Knowledge Work Practices in Global Software Development

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Abstract: This paper is an exploration of knowledge work practices in a distributed software development setting. The author has undertaken an empirical study in the Irish subsidiary of a multinational company over a 16-month period. Our methods were inspired by ethnography; by spending an extended period of time with a software development team working on a specific project, we had the opportunity to observe real work practices in a real work setting in the specific circumstances of distributed work. The purpose of the current study is to highlight the ways in which technical and social factors are inextricably entwined in distributed work settings.

Keywords: collaboration, work practices, distributed work environments, global software development, knowledge work, mutual knowledge, transactive memory

1. Introduction

Software development is a knowledge-intensive, complex activity. In addition to its intrinsic complexity, nowadays software development has increasingly become a multi-site, multicultural, globally distributed undertaking (Herbsleb 2001). The forces behind the global distribution of software development activities are predominantly of an economic nature, turning national markets into global ones and spawning new forms of competition (Prikladnicki 2004). The phrase ‘global software development’ (GSD) has been coined to refer to “software development that is geographically, remotely or globally distributed with the aim of rationalising the development process and products” (Sarker 2003). The variety of settings in which GSD takes place include anything from globally distributed subsidiaries of the same organization to outsourcing arrangements, open source communities and virtual small companies with employees distributed throughout the world.

The ACM Job Migration Task Force report on globalization and software offshoring (Aspray 2006) shows that globalization of the software industry is expected to increase in the coming years, fuelled by both information technology itself, by government actions and by economic factors. The reasons for the global distribution of software development activities stay the same: cost reduction, flexibility, availability of a large and competitive labour pool, access to special expertise, good quality of work, closeness to particular markets. But at the same time, global software development poses specific challenges related to communication, coordination and collaboration that can hinder the success of distributed work (Carmel 2001). The conclusions of a workshop dedicated to global software development in 2003 listed as the main challenges for the field: the lack of informal communication, the cultural differences between distant sites and the difficulty of building trust among remote developers (Lanubile 2003).

Knowledge management issues within global software development have been highlighted in several studies. Herbsleb and Moitra (Herbsleb 2001), for example, categorize the effects of physical separation among project members along several dimensions:
- strategic,
- cultural,
- technical,
- communication related,
- knowledge management related and
- project and process management related.

Among the knowledge management issues, they mention the inappropriate level of knowledge sharing and documenting in distributed software projects. For the authors, knowledge management is just one of the aspects challenged by work distribution, seen in its concrete manifestations.

De Souza et al. (De Souza 2006) consider the management of knowledge in global software development projects absolutely essential in order to cope with the coordination and integration of multiple knowledge sources under time pressure and budgetary constraints. Building on the two dominant knowledge management strategies described by Hansen, Nohria and Tiernan (Hansen 1999), De Souza and his colleagues focus on distributed software development. The two initial approaches are: codification/focused on building central knowledge repositories, where knowledge is detached from its owner, put in context and
made available across the organization), and personalization (where knowledge sharing is fostered through people-to-peer interactions and dialogue). De Souza's study is based on knowledge management practices observed in more than 50 software organizations, and after taking into account three factors (the focus of the organization, the degree of structure and the knowledge repositories in place), the authors describe three models for distributed knowledge management architectures: client-server (corresponding to codification), peer-to-peer (corresponding to personalization), and a hybrid model, which is a combination of both.

While we agree that, taking into account the large variety of settings for global software development, choosing suitable approaches for each organization is important, our work is not focusing on the strategic level. We have instead chosen to explore knowledge work – "the work of producing and reproducing the knowledge" (Schultze 2000) – focusing on "what people do, i.e. their work practices, rather than on what they know" (Blackler 1993). A better understanding of knowledge work practices can provide useful insights in the role of the organizational culture and of a stimulating work environment as vital for the successful organisation of distributed work.

Speaking about knowledge in the context of software organizations, Davenport and Prusak describe it as "a fluid mix of framed experience, values, contextual information, and expert insights and grounded intuitions that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of the knower. In software organizations, it often becomes embedded not only in documents or repositories, but also in organizational routines, processes, practices, and norms". (Davenport 1998, pg.5)

We regard knowing as an essentially human feature and thereby maintain that knowledge cannot be stored using technical means. What is actually stored is information about knowledge (Rus 2001). The human actors are the only ones who can process, share and create new knowledge by interacting with each other and with the technologies. Regarding knowing as something people do (rather than looking at knowledge as something that people have) "draws attention to the need to research ways in which the systems that mediate knowledge and action are changing and might be managed" (Blackler 1995). Instead of speaking about knowledge being created, shared, and used, we prefer to look at the human actors who perform all these actions in a social context.

Our work is meant to extend the existing body of studies focused on work practices in Software Engineering, by contributing an insight on the particularities of knowledge work in distributed software development environments. The purpose of our paper is the exploration of knowledge work practices in a global software development setting. In order to do so, an empirical study in an Irish subsidiary of a multinational company was undertaken. The study covered a 16 month period and employed ethnographically-informed methods. What differentiates our approach from other global software development studies of distributed work settings are: the focus on social practices rather than on technical issues, the bottom-up approach – we are observing what happens in the real setting, using a variety of methods ranging from participant observation to interviews and document analysis - and the extended span of time of our studies.

The objective of the current paper is to discuss the impact of the global distribution of software development on collaborative work practices and knowledge creation, transfer and retention. The next section includes a description of the wider context of our work. Section 3 introduces the software development team we had the opportunity to observe. Section 4 presents a number of knowledge work practices that were noted during our time with the team, and the following section is dedicated to a discussion of these practices, with an emphasis on the impact of distribution; the final section presents our conclusions.

2. The context of our research

2.1 The socGSD project
At the University of Limerick, Ireland, a group at the Interaction Design Centre was established as part of a software engineering research consortium to study the social, organisational, and cultural aspects of global software development (the short name of the project is socGSD). This project aims to explore how organizations attempt to manage the coordination of engineering work via a variety of mechanisms. In our approach, we build on earlier Computer Supported Cooperative Work (CSCW) studies dedicated to issues such as articulation and coordination work, information sharing and knowledge management practices in distributed work, and the role of organizational memory support tools. The socGSD project is investigating
the nature of these issues through a variety of analytical and empirical methods highlighting both theory and practice in this domain.

Over the past 18 months, the socGSD team has been engaged in field work in several sites in Ireland where software development is being conducted involving geographically distributed teams. Our research methods mainly rely on an interpretive, naturalistic approach to data collection and analysis. This means that we study the phenomenon in the actual settings where the work activity takes place, attempting to make sense of the work through the eyes of those actually doing it.

We attempt to bring into light the diversity of ways in which distributed teams shape their work practices and achieve a shared understanding of their objectives. Another topic of interest is constituted by the ways in which people involved in software development manage to either cope with or re-shape the organizational rules and formalizations they are required to use through their work practices.

2.2 Research approach

In the ensemble of studies looking at global software development, our approach is relying on field studies of work practices over an extended period of time. Our work is informed by a long tradition of workplace studies presented in the CSCW literature.

We believe our approach complements studies undertaken from a macro-economic or strategic perspective by looking at participants in real workplaces in various global software development settings. These participants are studied in real work circumstances (as opposed to experiments), and are engaged in continually evolving working arrangements. By shedding light on the hidden aspects of these practices, we attempt to show what people actually do to get their work done in contrast with the prescribed processes.

Our data collection and analysis methods are mainly informed by ethnography and include observation, document analysis, in-context interviews, audio recording, focus groups and workshops. In this context, our study is not intended to be a simple description of the developers’ perspective and experience explained in their own words, but also an interpretation about how these people’s experiences can be understood in terms of the interplay between members and the researcher (Dourish 2006).

The purpose of our study is to contribute to a better understanding of the impact of global distribution of software development on knowledge work practices. How do software developers cope with distance when it comes to knowledge creation, sharing, transfer and application? What are the artefacts, tools and social practices facilitating distributed knowledge work?

2.3 The fieldwork at the described site

One of our field sites was the Irish subsidiary of a multinational company involved in software development. We were granted the opportunity to follow a software development team starting with January 2006. In the first 3 months, we participated in a number of team meetings, studied the documents in the project repository and interviewed the team manager and a few developers, in order to familiarize ourselves with the context and the work being done.

After that, we spent more than 50 days in the field, observing the activity of the team in its own work environment, participating in meetings and group activities and occupying a desk in the open plan next to the team’s area. The periods of time spent in the company varied between 6 consecutive days when the team was approaching an important milestone or release, to one day weekly in order to maintain contact and awareness.

The research team was granted access to the company intranet, to the project’s document repository and to the team’s mailing list. The author was also allowed to make use of the company’s own instant messaging system, useful both as an awareness mechanism and as communication channel with the members of the observed team. This allowed her to reach a better understanding of the ongoing activities and carry on her observation even when not present on site.

During the 16 months of observation, the author developed a good relationship with all the team members and found opportunities for conducting both formal interviews and informal discussions on various topics.
One of the best ways to observe directly the team members’ interactions with people in various other locations (US, Germany, India) was the researcher’s silent participation in teleconferences. The team manager, who granted us this opportunity, was extremely supportive not only by allowing us to follow the information displayed on his screen, but also by answering to our questions at the end or commenting for us whenever possible. The remote participants were made aware of our presence in the room on these occasions. The author also kept a diary and took detailed notes each day that was spent in the field.

10 months into the project, the author also travelled to one of the company’s sites in Germany and interviewed five people with different roles in the collaboration between the two sites (managers, architects, technical planners).

The research team organized two workshops (one with the development team and the quality engineers, and the other with managers and some of the remote collaborators of the team) in the early phases of observation. The purpose of these meetings was to explain our methods to the team, and also to discuss our research-in-progress and illuminate some of the topics and situations we found of interest.

The data collected from the field was periodically discussed and analyzed by the extended research team, in order to identify topics, trends and problems and compare the findings to those from other similar sites where fellow research team members were observing similar processes and activities.

3. The observed project team

The project started in January 2005 with 8 developers and 2 software architects (one on site and the other one working from his home in another European country). 5 of these developers had worked together before (lead by the same development leader) on a specific component of a similar product, bringing valuable expertise to the team. A team of 4 quality engineers started its work on the product and collaboration with the developers later that year.

The development leader reported to both a local manager (dealing with administrative and HR matters) and to a second one, located on the East Coast of the US (dealing with business issues related to the new product). A user interface designer and a technical writer, both located in the US, were also assigned to the team.

Over time, the team grew to 15 people, with a high turnover during the 2 ½ years period of project duration. Only 4 members of the initial team stayed with the team until the end, both the local software architect and the development leader having to move to other projects before its end. Despite this, the team reached a good cohesion level after their first release (approximately 18 months into the project), and learned how to quickly adopt newcomers (either from inside or from outside the company) and deal with the departures.

The collocated team included people of various nationalities and with different backgrounds. Some of them had worked in the company for all their professional life, while others were student interns or had just finished their studies obtaining graduate/postgraduate degrees. The team was regarded by the other teams on site as being over-disciplined and extremely hard working, but having a good social life as a group. The cultural differences were leveraged as an advantage in the interactions with colleagues from other geographies – we witnessed phone and instant messaging conversations in no less than 5 languages other than English. It was a well-established procedure that senior members of the team worked from home 1-2 days a week to avoid commuting to work, using the same interaction mechanisms with their team as the members located in other countries (e-mail, instant messaging, phone, project databases).

While in the first year people worked on isolated components, the integration effort and the work on their first release brought people closer and contributed a lot to the formation of an efficient and flexible team. A post mortem analysis was organized after the first release, discussing the challenges encountered, the achievements, and the lessons learned. This was followed immediately by the kick-off of 2 new projects, building on the code of the previous release, but involving different technologies. In the next 9 months, the team encountered plenty of difficulties, most of them due to the immaturity of the new in-house technologies they were building on. In May 2007, the top management took the decision to relocate the work in another European country, where 2 of the underlying technologies were developed. The decision was based on a realignment of corporate priorities and on the need to reduce interdependencies between sites. The project came to a normal closure on the Irish side after the next milestone, one month after that.
The activity of the team was centred on a number of shared repositories:
- version control system for the code developed,
- defect tracking system for the problems encountered in the functioning of the code,
- project database for the architectural guidelines, specifications, important decisions in the course of the project,
- project documentation,
- work schedules and
- email archives.

For communication between the members of the team, face to face interaction (where possible), instant messaging, e-mail and phone were the most important means used. The team met weekly in a meeting room, joined by the remote members using the internal conferencing system.

4. Exemplars of practices

In this section, we will present three vignettes that illustrate work practices established by this specific team to cope with distribution. For each of them, we will mention the artefacts people use, the corresponding knowledge repositories and the role played by human actors. The vignettes are focused on knowledge creation, sharing, transfer and documentation practices that were observed by the author during her time spent with the team.

4.1 Talking the developer through his assigned work

The project started with an architect located abroad and a core group of developers in Ireland, who in the first phase developed prototypes to illustrate the product idea and its functionalities. The architect had worked for years on developing 5 similar products for different platforms during his career and had accumulated a lot of expertise in the field, being considered a “guru”. While re-developing the same ideas for an enterprise portal environment, he also had the chance to introduce new features and bring the product up-to-date. Instead of spending an extended period of time developing product specifications working in isolation from his home office in another European country, in the early stages of the project the architect preferred to interact with the developers’ team in Ireland, testing the opportunities offered by the underlying platform and on the same time building mock-ups to enable him to demonstrate his ideas to the top management and gain their support for the project. Instead of writing specifications for the developers, the architect used to develop his ideas in one-on-one phone meetings with various developers or in specially designated team meetings.

In the one-on-one meetings, the architect explained his ideas to the developer, who had then to write the code. “He is telling me what to do and how to do it”, one of the developers said to us.

Sometimes, artefacts such as UML or box & arrow diagrams, tables, text, screen shots or PowerPoint slides were sent to the developer beforehand, and the explanations were based on them, but this wasn’t the rule. Most of the time, the specifications remained very high level and the functionalities to be added were specified by the architect in emails sent to the developers assigned to each component.

After a first iteration, a code inspection phone meeting followed, where the developer shared his screen with the architect. In some of these meetings, the American User Interface designer was also invited. Speaking about one of these meetings, a junior developer confessed: “it was very good, because it clarified a lot of problems. My last week’s work will have to be thrown in the bin, but I am much closer to a solution now. It’s basically a trial-and-error process, and it’s important to have the code inspected as early as possible”.

After the functionalities of a specific component were discussed, the general specifications for the component had to be drafted by the developer. These specifications were further used by testers (Quality Engineers) for running the functional tests, and by the technical writer for writing the product documentation. This agile practice might be pretty frequent in collocated settings, but this particular team has adapted it to work over distance. While the product expertise belonged to the architect, he found that the most rapid and efficient way to check his ideas and get the work done was “to sit down with the developer and talk him through the specific component.” During a phone interview, he admitted it was difficult (and frustrating at times) to work with junior developers, who “were missing the big picture”, unable to understand the product beyond the functionality they were supposed to develop, and lacking the chance to have seen any similar
product working in a customer site. “They are like blind, and we have to guide them.” From his experience, working with a remote team he knew well for several years was not a problem – but in this case, the distance was a real challenge. The architect, coming from an agile development background, found his own way to deal with marketing driven deadlines imposed by the corporation – apparently impossible to meet.

This is an illustration of a knowledge transfer practice making extensive use of tools (phone, screen sharing, instant messaging) for alleviating distance. It does not coincide with the recommended corporate processes, but it proved efficient and helped the team deliver on time. In order to avoid e-mail exchanges that could have taken weeks to reach the same result, synchronous communication and collaboration were preferred.

4.2 Surviving the Babel Tower

Before the first release of the application in July 2006, the product under development had to be translated from English into 29 other languages, in order to make it available in all 30 languages on the date of the release. To make this happen, the company had a set of procedures, policies and tools. The role of translation testing coordinator was assigned to a software engineer who joined the team only 3 months before the localisation process started. His excellent communication and social skills, together with his eagerness to learn, designated him as the right person for the job – the development leader told us. Not only was speaking several languages and had lived on three different continents before joining the team, but he was also able to give clear explanations and react appropriately in tense situations.

He was given time to familiarise himself with the tools and the procedures and to contact the corporate team involved in the translation process, whose members were located in different places around the world. He was in an uncomfortable situation: he had to become the team’s only specialist in a specific task, without having anyone around he could learn from. “It’s more like learning by doing”-he told us, “there’s plenty of stuff out there (on the company’s intranet), but information is difficult to find”. The solution? Networking! “If you know who knows something – they point you to the right resources! And nobody ever turned me down when I asked for information!”

The strings belonging to the user interface (including help files and documentation) had to be separated from the actual code and sent to the translation team 10 weeks in advance. In order to understand the new product and make sense of the context of the text strings that needed to be translated, the individual translators were given a prototype of the application and the corresponding documentation. During that 10 weeks period, the translation coordinator had to dispatch all the requests coming from various translators regarding specific strings. When a translator had problems understanding a specific situation when a particular text had to be displayed on the screen, the coordinator tried to help him and discussed the context via instant messaging. Sometimes, he had to involve in the instant messenger conversation the specific developer who had written that specific part of the code, to save time and give an immediate answer to the translator who could continue his work after that. The alternative would have been to check the code repository and try to figure out the context himself, but obviously this would have required more time. The working time overlap between the team in Ireland and the various translators was also, in some cases, very short. The developer who had written the code was the most knowledgeable about specific occurrences of a string being displayed on the screen; for him, it was almost obvious. But taken out of context, it was difficult for the translator to make sense of it and find the right equivalent. The translation coordinator facilitated the explanation on the context and the knowledge transfer to the translator by bringing together the developer and the translator in an ad-hoc instant messenger conversation. Not only did he learn the answer to specific questions (usually the ambiguous messages were rapidly detected), but he also retained these answers for future use in his instant messenger archive.

This case is interesting because it illustrates how a team member has temporary become a central hub, connecting the members of his own team with the members of the distributed localisation team and facilitating the transfer of contextual knowledge related to string translation. During this process, the coordinator also learned, both about the localisation process and about the product under development. This enabled him to answer some of the questions himself. The instant messenger was used for solving the problems in real time, and its archives were used as an ad-hoc repository, capturing the content of past conversations.

4.3 Inventing a new role: The integrator

The early stages of the project were spent exploring different alternatives and developing mock-ups. After a second software architect joined the team on site, the development efforts became more systematic. At the
same time, the top management decision to integrate the software product developed by the team in a bigger package that had to be released in July 2006 accelerated the pace of the development efforts. Until then, the developers had worked on their specific components and tested them separately. At that moment in time, the modules needed to be integrated and tested together on the underlying software platform, still under development itself and unstable. One of the developers volunteered to take up the integration task, in addition to the development of a module.

He had worked with the team for two years, and had a few years of experience in customer support in the same company. Some of his more experienced colleagues were expected to do this – the development leader told us, but he volunteered and in a short while, his role became a quasi-official one. “I am the team’s integrator” he introduced himself. “And what we’re doing here looks like building a house using bricks that are not yet ready”.

“There was never such a role on any of my teams before” – the development leader said, “it was just a task – but he added a new dimension to it, taking responsibility for the result and doing his best to solve the problems”.

The “integrator” was the one to speak to all the other team members, becoming aware of the gaps, problems and critical issues. Not only that he was integrating the modules, but in a way, he was also a people connector. While working on isolated components, the team members didn’t have to interact a lot for professional reasons – and their social interactions were not restricted to team mates. The more the integrator spoke and listened to them, the more they were passing him information relevant to the others in the group. Soon, they started to interact much more with each other – not only because of the interdependencies between modules, but also because the integrator was now more aware about who knew what, and he was asking specific people to go and help their mates when incidents they once solved with success reoccurred.

In time, the integrator got to know not only the components of their application very well and the way they were supposed to function together, but also the underlying technologies, and – the most important thing - the people working on specific components, both inside and outside the team. 20 month into the project, the collocated architect, who until then was dealing with the external contacts, was assigned to another project. The integrator did his best to replace him in this role until another software architect joined the team and ensured the interface with the other teams they had to work with.

Then, a system testing phase that was supposed to end 3 months after the first release went on for another couple of weeks. The integrator was involved in the efforts of fixing complicated defects resulting from the coupling of different technologies, but his expertise was also required for the current development efforts. He realised he was becoming a bottleneck, and no matter how much he wanted to be everywhere and contribute, his time was limited. He initiated weekly meetings he named “knowledge transfer sessions”, where he presented topics related to the product under development and the underlying technologies and encouraged his colleagues to share their specific knowledge as well. When two new developers and an architect joined the team, he found time to give them a crash-course on the product itself and the technologies involved, for bringing them up-to-speed.

Around Christmas 2006, while he was on vacation abroad, a critical bug occurred. The development leader decided to ask for his advice, and the integrator had to communicate with another developer via phone on how to approach the problem; two days later, the problem was solved.

This last vignette highlights the contribution made by a developer with excellent technical and social skills to the timely delivery of the software product. As the coordinator in the previous example, he became a central hub, first inside his team, and later on at its interface with other teams. Through the integration process, he gradually learned about the various modules, their internal and external interfaces, the underlying technologies and the corporate procedures that had to be followed in the development and testing process. All his activity turned around the code repository, driven by product architecture, detected defects, corporate rules and procedures. His deep knowledge about the various code components - acquired through an extensive practice, together with his social skills and willingness to share, enabled him to support his mates, understand their knowledge gaps and initiate knowledge transfer.
5. Discussion

In the examples presented in the previous section, we described practices that were developed by the developers’ team to help them cope with distribution. The company had, of course, recommended corporate processes for dealing with those specific situations. But, as Brown and Duguid show, “process deals with prescription and formality, whereas practice deals with all the variations and disorderliness of getting work accomplished. Process may be the ideal, but practices define how actual work gets done.” (Brown and Duguid 2000)

Our goal was to look specifically at practices involving knowledge sharing, transfer and creation with an emphasis on the role of human actors. In the first vignette, the software architect has deep knowledge about the product to be developed, the opportunities offered by the new underlying technologies the product will be delivered with, the customers’ needs and perspective. He has been involved in the development of 4 similar products, has visited customer sites, and was fully aware of the competition in this segment of the market. He went through the same process before, but in most of the cases worked with a collocated team, or collaborated at distance with a team he already knew after a period of collocated work. He was asked to do highly creative work under extreme time pressure, and as a consequence, he decided to assume the role of the seer who has to guide the blinds. Telling each developer what to do and how to do it and revising the results rather sooner than later became his way of dealing with the time constraints. Even if general presentations have taken place, there was not enough time to discuss the whole philosophy of the product with everyone; besides, the software architect himself didn’t know precisely how the product was going to look like in the end. This case illustrates knowledge transfer and co-creation – a “chunk of knowledge” regarding the functionalities of a specific component was transferred – but the structural knowledge remained hidden to the developers until later. It was only during integration (and later on through the knowledge transfer sessions) that they become aware of their product as a whole. During the one-on-one meetings for component development, architect and developer built a shared understanding of specific components. Documenting is well known as being something software developers would do only if they consider it relevant for their work (Lethbridge et al 2003). In the example presented, documenting occurred after that shared understanding was made explicit. The people who documented the product functionalities were actually the direct beneficiaries of that specific documentation. Even if a whole range of tools, models and methods have been developed to help architects capturing the design rationale, they have failed to transfer to practice. Capturing assumptions and decisions doesn’t appeal to the architect, because he is not the one who benefits from it (Kruchten 2006). This practice enabled the architect to hand over the documenting task to the developers.

