A Framework for Knowledge Integration and Social Capital in Collaborative Projects

Mamata Bhandar
Universitas 21 Global, Singapore
mbhandar@u21global.edu.sg

Abstract: Collaborative projects are increasingly common today and such projects require specialized knowledge of the partners to be integrated, therefore posing the challenge of inter-organizational knowledge integration; integrating diverse knowledge bases across organizations. Studies on knowledge integration and inter-organizational networks indicate the positive influence of social capital in the context. Since partners in a collaborative project are likely to possess this resource due to their partnership, a knowledge integration view is adopted to conduct an empirical investigation of a three-partner collaborative project to investigate the influence of social capital. The study shows how the different aspects of social capital influence the knowledge integration behaviour of the partners for the project. Implications to research and practice are discussed.

Keywords: social capital, collaborative projects, knowledge integration

1. Introduction

Collaborative projects for mutual benefits between partners are becoming increasingly common for several reasons including increasing competition, improving transactional efficiencies, improving resource efficiency (e.g. Simatupang et al 2002). Of interest to this study are collaborative projects that involve existing partners collaborating on a project with or without an external vendor. The implementation of such projects requires knowledge from each of the collaborating organization that can be highly differentiated and therefore has to be integrated for the project (Pan et al 2001, 2007). Collaborative project implementation therefore, can be viewed as a process of inter-organizational knowledge integration.

Knowledge Integration (KI), in this context is conceptualized as the process through which disparate, specialized knowledge across organizations is combined, applied and assimilated (Bhandar et al 2007). For instance, in collaborative IS/IT projects, each organization has to contribute knowledge related to their workflows/processes/system. This knowledge is then combined and applied to build the system. Lastly they assimilate the system by making necessary changes to their work practices (Faraj and Sproull 2000) by adopting/using the system. KI is essential in these projects since if knowledge from a particular organization is missing or is not integrated, the project outcome may suffer.

Managing the implementation of a collaborative project is therefore an essential yet challenging task. The challenge is not only because knowledge is often dispersed, differentiated and embedded (e.g. Pan et al 2007) in the various collaborating organizations but also because each organization has its own agenda and may possess diverse competencies (Pisano 1994) and conflicting interests. How then can such projects be managed effectively?

The importance of social capital has been noted for KI (e.g. Pan et al 2001) as well as in the context of inter-organizational networks (Liebeskind et al 1996; Kale et al 2000). Social Capital is a resource based on social relationships that inheres in structures such as organizations and organizational networks (Nahapiet and Ghoshal 1998) and can manifest as trust, norms, cooperation, information benefits and power (Adler and Kwon 2002) and that influences the behavior of the members. But what aspects of social capital are significant and how exactly do they influence collaborative projects?

To address this question an empirical study of a collaborative project that involved three partners and an IT vendor was conducted. The project was viewed as an inter-organizational KI process and was analyzed using a social capital framework. If the primary goal of collaborative projects is to integrate knowledge then a KI view is justified and studying the environment that influences the behavior of the organization towards the process can answer the questions raised earlier. This study extends the indication by most studies on the significance of social capital on KI in inter-organizational settings by elucidating the specific aspects and exact nature of its influence in collaborative projects.
2. Literature review

2.1 The KI view of collaborative projects

This study bases itself on the view that knowledge exists both in the individual and the collective (Nonaka 1994). Individual knowledge is personalized information related to facts, procedures, concepts, interpretations, ideas, observations and judgments, possessed in the mind of individuals that exists as justified belief and increases the capacity for effective action (Nonaka 1994). Organizational knowledge (the collective in this study) is embedded in and carried through multiple entities that include organizational culture and identity, routines and policies, systems and documents as well as individual employees (Grant 1996).

Table 1: Summary of KI definitions and views

<table>
<thead>
<tr>
<th>Definition</th>
<th>Author/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application of knowledge</td>
<td>Grant 1996</td>
</tr>
<tr>
<td>Synthesis of knowledge bases</td>
<td>Alavi and Tiwana 2002</td>
</tr>
<tr>
<td>Process view- an ongoing collective processes of constructing, articulating, and redefining shared beliefs through social interaction of organizational members</td>
<td>Huang et al 2001</td>
</tr>
<tr>
<td>Distinguish between knowledge integration process and knowledge integration per se. The process involves the actions of group members by which they share their individual knowledge within the group and combine it to create new knowledge. By contrast, knowledge integration is the outcome of this process, consisting of both the shared knowledge of individuals and the combined knowledge that emerges from their interactions</td>
<td>Okhyusen and Eisenhardt (2002)</td>
</tr>
<tr>
<td>Tiwana defines knowledge integration specifically in the context of IS projects as the process of embodying business application domain knowledge with technical knowledge in the design of the software.</td>
<td>Tiwana (2004)</td>
</tr>
<tr>
<td>Process view- process through which relevant knowledge is combined, applied and assimilated</td>
<td>Bhandar et al(2007)</td>
</tr>
</tbody>
</table>

Scholars have proposed different definitions of KI (table 1). For this study, KI as proposed by Bhandar et al (2007) is adopted since it incorporates a process view and can be easily applied to an inter-organizational context. According to them, KI is the process through which relevant knowledge is combined, applied and assimilated for the project. Extending this definition to the context of a collaborative project, it is the process that involves the combination, application and assimilation of knowledge across collaborating organizations. The process incorporates several activities starting from project negotiations to the post-implementation stages and is also influenced by the behavior of the collaborating organizations towards the project.

From a KI view, coordinating collaborative projects is not easy given it involves the integration of knowledge spanning cross functional capabilities (Carlile and Rebentisch 2003) which is more complicated compared to integrating one kind of knowledge across individuals or groups(Grant 1996), notwithstanding the inherent characteristics of knowledge that can make its integration difficult. The common knowledge (Demsetz 1991) that exists in inter-organizational set-ups is also modest (Grant 1996) further making KI difficult. Apart from the ‘knowledge’ related challenges, collaborative projects also involve the challenge of managing multiple organizations with distinct competencies (Pisano 1994) and conflicting interests. Differing and distinct businesses interests and strategic objectives increase time needed for consensus on collective goals and action needed for the project. These conflicts although healthy from the perspective of the organization can affect their behavior towards the project in terms of knowledge contribution, assimilation etc.

So how then are these challenges addressed in collaborative projects? Scholars have suggested the role of social capital, a resource based on relationships to positively influence KI and formation of networks (Pan et al 2001; Walker et al 2007). The following section therefore reviews social capital literature and describes the framework that will be used for the study.
2.2 Social capital –THE OMA schema

Social capital, defined as the resource that exists in network of relationships possessed by an individual or social unit (Nahapiet and Ghoshal 1998) has been emphasized for KI (e.g. Huang et al 2001) as well as for inter-organizational networks (e.g. Liebeskind et al 1996). It improves coordination and cohesion within the structure, helps in aligning the different stakeholders to the collectives’ goal and reduces time and effort associated with developing an agreement (Huang et al 2001; Lesser and Prusak 2000). Individuals use the network as a rationale for deferring immediate individual interests in favor of long-term group and organizational goals (Leana and Van Buren 1999).

Adler and Kwon (2002) propagated social capital as an umbrella concept and identified opportunity, motivation and ability (OMA schema) as its three sources that need to be present for social capital to exist. The OMA view of social capital is used for this study. The rationale being; (1) it is comprehensive and integrates the many facets of social capital (2) allows its application and analysis at the organizational level (3) incorporates practical aspects like motivation and resources that significantly affect social behavior of the organizations. The paper argues that social capital influences the KI behavior of organizations towards the collaborative project. The three sources of social capital (OMA) as proposed by Adler and Kwon (2002) are discussed ahead.

The Opportunity Source of Social Capital (O) reflects the accessibility that the network provides for social capital transactions. For example, in a collaborative project the prior relationship/ties between the partners provide an opportunity for members to interact and share their knowledge for the benefit of the project, thus performing an action based on the social capital. The motivation source of social capital (M) is the motivation that contributors have to help recipients even in the absence of immediate or certain returns. It is usually facilitated by norms and a sense of trust (Putnam’s 1993). Norms represent the degree of consensus in the network (Coleman 1990) that facilitate cooperation and motivate actors to engage in exchange processes (Putnam 1993). Apart from the softer aspects like trust and norms, motivation is strongly influenced by practical aspects like anticipation of benefits, perceived effort and costs. Ability (A) construes the competencies and resources of the network members to be able to contribute to the social capital. Shared languages, codes, and narratives build a shared understanding and collective knowledge in the network, thus improving their ability to contribute and comprehend the knowledge in the shared pool. For e.g., bio tech firm networks share a high level of common knowledge and shared understanding because of their similar domain knowledge and shared codes. Thus the ability of members to comprehend and contribute requisite knowledge is higher.

Based on the above discussion, Social capital for this study is defined as the resource that exists/evolves due to the presence of OMA in a structure (e.g. inter-organizational project) and that facilitates action towards the goal of the structure. This study focuses on the aspects that lead to the development of social capital and not on what constitutes social capital.

3. Research methodology

Qualitative research method was adopted for this study since it allows an emphasis on processes and meanings (Denzin and Lincoln 1994) essential for this study investigating a KI process. The case study method was deemed appropriate for data collection since the phenomenon of KI is closely intertwined with the context of the collaborative project (Yin 2003). The study also required informants to reveal sensitive data (e.g. partner relationship) that required comprehension of the context (e.g. to interpret the quotes in light of their relationships) which was possible through long and informal interviews. This project was chosen for the study based on three criteria: the project was recently completed to ensure that participants could recall events, permission to study the project was granted by the top management so as to allow access to rich data, and it provided a right context for the study, a collaborative project with a seven year partnership.

The main source of data was face-to-face interviews conducted with representatives of each organization involved in the project at different hierarchies (top management, middle management, team members and users). Questions were asked to understand the motivations/expectations/views of each organization for the project, their account of how the project progressed, the conflicts, resolution of conflicts etc. The richness of the data came from the fact that at-least one organization would have a different perspective of an issue, which brought out the inter-organizational and knowledge dynamics we were looking for. The issues were then explored through more questions and
for evidence from secondary sources. Secondary data was collected from organizational websites (e.g. organizational background), articles, and third parties (employees of the companies not involved in the project). The multiple sources provided for triangulation (Stake 1994) of evidence and ensured that facts stated by one could be verified by others and also provided multiple perspectives.

Data analysis was done in iteration with data collection (Myers 1997). Data collected was transcribed in consideration with recording media for qualitative studies (Walsham 1995, 2006). Themes were identified using open-coding (Strauss and Corbin 1990) that influenced the organizations KI behavior throughout the project. For instance, ‘prior experience’ and ‘lack of motivation’ were identified as themes that influenced ‘requirement gathering’ since they affected time taken/outcome for that activity. Interesting comments, surprising revelations, special notes/observations made during the site visits or interviews were also considered. For example, highly formal atmosphere, and interviewees being very guarded in disclosing facts were all noted. The identified themes were theoretically abstracted to arrive at a framework figure 1.

Table 2: Case data collection details

<table>
<thead>
<tr>
<th>Organization</th>
<th>Interviewees</th>
<th>Interviews</th>
<th>Interview background</th>
</tr>
</thead>
<tbody>
<tr>
<td>IT Vendor</td>
<td>General manager</td>
<td>3</td>
<td>Was the lead to the case. Interviews were semi-formal and detailed data included e-mail exchanges and phone calls. Provided third party perspective on the partners relationships, project procedures, management, IT capability etc.</td>
</tr>
<tr>
<td></td>
<td>Account manager</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Business development manager</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IT manager</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>PhotoChem</td>
<td>Logistics manager (Project manager)</td>
<td>1</td>
<td>Logistics manager provided data on reasons for initiating the project, for selecting the IT vendor, on the inter-departmental communications and inter-organizational communication. Other department managers provided data on system adoption, their involvement in the project and on the issues on system adoption by the partners.</td>
</tr>
<tr>
<td></td>
<td>Shipping manager</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Shipping supervisor (user)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Warehouse manager (users)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Warehouse supervisor (users)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Service providers</td>
<td>Directors</td>
<td>2</td>
<td>The directors talked about their lack of motivation for the project and how/why they agreed. The operations officer spoke about the system, meetings for system development, their problems in updating the system</td>
</tr>
<tr>
<td></td>
<td>Operations officer (user)</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

4. Case description

In early 2001, PhotoChem, a Japanese MNC that produces photographic chemicals, explored the idea of a web-based collaborative logistics system through which it could interact with its logistics service providers, online. PhotoChem realized it was inefficient to interact with them through faxes and phones and selected ChemXlog; an IT firm specialized in providing collaborative logistics systems for chemical companies, as the vendor. ChemXlog would now assist PhotoChem in getting the service providers on board the system, a task that was not going to be an easy. The logistics service providers; a haulier and a freight forwarder provided services to ship PhotoChem products around the world. The background of the four firms is described in table 3. Both, the haulier and freight-forwarder were cost conscious and traditional firms with limited knowledge and use of IT. They both used a 56 kbps dial up modem to access the internet. The freight-forwarder's director confessed:

“Computers stuff? I'm not good at that”.

PhotoChem shared a nice seven-year relationship with its service providers. They functioned like a close-knit community and none indicated any issues against each other. PhotoChem did experience operational inefficiencies in its logistics workflows for which it felt the need for the system. Its logistics manager said:
“We faced problems and internal inefficiencies ranging from inter-departmental communications, manual operations documents getting lost and extra payments being made at the port for delayed pick-up and so wished to streamline the logistics processes.”

The IT vendor, ChemXlog, is a small private limited IT firm that specializes in developing and implementing collaborative logistics solutions for private logistics communities in the chemicals industry. It was formed by pooling the collective domain expertise of SembCorp industries (SCI), a logistics giant in the region and Singapore Computer systems (SCS), an IT firm. This parentage provided it with a strong logistics expertise. It was also one of the few companies that could provide direct access to TRADENET, a system that companies were mandated to use to file their trade documents. These were also the reasons PhotoChem decided on ChemXlog as the vendor. ChemXlog then met with the service-providers to get the project started and understood the relationship between the partners since it was a Singaporean firm and had worked with similar communities before. It empathized with the service-providers and their reticence to the system. Its task was also difficult because PhotoChem expected the service-providers to share the cost of the system.

4.1 The project

The directors of the service-providers were so averse to technology that they had their emails printed out for them. They were not receptive to change and from their perspective, this system only entailed additional work and costs for them. The tension between the partners was due to their distinct strategic directions as revealed by the haulier’s director:

“.. the basic directions are quite different. ChemXlog is eager to solicit business, the freight-forwarder’s basic attitude and direction are just like mine; we don’t see immediate interest or savings. Of course there will be some argument and conflicts. In terms of the system, we have no problem. They [ChemXlog] have the required expertise.”

ChemXlog took three months to convince the service-providers and managed to get their assent after it got them a government grant that was to help SME’s (small and medium enterprises) pay for technology projects. The service-providers confided that they acceded to the system partly due to their vulnerable strategic position; PhotoChem was a major client and the service-providers felt the system could lock them in a long-term relationship hence business, although there was no formal commitment on this from PhotoChem.

Table 3: Background of the collaborating organizations

<table>
<thead>
<tr>
<th>Collaborative Partners</th>
<th>Background and Nature of Business</th>
<th>Use of IT Prior to the Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>IT vendor- (ChemXlog Pte Ltd.)</td>
<td>Small IT firm that develops and implements collaborative logistics solutions for private communities. The parent company is a major logistics company.</td>
<td>High</td>
</tr>
<tr>
<td>PhotoChem</td>
<td>One of the manufacturing facilities of a Japanese MNC. Employs 150 people and is a major client for the two logistics service providers</td>
<td>High. Use legacy systems and had experience with a JDEdwards system</td>
</tr>
<tr>
<td>Freight-Forwarder</td>
<td>A small firm, incorporated in 1995 with annual turnover of S$1.5m. Coordinate with haulier for servicing clients logistics activities</td>
<td>Minimal. Accounting package and e-mailing</td>
</tr>
<tr>
<td>Haulier</td>
<td>A small firm, founded in 1987, and annual turnover of $6m. Owns a fleet of trucks and containers that are coordinated manually</td>
<td>Minimal. Only for word processing and e-mailing</td>
</tr>
</tbody>
</table>

The system was developed through prototyping; an initial prototype was built by ChemXlog that was continually refined through inputs from the partners over several collective meetings. The
development lasted for six months and involved abundant inter-organizational interaction to design GUI’s (Graphical user interface) and workflows for the system. The process required the logistics partners to understand questions posed by ChemXlog and be able to chart workflows of business processes to be built into the system. Each organization wanted a GUI suiting them, thus resulting in conflicts but were overall cooperative in resolving issues. They also exhibited a consideration for others’ requirements. A user from the freight-forwarder’s very understandingly quoted:

“Some may want to see more information and some may think the lesser I see, the lesser problems.”

In terms of understanding each other’s domain knowledge and interacting with ChemXlog for stating requirements, this stage was surprisingly smooth considering the diverse functional backgrounds. ChemXlog’s knowledge of logistics was a tremendous help. This stage required extensive sharing of business information with each other and ChemXlog. The partners trusted ChemXlog on this issue.

After the system was implemented the initial adverse feelings of the service-providers’ changed. The directors were pleased and felt locked in a long-term relationship with PhotoChem. The system was very well received at PhotoChem. A review committee was set-up to identify issues related to the system, coordinate with ChemXlog or related parties to resolve those issues and also follow up on system updates and other progressive issues. The review committee met once in two months and comprised of core users and project managers from the partners. Users could share their issues with the committee but interestingly they raised only a few technical issues although they faced many more because they did not wish to disrupt the community. One user from the freight-forwarder said:

“We did mention some issues about the system being slow etc., as for the other changes, we didn’t raise them, since everybody seems fine with the arrangement now. We do not want to disrupt them”.

PhotoChem adapted well to the system. They did face difficulty getting forklift drivers to use the system and to deal with it, assigned a leader to each warehouse section that would be responsible for teaching the rest. In response to the system there was also a merger of departments. There were some issues at the service-providers’ end in adopting the system. There were delays in updating the system and PhotoChem’s warehouse manager said he had to telephone to remind them to update the system, yet empathized with their slackness. The service-providers complained of difficulty logging in to update since they used dial-up connection and the slow speed caused delays. They also said they felt more comfortable using phones and faxes to get immediate confirmation in instances such as truck break down. Despite these issues, they agreed the system was easy to use and that eventually they would get used to it.

5. OMA analysis

This project involved four organizations: PhotoChem, its two logistics service-providers and the IT vendor (ChemXlog). Conceptualizing social capital as the resource present in the project due to the presence of OMA in the collaborating organizations, in this section the influence of OMA on the KI behavior of the organizations is elicited. Analysis was conducted as follows: interaction between the organizations and the absence/presence of OMA was noted for key activities (e.g. lack of motivation in service providers for buy-in). Aspects that enabled/facilitated/impeded OMA for that organization were then identified (e.g. prior ties and project structure enabled opportunity source of social capital). Lastly the influence of the presence/absence of OMA on the KI behavior for the project was elicited. The OMA analysis, summarized in table 4, is discussed ahead.

5.1 Opportunity

Adler and Kwon (2002) proposed that opportunity source of social capital is provided by network ties and configuration. Consistently, in this study prior ties and project structure provide the opportunity for social capital transactions.

The seven year partnership provided the opportunity for the firms to engage in social capital transactions and that influenced the project. The prior ties provided a sense of obligation between them, evident in the following instances: during the collective meetings, the service providers would ‘nod’ their head and say ‘yes’ to every proposal easily because they did not want to appear uncooperative to PhotoChem. This can be seen as norms of behavior that govern relationships and appropriate behavior of members in a network through institutionalized rules (Gulati et al 2000).
Table 4: OMA analysis

<table>
<thead>
<tr>
<th>Social Capital</th>
<th>Aspects</th>
<th>Effect on the knowledge integration behavior of the collaborating organizations</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Prior ties, seven years of partnership</td>
<td>Cooperation, compromises, tolerance, Understanding, obligation - obligation in saying ‘yes’ in collective meetings, being cooperative for meetings, making compromises on GUIs, being tolerant towards service providers when they were not updating the system.</td>
</tr>
<tr>
<td>M</td>
<td>Project structure</td>
<td>Not very effective in this case since it was very informal and the interaction it could provide was already present. It was an opportunity for the vendor to build relationships and ties with the partners</td>
</tr>
<tr>
<td>M</td>
<td>Obligation/trust</td>
<td>Service providers felt obliged to return PhotoChem’s favor, i.e. business of seven years and so agreed to their proposition. The trust that PhotoChem would return their favor by long term business also helped get their buy-in. Service providers had not signed any agreement/contract even with vendor since they trusted vendor would not leak any information</td>
</tr>
<tr>
<td>M</td>
<td>Need, benefits</td>
<td>PhotoChem’s need for the system meant their commitment and effort to the project. Service Provider’s lack of perception of benefits delayed their buy-in for the project, their effort in acquiring resources for the project and adopting the system. The vendor’s motivation for business made them exercise effort to get the government grant for the service providers, build relationships with the partners and coordinate the project.</td>
</tr>
<tr>
<td>A</td>
<td>Contractual</td>
<td>Comments from service providers suggest that a commitment for extended business from PhotoChem may have expedited buy-in.</td>
</tr>
<tr>
<td>A</td>
<td>Shared codes/common knowledge provided by prior experience</td>
<td>The partners understood each others requirements and jargon and hence it was easy while gathering requirements and during the collective meetings making knowledge integration harmonious. The vendor’s common knowledge with the partners in logistics and knowledge of software made it easy for them to comprehend the requirements again making knowledge exchange easy.</td>
</tr>
<tr>
<td>A</td>
<td>Specialized knowledge</td>
<td>The vendor’s domain knowledge in software and logistics was one reason for their selection. This ensured harmonious knowledge integration since there was dependency, every cluster knew the importance of complementarities of the other organizations’ knowledge.</td>
</tr>
</tbody>
</table>

The ties also induced cooperation for scheduling collective meetings which eased ChemXlog’s difficulty in arranging meetings convenient for all four organizations. Their ties also helped in achieving consensus on GUIs when there were conflicts when each organization demanded a GUI intuitive to them. ChemXlog would call for a collective meeting to resolve the conflicts during which the service-providers empathized with PhotoChem’s need to see all the fields and so compromised, even though it meant a complex GUI for them. PhotoChem reciprocated by being tolerant of the service-providers’ slackness in adopting the system. One user from PhotoChem said:

“The service providers don’t just do our business and not all of their customers use this system... So updating the system is out of their normal business procedures. We understand if they take longer to update and remind them to do it.”

Even when the review committee was set-up, users did not mention all issues since they did not want to disrupt the community thus exhibiting concern for the collective and willingness to compromise for collective good.

In terms of the project structure; in this case there was no formal project structure and interaction between organizations was informal since they knew each other thus making access to knowledge faster. In addition the regular meetings and frequent interaction provided a favourable conduit for knowledge flows. For instance, users from PhotoChem would call up the service providers to remind them to update system. The opportunity source of social capital therefore in this project in the form of ties of seven years between the partners and an informal project structure induced cooperation, compromises and tolerance among the partners for easier KI.

5.2 Motivation

Motivation as a source of social capital is the incentive that members have to engage in social capital transactions and has shown to be enabled by softer aspects like trust, norms and obligations especially in the context of individuals. In a collaborative organizational setting, as previously discussed, practical aspects such as perception of benefits, effort and cost incurred also influence organizational behavior towards KI. In this case, obligation, trust, need/perceived need and
contractual terms are shown to be significant aspects for motivation. In terms of obligation; the vendor claimed that one of the reasons the service-providers agreed for the project was out of obligation to PhotoChem for their seven years of business. It was also partly due to the trust that PhotoChem would extend business with them if they agreed to the system. This can be said because there was no formal commitment from PhotoChem indicating such an arrangement. The service-providers’ remark also suggests that such a formal commitment may have actually expedited their buy-in to the project inline with Parkhe’s (1993) assertion that long term commitments can promote cooperation between partners since it develops mutual trust, even with uncertainty in the relationship.

The stronger motivating influence was the perceived need/need of the system. PhotoChem initiated the system to reduce inefficiencies in its logistics processes which afforded its commitment and cooperation. It was quick to adopt the system and could even get its manual labourers to use the system. On the other hand the lack of such a perception in the service-providers was one of the major hindrances in this project. Its management believed the system was of no immediate value to them and it added to their costs and effort which affected their buy-in to the system. KI was delayed since it took ChemXlog three long months to convince them for the project. One of the service-providers’ director, confided:

“Our only motivation was the hope of getting long-term business from our major client and with the government grant some of the expense was taken care of too.”

They agreed to the system eventually but their reticence showed again when they had to start updating information on the system on a daily basis. They did so only when reminded by PhotoChem and claimed it was increased effort considering they still did manual updates for the other clients and had to use the system only for PhotoChem. The slow speed of the dial-up connection and their discomfort with technology added to their slack.

