foremen (both direct users of the technology in coordinating the physical and administrative work being undertaken on-site). The reason for this approach is to gain understanding the factors influencing ICT diffusion from multiple perspectives.

<table>
<thead>
<tr>
<th>Interviewee</th>
<th>Case study</th>
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<tr>
<td></td>
<td>CSA</td>
</tr>
<tr>
<td>IT strategist</td>
<td>1</td>
</tr>
<tr>
<td>Implementer (L1)</td>
<td>1</td>
</tr>
<tr>
<td>Project/Engineering manager (L2)</td>
<td>4</td>
</tr>
<tr>
<td>Site engineer (L3)</td>
<td>1</td>
</tr>
<tr>
<td>Foreman (L4)</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>8</strong></td>
</tr>
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</table>

Case Study A (CSA)

CSA is a large construction contractor with well over AUD$ 1 billion in annual global turnover. The chief executive officer of CSA established an IT quality assurance strategy vision in 1996. He envisioned IT assisting integration of construction information within CSA. From this vision, the group of regional managers and quality assurance managers had meetings to discuss and explore ICT that could be used for effective communication and coordination between project members within CSA. During the development period, IT staff in CSA worked closely with managers, key end users and champions who have relevant construction work processes experience.

The development of the ICT application was based on a software package that provides the basic communication functions for general business needs. Traditionally, most construction information transfer relies on paper-based systems so the software...
package required design and customisation of user-interfaces to suit the traditional construction approach. The ICT application had been customised to be compatible with organisational forms and work processes and this encouraged users to familiarise themselves with entering information using ICT instead of paper. The modules of ICT used by CSA consisted of main processes such as tendering, project communication, and construction database applications. This study focused on project communication.

Figure 2 illustrates five examples of COP that facilitated the ICT diffusion (Peansupap et al. 2003a). One of the senior engineers had a role in validating the ICT initiative and informally created the development of COP(1) with staff from the firm’s IT department. When he experienced problems with using ICT applications from a practical and/or technical perspective, he would resolve them with the IT people.

Figure 2: Case study A’s communities of practice
One office project manager helped establish COP(2) by providing time in the morning to talk and exchange ICT knowledge with his colleagues. He spent his morning time providing specific training and discussion about ICT problems with his subordinates and encouraged their feedback and participation. COP(2) assisted the diffusion of ICT through this team because it shared problems and new ideas on how to apply ICT to assist traditional work processes. In addition, COP(2) facilitated additional feedback to be channelled between users and ICT tool developers. COP(3) is a different group of individuals that often communally solved ad hoc problems through the gatekeeper, usually by phone, and if they could not through IT people. COP(4) also solved ad hoc problems, but on a one-to-one basis through the gatekeeper linked to IT people. COP(5) used an email discussion group to facilitate ICT use, to communicate with each other to get help. COP(5) helped users who had problems with relation to the ICT use. Members post their questions and the IT staff for other COPs to respond to. Users shared their experiences and problems and also suggested solutions. This reduced repeated questions on the use of ICT and reduces IT staff workload in repeatedly responding to the same problems.
Case Study B (CSB)
CSB is one of the largest construction companies in Australian. The company consisted of many core business units including design, construction and project management. In 1997, the managers from the construction e-business unit set up the IT strategy based on a perceived benefit of gaining competitive advantage from Internet technology use. The company evaluated many available groupware integration applications, however, there was no suitable ICT application available at that time that suited the company’s needs. Therefore, CSB decided to design and develop its own ICT groupware interface tool linked to standard email, web, etc.

The development of ICT was initiated by a CSB group that consisted of experts from many construction fields such as architecture and design, project management, and construction. These experts worked together with developers from an IT consultant company that has the key responsibility in programming the ICT, whereas experts provided the knowledge of technical aspects of construction processes. Additionally, the group was strongly supported by an ICT project-initiating sponsor.

Although the objective of the ICT application was to improve communicate and coordinate of construction project information, participants provided mixed opinions about ICT usefulness. The reason for this is that the ICT was designed to facilitate managing construction projects. Therefore, it may not be perceived as useful for design managers who were not involved with construction activities. In addition it was rarely used by all project parties thus inevitable duplication of both electronic and manual document transfer effort occurred.