In the first vignette, the developer was part of the architectural development process and was given the chance to build an understanding of both the emerging specifications and at least some of the reasons behind every specific decision. In the second example, once a specific context was explained to someone else in his presence, the translation coordinator was able to answer similar questions in the future without having to involve the developer. People who have spoken to the integrator in our third vignette about specific problems and managed to solve them with his support are later on capable of replacing him and help their colleagues in similar cases. In all these cases, the participants construct mutual knowledge. Mutual knowledge as defined by Cramton is “the knowledge that communicating parties share in common and know they share” (Cramton, 2001) and is considered to be a central problem of geographically dispersed collaboration. Distributed communication tends to get fragmented, and even with the information available to the whole group (on mailing lists or in project databases), it is actually difficult to retrieve it. Boundary spanners (Curtis 1988) such as the guru architect, the translation coordinator and the integrator in our three examples are the ones who maintain a big picture of the situation in its progress and of the information available, and are able to connect people to other people, and people to information. As the translation coordinator put it, the first and most difficult step is “to find someone who knows”. Inside the team, people usually know where to turn to for getting specific information. Wegner has coined the term transactive memory for describing this phenomenon: after becoming part of a well-integrated transactive memory system, one can access information “well beyond his or her own internal storage” (Wegner 1986). More than that, information is naturally delivered by the group to the appropriate expert, contributing to an even more accentuated centralisation of information. What happened to the integrator when he understood he was becoming a bottleneck is also described by Wegner in terms of transactive memory: “Questions about the domain are typically directed to this person by default and it is sometimes difficult for the person to escape continuing responsibility for storage in the domain once expertise is generally acknowledged.”
The remote architect knew who developed each component and how efficient they were at transposing his ideas into practice. Both the architect and the integrator had a feel of where the weak links were and which components or interfaces were likely to cause more problems than the others. This enabled them “to guesstimate” when were defects caused by architectural decisions or by the actual code, when a problem occurred in a component and when it was caused by the interface between the product components.

The translation coordinator in our second example had to deal with people belonging to different teams distributed globally and was able to dispatch the requests because he possessed relevant information about the team members who developed each component.

One interesting aspect is that the infrastructure enabling all these people to look for the relevant information, discuss alternatives and make quick decisions is a very common tool: instant messaging. What really makes a difference in this case is the organizational culture that encourages its use, providing every employee with a straightforward mechanism for accessing the right people at any level in the organisation and in any location, in the shortest time. Instant messaging was turned into a highly effective transactive memory system, enabling people to maintain lists of contacts grouped according to expertise, team or location. Instead of having to look for contact names in directories and email archives, once a contact had been found, it was stored in the instant messenger list, providing a shortcut for interacting with people who were infrequent or temporary collaborators (as in the case of translation and localisation).

In a distributed context, social relationships take a different dimension. In most cases, people do not get the chance to meet in person. The relationships are shaped by mediated interactions (participating in the same teleconferences, email exchanges, chats and phone calls), by peers’ references and professional reputation. Communication skills and a reliable communication infrastructure are extremely important, as the situations described earlier illustrate. In the communication with remote colleagues, simple features like good will and common sense prove to be vital for collaboration in an environment where time constraints and tensions are present every day.

6. Conclusion

The purpose of our paper was to put into light a number of actual knowledge work practices through some particular examples of collaborative work over distance.

Much research is dedicated to building new collaborative tools, envisaging better processes, creating new frameworks, methods and models, and a much smaller amount is actually looking at the human actors struggling with the implementation of all these in practice. It is too often forgotten that software development happens in the real world and “suffers from all the variation and unpredictability associated with people, who have their individual strengths and weaknesses, insights and blind spots.”(Dawson 2003).

We focused here principally on the role of human actors, of their values and social connections in dealing with the challenges of distributed work and getting the work done. The practices described in this paper were developed by the team as they carried out their normal workaday activities, but we can assume other teams might create their own practices around the same tasks.

By adopting an ethnographically-informed approach, we attempted to put on “new lenses through which to see the world” (Dourish 2006) and shed a different light on the relationship between technology and practice. In a distributed environment, it is difficult to separate the technical practices of developers in one location from those of the other people across the organisation with whom they interact, from whom they learn, and with whom they exchange people, information and artefacts. Some practices remain specific to one team, while others spread and are adopted across the global organisation.

Our final conclusion is that the decisive factor for the success of projects with distributed team members is the human one, supported (or inhibited) by the organizational culture. Tools, although important, play only a secondary role. The utility of knowledge repositories increases appreciably in the presence of peers who can guide people to access the most appropriate and up-to-date resources and can be simply nullified when people are reluctant, or refuse, to adopt them. For people working in a distributed environment, communication and social skills need to be taken into account together with the technical ones.

Software development is just one of the knowledge intensive industries expanding so quickly nowadays. Knowledge work has its own particularities, and the additional challenges brought in by global distribution
require attention. Despite our current focus on global software development activities, we expect our findings to be of interest for people involved in distributed work arrangements in other domains as well.

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References

Intellectual Capital and Organizational Performance: an Empirical Study of the Pharmaceutical Industry

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Abstract: This paper directly measures the impact of intellectual capital management on organizational performance. Although this is an area widely studied in the literature, the nature of most of the work to date is to focus on specific aspects of intellectual capital (human, structural, or relational capital) and their individual impact on performance. This study specifically looks to identify firms that manage overall IC, whatever its nature, better than competitors. We then ask the question, do these firms actually see market results better than those of competitors?

In order to do this type of analysis, we felt a need to focus on a specific industry. If wide differences do exist between industries in terms of physical capital needs and human, structural, or relational capital needs, then random firms are harder to compare. Those within a single industry, such as the pharmaceutical firms studied here, should have relatively similar structures in relation to all these needs. We collected data on 139 firms in the drugs industry. We sorted and divided the sample according to market capitalization and book value (a common measure of intellectual capital) then looked at return on assets, investment, and equity, as well as beta. By one measure, firms with the highest level of intangible assets clearly performed better than those with lower levels. The high level firms had significantly better returns and significantly less variability in stock price. According to a second measure, the results were less convincing but still lent support to further research using this methodology.

So, as a first cut, this study had very promising results. We intend to repeat it for other industries, experimenting with the measures and means of cutting the data. Although industry-specific is obviously the initial way to go, we also intend to perform some cross-industry comparisons with the measures we develop. We believe the results of the full research program will be significant to practice and will provide substantial support to those championing better management of intangible assets within firms.

Keywords: intellectual capital, knowledge management, organizational performance, market/book ratio, ROA, ROE, ROI, beta

1. Background

The advent of the “knowledge economy” has engendered a great deal of interest in how intangible knowledge assets or intellectual capital (IC) are managed in organizations. The implicit or explicit assumption in both practical and scholarly work is that better management of IC will lead to unique, sustainable competitive advantage. Consequently, a great deal of time and effort have been expended on measuring IC, on developing systems and tools to manage it, and, to a more limited extent, estimating the impact of IC on performance. IC management is, of course, a variation on the concept of knowledge management. We choose to use the former term in this article given our emphasis on financial data and measurement of knowledge assets. The latter term is more often used with the techniques and systems employed in managing those same knowledge assets.

Given the case many scholars and practitioners make for the potential in better managing knowledge assets, it's surprising that work in this area has been relatively limited. There have been studies on whether and how specific areas of intellectual capital contribute to better organizational performance, but very little work exists on whether better overall IC management translates into better financial results. We'll discuss some of the existing work shortly.

Thus, this study is an initial exploration into the impact of better management of the full range of knowledge resources on overall organizational performance. We concentrate on a single industry so as to eliminate issues such as type of IC and the impact of industry structure and rivalry on financial performance. Although the measures employed are fairly broad, we do believe them to be enlightening and, as the results show, worthy of significant additional exploration.

The idea that superior knowledge of managers and workers can lead to competitive advantage is not new but the more formalized concepts of intellectual capital and knowledge management really took flight only in the 1990's. Based on insights from sources as disparate as Schumpeter and Drucker, the literature began to
evolve, recognizing that competitive advantage could come from the human element of the firm. Indeed, the resource-based theory of the firm reinforced the idea that competitive advantage flows from unique resources of the organization (Nelson & Winter 1982), eventually leading to sustainable core competencies (Prahalad & Hamel 1990). As capital and basic labor became readily available to most organizations of any size, scholars began looking for other factors that might explain why one firm is successful and another is not.

Parts of the discussion focused on intangibles, and we're all familiar with concepts such as goodwill and brand equity, so the idea that intangible assets have value is also nothing new. Indeed, the Tobin's Q measure of intangibles (market value to replacement cost of assets) goes back decades. Newer measures developed during the 1990's include the Balanced Scorecard (Kaplan & Norton 1992). These two approaches (two of many, see Tam, Plowman & Hancock 2007 for a review) reflect a major difference in approach, with most scholars in the last decade following the latter. The earlier approaches took a very broad approach to assessing intangible assets—as is the case with Tobin's Q and its remainder technique (what's left over after subtracting out the tangible assets is the value of the intangible ones). More recent approaches such as the Balanced Scorecard look to identify the specific pieces of intellectual capital and evaluate their individual impacts.

Another strand of IC theory suggests that two types of knowledge assets exist, tacit and explicit (Nonaka & Takeuchi 1995). Tacit knowledge is typically in the heads of employees, hard to express or capture. Explicit knowledge is codifiable, sharable, and able to be captured by contemporary IT-driven knowledge management systems. Theory and practice also deal with a different but equally important division of IC into the categories of human capital (HC, what people know about their jobs), structural capital (SC, corporate infrastructure, information systems, and culture), and relational capital (RC, what people know about interacting with those outside the organization, including suppliers, customers, regulators, etc.) (Bontis 1998; Edvinsson & Malone 1997, Stewart 1997).

These directions have been fueled by practice as knowledge management installations are specifically designed to capture the explicit knowledge of the firm, to turn some tacit knowledge into explicit, and manage and share tacit knowledge by other means. And practicing managers have also been interested in measuring and managing explicit and tacit knowledge organized into the more specific HC, SC, and RC categories. So IC reports, such as Skandia Navigator, look to identify and measure the amount of these specific knowledge assets within a firm (Edvinsson & Malone 1997). National or regional IC reports have followed related formats (Bontis 2003; Pasher 1999). The obvious question is what to do with such data and whether these measurements lead to actual improvement in organizational performance.

This is the area on which much of the performance evaluation literature has focused. The scholarship has tried to better identify the specific pieces (HC, SC, RC are often but not exclusively used) and then measure impact (Marr & Schiuma 2001). And although the best-known frameworks do include overall assessments of IC, they also include the component parts. Indeed, the studies that employ them tend to focus on the component parts. Lev's well-known work, for example, looks at the overall valuation and physical capital employed, but then often focuses in on a specific part of the remainder such as R&D or structural capital, looking to estimate impact (e.g. Lev & Radhakrishnan 2003). Similarly, Pulic's (2004) VAIC system, widely used by both practitioners and academics, measures the full range of IC but is typically employed only on a single component in academic studies (e.g. Firer & Williams 2003, Chen, Cheng & Hwang 2005, Tan, Plowman & Hancock 2007).

There are a number of very practical reasons for these tendencies. Overall, IC can be a fuzzy concept. Although we have several suggested ways to estimate it, none are bulletproof. Further, the makeup of IC components varies widely by industry, so the nature of $10 billion in intangible assets in the microprocessor industry is very different from $10 billion in intangible assets in the investment banking industry. And the differences matter to practicing managers. Finally, breaking the knowledge assets up into pieces allows for academics or consultants to conduct analyses of individual companies, including those not listed on stock exchanges (so non-public firms can be studied and/or employ IC assessment). Strong reasons exist for burrowing deeper into the IC of a firm, differentiating tacit from explicit knowledge assets and separating out the human, structural and relational components.

Our perception is that such approaches miss an opportunity to more firmly establish the impact and importance of IC on a broader scale. Directly comparing high IC performance firms with lower IC performance firms would help to demonstrate the power of harnessing and better managing knowledge.
assets. Consequently, we seek to go beyond the established literature and assess the effect of better IC management, in total, on financial performance.

2. Methodology

As noted, performance evaluation studies in this field have typically focused on specific types of intellectual capital and their impact on financial results. At least part of the reason is the interest in what parts of IC have the most impact on organizational performance. Is human capital or structural capital more important? What about relational capital? But another reason for this emphasis is the differences between industries. Human capital can be more important in an industry requiring expertise built up over time. Structural capital can be critical in industries demanding an extensive IT infrastructure or strong corporate cultures. Relational capital can be more important in an industry requiring close supplier contacts, close customer contacts or strong brands, or requiring substantial regulatory compliance. The importance of a particular class of knowledge assets can vary widely by industry (Rothberg & Erickson 2005). So if we are to consider the impact of overall IC on performance, industry considerations certainly need to be taken into account.

Consequently, this study focuses specifically on one industry and addresses the question of whether firms appearing to do a better job managing IC also perform better financially. An industry-specific approach allows us to control for differences in physical capital requirements as well as different levels of human, structural, and relational capital. Everyone competing in a given industry needs similar physical capital assets, employees with similar skills and abilities, and will reflect the same basic ratios concerning all of the above. As a result, we can look precisely at a basic measure of firm-wide IC development and its seeming effect on common measures of organizational performance without worrying about huge variations in physical capital, human capital, structural capital, or relational capital.

We chose the pharmaceutical industry for this initial comparison for several reasons. Pharmaceutical firms traditionally have certain physical asset requirements for R&D and production as well as heavy investment in intellectual property (which is an intangible asset and a formalized piece of intellectual capital). Pharmaceutical firms also particularly require considerable human capital in R&D, production, marketing and sales, and other areas; can have structural capital in their IT systems, corporate culture, and areas of specialization (e.g. cancer, hypertension); and can have relational capital concerning research partners, the FDA, and sales targets such as physicians, insurance companies, and pharmacies. We know knowledge is critical to this industry, whether formalized or not. So IC would seem to be a particularly important factor, can be important in all of its components (and in similar proportions across companies), and is as identifiable as it is likely to be in any industry.

The basic hypotheses behind this study are straightforward. Firms within an industry doing a better job of managing IC should see better performance. We choose to measure IC in the most basic manner, market value less book value. Tobin’s Q suggests that market value to asset replacement value is the key to understanding intangibles. But the difficulty has always been measuring replacement value. Book value has frequently been used as a workable proxy. Thus, this measure is well-established in the literature and, although broad, readily identifies those organizations doing a better job with their knowledge assets. A greater difference between market value and book value indicates a firm developing more intangible assets. Ceteris paribus, more intangible assets suggest a better job of managing intellectual capital. If you can build substantially greater intangible assets, especially those recognized by investors, you are seemingly doing a better job managing those intangible, knowledge assets. You are building IC that other firms are not.

As noted in the literature review, other, more specific and perhaps more sophisticated, IC measures are available. We chose the basic measure for a couple of reasons. Initially, at this point, we don’t plan to divide IC into its component parts, we are more interested in a single measure of all knowledge assets that is robust enough to eventually repeat across numerous industries (aerospace/defense, investment banking, and asset management banks are in process). Secondly, these data are readily available for a large number of firms within multiple industries, adding heft, reliability, and, again, repeatability to the research program.

In terms of performance, the most obvious and commonly used measures seem the way to go. As this is our initial study, we tried out several alternatives, gathering data on return on assets (ROA), return on equity (ROE), and return on investment (ROI). The first (ROA) is the most universally reported figure, revealing less gaps in the data set. We also collected betas, the often-used measure of risk through variability in stock movements relative to market variability. In a preliminary study, we weren’t really looking to formally test hypotheses, but the basic idea is the following:
Proposition: Higher levels of intangible assets should yield:

- Higher ROA
- Higher ROI
- Higher ROE
- Lower beta

As we are able to take a closer look at the data, other measures and/or other means of employing the data may also prove to be useful. We’ll discuss some of these possibilities later in the paper.

We collected financial data from Standard & Poor’s Research Insight/Compustat, specifically SIC Industry Group 283: Drugs. We gathered standard financial status and performance data including market capitalization, book value, return on assets, return on equity, return on investment, beta, and several other measures from fiscal 2004. The final list included 139 companies traded on North American stock exchanges, though not all data were available for all companies.

3. Results

We ran some preliminary summary statistics to judge the nature of the data. There appeared to be some promise in the numbers, so we moved on to more formal ANOVA procedures which are also more firmly established in the literature and allowed in-depth comparison of the group means.

As noted earlier, the pharmaceutical industry has both physical assets and intangible assets. From a data set of 130 publicly traded firms in this industry, the average level of market capitalization was $11.4 billion and the average shareholder's equity was $2.92 billion, the latter indicating substantial physical assets. The difference between the two figures shows almost $8.5 billion in intangible assets per company, or a ratio of almost 3:1 of intangible to tangible assets.

In analyzing the data, there are two possible approaches. On the one hand, the difference between market capitalization and shareholders’ equity could be treated as exactly that, the absolute difference between the numbers. Those firms generating a large number would possess large amounts of intangible assets or intellectual capital. With this approach, however, larger firms with longer histories would clearly have a higher likelihood of being classified as more successful in managing IC. Small firms, though potentially very successful with IC might simply not have a high enough asset level to rank highly. Using differences has potential but also favors larger, established firms. Further, the really small firms with potentially big swings in returns would be grouped in one category, potentially skewing the results.

On the other hand, this issue can be partially resolved by using a ratio of market capitalization to shareholders’ equity as the measure of IC management capabilities. With a ratio, all sizes of firms are on a more even basis. Indeed, this method runs the risk of having some particularly small firms having too much influence over the results. A startup, for example, with a very high stock price would rate very highly according to this measure even though its IC may or may not pan out in the future. But, generally, listed firms have some credibility to their market caps, and really outrageous numbers can be weeded out using either approach (especially the former, where, again, the obviously extreme results are all grouped near the bottom of the ranking). We employ both in this study in order to start the discussion over the best methodology for determining the impact of better IC management.

Table 1 contains the results from the difference approach. The market cap/shareholders' equity difference was calculated for all firms in the sample. All were then ranked. Once this was done, as expected, it became apparent that the very smallest firms had dramatically different results in terms of returns—not so much in one direction or in size but rather in the wide swings in value. As a result, the sample is truncated, dropping the very smallest firms. The remaining firms were divided in half, and the beta, ROA, ROE, and ROI of the groups were compared.
Table 1: IC Performance (Differences) and Financial Returns

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Variance</th>
<th>F (F-crit = 3.96)</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beta</td>
<td>1.00 (42)</td>
<td>0.74</td>
<td>3.69</td>
<td>0.058**</td>
</tr>
<tr>
<td></td>
<td>1.41 (42)</td>
<td>1.21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROA</td>
<td>-6.57 (44)</td>
<td>1153.75</td>
<td>8.05</td>
<td>0.006*</td>
</tr>
<tr>
<td></td>
<td>-25.89 (44)</td>
<td>885.67</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROE</td>
<td>-16.55 (42)</td>
<td>8147.16</td>
<td>3.15</td>
<td>0.080**</td>
</tr>
<tr>
<td></td>
<td>-51.78 (40)</td>
<td>7981.22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROI</td>
<td>-13.99 (44)</td>
<td>4680.64</td>
<td>3.85</td>
<td>0.053**</td>
</tr>
<tr>
<td></td>
<td>-43.23 (43)</td>
<td>4981.96</td>
<td></td>
<td></td>
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</tbody>
</table>

*Significant at the 95% level
**Significant at the 90% level

As noted in the table, the results are as expected. The group less successful at developing intellectual capital has better ROA, ROE, and ROI, and all are significant at the 90% level (two at or very close to the 95% level). Further, the betas are lower for the better-managed group, also significantly different at close to the 95% level. The results are in the expected direction and are significant. Regardless of how financial performance is measured, better IC management is associated with better returns.

The results are a bit less convincing with the ratio approach. Since the odd results were not as obviously concentrated in one group or another using this method, we included the full sample, where data were available. The results are mixed. The beta and ROA findings are in the expected direction, the ROE and ROI findings are not. None of the results are significant above the 85% confidence level. There may be several reasons for this. Initially, the odd results, while not concentrated in one group or another, result in such large variances that the overall findings are skewed. Secondly, as should be obvious from the values of the highly negative mean returns, 2004 appears to have been a poor year for the pharmaceutical sector as a whole. Consequently, returns for some firms, even if conceivably managing IC well, may have swung wildly in the negative direction due to other risk factors. Of course, this latter does little to explain why the results are so different from those found using the difference method. The topic obviously needs more study.

Table 2: IC Performance (Ratios) and Financial Returns, Full Sample

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Variance</th>
<th>F (F-crit = 3.92)</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beta</td>
<td>1.34 (59)</td>
<td>0.96</td>
<td>1.22</td>
<td>0.271</td>
</tr>
<tr>
<td></td>
<td>2.69 (65)</td>
<td>87.79</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROA</td>
<td>-27.49 (61)</td>
<td>2001.82</td>
<td>2.10</td>
<td>0.150</td>
</tr>
<tr>
<td></td>
<td>-115.52 (69)</td>
<td>222988.80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROE</td>
<td>-98.38 (58)</td>
<td>122245.20</td>
<td>1.40</td>
<td>0.240</td>
</tr>
<tr>
<td></td>
<td>-40.34 (54)</td>
<td>8364.70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROI</td>
<td>-54.97 (61)</td>
<td>10579.03</td>
<td>1.11</td>
<td>0.294</td>
</tr>
<tr>
<td></td>
<td>-37.76 (59)</td>
<td>5325.00</td>
<td></td>
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</tr>
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</table>

4. Discussion and conclusions

These initial results are relatively encouraging. They lend at least some support to the propositions/hypotheses and the methodology. We look forward to extending the analysis to other industries, particularly those with different IC structures in terms of the importance of KM and the breakdown of HC, SC, and RC. As noted earlier, we have already begun initial data analysis of aerospace/defense, investment banking, and asset management banking. We also hope to extend the analysis to years or sectors with more positive returns.

In doing so, there are several obvious improvements, other directions that could improve the analysis. Initially, our cutting of the data, while not ad hoc, could probably use some more thought. There may be justifications, including previous studies, for dividing firms differently, especially if a different approach allows
us to more confidently include or exclude the low IC firms (with their high variability and idiosyncratic numbers). We intend to look for a more systematic manner for dividing up the database that will naturally extend to further studies.