For ChemXlog, the key motivation was the business and potential business from other chemical firms in the hub if this project was a success. This drove them to go through the extensive process to help the service-providers get the government grant to pay for the project. To get the buy-in of the service-providers and make sure they used the system, ChemXlog also made effort to build personal relationships with the users and bought them pastries thus trying to assist in assimilation of the system.

5.3 Ability

Ability dimension of social capital represents capabilities that members have to engage in social capital transactions. The capabilities are provided by shared codes, shared jargon and common knowledge; all of which provide a common platform for members to comprehend and exchange knowledge. In this case, the ability dimension of social capital is enabled by: common knowledge or shared understanding that existed between the partners due to their prior ties, resources and infrastructure, prior experience of PhotoChem with IT projects and the specialized knowledge of the vendor which was sufficiently complementary with that of the partners yet afforded some understanding of their domain knowledge. The long-term association between the partners provided a shared understanding of issues and each others’ business processes that allowed for faster consensus and resolution of issues. This was evident when the service providers said they were cognizant of PhotoChem’s need for the system although they themselves perceived no need for it. Even PhotoChem was tolerant of the service providers’ slack in adopting the system and expressed their understanding of their constraints. When consensus was needed on GUIs, the service providers expressed understanding for PhotoChem’s need to have so many fields on the screen and compromised, although it confused them. Knowledge and awareness of each others processes therefore harmonized KI.

The aspect of resources and infrastructure in this case also provided ability for KI in terms of applying knowledge and even assimilating knowledge. PhotoChem’s prior experience in implementing and adopting the JDEdwards system helped its system assimilation. Its users said they were accustomed to train their laborers to upgrade themselves and so that helped in getting the forklift drivers who had never seen computers before to use the system. The service-providers on the other hand lacked technical competence to comprehend the system’s proposed benefits which delayed their intellectual buy-in (Huang et al 2001). ChemXlog’s sales manager said:
They [service providers] did not understand the technology so refused to acknowledge the benefits of the system. Their lack of experience and discomfort with new technology meant slower adoption.”

The service providers did agree that lack of resources was one reason why they were against the system and that they eventually agreed because they got the government grant to pay for the project. The lack of decent infrastructure in terms of broadband connection and exposure to technology like computers and internet compounded their slack in assimilating the system. Their users were uncomfortable with system and would not update the system on time claiming it was inconvenient to use and that it was slow because of the 56kbps connection. They had to be reminded to update the system everyday.

Although the case shows that the lack of technical competence in addition to the lack of infrastructure (e.g. no broadband connection) affected system assimilation, ChemXlog claimed that it had a positive implication too. The sales manager from ChemXlog added:

“It was better that way. Otherwise we would have to spend lot of time answering many questions on security etc. like we did with PhotoChem.”

ChemXlog expressed fear that the software was quite simple and only had to be customized and implemented which if clients possessed some IT sophistication could do it themselves. This revelation suggested that complementarities between the organizations provide the dependency which makes the inter-organizational arrangement meaningful (Ciborra and Andreu 2001). The prior experience and knowledge base of the vendor provided some common knowledge to ease their communication with the partners but also made the partners dependant on its knowledge base. Another aspect of the ability dimension that was significant in this case was the specialized knowledge base of the vendor. The fact that they were a subsidiary of a logistics company and a software company provided them with specialized knowledge needed to implement the system as well as common knowledge with the partners’ knowledge bases that helped them comprehend the partners’ business processes. PhotoChem acknowledged that this partly a reason why they engaged ChemXlog. The service-providers also acknowledged the ease with which they could communicate requirements and business processes with the Vendor. The vendor proudly acknowledged its strong logistics backing and said it made it easier in terms of comprehending the partners’ requirements and applying that knowledge to build the system.

6. Discussion

The objective of this study was to unravel the role of social capital in collaborative projects. Through an OMA analysis of a collaborative project viewed as a KI process, the study finds that social capital conditions the project environment by influencing the KI behavior of the collaborating organizations. Specifically: 1) The Opportunity source of social capital provides access to the organization’s knowledge required for the project 2) The Motivation source of social capital provides the raison d’etre for organization’s involvement in the project and 3) The Ability source of social capital provides the platform for knowledge exchange and accentuates the complementarities of organizations’ knowledge for harmonious KI. The findings are summarized in table 5 and also organized in a framework (figure 2) depicting the interaction between KI and social capital in collaborative projects.

<table>
<thead>
<tr>
<th>Finding</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Opportunity source of social capital provides access to the organizations’ knowledge</td>
<td>The Opportunity source of social capital in terms of prior ties, relationships and structures provides access to the organizations’ knowledge and aids in locating knowledge needed for the project.</td>
</tr>
<tr>
<td>The Motivation source of social capital provides the raison d’etre for involvement in the knowledge integration process</td>
<td>The Motivation source of social capital in the form of trust, obligations, system benefits, effort and cost incurred provide the raison d’etre for effective involvement in the knowledge integration process and directs effort towards project goal.</td>
</tr>
<tr>
<td>The Ability source of social capital accentuates the complementarities of organizations’ knowledge for harmonious knowledge integration</td>
<td>The Ability source of social capital provides the common knowledge and hence a platform for knowledge exchange while also accentuating the complementarities of the organizations knowledge for dependency and harmony in the knowledge integration process.</td>
</tr>
</tbody>
</table>
The framework (figure 1) shows how the various sources of social capital condition the project environment by influencing the KI behavior of the organizations. The three sources of social capital (O, M and A) and their aspects significant in the context, are shown in separate boxes around the project structure viewed from a KI perspective. The nature of influence of each dimension on the KI structure and behavior of the organizations is shown in block arrows leading from the social capital dimension boxes to the project structure.

**Figure 1** Framework for KI and Social Capital interaction in Collaborative projects

**6.1 Opportunity provides access to organization’s knowledge and facilitates knowledge location**

Prior studies acknowledge that cross functional teams may not be difficult to set-up, but can face the challenge of accessing the breadth and depth of pertinent knowledge (e.g. Imai et al 1985) and integrating that knowledge (Huang and Newell 2003). The challenge of accessing knowledge has also been noted in practitioner-oriented publications (e.g. Anand et al 2002) but the aspect has been largely ignored in collaborative projects. Another issue is locating knowledge needed for the project. In IS projects, developers apply just as much effort and attention determining whom to contact in an organization as they do getting the job done (Inkpen and Tsang 2005).

This case shows that the opportunity source of social capital provided by prior ties in the form of partnership between the organizations and the interaction structure for the project influenced the location and accessibility of knowledge required for the project. Prior ties enabled faster and easier access to knowledge since members knew each other and could easily access them through phones. It also helped that the organizations were cooperative made themselves available for the collective meetings. The ties also created an obligation between the partners; which assisted in breaking boundaries for accessing knowledge. For instance, in collective meetings the service providers felt they could not refuse a proposition and felt obligated to reveal what they had to. Ties have been noted to facilitate social interactions and provide channels for knowledge exchange (Inkpen and Tsang 2005) and this case confirms they provide access to required knowledge by inducing obligation, cooperation and lowering boundaries between members.

The informal project structure in this case also enabled access to knowledge. Contrary to the expectation that an informal would make it harder to locate and access knowledge needed for the project, this case showed that because the partners were used to interacting informally, any time any
information was needed phone calls could be made. The frequent collective meetings also provided a forum for knowledge access. Some scholars have argued that structures can act as a barrier for knowledge processes (e.g. Nonaka 1994) while some (e.g. Okhyusen and Eisnehhardt 2002) contend that absence of structure can make it difficult for groups to organize themselves for the KI process. This case shows that when prior ties are present the effect of a formal project structure is not significant. In other words, a suitable project structure for a collaborative project is contingent on the nature of ties between the collaborating organizations.

6.2 Motivation provides the raison d'etre for organization’s involvement in the KI process

Situations, where firms have mixed motives with private and common interests and access to one another’s knowledge may have benefits for only one partner, are not uncommon in alliances (Gulati et al 1994) and such asymmetry in benefits can lead to departures from expected collaborative behaviors (Khanna et al 1998) as is seen in the case.

In the case, the trust and hope of long term business was one of the lure the service-providers had to agree to the system. From ChemXlog’s perspective, it could also be perceived as an obligation to PhotoChem for their seven years of business. Further, the need for the system ensured the commitment of PhotoChem towards the project. The lack of perception of the system’s benefit and the potential costs and effort, precluded the involvement and participation of the service-providers’ thus causing a delay in buy-in and system assimilation. Their comments however indicate that a commitment for extended business from PhotoChem may have expedited their buy-in thus emphasizing the influence of formal mechanism/contracts for KI.

The IT vendor on the other hand was strongly motivated for the project since it meant business for them and to get that they made extra effort, coordinated the entire project, got the government grant for the service-providers and also built relationships with the partners and users to encourage their involvement. The case therefore shows that the motivation source of social capital, provided by trust, obligation and practical motivators like benefits from the system, cost and effort incurred and the contractual terms can provide a raison d’etre for organizations to work towards the project goal. It also affords concerted effort of all organizations’ towards the project goal through contracts etc.

Studies have argued for and against formal mechanisms to govern collaborative arrangements. Tiwana (2004) argues that because the acquisition of new information from partner firms is often based on tacit knowledge, simple contracts governing their transfer are typically inadequate. Others such as Inkpen and Li (1999) contend that in new or young alliances where partner firms have had little shared collaborative experience, a more formal governance mechanism serves to mitigate initial concerns of distrust and potential misconduct on the part of an unknown partner. On the contrary, this study shows that formal governance mechanisms can influence KI behavior of the organizations even in pre-existing partnerships and formal contracts can to an extent influence KI behavior regardless of the nature of knowledge.

6.3 Ability provides knowledge dependency between organizations for harmonious KI

Four aspects are considered that provide for the ability source of social capital; Prior experience, shared codes /jargon and resources and infrastructure. Although each aspect is considered individually they are closely related. These aspects provided for the common knowledge between the organizations and also accentuated their specialized knowledge.

PhotoChem’s prior experience in implementing and adopting the JDEdwards system helped them assimilate the system much faster. The lack of such experience of the service-providers affected their assimilation of the system and initially even their buy-in to the project. The prior experience of ChemXlog in interacting with small firms such as the service-providers made them aware that to get the service-providers’ buy-in it would be important to get the government grant that would help them pay for the project. This move helped in getting the buy-in of the service providers.

The prior ties and partnership between the partners helped in providing a shared understanding for issues and in developing common knowledge between them. This helped in achieving compromises and expediting resolution on GUI design since they were cognizant of the other organizations’
requirements and constraints thus making KI more harmonious. In terms of resources and infrastructure; the lack of required resources in the service-providers affected KI in terms of getting their buy-in and well assimilation of the system. The IT vendor’s specialized knowledge in logistics and software made their knowledge complementary to that of the partners but also provided common knowledge for them to communicate efficiently. ChemXlog suggested that their own combined knowledge and the lack of knowledge of IT in the service-providers was in way good since it enhanced the complementarities of their knowledge and made the partners dependant on them. They felt like this since if the service-providers had more knowledge of IT they could have implemented the software themselves and may have extended the sales cycle by asking too many questions.

This interesting observation on the relation between common and specialized knowledge is significant. Common knowledge helps, but too much can be impeding as suggested in the case. It is important for organizations to perceive the necessity of others’ knowledge, since when that is present there is a dependency and harmony. The ability sources of social capital therefore affords shared understanding between the organizations and enhances the complementary specialized knowledge base of each organization thus influencing harmony in the process for knowledge exchange, increasing ability to apply and assimilate knowledge.

Complementarities of existing firm assets have been assessed as having potential impacts on knowledge transfer in alliances (Tiwana 2004). Chung et al (2000) have also talked about the importance of Complementarities along with status similarity and Social Capital for alliance formation. This study demonstrates the importance of knowledge complementarities between organizations for effective KI in a collaborative project as well. The search for complementary knowledge bases is from ICV (International cooperative ventures) literature, which identifies the possession of complementary knowledge as conducive to ICV formation (e.g. Beamish 1988). Balakrishnan and Koza (1993) in fact define a joint venture as a special mechanism for pooling complementary assets and assert that achieving complementarities is often the raison-d’etre of ICVs. This case demonstrates the same phenomenon in collaborative projects. All of these suggest that if complementarities is essential for a collaborative project then ability source of social capital accentuates that complementarities and induces harmonious KI.

7. Implications and conclusion

The significance and complexity of collaborative projects motivated this study of understanding how a naturally occurring resource, social capital, can be leveraged. Using concepts of KI and social capital this qualitative case study, shows how different aspects of social capital influences the KI behaviour of collaborating organizations. The study finds that social capital facilitates access to organization’s knowledge, provides a raison d’etre for its effective participation and accentuates the complementary specialized knowledge. Findings are organized into a framework (Figure 1) that represents the interaction between social capital and KI in collaborative projects.

This study makes key contributions to project management, inter-organizational and social capital literature. The framework is a critical step towards using a KI and social capital view to understand complex phenomena such as collaborative projects. The study extends the indication by prior works on the importance of social capital for KI and collaborative projects by eliciting its roles and aspects. Another significant implication of this study is the conceptualization of social capital to the context of collaborative projects. In doing so it has addressed the call of scholars that claim social capital is highly contextual and that it has to be studied in depth in each context (Koka and Prescott 2002). In addition this view incorporates the practical and organizational aspects into social capital.

The framework developed in this study comprehensively highlights the role and aspects of social capital in collaborative projects and emphasizes the KI view for such settings. It thus helps explicate strategies for managing collaborative projects. Findings indicate the importance of structures to foster ties between organizations through project team collocation, regular meetings, social activities etc. Project goal needs to be clear and mechanisms instituted to achieve concerted effort of all organizations towards that goal. Knowledge dependence between organizations should be emphasized by identifying vendors based on balancing common vs. specialized knowledge. The nature of relationships in terms of OMA can be assessed to devise appropriate and effective strategies. For instance, structures can be designed differently depending on the ties between the organizations. In situations where ties are limited they can be fostered through social activities and collocation.
This study was conducted in an Asian country and there was an element of conservatism shown by the interviewees in revealing data that may have affected some of the insights. To overcome this limitation, multiple people were interviewed on the same subject. The organizations also hesitated to share too many project related documents and to make up for this multiple people were interviewed to get oral confirmation of the data. It must also be noted that this study has the inherent limitations of a case study in terms of it being very context specific. The goal of this paper is therefore not to make generalizations applicable to all settings, but to be able to contribute to the underlying KI theory. The findings in this paper are based on a single case study and need to be further researched through questionnaires or more detailed case studies. This study provides two new significant perspectives through which collaborative projects can be studied using the framework as a starting point.

References


Knowledge Management in Evidence-Based Medical Practice: Does the Patient Matter?

William Boateng
First Nations University of Canada, Prince Albert, Canada
wib980@mail.usask.ca

Abstract: Evidence-based medicine has greatly influenced decisions and actions throughout the health care industry for a couple of decades, particularly in the advanced countries. However, little is known as to how patients with their tacit knowledge have fitted into the evidence-based medical practice equation especially in the developing world, hence the need for this study. The combined use of the theory of communicative action and the AGIL taxonomy of adaptation, goal attainment, integration, and latent pattern maintenance by Talcott Parsons served as the theoretical framework for the study. The theory of communicative action provided the benchmark in understanding how doctors and patients are motivated to adapt and integrate the explicit and tacit knowledge forms in attaining the goal of quality evidence-based medical practice in line with the AGIL taxonomy. The qualitative interviews with fifty respondents - twenty doctors and thirty patients - in the central region of Ghana are utilized as the data base for the discussion. The study concludes that at present patients' tacit knowledge does not matter in the practice of evidence-based medicine in Ghana. This situation has to be addressed by empowering patients to be actively involved in clinical decision-making affecting their health. This is critical because effective implementation of evidence-based medical practice demands a good blend of explicit and tacit knowledge forms possessed by doctors and patients respectively. It is believed that embracing this strategy of managing knowledge in the health care dispensation holds the potential to bring about improved health care outcomes.

Keywords: knowledge management, explicit and tacit knowledge forms, codification and personalization knowledge management strategies, evidence-based medical practice

1. Introduction

Evidence-based medicine is defined as the integration of research evidence, clinical expertise, and patient preferences and values in clinical decision-making (Sackett et al., 1996). This model of medical practice has influenced decisions and actions throughout the health care industry for about a couple of decades, particularly in the advanced countries. However, little is known as to how patients with their tacit knowledge have en suite into the evidence-based practice equation especially in the developing world.

An understanding of how patients fit into the evidence-based medical practice is critical because patients, more than ever, are equipped with wealth of tacit knowledge about their health needs. Such tacit knowledge can have a dual connotation on health care delivery by either promoting or obstructing the acceptance of medical expertise based mainly on explicit knowledge & clinical experience. Incorporating patients’ needs, values, and expectations rigorously in medical practice has many benefits. It holds the potential to deal with inappropriate tacit knowledge that patients may have on their health conditions, while at the same time reinforcing appropriate knowledge that can promote their health.

Marginalization of patients’ tacit knowledge in the evidence-based equation can easily spell the doom for the health care industry. This is because effective health care delivery is based not only on rigorous scientific knowledge, but also on clinically relevant experience as well as patients’ values. Patients’ values take into cognizance the unique preferences, concerns, and expectations each patient brings to the clinical encounter. These are values that must be integrated into clinical decisions if they are to serve the patient. In order to ensure optimal clinical outcomes, therefore, there is the need for an effective integration of the three elements espoused by the evidence-based medical paradigm– scientific knowledge of doctors, clinical experience and patients’ values. This paper, therefore, aims at assessing the inputs of patients’ tacit knowledge in the knowledge management dispensation within the evidence-based medical practice in Ghana.

The paper takes off with the rationalization for the evidence-based medical paradigm and closely followed by the knowledge forms and management strategies available in aid of clinical decision-making. Next, the study’s theoretical framework premised upon the mix application of the theory of communicative action and the Parsonian AGIL taxonomy is discussed as the benchmark in assessing
the role of patients’ tacit knowledge in evidence-based medical practice. This is followed consecutively by the study’s methodology, results, discussions, and conclusion.

2. Rationale for evidence-based medical practice

Evidence-based medical practice refers to the rigorous use of science or research evidence together with clinical expertise and patients’ tacit knowledge as the basis for making clinical decisions. Since the early 1990’s, various fields of human endeavour, particularly medicine and health care policy-making, have taken up the challenge of evidence-based practice. Proponents of evidence-based practice believe that explicit knowledge as well as tacit knowledge forms should constitute central pillars of clinical or micro level health care decision-making.

The rationale for evidence-based medical practice derives strongly from the need for health care providers to be more accountable to their clients. Now, more than ever, there is an increase in the availability of information about health and illness, by the media and on the Internet (Hardey, 1999; Karpf, 1988). Public awareness and interest in health matters is on the rise, as seen in the increased interest in health and wellness, the setting up of support groups activities, and the creation of health discussion groups. This is leading to a growing wealth of knowledge with which the public can use to question professional health care services. Doctors, therefore, are being pushed to develop evidence-based practices and treatments in order to substantiate and justify their decisions and actions. Evidence-based medical practice is, therefore, a relatively systematic and scientific approach that has developed out of social accountability.

The practice of evidence-based medicine follows four steps: (1) the formulation of a clear clinical question related to the patient’s problem, (2) a search in the literature for relevant clinical articles (i.e. the best available evidence), (3) the evaluation of this evidence for its validity and usefulness, and (4) the implementation of the evidence in clinical practice (Rosenberg et al., 1995). Clearly, evidence-based medicine starts with and depends on scientific research which is based on the use of explicit (externally generated scientific) knowledge. The literature on evidence-based medicine is thus emphatic on externally generated scientific evidence. Although it does not ignore the important role of clinical expertise and patient values and preferences, those two factors especially the latter are downplayed.

This observation clearly signifies that internally generated explicit knowledge, as well as the tacit knowledge doctors derive from their daily encounters with patients, may be easily ignored. Without a doubt, clinicians may find it difficult or almost impossible to support their practices and actions with only tacit knowledge as evidence. Yet, ignoring or overlooking the significance of tacit knowledge in clinical practice may not serve the interest of the health care system. This is because doctors gain a wealth of knowledge from their practice, which should be placed at the disposal of patients for improved health care delivery. Furthermore, patients are more likely to accept the medical directives of doctors, not only because of their esoteric scientific knowledge, but also because of the intrinsic pay-off associated with patients’ involvement in clinical engagements. Under this dispensation, patients are seen not just as mere clients at the receiving end of medical practice, but as active players in the health care delivery process.

The organization and management of clinical experience as well as patients’ inputs in a form of tacit knowledge can complement scientific evidence in clinical practice. Doctors and patients are likely to optimize clinical outcomes and improve quality health care delivery when scientific research evidence accords with clinical expertise derived from clinical practice and patient values and preferences. This reinforces the view that external clinical evidence can inform, but never replace individual clinical expertise. To be sure, it is the clinical expertise that determines whether the external evidence applies to the individual patient at all and, if so, how it should be integrated into a clinical decision with the patient’s values and preference in mind (Sackett et al., 1996). Theoretically, evidence-based medical practice is premised upon both explicit and tacit knowledge use. These knowledge forms and the management strategies commensurate with them are assessed hereafter.

3. Knowledge forms and management strategies

The balance of power within the doctor-patient relationship has been characterized by the distinction between explicit and tacit knowledge forms possessed by doctors and patients respectively and which one features prominently in clinical decision-making. The fact that doctors’ explicit knowledge features more prominently in clinical decision-making than patients’ tacit knowledge provides them with more
authority in the doctor-patient relationship. Patients’ tacit knowledge is, therefore, relegated to the background when clinical decisions are being made.

The explicit and tacit knowledge forms are currently recognized as the de facto knowledge categorization informing decision-making in almost all organizations. However, Polanyi (1967) believes that a large part of human knowledge is tacit. Knowledge of this type is action-oriented and has a personal quality that makes it difficult to communicate. Accessing tacit knowledge, therefore, presents a number of challenges, due to factors such as the absence of explicit scientifically repeatable process for eliciting such forms of knowledge. Explicit knowledge, however, can be communicated across time and space.

Conceptually, there is a clear distinction between these two forms of knowledge. Nevertheless, they are not discrete or independent in the practical sense. These forms of knowledge are not dichotomous, but mutually dependent and reinforcing (Alavi and Leidner, 2001; Lam, 2002). Fostering a dynamic interaction between tacit and explicit knowledge, therefore, generates new forms of knowledge vital in decision-making (Nonaka and Tekeuchi, 1995; Lam 2002). This implies that effective utilization of knowledge (both explicit and tacit) in health care decision-making can be assured if health care organizations put in place appropriate knowledge management strategies to maximize knowledge use in decision-making.

Knowledge management is defined as the process by which an organization creates, captures, acquires, validates and uses knowledge to support and improve its overall functioning (Kinney, 1998; Davenport et al., 1998; Bhatt, 2001). It entails a plan that describes how an organization intends to better manage its knowledge for the benefit of that organization and its stakeholders. A good knowledge management strategy is closely aligned with the organization’s overall strategy and objectives. Selecting the right knowledge management strategy is, therefore, an important prerequisite for attaining organizational objectives.

Hansen et al. (1999) point at two contrasting strategies for knowledge management: codification and personalization. They believe that the best knowledge management strategy is always a combination of the two, but with a stronger emphasis on one. While a codification strategy is appropriate for explicit knowledge to thrive, the personalization knowledge management strategy better supports the use of tacit knowledge in decision-making (Jasimuddin et al., 2005). Since tacit and explicit knowledge forms are complementary, an organization’s efforts towards knowledge management should be focussed on instituting the most appropriate strategy to maximize knowledge use in decision-making.

These two knowledge management strategies have distinctive features. The codification knowledge management strategy ensures the re-use of explicit knowledge by capturing, codifying, classifying and making available knowledge to support routine problem solving. Uniformity in action is ensured since knowledge is recycled to guide decision-making. Questions regarding problems and the usual response to them serve as the primary questions guiding codification strategies in decision-making. For such questions to be resolved, libraries of procedures, policy documents, guidelines, data collection forms, typical cases and outcomes, and risk assessment tools derived from all parts of the organization must be developed and made available to all individuals in the organization in aid of decision-making. The codification knowledge management strategy also thrives on the availability of incentives to encourage staff to use the system. This implies that organizations adopting the codification knowledge management strategy should reward the use of, and contributions to, document databases as recognition of staff adherence to policies. The codification strategy, in general, involves intensive investment justified by multiple knowledge re-use.

At the same time, the codification strategy seems to overemphasise internally generated explicit knowledge re-use, without any reference to the use of externally generated explicit knowledge in the form of research evidence. This is a flaw that is not addressed in the strategies of knowledge management presented by Hansen et al. (1999). Since explicit knowledge comes from both internal and external sources, attempts at its management should be comprehensive enough to reflect this duality.

This notwithstanding, the codification knowledge management strategy based mainly on internal explicit knowledge can complement the evidence-based decision-making paradigm, which also seems to be tilted towards externally generated explicit knowledge to the neglect of explicit knowledge.
generated internally in an organization. Harmonizing the codification knowledge management strategy and the evidence-based decision-making paradigm has the potential to provide a more comprehensive perspective on explicit knowledge management in health care decision-making.