![Diagram of Communities of Practice](image)

**Figure 3: Case study B’s communities of practice**

Figure 3 illustrates two examples of COP that facilitated the ICT diffusion (Peansupap et al. 2003a). At the organisational level, ICT use depended upon the implementer who had most technical knowledge. The implementer was at the centre of and developed COP(1) associated with use of the all-embracing ICT web application. He transferred his knowledge to users and also received feedback from COP(1) and used email and phone extensively to communicate and help solve problems of ICT users. Thus, a virtual COP to improve effective ICT use was created. In general, CSB
presented a strong culture of helping each other (not limited to IT issues but also people can ask help from many experts in CSB). At the project level, ICT discussion and help by COP(2) started with colleagues who worked on the same construction project. Most participants confirmed that they sometimes share and exchange knowledge of ICT use. However, they had time and ICT knowledge limitations. Technical ICT assistance was mainly received from implementers. In addition, construction foremen have more responsibility for construction technique aspects, while site engineers, project administrators, and project managers handled most administrative tasks. COP(2) indicates the frequent situation where very small groups that helped each other formed and disbanded mainly for ICT issues to be solved at a low functionality level, because they tended to get help from the ICT implementer when trying to use the ICT application at higher functionality levels.

**Case Study C (CSC)**

CSC is a highly innovative Australian construction contractor. The company has an annual global workload of over 1 billion AUS$. Their projects include building and civil engineering infrastructure. This company received several awards relating to construction innovation and have a sound absorptive capacity. The company has strong policy support for improvement of construction productivity and safety. At the time of this study, their commitment to using ICT was project-by-project based. They briefed project participants to provide them with an understanding of benefits of using ICT. After obtaining commitment for ICT use from CSC project managers and other main project participants (such as client, design consultants), the implementer would provide training for project participants and expected CSC users.

An external project web service developed the ICT application. The implementer also had a role in facilitating customisation of the ICT application to suit the company’s work processes and provided strong support for diffusion of ICT within CSC and other project participants. The strength of COP(1) in Figure 4 (Peansupap et al. 2003a) is mainly dependent upon the implementer who had the knowledge and background of both the construction and computer context. He started his own communities by providing training on how to use the application for his teams and main project participants.
In addition to COP(1), the implementer, interacts in COP(2) a COP of colleagues. Several COP(2) existed for collegial help and they have a positive influence on novice engineers who did not receive any training sessions to develop skills and be able to use the ICT application. A COP(2) member mentioned that his senior engineer helped him use the ICT application. The project manager also encouraged and helped his subordinates by providing advice on ICT use. Although he has limited knowledge, he tried to resolve problems regarding its use through the implementer.

COP(3) is the organisation-wide network for each business group. CSC started the technology centre with its key functions being to promote and expand a range of ICT technological innovations into business units (BUs). The centre aimed to improve work performance, safety, and quality in construction work processes. It consisted of people who were ‘the experts’ from different BUs across the organisation. They dedicated time to meet every 3-4 months. The technology centre provided support and advice to BUs on adopting ICT innovation initiated and was supported by all BUs.

AUSTRALIAN CASE STUDIES—DISCUSSION

In all three cases it was clear that IT groups held a significant and pivotal position in the ICT diffusion process through a combination of help-desk, 1-2-1, and 1-2-many communication channels. The use of groupware for email and Intranet access for resolving diffusion issues was also substantial in all three cases. Rich communication channels were also used—the COP provided reflection and feedback, facilitating interrogation and ideas clarification/testing. From the three cases, several types of COP networks emerge: institutional, implementer or technical support; project manager/engineer focussed; and collegial support. Each has its individual focus, resources and behaviour/attitude implications.

It is important to realise that the literature on COPs stresses that COPs are already ‘out there’, they exist as social networks of friends with shared interests and experiences that want and need to communicate. COPs can often evolve in an ad hoc manner from an association of ‘mates’—past co-workers who have gained a bond of trust and commitment through joint effort of working on projects or specific tasks together. They can also develop from membership of a special interest group such as a professional association where members may well have never worked together before but share a passion and commitment to sharing and re-conceptualising knowledge about specific issues. Thus there is a relationship within organisations as highlighted in the case study reported upon above (Peansupap et al. 2003a) and between organisations. The study was restricted to within-organisation COPs and so this will be discussed first before moving on to discuss COPs across organisations.