This study also presents only one way of analyzing the concepts of successful IC management and organizational performance. In the former area, we used the difference between market and book value. This measure will tend to favor larger firms, who may have more intangible assets because of sheer size, not because they are clearly better at managing such assets. An alternative way to approach this measure is a ratio of market to book value. This eliminates the size issue. But it brings back into the equation the issue of smaller firms with wild variations in stock price and ROA. A combination of judicious cutting of the data set and the combined use of both market/book measures is an obvious next step.

And the clarity and choice of return measures could also be extended. In this study, we used ROA, ROE, ROI, and beta. It's not altogether clear why we see the difference in the first three in the ratio results in Table 2. While they do measure different things, they are also similar in some regards. It seems counterintuitive that we should see such different results. Testing differences in the variances of the measures or other data could also be of interest.

This study also contains only one year of data. As market value, returns, beta, and other measures can vary dramatically from year to year for reasons that have nothing to do with what we're trying to assess in this research program, we have a problem. Some of the problem is eliminated by looking at a large sample of firms. But multiple years of data would prove even more useful, washing out most of that variability altogether.

Finally, some correlation analysis will also be appropriate as we extend the work.

This preliminary study suggests that a strong relationship may exist between successful development of intellectual capital and organizational performance. We look forward to expanding the analysis to a broader field and in an even more convincing manner.

References

Abstract: In the last few years several theoretical models of organizational learning have been developed from the perspective of diverse disciplines. One of the most influential models is that of Crossan, Lane and White (1999), who believe that organizational learning occurs through four processes (intuiting, interpreting, integrating and institutionalizing) and in two ways: from the individual to the organization (feed forward) and from the organization to the individual (feedback). This model, however, attributes to intuiting (defined by the authors as “the preconscious recognition of the pattern and/or possibilities inherent in a personal stream of experience” p. 525) the whole explanation for individual learning, ignoring the influence of conscious learning processes. Zietsma, Winn, Branzei and Vertinsky (2002) introduce two modifications to the model: the process of attending and the process of experimenting. The value of their proposal lies in the recognition of the influence of a conscious process in learning, namely attention. Attending, however, is just one of the many processes that intervene in individual learning. Castaneda and Perez (2005) make a contribution to the original model of Crossan, Lane and White (1999) by redefining individual learning from the perspective of social cognitive theory as developed by Albert Bandura (1986). The result is an integration of human capabilities and learning sub-processes beyond mere intuition that excludes other cognitive processes and forms of conscious learning. Humans have the capacity for symbolization, forethought, learning through modeling, self-regulation and self-reflection. Individual conscious learning includes the process of attention; yet, at the same time (according to Bandura, 1986), it includes three other processes: retention, production and motivation. This paper presents an improvement proposal at the group level of the model, adding two conscious processes: conversation and social modeling. Finally, a case is described with examples of each of the new introduced processes, at the individual and group levels.

Key words: organizational learning, individual learning, group learning.

1. Introduction

Organizational learning is a field of academic research and professional practice with a relatively recent development. The first reference to organizational learning is presented by Cyart and March (1963) in “A Behavioral Theory of the Firm.” According to Cyart and March, companies learn from experience with the intention of adapting themselves to the conditions of the environment. Two years later Cangelosi and Dill (1965) published the article “Organizational Learning: Observations towards a theory”. This was the first time the words “organizational learning” were used in the title of a publication. In the 70s the famous work of Argyris and Schön (1978), “Organizational Learning: A theory of action perspective,” introduced the concepts of single loop learning and double loop learning. Other important publications in that decade appeared by Duncan (1974), March and Olsen (1976), and Duncan and Weiss (1979). Representative works of the 80s are those of Hedberg (1981) on types of learning, of Shrivastava (1981) about learning systems, of Daft and Weick (1984) regarding organizations as systems of interpretation, and those of Fiol and Lyles (1985) in relation to levels of organizational learning. In the decade of the 90s there was an explosive growth of publications on organizational learning; perhaps the most quoted publication is the special issue of the journal Organization Science (1991). Organizational learning is still an area of interest if measured by the number of publications in its field (Maier, Prange, and Rosenstiel, 2003).

Organizational learning is understood here, from an academic point of view (Tsang, 1997; Easterby and Lyles, 2003), as the study of learning processes of and within an organization. Particularly, organizational learning is a process based on individual learning through private and public organizations engaged in creating and obtaining knowledge for the purpose of institutionalizing it in order to adapt as an organization to the changing conditions of the environment or to change the environment proactively, depending on its level of development (Castaneda and Fernandez, 2007).

2. The organizational learning model of Crossan, Lane and White (1999)

Sometimes research based on previous results is deficient (Easterby, Crossan and Nicolini, 2000; Zietsma, Winn, Branzei and Vertinsky 2002; Castaneda, 2004); for this reason, the purpose of this paper is to suggest a theoretical improvement of the original model of Crossan, Lane and White (1999) and of subsequent proposals (Zietsma, Winn, Branzei and Vertinsky 2002; Castaneda y Perez, 2005).
The model of Crossan, Lane and White (1999) of organizational learning is well-known and often used in academic contexts. The value of the proposal lies in its integration of three levels of learning into the same model, namely individual, group and organizational learning, and of two routes of learning: from the individual to the organization and from the organization to the individual. Individual learning itself does not guarantee organizational learning; it is necessary a transference process of knowledge among people, with the purpose of institutionalization (Senge, 1990; Wang and Ahmed, 2003; Easterby and Araujo, 1999).

Figure 1: Crossan, Lane and White Model (1999) of Organizational Learning

The model of Crossan, Lane and White (1999) identifies four processes of learning: intuiting, interpreting, integrating and institutionalizing (see figure 1). The first process, intuiting, takes place at the individual level. Crossan et al. (1999), based on the work of Weick (1995), defined intuiting as “the preconscious recognition of the pattern and/or possibilities inherent in a personal stream of experience” (p. 525). In the words of Underwood (1982), it is critical to understand the subconscious in order to understand how people comprehend something new for which there was no prior explanation. A limitation of the model, however, is the belief that intuiting is the unique process that explains individual learning; most of human learning is a conscious process. Later on in this paper the relevance of conscious processes in organizational learning will be defended from the perspective of the social cognitive theory of Bandura (1986).

The second process, interpretation, occurs at the individual and group levels. It is defined by Crossan et al. (1999) as “the explaining through words and/or actions, of an insight or idea to one’s self and to others. This process goes from the pre-verbal to the verbal, resulting in the development of language” (p. 525). Individuals think about their intuitions and share them with others, thus transferring them to individual and collective interpretation (Weick, 1995; Zietsma, et al, 2002). Preverbal intuitions are shaped and shared through conversation, imagery, and metaphors (Crossan, et al., 1999). In a broad vision Huff (1990) suggests that individuals develop cognitive maps from their context while at the same time these maps affect what part of the context is selected and interpreted. This conception is compatible with the concepts of social cognitive theory previously called theory of social learning and later changed to social cognitive theory (Bandura, 1982, 1986), which proposes a more comprehensive explanation of individual learning.

The social cognitive theory of Bandura (1986) has some advantages. On the one hand, it describes and integrates human cognitive capabilities and their relation to learning, which goes beyond the concepts of
intuition and interpretation; on the other hand, it explains the reciprocal influence between cognition, behaviour and environment. Additionally, it explains how learning occurs in a social context.

The third process of the model of Crossan, Lane and White (1999) is integrating, defined as “the process of developing shared understanding among individuals and of taking coordinated action through mutual adjustment. Dialogue and joint action are crucial to the development of shared understanding” (p. 525).

The fourth concept, institutionalizing, “is the process of ensuring that routinized actions occur. This is the process of embedding learning that has occurred by individuals and groups into the organization and it includes systems, structures, procedures and strategy” (Crossan, et al., 1999, p.525).

The processes of institutionalizing will not be discussed in this paper; instead, a proposal for the improvement of the model will be postulated, particularly at the group learning level.

Zietsma, et al. (2002) presented an improvement proposal of the multilevel organizational learning theory of Crossan, et al. (1999). The first process added at the individual level is called attending, a name adopted from Kleysen and Dick (2001), understood as an active process of seeking information from the environment. Continuing in the same direction, they added a second active process of learning called experimentation (see figure 2). Zietsma, et al. (2002) stated that “individuals and the groups experiment and the result of their actions add substance to their cognitive interpretations” (p.63).

In their research based on a Canadian company, Zietsma et al. (2002) found support for the four processes of organizational learning proposed by Crossan et al. (1999) and for the two processes explained by them. The main contribution of the work of Zietsma et al. (2002) consisted of emphasizing the importance of active learning. If the individual does not realize that results are a consequence of his actions, then little or no learning occurs (Bandura, 1986).
4. The social cognition approach applied to organizational learning

The social cognition approach deals with how people interpret and create a social environment (Weiner, Graham, Taylor and Meyer, 1983; Gioia and Sims, 1986). It studies the social behaviour and mental processes present while individuals interact (Martin and Clark, 1990). It is also about the social processes involved as a whole in information acquisition, storage, transmission and use, with the purpose of creating intellectual products (Larson and Christensen, 1993).

Organizational learning is a social process (Akgün, Lynn and Byrne, 2003). If social cognition studies how individual cognition is influenced by interaction with other individuals and by organizational norms, routines and culture (Virkunen and Kuuiti, 2000), then it is possible to integrate cognition and social interaction into the study of organizational learning (Alllard-Poesi, 1998).

5. The social cognitive theory of Bandura

According to the social cognitive theory of Bandura (1986), individuals are not governed by internal forces or by external stimuli. Human function is explained by a triadic reciprocity where personal factors, environment and behaviour interact. Is behaviour controlled by cognitive factors or by external stimuli? Bandura (1997) declares that people are producers as well as products of their social environment. Internal personal factors (in the form of cognitive, affective, and biological events), behaviour and environmental events all operate as interacting determinants that influence each other. Reciprocity, however, does not mean equal strength of influence. When the requirements of a situation are weak, then personal factors are predominant in the regulator system (Bandura, 1983).

With regard to organizational learning, Bandura (1997) states that organizations are changed by people’s behaviour. The impact of sociostructural factors on organizational performance is mediated by individual learning. Organizational learning occurs through interactive psychosocial processes, not only in the context of organizational attributes operating independently of human behaviour. Organizational learning is a collaborative effort where individuals create new ideas by sharing their knowledge through interaction with others.

According to social cognitive theory, individuals are not only reactive to situations, but also proactive and anticipative, and, in addition, function as regulators and self-evaluators of motivations and actions (Bandura, 2001). Persons are organisms with aspirations and the capacity for anticipatory self-control of behaviour (Bandura, 1991). In this context an important concept is that of human capabilities. Bandura (1986) states that humans are capable of: symbolizing, learning through modelling, forethought, self-regulation and self-reflection.

Symbolizing means using symbols as a mechanism of change and adaptation to the environment. Through symbols people give significance, shape and continuity to lived experiences. At the same time, people use previous knowledge and the capacity to symbolize to decide on what action to take. It is not necessary to perform a certain action in order to solve a problem, but people symbolize multiple situations in their mind before acting.

Forethought means the capacity to regulate future actions. People use forethought to predict consequences of actions, to formulate goals and to motivate themselves in an anticipatory way. Additionally, people not only learn from their own behaviour, but they can learn through modelling, observing other’s behaviour and through the consequences of their own actions. Through modelling, individuals can learn the rules of behaviour just by observing. Furthermore, self-regulation means that part of people’s behaviour is self-motivated and regulated by self-evaluation. Finally, self-reflection means that people have the capacity to know themselves. Individuals can observe their ideas and predict their actions accordingly. One of the most representative capacities for self-reflection in humans is self-efficacy. This is the belief that their capacities can produce effects (Bandura, 1997).

Another important concept of Bandura (1986) is that of the component process governing observational learning. According to the author most of human behaviour is learned in a conscious way by observing others. Observational learning is governed by four component processes: attention, retention, motor preproduction and motivation. First, an individual cannot learn much by observation alone unless he or she attends to and perceives accurately the significance of reality. Second, what it is learned has to be represented to memory in symbolic form. Thirdly, symbolic representations have to be converted into appropriate actions. Finally, people do not enact everything they learn, but behave according to their motivation.
Attention is a cognitive process which regulates exploration and perception. Attention determines in a selective way what is chosen and depends on the characteristics of observers, on the situation and models. Perceptions are guided by preconceptions, so that the cognitive skills of the observer and their perceptive tendencies lead the individual to observe some things and ignore others. At the same time, observational skills influence the amount and quality of learning. People learn not only activities or tasks but also rules.

Retention is the second process which consists of transforming the information of an event in order to be represented to memory as rules or concepts. Learning is supported by two systems of representation: image and verbal constructions. Bandura, Jeffery and Bachicha (1974) have demonstrated that learning involves active construction of symbols by the individual and also that codification structures affect retention.

Motor reproduction or production is the third process and it is about conversion of symbolic representations into actions. In order to act, it is necessary for the individual to organize answers in space and time.

Finally, motivation is the fourth process. Bandura (1986) distinguishes between cognitive acquisition and behaviour. An existing learning turns into behaviour depending on the importance of the perceived consequences. All of the following play an important role in human motivation: external social and tangible incentives, modelled incentives, (that is, observed benefits awarded to others for their behaviour), as well as self-initiated incentives. Bandura (1965) found that in the presence of incentives a not yet shown learning can be transformed into action.

6. The improvement proposal of Castaneda and Perez (2005)

![Castaneda and Perez’ (2005) extended model of organizational learning.](image)

The social cognitive theory of Bandura (1986, 2001), enriches the Crossan, Lane and White model of organizational learning. In particular, a broader understanding of individual learning is incorporated into the model, adding conscious processes. In the original proposal (Crossan, Lane and White, 1999), individual learning is explained as a result of a process called intuiting. According to Hogarth (2001) intuition is characterized by a lack of awareness about how judgements and results are acquired. In this sense, intuition only explains a kind of learning where attention is not required; most learning in the context of organizations, however, is based on direct experience and conscious observation.
Zietsma, et al. (2002) added a process called attending to the individual level. This is an outstanding improvement, since most of human learning is a conscious process. However, human learning includes other identifiable processes in the context of human capabilities as shown by authors like Bandura (1986, 1997).

Besides attention at the individual level of the model, Castaneda and Perez (2005) incorporated three new processes: retention, production and motivation. At the same time, because of human complexity, they also included what Bandura (1986) calls human capabilities: symbolizing, learning through modelling, forethought, self-regulation and self-efficacy as a self-reflection capacity (See figure 3).

Including a human capabilities component in the model broadens understanding of learning. Humans are active beings, capable of observing, describing and analyzing reality. Additionally, the proposal suggests using the term socialization along with the term interpretation to signify the process of learning with others in a conscious way. Traditionally, interpretation is considered a personal, not a collective process. On the other hand, individuals do not learn exclusively from sharing intuitions but also as a result of conscious thoughts, ideas and previous experiences.

7. The proposal of this paper

The proposal of Castaneda and Perez (2005) has received positive feedback in its relation to the inclusion of psychological mechanisms at the individual level of learning. At the same time, using a simpler graphic representation of the model has been suggested. A new proposal is herewith presented (see figure 4).

A second input to improve the model is to include two conscious processes at the group level of learning: Conversation and social modeling.

In the original proposal, Crossan, Lane and White (1999) stated that group learning can be explained by a process called interpretation. The authors stated “interpretation has to do with refining and development of intuitive insights” (p. 525). The raw material for interpretation is intuition, a preconscious process. Crossan, Lane and White (1999) documented the importance of conversation in interpretation; conversations, however, are not made up only of people’s intuitions but of conscious thoughts and observations.

Conversation is a central aspect of a functioning organization (Denning, 2005) and most of it is a conscious process. Conversation or dialogue, however, is not the only process that explains group learning.

Theorists like Harris (1995) and Bandura (1982) emphasize the role of modeling and observation in group learning. Particularly, Bandura (2003) says social modeling facilitates high levels of learning. People learn modeled actions by observing others; also, members of a group learn judgements by observing other people. In abstract observational learning, observers extract the principles or standards embodied in the thinking and actions exhibited by others (Bandura, 2003). Effective modeling teaches general rules for dealing with different situations rather than only specific responses or scripted routines (Bandura, 2000).
8. Learning processes: A case of knowledge organization in the educational sector

Our example illustrating the learning process is a research being documented by one of the authors of this paper (Castaneda), who is working on the definition of the teaching-learning-knowledge (TLK) system in a large private educational institution in Colombia. Examples will be presented of the new concepts introduced at the individual and group levels of the proposed organizational learning model based on the model of Crossan, Lane and White (see figure 4).

At the individual learning level, symbolic capability is demonstrated when somebody listens to a concept like "teaching" and represents it in his mind without observing someone who is actually teaching. Forethought occurs when a participant can imagine the long term organizational benefits of the success of the TLK system. Learning through modelling happens, for instance, when a teacher learns a new technique from a colleague for having participants of a course introduce themselves to each other by observing him doing it. Self-regulation happens when a group member wants to express an idea immediately as it occurs to him during a group discussion but regulates his behaviour by waiting to speak until his partner finishes. Self-reflection occurs when a person asks himself whether he has the capacity to express an idea in an effective manner or not.

Following are some examples of the processes related to individual learning: When a member of an organization focuses in a conscious way on a colleague doing an introducing exercise, in order to learn the relevant characteristics of the technique. Thus he memorizes the objectives, steps and expected results of the technique. Days later, when he is going to use the technique, he employs a production mechanism to recover the knowledge stored in his brain. Finally, because of his motivation, he is ready to apply the technique for introducing the participants in a new academic course.

Members of the technical team constructed the concept of teaching-learning-knowledge (TLK) through conversation, as a group. Initially they were working according to the traditional model of teaching-learning, but as the result of some input based on knowledge management concepts from one of the members of the team, discussions brought the group to the TLK concept. Originally the focus was on the processes of teaching and learning and not on how to manage the result, which is knowledge. Now the organization is interested in using knowledge strategically.
The other group process is social modelling. Here is an example: One of the members of the team working on the TLK system is an expert in personal skills development. Members of the team learned the technique by observing their partner applying it in an assertive communication workshop. In summary, the technique follows these steps: 1) showing an individual how to perform the skill correctly, 2) rehearsal of the behaviour by the person being trained, 3) feedback on the observed performance, 4) a second rehearsal of the behaviour, 5) a second feedback on the performance, and 6) homework exercises. When the team members observed their partner applying the technique, they learned how to use it, but at the same time they went a step further, namely deciding to incorporate it as a TLK technique to be used in the development of other skills.

9. Conclusions

In this age of information and knowledge it is indispensable to understand how organizations learn. For this reason models like those of Crossan, Lane and White (1999) and further improvement proposals (Zietsma, Winn, Branzei and Vertinski 2002; Castaneda and Perez, 2005) are welcome. Based on this model it is possible to state that learning occurs at three levels: individual, group and organizations; also, learning takes two routes: from the individual to the organization and from the organization to the individual. In this sense institutionalization of knowledge produced by individuals and groups, as well as learning by individuals and groups of individual key organizational knowledge, are important.

Additionally, Castaneda and Perez (2005) develop a broader concept of individual learning. It is clear that part of individual learning happens as a result of intuiting. It is also true that most learning is supported by attention. At the same time, additional processes like retention, production and motivation are necessary to guarantee learning and influence action.

This paper proposes the inclusion of two new processes at the group level. These processes are conversation and social modelling.

Then, a case is presented in order to illustrate the proposed processes in action.

Further study of how these human capabilities and learning processes are manifested in different types of organizations is needed. Additionally, in-depth studies of the group mechanisms of learning are recommended. Crossan, Lane and White (1999) raise the topic of interpretation; we proposed the concepts of conversation and social modelling. Research is needed, however, to explain how personal variables like attitudes and self-efficacy as well as organizational variables such as culture and structure influence interaction in learning processes. This could be a way of enriching the model with empirical evidence.

Finally, it would be useful to do transcultural research in order to explain how national culture as a variable plays a role in individual and group behaviour as it relates to organizational learning.

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References


Tacit Knowledge Elicitation and Measurement in Research Organisations: a Methodological Approach

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Abstract: Contextual complexities as a result of the nature of knowledge based resources of organisations are increasingly the bases of competitive advantage. In the third generation of KM theories and techniques, intra-organisational flows of knowledge resources have become as important as the resources themselves. Management of such flows is an imperative rather than an alternative for most organisations. When attempting to implement effective KM strategies, most organisations assume complete awareness of what knowledge-based resources they own and which elements of these, need to be shared. However, such an assumption may not always be valid. While many scholars have conducted research into measurement and management of explicit knowledge, limited progress has been made in applying similar processes to tacit knowledge resources. The KM research and practice communities agree on the importance of identifying and measuring tacit knowledge-based resources, while absence of suitable instruments designed to apply to it continues to be a problem. This paper outlines a method to identify and measure organisational tacit knowledge-based resources based on the concepts of tacit knowledge stocks, their intra-organisational flows, and enablers and inhibitors of such flows. The research paper describes the method, and the process of its validation, performed within a research and development organisation.

Keywords: organisational tacit knowledge, knowledge discovery, tacit knowledge stocks, tacit knowledge flows, knowledge enablers, knowledge inhibitors.

1. Introduction

Inherent contextual complexities in which most firms operate have made knowledge resources a primary source of competitive advantage for organisations. At the same time, the literature shows a wide range of conceptual approaches of knowledge, by knowledge management (KM) researchers and practitioners. As a result of such a wide range of appreciation of what knowledge-based resources are, a diversity of strategies for their management has emerged. Most current techniques are heavily based in technologies and –as a consequence, only consider knowledge when it has been made explicit, thus ignoring the characteristics that define its human nature. This observation is particularly relevant when it comes to discovering, measuring and evaluating tacit knowledge-based resources. Such processes, applied to tacit knowledge, are essential as they are likely to feed further KM strategies. Therefore, it is recommended that they are performed before, during and periodically after the implementation of any KM strategy or technology if knowledge is to be considered to its full extent. Otherwise, projects risk falling into the category of information management ventures.

In an attempt to contribute to the current debate on ambiguities about knowledge, this research offers a method to analyse the tacit knowledge, and goes on to explore what could be interpreted as tacit knowledge stocks, and how such resources integrate within organisations. The analysis highlights the role of enablers and inhibitors of such integration. Using action research as a research paradigm, we then designed a methodological framework to aid the discovery and measurement of organisational tacit knowledge-based resources. General issues about the framework and its process of validation within a research and development organisation are described.