The personalization knowledge management strategy, on the other hand, is suitable for tacit knowledge use. Since communication is the bedrock of the personalization strategy, organizations adopting this strategy must reward direct communication and empower people to share their views without any fear or intimidation. This strategy of managing knowledge entails a modest investment, justified by improved frequency and quality of communications (Hansen et al., 1999; Wyatt, 2001). Relating this to the evidence-based paradigm, therefore, it can be concluded that this strategy of harnessing knowledge can best be utilized in tapping patients’ tacit knowledge to be incorporated in clinical decision-making. This will enable doctors to package health care services in such a manner to reflect patients’ values and expectations.

Since codification and personalization knowledge management strategies exhibit contrasting features, they should be commensurate with the dominant knowledge form of any given organization. The features of the two knowledge management strategies indicate clearly that organizations embedded with routine and non-routine tasks lend themselves largely to codification and personalization knowledge management respectively.

The two knowledge management strategies have their unique advantages and disadvantages. The personalization strategy is recommended for its contribution to innovation (Alversson, 2001), and its low investment in information technology (Johannessen et al., 2001). Disadvantages associated with the personalization strategy include an organization’s inability to store knowledge beyond the minds of individuals without some process of articulation. In other words, personalized knowledge is difficult to be communicated to others (Connell et al., 2003). The most serious difficulty associated with personalization strategy as a support for evidence-based medical practice is the lack of confidence on the part of some patients to share their tacit knowledge with doctors.

The codification strategy does protect the loss of knowledge associated with the exit of employees because such knowledge is taken from individuals and codified for general organizational use. This is particularly critical in an environment of a high labour turnover, like the current situation in the health care sector, particularly in the developing world. The fact that knowledge is codified, however, makes organizations “externally vulnerable” because codified knowledge can easily be leaked out of the organization. It is also costly pursuing a codification strategy because it is based heavily on information and computer technologies.

The choice of knowledge management strategy should also be based on the organization’s knowledge and objectives. Business and profit-oriented organizations are more likely to embrace the personalization strategy to insulate themselves against knowledge leakage to “business rivals” (Jasimuddin et al., 2005). All other things being equal, health care decision-makers, like most decision-makers in non-profit and quasi-profit oriented organizations, may not necessarily be afraid of knowledge leakage. In this case, they are likely to be better off if they codify knowledge and share it with others in the industry for improved health care delivery.

In spite of the benefits associated with the codification of health care knowledge, Wyatt (2001) called for the development of personalization strategy for knowledge management in health care decision-making. This means that a case has been made for an amalgamation of explicit and tacit knowledge forms in health care decision-making. In order to buttress this perspective, an understanding of the knowledge management strategies in support of evidence-based medical practice becomes critical, hence the need for the study.

4. Theoretical framework

Two contrasting perspectives have been advanced in assessing the role of patients’ tacit knowledge in clinical decision-making. There is the Parsonian perspective, which characterizes medical and explicit knowledge as having primacy over tacit understandings of health and illness, thus making the doctor the sole active determinants of health and illness. The patient is therefore rendered a mere passive recipient of medical explicit knowledge (Parsons, 1951). This Parsonian view of explicit knowledge use in clinical decision-making took decades to be challenged by social control theorists.
like Friedson (1970), who saw the one-sided rationalization of explicit knowledge use in clinical decision-making as primarily hierarchical and essentially an affront to the majority of patients.

The key characteristic facilitating the power doctors have over patients, according to Friedson, is knowledge control, which many doctors are doubtful to give up easily. He, however, proposed a remedy to the situation through empowerment of patients to play a more active role in clinical decision-making as well as in the overall delivery of healthcare services, both at the micro and the macro levels. Friedson's work formed the basis of a new interest in studying and understanding patients' knowledge use in clinical decision-making (Scambler and Britten, 2001); and the facilitation of the evidence-based medical practice, particularly in the advanced world in the 1990s. The evidence-based paradigm can at best be described as an alternative to medical practice based on authority, tradition, and doctors' sole expertise and experience.

One of the applicable sociological theories that can be adopted to understand the motivation behind the doctor-patient communication and the attainment of the latent pattern maintenance is the Habermas' theory of communicative action. As per the tenets of the evidence-based medical paradigm both explicit and tacit knowledge forms are expected theoretically to play a part in informing clinical decision-making. How these two forms of knowledge feature in clinical decision-making remain unexplored in the context of health care systems in the developing world.

Communicative action, according to Habermas (1990), is a distinctive type of social interaction based on mutual understanding reached by all the parties involved in the interaction process in an unrestrictive fashion. This action facilitates a decision-making process that encourages collective construction of goals and means to attain mutual agreement, rather than the achievement of concealed interest. Decision-making in this context becomes an interactive collective task, where communicative rationality is reached mutually by means of the application of varied knowledge forms, including scientific, moral, ethical, and emotional analysis (Healey, 1997).

Practically, however, communicative action geared towards communicative rationality is difficult to be attained in clinical decision-making process ingrained essentially in strategic rationality. Such strategic rationality operates by identifying and pursuing set goals, with reference primarily to scientific knowledge and adopting scientific solutions with patients being kept on the fringes. Communicative rationality, by contrast, involves the development of shared understandings about things which can then be used as the basis for mutually agreed action. Doctors and patients are likely to attain communicative rationality if they are motivated to adapt and integrate the explicit and tacit forms of knowledge as resource in attaining the goals of quality evidence-based medical decision-making.

In this study, how the communicative rationality is attained in clinical decision-making by meeting the needs defined by the AGIL taxonomy - adaptation, goal attainment, integration, and latent pattern maintenance – is explored. According to Parsons (1951), all social or action systems have four major needs – adaptation, goal attainment, integration, and latent pattern maintenance. How these needs are met determines the success of any social system. In relating this to the healthcare system, adaptation refers to the need to secure sufficient knowledge (resources) in informing clinical decisions. The knowledge mobilized is then utilized in ensuring specific goal attainment within the healthcare system. Effective adaptation geared toward goal attainment becomes a reality when knowledge forms marshaled are well integrated within the system. Integration thus connotes the need to coordinate, adjust, and regulate relationships between doctors and patients with the objective of reaching mutually agreed clinical decisions. These decisions can best be reached in a form of communicative rationality when doctors and patients are sufficiently motivated to play their parts within the health care system, thus ensuring the latent pattern maintenance. A mixture of the theory of communicative action and the AGIL taxonomy, therefore, anchors this study.

5. Methods

In this study, interviews with fifty respondents from the central region of Ghana – thirty patients and twenty doctors are analysed as the basis for examining the place of patients’ tacit knowledge in the evidence-based medical practice paradigm. The convenience sampling technique was adopted in selecting the thirty patients at the Central Regional Hospital in Cape Coast, Ghana. For the doctors, the purposive sampling was the benchmark in the selection of the twenty participants from hospitals in the region. This made it feasible for doctors at the various strata of the medical hierarchy to be selected for the study.
Qualitative interview was the main data collection technique used in this study. The interviewing technique was chosen over the other techniques because the face-to-face interview is said to be perhaps the most powerful and useful tool in research (Kerlinger, 1986). To ensure that the questions were not ambiguous, a number of health care decision-makers and members of the general public were interviewed at the pre-testing stage. Their responses to the interview questions were analyzed to assess the quality of the instrument. This opportunity assisted greatly in structuring a good and clear instrument for the respondents.

The actual interview session lasted for an average of thirty minutes. Responses were audio taped, and some notes were taken during the interviews. Themes raised during the interviews were guided principally by the theory of communicative action and the AGIL taxonomy and their application to knowledge use in clinical decision-making. This was approached with much emphasis on patients’ tacit knowledge use in clinical decision-making. The interview instrument for the doctors covered the following areas: (1) perception of evidence-based medicine, (2) types of knowledge used for health care decision-making, (3) perception of patients’ tacit knowledge in clinical decision-making and (4) knowledge management practices in health care decision-making. The interview instrument for the patients also entailed the following issues: (1) perception of evidence-based medicine, (2) patients’ knowledge and its place in clinical decision-making, and (3) knowledge management strategies patients believed should be adopted in support of evidence-based medical practice.

A combination of inductive and deductive approaches was adopted to categorise the factors and variables entailed in the data. The analysis progressed in two stages. Stage one of the analysis entailed thorough individual interview transcripts, which were reviewed manually, line by line, in order to identify patterns or themes and produce key words and phrases (inductive process). This process is sometimes referred to as “open coding” (Strauss and Corbin, 1990). Labels or categories were produced from the key words or phrases as a way to uncover common factors or variables. Relationships among the factors or variables were then established, which were matched with those from the literature. Stage two of the analysis involved cross interview transcripts. Similarities and differences in the factors or variables were identified in order to determine how they were linked. This process is referred to as “axial coding” (Strauss and Corbin, 1990), which facilitated an integrated link among the factors and the variables. Similar factors and variables were identified and given common names, while retaining the unique variables. Factors and variables involved in knowledge management processes entailed in clinical decision-making were then established.

6. Study results

It is explicit in the literature that the practice of evidence-based medicine entails integrating individual clinical experience with the best available external clinical evidence (Sackett et al., 1996). Such practice clearly flourishes with the development of systematic reviews and meta-analyses, which summarize the best available evidence on a topic. For optimal health care delivery, therefore, an evidence-based medical resource that continually search, appraise and summarize the literature for doctors’ use in clinical decision-making becomes a prerequisite. Further, an availability of a community of practice for medical teams also becomes paramount. Wenger et al. (2002) defined communities of practice as groups of people who share concerns, set of problems, or a passion about an issue, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis. Communities of practice are, therefore, critical in ensuring successful evidence-based medical practice because best evidence does not need to be generated by all doctors on individual basis. Note that credible medical evidence can be shared & authenticated by fellow practitioners if they indeed practice as a community. These critical parameters of the evidence-based medical practice provided the basis for the questions posed to the doctors interviewed for the study.

It was unanimously expressed by the doctors interviewed that evidence-based medical practice is the best route to ensure effective health care delivery. They were, however, quick in admitting that conditions on the ground made it almost an impossibility to implement the practice fully. Unavailability of sufficient funding to provide an effective foundation for evidence-based medical practice stood tall among the problems mentioned. Next was the limited access to improved modern technologies and up-to-date medical research from both home and abroad. Note, however, that these are critical linchpin for successful implementation of evidence-based medical practice. One doctor responded as follows:
“Evidence-based medicine though we embrace it and try to put it into practice, unavailability of resources makes it difficult to implement it. This is the reality and we cannot run away from it. I hope it changes for the better though.”

The doctors further admitted that explicit knowledge combined with clinical experience essentially provided the basis for making clinical decisions. These knowledge forms were not codified to be easily accessed by all doctors. It was evident that whereas some doctors made efforts to codify the knowledge acquired in practice for easy re-use, others found no need for it because the system did not support it. All the doctors, however, expressed interest in the codification of their clinical expertise and indicated their readiness to embrace this strategy of managing knowledge if resources such as computers and access to credible scientific journals are made handy to them. A doctor had this to say:

“Most of us do applaud evidence-based medical practice; we were trained to accept it. But as to whether we keep to it, is a different question. We are doing our best within the constraints surrounding our work.”

Another doctor made the comment below:

“Evidence-based medicine though fine on paper, its practice can be hell given the resources we have available to support it. Evidence-based medicine thrived on availability of reliable relevant technology, which we largely lack in the dispensation of our services. A significant practice of evidence-based medicine, though relevant, we are yet to embrace it fully. But we are on course & believe we will be there one day soon hopefully. There are enough signs on the ground in support of my assertion like installation of internet connectivity, though unreliable, it is a way forward.”

It also became evident that the doctors relied on available medical journals to inform themselves of medical expertise & clinical experience from elsewhere. Excessive demands at work, they expressed, limit them to take full advantage of these journals. They however could not access all the journals they needed because of the high subscription cost involved. Such cost, though could be reclaimed, many doctors did not do so because of the numerous administrative hurdles entailed in securing the refund. Clearly, there is no institutional or official policy in place to support effective knowledge management in clinical decision-making, a condition critical in the successful practice of evidence-based medicine.

In line with the theory of communicative action, the doctors were asked about their position on the involvement of patients’ in making clinical decisions and whether there are laid down rules in ensuring a mutual use of explicit & tacit knowledge possessed by doctors and patients respectively in clinical decision-making. It was unanimously expressed by the doctors that patients’ tacit knowledge should not be extensively involved in the process of making clinical decisions because of their limited and most often erroneous and questionable medical and health viewpoints. This viewpoint contradicts the tenet of the evidence-based medical paradigm, which recognized patients’ tacit knowledge as critical in making effective clinical decisions. The following comments were among the views generally expressed by the doctors with regards to the use of patients’ tacit knowledge in clinical decision-making:

“At best we listen to patients in order to know their concerns, but can hardly use their often distorted, superstitions and unempirical knowledge about their health in clinical decisions. We aren’t there yet.”

“Patients’ largely do not know anytime about medicine for their inputs to play a role in clinical decision-making. We do listen to their needs & I think it should end there for now, till patients’ are well informed enough to play a major role in clinical decision-making.”

The doctors, however, believed that health care delivery could potentially be improved significantly with the involvement of patients in clinical decision making. This notion is premised on the assumption that patients, all other things being equal, will embrace & actively adhere to clinical directives if their inputs are sought in making decisions about their health. Active involvement of patients in clinical decisions could also provide clinicians with a platform to learn about what patients know about their health and counsel them appropriately.

This revelation shows that whereas evidence based medical practice has proceeded with active involvement of the patients in making clinical decisions in the developed world, the situation is different in the developing world where medical staff are suspicious of the tacit knowledge possessed
by the lay public. In the developing world, therefore, evidence-based medical practice can only be given a real meaning if the public becomes more enlightened on health and medical issues to enable them participate actively in clinical decision-making affecting them.

From the patients’ perspective, there was a mixed reaction with regards to their stance on their involvement in clinical decision making. More than half of the respondents believed strongly that clinical decision making should be a sole prerogative of doctors because of the complex nature of medical expertise. A patient has this to say:

“What do we know to be part of clinical decision-making? Doctors are the ones trained to do that, so that decision has to be left for them. It is in our own interest to stay out of it.”

Very few respondents, however, shared the contrary view, claiming the need for patients to be central in clinical decision making because such decisions affect them directly. They were quick, however, in adding that the esoteric nature of medical expertise makes it necessary for doctors to take control of the clinical decision making process, with the inputs of patients being sought as the basis upon which the ultimate decisions are premised. Public education and enlightenment on health and medical issues, therefore, becomes critical if the public are to play any meaningful role in the health care delivery process. A respondent who applaud the active rather than passive involvement of patients in clinical decision-making passed this comment:

“Clinical decisions are about the well-being of patients and as such should be involved in the decision-making. It is an insult to say that patients are uninformed about medicine and for that matter should be excluded. I know the basics about my health & feel confident in diagnoses where my input is recognized. I believe many other patients share my view.”

The concept and practice of evidence-based medicine is confronted with mixed reviews from the public. Whereas there is excitement from those in the academic and research worlds, there is suspicion from those in the "real world," who find the evidence-based medicine impractical in a busy medical office or hospital with a very high workload for doctors and other clinicians. However, evidence-based medicine is doable in the developing world if only governments can resource the health care industries to take advantage of the large availability of database of medical research, a wealth of new evidence-based resources, the rise of “information mastery” and access to information via the Internet. The section following will discuss what needs to be done in creating an enabling environment by governments, health care providers, and the general public in order to take maximum advantage of the evidence-based resources abound in contemporary knowledge-based society.

7. Discussion of knowledge management in clinical decision-making

Quality health care delivery is contingent upon the adoption of the right strategy of managing knowledge commensurate with the dominant form of knowledge informing clinical decision-making. Ensuring effective knowledge management in support of doctors’ decision-making, therefore, requires that health care organizations adopt a knowledge management strategy to guide the various knowledge processes. There are many approaches to the development of knowledge management strategies in organizations; there is no one size that fits all. The key is for organizations to align their knowledge management strategies with overall organizational strategies and goals. The evidence-based medical practice is one of the feasible strategies that have been adopted to maximize knowledge use in doctors’ decision-making. This paradigm of knowledge management, though has been widely embraced in the advanced world for almost two decades, it is yet to become entrenched in the developing world. The fitness of the evidence-based medical practice in the health care system in Ghana is discussed hereafter.

As stressed prior, the evidence-based medical practice thrives on the use of both explicit and tacit knowledge forms by doctors and patients respectively. These forms of knowledge, however, are not utilized in equal proportions in clinical dispensation. The esoteric nature of medical expertise clearly establishes explicit knowledge form as the main reference in clinical decision-making. The use of patients’ tacit knowledge form in doctors’ decision-making, therefore, becomes peripheral. This revelation largely undervalues the role of tacit knowledge in clinical decision-making. Hence the need to harness both forms of knowledge in clinical decision-making, but of course with more emphasis on the dominant form of knowledge, which indubitably is explicit knowledge in the case of clinical decision-making.
From the Habermasion communicative action theory, therefore, it could be inferred that communicative rationality in clinical decision-making is attainable only when the communicative action engaged in by patients and doctors is premised upon mutual respect for each other's inputs. Such a communicative rationality is based not only on scientific evaluation of what is rational, but also on socially deterministic values that patients’ bring to the table.

Evidence-based medical practice to be a reality rather than a myth demands an institutionalization of an explicit or official policy on knowledge management. Though the Ghana health care system can brag of having various forms of knowledge management practices in place, the absence of an explicit policy guiding such practices negates the benefits associated with them. Knowledge management policy is critical in spelling out in clear terms the overall objectives of the evidence-based medical practice, the knowledge management forms, strategies and practices to be adopted, and the role to be played by the health care staff and policy makers in support of the paradigm.

7.1 Nurturing evidence-based medical practice

Following the analysis of the knowledge management practices currently being adhered to by doctors; it is evident that codification knowledge management strategies feature more prominently than personalization knowledge management strategies in clinical decision-making. Since codification knowledge management strategies ensure re-use of explicit knowledge by capturing, codifying, classifying and making available knowledge to support routine clinical decision-making, the availability of incentives in support of such strategy becomes paramount in the health care system. This is important because codification knowledge management strategies, unlike personalization strategies, need to be carefully and tactically nurtured to maximize its impact in decision-making (Hansen et al., 1999).

The implementation and nurturing of the evidence-based medical practice is dependent upon availability and use of internet and communication technologies to marshal and re-use best clinical practices by doctors. Taking this road, though might be very expensive, the overall pay off in the long-run is huge in ensuring improved health care delivery for all. The use of the internet and communication technologies, in addition to being an important intervention for internally generated knowledge, has the potential also in taking advantage of externally generated knowledge. Clinical best practices identified by doctors elsewhere can be obtained as an add-on to the internally generated clinical knowledge.

Doctors because of the availability and use of the internet and communication technologies can also form communities of practice as a platform to share knowledge and experience on best clinical practice. Even though communities of practice generally emanate voluntarily, they can be deliberately introduced and nurtured in organizations. Cultivating communities of practice among doctors implies that arrangements such as: formal physical, virtual spaces to facilitate free flow of information and organizational motivation for them to belong to such communities are provided.

Further, the online communities of practice can be introduced and nurtured to enable doctors to share best practices not only with colleagues at work, but also with other clinicians all over the globe in support of evidence-based practice. All these, however, are feasible if doctors and other health care providers are retrained and well resourced to maximize the use of computers and internet and communication technologies in search of best clinical evidence in support of their practice. Such training should also be extended to appropriate supporting staff to equip them with the necessary skills and tools in the search and retrieval of relevant knowledge in aid of clinical decision-making. Clinical libraries equipped with the requisite resources - qualified staff, contemporary and top medical journals, computers and internet and communications technologies are critical in providing the enabling condition for evidence-based medical practice to thrive.

7.2 Challenges to effective evidence-based medical practice

Evidence-based medical practice like any paradigm is not impervious to challenges. Adopting it demands commitments on all fronts – government, health care system, and the general public. The government should be willing and ready to provide the needed resources to facilitate the paradigm. Further, there is the need for education on the rationale of the paradigm to be spelt out cogently to all the stakeholders within the health care industry, particularly doctors, who largely doubt the contribution the lay public can make into health care decision-making.
In order to ensure that the public participate actively in the evidence-based medical practice, they should be well educated on common health issues affecting them and also be empowered to form communities of practice to share what they know and feel about their health. This will encourage patients to be more confident to bring their tacit knowledge to bear in clinical decision-making. Health promotion and education, therefore, becomes paramount in order to address the limited access to medical information by patients. Health promotion, as an indirect requisite of the evidence-based medical practice, has the potential to bring about a healthy society and ultimately helps to minimize the ever escalating health care cost in the country.

8. Conclusion

So far, it has been made explicit that evidence-based medical practice is doable in Ghana. Embracing this strategy of managing knowledge in health care dispensation holds the potential to bring about improved health care delivery, and also flatten somehow the knowledge base in health care decision-making, which has long been vilified by many social control theorists as a one-sided rationalization based primarily on explicit knowledge with patients tacit knowledge grossly back dropped. Though the knowledge base of patients, generally in the Ghanaian context as a developing country is not so strong, ignoring evidence-based medical practice because of that could be detrimental to overall health care improvement in the country. Ensuring evidence-based medical practice in Ghana and the rest of the developing world demands that patients and communities are empowered to take the centre stage in the delivery of health care services. This will significantly enhance the communicative actions between doctors and patients in such a way that knowledge from these two parties could be harnessed in an unconstrained manner towards effective clinical decision-making for better health care outcomes for all.

References


Methods and Tools for Knowledge Management in Research Centres

Jean-Louis Ermine
Telecom Business School, Évry, France
jean-louis.ermine@it-sudparis.eu

Abstract: In the Knowledge Based Economy, research centres whether industrial or public, play a fundamental role. In terms of Knowledge Management, these organisations have a special status, because their production is knowledge and only knowledge. The Knowledge Capital they accumulate in their activities therefore is a strong strategic issue and the management of these assets has become crucial. The problem addressed in this paper is to design a pertinent methodology for Knowledge Management considering the specificity of knowledge production by research centres. This methodology is based on a suitable model to describe that knowledge production. The reference model is built on knowledge flows between the organisation and its knowledge workers, and a subsystem called "Knowledge Capital". A research centre is defined by the fact that its product is only knowledge and is accumulated in its knowledge subsystem. Some economical characteristics of this Knowledge Capital are shown as being very adapted to knowledge produced in research centres. The methodology is based on two tools. The first tool is the knowledge map that can represent a comprehensive model of the Knowledge Capital of the organisation, which is often not well known or unstructured. That map is built on a shared and consensual vision of the main knowledge actors. It is not a map produced by a knowledge tool, but a co-construction (through interviews) with the knowledge actors. The second tool is a grid for criticality analysis (Critical Knowledge Factors), which evaluates the knowledge domains of the organisation and suggests appropriate actions to be put in place for the most critical domains. This tool is a guide for interviewing knowledgeable actors in the organisation, to collect and analyse a set of data for decision support. The aim of the methodology is to provide a set of recommendations to build a KM plan of actions to preserve, share and make evolve the Knowledge Capital. The methodology has been elaborated through constant feedback with practice, and has been validated in many real cases in various countries. Three case studies (France, Brazil, and Canada) are succinctly described to exemplify the effectiveness of the methodology.

Keywords: knowledge management, knowledge capital, research centre, knowledge map, critical knowledge factors

1. Introduction

In the so-called "Knowledge Based Economy", the role of research centres, private or public, is becoming predominant (OECD 2000, OECD 2004). They are crucial for the production of knowledge, which is an economic asset capable of sustainable growth and a decisive competitive advantage for businesses. For example, the objective of the Lisbon process, launched in 2000 by the European Council, clearly defines the framework for this community of nations: making in Europe the most dynamic and competitive knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion, and respect for the environment by 2010" (Europe 2000).

The challenge is, first of all, macro-economic: nations, like companies or organisations, must invest heavily in research and innovation. Such investments in "knowledge" are increasing sharply in the world. Moreover, this interest in knowledge and innovation greatly impacts research centres, which are particularly involved in the knowledge economy, whether private or public. These organisations have the characteristic of having knowledge as a core asset and as their only product. In the Knowledge Economy context, they must manage their production as a strategic asset. They therefore are in the situation where the management of their knowledge capital is the key factor of their successful integration into their socio-economic environment.