Institutional Network

An institutional network is defined as a strategic group, interested in development of technology innovation within an organisation. Development of ICT required staff that had construction processes experience in all three cases—the aim is for business process needs to drive ICT development so customisation, testing and piloting, feedback and fine-tuning is required to be delivered by construction management experts and ICT experts. This COP principally links business process domain experts...
with an ICT strategist. Resources required include high-level domain expert input and substantial face-to-face time with reflective management behaviour.

Introduction of CSA’s ICT was developed from a meeting of regional managers responsible for quality assurance responsible IT experts and for health and safety and the environment. This group dedicated time for testing ICT and designing simple user-interfaces. This type of COP was a temporary one, formed until the objectives of ICT development had been defined and rolled out. After the development of the ICT initiative, the IT department took over responsibility for implementation. Similar to CSA, ICT in CSB was developed by senior managers with expertise in construction from the e-business group and IT consultants who identified relevant ICT opportunities. This group has been formed to design and develop the ICT tool for developing and managing construction projects. Therefore, the initiative group of CSA and CSB may be classified as a task-oriented team (Storck and Hill 2000).

CSC initiated a technology centre to promote and explore technological innovation relevant to its business units (BUs). Groups of people with backgrounds from various BUs across the organisation dedicated time to formally explore and discuss the opportunities of using the technological innovation in construction processes. Thus the initiative group of CSC may be classified as a strategic community alliance (Storck and Hill 2000).

Implementer or Technical Support Network
CSB and CSC had a key champion with sufficient drive and enthusiasm to be the ICT initiative implementer who envisioned the ICT strategy. A COP would then be built or emerge, nurturing the ICT implementer whose role is to transfer ICT knowledge within project teams to expected users. The implementer plays a significant role in training and being a mentor to users who have a background of construction processes sufficient to understand any potential problems and/or implications of using ICT in construction processes. This person would also be involved with the software company who provided the ICT service and would participate in the development of the ICT initiative. CSA was dependent on the ICT team for training and development. Typically implementers reside at the hub of the COP, they are the organisation’s experts and main resource in making sense of the ICT and its development. They require resources to sustain the COP that links and permits ICT initiative knowledge to be cross-levelled and diffused widely across the organisation, as suggested by (Nonaka and Takeuchi 1995). Their behaviour is supportive, inclusive and that of an enthusiastic knowledge activist (von Krough et al. 2000).

Project Manager/Engineer and Collegial Support Network
It became clear from the interviews that project managers play the significant role in ICT diffusion by developing their own community of practice. One of the office managers in CSA mentioned that his team uses part of the morning time to discuss how to best use ICT. He found it very helpful for new engineers who received ICT training but may take time to understand how to apply it in their work. He also attempted to support resources for delivery and feedback from end-users to IT staff to improve the application to meet end-user needs.

Furthermore, the collegial network being considered as the first source of help to users (who have limited ICT knowledge) is consistent with a study of 2000 aerospace
engineers who found that well-informed technological gatekeepers with an intimate knowledge of the technical tasks being undertaken were the preferred first choice for finding salient information or knowledge (Anderson et al. 2001, p151). Personal communication with a peer who knows the context of the problem provides a rich and clearer communication channel for assistance. It often allows users to observe and learn from real examples by real or virtual demonstration (Wenger et al. 2002). It is easier and quicker to get help from colleagues relating to ICT use.