2. Organisational knowledge-based resources

This research finds its theoretical basis in the work of Polanyi (1962) by assuming that all knowing involves skilful action, and that the knower participates in all acts of understanding. As an extension to the work of Polanyi, the research adheres to the understanding of knowledge by Snowden (2002). Snowden added to the assumption that “we can know more than we can tell” (Polanyi 1966, p. 4) the hypothesis that “we can tell more than we can write down”. From our interpretation of these two notions the following types of knowledge emerge:

1. Knowledge that can not be communicated;
2. Knowledge that can be communicated but can not be expressed in documents;
3. Knowledge that can be made explicit and shared through written language, often embedded in documents.
An extensive search for a definition of knowledge that considered both Polanyi’s work and current KM trends led adoption of Davenport and Prusak’s (1998) approach to knowledge. According to Davenport and Prusak (1998, p.5), knowledge is

"a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers. In organisations, it often becomes embedded not only in documents or repositories but also in organisational routines, processes, practices, and norms."

Davenport and Prusak’s definition acknowledges the role of the knower in all acts of understanding. It also considers Polanyi’s view of explicit, abstract representations i.e. documents, routines etc., as “cognitive tools” that aim to enable purposeful human action. As argued by Polanyi and Prosch (1975), these tools cannot read themselves; they require the personal judgement of a human agent, a skilled reader, to be related and applied to the world. Thus, Davenport and Prusak’s view of knowledge acknowledges the existence of both, knowledge gained through experience that remains in its tacit form and cannot always be expressed through language, and knowledge embedded in cognitive tools such as documents. Another significant point in Davenport and Prusak’s definition mentioned above is that they not only interpret knowledge from an individual’s perspective but also see this resource as an organisational asset. Thus, Davenport and Prusak’s notion of knowledge is not only coherent with theoretical notions provided by authors previously mentioned; it also has the levels of pragmatism required in the current socio-economic context.

Although following a number of different approaches to knowledge, knowledge management theory and practice have substantially evolved in the last decade. KM scholars such as Snowden (2002) following Polanyi’s (1962) notion of knowledge, describe three different generations of KM. In his work, Snowden (2002) emphasises that “in the third generation we grow beyond managing knowledge as a thing to manage knowledge as a flow and thing”. Traditional KM strategies have been heavily based in the use of information technologies and have mainly considered organisational stocks of explicit knowledge resources and their flows. Knowledge flows in these cases, have been understood as different levels of access to stocks of documents and the like. However, much of the critical knowledge in an organisation relies in the skills and talents of members of the organisation. Intra-organisational knowledge develops while it flows, as a result of people participating in the practices of the organisation as a social community (Wenger, 1998). Personal willingness to share and learn from one another comes from connections between people (Mohrman, 2003). This makes intra-organisational stocks and flows of knowledge involving human actors particularly relevant to the aims of this research. Therefore the research focuses on three general knowledge concepts related to tacit knowledge. They are: tacit knowledge stocks, tacit-knowledge flows and enablers of tacit-knowledge work.

The concepts of knowledge stocks and flows are similar to the concepts of idea generation and sharing, respectively. They have been referred to by a number of scholars including Boudreau (2003) and Deeds (2003), and their analyses shape the understanding of such terms by this research.

2.1 Tacit knowledge stocks

Tacit knowledge stocks, a concept that is valid for both individuals and organisations’ profiles, are related to existing levels of tacit knowledge at a certain point in time. In organisational contexts tacit knowledge stocks have been described as accumulated knowledge assets that are internal to the firm or organisation (Boudreau, 2003). Tacit knowledge stocks reflect both organisational knowledge and performance, but at individual level they reflect personal attributes such as education or experience. This research has focused on identifying different types of individual tacit knowledge stocks potentially contributing to organisational goals. These include:

- individuals’ education, abilities, experience,
- individuals’ ideas expressed or not in publications or patents, citation patterns, and also
- individuals’ awareness of others’ tacit knowledge stocks within and outside organisational boundaries.

An example of tacit knowledge stock could be the ability and experience of a graphic designer. Such knowledge resources could be valuable for others within the organisation as long as they are aware of it and the knower has the willingness and meanings to share them.
2.2 Tacit knowledge flows

Flows of knowledge may be defined as the movement of knowledge between entities at different levels including organisations, organisational units and individuals (Deeds, 2003). In organisational contexts knowledge flows have been described as streams of knowledge that may be assimilated over time and developed into stocks of knowledge. Such streams may have originated outside the organisation, though they can also emerge from inside the organisation comprising one or different organisational units. This research has identified as tacit knowledge flows a set of resources that include the movement of routines, tools (i.e. methods) and ideas (included in publications and patents) inside the organisation or between organisational participants and external sources.

2.3 Tacit knowledge enablers/inhibitors

Tacit knowledge enablers and inhibitors include processes, structures and activities that have the potential of influencing knowledge flows and as a consequence have an effect in organisational knowledge stocks. The presence of knowledge enablers positively affects knowledge stocks and flows. However, their absence potentially acts as an inhibitor for such resources. Enabling mechanism and structures affecting tacit knowledge stocks and flows include technologies, any sort of personal or professional proximity between organisational participants, and links between organisational participants and external organisations and networks.

2.4 Knowledge elicitation in organisations

If knowledge were primarily seen as a thing in industrial and organisational contexts –as in previous generations of KM theories and tools, it could be managed and measured in the way traditional approaches have done it. Research looking into explicit knowledge stocks and flows has been performed by several scholars including Goodman and Darr (1998), Kyriakos and De Ruyter (2004) and Watson and Hewett (2006). Although they have argued that their focus is the intra-organisational knowledge transfer process, their research mainly involves codification, storage and access to knowledge embedded in documents stored in organisational repositories. Such an approach has indirectly promoted the use of information technologies (IT) in the implementation of information management strategies under the umbrella of knowledge management, ignoring the complexities inherent to the human side of knowledge.

Within this context, elicitation and measurement of tacit knowledge in industry and organisational environments is an area that has not received a great deal of attention. According to Cooke (1999), knowledge elicitation had its beginnings as a research area in the context of knowledge engineering for expert systems. Its methods were initially adapted from cognitive methods or other disciplines such as education or ethnography. Researchers have then highlighted the importance of eliciting knowledge of individuals and organisation as a mechanism for preservation of this knowledge and experience, improvement of knowledge reuse, and acceleration of processes such as individual and organisational learning. The knowledge elicitation techniques include concept mapping, interviews, knowledge audits, cognitive modelling, data analysis and work patterns analysis, among many others. However, according to Hoffman et al. (1999) one of the most important approaches to knowledge elicitation is to use a combination of existing methods according to the conditions of the organisation being analysed.

3. Research method

The primary goal of our research was to explore how to provide an organisation with details about valuable tacit knowledge resources held by its members. The best approach to reach that aim was to work on a real organisation that was aware of the importance of their knowledge and experience and at the same time required improvements. We had previously contacted experts from an organisation that was looking at implementing a KM strategy in collaboration with the university. We approached them again –this time using email, to discuss the possibilities of collaborating in this area. We knew that the KM strategy previously mentioned had not been defined. That situation offered the ideal setting for the aims of this research. As researchers, we were interested in exploring how those tacit knowledge resources that were hidden in the organisation could be elicited. As knowledge practitioners, the organisation was interested in taking one step towards the implementation of a KM strategy that allowed them to increase their competitiveness in many ways.

Additional issues helped us to get involved in this collaboration. As a result of previous interaction with key organisational participants they were aware of the type of research we were doing. Also, financial issues...
would not have to be discussed because the researchers were located within a short distance of the organisation. Expenses related to the research could be reduced to a minimum.

This setting was one in which both parties had clear objectives even before we had formally met to discuss our potential collaboration. In our first meeting we would then be looking at balancing such goals to make both sides able to satisfy their needs as described by Kock (1997) within a short term (up to 3 months) project.

3.1 The research site

The research was implemented in a small organisation doing working in a sensitive research area. In order to maintain the levels of confidentiality agreed with the organisation, it will be referred to in this paper as Refor. Also, results that may reveal specifics about the organisation and its business will be omitted in this paper, given the type of research they perform. Although this places a limitation on appreciating the entire picture of the organisation, it does not hinder the understanding of the methodology being applied, the validity of its findings, or its applicability in other organisational settings.

Refor has 35 members doing full-time research. They are all educated to University level and most of them have had field experience before being dedicated to research. These researchers are grouped in four units, each of which undertakes research on different strands within a common field. The organisation has a flat structure, which means that there are no formal unit managers but a unique general manager who is also an active researcher. The research topics and developments are centrally set and controlled through various means by a major institution to which Refor directly contributes its research outputs. Such an institution is in charge —using different means, of all financial issues concerning Refor, and one of the members attends every general meeting —held at Refor on a regular basis, with quality control aims. Therefore, this research considers as members of the management board of Refor its general manager and the member of the institution previously mentioned attending the general Refor meetings. There is no formal collaboration between different Refor units, except for the general meetings previously mentioned, where all research is discussed. After such meetings, feedback from members of the organisation is considered by the corresponding researcher/team.

3.2 Research design

The characteristics of the research problem suggested adoption of an interpretivist perspective. According to Walsham (1995) interpretive methods of research assume that our knowledge of reality is a social construction by human actors. Understanding KM problems within an organisation and attempting to provide a solution are processes heavily based on the views of organisational participants. By interacting with members of Refor we would focus on making sense of their notion of the organisational knowledge base, the benefits it offered and the contribution they could make to it.

Results of initial interactions between the authors and Refor experts made us choose action research as a research paradigm. The reasons for our choice —derived from the analysis of authors such as Susman and Evered (1978) and Baskerville and Wood-Harper (1996), included: First, Refor was conscious of the lack of awareness of their researchers about the knowledge resources available within the organisation. Refor understood that this problem placed a number of limitations to their competitiveness and they had unsuccessfully tried to alleviate this situation in the past. They believed that it was necessary that the authors applied our KM expertise to help them solve the problem. Second, the authors understood that action should be taken in Refor to solve the problem, and such actions would improve our theoretical background on the research topic. Finally, such action and research processes were feasible without compromising the results of any of them. All of these also led us to adoption of participatory action research. According to Baskerville (1999), participatory action research allows researchers to become involved with the organisation in the solution of its problem while also engaging practitioners in the research process.

One of the main results of our first meeting was the project design. Researchers and practitioners agreed on structure of our collaboration and plan of actions, detailed in following sections. Such definitions relied on the cyclical process of action research proposed by Susman and Evered (1978) in figure 1.
The action research team included the researchers and two practitioners: the general manager and one of the researchers who had been doing KM research in the past and had acquired a reasonable understanding of KM issues.

Due to a number of reasons the action research team decided to implement one complete cycle of the action research process. If proven successful, further actions would emerge from this research, to be implemented by Refor in the near future.

3.3 Data collection

During three months the researchers collected data through different means and in different formats. Data collection mechanisms included:

- Observations of the way Refor participants performed their tasks;
- All email communication between the manager and organisational members, as well as communication between the action research team members;
- Working notes taken during Refor monthly general meetings and during project meetings;
- A set of 16 interviews with a similar number of members of Refor including those in the action research team. All interviews took place in a study room within the library of the institution;
- Questionnaires completed by participants in the validation stage of the research.

4. Reporting the action research cycle

4.1 Stage 1. Diagnosis

Having established initial contacts with Refor and understood their problematic situation the action research team met and agreed in a set of theoretical assumptions including:

1. Lack of knowledge awareness. Most members of Refor –including its manager, are not aware of the knowledge resources available beyond their own research team.
2. Importance of knowledge resources that have not yet become part of Refor’s public knowledge base: By eliciting knowledge resources that are currently unknown to others and sharing such resources with other
organisational participants Refor will experience an improvement in the results of its work in different areas.

3. Feasibility of elicitation. Knowledge resources not yet in Refor’s knowledge base can be elicited from experts using a combination of existing knowledge elicitation techniques.

4. Feasibility of sharing. The resulting knowledge base can be shared between Refor’s teams through a basic KM strategy.

Such theoretical assumptions –derived from practitioners’ experience and researcher’s analysis of the problematic situation, led to the definition of the research question as follows:

How can valuable knowledge based resources be elicited from experts in an organisation with the characteristics of Refor?

4.2 Stage 2. Action planning

During two weeks the researchers worked on a proposal of data collection methods and project scope giving the time constraints discussed by Refor experts. In the second team meeting such a proposal was discussed and agreed. From the existing methods of knowledge elicitation we had decided to work on interview-based techniques. The first two Refor members to be interviewed were those in the action research team. Then, team leaders and finally some team members. Interviews would be semi-structured and following the general format in appendix A, using parameters for knowledge measurement provided by Deeds (2003). This means that the main issues to be explored were tacit knowledge stocks, tacit knowledge flows, and enablers and inhibitors to knowledge work within Refor. Interviewing the manager would also allow to further understand his vision of Refor and his expectations about this project in particular. Some questionnaires were also planned as part of the evaluation of importance of elicited knowledge resources towards organisational goals.

Existing documentation would be reviewed and the researchers also planned to attend general meetings at Refor during the period of the research. This would allow them to gain an understanding of the issues that were to be discussed with experts in the interviews.

4.3 Stage 3. Action taking

The actions planned were performed during the two months following the action planning team meeting. A presentation in the general meeting allowed Refor’s members to know details of the project and its benefits, followed by a call for support by the manager. 18 experts were selected on the basis of the complexity of their research project –as suggested by the manager. Interviews were later arranged by email and 16 organisational participants doing research in different knowledge areas were interviewed. The other two were members of its management board. Before the research was completed another presentation was made, where Refor members were informed about the research results. The action research members were always aware of the actions being taken.

Results of the action research process are discussed in section 5.

4.4 Stage 4. Evaluation

The authors considered that validity of the outcomes of the action research cycle depended on the importance of the resulting knowledge base towards organisational competitiveness. Such an evaluation was implicit in the methodological framework under development and was performed using a questionnaire. Once a set of knowledge resources had been discovered we contacted a number of organisational actors to validate the relevance of these resources, and to obtain the knowledge base that would provide a snapshot of current organisational tacit knowledge based resources.

5. The methodological framework for tacit knowledge discovery and measurement

We have designed a methodology that spans over two phases: one for identifying and locating the tacit knowledge-based resources, and the second one for their verification and measurement. The methodology has been designed in such a way that it can be applied at different levels in organisations or in teams with diverse characteristics and structures, as shown in Figure 2.
Each of the three levels considered by the methodology relies on a set of knowledge, human and systems components, as shown in Table 1.

Table 1: Organisational components considered by the methodology at different levels

<table>
<thead>
<tr>
<th>Level</th>
<th>Component</th>
<th>Knowledge</th>
<th>Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organisation</td>
<td>Management board</td>
<td>Organisational knowledge-based competencies: known, possessed and unique tacit resources</td>
<td>1. KM strategies and systems in place.</td>
</tr>
<tr>
<td></td>
<td>Organisational units:</td>
<td>Unit competencies: tacit knowledge stocks and flows</td>
<td>2. ICT-based systems:</td>
</tr>
<tr>
<td></td>
<td>departments/ groups / teams</td>
<td></td>
<td>- Systems for data and information storage, processing, protection and retrieval.</td>
</tr>
<tr>
<td>Individual</td>
<td>Knowledge workers</td>
<td>Individuals’ tacit knowledge stocks and flows</td>
<td>- Live and asynchronous information and transmission systems</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3. Organisational structure and culture (routines, etc.)</td>
</tr>
</tbody>
</table>

5.1 Stage 1: Definition

During the initial phase of the study both researcher and practitioners collaborate in the definition of the project. As a result a research team formed by the researcher(s) and the subjects of the research is formed. This stage involves a collaborative analysis of the social situation by the research team, leading to an agreement about the scope of the research. Scope of the research is defined by the number of organisational units/departments to be studied (width) and to what extent each area will be explored (depth).

General issues are defined, including access to resources, non-disclosure agreements etc. Such issues acquire particular relevance in a context where employees and managers at all levels are expected to contribute to the outcomes of the research by providing an overview of their individual competencies.

In our research project this definition stage was conducted in the first week of February 2007, and included:

- A meeting with the management board to discuss the purposes, expected benefits for the organisation and researchers, and details of the research methodology, and
- A 20-minute presentation of the research plan and expected outcomes as envisaged by the researcher to Refor staff in one of its general meetings.
- The researcher not only described the research and its potential outcomes but also covered different concepts including information, knowledge, knowledge stocks, flows and enablers. Following the researcher presentation, the manager explained the need of this research and called for the maximum degree of support to it.
5.2 Stage 2: Building the researcher’s knowledge about Refor’s business and its operation.

During this stage the researchers work towards gaining a general understanding of the organisation and its business using different means including:

- Document analysis,
- Observation and informally meeting the staff during lunchtimes and coffee breaks, and
- Attending some of the group meetings where no confidential information is being provided.

During the implementation of this phase of our project the researchers had access to documents and online information, attended informal meetings held in different departments and a general meeting. By the end of February 2007 we had acquired a significant level of understanding of Refor and its business – including organisational structure, goals, research projects and tools being developed, etc. We had also gained a level of trust that would facilitate the data collection process.

5.3 Stage 3: Data collection.

The data collection process is the main stage of the methodology. For the conditions of Refor this process is based on semi-structured interviews and questionnaires. Such methods are held in two main stages including key players within the organisation, from the chief executive officer (CEO) and chief knowledge officer (CKO) to team leaders and certain knowledge workers. The first stage is concerned with identifying and locating tacit knowledge-based resources. The second phase aims to determine the importance of previously identified knowledge resources with relation to organisational goals. Both steps are complementary in the process of providing a snapshot of the tacit knowledge resources available within the organisational boundaries.

5.3.1 Phase 1. Discovery of tacit knowledge-based resources.

A series of interviews of key organisational actors from the highest to the lowest organisational level is expected to have, at that stage, a double effect: it should provide new insights into tacit-knowledge stocks, tacit-knowledge flows and enablers/inhibitors to knowledge work within the organisation, as well as validating what has been previously found. A synthesis of the questionnaire leading the interviews can be found in appendix A. Ideally before each interview the potential interviewee will be provided with an overview letter outlining the topics to be discussed and expectations of the researcher from the interview.

While doing research at Refor we used the email to arrange interviews. An overview letter was also sent to the interviewee two days in advance providing some details of our expectations from the interview.

Interview with the top management board.

The aim of this interview is to capture the understanding of the top management board about the organisational tacit-knowledge base. Topics for exploration include the tacit competencies of the organisation and those of every one of the organisational units. This analysis is based on the understanding that the management board may have of the position of the organisation in its sector, as well as its abilities to compete in any sector related to its business. Interviews are to be guided towards analysis of stocks and flows of tacit knowledge at organisational level, as well as the enablers and inhibitors to intra-organisational knowledge work.

Interview with the middle-level management board.

Middle-level managers and heads of selected organisational units are interviewed with the aim of capturing their understanding about issues previously identified by the management board. Interviewees at this stage have the opportunity to validate the general picture of the organisational tacit knowledge base provided by the top management board, as well as to contribute to such a general background. These aims are expected to be achieved by exploring the following issues:

1. To what extent and how the departments/units contribute to organisational competitiveness in areas that have been previously identified,
2. Other stocks and flows of tacit competencies present within the departments/units and that have been missed by top managers.

These interviews also provide a picture of the departments/units being studied, their operation, structure and other enablers/inhibitors to knowledge work.
Middle-level managers are to provide their views on the individual tacit knowledge based resources available within their departments/units. This means – at a unit level, tacit stocks held by some of the key members within the unit, and tacit-knowledge flows that these members participated in. These will be the source of the next set of interviews.

**Interview with key knowledge workers.**

Some key knowledge workers – previously identified by middle managers, are interviewed at this stage. This set of interviews will add to the research impressions of employees about information that has already been provided by the management board and team leaders. These organisational participants are expected to contribute to the research by providing a picture of their educational background and experience gained through employment in this or relevant sectors. Flows of knowledge in which they participate should also emerge, as well as those factors that they identify as enablers or inhibitors to their knowledge work.

During the validation of the methodology, the organisational structure of Refor allowed interviewing a total of 16 employees including its management board. Only individuals playing a key role within the some of the most important projects were included in this study. These individuals were identified by the management board, covering all departments. Although interviewing only 50% of the employees could be deemed to be a limitation of this study, all members of Refor were to be approached through a second, complementary application of this study if it proved successful.

Tacit knowledge stocks were organised in three categories: those derived from educational background, those gained through work experience and those acquired in current job. Tacit knowledge flows were classified as intra-organisational and external to the organisation. Enablers and inhibitors to knowledge work were classified as related to individuals, or related to team or organisational policies. A total of 102 different resources were identified. These included:

- Different employees had experience in the publishing sector:
  - One of them had been working for over 10 years in the publishing business,
  - Seven of them had published results of research projects through one or more journal papers in the past,
  - Six of the interviewees had published their work in conference proceedings.

- Three employees had experience in anatomy and physiology:
  - Acquired thorough formal training in medicine in one of the cases,
  - Two of them acquired training through empirical work doing forensic research.

- There are language skills in Refor covering at least French, Spanish and Portuguese.

- Individuals at Refor have significant levels of collaboration in research with at least 16 organisations, 6 knowledge networks and 25 professionals worldwide. There is a considerable level of exchange of information and knowledge with external sources on a regular basis.

The order in which such resources were identified during the interview process was:

1. The manager identified 25 tacit stocks and was not able to spot more than 3 flows including such tacit competencies. 11 of the identified tacit competencies were significant at organisational level, 8 of them at unit level and 6 at individual level;
2. Individuals corroborated the existence of the 25 competencies previously identified and added another 77 stocks and flows of tacit knowledge-based resources.

Knowledge-related factors not entirely positive but equally relevant to the aims of the research were also identified. Some of these included:

- 90% of the identified competencies are unknown to individuals other than those who hold them, including the manager,
- There is a minimum level of collaboration between different Refor units; only two of the interviewees admitted that they have interacted with members of other units to perform a research-related task,
- No individual has cited or even known the specifics of any work being published or patented outside its unit (within organisational boundaries).

It is acknowledged that the lack of a middle management board places a limitation to the completeness of analysis of each of the organisational units/departments. Even the management board is also unable to
provide an in-depth view of each section. All these limitations affect the number of competencies potentially known and shared within an organisation with a similar structure, and highlight the need of involving a major number of employees in the study.

5.3.2 Phase 2. Evaluation of tacit knowledge-based resources.

After a list of organisational and individual tacit competencies has been outlined in a top-down process the research comes back to those previously interviewed to capture their understanding of the importance of such resources towards at least one of the organisational projects. This phase can be performed either through interviews or questionnaires in the following order:

Survey of middle management board.
Middle managers or unit leaders analyse individual and unit tacit stocks, flows and enablers already identified in order to:
- Determine whether such resources help or hinder the unit performance and how they effect achievement of organisational goals, and
- Express their understanding of the importance of the tacit competency through a numerical value from a metric previously defined.

Survey of the top management board.
Results of the previous steps will be presented to the top management board in a similar way and with the same aims. This will have a double effect of contributing to the research outcomes and raising the board’s understanding of the organisation from a knowledge perspective.

In the process of validating the identified resources within Refor second interviews of members of the management board were conducted. Two weeks before the interviews were scheduled, the manager and the representative of the leading institution were provided with a full list of tacit knowledge stocks, flows and enablers previously identified. Also, the parameters that would be used to assess the value of every resource towards organisational aims were specified.