Knowledge Management in a research centre poses specific problems, which are related to the nature of knowledge, whether public or private. In this paper we propose a theoretical reference model, specific to the production of knowledge in a research centre; and we develop tools for modelling and assessment, in order to supervise and manage the production of knowledge. The proposed method is now sound and validated (Ermine 2008), and is currently being deployed in numerous organisations in different countries. We illustrate the approach developed by various case studies, in France, Brazil and Canada.
2. A reference model for knowledge management in a research centre

2.1 Knowledge management in research centres

Research activities and Knowledge management are often linked in an information management perspective, for research communities (Gaines, Shaw 1997, Oliveira et al. 2005) or for research project (Barthes, Tacla 2002). Knowledge Management in research centres is seen as a productivity tool for knowledge creation or innovation (Hasan et al. 2006, Armbrecht et al. 2001, Suh, Sohn and Kwak 2004), general studies are made to discover the impact of Knowledge Management in R&D centres (Davis 2001, Frederiksen 2004). Except the numerous studies of implementation of technical information systems, there is a consensus on the impact of Knowledge Management in research centres on "critical factors enabling knowledge flow, with choice of IT tools of secondary importance" (Armbrecht et al. 2001).

Knowledge flows usually are not identified as such; there are often seen as information flows. Models dedicated to KM for research activities are linked to production processes, or innovation process or information sharing. Knowledge is not seen as an asset, and the status of knowledge flows are not clear. We propose a simple (even if restrictive) model to specify the knowledge flows, and how they participate in creating a new asset.

2.2 The knowledge centre as knowledge processor

The proposed model is based on the principle that a research centre has a "knowledge reservoir" of its own. This knowledge base is much more than the sum of individual knowledge of employees, and it is capitalised, more or less over time, through information products (documents, databases, software etc.) or by knowledge exchanges/transfers, individual or collective. The knowledge is created by the research actors (which are the principal “knowledge workers” of a research centres), most of time by in interaction with the various information systems available in the centre (databases, search engines, document management systems, software etc.), some knowledge is exchanged in an informal or semi-formal way (discussions, communities, seminars etc.), it produces tacit knowledge. Some knowledge is codified in new records (publications, reports, documents etc.), it is explicit knowledge. It accumulates in the firm during its history, and forms what is called a "Knowledge Capital".

The existence of this capital, as an intangible sub-system of the company, is still controversial, because it represents a radical alternative to the conventional view that usually equates it to processing information system for Knowledge Workers. There is then a confusion between Knowledge Capital and Information Capital.

This vision of the organisation as a "knowledge processor" can be represented by the systemic pattern of Figure 1. In this model we don't visualise yet the inputs and outputs of knowledge production as in a classical production model.

The interest of this model is in being able to visualise the knowledge flows, which are a specific production of the organisation, but not represented as such in conventional models. The Knowledge Capital appears as a "reservoir" which accumulates this knowledge. This sub-system is clearly an active system. This classically results in flows that create interactions with other sub-systems of the system. We have seen that these flows can be classified into two categories. The first one links the other organisation's sub-systems to the knowledge sub-system, and corresponds to the enrichment (over time) of the Knowledge Capital of the firm, through its various human actors and information systems. The second one is composed of the flows in the opposite direction corresponding to the appropriation of this knowledge to create new knowledge.

The detailed model, and the mathematical formalism can be seen in (Ermine 2005) and (Ermine 2008).

In the following we discuss the specific nature of the Knowledge Capital in research centres.
2.3 The nature of knowledge in a research centre

Knowledge management poses new problems that have been raised by this new discipline called the "Knowledge Economics" (Foray 2004). Knowledge is indeed a very strange thing. It has three basic properties, like an economic good:

- Knowledge is a good which is very difficult to control and which generates "externalities". This means that a company has much more difficulty controlling its knowledge than its machines. Two fundamental risks exist (Cohendet et al. 2006): "spill-over", which is the inadvertent disclosure of knowledge, and, conversely, "lock-in", which is an exclusive knowledge-sharing relationship, which prevents people from accessing external knowledge. Spill-over is constant, knowledge is always escaping from a firm (for instance in the market, inside the products). Such knowledge may benefit competitors, and gives nothing in return. This is called "positive externalities" (unlike patents, for example).

- Knowledge is what one calls a non-rival good. Unlike tangible goods, knowledge as a resource is inexhaustible, because it is not destroyed by use. Agents who use the same knowledge are therefore "non-rivals". An agent can use knowledge an unlimited number of times, so an unlimited number of agents may use the same knowledge. Transmitting knowledge is a positive sum game: it merely increases the number of holders.

- Knowledge is a cumulative good. Knowledge is the key element that helps create new knowledge. Knowledge accumulates and therefore this accumulation is a factor of collective progress for the stakeholders.

These properties, which can be negative aspects in a firm, are positive features in a research centre, especially the public ones: "lock-in" is usually not deontological, and "spill-over" is encouraged, the non-rival character of knowledge is driving the research, the accumulation of knowledge is the current priority of the research activity. We notice that this could lead to paradox, in the case of a private research centre, that needs to protect the produced knowledge. It is a common "necessary contradiction", that is not always obvious to manage.

In a firm, centred on its production process (of goods or services), knowledge is, in economic language, a "joint product". The production of knowledge in business occurs "accidentally", as a side effect, while the relevant community is oriented towards other goals. Knowledge and know-how in the

Figure 1: Research centre as a processor of knowledge flows
company are produced “unintentionally”. This is a complex process related to learning, including learning by doing. This process, as we have already said, is cumulative: the knowledge cannot be seen as a volatile flow (as it often was), but as a capital accumulating in the organisation. Thus, while fulfilling the production tasks, the firm produces jointly, an unintended (or even free!) new wealth that accumulates in the organisation. There are a lot of questions about this new wealth, because currently it is unclear how this wealth is reinvested in the productive loop.

In the framework of a research centre, this assumption is unfounded. The basic production of such an organisation is knowledge itself; it is not a joint product. Its Knowledge Capital is the core asset, and the cumulative nature of knowledge makes the Knowledge Capital the basis for production of new knowledge. It therefore appears that the model given in figure 1 can be used for a research centre with the emphasis on the Knowledge Capital as a strategic element. It is the main asset of the organisation and not a joint asset.

In the following we propose a specific representation of the Knowledge Capital, in order to set up a specific asset management.

3. Knowledge mapping or cartography

If we consider that Knowledge Management is the management of a Knowledge Capital as defined and modelled in the previous §, this management poses an obvious problem. In fact, this capital is not fully visible in the organisation, it is partially so through its visible part (records of explicit knowledge, such as the publications of its researchers). Its full identification is not obvious and does not always correspond to the intuitive idea that people have. It includes in fact all components, internal or external to the organisation, involved in the constitution of the knowledge corpus concerned. The identification of these components is necessary to delineate the body of knowledge that we want to manage. In a research centre, it would be wrong to believe that the structure of the corpus of publications, often of a "disciplinary" type, is a unique vision of this capital.

This raises the problem of representing that capital in a meaningful way, and according to various management objectives. For that purpose, there are tools and methods grouped under the term "knowledge mapping" or "knowledge maps" (Eppler 2003). According to (Speel et al. 1999), "Knowledge mapping is the set of techniques and tools used to analyze and visualize areas of knowledge, relations between these areas in order to highlight some specific features in different professional knowledge.” Knowledge maps are designed by representing some attributes of tacit or explicit knowledge in a graphic form which is easily understood by end-users (managers, experts, engineers, etc.). They help to make a careful analysis to determine, in a strategic objective, what knowledge has to be supported, developed, abandoned etc... The mapping (or cartography) becomes a tool for decision-making.

In the context of an entity dedicated to research, knowledge maps are tools that make more sense than elsewhere, since they are "structural" representations of the entity, and almost become tools to help manage the production, not only to improve performance. They play the role of business process modelling for productive organisations.

As a mapping technique, there is a famous methodology, called « Mind Mapping », created and popularised by Tony Buzan (Buzan 2003). This is the area of “Mind Maps”, sometimes called mental maps, or heuristic maps or cognitive maps. This is an approach that permits the mental representation of one or several persons concerning a specific problem to be visualised graphically. This is a tree-like representation, that is built recursively from a root node (the subject of the map), eliciting gradually, by building more and more refined branches, the different elements linked to the previous node. This is a visual and symbolic way to represent a complex problem in a “simple” manner. A cognitive map is enriched, in general, by different elements which improve its comprehension: icons, colours, graphics (images, symbols), annotations etc. that theoretically allow an easy understanding.

Our method uses principles of Mind Mapping, but in a very controlled manner. The map of knowledge domains of the concerned research centre (or a part of it) is built by analysing documents (activity reports, strategic documents …) in a first part and, in a second part, by interviewing significant people, aware of the research projects and the research organisation, identified by a “name-dropping
process”. The map has a defined semantic and its own graphical symbolism. The usual software to build the map is a classical customised Mind Mapping tool like MindManager®.

Below, in the examples, we show how mapping techniques were used (e.g. Figure 3).

In the next §, this representation of the centre’s Knowledge Capital is used to perform a kind of “risk/opportunity assessment”, called criticality analysis, that can be used to build a coherent Knowledge Management plan.

4. The criticality analysis

Organisations wishing to manage their Knowledge Capital must therefore make a careful analysis to determine their strategy and what knowledge they need to keep, develop, abandon etc. Knowledge Mapping then becomes a decision-making tool (Grundstein 2000), and can become a strategic tool for managing critical knowledge in the sense of “dynamic capabilities” of (Teece, Pisano and Shuen 1997). We show now how to use the knowledge map as a decisional tool by assessing the “criticality” of each knowledge domain of the map, to enable to decide what is the best relevant KM action regarding the criticality.

To do this, we must develop specific criteria to assess, in the knowledge map, what knowledge is most critical for the company and why. The criticality of a knowledge domain is defined as an assessment of risks/opportunities in the domain for the organisation. There may, for instance, be a risk of knowledge or expertise loss that may prove harmful, or that it may be interesting to develop a knowledge domain for some benefits for the company (productivity improvement, new market share, etc.). It is therefore necessary to define “objectively” what are the Critical Knowledge Factors (CKF) and provide a method of evaluation to identify the most critical knowledge domains in the knowledge map.

In the literature there are a lot of attempt to define sets of criteria for Knowledge Management, for different purposes:

- Key factors of success for implementing a Knowledge Management system (see for instance the studies in (Alazmia, Zairia 2003) or (Wong, Aspinwall 2005)
- Sets of qualitative parameters designed to evaluate the performance of an organisation’s knowledge assets. There seems to have now a growing consensus around the seminal approaches by (Sveiby, 1997), (Edvinsson, Malone, 1997), (Norton, Kaplan, 1996), cf. (Bontis 2001)
- Sets of criteria to qualify a Knowledge Based System (O’Hara et al, 2000)
- Sets of criteria for knowledge strategic analysis (Bohn 1994), (Tiwana 2000)

Those criteria are not dedicated to Knowledge criticality assessment as we are interested in. They have to be modified, and there is a necessity to add new criteria to address all the facets of Knowledge Criticality. We propose a set of criteria that has been designed in a workgroup grouping a lot of companies of all kinds (small, multinational, public and private research centres, many sectors …) during nearly one year, and have been tested in some of those organisations (cf. Figure 4). To address the specific nature of Knowledge in research centres, those criteria have been adapted. They are briefly described in the following.

4.1 The critical knowledge factors (CKF)

The CKF are not necessarily easy to develop. The CKF which determine the strategic importance of a knowledge corpus can be diverse, and highly dependent on the culture and business situation. One can also try to be more or less relevant or comprehensive in the development of CKF according to the importance of the KM project. Generally, there are two kinds of CKF:

4.1.1 The factual criteria

They assess the nature of knowledge, regardless of a priori knowledge of the content. These factors are intuitive, now fairly standard, and can qualify knowledge. They are classified into two classes: one evaluates the degree of expertise of the knowledge, the other assesses the rarity and fragility of the knowledge.
Examples of such factors, characteristic for knowledge in research centres:

- The depth: non expert, technical, specialized, expert
- The width: specific, multidisciplinary, transdisciplinary, generalized
- The complexity: complicated, simple complexity, complexity, high complexity

4.1.2 The strategic criteria

They are unavoidable in a criticality study. They describe the adequacy of knowledge with respect to the missions or the strategic objectives of the organisation. Knowledge can be complex, rare and fragile, but it may not be critical because it is not consistent with the objectives and this point must be carefully analyzed in regard to the strategy of the organisation. The strategic criteria are of course specific to each organisation. They must be prepared carefully in conjunction with executives at the highest level of the organisation.

4.2 The evaluation grid for CKF

Each CKF is intended to be evaluated. Each factor is rated on a scale with multiple levels, representing different levels of achievement. Each CKF evaluation is based on a question. Each level must be expressed by a clear and concise sentence, avoiding vagueness and confusion.

The evaluation of the criticality of a knowledge domain is assigned a score for each factor and for each knowledge domain. The more critical the domain, with respect to the factor, the higher the grade. Each domain is assessed independently with all the CKF. This may lead to a laborious implementation because of the large number of domains and criteria, and if there are many evaluators. Therefore the material used should facilitate the assessment task. The results are summarized graphically with the help of Excel Radar diagrams (also called Kiviat) (see examples below, e.g. figure 2).

4.3 Calculation of criticality of a domain

For each domain, several agents may be involved in the assessment. The principle of evaluation is that different evaluators should assign a rating to all factors. The calculation of the average evaluations facilitates the analysis of criticality on different levels (overall average, per reviewer, per factor). The calculation of the global criticality of a domain is obtained by averaging all scores. Several criteria can be combined or merged for different kinds of cross-analysis.

5. Examples

We have described a research centre as a “Knowledge Processor”, which includes a “Knowledge Capital” as a subsystem per se, with specific characteristics. Knowledge Management in those organisations must take into account that point of view. For a pertinent representation of the Knowledge Capital, we propose to use “knowledge mapping” techniques derived from Mind Mapping to build, with knowledge actors, the knowledge map which is a representation of the Knowledge Capital. A risk/opportunity assessment for this Knowledge Capital to support decision is necessary, and has to consider the specific nature of knowledge in research centres. We propose to use “Critical Knowledge Factors” that are evaluated by knowledge actors in the organisation. Those two tools are useful for decision making for implementing KM processes and tools.

In that §, we give examples of implementing methodologies using the tools described above, with three essential phases:

- Knowledge map construction with knowledge actors
- Criticality analysis made with knowledge actors
- Decision and KM methods or tools implementation.

Those examples have been chosen for different reasons:

- There are not confidential
- They represent a representative panel of research centres in different countries
- The author of that article was deeply involved in the realisation of those projects
There exist some available articles on those projects to get more details, if needed

There is some variability in each case, for building the knowledge map, for designing and evaluating Critical Knowledge Factors.

5.1 National Research and Safety Institute (INRS)

The INRS (French National Institute of Research and Security) was created in 1947 with the support of the National Health Insurance Office of Workers. The INRS is a non-profit organisation. Its aim is to contribute, by all appropriate means, to the improvement of safety and hygiene in professional activities, and to prevent accidents and professional diseases. It has 625 staff on 2 sites. The KM project took place in the Research and Study Centre (450 people).

The INRS started with a pilot KM project (Matta et al. 2001). The objective of this operation was to demonstrate the value of a knowledge capitalisation methodology. The capitalisation process at the INRS led to the implementation of a “Knowledge Book”. This Knowledge Book highlighted the interest of the tacit knowledge capitalisation to the INRS. The INRS wished to have a global view of relevant critical knowledge to be capitalized. A study based on knowledge mapping was then proposed in order to point out critical knowledge domains in the INRS (Aubertin 2006).

The research centre has the vocation to produce knowledge, an immaterial product. The development of the knowledge map started from a conceptual classification of domains, which organizes the information around subjects, objects or finalities. The process has several steps:

5.1.1 Location of knowledge domains

This step consists (from reference documentation and eventually from interviews) in highlighting knowledge domains by the successive analysis of research departments, their activities, projects and products.

The necessary reference documentation consists of:

- The documents on organisation (missions, organisational charts, descriptions of activity, portfolio of activities etc.);
- Documents concerning production (publications, studies, activity statements, etc.);
- Strategic documents (mid-term plans, summaries of previous mid-term plans);
- Quality documents.

5.1.2 Construction of the representation of the knowledge capital by a knowledge map

The former step is a deep analysis of the activities of the firm. The next step aims at making it accessible and more usable. The representation must be adapted to the operational vision of the people concerned. The main idea of the cartography is to distribute the different knowledge domains on strategic axes.

The definition of strategic axes is conditioned by the strategic orientation given to the business process. One may use the missions of the firm as they are defined in the basic strategy, but it may also integrate new axes concerning strategic development.

The map was built following a considerable number of discussions with different actors and numerous cross-validations. First of all, the cartography was carried out on the research domains of the institute. It was then extended to the whole portfolio of activities, including the support activities. The map is now available on the intranet with an online form, which allows employees of the institute to “self-declare” regarding a certain number of their skills.

5.1.3 Drawing up of critical knowledge factors

A set of Critical Knowledge Factors was established by taking into account the specificities of the organisation and the expectations of the cartography project. These criteria presented are organized in six families:

- Criteria concerning technical content
- Strategy criteria
5.1.4 Criticality evaluation

Every criterion must be evaluated, for each knowledge domain. For that, an evaluation scale has been established for each criterion, inspired by the evaluation methodology of the (EFQM 1999). Each criterion is given a grade from 0% to 100% representing the level of effectiveness of the criterion and each evaluation of a criterion relies on one question. Each level is expressed by a clear and synthetic sentence avoiding vague terms which may lead to confusion. The final result is displayed in a “radar” form (see figure 3). The detection of criticality has been done in an interactive way with the heads of the INRS Departments.

Figure 2: Criticality diagram for a knowledge domain

5.1.5 Conclusion

After a first pilot project, the process Knowledge Mapping/Criticality Assessment has been deployed in the whole organisation. The KM tool chosen is a knowledge portal for the researchers of the organisation. Some of the most critical tacit knowledge has been capitalised with the “knowledge book” technique.

The knowledge map, which is now available on line in the company intranet, is now used as an interface for a “knowledge server” offering a selective access to different knowledge resources:

- The criticality analysis for decision making;
- The available documentary resources;
- The knowledge repository;
- The skills repository;
The modelled processes mobilizing the key skills.

5.2 Instituto des Pesquisas y Nucleares (IPEN)

IPEN is a research centre of the National Centre of Nuclear Energy (CNEN: Comisao Nacional De Energia Nuclear) of Brazil.

Knowledge Management, for this organisation, is an important problem. Brazil has developed a real corporate knowledge in this domain, with long term investments, research and technological transfer. Nowadays, the nuclear field, as in other countries, is suffering from problems related to this considerable accumulation of knowledge: the risk of the evolution and the future of knowledge. Other specific characteristics of the Brazilian model add to these difficulties: the federation of different independent institutes, the risk of a “generation gap” due to a lack of hiring for ten years, the existence of knowledge pits which have not developed because of great changes in strategies and nuclear politics.

The project described below was conducted in a radiopharmacy centre at the research centre of Sao Paulo (IPEN) (Ricciardi, Barroso 2006). The role of this centre is the production and distribution of radiopharmacy products for use in nuclear medicine (diagnostic therapy).

This centre was created by the transformation of a research unit into an industrial production centre (and under certain aspects into a profit centre) certified ISO 9001/2000. Its employees are workers of the public sector, and it has a limited autonomy. This centre supplies 300 hospitals and clinics in Brazil. We have to note that the production of radioisotopes and of radiopharmaceutical products is still a monopoly of the Brazilian State, and that demand is growing 10% each year.

In the radiopharmacy centre, the project was developed in several steps:

5.2.1 Studies of processes

This work was done within the context of ISO certification. The processes were described in a classical way using diagrams of flows linking related activities to processes.

5.2.2 Identification of enabling knowledge

By a precise investigation close to the actors of processes, on each activity, operational knowledge has been identified as necessary and sufficient to carry out the processes in the best way: this deep analysis of the processes enabled the realization, for each process, of a table linking the processes, the activities and the knowledge (with added information on the products). The compilation of knowledge, extracted from each activity, allowed the precise identification of necessary and sufficient knowledge for the whole activity of the centre.

The completeness of this compilation is guaranteed by the fact that all the production processes have been used.

5.2.3 Construction of the knowledge map

The compilation described above gives a non-structured set of available knowledge in the centre. This set contains a lot of knowledge domains. It is neither readable nor exploitable. Then it had to be structured in a tree-like map which integrates identified knowledge, for sure, but which structures itself according to the definition of the activity and the definition of the centre’s mission. A map with seven axes, corresponding to fundamental knowledge domains, has been defined: planning, specific processes, production technology, norms and regulations, radioprotection, quality control, research and development. Each axe is split into themes which are themselves broken up into sub-themes (see the general map structure in figure 4).

5.2.4 Criticality analysis

First, Critical Knowledge Factors have been defined using Bohn's scale (Bohn 1994), adapted by (Tiwana 2000). Two criteria of “pertinence” (volume quality and complexity, importance regarding the strategic objectives of the organisation) and four criteria called “vulnerability” (difficulty to have or to train professionals of quality, difficulties due to the context, to the people involved or to the referential,
availability in the internal or external context). A questionnaire and an interview plan were established, a targeted group of chosen people was formed, according to certain criteria, and the analysis of the entire knowledge domain was realized. The cartography and the analysis of criticality were largely validated during plenary sessions. The pertinence grade represents the content and the strategy. The vulnerability grade represents the difficulty of acquisition, the capacity of sharing and rarity.

A knowledge domain is called critical if the global grade is superior or equal to the average (the scores are 0, 1.5 and 3). About 30% of fields were estimated as critical, and the justifications were established.

Figure 3: General view of the knowledge map of CR

5.2.5 Conclusion: Setup of an action plan
A set of actions which could reduce the criticality of some knowledge domains have been identified:
- A knowledge base with critical features of processes;
- A database of problems/solutions extracted from the return on experience;
- A program “RC teaching RC” (meetings and tacit transfer);
- Communities of practices;
- A program of functional development, Knowledge Management oriented;
- An organisational memory;
- A more proactive client extranet;
- A knowledge portal.

Several actions are now under way, including the design of a business portal, the design of a memory using a knowledge book methodology.

5.3 HydroQuébec Research Centre (IREQ)

HydroQuébec (Québec, Canada) is one of the biggest electricity producers and suppliers in North America. HydroQuébec is a public company and its principal shareholder is the Québec Government.

HydroQuébec has about 21,000 employees and faces difficulties linked to massive retirements and particularly the departures of the most experienced employees:
- 500 per year from 2003 to 2008
800 per year from 2008 to 2011
We can notice also that the « age curve » is very unbalanced.

Since the acquisition of the IREQ, the Québec Research Institute, by HydroQuébec, the firm has redefined the research activities of the institute with respect to its activity domains. Today, on the one hand, the firm is trying to improve the profitability of its projects and on the other hand, to reduce the global cost of research. In this context, IREQ started cartography of its different domains of expertise. The principal target is to rapidly identify the domains that must be reinforced, according to their respective contribution to the future development of the firm and the ageing phenomenon. Once the map of knowledge domains was drawn up, with a dozen domains, a criticality analysis was performed.

5.3.1 Collection of criticality data

The data collection was made with over 80 interviews with the expertise leaders, innovation managers, and business unit managers. The grid of analysis is made up of 21 criteria divided into 4 thematic axes: rarity, usefulness for the firm, difficulty to capture knowledge, difficulty to operate knowledge (figure 6). Each criterion is evaluated on a scale from 1 to 4. These four levels are different descriptions aiming to define the domain studied in the most accurate way.

The criteria of “rarity” and “usefulness” themes have been estimated twice: for their actual and future criticality (horizon 10 years).

<table>
<thead>
<tr>
<th>Thematic axes</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rarity</td>
<td>Number and availability of possessors</td>
</tr>
<tr>
<td></td>
<td>Specific (non-subsidiary) character</td>
</tr>
<tr>
<td></td>
<td>Leadership</td>
</tr>
<tr>
<td></td>
<td>Originality</td>
</tr>
<tr>
<td></td>
<td>Confidentiality</td>
</tr>
<tr>
<td>Usefulness for the company</td>
<td>Appropriateness to business operations</td>
</tr>
<tr>
<td></td>
<td>Creation of value for parties involved</td>
</tr>
<tr>
<td></td>
<td>Emergence</td>
</tr>
<tr>
<td></td>
<td>Adaptability</td>
</tr>
<tr>
<td></td>
<td>Reusability</td>
</tr>
<tr>
<td>Difficulty to capture</td>
<td>Difficulty in identifying sources</td>
</tr>
<tr>
<td></td>
<td>Mobilization of networks</td>
</tr>
<tr>
<td></td>
<td>Tacit character of knowledge</td>
</tr>
<tr>
<td></td>
<td>Importance of tangible sources of knowledge*?</td>
</tr>
<tr>
<td></td>
<td>Rapidity of evolution</td>
</tr>
<tr>
<td>Difficulty to operate</td>
<td>Depth</td>
</tr>
<tr>
<td></td>
<td>Complexity</td>
</tr>
<tr>
<td></td>
<td>Difficulty of appropriation</td>
</tr>
<tr>
<td></td>
<td>Knowledge background</td>
</tr>
<tr>
<td></td>
<td>Environmental dependency</td>
</tr>
<tr>
<td></td>
<td>Internal relational networks</td>
</tr>
<tr>
<td></td>
<td>External relational networks</td>
</tr>
</tbody>
</table>

Figure 4: Critical knowledge factors

5.3.2 Divergence resolution

All the important divergences were solved by consensus. It was rather easy to obtain a grade suitable to all the evaluators.