The existence of the within workgroup COPs such as CSA COP(2, 3, 4) and CSC COP(2) link colleagues together as well as providing gatekeepers to the ICT support COP members. In CSA COP(4) the pattern was individuals interacting on a one-to-one basis with the gatekeeper through to the ICT support group. In this kind of COP from a collegial perspective there is a dyad relationship in which the gatekeeper supports the user and learns, filters and consolidates typical difficulties colleagues experience with ICT application. This is then fed back to the ICT developers and the gatekeeper becomes a valuable focal point in that COP. However, the value of colleague interaction is minimised, compared to the more connected CSA COP(2 or 3) in which there is more cross group interaction. A more isolating COP model is evident in CSB COP(1) where most of the help is gained from a dyad relationship between the ICT implementer and people in that COP. In this example it is necessary for temporary or small scale COP to emerge as illustrated in COP(2) but often their skill level for answering urgent questions is limited.

The resource implications for maintaining collegial support is a need for committed gatekeepers who are provided with the means and motivation to support the COP. Additionally, any COP that is linked via groupware needs that ICT application to be effectively diffused for it to be of any use. There needs to be an attitude and behaviour consistent with openness, knowledge-sharing and also motivation and rewards for participation, even if these rewards are intrinsic (Nahapiet and Ghoshal 1998).

Relationships of COP Within an Organisation
The three case studies show that COPs can help construction firms diffuse ICT knowledge by COP members sharing experiences and insights and helping each other to solve problems related to their ICT use. This discussion underlines the concept of a COP by focusing on relationships between the identified within-firm COPs. These relationships play a significant role in linking several communities together. From our case studies, the institution of COPs has the complementary role of sharing the message of potential and realised ICT benefits through construction business managers. For example, one senior construction manager may need to find a solution to improve their work business processes. Members who have an experience on ICT capability may suggest a solution to the manager. At this stage, the solution may be a preliminary concept to improve the business process. Within institutional COPs, this intra-relationship can help members be aware of the availability of current ICT tools or to develop interest in the use of an ICT application. Facilitators of an institutional community of practice (who provide leadership and support) should comprise key representatives, such as top management, to reinforce ICT diffusion throughout the organisation. Such people provide policy drivers. Perhaps a senior quality manager who is involved in improving construction processes could be appropriate, likewise senior project managers who have practical experience in the field or perhaps senior IT managers who have a strong background of IT knowledge contribution. These
representatives may have significant roles in connecting and linking COPs and facilitate knowledge sharing between COPs.

Figure 5: Three types of COP within an Organisation

Figure 5 illustrates that the first relationship in attempting to integrate or link COP within an organisation is the connection between the institutional COP and any COP facilitated by the ICT implementer or IT support groups. A senior IT manager can play an important role in linking these two COPs. If the senior IT manager is a member of these two groups then he/she can work with IT members to seek more technical information on how to best apply ICT applications to improve construction work processes. Groups of implementers or IT support personnel may share their technical experience with senior IT managers and this in turn provides feedback to COP members within the institutional COP. On the other hand, the decision adoption of ICT application to support the business need may depend on several business constraints in which groups of implementers or IT support staff may not have sufficient experience. Therefore, the relationship between these two groups may help IT people to understand business operation realities, which in turn provides a suitable ICT application for business needs to address the issue of improving such processes through the use of ICT supporting infrastructure. Meanwhile, people in business units can improve and updated their understanding of ICT application knowledge.

The second relationship is a connection between the institutional COP for any project manager or a collegial COP that may be based around workplaces. It could be suggested that a senior quality manager or senior construction manager can play an essential role in linking these two COP. Experienced construction managers may help share their experience of how to encourage colleagues to use ICT applications. The experience may be useful to business managers in adapting strategic management plans or to improve ICT implementation strategy. Some experience may be useful in highlighting best practice knowledge where BUs receive help on decision-making for future projects. Senior construction managers may also learn from business planning people that could have a positive impact on their future projects. For example, if a construction firm successfully used web-based project management tools, then this

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1 It should be noted that experience relates to relevance—it is probably that younger organisational staff may have considerable ICT use experience to share with older staff and older staff may have deep insights from their industry experience on how best to apply ICT tools in a practical manner.
message may be fed through a COP in which business managers and construction managers can learn and share options about how to best diffuse these tools.