The management board determined that 76 of the identified knowledge resources were above 80% of positive value for achievement of organisational goals. It was also found that only 13% of the stocks and flows of tacit knowledge-based resources were known by a majority (more than 75%) of members of Refor that were interviewed. The other 87% of the identified competencies was unknown to the majority of interviewees.

This stage of the validation process was completed in approximately eight weeks: one week needed to arrange the interviews, two weeks for interviewing staff, another two weeks to analyse the interviews and three weeks to perform the second interview of the manager and analyse its results.

5.4 Stage 4. Analysis and presentation of results.

Results of all previous stages may be compiled and analysed so that they can be finally provided to the top management board for further action. The research outcomes will include not only the set of organisational tacit-based competencies (stocks of tacit knowledge at organisational, unit and individual levels and their intra-organisational flows) but also a significant number of factors related to such resources. Such parameters include –among many others, the associated level of strength/weakness depending on several aspects such as need, availability and use, perceived importance towards organisational goals, location of the tacit knowledge resources (department/unit, individual, etc.), location where each knowledge resource is needed (organisational participants who may need each identified competency at present or in the near future), perceived levels of sharing of resources, etc.

A notion of the expected frequency of significant changes occurring within the organisational set of tacit competencies will also result from application of the methodology. Such changes in tacit knowledge stocks and flows not only depend on enablers and inhibitors to knowledge work identified by the methodology, but also on the activities that the organisation, its departments/units and individuals are involved in. This outcome will be useful to define the need of re-applying the methodology in the future with the aim of exploring how aspects such as tacit knowledge flows have changed, the effects such changes have had on tacit knowledge stocks, and the role being played by current or emerging enablers and inhibitors to tacit-knowledge work within the organisation.
Regarding the way this stage of the methodology can be applied to two general issues need to be considered. These are:

1. Analysis of results depends on characteristics of the organisation and scope of the study. It may include a certain degree of statistical work to determine certain factors such as correlation between tacit knowledge stocks, sharing at different levels, etc.

2. The results of this study may well be presented in written form through a research report. Once such a report has been analysed by the organisation, the researcher is expected to be open to further discussion of the results. Such an analysis could lead to the design of KM strategies focused on existing enablers and inhibitors to knowledge work within the organisational context. The ultimate aim of action taken after application of the methodology will be to increase competitiveness of the organisation by:

   - Developing new stocks of tacit knowledge in areas where they are needed and using appropriate strategy (formal training, etc.)
   - Encouraging the application of existing stocks and their replication through formal and informal flows within the organisational boundaries.

During validation of this stage it was feasible to have a group meeting with most of the staff within Refor (92% of attendance) after having provided the manager with the results in writing. The meeting consisted of a presentation of the results by the researchers, followed by a group discussion. The aim of the debate was to explore new ways of overcoming the limitations imposed by the identified inhibitors to knowledge work and increasing information and knowledge sharing. An outline of a new knowledge sharing strategy to be explored by Refor emerged and is currently under development. In addition to face to face interaction through different means, the strategy also explored facilities provided by information and communication technologies to improve communication while employees are not physically accessible. These include a variety of tools such as individual and departmental profiles with previously identified competencies, live communication and documents sharing facilities.

6. Conclusions

This paper has described an action research project that resulted in a definition of a methodological framework that aids the discovery and measurement of organisational tacit knowledge based resources. The methodology embeds two phases: one for identifying and locating tacit knowledge stocks, flows and enablers/inhibitors, and the second one for their verification and measurement. Both phases involve organisational participants at all levels.

The main contribution of this research falls into three main areas. First, it has added to existing research on knowledge elicitation by validating a combination of techniques in the particular context of a research and development organisation. Interview-based knowledge elicitation techniques provided best results in this context. Second, the research goes one step further than traditional knowledge elicitation techniques by attempting to provide a measurement mechanism for validation of the elicited knowledge base. Third, the research has shown that participatory action research is a valid methodology to study knowledge elicitation in organisations.

The knowledge elicitation method was designed and validated in a research and development organisation within a timeframe of three months. Although this process was limited to 50% of organisational participants within the chosen organisation, its success led to the planning of a second application of the research involving those who were not initially included. Over one hundred tacit competencies were identified at both individual and organisational levels, most of them classified as relevant by participants. This significantly raised the understanding of the organisational knowledge resources by all of its members and allowed the analysis of new strategies and technologies to increase organisational competitiveness.

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References


Appendix A. Structure of the interview.

1. Introduction to the interview

2. About Refor:
   Interviewee’s Understanding about organisational competencies. Awareness of knowledge as a competitive advantage.

3. Knowledge stocks:
   Ideas potentially leading to patents, publications or already patented or published (own ideas as well as awareness of someone else’s).
   Interviewee’s use and citation of someone else’s work or ideas. Interviewee’s awareness of others citing his/her own work.
   Competencies, education and experience (both personal and those of someone else).

4. Knowledge flows:
   Perception of the intensity of information and knowledge exchanges including the interviewee as a provider or beneficiary of these processes.
   Perception of the degree of intra-organisational collaborations that include the interviewee.
   Interviewee’s awareness of each other’s skills in the organisation. Interviewee’s perception of other employees’ awareness of his/her own skills.

5. Knowledge enablers:
   Any kind of proximity of the interviewee to other organisational participants (i.e. physical, personal, religious, political proximities).
   Interviewee’s personal alliances with organisations and individuals (both locally and internationally).
   Individual and professional networks to which the interviewee belongs.

6. Any other issues regarding knowledge work that the interviewee considered relevant.
Competence Matters More than Knowledge

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Abstract: This paper develops a general framework for assessment and management of competence. It then illustrates a case study demonstrating how to pragmatically assist engineers and managers to confirm their competence, knowledge and understanding against occupational standards without placing undue pressure on their time. It proposes a form of continuous assessment over a 3-6 month period using electronic evidence provided by the candidate in response to a set of focussed emailed questions to build up a paperless portfolio. It also briefly looks how the process can be extended to maintain and update competence and possible future steps to quantify the assessed competence based on weighted performance measures.

Keywords: knowledge life-cycle, competence assessment, competence management, competence benchmarking

1. Introduction

Traditionally knowledge and its creation/acquisition, development and application have been considered by the academic and management communities albeit with different perspectives. In this paradigm, knowledge is the key commodity and the focal point of all activities hence the term Knowledge Management (KM). We propose an alternative and utility based paradigm in which realisation of value through prudent application of knowledge is given prominence over mere acquisition, development, storage, use and ownership of concepts and facts. This is broadly referred to as competence which in a systems paradigm, involves a great deal more than knowledge alone. It is argued that in a real and pragmatic world, it is competence that matters rather than awareness, creation, appreciation and ownership of knowledge. Whilst knowledge is a key and fundamental component in this paradigm, many other factors come together in a systemic form to generate the key benefits from knowledge. This is a utilitarian perspective on knowledge and strives to establish a value system where knowledge is no longer the key commodity but its application in developing solutions to a tapestry of social, technical, global and political problems which is the transformational ability referred to as competence. This by necessity is a human attribute for the time being until cybernetic systems capable of emulating all facets of competence are developed and deployed.

2. Knowledge life cycle

In a similar fashion to any other product or service, knowledge undergoes a number of stages from creation and/or acquisition to disposal. This life cycle perspective is instructive in managing it prudently. The key Knowledge Life-cycle phases are:

1. creation, discovery, emulation or acquisition;
2. formalising and representation;
3. capture, encoding, storage and protection;
4. retrieval, dissemination and application;
5. review and enhancement;
6. adaptation and re-deployment;
7. release and disposal.

Each phase necessitates special skills and talents to ensure success. The first phase requires identification of a strategy for acquisition which may involve research, innovation, synthesis, emulation or mere procurement/licensing. These are quite rare capabilities. Formalisation and representation in text, mathematical or diagrammatic form likewise requires the mastery of selecting the most appropriate form or encoding for newly acquired or found knowledge. Once a representation style and form is chosen, the newly acquired knowledge can be captured or translated into this form, classified, encoded, stored and where appropriate, protected. The end users would subsequently retrieve, decipher and apply the captured and encoded knowledge. This is where a combination of other capabilities is called for to ensure the desired outcome at the requisite level of quality and to the satisfaction of the clients is achieved. Given knowledge can always be augmented and improved through usage, phase five involves incorporation of newly found aspects in the formalised knowledge hence enhancement. Knowledge is also often adapted for new
environments and domains of deployment. This is where innovation is potentially the outcome since it involves synthesis and adaptation rather than creation of new knowledge in an attempt to realise new value. The phases 1-6 are necessarily iterative but, it is always possible that knowledge becomes out of date in view of discovery of new and more efficient methods and approaches to the same end. This eventually involves disposal or release of knowledge and its repository, paving the way for the new and more effective variations. In carrying out all these, some form of higher level knowledge (meta-knowledge) is required. The meta-knowledge required for successful application is called competence. It contextualises knowledge and deploys a portfolio of synergistic capabilities to realise the inherent value of knowledge in providing answers to real world issues and problems.

3. Competence

The European Guide to good practice in Knowledge Management (Euro Guide 2003) defines competence as an appropriate blend of knowledge, experience and motivational factors which enables a person to perform a task successfully. In this context, competence is the ability to perform a task correctly, efficiently and consistently to a high quality, under varying conditions, to the satisfaction of the end client. This is a much more demanding portfolio of talents and capabilities than successful application of knowledge. So a competent person is much more than a knowledge worker. Competency may also be attributed to a group or a team when a task is performed by more than one person in view of the multi-disciplinary nature, complexity or the scale.

A competent person or team require a number of requisite qualities and capabilities namely;

1. The domain knowledge empirical, scientific or a blend of both;
2. The experience of application (knowing what works) in different contexts;
3. The drive and motivation to achieve the goals and strive for betterment/excellence;
4. The ability to adapt to changing circumstances and demands by creating new know-how;
5. The ability to perform the requisite tasks efficiently and minimise wastage of physical and virtual resources;
6. The ability to sense what is desired and consistently deliver it at a high quality to the satisfaction of the end client.

The right blend of these abilities renders a person or group of people (a team) competent in that they would achieve the desired outcomes consistently, efficiently, every-time or more often than not satisfying or exceeding the expectations of the clients over varying circumstances. Such persons/groups will be recognised for their mastery of the discipline and not just considered a font of relevant knowledge. In this spirit, competence is the ability to generate success, satisfaction, value and excellence from the application of knowledge. This supports our axiom that competence matters more than knowledge alone.

4. Competence assessment and management, a systems approach

Given the six facets of competence elaborated earlier, the acquisition, assessment, development and management of competence poses a challenge beyond the traditional education and curriculum vitae. Whilst a blend of all six facets is a pre-requisite for competency and mastery in a given discipline, the significance of each is highly dependent on the context and requirements of a given domain. Whilst theoretical knowledge plays a more significant role in abstract scenarios, experience of application, adaptability and creativity may become more prominent in other domains. Whichever the domain however, a systems framework for the evaluation, development and enhancement of competence is called for. This by necessity comprises two inter-dependent frameworks, one focused on evaluation and assessment and the other on the management of competence.

4.1 Assessment of competence

The competence assessment framework provides an integrated perspective on competence in a given context whilst additionally empowering the duty holders or the organisation to benchmark each aspect, measure, assess and where necessary take actions to enhance various elements in the framework. This is illustrated in the Weighted Factors Analysis (Hessami 1999), schema of Figure 1. The latter aspects of benchmarking, evaluating, assessing and potentially enhancing competence are inherent in the underpinning WeFA methodology (Hessami & Gray, 2002) and not elaborated here.
The determination, benchmarking, evaluation and quantified performance assessment of five driver and three inhibitor Goals in the above WeFA schema is carried out as follows;

4.1.1 Driver goals

The requisite domain knowledge in a given context as depicted in the driver Goal 1 (G1) is broadly supported by relevant industry’s skill/competence frameworks. There are a number of such frameworks in use mainly within various engineering disciplines in the UK, for example OSCEng (2006), IRSE (2007) and IET (2007).

The composition and extent of relevant experience in a given context as depicted in the driver Goal 2 (G2) in the assessment framework is supported by subsequent decomposition of G2 into lower level WeFA structures, the so called Level 2 and Level 3 goals. This principally helps determine the driver and inhibitor goals for the higher level goal, the domain experience.

The nature and degree of motivation and drive in a given context as depicted in the driver Goal 3 (G3) in the framework is supported by subsequent decomposition of G3 into lower level WeFA structures in WeFA. This principally helps determine the driver and inhibitor goals for motivational and drive aspects.

The essential determinants and degree of efficiency in carrying out tasks and avoidance of wastage of resource in a given context as depicted in the driver Goal 4 (G4) in the framework is supported by subsequent decomposition of G4 into lower level WeFA structures.

Finally, the key determinants of quality and consistency in carrying out tasks in a given context as depicted in the driver Goal 5 (G5) in the framework is supported by subsequent decomposition of G5 into lower level WeFA structures, drivers and inhibitors respectively.

4.1.2 Inhibitor goals

The key aspects and the extent of absence of relevant new learning in a given context of application as depicted in the inhibitor Goal 1 (G1) in the proposed framework is supported by subsequent decomposition of G1 into lower level WeFA structures, the so called Level 2 and Level 3 drivers and inhibitors in WeFA.

The key determinants and the extent of change in a given domain/context as depicted in the inhibitor Goal 2 (G2) in the proposed framework is supported by subsequent decomposition of G2 into lower level WeFA structures to aid clarity and presentation.
Finally, the key predictors and the extent of the currency of relevant practice in a given context as depicted in the inhibitor Goal 3 (G3) in the framework is supported by subsequent decomposition of G3 into lower level WeFA structures.

A suitably developed and validated WeFA schema for competence assessment in a given role, context/domain additionally requires a measurement scale for each goal (driver or inhibitor) as well the weights, i.e. the strengths of influence(s) from each goal on higher level goals. Once established, the weighted framework lends itself to application for assessment and management of individual’s or groups’ competence in fulfilling tasks in the particular context as depicted by the framework. This would render a number of advanced features and benefits namely:

- Up to 5 levels of competence comprising apprentice, technician, practitioner, expert, leader in a given role/domain;
- Identification of the gaps and training/experience requirements;
- A consistent and systematic regime for continual assessment and enhancement.

It should be noted that assessment here is devised and intended as a tool in the service of systematic approach to staff development and should not be misconstrued as an adversarial instrument for classification of people’s contributions to the organisation.

### 4.2 Management of competence

The deliverables of the engineering process applied to the creation and realization of parts, products, systems or processes often follow a life cycle from concept to decommissioning as popularised by engineering standards typically comprising:

1. Concept & Feasibility
2. Specification & Design
3. Development
4. Commissioning
5. Deployment
6. Maintenance & retrofit
7. Decommissioning

In this spirit, the human resource involvement/employment within an engineering environment, organisation or project likewise follows a life-cycle comprising seven key phases essential to the systematic and focused management of knowledge namely:

1. Proactivity: comprises corporate policy, leadership, mission, objectives, planning, quality assurance and commitments to competency and service delivery for the whole organisation;
2. Architecting and Profiling: which comprises specification and development of a corporate structure aligned with the strategy and policy objectives together with the definition of roles and capabilities to fulfil these;
3. Placement: this essentially involves advertising and attracting candidates matching the role profiles/requirements involving search, selection and induction. Selection relates to deriving role focused criteria and relevant tests to assist with the systematic assessment, scoring and appointment tasks. Induction, involves a period of briefing, familiarisation and possibly training the extent of which is determined by the familiarity and competence of the individual concerned and the complexity and novelty of the role.
4. Deployment & Empowerment: this involves a holistic description depicting the scope of the responsibility, accountability and technical/managerial tasks associated with a specific role and empowering the individual to fulfil the demands of the role. This would include training, supervision, coaching, resourcing, delineation of requisite authority and accountabilities, mentoring and potential certification as means to empowerment for achievement and development;
5. Appraisal: which involves the planning and setting performance objectives, and identification of the performance indicators/predictors synergistic to the demands of a role and the individual’s domain knowledge, aimed at ensuring all relevant and periphery aspects of the role are adequately addressed and the necessary provisions are made for learning where a need is identified. The evaluation and appraisal provides the necessary feedback on compliance with individual and organisational objectives and achievement, enabling the
organisation to identify and reward good performance and develop remedial solutions where necessary;

6. Organisation and Culture: this involves clarification of role relationships and communications, support, reward and motivational aspects for competency development including requisite resources and learning processes for attaining the policy objectives. This is intended to develop and foster a caring and sensitive approach/culture nurturing talents and paving the way towards an innovating organisation.

7. Continual Development and Progression: this comprises identifying the synergistic aspects which may serve as a complementary and rewarding extension to individuals'/teams' specific roles. Development may involve managerial, technical, support functions or an appropriate blend of duties at the whole life-cycle level or extensions to the role specific activities and vision/ career paths above an existing role into other parts of an organisation and even beyond. The review and assessment of success in all the principles inherent in the framework also fall within the Continual Development principle.

The seven focal areas/principles constitute a systematic competency management framework. It is worth noting however that employment and project/product life-cycles are orthogonal in that securing the requisite human resource and competence for any phase of an engineering production activity would potentially involve all the seven phases of the competence management.

The systematic framework for management of competence is depicted in the WeFA schema of Figure 2. Note that the two frameworks for assessment and management of competence are inter-related and complementary. Whilst assessment focuses on the individual and/or the team in terms of performance, the management framework addresses broader issues relating to the corporate’s policy and a nurturing environment to foster talent and innovation as an embedded culture thus creating a sustainable business/service provision.

**Figure 2**: The systemic competence management framework
A case study of an industry process for competence assessment and management is presented in section 5 to illustrate current practice and highlight the necessity and potency of systemic frameworks for effective realisation, development and appreciation of this invaluable human attribute.
5. Case study: Competence assessment & management in industry

5.1 Making time for the assessment of competence and knowledge

One of the problems with getting commitment to a scheme that assesses knowledge and competence is to convince both the candidate and their line manager that the time spent is worthwhile and that there should be sufficient resources allocated to the process. In addition to the benefits of a quantifiable system for developing skills, there will be the need for an auditable record which shows that work has been carried out by those who have met the required occupational standard as part of a quality management process. Persuading people can be difficult particularly when individuals think they have been carrying out an activity satisfactorily for some considerable time. It is preferable to use the term “confirming competence” to define the assessment scheme, rather than the need to “demonstrate competence” which implies that, prior to the assessment, the candidate may be “not yet competent”.

For tasks with a high practical element such as manufacturing, installing or maintaining, the most accurate assessment method is usually by observation of the candidate carrying out the task with an examination of their completed work. Any knowledge that could not be inferred from the observation but is required to meet the occupational standard would be covered in questioning or tests. The candidate is assessed in the work environment carrying out the activity they would normally be doing. The non–productive time for the candidate would then be limited to answering any questions raised by the assessor.

It is different however for many engineering and managerial roles including project engineers and designers whose work is usually more desk based. The activities tend to be spread over a longer time span covering discussions and analysis which are difficult to observe in action and the candidate may need to gather information, arrange meetings etc before an outcome can be demonstrated. In these instances the conventional way of assessing managers and engineers has been for them to write a personal report stating how they carry out their work and assemble a portfolio of documentary evidence cross-referencing to the occupational standard.

There tends to be some reticence against this additional work to “demonstrate I am doing my job properly” particularly in the climate where there is little “free” time for personal development unless there is some financial inducement or it is necessary to meet contractual or regulatory requirements. There is also the assessor’s time that needs to be considered and the probable lack of assessors at a senior level. The assessor should be occupationally competent at the level of the candidate as well as being a qualified assessor. Many organisations may feel that engineers and managers at this level are more productive carrying out engineering or managerial duties than assessments. Not having sufficient assessors available also has a negative effect, since if a candidate has put in considerable work to assemble a portfolio and then has to wait a long time for the assessment; the news soon gets around and has a detrimental effect by deterring other candidates from starting.

Therefore in order to gain acceptance of a scheme to assess competence and knowledge, it is necessary that the process does not become a burden on both the candidate’s and assessor’s time.

5.2 Targeted questions for continuous assessment

Some processes for demonstrating competence rely on the candidate “raiding the filing cabinet” searching for historic evidence. However, a more staged approach based on short answers to email questions ensures currency and helps the candidate to compile a portfolio without setting aside large amounts of time and interfering with their day job. There are now many emails sent and received by managers and engineers as routine and the plan builds on their responses to short email questions which have been aligned to the occupational standard. Then over a period of time the candidate will have effectively carried out a self-assessment against the occupational standard for their tasks, and supplied sufficient evidence to the assessor for a decision on their competence to be made.

Each of the performance requirements needs to be converted into a format of a suitable email question, such that the answer is a short statement which, when accompanied by supporting documentary evidence, would be acceptable to the assessor. By asking the question in the form of “Please describe how you did …….”, the candidate is encouraged to undertake a reflective review of how they carried out the work in their reply.

The questions are graded such that the first few cover daily or weekly routines for which the candidate will have little trouble in answering and finding the evidence, so giving them confidence to complete the program.
As the candidate progresses, several related performance requirements can be grouped in the email questions. If the candidate has not recently carried out the specific activity but plans to in the near future, then a response indicating a later date is acceptable. Finally, to complete the process a professional discussion between the candidate and the assessor is held to confirm the authenticity of the work submitted and resolve any outstanding issues.

5.3 Example from an occupational standard

A number of occupational standards have been used in the process including those from MCI (1997) for management standards and from OSCEng (2006) for engineering standards. As an example, consider the following performance and knowledge requirements taken from the MCI 1997 Management Standards:

Unit D6 “Use information to take critical decisions”
Element D6.1 “Obtain the information needed to take critical decisions”
D6.1e The information you obtain is accurate, relevant, and sufficient to allow you to take decisions
D6.1f Where information is inadequate, contradictory or ambiguous you take prompt and effective action to deal with this

“Associated knowledge”
- How to judge the accuracy, relevance and sufficiency of information to support decision making in different contexts
- How to identify information which may be contradictory, ambiguous or inadequate and how to deal with these problems

5.3.1 The question to the candidate is emailed (for example on a Monday morning) in a format as follows:

Q1 - Please reply to this email by next Monday with a brief statement describing how you have obtained information to take a critical decision. Explain how you ensure that the information obtained was accurate and sufficient; where any information was suspect, describe how this was resolved.

You should attach to the reply some recent supporting documentary evidence such as:
- Examples of accurate information used
- Examples of information that is incorrect
- Correspondence requesting clarification of the information
- Documents you have returned where you have marked ambiguities or errors

Please use a unique file reference for each attached piece of evidence eg XX01 (where XX are your initials).

5.3.2 The short answer may be in the form of:

I obtained performance statistics from the company’s information management system and also data directly from my 3 supervisors to help me decide on resource planning for next year. However, the data received from area AAA was inconsistent with that on the system and I requested clarification from a second source. I also visited the site to establish the facts first hand.