5.3.3 Cross-analysis

The criticality analysis allowed a strategic analysis of the institute’s knowledge, thanks to cross-analysis between some criteria. This cross-analysis is represented by graphs of points, where the respective grades of each criterion are positioned. Each graph is significant for a strategic analysis:

- The graph “creation of value/pertinence” shows the promising domains ;
The graph “usefulness to horizon 10 years/difficulty to capture knowledge” shows the domains to support;

The graph “rarity to horizon 10 years/difficulty to capture knowledge” shows the domain to develop with partnerships;

The graph “usefulness to horizon 10 years/graph rarity to horizon 10 years” gives a vision of what could be the knowledge domain of IREQ in 10 years;

5.3.4 Analysis by criteria

For each criterion, a precise analysis has detailed the possible improvement tracks. The principal axes of improvement concern the themes “difficulty to capture knowledge” and “difficulty to operate knowledge in the HydroQuébec context”.

<table>
<thead>
<tr>
<th>Knowledge domains</th>
<th>Domains with great expertise</th>
<th>Domains to be valorised</th>
<th>very vulnerable domains</th>
<th>Domains that need to improve/adapt methods for training courses, knowledge transfer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domain A</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Domain B</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Domain C</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

Figure 5: Example of cross-analysis

5.3.5 Conclusion

The criticality analysis in this project has allowed:

- The drawing up of a refined and well structured strategic vision in all the knowledge domains developed by the institute;
- These domains to be put into perspective, following the strategy of the firm;
- Numerous potential actions to be identified, adding value to the whole knowledge capital of the institute: from the creation of communities of practices to capitalisation and modelling of various knowledge domains.

The project has now been generalized to the whole company (Ermine, Boughzala and Tounkara 2006)

6. Conclusion

In the Knowledge Based Economy, research centres, whether industrial or public, play a fundamental role. In terms of Knowledge Management, these organisations have a special status, because their production is only knowledge. The Knowledge Capital they accumulate in their activities therefore is a strong strategic issue. The management of these assets becomes crucial.

Our assumption is that:

- The Knowledge Capital must be considered as a whole subsystem of the organisation where the knowledge created by knowledge actors accumulates and is reused,
- And that knowledge in research centres has specific characteristics

We can prove that assumption by building a “visible model” of that a priori previously invisible system (the Knowledge Capital): the “Knowledge Map”, and by building a specific description of the knowledge by criteria called “Critical Knowledge Factors”, in a risk/opportunity assessment objective.

Our goal is to build an operational methodology, based on those tools, providing a global approach for Knowledge Management in Research Centres. This methodology is based on three essential phases:

- Knowledge map construction with knowledge actors
- Criticality analysis made with knowledge actors, which evaluates the knowledge domains of the organisation and highlights the actions which are appropriate to be put into place for the most critical domains
• Decision and KM methods or tools implementation.

This approach has been validated in many real cases in various countries. Three examples of different applications of that methodology have been given in that paper.

References


Is Tacit Knowledge Really Tacit?

Anu Puusa and Mari Eerikäinen
University of Joensuu, Finland
anu.puusa@joensuu.fi

Abstract: The aim of this article is to increase understanding of tacit knowledge as a phenomenon and also, to specify and understand tacit knowledge of an expert in a given context. In the discourse of organizational behavior, the use of the concept of tacit knowledge and empirical scientific research on it has become more popular only in the 1990s. The strong increase in expert work and knowledge-intensive fields make examining the topic timely and both theoretically and practically interesting. The most significant theoretical contribution of the study is the increase in understanding, as well as, the creation of new knowledge of the contents and the nature of tacit knowledge. Based on our study, it seems that the current division of knowledge to explicit and tacit is not sufficient to describe the phenomenon. It has been proposed that explicit knowledge is visible and “articulated” knowledge that can easily be transferred and codified, e.g., through speech, documents and various information management systems. Implicit knowledge, on the other hand, is "silent", hidden and non-verbal knowledge that is difficult or even impossible to transfer and express verbally. We propose that tacit knowledge comprises different components, some of which can be articulated and made explicit. Examples of such are individual’s or organizations accustomed lines of action that are based on explicit instructions. On the other hand, individual-specific tacit knowledge that includes feelings, emotions and intuition, individual’s intuitive behaviour or personal relationships, can be considered as “the genuine tacit knowledge” in the sense that it cannot be made visible or transferred. These findings suggest that the interconnectedness of explicit and tacit knowledge ought to be examined further.

Keywords: tacit knowledge, nature of tacit knowledge, components of tacit knowledge, explicit knowledge, organizational culture, case study

1. Introduction

The role of knowledge is highlighted in today's organizations. Knowledge, knowing and know how are nowadays considered as the most important resources and factors of production in an information society. (Drucker 1993; Karvonen 2001) During the last decades, the amount of expert work and knowledge intensive fields has strongly increased in every industry. Ståhle and Wilenius (2006) state that both production resources as well as the ones that create competitive advantage have become more and more intangible. In addition, there are more fields where instead of equipment and production processes the most productive equity is knowledge and its development. This development concerns all the employees. The transfer from a production economy to a knowledge-based economy and from a material property to an immaterial equity requires more efficient and effective use of personal knowledge and know how as those of the whole organization. (Järvinen, Koivisto & Poikela 2002) Consequently, it is important to examine what kind of knowledge is processed, what are its sources, how is it maintained and how the creation of new knowledge could be supported and enhanced.

Knowledge is a multidimensional and ambiguous notion. Different types of knowledge can be identified. The most common division of knowledge is to separate explicit and implicit knowledge from one another. Explicit, exact and observable knowledge represents only a small part of the whole character of knowledge and know how. A great majority of the whole knowledge capital is hidden in people's experiences, knowing and skills. Consequently, we are talking about knowledge capital that has taken a relatively undefined form. (Ståhle & Laento 2000, 28.) Specifically tacit knowledge is understood to yield competitive advantage in an expert organization (Ståhle & Grönroos 2002, 48 - 49).

Research so far has indicated that even though tacit knowledge may seem a simple idea, its implications are large and far reaching. If important knowledge is tacit, then it cannot be effectively spread through an organization. This means that useful knowledge will not be able to reach those who need it without direct, face-to-face contact.

In this study, the target phenomenon is tacit knowledge in an expert context. During the last years, the interest in studying tacit knowledge has increased because it is regarded as an explaining factor of expertise (Virtanen 2006, 1). Still, Seidler-de Alwis & Hartmann (2008) point out that for many, tacit knowledge is a new domain about which little is known. The concept of tacit knowledge was first
introduced by Michael Polanyi. He introduced his ideas in a systematic form in Science, Faith and Society in 1946. Later he expanded the theme and argued that human knowledge can be divided into two different categories: tacit knowledge and focal knowledge. Everyone has tacit knowledge but it is difficult to define. In organizations, a significant part of knowledge and know how that accumulate through experience, is specifically tacit knowledge (Polanyi 1958, ix; 1966; ix).

To understand the phenomenon of tacit knowledge, Polanyi takes an example from the face-recognition: if we know a person’s face, then we can recognize it among thousands, even if we usually cannot explain how the recognition happens. Tacit knowledge can be described as a knowledge people carry in their minds and is, therefore, difficult to access and share. Consequently, most of tacit knowledge cannot be articulated. (Polanyi 1966, 4 - 5.) In most cases, it is assumed that people are not aware of the knowledge they possess or how it could be valuable to others. Consequently, tacit knowledge has been highlighted in the late 1990’s in the literature of knowledge management. According to Grant (2007), the tacit-explicit dimension of knowledge is, in fact, one of the most widely discussed topics in knowledge management.

The aim of this study is to increase understanding of the phenomenon of tacit knowledge. The focus is to specify and understand tacit knowledge of an expert in a given context. We chose a qualitative case study as the methodological approach of this study (See for example Yin 2003; Koskinen et al. 2005; Puusa 2007). Kuronen et al. (2007) state that generally, experience-based knowledge and skills are recognized to be significant only in the environment where they generate. Thus, exploration of tacit knowledge in individual contexts is both justified and meaningful. The data was collected in one Finnish organization operating in the field of education. The case organization is an expert organization regarded as an example of an organization where there are several key employees about to retire during the next couple of years. In the next sections, we consider previous research that has addressed tacit knowledge related specific issues.

2. From explicit to tacit knowledge

According to Polanyi knowledge can be divided into two classes: tacit knowledge and focal knowledge. Polanyi’s thought of the twofold nature of knowledge was based on his observation that we can know more than we can tell. It is not easy to say exactly what it means. However, we need both tacit and explicit knowledge to handle things. According to Polanyi, tacit knowledge is necessary background knowledge so that we can handle and develop explicit knowledge. (Polanyi 1966, 4; Polanyi 1964, 144) The essence of Polanyi’s theory is that there are two different states of consciousness: focal awareness and subsidiary awareness. Focal awareness and subsidiary awareness exclude one another. Focal awareness includes the object to which the activity or knowing relates and of which one is explicitly aware. The knowledge handled in the subsidiary awareness is tacit knowledge related to the object of focal awareness that cannot be expressed. If we turn our attention from the objects of focal awareness to the objects of subsidiary awareness our activity is disturbed. For example if a pianist shifts his attention from the piece he is playing to the observation of what he is doing with his fingers while playing it, he gets confused and may have to stop. According to Polanyi, unarticulated knowledge is dealt with in subsidiary awareness whose activities include also the combining of the undefinable parts of the phenomenon in hand i.e. of the totality existing in focal awareness. The knowledge related to subsidiary awareness can be regarded as a manual of what should be done with an object at each time. It is indefinable to its holder but, according to Polanyi, the process of knowing lies heavily on it. These two different states of awareness exclude one another in a sense that one can pay attention to only one of them at a time. According to Polanyi, tacit knowledge is situated in subsidiary awareness but it expresses itself through an object in focal awareness. (Polanyi 1958, 55 - 65.)

According to Polanyi, all knowledge is either tacit or is based on tacit knowledge (Polanyi 1958; 1966). Polanyi states that all knowledge has a tacit component. In the other words Polanyi never intended tacit knowledge to be a separate category of knowledge, but rather to be an integral part of all knowing. It is with the help of tacit knowledge that we can know when to trust in explicit knowledge. A document, on the face of it, holding explicit knowledge has also the dimension of tacit knowledge because it is dependent on the cultures, languages and understandings of its writer and reader. Thus, according to some researchers, tacit and explicit knowledge are not counterparts to one another. They are mostly two sides of the same thing and complete one another. Adopting and applying tacit knowledge requires often the support of explicit knowledge and vice versa. Tacit knowledge guides our choices in dataflow. Based on it, we can disregard a vast amount of unnecessary knowledge.
without reacting to it at all. (Polanyi 1958, 87; Polanyi 1966, 20 - 21; Koivunen 1997; Kuronen et al. 2007.)

According to Nonaka and Takeuchi (1995), explicit knowledge is formal and systematic and it can be expressed in words and numbers. Moreover, it can easily be processed by computers, transmitted electronically or saved in databases. Tacit knowledge in turn, is very personal and difficult to make visible because of its abstract character. Tacit knowledge includes subjective views, intuition and perceptions as well as experience, ideas, values and feelings. (Nonaka & Takeuchi 1995; Virtainlahti 2006.) Nonaka and Konno (1998, 42) state that tacit knowledge is highly personal and hard to formalize, making it difficult to communicate or share with others. It is deeply rooted in an individual’s action and experience as well as in the ideals, values or emotions s/he embraces. Also Haldin-Herrgård (2004, 14) conclude that tacit knowledge is personal and abstract and that it is possible to share it among people nonverbally through practice and experience. The line between tacit and explicit knowledge is unclear and the use of the concepts is not rigorous. Different researchers mean different things when using the same terms and a researcher may even use the concepts in different meanings in a same study.

Scharmer (2001, 137 - 139) adds one more type of knowledge to the categorization: self-transcending knowledge that is a part of tacit knowledge. By tacit (embodied) knowledge Scharmer means tacit knowledge that the owner is already using. Self-transcending knowledge (not-yet-embodied knowledge) is kind of a pre-stage of tacit knowledge that comes up as sensations, feelings and intuition. According to Polanyi (1966, 23), it has to have been about this kind of tacit pre-knowledge, for example, when even pressed, Copernicus continued stubbornly to examine solar system with sun in the center till he died.

3. The concept and character of tacit knowledge

The etymology of tacit knowledge, tacitus, relates to quiet, silent, not speaking, peaceful, unmentioned, unthought-of, undealt with; wordless, secret and unnoticed. When tacit knowledge is talked about, the terms soundless, hidden, implicit knowledge and practical know how, are also used. Tacit knowledge is comprehensively present in a person. It is the skill of hands, the knowledge of the skin and of the deep layers of the brain. (Koivunen 1998, 77 - 79) According to Nyström (2004), tacit knowledge develops as the result of a long experience and it is shown outside as a skillful activity. Also Rastas and Einola-Pekkinen (2001) state that it is especially meaningful to notice that tacit knowledge that has emerged through experiences, defines the way decisions and choices are made in an organization. Tacit knowledge shapes the being and behavior shared by the members of the organization. By understanding tacit knowledge, an organization can build organizational unity and strength. One view is that the strength of explicit knowledge is to maintain strategic and operational flexibility by renewing the know how of the organization actively. (Rastas & Einola-Pekkinen 2001, 46.)

According to Koivunen (1998), tacit knowledge includes all the genetic, bodily, intuitive, mythical, archetypical and experience-based knowledge that we have and that cannot be articulated (Koivunen 1998, 78 - 79). On the other hand, Varila (1994) points out that characteristic to tacit knowledge is that memorizing instructions or learning information structures is not enough in adopting it. Tacit knowledge is developed through personal practical experience. Tacit knowledge is the overall result of failures, corrections, misconceptions and changed ideas. It is nonverbal knowledge that can be expressed in the form of statements. A person can, for example, use a language but cannot express the rules of it. In the context that Virtainlahti (2006) examined, tacit knowledge was very bodily, related to the use of senses.

Kuronen et al. (2007) state that according to some researchers, tacit knowledge is bound to different contexts and time. (Kuronen et al. 2007, 6.) Järvinen et al. (2002) describe tacit knowledge to be “here and now” knowledge which is produced in a specific practical context and is very personal and based on experience. According to them, explicit knowledge is “there and then” knowledge, i.e. it concerns with past events, and with the help of it, a context free theory is aimed at. Tacit knowledge is also called artistry that expresses itself in occupational know how of an expert. It develops as a result of a long practice. It is shown as a skillful, intuitive-like action and it is completely dependent on its holder. (Schön 1983, according to Järvinen et al. 2002, 72.) According to Seidler-de Alwis & Hartmann (2008), tacit knowledge is the less familiar, unconventional form of knowledge that resides
in individual skills, previous experiences of collaborations and their social context. Many of these skills and social arrangements are related to work activities.

To sum up the theoretical part of the article, knowledge can be divided to explicit and implicit. Explicit knowledge is visible, observable and it can easily be transferred and saved. On the other hand, implicit knowledge is invisible, unarticulated and it is difficult to describe verbally and share. The line between tacit and explicit knowledge is unclear and the use of the concepts is not established. Many of the definitions of tacit knowledge are based on Polanyi’s much cited definition which he introduced first time in 1958. According to it, “we can know much more than we can tell”. In Polanyi’s thought there is always something unarticulated behind explicit knowledge and, thus, all knowledge is either tacit or based on it. Tacit knowledge is always present in the skills and processes of an individual or a group. According to Polanyi, it is relevant even if it cannot be articulated or shared. (Mooradian 2005, 104 - 105.) In the discussion of business economics and administration, the concept has become general only in 1990’s. It has been defined in many ways. Broadly understood it includes all the genetic, bodily, intuitive, mythical, archetypical and experience-based knowledge that we have and that cannot be expressed verbally. Tacit knowledge can be understood as necessary background knowledge in order to deal with and develop explicit knowledge. This view, however, is not shared by all researchers.

4. Empirical research process and the components of tacit knowledge

The data was collected by using individual theme interviews. Interviewees were administrative officers in one Finnish university. The basis of the choice of the sample was that in regard to the studied phenomenon and the context, administrative officers as extensive experts are an especially interesting group of staff. Expertise is tightly connected to knowledge. Experts have an ability to outline and combine knowledge in a way that it creates coherent entities. In addition, as they receive information they organize it in a functional way. They are typically quick in retrieving and identifying essential knowledge. They are also at ease in processing and applying knowledge. These processes are unconscious and they are extremely difficult to observe or analyze. Through them tacit knowledge expresses itself in the work of an expert. (Kuronen et al. 2007, 13.) The administrative officers that were recruited at the stage when the university was founded are approaching retirement and, consequently, preparations for retaining their experience and know how should be done. On the other hand, also younger officers were chosen in to the sample.

The interviews lasted approximately an hour each. They were recorded and transcribed. We subjected the transcripts to a form of a qualitative content analysis. The interviews yielded a large amount of qualitative data. Analysis process included going back and forth between the corpus and the theoretical framework. From the point of view of the research process, the central concepts are experiences, conceptions, interpretation, understanding and the hermeneutical circle. Myers (2009, 77-78) state that an interpretative case study, that relies on an interpretive and constructivist epistemology, generally attempts to understand phenomena through the meanings that people assign to them.

In the beginning of the interviews, administrative officers described their present field of work and told about their work history. The perceptions of the interviewed officers about their work were very similar. Interviewees thought that, in general, people can identify tacit knowledge in their own work. Although they may belittle their know-how and tacit knowledge or these may have become so routinized that they cannot point these out unless some one else asks about them. Thus, people can, at least to some extent, and are willing to share tacit knowledge when asked but they will not take initiative in it. On the other hand, a new employee might not know the right questions in order to benefit from tacit knowledge.

Based on the analysis, we identified four components of tacit knowledge from the data. The components are experience, mastery of the big picture, expert networks, and social skills. In the following each of them is discussed in more detail.

5. Components of tacit knowledge – experience

During the interviews the experience component of tacit knowledge was brought up in several different occasions. When the interviewees referred to experience they meant the knowledge, ability and skills that had not been attained through education but that were based on the knowledge and skills acquired through experience. The work of administrative officer is very much based on this
experience. Education creates a good and necessary basis for the work but only through experience it is possible to achieve adequate expertise. Later discussed mastery of the big picture and expert networks include to the tacit knowledge attained through experience.

According to the results, with the help of experience an administrative officer knows how to act with certain people. It helps understanding the things that should be emphasized on. In addition, experience makes planning easier when one becomes familiar with the organization and its routines. This in turn, helps predicting the future as well. In other words, by experience an administrative officer has developed an intuitive ability to plan and develop operations further. Moreover, by experience they have collected tacit knowledge about how things have been handled and what have been the consequences. Consequently, they have a broader picture also of the present situations. These conclusions support the idea that time affects the construction of tacit knowledge.

Interviewees stated that the general knowledge of the senior administrative officers about the university has developed in the long run. Their work tasks have increased as well as developed along with the university. So, the tacit knowledge attained during a long career is difficult to transform into explicit and to share. Written instructions and templates of documents enhance, for example the preparation of reports and are, thus, easier to be learned by a new officer. All experience-based knowledge is, however, difficult to transfer despite the instructions. This knowledge is especially valuable because the employee takes it away with him/her when s/he leaves. On the other hand, the interviewees pointed out that universities are at present going through so big changes and reforms that former solutions and ways of doing things are not necessarily relevant anymore. Senior experts can answer questions and show who to turn to if they cannot solve the matter themselves. But without asking questions the bringing up of the tacit knowledge is difficult.

Interviewees stated that new employees bring their own experience and, thus, new ways of thinking and acting to the organization. They are often eager and quick to learn new things. It is worth while to take advantage of the observations made by a new employee in the beginning. S/he may notice things that the permanent personnel have gotten used to already. The interviewees also felt that the experience-based knowledge is best transferred by a real work task and problems are solved as they come up. In situations where more experienced administrative officers have to talk about and explain their train of thought, a part of the tacit knowledge has come up and a more inexperienced officer may have learned something new. On the other hand, also the experienced officer learns when s/he tries to explain something in a way that the other one understands it. The accumulation of tacit knowledge adds knowledge of both the experienced and the inexperienced employee.

As a conclusion, it seems that tacit knowledge has a cumulative and changeable nature. As a phenomenon it is, thus, dynamic. Based on the data, it would also seem that it is bound not only to an individual but also to the context where it generates and expresses itself.

6. The components of tacit knowledge – mastery of the big picture

All the interviewees brought up that an administrative officer should know the processes in the university more broadly than only those that concern his/her own field of work directly. Thus, the mastery of different entities, of the connections between them and of the scope of influence could be possible. All the administrative fields of general, financial, human resource and study matters have their core processes of which the administrative officers have to have measure so that the tasks of planning and control can be coordinated and organized in the faculty. Usually, the work tasks can be defined in the application notice of a new officer. However, this definition does not yet describe how s/he should act and it does not give competences to the mastery of the big picture. That includes the perception of what is aimed at with higher education politics as well as the familiarity with the science community and the development of its practices.

According to the interviewees, the mastery of the big picture is enhanced if one is well familiar with the organization and with the operative culture of the administration. Being acquainted with the work processes of staff, teachers, researchers, students in the own unit, helps with the mastery of the big picture. It enhances the work of a superior if s/he knows the strengths and weaknesses of each employee. The mastery of the big picture requires good background in theory, all-around education, a situational sensitivity, an ability to connect things and an intuition to outline future happenings. Thus, again with this theme the interviewees pointed out the importance of intuition in applying instructions
and practices. In addition, based on this theme as well, tacit knowledge relates to an individual but also to groups that experts rub elbows with.

7. The components of tacit knowledge – expert networks

Based on the analysis, it can be argued that expert networks become an important component of the tacit knowledge of an administrative officer. Expert networks are often networks of people that have emerged around a certain task, an assignment or a problem. Its operation may have started informally based on the shared relationships between the members. In other words, they can originate informally by the actions of those experts that are willing to collaborate and who work together to learn and solve problems. The operation of the networks is based on the interaction of the experts.

According to the interviewees, expert networks are created from networks both in and out of the university. External expert networks consist of, for example, other universities in Finland and especially the administrative officers in their faculties. Internal expert networks include mainly experts in central administration and administrative officers in other faculties. Through experience the administrative officers have formed a broad collaboration network especially inside the university that is useful in their every day work. The social tacit knowledge of an individual shows itself in the fact that s/he knows the right people and can create a network him/herself that acts as a pillar when things get complicated. Because it is not possible to control and know everything by oneself it is important to know who one can turn to in each situation.

The interviewees pointed out that, in addition to expert networks, it is important to be familiar with the whole acting environment and to be able to predict its changes. The acting environment of a university includes among others ministry of education, Academy of Finland, other universities, actors in the neighbouring area, personnel and students.

8. The components of tacit knowledge – social skills

The interviewees stated that they need good social skills constantly in their work. An administrative officer acts in collaboration with teachers, students as well as the members of the faculty and central administration. They work in faculties under the administrative office but, at the same time, they look after the benefits of their own unit. With the new model where the administrative personnel are no longer subordinates to heads of departments but are managed from larger administrative service centers, the superior work has increased. An administrative officer is in charge of the operation of the service center in his/her faculty and acts as a superior to the personnel. Thus, social skills are demanded in human resource management.

Listening to people takes a considerable part of the work time and it has not been written in the job prescription. The officer also acts as a link between different quarters. For example, s/he transmits information about how the personnel are doing to the management of the university. People get tired to the flood of papers as the amount of administrative documents has increased considerably.

9. Summary

The components of tacit knowledge that were brought up from the data are not independent of each other, nor can they be clearly differentiated from each other. Of the components, experience would seem to form the main category that includes the other components. As a category, expert networks are related to mastering the big picture and includes interpersonal relationships and social skills. On one hand, social skills as a component of tacit knowledge seems to be related to the organization, its networks and interpersonal relationships, and on the other hand, through personal qualities and experiences to the individual, the expert him/herself.

The experience component of tacit knowledge includes both knowing how to act with different people and having insight concerning the future. Tacit knowledge does not only include the knowing related to individual’s know how but it can express itself in the forms of interaction and collaboration between individuals. These forms have been created as the results of development in relationships and ways of working and they express themselves only in shared situations of acting. (Järvinen et al. (2002, 73)

As for the future aspect, in the results, it was presented that the interviewees have through experience developed an intuitive ability to plan and develop their work. For example, the regulations and instructions that guide work are explicit knowledge but to be able to refer to a right regulation or instruction in a right situation or the interpretation and application of them is often experience-based.
Intuition relates also to the social skills of an individual that are formed through experience. On one hand, it could be said that intuition is bound to a person; it is part of his/her personality and, thus, represents tacit knowledge that cannot be transferred to another person. On the other hand, if we believe that intuition and through it tacit knowledge that is bound to a person develops over time and through experience, then we can argue that it is affected by the context where the person operates.