Finally, the connection between ‘Implementer or IT support COP’ and the ‘Workplace COP’ (see Figure 5) can help people share experiences of combining both construction and IT technical knowledge. Most members in Workplace COPs have high levels of experience of construction procedures and processes. Thus, sharing this construction experience with members of Implementer or IT support COPs should be helpful for improving ICT application to suit users’ requirements. On the other hand, knowledge about ICT applications also helps members of Workplace COPs to understand limitations associated with ICT applications. Linking COP types can improve mutual understanding of ICT innovation support staff and operational users to help each party improve their application of ICT rather than blaming each other for poor implementation of any ICT initiative.

Relationships of COPs Between Organisations

The above discussion centred on within-organisation COPs. This section focuses on inter-organisational COPs relationships. These groups also provide benefits for each member organisation because they facilitate sharing and learning from each other. Figure 6 illustrates these relationships.

![Figure 6: Relationships of COP between organisations](image)

It is important to recognise that these COPs are already exist, cannot be controlled by the organisation in any heavy handed way and if suppressed will merely go ‘underground’. Therefore, it is wise for organisations to embrace them and to actively and proactively help shape them to align organisational objectives where appropriate with the COP rather than vice versa. For example, members of professional institutions may share information about standards of using ICT in the construction industry and these may develop into a useful collaborative network such as the...
Construction Industry Trade Exchange (CITE) in Australia and similar cross-industry initiatives elsewhere. In some cases, knowledge alliances are formed around these COPs. In the oil and gas industry for example, the Transfield Worley Best Practice Alliance has developed in Australia where a group of competing companies and supply chain specialists have formed a community of practice that is supported by web tools to link geographically dispersed people and to organise forums, discussion groups, conferences and COP activities within that knowledge alliance.

Additionally, previous co-workers and friends may influence sharing the knowledge of ICT applications through membership of formal or informal social networks and COPs. People feel comfortable to ask those close to them that they trust, therefore these COPs could sometimes help staff learn how to use ICT application even though the individuals concern are affiliated with competing organisations. Teigland (2000) observes from a study of an IT-intensive firm that people in organisations generally have conflicting loyalties between their organisation and their COP. Professional knowledge flows across organisations through COPs that span many members from many different organisations. The strategy of organisations managing this knowledge resource that has ready-access to external competitors should not be to pretend that such knowledge leakage does not occur but that it is openly recognised that they stand to gain as much (if not more) than they stand to lose. When, an individual needs specialised help on a complex problem and he/she has to go to their external COP and gets help, there has been a valuable transaction taking place. The value obtained could have been expensive if purchased (and probably was unobtainable on the ‘open market’) and represents barter or exchange tokens of favours through a process of trust building—favours can potentially be retrieved at some later date. By supporting, monitoring and engaging in such COPs, organisations help ensure that they get their fair share of any rewards to be gained from this natural and organic form of collaboration. As cross-organisational COPs have the power to effectively diffuse ICT knowledge between organisations, these organisations should be aware of this reality and reinforce the COPs by encouraging staff to join them.

CONCLUSIONS

In this chapter we argued that there are three types of within-organisation COP that can be developed to positively contribute to ICT diffusion. Institutional COPs help set the strategic direction for ICT development and validating. Implementer or technical support COPs link users with ICT support staff through gatekeepers that can help with the process of interpretation and re-framing problems and difficulties. Supporting work group COPs provide technical support COPs gatekeepers in the project manager/engineer network and collegial support COP that provides much of the necessary one-to-one or small group support. We also indicated how the knowledge from organisation-external COPs may be effectively harnessed. Two of these were previous work colleagues and friends, and professional institution members.

Effective ICT and knowledge sharing is also emerging as a competitive advantage in project alliancing. For example Bovis Lend Lease won the right to construct the

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National Museum of Australia as a result of its information management strategy (Duyshart et al. 2003; Walker and Hampson 2003).

PRACTICAL TIPS AND LESSONS LEARNED

1. COPs are already ‘out there’, organisations should recognise their usefulness and power for knowledge creation and sharing.
2. COPs can be guided, supported and nurtured by organisations though a heavy-handed approach should be discouraged.
3. COPs can be an effective support mechanism for ICT innovation diffusion.
4. The three Australian case studies demonstrate that COP types need to be established within organisations that service different the needs of people at various levels within organisations.

REFERENCES