Supporting evidence (attached)
AB01 Statistics for 3 areas
AB02 Data from AAA
AB03 Clarification request
AB04 Notes of site visit

5.4 Flow of information (see figure 3)

After briefing the candidate on the process, the assessor sends out an email in the format as shown in the example in 5.3.1; this should generate a reply similar to that shown in 5.3.2. On receipt, the assessor adds the text and attached files to the candidate’s electronic portfolio. Should more information be required or additional documentary evidence needed, then the assessor would reply with a second email request. If the initial reply shows that the candidate has not met the associated knowledge requirements, then the assessor would ask a direct question to cover a specific area of knowledge.

One advantage of the process is that the assessor can provide guidance and feedback whilst carrying out the staged assessments remotely, thus reducing non-productive travelling time to meet the candidate and review the evidence. This can be a significant benefit particularly when there may be a limited number of assessors available locally.
The emailed questions could be sent out in conjunction with a “real-time” plan, i.e. questions that match dates when certain regular activities take place and actions are due. For example within operational management, decisions may be based on a 13 week cycle (roster planning meetings, ordering of materials etc); or tie in with known seasonal or climatic changes, then the email questions could coincide with these activities prompting responses from the candidates concurrently as they carry out the work.

**5.5 The candidate’s electronic portfolio**

Microsoft Access is used to create an electronic portfolio, which permits documentary evidence to be embedded as electronic files and therefore the creation of a separate paper portfolio is not required. Each electronic portfolio consists of a set of performance requirements, which define the standard that needs to be achieved with guidance and a list of suggested types of evidence that could be used to demonstrate competence. Where the candidate is completing the portfolio themselves, they will enter short statements describing how they meet the performance requirements as they carry out their engineering or management duties. Each statement can be supported with a range of electronic evidence, such as reports, spreadsheets, emails, witness testimonies, digital pictures, short videos etc. The assessor reviews the statements for each of the performance requirements and can view the supporting documents by clicking on the embedded evidence in the list (see Figure 4).

In the process described in this paper, the electronic portfolio is used by the assessor who enters the email responses and the attached supporting evidence on behalf of the candidate. The assessor then carries out an immediate assessment of the evidence submitted and provides feedback to the candidate.

**5.6 Adding the personal statements and evidence**

An extract of the “Assessor’s Page” of an electronic portfolio is shown in Figure 4; across the top are the unit and element titles followed by a brief summary of what needs to be provided to demonstrate competence. The email response from the candidate has been entered under “Candidate’s personal report” together with the supporting evidence. The assessor then adds their judgement including any questions to ask the candidate and responds back accordingly. The program has the facility to export a report which includes the assessor’s feedback and lists those requirements which have yet to be met. The result is that over a period of between 3 to 6 months depending on the complexity of the standard, either the candidate is confirmed as
competent, or a training and development need is identified. In the latter case, action can be taken immediately rather than waiting for the final assessment. The exercise should take no more than 15-30 minutes a week for both the candidate and the assessor. The final report includes an overall summary and any independent assessment or verification of the portfolio that may be required prior to submitting for an award.

<table>
<thead>
<tr>
<th>Unit D6 Use information to take critical decisions - D6.1 Obtain information needed to take critical decisions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Performance and Knowledge Requirements</strong></td>
</tr>
<tr>
<td>D6.1e The information you obtain is accurate, relevant, and sufficient to allow you to take decisions</td>
</tr>
<tr>
<td>D6.1f Where information is inadequate, contradictory or ambiguous you take prompt and effective action to deal with this</td>
</tr>
<tr>
<td><strong>KNOWLEDGE REQUIREMENTS</strong></td>
</tr>
<tr>
<td>• How to judge the accuracy, relevance and sufficiency of information to support decision making in different contexts</td>
</tr>
<tr>
<td>• How to identify information which may be contradictory, ambiguous or inadequate and how to deal with these problems</td>
</tr>
<tr>
<td><strong>Suggested Evidence</strong></td>
</tr>
<tr>
<td>• Examples of accurate information used</td>
</tr>
<tr>
<td>• Examples of information that is incorrect</td>
</tr>
<tr>
<td>• Correspondence requesting clarification of the information</td>
</tr>
<tr>
<td>• Documents you have returned where you have marked ambiguities or errors</td>
</tr>
<tr>
<td><strong>Candidate’s personal report &amp; supporting evidence</strong></td>
</tr>
<tr>
<td>I obtained performance statistics from the company’s information management system and also data directly from my 3 supervisors to help me decide on resource planning for next year. However, the data received from area AAA was inconsistent with that on the system and I requested clarification from a second source, I also visited the site to establish the facts first hand</td>
</tr>
<tr>
<td><strong>Ref</strong></td>
</tr>
<tr>
<td>AB01</td>
</tr>
<tr>
<td>AB02</td>
</tr>
<tr>
<td>AB03</td>
</tr>
<tr>
<td>AB04</td>
</tr>
</tbody>
</table>

| Assessors comments/questions |
| Evidence shows sufficient and accurate information obtained from reliable sources (company information system) and querying where there is ambiguity (area AAA) |
| Q – What steps have you taken to ensure correct information is provided by AAA in the future? |

Figure 4: Extract of the “Assessors Page” in the electronic portfolio

5.7 Maintaining and updating competence

Having achieved the target of confirming competence at the end of the exercise the process can be adapted to monitor and reassess the candidate to ensure that they maintain the level of skill, experience and knowledge required for satisfactory performance. For example a review could be planned after 12 months as part of the candidate’s development. This can be initiated by an email from the assessor, but this time looking only at areas where an improvement is expected, perhaps in response to a development objective set by the candidate’s line manager as a result of a performance review.

The focus and frequency of monitoring would depend on a number of factors taking into account development plans, the introduction of new processes or equipment, dealing with infrequent events and any risk associated with poor performance. A plan could be devised showing target levels to be achieved by certain dates following the completion of any training and development courses. The email questions could be triggered to request evidence of the newly developed skills.

5.7.1 Certification schemes

Many competence certification systems such as those accredited to the European Standard BS EN ISO/IEC 17024 (BSI 2003) will have an expiry date on the “certificate of competence”. In addition they require that those assessed as competent need to demonstrate that they maintain their competences and continuously carry out tasks to the required standard. ISO17024 clause 6.4 “Surveillance” requires a “pro-active surveillance process to monitor certificants’ compliance with the relevant provisions of the certification scheme” and that there is “impartial evaluation to confirm the continuous competence of the certified person”. Regular email questions can be sent requesting a current “Reflective review” with supporting evidence that demonstrates continuous competence.

The IRSE (2007) Licensing Scheme, as part of its compliance with ISO17024, requires that a Licence Holder consistently works to the standard defined in the licence. Evidence of this should be by verified entries in their logbook which is then reviewed on an annual basis. An email by the assessor could request a copy of
this review, and if there was insufficient evidence of continuous competence then corrective action can be taken.

5.7.2 Competence below the expected level

The Office of Rail Regulator (ORR 2007) in their publication Railway Safety Publication No 1 “Developing and maintaining staff competence”, discusses situations where competence may start to fall below what is expected. This may be due to the lack of opportunity to practice skills because of their low level of occurrence (infrequent event), but at the other extreme due to over familiarity, when people “reach a level of almost automatic performance” and “regress into bad habits and lapses”. A program of email questions with a number of case studies would assist in dealing with the lack of practice of those skills that are rarely used, whilst a program which focuses email questions on those areas where lapses are most likely to occur should pick up the possible onset of bad habits before they take hold.

5.8 Quantifying levels of competence

The process described is to confirm and maintain competence and knowledge at a specific level, but it can also be used to motivate the candidate’s career development. For competence based qualifications such as NVQs (QCA 2007) the candidate is either “competent” or “not yet competent”. However there may be different levels of competence within an occupational area and a measure of competence could be incorporated within the program. A rating between 1 to 5 such as proposed by the IET in their “Competence Framework – Assessing Competence” (IET 2007) could be used. Since each of the performance requirements may also have a different weight in relation to its importance to the job role, the program could compute a score based on the weighting factor and a judgment of the level by the assessor. Indeed the candidate’s job role may not require the same level throughout the related occupational standard, for example, they may need to be at level 4 for some performance requirements but at level 2 for others. The evidence supplied by the candidate would be judged against the target levels for their job.

5.9 Enhancements

The process could be enhanced with the use of a central server, to which the candidate and assessor have access, enabling the candidate to view their progress online. In addition, auto reminders could be used in order to reduce the build up of any backlog if replies were not received by the due dates.

It may also be possible to set up simple rules within the email programs such that when the candidate uses selected words or phrases in their emails as part of their normal work, then a copy of the email with attachments is automatically sent to the assessor or routed directly to the candidate’s electronic portfolio.

6. Conclusions

With competence gaining pervasive prominence in preference to mere focus on knowledge, the adoption, deployment and continual enhancement of competency frameworks founded on systemic principles and a systematic approach provide an advanced basis for management of this strategic capability. We have illustrated a candidate architecture for an advanced and systemic competence assessment and management framework which can fulfil the requirements and meet the challenges of this complex domain whilst illustrating the current practice.

Acknowledgements

Atkins Rail, Network Rail, IRSE - for support in developing the electronic assessment process
Ian Harrison - for the development work on the Access database
Laura Kinane-Powell - for the process of emailing questions to candidates

References

BSI (2003) European Standard BS EN ISO/IEC 17024 Conformity Assessment - General criteria for certification bodies operating certification of personnel

IRSE (2007) Institution of Railway Signal Engineers Licensing Scheme (www.irselicences.co.uk)

MCI (1997). The UK's National Occupational Standards for Management were originally developed by the Management Charter Initiative and have been taken over by “The Management Standards Centre” (www.management-standards.org)

ORR (2007) The Office of Rail Regulator Railway Safety Publication No 1 Developing and maintaining staff competence


QCA (2007) Qualifications and Curriculum Authority. QCA has overall responsibility for National Vocational Qualifications (NVQs) in England, Wales and Northern Ireland. NVQs are work-related, competence-based qualifications based on national occupational standards (www.qca.org.uk)
Managing Structural Diversity: the Case of Boundary Spanning Networks

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Abstract. This paper reports from an interpretive case study conducted in a multinational company that operates in the marine insurance industry. The study focuses on how structural diversity influences knowledge work activities performed by participants who are members of distributed networks of practice (DNoPs). In this paper, a DNoP is defined as a loosely knit, geographically dispersed group of participants who share knowledge with the purpose of solving business problems and improve daily work practices within an organization. The paper takes the view that dimensions of structural diversity such as geographical dispersion, business functions and business divisions define internal organizational boundaries. Thus, knowledge sharing in structurally diverse networks may be less efficient due to the barriers that these internal boundaries may cause. Structural diversity, however, may also enhance creativity and innovation where radical new insights arise from different perspectives introduced by the participants. Consequently, diversity and its potential boundaries embed a duality of contradictory features.

The interviewees who participated in this study regarded diversity as a valuable resource. Different perceptions of business concepts, however, caused misunderstanding and conflicts between participants who worked at different business divisions and thus were geographically dispersed. Interesting findings demonstrated that the DNoPs under study went through an evolution where participants enacted through boundary spanning activities to overcome the barriers that structural diversity caused. The role of knowledge brokers and the use of boundary objects were crucial in these activities. While some boundary objects acted as obstacles, unexpected and illogical objects emerged from practice and became the most efficient boundary objects in use. Different communication media such as video- and teleconferences, email and intranet supported the boundary spanning processes. This paper brings the insight that networks were transformed by the influence of diversity, and that knowledge practices within the networks supported a shift as the networks evolved through cross-network interactions.

Keywords: Network of practice, knowledge sharing, structural diversity, boundary object, boundary spanning, knowledge broker.

1. Introduction

The stream of knowledge management (KM) literature has paid increased attention to informal organizational groups like communities of practice (CoPs) and networks of practice (NoPs), and their significance for knowledge sharing, learning and innovation (Brown and Duguid 2001; Wenger 1998). CoPs and NoPs are emergent and self-organizing groups that represent “invisible” relations existing beside the formal organizational structure (Brown and Duguid 1991; Lave and Wenger 1991). They create veins for knowledge flows and a “tighter” organization by integrating different business divisions and geographical locations in multinationals companies (Hansen 1996). Achieving efficiency in distributed knowledge work activities is, however, challenging. By their very nature, multinational enterprises comprise organizational members from various nationalities, cultures, and demographic backgrounds. These employees are from a number of organizational functions, divisions, and hierarchical levels, thus leading to high degrees of diversity within the organization. A number of studies on distributed multinational teams and workgroups have found that a high degree of team heterogeneity may cause challenges in developing group cohesion, shared identity and collaboration know-how across geographical and organizational borders (Earley and Mosakowski 2000; Fiol and O’Connor 2005; Maznevski and Chudoba 2000). Interaction problems are also associated with diversity, leading to conflicts and communication breakdowns in groups’ relationships (Cox and Blake 1991). Thus, it has become important to understand how compositions of different organizational groups may affect knowledge sharing, creativity and organizational outcomes (Cox and Blake 1991; Cummings 2004; Van der Vegt and Bunderson 2005).

While several research studies have focused mostly on demographic and cultural diversity, only a few studies have paid attention to structural diversity in terms of e.g. organizational role, geographical location, functional assignments and business units (Cummings 2004; Majchrzak et al. 2005). In one study, structural diversity was found to cause challenges in terms of increased misunderstandings due to divergent perspectives (Jehn et al. 1999). However, Cummings (2004) manifested contrary results in a study on dispersed work groups where higher degrees of structural diversity where associated with higher value of external knowledge sharing and increased performance. Building on former research results in work groups...
and teams, the argument in this paper is that structural diversity in a distributed network of practice has a potential for becoming a resource of creativity and innovation if the competence of managing and utilizing this opportunity is present among the members of a network. The limitation of research that specifically investigates structural diversity and its relation to knowledge sharing within distributed networks of practice (DNoPs) motivates this research. Thus, the research question addressed in this study is how DNoPs can manage the effect of structural diversity to achieve efficient knowledge sharing among participants that work geographically dispersed from one another.

Previous research that has examined transformation of knowledge at different cross-functional boundaries primarily pay attention to integration of interdependent sequences and stages within production (e.g. Bechky 2003; Carlile 2002). The interest of this study, however, relates to knowledge activities at cross-functional and geographical boundaries between communities without requirements of coherence as such.

To investigate how members of knowledge sharing DNoPs managed the effect of structural diversity, we conducted a case study in a small multinational firm operating in the marine insurance industry.

Although the interviewees considered diversity as a valuable organizational resource, to utilize this opportunity represented quite a challenge. Frictions because of different business language across different divisions led to conflicts between different networks. Proposals of cross-network interactions were important in order to manage the effect of diversity. In these initiatives the role of boundary spanners (Ancona and Caldwell 1992), knowledge brokers (Brown and Duguid 1998), and boundary objects (Star 1989; Star and Griesemer 1989) were identified as critical.

The paper is organized as follows. Section two introduces the concepts of DNoP, structural diversity, boundary spanning concepts and related research studies. Section three presents the research site, method and data collection techniques, and section four presents the findings from this study. Finally, section five provides a discussion and some concluding remarks.

2. Distributed networks of practice

CoPs and NoPs are groups of individuals connected together through social relationships that emerge as individuals interact on task-related matters when conducting their work (Brown and Duguid 1991; 2001; Lave and Wenger 1991). Researchers have investigated different forms of these networks of practice in several settings, with CoPs being the most well-known research concept. A community of practice consists of a tightly knit group of members engaged in a shared practice who know each other and work together, typically meet face-to-face, and continually negotiate, communicate, and coordinate with each other directly in course of their work (Brown and Duguid 2000: 143). In contrast to a co-located CoP, a DNoP consists of a larger, more loosely knit and geographically dispersed group of participants engaged in a shared practice or common topic of interest (Hustad and Teigland 2005; McLure Wasko and Faraj 2005; Teigland 2003). DNoPs use a variety of electronic channels to communicate and share knowledge (Hustad 2006). Examples are video- and telephone conferences, instant messaging, e-mail, intranets and knowledge repositories that support transmitting and receiving of information.

In this paper, the context of a DNoP is considered as a dynamic relationship of members who interact primarily through electronic means from across co-located CoPs involving two or more locations. Since several communities of practice may be represented in a DNoP, this type of network represents an inter-community structure (Hustad 2007). Due to the physically distributed nature of networks of practice, the ties linking the members together are generally weaker in terms of lower degree of involvement, lower emotional intensity, intimacy, and reciprocity. Moreover, knowledge is less redundant in a distributed network since new insights and perspectives from different environments might stimulate the diffusion of new creative ideas (Granovetter 1973).

2.1 Structural diversity

Researchers have proposed that DNoPs may facilitate more innovative knowledge activities than CoPs since their members may have a more extensive network of both internal and external contacts (Brown and Duguid 2001). This is reflected in the research on formal groups such as teams and workgroups and particularly that which examines diversity in such settings. In this literature, numerous different definitions of diversity have been put forth; however, they generally distinguish between two main sets of characteristics: 1) diversity of observable or visible detectable attributes such as ethnic background, age, and gender, and 2)
differences with respect to non-observable, less visible or underlying attributes such as knowledge disciplines and business experiences (Jackson et al. 1995; Milliken and Martins 1996).

Researchers have tended to focus primarily on the first category of diversity in terms of its effect on communication, conflict, and social integration processes and have paid relatively little attention to diversity in terms of organizational affiliation, geographical location, role, or position (Cummings 2004; Maznevski 1994). However, one study of dispersed workgroups in multiunit organizations found that the latter form of diversity, labeled structural diversity, was more strongly related to effective knowledge sharing and workgroup performance than demographic diversity (Cummings 2004). Although the study identified four types of structural diversity: 1) geographic, 2) functional, 3) reporting managers, and 4) business units, the common denominator of these four types is that each leads to the possibility of increased access to diverse social networks which provide unique information, expertise, and feedback. These findings are supported in other studies of diversity, and the argument is that interaction between individuals with different expertise and divergent perspectives is a key source of learning and innovation (Majchrzak et al. 2004). As mentioned in the introduction, however, interaction problems are also associated with diversity, leading to frictions, and fragmentation in groups’ relationships (Cox and Blake 1991; Jehn et al. 1999).

Similar to dispersed workgroups in multi-unit organizations, DNoPs in a multinational organization would be characterized by a high degree of both demographic and structural diversity that is expected to have an impact on knowledge activities. In contrast to formal workgroups and teams being designed by management, however, DNoPs are emergent with individuals forming relationships based upon mutual interests and shared work practices. Building on related research of structural diversity within workgroups (Cummings 2004), it is of interest to investigate structural diversity in somewhat different perspective by utilizing the concept of a DNoP.

2.2 Boundary spanning concepts

In this paper, the argument is that structural diversity may create internal boundaries within DNoPs. These boundaries represent both barriers and opportunities for creativity and efficient knowledge sharing between dispersed participants. For instance, while knowledge sharing inside a practice of a community or a network seems unproblematic, the transfer of knowledge becomes more complicated across practices (Bechky 2003; Carlile 2002). The dynamic interaction between different communities, however, seems to stimulate the emergence of new configuration of knowledge and innovation. Boland and Tenkasi (1995) define perspective making within a community of practice as the ability of participants to develop a strong core practice by strengthening their own knowledge domain within a community. **Boundary objects** may act as the nexus of perspectives that need to be coordinated across diverse practices. In the field of KM, the focus has been on individuals who occupy boundary spanning roles through facilitating communication and sharing of expertise by linking groups who are separated in terms of location, division or function (Levina and Vaast 2005; Pawlowski and Robey 2004). Knowledge brokers are individuals who participate in multiple communities and facilitate knowledge transfer among them (Brown and Duguid 1998). Brokering enables connections between communities through participants who introduce elements of one practice into another (Wenger 1998).

Boundary objects may act as the nexus of perspectives that need to be coordinated across diverse practices of multiple communities (Wenger 1998). The concept was originally introduced by Star and Griesemer (1989) to address the problem of how members of different social worlds interact. They define these objects as:

> “Boundary objects both inhabit several intersecting worlds...and satisfy the informational requirements of each of them. Boundary objects are objects, which are both plastic enough to adapt to local needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites. They are weakly structured in common use, and become strongly structured in individual-site use. These objects may be abstract or concrete. They have different meanings in different social worlds but their structure is common enough to more than one world to make them recognizable, a means of translation. The creation and management of boundary objects is a key process in developing and maintaining coherence across intersecting social worlds” (ibid.: 393).

Moreover, effective boundary objects are those which are embedded in the practice of agents who use them and have a common identity across practices (ibid.).
In information systems (IS) research, a broad range of information and communication technological (ICT) artifacts have been classified as boundary objects. Examples are intranet applications (Levina and Vaast 2005), enterprise resource planning system (Pawlowski and Robey 2004), and repositories (Carlile 2002). ICT artifacts may act as boundary objects in a DNoP by becoming a part of a network's shared repertoire.

This paper utilizes the notion of structural diversity in combination with the concepts of boundary spanning introduced in this section as a contribution to increase our understanding of structurally diverse DNoPs. Hence, managing structural diversity is in this study considered as a boundary spanning process where different dimensions of structural diversity constitute a boundary in which members are separated by either location or both location and business functions. The challenge is then to facilitate knowledge sharing of expertise that exists at each boundary.

3. The case study of Insure

Insure (pseudonym) is a small multinational firm operating in the marine insurance industry. After an organizational merger between departments from two other companies, Insure today has three different business divisions and provides claims handling and underwriting activities for ships owners (P&I division), the hull and machinery market (Marine division), and the oil and gas industry (Energy division). Insure has approximately 350 employees working in ten different locations of Europe, Asia and America. In addition, numerous correspondents assist Insure with their local expertise worldwide.

Insure needed to go through an organizational change from being a monolithic organization representing one business division towards a heterogeneous company consisting of three different business divisions of marine insurance. Dispersed organizational members needed to communicate frequently to ensure integration and transformation of knowledge to develop a more holistic understanding of different business concepts of marine insurance.

An interpretive case study was conducted to examine the effect of structural diversity on knowledge activities within DNoPs. In addition, this exploration concerned how the members managed and utilized the effect of structural diversity by enacting in boundary spanning activities. A case study approach was chosen because of the importance of studying networks of practice in their real-life context (Yin 2003). Secondly, a case study was appropriate since the existing body of research and literature did not adequately describe the phenomenon under investigation (Eisenhardt 1989). Finally, a case study provides a comprehensive in-depth study and a rich picture of one organization in which all the specificities that are unique for that particular organization are looked into more carefully (Stake 2000).