Work community seems to affect the accumulation of tacit knowledge. The performance of experts is usually bound to a certain field, i.e. expertise, like tacit knowledge, is context bound. In a certain context, experts are able to notice broad and meaningful regularities, i.e. to combine large quantities of knowledge by observing things that are unnoticeable or may seem chaotic to an inexperienced eye. The skills of experts are of a great part automatized which characteristically leads to performance that is, at the same time, quick and of good quality. Typically, experts both observe and describe the problems in their field more deeply and at a more abstract level than inexperienced workers do. (Kuronen et al. 2007, 12.) In other words, what kind of a career one has affects on what kind of tacit knowledge is constructed and which components of it are emphasized. Thus, context “guides” and affects the construction of tacit knowledge. If an organization and through that work tasks are quickly changing the importance of experience and knowing the organization is different compared to a situation where the organization and work tasks remain the same. Juuti (2008, 229 - 230) states that if work tasks remained the same year after year it would be relatively easy to transfer experience-based knowledge because the stories of the previous employees to the new ones would guide the construction of their knowledge and identity. The transfer of experience-based knowledge is more difficult when organizations and work tasks change constantly.

In the work of administrative officers there is a lot of tacit knowledge that relates to human relationships and that is either difficult or unnecessary to transfer into explicit knowledge of a group or the whole organization. In the study, it was pointed out that it is not necessarily worth while to burden the newcomer with all the knowledge regarding human relationship. S/he should be given a chance to start with a clean slate. Thus, it is justified to state that it is not necessary or worth while to try to transfer all tacit knowledge. The ability to unlearn some practices should also be developed in organizations. Every new person brings his/her own experiences and background to the work community. Thus, s/he can bring a lot of good and new ideas when thinking is not too much chained, for example, with prejudices or differences in human relationships.

The mastery of the big picture consisted of being familiar with the processes of the university in a broader scale than own field of tasks would have required. Being well familiarized with the organization and the operative culture of the administration enhances the mastery of the big picture. It also helps when one is familiar with the staff of the unit. In the data, the accumulative and changing character of tacit knowledge was brought up. It seems that tacit knowledge in addition of being bound to a person is bound to the context where it expresses itself and emerges. According to Nyström, the know-how of an expert is often divided into practical (experience-based, functional, and contextual), formal (gained through education) and meta-cognitive knowledge. The latter requires examination of one’s self and action, reflection. Part of the knowledge is formed in practice through reflection. (Nyström 2004, 6.)

Thus, the targets of tacit knowledge are different. Based on the data, tacit social knowledge relating to an individual and to a group were highlighted. Both conclusions were brought up when examining the experience and mastery of the big picture as the components of tacit knowledge. This leads us to consider the relationship between tacit knowledge and organizational culture which is traditionally divided into official and unofficial part (see for example Schein 1985, 21 - 33; Hatch 1997, 210 - 217; Juuti 1994, 27 - 28; Näsi & Giallourakis 1991, 3 - 4). Visible parts of the cultures are, among other things, ways of doing things, instructions, orders and norms that guide ways of behavior and whose application becomes automated, i.e. they become established ways of doing things that are not questioned. Linde (2001, 161 - 162) points out that besides social personal knowledge, also social knowledge exists. It is held by the group or institution itself. Some social knowledge is explicit, for example, the knowledge expressed in forms, formal procedures, file cabinets, and databases. However, in addition to procedures, there is also tacit knowledge which manifest as work practices, as well the knowledge about how and when these knowledge resources. This kind of knowledge is held by an institution as a whole rather than by individuals who comprise it.
In this study, expert networks formed important components of tacit knowledge of administrative officers. The operation of the networks is based on interaction. According to Hakkarainen et al. (2002, 448 - 458) no one is an expert because they know everything that is required but because they can on the basis of previous knowledge create, often together with colleagues, the knowledge needed in problem-solving. Typical for experts is also that they have multifaceted network relationships through which they can solve uncommonly difficult problems. This sub-theme supports the conclusion that, at least some parts of tacit knowledge are bound to organizational context. Consequently, it is justified to state that tacit knowledge relates to organizational culture. In other words, expert networks are different in different organizations and, thereby, organizational tacit knowledge is organizational specific. So, in addition to being individual specific tacit knowledge can, as a phenomenon, be also organizational specific. The theme of expert network lead us to ask could the context where tacit knowledge is examined explain what kind of tacit knowledge is emphasized: the one bound to an individual or to a group or to an organization?

10. Conclusions about the nature of tacit knowledge

There are solid justifications to the statement that explicit and tacit knowledge can be distinguished. They represent different types of knowledge whose differences, at general level, can be described, for example visible/invisible, general/bound to a context or a person, vindicative/bound to a person and interpretative. It is more difficult to define tacit than explicit knowledge. Also from the research point of view, examining tacit knowledge is challenging. Researchers have become interested in the phenomenon of tacit knowledge much later than in explicit knowledge. Tacit knowledge has been examined in many fields and from different starting points. This has affected the fact that there is no consensus of the definition of the concept or the nature of the phenomenon. The meaning of the concept in every day and scientific languages differ considerably from one another. Consequently, the use of the concept is not rigorous.

It seems that the current division of knowledge to explicit and tacit is not sufficient to describe the phenomenon. It has been proposed that explicit knowledge is visible and "articulated" knowledge that can easily be transferred and codified, e.g., through speech, documents and various information management systems. Implicit knowledge, on the other hand, is "silent", hidden and non-verbal knowledge that is difficult or even impossible to transfer and express verbally. Based on this study, we propose that tacit knowledge comprises different components and types, some of which can be articulated and made explicit (figure 1). Examples of such are individual's or organizations accustomed lines of action that are based on explicit instructions. Behaviour based on intuition or personal relationships represent the other kind of tacit knowledge. In other words, the nature of tacit knowledge varies. These findings suggest that the interconnectedness of explicit and tacit knowledge ought to be examined further. It is theoretically interesting and from a practical point of view, many practitioners contemplate about the means to transfer tacit knowledge or to make it visible. In this task asking questions is essential.

On the grounds of above mentioned, there are parts of tacit knowledge that can be identified, expressed and made visible. Thus, our study supports the idea that tacit and explicit knowledge complete one another and that they have interactive relationship (c.f. e.g. Kuronen et al. 2007.) On the contrary to e.g. Polanyi's (1966) and Virtainlahtii's (2006) views that tacit knowledge is necessary background knowledge so that we could handle and develop explicit knowledge, we state that the relationship between tacit and explicit knowledge is not one-way.

As a conclusion, we propose the following regarding the nature of tacit knowledge: Tacit knowledge is immaterial and therefore, a highly abstract phenomenon. It is also empirical (e.g. Rastas & Einola Pekkinen, 2001; Nyström, 2004). By nature it is also dynamic (e.g. Virtainlahti, 2006), continually changing, which is partly explained by the interplay between explicit and tacit knowledge. Tacit knowledge is often assigned value, even beneficial purpose for the individual or the organization. Therefore, tacit knowledge is significant for the practical operation. In other words, it can be assigned a functional dimension. For example, Kuronen et al. (2007) highlight the importance of tacit knowledge in the process of decision-making. According to them, making decisions is a central part of an expert work in a dynamic environment. Critical decisions are usually made by experienced experts because others do not have facilities to make decisions that call for deep understanding of the context and related phenomena as well as of the other things related to the decision. Usually, the processing of information has to be done quickly and decision-making requires, among other things, interpretation, combining and applying of tacit knowledge. The importance of tacit knowledge
becomes visible when experts are asked to describe their decision-making. It is very difficult for them to describe in detail, for example, how decision-making is done and how it is affected by the knowledge acquired at that moment and prior to it. Thus, decision-making requires processing a vast amount of knowledge, majority of which is subconscious, tacit knowledge. Consequently, the importance of tacit knowledge for an individual and for decision-making is remarkable. (Kuronen et al. 2007, 14 - 16.)

**Figure 1**: The nature of tacit knowledge and its interrelation with explicit knowledge

Previous research often relates tacit knowledge to individual, not group or organization. The findings of this study support the view that tacit knowledge is personal (Polanyi 1966; Nonaka & Takeuchi 1995; Nonaka and Konno 1998; Karvonen 2001) and subjective but also context-dependent and organization-specific. Generally, experience-based knowledge and skills are recognized to be significant only in the environment where they generate. Therefore, tacit knowledge can be understood to be knowledge that is, at least to some extent, embedded in an organizations’ culture. It holds value because it is difficult to share with people not embedded in that particular culture. The interconnectedness of organizational culture and tacit knowledge ought to be studied further.

We argue that tacit knowledge can, for example describe the self-transcending knowledge that Scharmer (2001) refers to. This kind of knowledge consists of sensations, feelings and intuition. Based on that this level of tacit knowledge can be regarded as bound to an individual and as “a genuine tacit knowledge” in the sense that it is not possible to transfer it or make it visible. The individuality connected to tacit knowledge is shown at an individual level but the traits of tacit knowledge can be to some extent individual when organizations are compared with one another. Consequently, we state that in addition to being bound to an individual tacit knowledge can also be to some extent organization specific. There are arguments based on previous knowledge that tacit
knowledge is connected to organizational culture. For example Rastas and Einola-Pekkinen (2001) state that it defines how choices and decisions are made in an organization. Thus, it shapes the common existence and behavior of the work community in the organization. By this it is often meant shared values and assumptions of how it is acted in certain situations. These, on the other hand, are matters that in literature are often connected to the concept of organizational culture. For example according to Järvinen (2002, 73), tacit knowledge can hide itself into professional- or organizational culture. In addition Karvonen (2001) states that the interconnection between tacit knowledge and organizational culture has become an important theme and research area in the field of organization and business studies (Karvonen 2001, 129).

It is important to recognize the study's obvious limitations. This was a qualitative case study and due to the nature of this kind of methodological approach, the findings cannot be applied as such to other organizational contexts and populations: By nature, tacit knowledge is personal and context-dependent phenomenon. Therefore the results presented here must be regarded as highly case dependent and their generalization into other types of organizations must be treated with caution; the conclusions presented here are based on findings obtained from one single expert organization and its specific personnel group. The extracts and analysis presented here are our interpretation, our argument for understanding the case in a particular way, just as we are suggesting that the organizational members were arguing for particular perspectives. However, this case study can be used as a basis for conceptual generalization.

11. Finally

Most definitions of tacit knowledge are based on the much cited definition by Polanyi presented first time in 1950’s. Polanyi encapsulates the essence of tacit knowledge in the phrase “we can know more than we can tell”. On one hand, it maybe, that holding to the original definition have restricted the research. Perhaps now, especially when tacit knowledge is explored in different contexts, more versatile approaches should be applied. On the other hand, Grant (2007) points out, that we can still learn from Polanyi; a fuller examination of his work could be used to raise questions about some approaches to knowledge management. In addition, Grant continues, there seems to be only a little consistency in the use of Polanyi’s actual work and it has frequently been misinterpreted. (Grant 2007, 173 - 174, 177 - 179).

The relation between the concept of tacit knowledge and related concepts is still somewhat unclear. For example, tacit knowledge is also called artistry that expresses itself in the professional know-how of an expert. It is developed as a result of long time practice and it is shown as skillful, intuitive action and it is entirely dependent on its holder. (Schön 1983, according to Järvinen et al. 2002, 72.) From this perspective, the concept of tacit knowledge is brought to the discussion concerning knowledge management. Different approaches to knowledge management as well as conceptual unclarity have created obstacles to bringing it to practice. Moreover, the concept of knowledge management has not yet been established either. (Sydänmaanlakka 2007, 136; Viitala 2005, 9.) Consequently, more theoretical and conceptual research is needed in order to better understand these concepts. (Mooradian 2005, 104 - 105) Moreover, at least in the field of organization studies, the amount of empirical research concerning tacit knowledge is limited. In addition, most of the empirical data has been gathered in factory context. However, as a phenomenon, it exists in all kinds of organizations. This study was an example of tacit knowledge in an expert organization. In order to understand the phenomenon better, more empirical data needs to be gathered from different contexts.

In many research, tacit knowledge is linked to an individual rather than to a group or an organization. The findings of this study support the view that tacit knowledge is personal and subjective but also context-dependent and organization-specific. Generally, experience-based knowledge and know-how are recognized to be significant especially in the environment where they generate. According to this study, tacit knowledge seems to have a strong connection to organizational culture. This interrelation should be studied further.

From a practical point of view, further research-based knowledge is important because many organizations are looking for practical knowledge on ways to make tacit knowledge visible and transfer it. This study acknowledges that posing questions is vitally important in attempts to understand tacit knowledge and make it visible. On the other hand, all tacit knowledge is not possible, nor necessary, to transfer.
References


www.ejkm.com 317 ISSN 1479-4411
The Inertia Problem: Implementation of a Holistic Design Support System

Nicholas Reed¹, Jim Scanlan¹, Gary Wills¹ and Steven Halliday²
¹University of Southampton, UK
²Rolls-Royce plc, Rotherham, UK
nreed@soton.ac.uk

Abstract: This paper describes and reflects on the implementation of a Knowledge Based Holistic Design Support System – termed “HolD” – into a business environment. The paper introduces the rationale and development behind the system, a consciously different approach to traditional knowledge based systems in engineering in order to meet the requirements of a small business, producing bespoke low volume products. Typical knowledge based engineering systems rely on explicitly codified knowledge which often supports product optimisation rather than creative design activities. Such a system would provide little benefit to a business producing bespoke products. Instead, the system presented here, supports the creativity of designers through codified tacit knowledge input by designers as meta-data for past designs. The problem of individual inertia in adopting the system and sharing knowledge was approached early in the construction of the system. The steps taken to lower user barriers and encourage day-to-day use are detailed, including the design of a multi-stage input process designed to interact at key stages of users’ existing processes. The immediate results after a six month trial period are presented and the results show slower than anticipated usage. In particular designers were found to be reluctant to input detailed information beyond common identifying data and did not attempt to seek information from the system. The reasons for this slower usage are discussed and possible solutions presented. The paper therefore provides industrial based evidence of the inertia encountered when implementing a knowledge system and argues that technology alone is insufficient to overcome this inertia.

Keywords: engineering design, knowledge based systems, ethnographic study, fixture and tooling, design re-use

1. Introduction

The field of Knowledge Management [KM] has grown rapidly over recent years into a widespread field of research (Lloria, 2008). Despite the proliferation of articles, empirical studies have so far been limited (Zack et al., 2009) and the relationship between knowledge management activities and business performance on an organisational level remains in debate (Darroch, 2005). The study presented here is designed to address this weakness through the implementation and evaluation of a software based Design Support System. The aim of the study was to develop a bespoke system using common technologies to best support a design team and facilitate understanding of the impact the system has on the business.

The theoretical origins of KM date back several decades, arguably to the Penrosian theory of firm growth (Penrose, 1959). Penrose espoused the idea of firm growth dynamically constrained by the availability of experienced staff resource – founding the concept of the resource-based view of the firm (later furthered by Wernerfelt, 1984). Over the following decades the idea of knowledge as a deployable resource (Machlup, 1962) and the knowledge driven economy (Bell, 1974) led to the idea of the knowledge based firm (Grant, 1996).

It is now accepted that global markets have evolved, due to increased emphasis on innovation to provide a business’s competitive edge (Swan et al., 1999, Milton et al., 1999, Levy et al., 2003), knowledge has risen above the traditional advantages of capital and labour as a company’s key asset (Brint, 2001). The shift in primacy is particularly important for companies in manufacturing and engineering, traditionally limited by factors of production such as materials, labour and money. It is unsurprising therefore that Knowledge Management is seen in engineering as the new step change since CAD/CAM introduction (McMahon et al., 2004). This shift is introducing new demands on companies, requiring them to efficiently manage and exploit their knowledge as effectively as they currently manage capital and labour, in order to maintain a competitive advantage and maximise their returns (Bose, 2004). This need has given rise to the field of Knowledge Management (KM).

By its very nature, Knowledge Management encompasses a wide range of issues and subjects and consequently, its definition varies depending on which perspective it is viewed from. A review over some of the key authors (Wiig, 1997, Grant, 1996, Nonaka and Takeuchi, 1995, Davenport and...
Prusak, 1998) allows at least a rough concept to be elicited as: “The management (by which it is meant the deliberate and systemised generation, organisation and application) of knowledge, either explicit or tacit, in order to provide benefit to the wider business context, where benefit is ultimately measured as business value”.

Numerous studies have been completed, presenting theories and best practice approaches to Knowledge Management (Hahn and Subramani, 2000, Gruber and Russell, 1991, Hicks et al., 2002). Yet as highlighted by Lloria (2008) the majority of studies are theoretical in nature and a review of the literature returns few conclusive studies that evaluate the effects of Knowledge Management on a company. There has also been little study in support for Small to Medium Enterprises (SME’s) which, arguably require as much or more support than larger companies, but have limited resources to invest (Pillania, 2008).

It is therefore believed that there is a need to study and evaluate the effects of Knowledge Management and in particular the effects of knowledge on SME’s in engineering (Briggs, 2006).

2. Industrial case study

This study is supported by industrial partners who utilise a unique approach to the design and manufacture of special-to-product fixtures and tooling in the Aerospace sector. Coupling state-of-the-art laser-cutting processes with unique design and assembly methods, the company excels at providing bespoke, customer solutions in ultra-short lead times compared to traditional machined fixtures.

Fixtures and tooling are intended to provide the means for manufacture and assembly, typically supporting manufacturing operations such as drilling, welding and assembly etc. They are an unusual set of products for two reasons: unlike consumer products, aesthetics are almost irrelevant providing the fixture is functionally adequate; second fixtures feature as the “critical design-manufacturing link” (Cecil, 2001). Consequently, fixtures can rarely be produced prior to a components final design and therefore often contribute to the production part’s critical path. There is therefore always a demand for shorter lead times for fixtures and tooling.

The company studied here has addresses this through a novel design method utilising the benefits of rapid manufacturing and establishing value early in the design phase. This results in highly knowledge orientated products with vastly reduced lead times. As predicted by the knowledge based economy, this shift away from the value added manufacture to value added knowledge places increasing demands on existing designers and knowledge.

This novel design approach was primarily developed by a single and highly experienced mechanical design expert. At the outset of this study, new designers had been successfully seconded into the business, however, a large quantity of knowledge capital remained as tacit knowledge and only accessible through the single technical expert. This situation not only limits future growth, but also creates vulnerability for the company with over reliance on the expert.

2.1 Business context

At the time of the study, the company had operated for approximately two years and employed six engineers and maintained a dedicated on-site manufacturing capability. The business was in a strong position, but customer demand regularly outstripped the business capacity, due primarily to the limited number of experienced design engineers.

Academically, the company represents an ideal case study to implement and evaluate the benefit of knowledge based systems to a business. The problem facing the business due to potential loss of knowledge from a retiring expert epitomises the problems faced by many companies, while the need to leverage the company knowledge is paramount as an early start-up SME producing low volume, bespoke products.

The company required a system to protect against loss of knowledge, while utilising existing knowledge to maximise design capacity. Three scenarios were identified, each with a desired response that the system should facilitate:

- 1. The technical specialist retires: Business must continue with no critical knowledge loss
2. A inexperienced designer joins the company: Designer should be able to design new fixtures without a high dependency on existing designers

3. An existing product requires improvement or repeat manufacture: Engineer should be able to re-design and re-manufacture the product without significant design iteration

To address these issues the knowledge based solution must be capable of capturing and outputting tacit knowledge, support designers and be inexpensive to implement.

3. Review of knowledge management

Knowledge is usually described as the additional contextual understanding of facts that provide the foundation for our decisions (Brazhnik, 2007). A loss or lack of knowledge relating to a particular decision can lead to unnecessary rework, increased costs from acquiring the required knowledge, or an incorrect decision to be made. Knowledge is therefore a valued commodity.

Since the term’s first inception, the field of Knowledge Management has evolved substantially. A broad examination of the literature illustrates that Knowledge Management incorporates not only information systems research and business strategy but elements of psychology and sociology associated with human interaction and learning. The implication of attempting to manage human nature to the benefit of the wider business ensures that it remains a challenging subject of research.

There are a variety of approaches to Knowledge Management, in her paper Lloria reviews eight and highlights three regional differences in emphasis: European focusing on Intellectual Capital, Japanese focusing on Knowledge Creation and the Western (USA) focusing on technical capture and management (Lloria, 2008). Here the aim is to establish a proactive strategy to support knowledge re-use and insure against knowledge loss. The approach required can therefore be classified as a western approach. This approach typically utilises IT as a means to capture and codify knowledge into so called Knowledge Based Systems.

3.1 Knowledge transfer and management

The nature of knowledge has been debated throughout much of history: theories and their advocates range from Plato’s dialogue “Theaetetus” distinguishing between true belief and knowledge (Plato, 360 BC) to Polanyi’s concepts of tacit knowledge (Polanyi, 1958). While the philosophical debate is not relevant here, the tacit-explicit distinction forwarded by Polyani represents one of the fundamental problems facing knowledge practitioners – to what degree can knowledge be encapsulated and transferred? Polanyi argued that “we can know more than we can tell”, thus not all knowledge can be written down or taught.

Both forms of knowledge (tacit and explicit) are recognised as being crucial to a company and both must be accurately managed. As a result knowledge strategies often utilise both Personalisation and Codification approaches (McMahon et al., 2004). Practitioners have put forward frameworks to synthesise different methods into a single model managing multiple modes of knowledge conversion between explicit and tacit knowledge - most famous of which is Nonaka and Takeuchi’s SECI model (Nonaka and Takeuchi, 1995). The model includes tacit-tacit conversion (socialisation), accepting that not all knowledge can be codified, but also tacit-explicit (externalisation), thereby disagreeing in part with Polanyi that some tacit knowledge can be codified.

While multiple methods are preferred, Socialisation methods are not always appropriate. These methods fail to scale up if expert resource is limited and do not insure against knowledge loss in the short term. For the business studied here faced with a departing expert, the primary method was required to be a codified approach – externalising the experts tacit knowledge into a Knowledge Based System.

3.2 Knowledge based systems

There is an array of tools that fall under the classification of Knowledge Based Systems, ranging from knowledge repositories, to expert systems intended to replicate or replace human capabilities (Beckman, 1999). There have been many attempts to categorise the various different tools and techniques (Hansen et al., 1999), but in the authors opinion no method of categorisation adequately accounts for even the most common strategies developed. This is simply a consequence of the
various different characteristics that can be used to describe systems, from the level of automation employed by the system, to the degree of structure captured data is bound to.

Traditionally, systems were defined as Knowledge Based if they consisted of an inference engine and a separate knowledge base, from which the engine could determine solutions. This definition, however, was formed from the Computer Science perspective, evolving from Artificial Intelligence research stemming back to the 1950’s (Sandberg, 2003).

Traditionally too, this field is where the majority of knowledge management work has occurred in engineering. A subset of Knowledge Management is termed Knowledge Based Engineering, which combines a codified rule and knowledge base with computer-aided geometric design (McMahon et al., 2004). They are generally developed using formalised knowledge of relationships to assist or automate tasks to ensure faster design or production. These systems are becoming increasingly mainstream, and CAD vendors such as UniGraphics have introduced this capability into its NX range of software. But the emphasis of these applications is typically to support automation or optimisation on non-creative design tasks, where geometry is the desired output. These ‘intelligent systems’ are, however, limited to the domain they have been designed for and widening the domain usually causes a decrease in capability. While suited to solving “complex, highly structured problems” (Baxter et al., 2007) these systems are simply not capable of developing novel or new product and often require a high degree of investment and capability by the users.

Recently, the distinction of Knowledge Based Systems has become blurred from the precise description above as more varied systems are developed as Knowledge Based Systems, which do not necessarily utilise inference engines. Example systems include, Communities of Practice, Knowledge Topographies and Knowledge Repositories. Generally these systems have moved to manage the less explicit knowledge, for example storing free text questions and answers in the case of the Communities of Practice.

3.3 Design reuse

Design reuse describes the application of past concepts, ideas or geometry to a new problem, minimising the time and effort required to develop the new solution. Conceptually it is easy to understand the benefit to the design process by the efficient application of design knowledge. Busby (Busby, 1998) lists four key benefits:

- Use of existing designs avoids the use of resources consumed in the original design
- It helps avoid error and uncertainty associated with new development
- It helps familiarise production staff with the design
- It helps clients maintain consistent ways of using and maintaining the product

Studies indicate that experienced designers rely heavily on past designs (Ahmed et al., 2003), yet the designers primarily rely on past designs of their own - those that they are familiar with and remember. Thus despite the potential benefits to the business, design reuse across and on an organisational level is remarkably low.

In the study conducted by Busby, he utilises anecdotal evidence to establish themes which underpin the failure of design reuse, both the failure of implementation and the failure to reuse designs when attempted. While the findings highlighted the specificity of individual cases of failure, at a high level it was possible to discern particular themes. Notably, constraints associated with the organisation and processes represented 40% of all failure cases, together with a strong influence of designer’s individual preferences (and perhaps prejudices) which can preclude against reuse. Authors such as Davenport et al. (1997) and Swan et al. (1999), argue the single biggest source of inertia (or resistance) to building a successful knowledge management is from individuals. Knowledge has always been a source of influence and power, thus individuals are naturally predisposed to harbouring their specialist knowledge and the creation of a successful knowledge management project requires a fundamental change in this belief.

Busby concludes that an effective database of designs should remedy many of the issues observed. It is assumed that the database would attempt to encapsulate the rationale required (and often observed to be missing by Busby), aiding reuse. Based on the study, however, it would also need to
be established with a process for reuse to mitigate the organisational problems encountered in failure. It is this approach that is adopted in the current study.

4. Development of preliminary design system

Following the criteria described above, a system was proposed to meet two criteria:

- To capture, manage and protect existing tacit knowledge
- To reduce product lead times and improve the quality of designs by re-using this expert knowledge.

These functions would provide a tangible and valuable benefit to the business. The system must be accessible to non-experts and focus on providing knowledge throughout the entire design process – termed Holistic Support.

Existing strategies detailing frameworks and/or methodologies for Knowledge Based Systems were examined. Most relevant was Hahn’s, a framework based heavily on Nonaka and Tekeuchi’s model (Hahn and Subramani, 2000). These frameworks tend to assume a relatively large user population and knowledge base i.e. including expert databases (the so called ‘yellow pages’) and electronic discussion forums. Here, there is one expert and limited users. Traditional codified or ontological based knowledge approach would be too time consuming and costly to implement for the small company and would provide only marginal returns, given the bespoke nature of the products developed. Due to the low number of projects and designers, automated capture was also discounted as there would be an insufficient volume of material upon which to successfully data-mine (little formal documentation is currently produced).

A hybrid knowledge repository was therefore proposed which would be a semi-structured codified knowledge base but ‘lighter’ than intelligent systems (Reed et al., 2009).

4.1 Design system structure

The system was designed and built based on three ‘cores’ loosely supporting Lundvall’s (1996) classification of the forms of knowledge transfer, described as: know-what, know-why and know-how. The first is a derived ‘best practice’ methodology to guide users through the design process. The second is the knowledge base to provide users with descriptions, rationale and details behind past designs, while also storing and aligning to archive design documents and CAD files. Finally the third section is a set of bespoke numerical tools derived to support engineers with the development of more complex or precise elements of their design.

The intention with the system was to be able to support both the design process and individual design activities, while recording and reusing the design rationale.

The methodology was derived from the experiences of the existing designers following time spent discussing past designs and observing their approaches to new designs. This resides primarily as accessible training material in the form of a design handbook, flowcharts, and presentations.

The repository is a SQL driven database storing codified information and rich media about previous designs, including the design drivers, product requirements and materials, together with relevant CAD files, photographs and video files. Following a new customer delivery, information is entered via a form relating to: the client and product requirements, the details of the design, special considerations and design experiences. A search function allows users to search and retrieve required information on existing information.

The “toolkit” provides a single-point source for theoretical-developed design tools that are specific to the technology, supporting and accelerating more involved design work such as stress and strain based calculations used by the designers.
4.2 System implementation

The system was successfully sited into the business, running on a dedicated machine and offering limited client access (the designers, however, were on a separate network and could not readily access the system without moving to the system workstation).

The system was designed as an iterative loop - that is it is populated through its use and from future knowledge generation. A variety of methods were used with the existing mechanical design expert to capture an initial mass of knowledge with which to launch the system – a requirement argued for by Hahn and Subramani (2000).

The most common and most fruitful method was ‘storytelling’, using semi-structured interviews with the expert, who described individual designs, together with their rationale and an overview of the main problems and solutions encountered. These interviews were recorded and codified into the knowledge base. Where appropriate, longer reports were produced and these were uploaded into the system along with the recordings of the interview, CAD files, photos and other media.

At the time of launch the system contained over 200 records, with each record holding a potential 50 fields, although, the mean completion percentage was very low at 25%. Clearly the ideal system would have more fields completed, however, the figure is a consequence of the historical nature of the knowledge (not everything was known) and the role of the researcher as the codifier – it would be hoped that when designers enter the knowledge themselves, this would be significantly higher.
4.3 System evaluation

Following implementation of the preliminary system, observations were made as to its use and role within the workplace. In order to attempt to assess the system more quantitatively, an active controlled study (as opposed to ethnographic) was also conducted.

4.3.1 Observational results

It was clear from observations following the initial implementation of the system that the system was not in habitual use by the designers, either for inputting knowledge or searching for it. Two reasons were cited: the first was the difficulty in entering data and the second was the limited time available for designers. To assist with this, a structured approach was initiated whereby the designers set aside half an hour following the completion of any design to input the details in the system. A structured and visible job list was created within a defined office area and weekly team meetings were initiated to support a more team focused approach with population of the design system. The intention was to attempt to understand the pressures and constraints that individual designers may have and share with them the approaches that were being undertaken with the system development.

The approach was unsuccessful with designers spending too little time in the office to properly support the regular meetings and limited activity in maintaining and updating the job list. After 6 months, minimal details had been entered into the system, with the majority of these achieved through direct intervention of the author.

4.3.2 The controlled study

The controlled study was run in the middle of this period in order to determine its impact on the design process. The aim was to assess the effectiveness of the current design system, training and associated knowledge in the full development and design of a fixture.

To complete the test, engineers who were previously unfamiliar with the technology were asked to design a solution to a problem using the knowledge provided by the system. This same task was
given to existing designers and the relative approaches and designs compared. A total of five designers completed the task including the technical expert. The intention was for the unfamiliar designers to utilise the knowledge base and captured methodology to produce designs of equal standard and potentially of similar design.

All designers were given two day training on the system and the derived best practice methodology. At the end of the second day, they were presented with the design task and visited the production site for the required fixture. They were then given three days to produce a design (in CAD only) before the designs were evaluated.

The designers all completed a solution in the time designated with a variety of different designs. Structured interviews were held with all participants to obtain their feedback on the impact of the system. The interviews and observations demonstrated that all novice engineers found the knowledge repository useful in facilitating concept creation and providing the basis for new solutions and encouraging one engineer did reuse geometry. Despite this, designers did struggle with the detailed implementation and development of their designs, often seeking more detail and depth to the knowledge. Another problem observed was in assessing the mechanical performance of the design structures. This highlighted the need for additional CAD orientated tools (such as standard design features with validated structural data) to aid design. The level of system use was also highlighted as a concern, with the majority of system use occurring primarily through the author’s suggestions and designers often unsure of what to search for. Following this period, a second, modified system was proposed to meet these issues.

5. Development of HoIAD

Following observations and the results of the controlled test, a modification was proposed to the system. Of primary importance was the inertia demonstrated by individuals to populate the system and using the system to obtain knowledge. Second was the need to support the design stage with additional tools.

As discussed, prior studies have observed the inertia of individuals against knowledge sharing (Sveiby, 2001). It is often against individuals natural instincts to share knowledge openly. In the author’s opinion, the observations also suggest another potential issue - that is, designers are typically highly creative and goal-focused. Their primary objective is to solve a problem through design. It should be unsurprising therefore that they find recording the rationale behind their decisions a distraction to the design process. For the system to be adopted it must therefore form part of their existing design process.

5.1 System design

The most important change was to the system structure and in particular the synthesis of the methodology with the input pages. The system was rebuilt on a dedicated server, providing users with access from their own workstations. Furthermore input is now spread over several pages corresponding to existing stages of the design process. This is intended to benefit for two reasons:

- Less knowledge is required upfront, lowering the time taken to enter information and making the task easier.
- Interaction is required at existing and natural stages of the design process. These stages should become synonymous with interaction with the system and become part of the process.

Effectively the system behaves as a gated process, with webpages (requiring input of and displaying different information) corresponding to each gate. The pages are separated as:

- **Preliminary Information**: displaying the job description, the designer associated to the project, the requirements of the client and finally any specifications relevant to the job.
- **Post-Design**: displaying information on the design solution, the rationale behind the design, calculations and tools used together with photographs, CAD drawings, video and other media.
- **Job Completion**: displaying information received following the completion of the project, modifications that were required, and feedback from the clients and designer.
5.2 System implementation

In the previous version, to encourage designers to complete records in full, input fields were made mandatory i.e. they would have to complete all fields before they could submit the information. Rather than completing the boxes in full, designers would often enter random and non-valid data in order to force the system into allowing access to subsequent forms. The updated system, removes the mandatory fields but a graphical representation of the completed fields is used instead. Commonly termed a traffic light system, three lights are shown, moving from red to amber to green as fields are complete. This gives an at-a-glance view of the completed stages and the level of knowledge held on a particular design (a crucial requirement identified by Marsh, 1997) to ensure designers aware of the information available; it also allows a better performance assessment of designer’s contribution.

Following feedback from the designers using the previous version, the knowledge repository was expanded to store additional and more detailed knowledge. The system also supports wider document uploads, allowing quotes and other project reports to be accessed.

An improved search function was implemented offering users a free text search function and category based search, both allowing users to browse result pages of designs, showing the title, a thumbnail, a short description and the traffic light system. The system was launched towards the end of 2008 and existing data from the previous system was ported across to the new system with no loss of data.

5.3 System evaluation

While the previous method of testing system was useful in highlighting the benefits and deficiencies of the early version of the system, it was extremely demanding on resources. Furthermore the previous trial demonstrated that the individual behaviours of designers are far too fluid to evaluate over a short period of time. Therefore, a different approach was taken to evaluate the effect of the developed system combining longitudinal evaluation of user’s interaction with detailed case studies, an adaption of Brinkerhoff’s Success Case Method (Brinkerhoff, 2005). Here key projects are recorded in detail.
providing anecdotal evidence of changes in learning and working practise. By combining the detailed measurements and data obtained while observing designers with the longitudinal changes in the business it was possible to observe the influence of the design system to the designer’s work pattern and the wider business. The work remains ongoing, but preliminary observations have been completed.

5.4 Preliminary results

This paper reports results on the system after it had been operational for just over 6 months and several case studies have been completed. While long term conclusions will necessitate further longitudinal data, the observations to date provide for some interesting discussion. Notably, while the system has been used, the case studies indicate a slower response than hoped for. This suggests that there are other influences for the rate of the systems use that extend beyond the issues with the GUI highlighted by the previous system which contribute to individual’s inertia.

There were a total of 249 entries in the system, of which 30 had been entered since the updated system was launched, during which time approximately 50 projects had been undertaken. Of the 30 newly entered projects, 9 had photographs attached and one project had CAD files added. The average completion of fields by these new projects is 36%, with the highest listed as 82% and the lowest as 16%. This is a consequence of many of the entries only being completed for the first stage (customer initiation). Crucially the design and the feedback stages had not been completed for the majority of entries, lowering the value of the entries to support design reuse. Designers also did not appear to be searching for any information within the system. The following case study demonstrates exactly the situation Busby argues can be avoided.

5.4.1 Example case study

Designer A was asked for a set of 24 fixtures, functionally equivalent to a previous fixture designed by the technical expert over a year ago. The company required a new set of fixtures to support the manufacture of an updated product whose geometry varied from the original.

Designer A was made aware of the previous design and consulted the technical expert, requesting previous geometry files and discussing the project with him. An initial total of 3 hours was spent by designer A in the company of the expert.

Had the designer sought information on the system, he would have found a record of the previous entry. A video of a structured interview had been recorded of the expert and an extended document detailing the previous design had been produced. This illustrates the benefits the system could provide; it is possible that most if not all of the time spent with the expert could have been avoided and in particular the basic search and transfer of files should not be the occupation of the lead technical expert.

It is possible the designer did not consider alternative sources of knowledge. But it is more likely the designer chose what he believed to be the easiest and most profitable route to the knowledge. Yet so much knowledge could have been obtained at his desk, from a system designed specifically for its accessibility and ease of use. Why was this not a considered route? This will now be discussed.

6. Discussion

The issues of inertia and use in knowledge capture and knowledge reuse should be separated into their constituent parts: Failure to Reuse and Failure to Input.

6.1 Failure to input

As presented in the results section, designers are initiating the storage of jobs and there are several entries with a completed first page and some with minimal uploads. On the whole the knowledge required to meet the user scenarios described at the start is not being captured. Four suggestions as to why this may not be happening are:

 A lack of defined expectations

---

1 This figure is dependent on when a project is considered complete however.
Knowledge is seen as too valuable to share
- Other tasks are consciously prioritised
- Inputting information is too much of a burden
- Knowledge cannot be codified
- Confidence of work

6.1.1 Defined expectations and knowledge value
The initial two suggestions are, in the author’s opinion, unlikely reasons on their own in the study presented. Firstly, there has been a high level of understanding and dialogue with the end users throughout the development of the system and in explaining the rationale behind the system. Workshops have been run in order to obtain input from the designers on how to improve the business and how best to utilise the knowledge. Second, the designers are willing and at least appear happy to share their knowledge—they have never shown unwillingness to share knowledge via other means. This would agree with the findings of Kankanhalli et al. (2005) in which the authors found that the loss of ‘knowledge power’ did not appear to affect knowledge codification.

6.1.2 Issues of time and effort
The third and fourth suggestions above provide interesting discussion points. At the time of HolD’s implementation into the workplace, the design team underwent an annual review. The importance of the role of knowledge transfer in the organisation was made clear to the team by senior management. The team were encouraged to support the knowledge transfer programme with 30% of their time nominally aligned to this activity (of which the design system is one). This was designed as an aspiration target, in order for the designers to balance their requirements and improve their prioritisation of knowledge tasks.

From observations by the author, this is not the case. Designers spend very little of their time on knowledge related tasks and always prioritise design and manufacturing related tasks over those of knowledge transfer. It cannot be due to the burden of inputting knowledge alone, as the designers are all typically well motivated and remain committed in all other activities and tasks. It does appear true, however, that despite encouragement from management, as engineers they see notation and paperwork (and therefore knowledge transfer) as an aside to their primary role - an observation made in prior studies (Marsh, 1997). In the developing knowledge based economy, this view must change. Companies cannot afford for individuals (regardless of their ability) to operate in isolation and not support the company’s knowledge base.

6.1.3 Issues affecting the codification of knowledge
As per Polayni’s theory of tacit knowledge and knowing, it is possible that designers are simply not able to codify the knowledge required in the system. It would seem that the study supports this, of the ‘knowledge’ entered, the most common inputs were the initial specification page. This is arguably the most explicit knowledge and easily codified. Despite this, throughout the study the designers the designers were regularly encouraged to describe and document the issues they encountered and solutions they developed. This level of detail is regularly captured as part of improvement programs and customer feedback, in many organisations. Furthermore, much of the knowledge captured refers to descriptions of the product, its operation and key requirements. It is not felt that this reflects the ‘un-teachable’ knowledge described by Polayni (1967).

6.1.4 Designer confidence
It is possible that designers may not feel confident about sharing knowledge, not due to its valuable nature, rather due to a concern that their work may be incorrect or criticised. This is a valid argument, but inherently suggests the designers are therefore unsure about their work. The company does not currently enforce a formal interim or close-out review of every design project and feedback is generally delivered via the client after delivery. Therefore if formal review meetings were established and the designs were reviewed by a senior designer, the designer may feel more confident in sharing the design and development.
6.2 Failure to reuse

In the study here, assessing the rationale behind the inertia of designers against reuse is more difficult than that of its capture for two reasons. Firstly, as described, the knowledge base is still limited, while containing a reasonably large number of designs, many (but not all) of them are well known to the designers. Secondly, the designers themselves have been based in the company for some time and have their own history of designs. Therefore when asked why they did not search the system, the answer is typically that they knew what they were doing.

This causes two problems. Firstly, failure to search and gain from the system means the designer’s will not see the benefit of the system and will be less inclined to store knowledge. Secondly, without the designers using the captured knowledge, they will not appreciate the quality of required knowledge stored, potentially resulting in irrelevant or poor knowledge being stored. Following this, four possibilities exist for the failure of knowledge reuse:

- Not invented here syndrome (unwillingness to use knowledge from others and trust)
- There is an easier route to source information
- Designers do not believe it is valuable enough
- Information obtained does not provide them with the knowledge they require

6.2.1 Not invented here syndrome

This is a recurring issue in knowledge reuse and engineering (Suresh, 2002). It can be argued that people typically prefer to work with ideas or objects they are familiar with. There may also be technical limitations when reusing geometry created by others. Here however, the intention is to present designers with examples and experiences and allow them to decide whether they are relevant and if the lessons learnt or the geometry is applicable for the new design. This has been made clear to the designers and while some geometric reuse is intended, adopting large sections of geometry were not intended unless it was a repeat product.

6.2.2 Use of other knowledge sources

As described in the case study, designers do seek information from other sources – primarily the technical expert or each other. The preference for personalisation approaches is well documented (Daft and Lengel, 1984) and has already been highlighted in this study. However, the role of the knowledge system is not to replace these interactions entirely, rather to make the majority of the discussions redundant.

It is also important that the designers understand the limitations of one-to-one interactions. With the technical expert due to retire, this ‘easy’ route option will not exist. Interactions with the expert currently must therefore be prioritised to those that make best use of his time and those which support the documented transfer of knowledge from the expert to the wider business. This final argument, coupled with the lack of a critical knowledge base probably corresponds to the reason behind user inertia. Rectifying this inertia will require a wider and more reliable knowledge base, but importantly, designers must perceive the knowledge base as relevant and valuable. Coupled with this should be an organisational and management led change in practise to actively encourage its use prior to interaction with the expert. Furthermore, discussions with the expert should be captured and stored on the system as part of the rationale and development of that particular project.

6.2.3 Value and content of knowledge captured

The final two suggestions are addressed by the discussion above - the designers believe the system is not valuable due to their own experience. Due to the limitations of the knowledge base this belief is likely to be true in many cases, but could be avoided with successful co-adoption. Conversely the author is not aware of any situations where designers have actually tried to find a past design and been disappointed; it is more common that they make the judgement prior to searching.

In an interesting development from the case study, when showed the codified knowledge and interview with the expert, the designer highlighted a component of the design which he had previously misunderstood. This was not a result of the expert misinforming, rather, the expert had simply not considered that the component to need explaining. Yet in the structured capture for the system, it had
been covered. It is proposed therefore that a structured knowledge capture approach may lead to
greater realisation of knowledge than unstructured personalisation approaches. However, it is also
acknowledged (and widely accepted) that the richness of interpersonal knowledge transfer cannot be
replicated with IT systems (Daft and Lengel, 1984).

These findings therefore lead back to the SECI model and the arguments of Hertzum and Pejtersen
(2000) – optimum knowledge transfer strategies need a combination of both inter personal transfer
methods and IT systems. However – the lack of uptake of the system remains an issue for long term
growth of the business. Regardless of the preference of designers for verbal communication,
documentation and long term knowledge capture is imperative for modern businesses.

7. Conclusion
This study presents the preliminary findings from an industrial case study of a knowledge transfer
programme and demonstrates that the development of a bespoke, accessible and easy to use to use
system is insufficient to overcome individual inertia.

No single reason could be attributed to the reluctance of designers to implement the knowledge
transfer programme described. The research here moved to optimise each of the abandonment
factors identified by Jones et al. (2009): visibility, integration, co-adoption, scalability, and return on
investment. Yet, while Designers did not appear to consciously avoid or oppose the programme there
remained a lack of genuine shareholder engagement. Overall it is believed that the combined
preference for verbal communication and the effort required to codify complex knowledge led to a
poorly populated system, in turn affecting knowledge re-use.

It is therefore argued that a knowledge system’s success requires an external influence (such as the
implementation of formal processes and audits) to change organisational behaviour, develop new
processes and encourage knowledge capture and re-use.

Acknowledgements
This work was jointly funded by the EPSRC and Rolls-Royce plc. The author wishes to thank all the
staff based at Rolls-Royce who have contributed to and supported this study.

References
Management Handbook. CRC Press LLC.
Structural Dynamics, and Materials Conference. Newport, Rhode Island, American Institute of Aeronautics
and Astronautics.
Brinkerhoff, R. O. (2005) The success case method: A strategic evaluation approach to increasing the value and
Advanced Manufacturing Technology, 18, 790-793.
design. Research in organizational behavior, 6, 191-233.
Management, 9, 101-115.
Business School Press.


Plato (360 BC) *Theaetetus*, BiblioBazaar LLC.


The Knowledge-Based Foundations of Organisational Performance Improvements: An Action Research Approach

Giovanni Schiuma and Daniela Carlucci
Università degli Studi della Basilicata, Potenza, Italy
giovanni.schiama@unibas.it
daniela.carlucci@unibas.it

Abstract: Purpose: The strategic and management literature grounded on the resource and knowledge based view of the firm, has widely outlined the importance of knowledge assets in a company's value creation. However, despite acknowledgment of the strategic relevance of knowledge assets and their management for driving organizational performance improvement, there is still a lack of suitable approaches to disentangle, explain and assess how knowledge assets support the achievement of a company's strategic outcomes. The paper investigates the role and relevance of knowledge assets in a company's performance improvement and provides some approaches, tools and managerial suggestions regarding the leveraging knowledge assets as value drivers for improving organisational performance. Methodology: The study is based on action research methodology. Findings: This paper highlights the role and relevance of knowledge assets as critical factors to manage for improving a company's performance. In particular, integrating the results of an action research project with the main insights from a literature review, the paper provides some approaches, tools and managerial suggestions mainly regarding: i) the identification and mapping of knowledge assets to be managed in order to improve performances; ii) the choice and the design of knowledge assets management initiatives; iii) the evaluation of the performance improvement gained by the implementation of knowledge assets management initiatives. Research limitations: The paper investigates the leveraging knowledge assets for a company's performance improvement in a specific context of analysis, i.e. the New Product Development (NPD) process. In order to have a more holistic view of the interactions between knowledge assets and company's value creation mechanisms, an extension of the investigation to other organisational processes is required. Moreover, to generalise the research's results, several applications in different industries and the use of different research methodologies are required. Practical implications: The paper, on the basis of theoretical and empirical insights, provides four managerial practices which managers might use in order to design and implement knowledge assets management initiatives aimed to support the improvement of company's performances. Originality/value: The paper provides more light on how knowledge assets and complementarities among them enhance organization's performances and provides approaches, tools and managerial suggestions for supporting managers in developing and leveraging knowledge assets. Especially the proposed approaches and tools intended to provide managers with information to assist them to allocate their managerial efforts to the knowledge assets with significant impact on performance.

Keywords: knowledge assets, new product development, performance improvement, knowledge assets management; action research.

1. Introduction

Traditionally, key assets for a company's competitiveness were physical assets and financial capital. These assets still represent and will continue to represent important factors for competitiveness. However, more recently, due to the complexity and turbulence of the competitive scenario, companies have recognised the need for increasing the level of 'intelligence' embedded in their processes and products and then the importance of continuously improving their core competencies and knowledge. Therefore, looking for new differentiators and drivers of bottom line performance, companies have recognised the relevance of knowledge assets as key sources of competitive advantage (Lev and Daum, 2004; Peteraf and Bergen, 2003; Teece, 2000; 2007).

In particular, in line with the main strategic thoughts provided by the Resources Based-View (RBV) (e.g. Barney, 1991; Penrose, 1959), the Competence-Based View (CBV) (e.g. Prahalad and Hamel, 1990) and the Knowledge Based-View (KBV) (Grant, 1996; Sveiby, 1997), companies have realised that their sustainable competitive advantage results both from the possession of resources that are hard to transfer and accumulate, inimitable, not substitutable, tacit in nature, synergistic, not consumable because of their use and the ways of combining and developing them.

Due to their relevance for organisations' competitiveness, knowledge assets have been and still are at core of an outstanding and fruitful academic debate, started several decades ago. For example, in strategic management field, several researches investigating knowledge assets and providing
definitions both of the contents and the nature of knowledge assets within organisations, have been provided (see for example Nonaka and Takeuchi, 1995; Grant, 1996; Zack, 1999).

In the last decades, with the aim to develop a more managerial and practical interpretation of knowledge assets, the concept of Intellectual Capital (IC) has been introduced and adopted (Edvinsson, 1997; Stewart, 1994; Roos et al., 1997). It can be considered as a holistic concept which embraces the different categories of organisational knowledge assets (Carlucchi and Schiuma, 2007).

This concept has driven the development of a number of managerial approaches and tools for the assessment of an organisation’s IC, e.g. IC-Index (Roos et al., 1997); Intangible Asset Monitor (Sveiby, 1997); Navigator (Edvinsson and Malone, 1997); Value Chain Scoreboard (Lev, 2001).

From the analysis of these frameworks emerges a broad consensus about the main dimensions of organisational IC. It is interpreted as the sum of three fundamental categories of organisational knowledge assets: human capital, structural capital and relational capital.

The human capital includes knowledge, skills, experience and abilities of people, technical expertise, problem solving capability, but also innovation capacity, creativity, know-how, teamwork capacity, employee flexibility, motivation, learning capacity, formal training, education and so on. Since any business and/or operation process is based on the know-how, skills, creativity, attitude and behaviour of the organisation’s people, they are core assets for a company’s competitive advantage.