The collection of empirical evidence took place in five organizational sites of the company (three offices in Norway, one office in England and one office in Finland) during the period from autumn 2003 to spring 2006. The data collection comprised approximately thirty in-depth, open-ended and semi-structured interviews, and observation of internal organizational videoconferences and open-ended mail-discussions in different DNoPs. The interviewees were from different hierarchical levels (operational and management), different business divisions, business functions and knowledge disciplines (lawyers, mariners, engineers, financial experts, IT-personnel, managers and knowledge officers). Secondary material was collected from the company's intranet consisting of internal reports, presentation materials, workshop reports, meeting agendas, meeting minutes, and internal documents. In addition, detailed information from the company’s ‘yellow pages' gave information about the organizational members' diversity in terms of their educational background, competencies, and their hierarchical position (role, division, function, department, location). Document analysis provided important contextual information of the company's organizational formal structure, policies, knowledge management strategies, competence development, quality management routines, day-to-day events, policies, and work practices. The process of data collection and analysis proceeded iteratively, allowing themes to emerge from the empirical material for categorizing, and then to be examined more deeply according to its relevance.

4. Findings

Several DNoPs were identified during the investigation. In this study, two different categories of DNoPs are presented and compared in terms of how structural diversity is managed. These categories represent the main business activities in the company regarding of claims handling and underwriting. The degree of members’ diversity in these networks varied. Both heterogeneous and homogenous networks existed and

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1 See Wenger (1998: 73) who defines different dimensions of practice as the property of a CoP.
they crossed boundaries of different diversity dimensions: geographical locations, business divisions, business functions, knowledge disciplines and organizational roles. However, as mentioned in the introduction, structural diversity dimensions in terms of geographical dispersion and business functions are the main foci. With the exception of one network (the Energy Underwriters), all of the networks of practice studied, were crossing boundaries of geographical locations.

Table 1 presents the findings related to structural diversity dimensions and boundary spanning activities within the claims handling and the underwriting networks.

### Table 1: Structural diversity and boundary spanning in networks of practice

<table>
<thead>
<tr>
<th>Networks of practice</th>
<th>Structural Diversity</th>
<th>Communication media</th>
<th>Efficient boundary objects</th>
<th>Less efficient boundary objects</th>
<th>Knowledge brokers and boundary spanners</th>
</tr>
</thead>
<tbody>
<tr>
<td>P &amp; I Underwriters</td>
<td>27 participants</td>
<td>Video conference</td>
<td>Target list Market prospect</td>
<td>QMS</td>
<td>Carol</td>
</tr>
<tr>
<td></td>
<td>14 core members</td>
<td>Email</td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>3 locations</td>
<td></td>
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<td></td>
<td>1 business function</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>1 business division</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marine Underwriters</td>
<td>42 participants</td>
<td>Video conference</td>
<td>Target list Market prospect</td>
<td>QMS</td>
<td>Carl</td>
</tr>
<tr>
<td></td>
<td>24 core members</td>
<td>Email</td>
<td></td>
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</tr>
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<td></td>
<td>6 locations</td>
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<tr>
<td></td>
<td>1 business function</td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td>1 business division</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy Underwriters</td>
<td>15 participants</td>
<td>Face-to-face</td>
<td>Not identified</td>
<td>Not identified</td>
<td>Carl</td>
</tr>
<tr>
<td></td>
<td>15 core members</td>
<td>Email</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>1 location</td>
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<td></td>
<td>1 business function</td>
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<td>1 business division</td>
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<tr>
<td>Joint Underwriters</td>
<td>84 participants</td>
<td>Face-to-face</td>
<td>Target list Market prospect</td>
<td>QMS</td>
<td>Carol</td>
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<tr>
<td></td>
<td>53 core members</td>
<td>Email</td>
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<td></td>
<td>Carl</td>
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<td>Intranet, DMS, KMD, Standardized terms</td>
<td>Not identified</td>
<td>Chris</td>
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In the following sections, the findings from these networks are presented respectively.

#### 4.1 Underwriting networks

Three different NoPs were identified in this category representing the business functions of P&I, Marine and Energy underwriting respectively (table 1). The P&I and Marine underwriters are geographically dispersed. These networks communicate and share knowledge through weekly videoconferences for each business division. The Energy underwriters are co-located. All three networks have email lists for distributing information to their own group.

Participants from each underwriting network discuss business practices and daily work activities connected to underwriting issues of P&I, Marine or Energy respectively. The main purpose of each network is to share common interests regarding global market trends of maritime underwriting by exchanging market information and individual experiences related to strategies for “taking control of the market”. The networks’ shared repertoires represent a high degree of tacit knowledge in terms of unwritten artifacts and narratives, which were difficult to translate into explicit modes due to their improvisational and less standardized ways of working.

The company wants to utilize opportunities for cross sales across business functions to achieve synergies. A combination of P&I, Marine and Energy insurances might be of interest for customers who operate in different markets.
4.1.1 Conflict and misunderstanding between P&I and Marine Underwriters

To meet requirements for cross sales after the merger, the P&I underwriters recommended some of their clients as potential customers for the Marine underwriters. However, in beginning this became a challenging and conflicting process due to lack of understanding for each other's business practices. The marine underwriters refused P&I clients without giving reasons. The conflict went on unresolved for some months before a mutual understanding across practices were achieved. The marine underwriters have other strategies, routines, customer profiles and selection criteria for their customers compared to the P&I underwriters. While the Marine underwriters operate in a commercial market, the P&I underwriters' practices build upon a non-profitable mutual insurance principle to protect ship owners in the P&I club. In addition, the Marine and P&I underwriters' market targets did not always represent an overlap of common interests.

4.1.2 Managing structural diversity

To avoid conflicts and gaining a common ground of understanding, three different initiatives were implemented to stimulate knowledge sharing and collaboration across different underwriting networks. The aim was to achieve synergies across practices. We refer to these initiatives as joint underwriting activities. By organizing these joint activities, the different underwriting networks managed to reduce the problems diversity caused by building trust and a common identity across networks.

4.1.3 Joint underwriting meetings

After the merger, the members of different underwriting networks meet in joint gatherings twice a year. One important goal of these meeting is to increase the basic competence about each others underwriting practices. To provide knowledgeable information to customers, a Marine or Energy underwriter must know basic elements and principles of P&I underwriting and visa versa. The aim for each network, however, is not to achieve high expertise in all three practices of P&I, Marine and Energy, but to reach a basic level of knowledge of the other practices while still advancing within the boundary of their own practice.

During these meetings, underwriters from the different networks present experiences related to their strategies, market targets, guidelines and underwriting criteria. These presentations became a part of the repository as PowerPoint files accessible from the company's intranet. Sometimes in combination with the joint underwriting meeting, or in separate meetings, all the members from the P&I underwriting network who are daily located in Norway and England meet physically to discuss their renewal strategies of clients' accounts. In addition, people from some of the branch offices such as Hong Kong, New York, Helsinki and Gothenburg also participate in these meetings. They participate because they are involved in the support of marketing activities in these areas, and are involved in development of prospects. The underwriters need to prepare presentations beforehand, and in the meeting they need to defend their suggestions for renewals and the proposed increases in premiums. This is arranged as an exercise to learn from the other underwriters' individual strategies. In addition, each underwriter must get their suggestions of renewals approved from two other underwriters. These exercises were appreciated as useful among the participants.

4.1.4 Joint underwriting geographical teams

Cross-functional work does not always result in establishment of common clients, since the members of the different networks have different criteria when they are searching new markets. The Energy business division which operates in the oil- and gas industry does not lend itself that easily to coordination. However, there are a lot of opportunities there too, and the members of the Energy underwriting network have a long experience in their field and have contributed with valuable product information to the P&I underwriters on related insurance covers in product development.

Establishing “Joint underwriting geographical teams” is one important initiative to facilitate cross-sales across all three divisions. The underwriters from different business units participate in cross-functional geographical teams where each team is responsible for the marine insurance market in a particular geographical area. Each team has created an email list for discussion purposes. The aim is to identify common target lists of customers and market prospects of similar interest within the geographical area belonging to a specific team. Furthermore, this initiative ensures a tighter collaboration between underwriters from different functional areas. By organizing these team structures, the three different underwriting networks are building trust by getting to know each other better.
4.1.5 Joint underwriting traveling activities

In addition to joint underwriting meetings, the underwriters belonging to a particular geographical team jointly arrange traveling activities for visiting customers. For example, it is sometimes useful for a P&I and hull underwriter who share interest in the same market, to do marketing preparation and visits together. Thus, P&I and Marine underwriters, who share the same market interests, pay common visits to customers as a way of learning each other’s business practices. When a Marine underwriter visits his or her customer, the P&I underwriter is a “passive observer” in that particular meeting and visa versa. Gherardi and Nicolini (2002) refer to this activity as “looking and seeing” which is fundamental in learning of a practice, and for absorbing tacit knowledge across practices.

4.1.6 Boundary spanning activities

The study identified boundary spanning events where different boundary spanners and knowledge brokers were important for translating knowledge across boundaries of structural diversity. Moreover, the networks applied different kinds of boundary objects (table 1). One of the managers, Carl (pseudonym) who is located in two of the business divisions (Marine and Energy) acted as a boundary spanner across these divisions. In addition, he visited the third division regularly, and was involved with traveling activities to the branch offices. As a manager, Carl is not directly involved at the operational level of Marine and Energy, but he sometimes participates in the Marine underwriters’ video meetings. He has been involved in the initiative for establishing joint geographical teams on the strategic level.

Carol (pseudonym), is a lawyer working in the P&I division, and has a role as a knowledge broker. She participates in multiple CoPs and DNoPs, and in joint underwriting meetings. She has established contacts with underwriters from both the Marine and Energy divisions to bring forth new product ideas and potential cross sales.

The most striking boundary objects which emerged among the different underwriting networks were their common target lists, market prospects which represented “illogical” boundary objects (Star 1989). The quality management system (QMS) and the underwriting guidelines, in addition to presentations at common gatherings, where characterized as less effective boundary objects among the participants. According to the informants, QMS was more interfering with than supporting their knowledge activities. The network’s common ground contained a high degree of tacit knowledge and “unwritten” artifacts taken for granted such as narratives, symbols and jargons. Documentation according to QMS requirements did not correspond to the underwriters’ improvisational ways of working.

4.1.7 Joint underwriters

Over time, a new joint underwriting network emerged consisting of underwriters from P&I, Marine and Energy business divisions (table 1, figure 1). The new network emerged through cross-network interactions encouraged by the three joint underwriting initiatives. These implemented initiatives were important for managing and utilizing the effect of diversity. According to Boland and Tenkasi (1995), the emergence of joint underwriting symbolizes a process of “perspective taking” (figure 1).

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2 See McDermott (1999) regarding the use of “unwritten” artifacts in CoPs.
During interaction in distributed video conferences, each of the functional underwriting network is involved in "perspective making" activities, whereby the network develops and strengthens their own knowledge domain and practices. As a perspective was strengthened, it became more complex; however, each network’s knowledge activities improve. Through the process of "perspective taking", different functional networks meet and communicate by taking into consideration each network’s unique world of thoughts. In order to integrate knowledge through perspective taking, communication systems must first support diversity of knowledge through the differentiation provided by perspective making within each of the networks of practice.

While different artifacts had potential features for becoming a boundary object embedded in practice across these networks, rather new and unexpected artifacts did emerge as the most critical objects for balancing structural diversity through cross-network interaction.

4.2 Joint claims handling network

The claims handling network has a high degree of structural diversity (table 1). The network encompasses geographically dispersed members from all business divisions. Before the company merger, the network consisted of members from the P&I functions only. Claims handlers belonging to the Marine and Energy divisions, however, became members in the network soon after the merger. The change of the composition within the network further increased the diversity since both new business practices as well as different organizational cultures were introduced. The members from the different business divisions carried divergent viewpoints and procedures for claims handling. These different perspectives brought dissimilar professional terms together. It was important to manage this diversity to uniform claims handling processes by utilizing and combining the different knowledge bases that existed in each of the business divisions.

The network’s coordinator organizes telephone conferences every week where members of all business divisions participate. These participants are located at seven different geographical sites. During the telephone conference, one participant makes meeting notes and records these notes as a knowledge management document (KMD) in the document management system (DMS). Thus, an electronic ‘meeting book’ is accessible from the intranet.

Twice a year, the members of this network meet in joint gatherings to discuss challenges of claims handling. For instance, they discuss how to achieve a consistent and standardized claims handling process across locations. The organization wants to avoid development of local routines and rules for claims handling at each geographical location. To achieve this consistency, equal access to information resources independent of location is important.

Members from different geographical offices held presentations in these meetings, thus the whole network gets an overview of local competencies at each site. It is important for the members to be aware of the professional and local competence at each site to establish contact points across the organization. These
meetings are particularly important for members located at the branch offices since they might have limited access to common resources of the information infrastructure because of limited line capacities of the network technologies.

4.2.1 Boundary spanning activities

Chris (pseudonym) is the coordinator of the network and acts as a knowledge broker. He stimulates collaboration across networks of claims handlers belonging to P&I, Marine and Energy respectively. He utilizes the advantages of structural diversity. This is in accordance with Wenger’s (1998) definition of brokers where individuals enable connections between different CoPs by introducing elements of one practice into another. Chris is a manager of joint claims in addition to be a line manager at the operational level of P&I claims. He started joint claims meetings soon after the organizational merger by organizing distributed weekly telephone meetings, and joint claims face-to-face meetings. He was active in the process of translating different business terminologies and business practices across functions by standardizing the terms to give them a common identity across business divisions. Additionally, as a coordinator of the network, he acts as a motivator for managing diversity by crossing boundaries of both geographical locations and business functions. Since he is a member of the top management group, he also has strategic and political motives for establishing the joint claims network since this is important for the overall business performance. In this sense, he has a role of a boundary spanner linking groups or communities separated by hierarchy, locations and functions. He acts as a scout by bringing information and resources into the joint claims network, or as an ambassador in terms of strategic, political interests (Ancona and Caldwell 1992).

The DMS is an example of an ICT artifact, which became a boundary object in use. The DMS artifact is a repository of shared documents that supports the management of diversity by creating a basic understanding across functions and distances in the claims handling network. Different KMDs represent belonging artifacts that became locally adapted and used by members at different geographical sites of the network.

5. Discussion and conclusions

Structural diversity causes both challenges and opportunities when knowledge crosses boundaries of practices and distances within distributed networks. By participating in DNoPs, structurally diverse members from various communities bring along different perspectives, which provide opportunities to create new knowledge through translations. Interesting findings demonstrated how participants in DNoPs managed and utilized the effect of diversity through boundary spanning activities that ensured efficient knowledge sharing.

Insure needed to go through an organizational change from being a monolithic organization representing one business division towards a heterogeneous company consisting of three different business divisions of marine insurance. Dispersed organizational members needed to communicate frequently to ensure integration and transformation of knowledge to develop a more extensive understanding of the overall business concept, which became more complex and diverse after the merger. Interesting findings demonstrate how participants in DNoPs managed and utilized the effect of diversity through boundary spanning activities that ensured efficient knowledge sharing.

Findings indicate that the networks were transformed by the influence of structural diversity, and that the knowledge practices of the networks supported a shift as the networks evolved. The role of knowledge brokers, boundary spanners and boundary objects were critical in this evolution encouraged by cross-network interactions.

According to Boland and Tenkasi (1995), it is through cross-community interactions that new configurations of knowledge emerge (Boland and Tenkasi 1995). Interpreting the languages across different communities, however, requires translation and transformation of various professional terms to create a basic common ground of understanding. In this study, boundary spanners, knowledge brokers and boundary objects were crucial for this translation and acted as agents that made local knowledge developed in one network graspable within another network. Former research has documented that boundary objects may support the understanding across different functional CoPs (Bechky 2003; Carlile 2002). A DNoP, however, has an inter-community structure, which represents a higher complexity than a single CoP. Knowledge sharing within a DNoP represents cross-community interactions, but findings from this study demonstrate cross-network interactions as well.

The networks managed structural diversity by applying boundary objects that reduced the ambiguity of knowledge interpretations and enabled tacit knowledge translation related to marine insurance practices.
Different communication media such as video- and teleconferences, email and intranet constituted an ICT infrastructure that supported the boundary spanning processes within and across different DNoPs.

Findings demonstrated both negative and positive effects of structural diversity. The negative effects of diversity were observed among the underwriters that experienced misunderstanding and conflicts. Different procedures for meeting the market needs made collaboration across underwriting networks challenging. Over time, however, diversity became a source of creativity as the participants managed diversity by enacting in boundary spanning activities that ensured efficient knowledge sharing. Joint underwriting activities were established in terms of cross-functional meetings, teams and travels. These initiatives increased the synergies across business functions and geographical locations of Insure and resulted in evolution and integration of different marine insurance practices.

Managing structural diversity to achieve translation and combination of knowledge across the underwriting networks seemed to be more complicated than for the various claims handlers. While claims handlers from different business divisions created a joint network just after the merger, the emergence of a joint underwriting network was more time-consuming. The network of claims handlers had a strong coordinator (Chris) who triggered the management of diversity and integration of practices. The underwriters did not have a permanent coordinator and their work routines had a more improvisational and unwritten nature. In addition, the pressure regarding cross sales caused conflicts that required both time and creativity to solve.

The joint claims network used ICT artifacts to manage their structural diversity of geographical dispersion and cross-functionality. The claims handlers had regular distributed telephone meetings and created KMDs by using the DMS as a boundary object. In comparison, the underwriters applied other types of boundary objects such as target list and market prospect that supported mostly the translation between different business functions. These boundary objects emerged from practice and were rather illogical boundary objects. QMS represented a logical boundary object that could tie underwriters from different functions together. However, QMS did not meet the requirements of adaptability and flexibility for being a boundary object for the underwriters. The participants evaluated this object as inefficient since it tended to be more interfering with than supporting the accomplishment of work tasks.

The findings from this study demonstrate that managing structural diversity requires boundary management skills among participants of DNoPs. Lessons learned from this study may have implications for other multinational companies that try to facilitate knowledge sharing networks in their KM strategy. Management should acknowledge structurally diverse networks as valuable resources for utilizing the knowledge potential of the organization. A KM initiative that focuses on the development of boundary management skills may be important to utilize the creative potential embedded in structurally diverse networks.

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Folksonomies, Collaborative Filtering and e-Business: is Enterprise 2.0 One Step Forward and Two Steps Back?

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Abstract: Enterprise 2.0 is the use of emergent social software tools to improve knowledge sharing and collaboration within and between firms, their customers and partners. This paper proposes that Enterprise 2.0 is a double-edged sword and should be adopted cautiously. Emerging trends in e-business are specialisation and collaboration, creating a diverse population of organisations, each tightly defined by its core competences, interacting in a constant sequence of transient relationships, each motivated by a particular market opportunity. These dynamic business networks depend on the establishment of appropriate platforms and global standards to enable smooth interaction between the service components, in particular, appropriate metadata such as ontologies. The dynamism of such an interconnected yet free-wheeling economy is constrained unless risks relating to investment in a new business relationship are reduced to levels where the risk-reward ratio favours agility rather than inertia. For its advocates, Enterprise 2.0 techniques promise to contribute to the evolution of dynamic, agile, collaborative e-commerce. However, its egalitarian and permissive nature creates challenges. Folksonomies allow a more customer-centric view of an organisation's value proposition but may also undermine carefully devised official ontologies. Collaborative filtering may provide a mechanism for mitigating risk but the trust created is dependent upon the perceived credibility of the reviewers. A high profile example of an initiative designed to facilitate dynamic e-commerce which failed due to unsatisfactory classification of its members and the perceived risk of interacting with unknown reputations is examined. Recent academic research and practical applications that address these conflicts are reviewed.

Keywords: Enterprise2.0, ontology, folksonomy, metadata, collaborative filtering, trust

1. Enterprise 2.0

Enterprise 2.0 is the manifestation and application of Web2.0 in the business domain. Web2.0 represents the revolution that is occurring as large numbers of previously passive consumers of content become active contributors. In Web2.0 the Web itself is merely a platform for interacting with content. Information is broken up into "microcontent" units that may be distributed across the Web. A new set of tools such as blogs, RSS (Really Simple Syndication - a mechanism that creates a "feed" of updates from specified news sites, blogs etc.) and Wikis (tools to facilitate mass collaborative authoring) are developing to publish, aggregate and remix microcontent in new and useful ways. Interfaces like these are changing the way we store, access, and share information. Evidence of the significance of this trend includes the acquisition of Myspace (www.myspace.com) and You Tube (www.youtube.com) by Yahoo (www.yahoo.com) and Google (www.google.com) respectively and the front covers of Newsweek and Time featuring the founders of the photo-sharing site Flickr (www.flickr.com) and a mirror (i.e. the reader). Advocates praise the egalitarianism, inclusivity and empowerment of Web2.0, critics bemoan its potential for dumbing down, narcissism and pandering to the lowest-common denominator. Enterprise 2.0 describes the use of emergent social software tools to improve knowledge sharing and collaborate within and between firms, their customers and partners. An example of Enterprise2.0 is the "mashup" - a website or web application that uses content from more than one source to create a completely new service. Tapscott and Williams (2006) examine the emerging paradigm of ad-hoc, self-organised mass collaboration and peer production. They propose the term "wikinomics" to describe an economy in which firms that are proficient at managing trust-based relationships with external collaborators (including customers) enjoy competitive advantage disproportionate to their size.

2. The e-business ecosystem

The ubiquity and standardisation of the Internet has created the ability to easily and cheaply dissolve and re-establish virtual co-ordinating relationships. This in turn has enabled the development of dynamic network organisations (Benjamin and Wigand, 1995; Fulk and deSanctis, 1995; Cravens et al., 1996). The huge benefit of the dynamic network organisation is the reduced asset specificity (Williamson, 1983) and the resultant increase in flexibility (Boynton and Victor, 1991). The linear, static value chain (Porter, 1980) is being "blown to bits" (Evans and Wurster, 1999) and replaced with “value constellation” partners (Normann and Ramirez, 1998). Iansiti and Levien (2004) note that "rather than focusing primarily on their internal capabilities [...] they emphasize the collective properties of the business networks in which they participate". Value-adding activities are continuously being "unbundled" and "rebundled" (Hagel and Singer, 1999). The increasingly virtual nature of organisational structures (Davidow and Malone, 1992) and reduction of the "friction" that slows the rate of change of business interaction is creating an economic paradigm known as...
the "business ecosystem" (Moore, 1996). A diverse population of "modular" organisations (Sanchez and Mahoney, 1996), each tightly defined by its core competences, exists in an "opportunity environment" (Moore, 1996), interacting in a constant sequence of transient relationships, each motivated by a particular market opportunity (Brandenburger and Nalebuff, 1996). Networks are driven and coordinated by the definition of a specific business need and the search for a business partner offering the best service at that point in time (Lorenzoni and Lipparini, 1999). The wider the "net" with which we can trawl for these services the greater the diversity we have to choose from and the greater the likelihood of there being one that does precisely what we are looking for. There is a greater likelihood of there being one – but what about the likelihood of finding it? Furthermore, if you did find what you were looking for could you trust them?