The structural capital includes all organisational infrastructures which can be either tangible or intangible in nature. Therefore, they can be split in two categories: physical infrastructure, i.e. tangible, and virtual infrastructure, i.e. intangible. Both are fundamental for a company’s performance and need to be considered together to understand how value can be generated by exploiting organisational assets. In this regards, Lev argues that “intangibles are frequently embedded in physical assets (for example, the technology and knowledge contained in an airplane) and in labour (the tacit knowledge of employees), leading to considerable interactions between tangible and intangible assets in the creation of value” (2001, p. 7). Nowadays, particularly important are those physical infrastructures such as structural layout and ICT, computers, servers and physical networks, which support knowledge development and management. Virtual infrastructures comprise intellectual property, that is assets whose ownership is granted to the company by law, such as patents, copyrights, trademarks, brands and so on, as well as internal practices, virtual networks, organisation routines, corporate culture and management philosophies. These assets are critical success factors for business performance improvement.

Finally, the relational capital includes knowledge assets related to a company’s relationships with its stakeholders, such as partnership agreements with suppliers, experts, research centres, or universities as well as relationships with regulators. Relational assets include also commercial power, negotiating capacity, distribution channels, environmental activities and the perceptions that stakeholders hold about the company, for example image, customer loyalty and so on.

All above mentioned knowledge assets can represent important performance drivers and are at the basis of a company’s value creation dynamics (Carlucchi et al., 2004; Cuganesan, 2005). Especially they contribute to create value not only by themselves but by their interactions (Penrose, 1959; Youndt et al., 2004). Knowledge assets dynamically interact with each other to be transformed into value. In fact, as underlined by Carmeli and Tishler (2004), the “interaction amongst elements is complementary in that the value of one element is increased by the presence of other elements” (p. 1261). The same authors argue that knowledge assets have a positive effect on organisational performance and, particularly, the interactions among the knowledge assets enhance organisational performances.

Despite the wide acknowledgment that knowledge assets operate in the value creation dynamics mainly as bundles, understanding the mechanisms by which these assets interact and impact on business performance still remains a challenge (Dierickx and Cool, 1989; Lippman and Rumelt, 1982).

This paper aims to shed more light on the linkage between knowledge assets and a company’s performance improvement. For this purpose we have carried out an Action Research (AR) project in
the R&D department of a big company. The research project was aimed to investigate the dynamics by which knowledge assets are linked to NPD process performances.

The NPD represents a relevant empirical context in which to investigate the complex mechanisms by which knowledge assets influence organisational performances both because it is a knowledge intensive process and because, in today's competitive scenario, the NPD represents a critical process to continuously improve in order to ensure the company's growth and survival.

We believe that a better understanding, grounded on empirical evidences, of the links between knowledge assets and performance improvement can have both theoretical and practical benefits. From a theoretical point of view, this might benefit the KBV and the RBV theories. In fact, as underlined by Carmeli and Tishler (2004), these strategic research streams need more empirical studies demonstrating how intangible elements and complementarities among them enhance organization's performance. While, from a practical point of view, this might improve managers' understanding of the role of knowledge assets in company's performance improvement as well as it might contribute to the generation of approaches, frameworks and tools for supporting managers in developing and leveraging organisational knowledge assets.

The paper is structured as in the following. In the first section, we address the main cognitive characteristics of the NPD process and the role of organizational knowledge assets in the process. In the second section, we describe the AR project. Therefore, in third section, on the basis of theoretical insights and project's results, we discuss some managerial implications regarding the management of knowledge assets. Finally we provide some final remarks for practice and research, as well as we outline both the main limitations of the research project and some recommendations for further development of the research in the field.

2. The role of knowledge assets in the NPD process

In the last decades, the innovation has kept a much more relevant role in determining companies' success. In particular, globalization of markets, dynamic technologies development, product life cycles ever shorter and fast changing of customers demand have involved that the product innovation has a fundamental role for company's competitiveness. In such a prospect, companies seem forced to improve the NPD process performances in order to develop higher quality products and to enhance continuously the value provided to customers.

The strategic importance of NPD has generated a great attention of academics and practitioners on organizational and managerial features of the process. In particular, many scholars have analyzed the NPD moving from the traditional approach, considering the NPD as a planning process of strategic and organizational aspects, to a cognitive approach which interprets NPD as a process based on learning and strategic knowledge management (e.g. Söderquist, 2006; Shani et al., 2006). The cognitive approach is rooted in the wider knowledge-based conceptualisation of innovation process, which considers innovation as aware and intentional development of a learning process and utilization of the created knowledge for an effective and efficient product development (Kline and Rosenberg, 1986).

Consistently with this approach, several scholars have described the NPD as a knowledge intensive process (e.g. Clark and Fujimoto, 1991; Davenport and Pruzak, 1998; Leonard-Barton, 1995; Nonaka and Takeuchi, 1995; Verona, 1999), outlining the central role of knowledge assets and its management for the process effectiveness.

Moreover a huge amount of studies focusing on the role of specific knowledge assets in the NPD process, such as, for example, company's relationships (see e.g. Ding and Peters, 2000), intellectual property (see e.g. Kalanje, 2005), ICT solutions (see e.g. Corso and Paolucci, 2001; Khodawandi, 2005), routine and practices (see e.g. Akgüna et al., 2007), has been carried out.

In addition, some recent managerial approaches like Concurrent Engineering and Multi Project Management take into account the importance of knowledge for NPD process. For example, in the Concurrent Engineering the attention is focused on knowledge socialization within interfuctional teams (Iansiti, 1995). In the Multi Project Management the focus is on the capability to stimulate knowledge sharing by a re-exploitation of project solutions over the time and on knowledge transferring among different projects (Clark and Fujimoto, 1991; Wheelwright and Clark, 1992).
In summary, NPD process can be interpreted as a process which simultaneously exploits and creates several knowledge assets, belonging to intangible assets categories above described, i.e. human capital, structural capital, and relational capital.

In order to understand how these assets are exploited and generated throughout the process, we can refer to the resource-based description of the R&D process, provided by Pike et al. (2005), properly tailored. Similarly to R&D process, the NPD process starts with an issue that is discovered or acquired. This corresponds either with the definition of a targeted improvement of an existing product or with the development of new one. Then possible solutions to the issue are identified. Subsequently, the most suitable solution is selected and implemented by carrying out product design, prototype and then the new product. Finally, the outcome of the new solutions implementation is evaluated, defining the information base for a new cycle of problem definition and problem solution.

During the different stages of the NPD process a number of knowledge assets are involved. In fact, the generation of new solutions requires cognitive abilities, which are mainly grounded on human capital. Any solution is then tested and codified forming elements of structural capital. Finally the evaluation of the generated solutions involves customers and other company’s stakeholders, creating new elements of knowledge assets mainly in the form of relational capital. More generally, each stage of the NPD process can involve several and heterogeneous assets. For example the generation of new solution can involve customers and inter-firm’s relationships, or the use of dedicated software and hardware infrastructure, and so on.

Therefore NPD process development involves human, structural and relational assets. They interplay each other during the different phases of the process, contributing to determine process performances.

3. Inquiring into the links between knowledge assets and NPD performance

3.1 2.1 The inquiry approach: An AR project

In order to gather empirical evidences regarding the role of knowledge assets in the NPD process performance improvement and to derive insights for analysing the relationships between knowledge assets and organisational performances, we carried out an AR project within the R&D department of a big company. The project has been aimed to design and implement some knowledge assets management initiatives within the company involved in the project, with a twofold aim:

- To inquiry the following research question: “How does knowledge assets development support NPD process performance improvement?”
- To improve the company’s NPD process performance by leveraging on knowledge assets development.

AR is a qualitative research method in which a researcher participates in organization’s activities and examines an ongoing situation. It always involves two main goals: to solve a problem and to contribute to science (Coughlan and Coughlan, 2002). In particular, AR simultaneously assists in practical problem-solving and expands scientific knowledge, as well as enhances the competencies of the respective actors, i.e. researchers and practitioners, being performed collaboratively in an immediate situation using data feedback in a cyclical process aiming at an increased understanding of a given situation (Hult and Lennung, 1980).

In the last decades, AR has become increasingly prominent among management researchers for carrying out research into management and organizations. This is because this method is particularly appropriate for developing theoretical insights that relate closely to practice and concern process of managing (Eden and Huxham, 1996).

The use of the AR methodology seemed well-suited to the needs of this study for several reasons.

First, the management literature stresses that knowledge assets and their management are strongly hydiosinratic and affected by the context, thus any research investigating the subject has to take into account the organisational context. This is a fundamental characteristic of the AR which uses an organisation as a physical laboratory for developing and testing practical interventions and advancing knowledge closely related to the context.
Second, the AR, as “research in action” (Coughlan and Coughlan, 2002), well deals with the outstanding need of improving the understanding about how knowledge assets and their management affect NPD, since AR allows to extract from practice, in accordance with an inductive approach, insights to be combined with those based on a theoretical deductive approach.

Third, AR, as a comprehensive research approach, captures fully the richness of the variables involved in knowledge assets management in practice and provides an appropriate context for the interpretation of findings resulting from the other forms of investigation (Petty and Guthrie, 2000).

Finally AR is a useful approach to overcome the reluctances, prejudices and resistances that sometimes the implementation of projects concerning the management of intangibles involves (e.g. sharing individual knowledge). In fact, the participative approach characterising the AR allows to create a broad consensus within an organisation on the development and implementation of initiatives directed to manage knowledge assets.

The AR develops around a spiral cycle and includes several phases. The cycle starts from the definition of a general idea or the identification of a problem at both theoretical and practical level. This can involve researchers and concerns also the negotiation of terms of entry and of the AR program. Basically the AR includes four phases (e.g. Kemmis and McTaggart, 1988) (see Figure 1). These phases recur cyclically.

- **Diagnosing**: It consists of data collection; feedback to participants and management; discussion on results of feedback, evolution of ideas for action
- **Planning**: It includes preparation of action plans, possibly experimental
- **Acting**: It includes implementation of action plans, continuous monitoring
- **Evaluating**: It includes evaluation of experimental actions; feedback to participants and management; problem redefinition or refinement as necessary

**Figure 1**: The basic phases of an Action Research

The phases described in Figure 1 define an “ideal type” of AR. In fact, as underlined by Wilson (2000), AR projects may vary in the emphasis given to one phase or another, in the extent to which the actions are viewed as experimental or permanent changes, and in the degree of involvement of the client organization’s managerial or other staff.

Different types of AR can be adopted. Grundy (1982) provides a useful taxonomy of AR projects which distinguishes among technical, practical and emancipatory AR.

According to this taxonomy, we have implemented a technical/practical AR project. It is technical, since it started with a specific research question well grounded on theoretical management literature background. In particular the following main points have been investigated during the research project: how to identify and map the knowledge assets to be managed in order to improve NPD process performance?; how to choose and design the knowledge assets management initiatives?; and how to evaluate the performance improvement gained by the implementation of management initiatives?

The AR project is also practical since the research phases have been carried out by creating a close cooperation between managers and researchers, looking for approaches, tools and managerial insights aimed to improve organisational performances and, particularly, the NPD process performances.

### 3.2 The context of the research

The research laboratory for the AR project was the R&D department of a world leader company in sofa production located within an industrial district in South Italy. In particular, we have focused our
attention on the NPD process. The NPD represents for the investigated company one of its most important business processes. The company’s competitive advantage acquisition and maintenance significantly depends on this process. This is because, today, the competitiveness in sofa industry is strongly related to company’s ability to create a wide range of products with a high number of stylistic and functional characteristics\(^1\), to frequently renovate the product portfolio and to improve efficiency by controlling production costs, standardising products’ components as well as by adopting new materials. In such a competitive context, having superior performance in NPD process represents a strategic lever for facing the growing competition.

The company’s NPD process is a not formalized process and greatly based upon know-how and knowledge with tacit nature, creative intuition and craftsmanlike ability of some key individuals operating in different phases of the process.

In particular, any new product, i.e. a new sofa model, is the output of a knowledge intensive process based on the know-how of some key individuals, the designers and the prototypists which, on the basis of their craftsman skills and tacit know-how, respectively design and prototype the different parts of a new sofa, providing to the product specific stylistic and functional characteristics.

### 3.3 The AR project

The AR project has been developed in four main phases: diagnosing, planning, acting and evaluating. Since in AR the researcher is an actor and hence subjectivity is central to the process of action and evaluation, in order to mitigate subjectivity within this research, the researchers paid particular attention to:

- Co-design and develop the AR phases together with the managers of the R&D department and the top management;
- Have a team of three action researchers, to reduce personal bias in onsite work and research;
- Have company check the write-ups;
- Seek for multiple viewpoints within the department.

In the following a brief description of the AR phases is provided.

**Diagnosing phase.** In this phase, first researchers and company's managers have identified some relevant problems affecting the NPD performances.

For this reason some focus groups involving the company's top management were performed.

The aim of these focus groups was understanding the most important NPD performances to be improved and identifying the factors determining under performances. In this phase, the links between general company's strategy and NPD performance improvements were analysed.

Two main performance dimensions affecting the NPD process efficiency and needing to be improved were identified: the product design activities and prototyping time and the conformity of the prototype to the standards of the designed product.

Therefore the reduction of product design and prototyping time and the improvement of the conformity have been targeted as performance objectives to be achieved.

In order to identify the specific NPD operational problems, related to the targeted performances, several data and information were collected by means of focus groups, structured and unstructured interviews, direct observations and document analysis. Both managers and employees working in the NPD process were involved. Four main problems affecting the NPD process performance were identified: i) poor knowledge sharing between prototypists and designers and lack of an effective knowledge interface between the design area and the prototype area; ii) low level of designers' know-how about the technical and structural features of a sofa; iii) lack of codified rules and procedures to drive both designers and prototypists in their activities; iv) lack of ICT tools to support

---

\(^1\) The investigated leader company has a product portfolio with an average of 90 different products and each product is basically available in 12 versions and in 100 different types of leather and textile covering. Furthermore, the average market life cycle of a sofa is 9 months.
information/knowledge storage, processing and managing. The results of the diagnosis phase were then adopted as inputs for the planning phase.

Planning phase. Once clarified the performance objectives to achieve and diagnosed the problems causing underperformance, researchers and managers have worked together during targeted focus groups in order to plan some managerial initiatives aimed to the achievement of targeted performance objectives by leveraging and developing knowledge assets.

At this stage of the research has emerged the lack of structured approaches to drive managers towards the identification of the strategic knowledge assets to lever on for achieving company’s key performance targets. Answering to this lack was a critical part of the research project.

As underlined by some scholars (Kaplan and Norton, 2000; 2004; Zack, 1999) any knowledge assets management initiative has to be aligned to business strategy; as a result it has to be planned and implemented with a view to achieve organisational performance objectives.

This encompasses three main elements: i) the identification of measures and indicators for evaluating the effects of management initiatives; ii) the identification of the key knowledge assets to be developed against performance objectives; iii) the understanding of the links of knowledge assets with the performance improvement targets.

Regarding the measures and indicators for assessing the effects of management initiatives, two main key performance indicators have been defined to assess the NPD performance improvement: (1) design/prototype time for a new sofa model; (2) level of conformity, measured on the basis of an appropriate list of features, of the prototype with the drawing of the designed product.

About the identification of knowledge assets at the basis of NPD performance improvement, a set of approaches and tools have been developed and applied.

First, a disclosure of the relevant knowledge assets involved in NPD process has been carried out. The managers of the R&D department together with designers and prototypists, supported by researchers, have identified and analysed the knowledge assets involved in the process, according to the taxonomy which classifies knowledge assets in human capital, structural capital and relational capital.

Especially a tool, called “matrix of direct dependencies”, was formulated and applied to facilitate the team working. In this matrix, knowledge assets are listed in rows and the targeted performance objectives are listed in columns. The cells of the matrix contain managers’ judgment concerning the importance of the knowledge asset on the row for achieving the performance objective on the column. Judgments are expressed recurring to a binomial approach, i.e. yes or not (see Figure 2).

<table>
<thead>
<tr>
<th>Performance Objective</th>
<th>Performance Objective 1</th>
<th>Performance Objective 2</th>
<th>......</th>
<th>Performance Objective n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge Asset 1</td>
<td>Y</td>
<td>N</td>
<td>......</td>
<td>Y</td>
</tr>
<tr>
<td>Knowledge Asset 2</td>
<td>N</td>
<td>Y</td>
<td>......</td>
<td>N</td>
</tr>
<tr>
<td>......</td>
<td>......</td>
<td>......</td>
<td>......</td>
<td>......</td>
</tr>
<tr>
<td>Knowledge Asset n</td>
<td>Y</td>
<td>Y</td>
<td>......</td>
<td>N</td>
</tr>
</tbody>
</table>

**Figure 2:** A generic matrix of direct dependencies

By using the matrix, the following knowledge assets have been identified as relevant for the improvement of the NPD process performance: i) technical expertise of the designers; ii) problem solving capability of the designers as well as of the prototypists; iii) ICT infrastructure and particularly knowledge-based design software; iv) team-working culture; v) codified knowledge in the form of procedures, rules and best practices.

Once identified the relevant knowledge assets against performance objectives, a more detailed analysis of their involvement in NPD process has been carried out. The analysis has provided more insights for designing proper knowledge assets management initiatives. Especially it allowed to
identify the most important knowledge assets to leverage and develop for achieving performance improvement.

For doing the analysis the strategy mapping concept has been considered (see Strategy Map (Kaplan and Norton, 2000; 2004); Success Map (Neely et al., 2002)).

In particular managers with researchers’ support have developed a visual framework made up by nodes and arrows providing a representation of the cause-and-effects relationships linking knowledge assets to performance objectives.

![Diagram of relationships linking knowledge assets to performance objectives](image)

**Figure 3**: Relationships linking knowledge assets to performance objectives

On the basis of an in depth analysis of the relationships visualised in the map, managers have identified the following key knowledge assets for the NPD process performance improvement: i) working practices in terms of team-working, ii) codified knowledge about the product design and prototyping with particular attention to the routines and procedures, and iii) software to support the design process.

Subsequently, the attention has been focused on the analysis of the management processes to be implemented in order to develop the identified key knowledge assets.

In this regard, the Knowledge Management literature provides a vast number of approaches, recommendations and insights (e.g. Holsapple and Joshi, 2000; 2002; Lev, 2001; Marr and Schiuma, 2001; Teece, 2000) for performing management processes.

The researchers have supported managers in choosing the most suitable management processes against key knowledge assets and their interactions shown in the map.

Two main knowledge management processes have been identified as relevant: the knowledge sharing and the knowledge codification process. Therefore, on the basis of the chosen management processes, two main knowledge assets management initiatives have been designed.

One initiative has been planned with the aim to create a knowledge interface infrastructure to facilitate the development of a team-working approach between designers and prototypists. While, the other one has been addressed to build knowledge repositories where to collect and manage codified rules and procedures of the NPD process.

*Acting phase*. In this phase the designed knowledge management initiatives have been implemented. The first initiative, aimed to create a knowledge interface for team working, has been translated into
action by the definition of new design standards based on the introduction of specific sofa-designed drawing and on a 3D virtual representation of a sofa and its components.

At present, once the designers have completed the design process they draw a detailed picture of the external stylistic characteristics of the sofa. Afterwards, the drawing is analysed by a team of designers and prototypists and, finally, it is elaborated by 3D software, which provides virtual representations of the sofa and its components. In addition, a platform of cognitive artefacts has been created. The platform allows designers and prototypists to work together breaking down the silos in which they used to operate. In this way, it is possible a prompt feedback about problems of the designed sofa and the knowledge sharing mechanisms between designers and prototypists are facilitated.

The second initiative, aimed to codify the tacit knowledge at the basis of the NPD process, has been carried out by developing a design sofa manual. Capturing and codifying tacit knowledge in a way that can be leveraged by the company was a great challenge.

For this purpose several tools have been used: workshop, interviews, analysis of documents, audio and video recording, field notes, collection and analysis of anecdotes.

Today, the company is updating continuously its own manual which collects and makes easily available codified rules and procedures on the design and prototype solutions. Moreover, it codifies knowledge about the features of company's product portfolio.

This is proving to be particularly useful for the identification of the best practices and solutions which support continuous improvement as well as for stimulating learning organisation mechanisms by moving the knowledge from individual to groups and from groups to the entire organisation.

**Evaluating phase.** In this phase the outcomes of the initiatives have been assessed. This has been carried out by gathering information from managers, designers and prototypists through structured and unstructured interviews as well as by collecting and analysing measures about the NPD process performances from the quality assurance department.

The implementation of the management initiatives have proved to generate value for the company mainly in terms of both the reduction of the time to develop a new model of sofa, in particular the average time has been today reduced of 30%, and the improvement of the stylistic/functional conformity of the prototype to the product design, which guarantees a better alignment with customers’ requirements.

4. Discussion

The analysis of the results of the AR project suggests some fundamental insights regarding the management of knowledge assets aimed to improve organisational performance.

In particular, the distillation of the empirical evidences shows that the design, implementation and evaluation of management initiatives aimed to sustain company's performance improvements by leveraging and developing knowledge assets can be articulated through four main cycle phases: **Value Strategy Clarification, Knowledge Asset Disclosure, Knowledge Assets Management Initiative Definition and Performance Improvement Assessment**.

**Value Strategy Clarification:** this phase is aimed to answer to the fundamental question: ‘What are the key strategic company’s performance improvements objectives to be achieved?’ Before starting a management initiative for knowledge assets development it is fundamental to clarify the company's strategy. This equals to define the company’s value propositions and the key company's strategic objectives related to the company’s value creation strategy. Once the company’s strategic value objects have been identified, these have to be translated into company's business performance and performance targets. Moreover performance measures need to be defined in order to monitor the achievement of the performance improvements targets. For this purpose the adoption of Performance Management and Measurement Systems is particularly useful for clarifying, communicating and assessing strategy. Once the company’s strategic objectives have been disclosed, the attention has to be focused on business processes involved in the achievement of those company’s strategic objectives and on the knowledge assets at basis of the processes.
**Knowledge Asset Disclosure:** this phase is aimed to identify and analyse knowledge assets which are relevant for achieving the targeted performances. At this stage the following question has to be addressed: *What are the key knowledge assets at the basis of organisational performance improvement?* The identification and the analysis of key knowledge assets value drivers necessarily involves managers in discussion and decision making process. The use of tools such as the “matrix of direct dependencies” and the strategy map can support the disclosure.

**Knowledge Assets Management Initiative Definition:** this phase is aimed at designing the knowledge management initiatives for the development of key knowledge assets. At this stage the following question has to be addressed: *What are the organisation knowledge management initiatives to be designed and implemented for knowledge assets development?* The principles of Knowledge Management can properly drive the design and the implementation of initiatives. Particular attention has to be paid to the organisational, managerial and cultural factors affecting the success of knowledge management initiatives, e.g. commitment and managerial support, motivation in people, unambiguous communication of the aims pursued by the initiatives.

In the research project one of the most important factors affecting the successfully implementation of management initiatives was the top management support.

**Performance Improvement Assessment:** this phase is aimed to evaluate the impact of knowledge management initiatives on organisational performance. It is addressed the question: *What are the benefits gathered from the knowledge assets management initiatives?* In particular, two aspects need to be investigated: the development of the key knowledge assets and the improvement of organisational performance involved. Monitoring and measuring the impact of the development of knowledge assets on performance is very important to get the approval and commitment of the entire organisation. For this reason, it is very important to have in place measurement systems which account the impact and benefits of the development of knowledge assets – the measurement makes tangible the benefits and justifies the investments. In particular, managers on the basis of performance measures can justify their investments into certain key knowledge assets value drivers, or, if their assumptions were wrong and there was not a performance improvement, they might go back to the start and understand the reasons of the failures both from strategic and operative point of view.

### 5. Final remarks

In the last decades, the economic and management literature has largely stressed the importance of knowledge assets for a company’s competitiveness. Grounded on the KBV and the RBV, this paper stresses the importance of better understanding how knowledge assets can be identified and developed to drive organisational performances improvement. The links between knowledge assets and organisational performances have been investigated by implementing an AR project within the R&D department of a leader company operating in sofa production. The project has highlighted the fact that despite managers recognising the strategic role of knowledge assets for company’s performance, they need guidelines and approaches for the identification, analysis and deployment of these assets.

Although this paper contributes empirical evidences about the importance of knowledge assets and their management for company’s competitiveness some shortcomings have to be stressed.

First, even if the NPD might represent a strategic process for company’s performance, it would be helpful to extend the investigation to other organisational processes, separately and/or jointly, in order to have a more holistic view of the interactions between knowledge assets and a company’s value creation mechanisms.

Moreover, to generalise the research’s results, several applications in different industries and the use of different research methodologies are required.

Future developments of the research could concern the analysis of the managerial factors affecting a successful implementation of knowledge management initiatives and how these factors can be governed in order to get the highest positive value impact on company’s growth. Finally, great attention should be paid to the exploration of the dynamic evolution of knowledge assets and their impact on a company’s value creation dynamics.
References