3. Metadata and the semantic web: Taxonomies and ontologies

Adding metadata to Web content is bringing into reality the Semantic Web - another vision of the Web's creator, Tim Berners-Lee (Berners-Lee et al., 2001). This vision is to embed meaning into the content making it self-describing allowing the development of new ways to manipulate, integrate and aggregate data across the Web. For example an online travel agency might copy a flight itinerary into an electronic diary or assemble a collage of photographs of a particular tourist destination. As metadata is readable by software the Semantic Web allows applications themselves to search for data and, critical to the vision of distributed software, to search for other applications. Metadata cannot exist in a semantic vacuum. We may assign the value of "Pride and Prejudice" to the metadata element "Title" but that is taking the meaning of "Title" for granted. This deeper level of definition is addressed by the creation of an ontology, a concept found in Aristotle's metaphysical study of the nature of being and existence. A taxonomy is a hierarchical classification of entities within a domain and establishes hierarchical inter-relationships (parent-child/broader-narrower) e.g. the Dewey Decimal system or the North American Industry Classification System. An ontology does more: it has strict, formal rules (a "grammar") about those relationships and encompasses attributes of knowledge rather than data i.e. assumptions, justifications - it is a conceptualisation of a knowledge domain.

4. Risk and trust in the e-Business ecosystem

The Internet lowers "barriers to new entrants" (Porter, 1979) such as economies of scale, capital requirements, switching costs, access to distribution channels and proprietary standards. Porter (2001) noted that a "flood" of new entrants had come into many industries and that "anything the Internet technology eliminates or makes easier to do reduces barriers to entry". Open electronic market places and standardised metadata platforms should create access to markets previously locked up in established inter-firm relationships for small firms and new entrants. However, this also creates, from the buyer perspective, the constancy of a "new buy" situation (Robinson et al., 1967). Dynamic e-commerce will not thrive unless risks relating to investment in a new business relationship are reduced to levels where the risk-reward ratio favours agility rather than inertia. Jacoby and Kaplan (1972) posit that risk consisted of six components: financial, performance, physical, social and convenience. The potential costs to a business of inferior inputs, in both financial and reputation terms, are very high due to problems such as product recalls or late completion of projects. Business-to-business (B2B) purchasing requires a detailed appraisal of the vendor in which the key stages are relationship formation (Ford et al., 1990) and initial trust formation (McKnight et al., 1998). Ford et al (1990) proposed "capability" as a key aspect of vendor appraisal. Factors such as the "Not Invented Here" syndrome (Katz and Allen, 1982) and "spatial learning myopia" (Levinthal and March,1993) may constrain the firm's ability to adopt such an approach. SME (Small and Medium Sized Enterprises) managers, in particular, tend to work with people they know and trust leading to insularity (Zhang et al., 2004). This is an example of high "bonding social capital" (Putnam, 2000) but low "bridging social capital" (Putnam, 2000) whereby the "ties that bind can also be the ties that blind" (Cohen and Prusak, 2001). For the "out-supplier" (Robinson et al., 1967) the task of changing a straight re-buy situation into a modified re-buy can be very difficult. Trust builds up over time and stable, long-term purchasing and collaboration relationships are very resilient to potential new partners – whether because they function well or through a sense of ‘better the devil you know’. In the 1980s UK Prime Minister Thatcher's government recognised this and had to force public sector organisations to open up to potential new suppliers through Compulsory Competitive Tendering.

Bauer (1967) defines risk as the perception that "any action of the consumer will produce consequences which he cannot anticipate with anything approaching certainty and some of which are likely to be unpleasant", recognising the limited cognitive capacity of the consumer. Trust attenuates perceived risk – the unresolved tension between a consumer’s purchasing goals and the outcome of the purchase decision (Cox, 1967; Doney and Cannon, 1997). Morgan and Hunt (1994) defined trust as "a generalised expectancy held
by an individual that the word of another can be relied upon” and further expand its meaning to be a confidence that the other party is “reliable, honest, consistent, competent, fair responsible, helpful and altruistic”. Moorman et al. (1993) define trust as “a willingness to rely on an exchange partner in whom one has confidence”. Anderson and Naurus (1990) and McKnight et al. (1998) give similar definitions. Sako and Helper (1998) defined “competence trust” as confidence that a supplier is capable of doing what they say they will do. Establishing trust online (Stewart, 2003) is considered even more significant in online transactions than traditional ones due to its impersonal nature (Ba, 2001; Ba and Pavlou, 2002; Castlefranci and Falcone, 1998).

5. A failure of taxonomy and trust: UDDI

Tapscott (2006) believes that “firms that figure out how to establish trust across a dynamic [business web] through automatic IT-based methods that substitute for formal contracts can gain agility and speed”. The Universal Description and Discovery Language (UDDI) ([www.uddi.org](http://www.uddi.org)) was designed as a standard that would help companies conduct business with each other in an automated fashion but provides a key example of the challenges facing such initiatives. Companies could publish the services they offered and how they wanted to interact at a central registry, the UDDI Business Registry (UBR). Other companies could find that information and use it to establish a relationship. It was supported by over 250 organisations including Microsoft, IBM, Oracle, Ariba, HP, Intel and SAP. Once billed as the global yellow pages for business services, the UBR closed in January 2006 (Krill, 2005). UDDI is now to be found acting as an internal resource management application. One of the main issues preventing the widespread adoption of such a public directory is trust. Public UDDI failed for two principal reasons (1) business classifications in the registry were often misleading, (2) perceived risk - very few businesses would be willing to take a chance on an unknown service provider. The part Enterprise2.0 may play in addressing these two flaws will now be explored.

5.1 Folksonomies

O would some Power the gift to give us To see ours elves as others see us! (“To a Louse”, by Robert Burns)

A defining characteristic of Web2.0 is “tagging” whereby users add their own metadata to content they produce, consume and share (this paper has been “tagged” with author-defined keywords). On Flickr ([www.flickr.com](http://www.flickr.com)) and Del.icio.us ([del.icio.us](http://del.icio.us)) for example, any user can attach tags to digital media items (files, bookmarks, images). The aggregation of these tags creates an organic, free-form, “bottom-up” taxonomy. The information architect Thomas VanderWal coined the term or "folksonomy" derived from the idea of a "folk-taxonomy" (Fitzgerald, 2006). Folksonomies are flat (that is, they have no hierarchy, and show no parent-child relationships) and, critically, are completely uncontrolled. A key implication of their lack of structure is that they do not support functions such as drill-down searching and cross-referencing. A key implication of their “anything goes” approach is the potential for highly idiosyncratic classifications. The growth of folksonomies has generated a great deal of discussion regarding their potential to interfere with “official” taxonomies and thus to generate “search noise”. However there is also much discussion of the potential for folksonomies to co-exist with and complement the "official" taxonomies.

6. Notable practical applications

- Meyer and Weske (2006) present an approach to defining service semantics in which modelling is incrementally refined by the users instead of prescriptively defined by the originator.
- IBM's Thinkplace project is a company wide, intranet-based "suggestion box" scheme where a global network of subject matter experts use data mining tools to track the most promising ideas and help manage top-rated ideas through the formal review processes. The project recognised that users' terms didn't always match IBM's official taxonomies for content such as industry and products and created “a way for users to enter keywords, or tags, that would be appended to the suggested terms from the formal taxonomy and thereby improve their ability to find relevant ideas” (Fitzgerald, 2006).
- IBM [www.ibm.com/ibm/responsibility/people/communications/online-jams.shtml](http://www.ibm.com/ibm/responsibility/people/communications/online-jams.shtml) have also used an Enterprise2.0 approach to redefine their corporate values statement. The “ValuesJam” project allowed the entire company to collectively discuss, debate and define IBM's core values for the first time in more than 75 years.
Fitzgerald (2006) also suggests that "companies could also test product concepts by letting users tag them and see what terms they use".

Rubell (2005) suggests that folksonomies may be used "to get some early buzz going around your product/service before it officially debuts by planting links and/or photos on these sites".

McConnell (2005) notes that Amazon has launched a new feature called ProductWiki that allows for "customer editable product information", extending the concept of the customer as co-creator (von Hippel, 2005).

The National Center for Biomedical Ontology (bioontology.org) used the Protege semantic development environment (Knublauch et al., 2004) to allow users to guide the development of the Open Biomedical Ontologies (OBO) library (obofoundry.org). The project recognised that users may wish to use an ontology even though some portions are not well designed and that they may choose semantic definitions with which they disagree.

7. Reputation systems

Reputation, reputation, reputation! O! I have lost my reputation. I have lost the immortal part of myself, and what remains is bestial. (Cassio, in Shakespeare's Othello, the Moor of Venice, Act II, Scene III)

Reputation is a valuable asset to traders, leading to higher trust in buyers (Ganesan, 1994; Andersen and Weitz, 1989). It is unlikely a trader with a good reputation will risk damaging it by acting opportunistically (Williamson, 1991; Chiles and McMakin, 1996). The surest way of generating trust is through personal experience of satisfaction in dealing with a person or organisation over a long period of time. Trusted brands are a powerful asset in risk mitigation (Roselius, 1971). Though industrial buying is generally thought more rational than consumer purchase behaviour, trusted brands still play an important role (Mudambi et al., 1997), particularly if failure of the component would have dire consequences (Hutton, 1997), hence the old adage "no one ever got tired for buying IBM". Perceived risk drives information search (Dowling and Staelin, 1994; Johnston and Lewin, 1996). If a buyer is contemplating purchasing from an unknown supplier then buying behaviour must be informed by the supplier's public-domain reputation (Thompson et al., 1998) through a mechanism based on transitive trust. Put crudely, if A trusts B and B trusts C, then A can trust C. There are two ways of generating a trust transitively: reputation derived from an authoritative, trusted third party ("top down") and reputation derived from collaborative filtering ("bottom up").

8. Collaborative filtering

A reputation is not possessed by a person or organisation - it is held by the individuals and groups with which they interact. Collaborative filtering occurs through the interaction of interested parties that share opinions to form a collective judgement. It is thus an aspect of Enterprise2.0 and is supported in the Semantic Web application FOAF ("friend of a friend", www.foafproject.org). The attraction of a public domain system of rating the reputation of vendors is that it mitigates information asymmetry (Akerlof, 1970; Spence, 1970; Rothschild and Stiglitz, 1976). The Internet creates a situation were anonymity and information asymmetry are highly significant but which affords great potential for peer-assessment and collaborative filtering. Rating systems are important features of major consumer-to-cosumer (C2C) commerce (e.g. eBay, www.ebay.com), as well as Business-to-Consumer (B2C) commerce (e.g. Amazon, www.amazon.com). Consumers shopping on eBay or Amazon can, with little effort and at no cost, obtain and contribute to the quality judgments made by peer consumers. E-Bay's feedback system is simple, and contains both a quantitative and qualitative element. The quantitative element is a positive, neutral, or negative (scored 1, 0, -1 respectively) rating for each transaction. The sum of a user's past ratings is represented as a score. The qualitative element is represented by comments made by other users. Based on an investigation of the eBay rating system, Reznick and Zeckhauser (2001) argue that the Internet provides a superior mechanism for distribution of the information which supports trust decisions.

9. Credibility

Trust and credibility are two fundamentally different concepts. Aristotle saw credibility as a persuasive factor deriving from good character ("ethos") rather than emotional ("pathos") or logical appeal ("logos"). Wathen and Burkell (2002) equate trust to dependability and credibility to "believeability". The credibility issue was highlighted recently in the mainstream media as concerns were raised about the value of online reviews on the sites of companies such as Tripadvisor (www.tripadvisor.com). Fearis (2007) reported that such sites have been increasingly affected by fake reviews and that it was unacceptable for hotels "to influence what was written or pass themselves off as travellers and post positive reviews". Online rating tools have so far been slower to catch on in B2B markets. This is because the products, services and transactions are
generally more complex and the number of ratings available is fewer and thus decisions based on them are less statistically valid. In this situation the credibility of the source becoming much more significant. Hovland et al. (1953) defined source credibility in terms of perceived expertise (or "authority") and perceived trustworthiness (or "good character"). Such work has informed advertising for many years (for example the use "men in white coats" and trusted celebrities). The antecedents of credibility of websites have been explored by, for example, Fritch and Cromwell (2001) and Metzger et al. (2003) but are not well researched in the B2B e-commerce context.

10. Notable practical applications

- Ekstrom et al. (2003) propose a credibility-weighted rating tool ("TrustBuilder") that enables the industry practitioner to utilise their experience, judgment and relationships. The user can take advantage of knowledge, which is pooled across the industry, while being confident that the opinions of persons that he or she knows and trusts will be given added weight.
- Xiong and Liu (2004) present an adaptive, distributed, reputation-based model of trust ("PeerTrust") based on the following five parameters : (1) satisfaction (2) scope (3) credibility (4) transaction context (5) community context. The last two contextual parameters reflect the significance a particular transaction (e.g. monetary value) and the nature of the community (e.g. its cohesiveness).
- Users (who are also collaborative developers) of the The National Center for Biomedical Ontology's (bioontology.org) Open Biomedical Ontologies (OBO) library (obofoundry.org) can “rate the raters” to express preferences for those reviewers whom they trust to define semantics in a manner agreeable to themselves.

11. Conclusion

The emerging paradigm for e-business is specialisation and cooperation. Companies focus on their core competences, and rely on a network of business partners for the support services required to compose a comprehensive offer for their customers. This vision depends on the establishment of appropriate platforms and global standards to enable smooth interaction between the service components, in particular, appropriate metadata such as ontologies. The Internet has been hailed as a means by which entrepreneurs could gain access to markets previously locked up by powerful brands or established inter-firm relationships. However, a small, unknown firm, even if it objectively offers the best product or service, may suffer from risk aversion in the marketplace. For its advocates, Enterprise2.0 techniques promise to contribute the evolution of dynamic e-commerce. However, its egalitarian and permissive nature creates challenges. Folksonomies allow a more customer-centric view of an organisation's value proposition but may also undermine carefully devised official ontologies. Collaborative filtering may provide a mechanism for generating trust online but technologies must recognise and incorporate the importance of source credibility in the business to business context.

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A Model of Antecedents of Knowledge Sharing

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Abstract: In the new era of the knowledge economy, knowledge-based work has replaced regular, sequential work with its characteristics of flexibility, complexity, and high uncertainty (Shieh-Chieh et. al., 2005). It is well recognised today that knowledge is one of the most competitive resources for the dynamic global business environment (Sharif et. al., 2005). Within this context, organisation’s ability to effectively implement knowledge-based activities becomes increasingly vital for the development and sustenance of competitive advantage (De Carolis, 2003; Grant, 1996). Fundamentally, knowledge-based activities include the creation and integration of knowledge, the accumulation and utilisation of knowledge, and the learning and sharing of knowledge and together, these comprise knowledge management (Shieh-Chieh et. al., 2005). Among these, knowledge sharing, or flow, is the cornerstone of knowledge management (Szulanski, 1996; Gupta and Govindarajan, 2000).

Egan (2003) argued that the effective flow of knowledge is only sustainable through people. Geraint (1998) contended that too much faith has been invested in technology at the expense of people issues. Despite the fact that factors affecting the behaviour of knowledge sharing have been quite heavily investigated (Wasko and Faraj, 2000; Ardichvili et. al., 2003), most studies have focused either on social or technological dimensions. Few studies integrating the both dimensions have been conducted (Fu and Lee, 2005).

This paper looks at how organisations can become more sophisticated at supporting knowledge sharing, by identifying antecedents of knowledge sharing. The basic premise of this paper is that effective knowledge sharing has three interrelated links. The first link relates to knowledge values held by organisational members, i.e. learning orientation which describes three organisational values routinely associated with the predisposition of the firm to learn: commitment to learning, open-mindedness, and shared vision. The second link relates to market orientation which typically focuses on three components: customer focus, competitor focus and inter-functional coordination. The final link relates to the organisations’ absorptive capacity which is defined as ‘the ability to recognise the value of new external information, assimilate it, and apply it to commercial ends’. The paper also argues that the successful sharing of knowledge requires enablers in the form of information technology infrastructure, a reward system that reinforces and encourages knowledge sharing activities and a positive social interaction that creates trust among organisational members. The paper represents work in progress. The final version of the proposed model will be tested in technology parks in Australia and Malaysia.

Keywords: Knowledge sharing, learning orientation, market orientation, networks, reward, technology

1. Introduction

In the new era of the knowledge economy, knowledge-based work has replaced regular, sequential work with its characteristics of flexibility, complexity, and high uncertainty (Shieh-Chieh, Fu-Sheng, and Kuo-Chien, 2005). Within this context, organisation’s ability to effectively implement knowledge-based activities becomes increasingly vital for the development and sustenance of competitive advantage (De Carolis, 2003; Grant, 1996). Fundamentally, knowledge-based activities include the creation and integration of knowledge, the accumulation and utilisation of knowledge, and the learning and sharing of knowledge and together, these comprise knowledge management (Shieh-Chieh et. al., 2005). Among these, knowledge sharing, or flow, is the cornerstone of knowledge management (Szulanski, 1996; Gupta and Govindarajan, 2000).

Researchers have argued that individuals, namely knowledge workers, are the prime source of knowledge (Jarvenpaa and Staples, 2001), and are important for the creation, capture and sharing of knowledge within organisations (Nonaka, 1994). Through their experience in the organisation’s key processes they create, find, and accumulate knowledge. Researchers argue that knowledge sharing of individually held knowledge can assist in knowledge creation at the collective level, i.e. the organisational level. For example, Senge (1990) proposed that organisational knowledge is created through communication of individual learning among co-workers. Nahapiet and Goshal (1998) postulated that organisational knowledge is created as a result of the combination and exchange of existing knowledge among employees. Egan (2003) argued that the effective flow of knowledge is only sustainable through people. Geraint (1998) contended that too much faith has been invested in technology at the expense of people issues. While Carter and Scarborough (2001) argued that many knowledge management initiatives fail largely because they ignored the people issues associated with sharing knowledge. Greengard (1998) indicated that all the technology and tools in the world won’t make a knowledge-based organisation. Roberts (2000) went further by assigning an 80% people, 20% technology ratio in discussing knowledge management. Furthermore, companies that understand the need to harness knowledge are aware about the pivotal issue of creating a work environment that fosters...
knowledge sharing mechanisms and learning capabilities within and across organisations. It is well recognised that knowledge-sharing mechanisms are highly complex processes to promote in the organisation (Allix, 2003). Indeed knowledge-sharing hostility is perceived rather as a phenomenon that widely dominates organisational reality (Husted and Michailova, 2002; Gupta and Michailova, 2004). In addition, despite the fact that factors affecting the behaviour of knowledge sharing have been quite heavily investigated (Wasko and Faraj, 2000; Ardichvili et al., 2003), most studies have focused either on social or technological dimensions. Few studies integrating the both dimensions have been conducted (Fu and Lee, 2005).

The view that people are indeed pivotal to knowledge sharing and the sustenance of a competitive advantage is grounded in the knowledge based view of the firm. For example, Sveiby (2001) argued that while competitive-based and product-based strategy formulation generally makes markets and customers the starting point for the study, the resource-based approach tends to place more emphasis on the organisation's capabilities or core competences. Thus the knowledge-based strategy formulation should start with the primary intangible resource: the competence of people. Sveiby (2001: 346) believes that people can use their competence to create value in two directions: by transferring and converting knowledge externally and internally to the organisation they belong to. When the managers of an industrial company direct the efforts of their employees internally, they create tangible goods and intangible structures such as better processes and new designs for products. When they direct their attention outwards, in addition to delivery of goods and money they also create intangible structures, such as customer relationships, brand awareness, reputation and new experiences for the customers. In both these above transactions shared knowledge, within an organisation, becomes a critical factor for the organisational performance and this is exactly the way sharing knowledge is conceptualised for the purposes of this paper.

This paper draws from the strategic marketing literature and proposes a positive relationship between learning orientation, market orientation and absorptive capacity and knowledge sharing. The basic premise of this paper is that effective knowledge sharing has three interrelated links. The first link relates to knowledge values held by organisational members, i.e. a learning orientation. Here, learning orientation describes three organisational values routinely associated with the predisposition of the firm to learn: commitment to learning, open-mindedness, and shared vision. The second link relates to market orientation which typically focuses on three components: customer focus, competitor focus and inter-functional coordination. The final link relates to the organisations' absorptive capacity which is defined as 'the ability to recognise the value of new external information, assimilate it, and apply it to commercial ends'. These three links/constructs relates to the earlier mentioned views of the firm: competitive based/ product based (market orientation), the resource based (absorptive capacity) and knowledge based (learning orientation). The paper also argues that the successful sharing of knowledge requires enablers in the form of information technology infrastructure, a reward system that reinforces and encourages knowledge sharing activities and a positive social interaction that creates trust among organisational members. The conceptual framework is shown in Figure 1.

![Conceptual framework](image-url)
2. Conceptual framework

2.1 Knowledge sharing

Knowledge sharing is not well defined in the literature partially because the research area have not been very active (Bechina and Bommen, 2006). Further, this is partially because according to Davenport and Prusak (1998), knowledge sharing occurs in organisations when members ask for knowledge from other members to solve their problems. Dixon (2000) pointed out that the so-called ‘common knowledge’ is the knowledge employees learn from doing the organisational tasks. After identifying the relationships between actions and outcomes, a state of common knowledge is gained by sharing the interpretations among members. Furthermore, Dixon (2000) indicated that both explicit and tacit knowledge require different processes for sharing. Finally, Bartol and Srivastava (2002) defined knowledge sharing as, individuals sharing organisational relevant information, ideas, suggestions, and expertise with one another. Therefore, it can be seen that knowledge can be explicit or tacit. Explicit knowledge can be expressed in words and numbers, and easily communicated and shared in the form of hard data, scientific formulae, codified procedures, or universal principles. This knowledge is viewed synonymously with a computer code, a chemical formula, or a set of general rules (Nonaka, 1995). It is a knowledge that can be easily blueprinted, put into books, reports, manuals and so forth. This kind of knowledge is best transferred through the impersonal communication of technological transfer method (Rebentisch and Ferretti, 1995). This view of knowledge is deeply ingrained in the Western management philosophy which views an organisation as an information processing machine (Nonaka, 1995: 8). In contrast to explicit knowledge is the concept of tacit knowledge. Tacit knowledge is highly personal and hard to formalise, making it difficult to communicate or to share with others (at least not via impersonal communication methods). Insights, intuitions and hunches fall into this category of tacit knowledge, to mention some. Furthermore, tacit knowledge is deeply rooted in an individual’s actions and experience, as well as in the ideals, values or emotions he or she embraces (Nonaka, 1995). Ultimately it goes to a person’s expertise (Bender and Fish, 2000). Nonaka (1994) suggested that tacit knowledge can be transferred through the processes of socialisation, observation, and apprenticeship which require the maximum opportunity for both the source and the recipient to work alongside. Thus, sharing knowledge, whether explicit or tacit, requires effort on the part of the individual doing the sharing.

Not only knowledge sharing requires effort on the part of the individual sharing it, it also contains an element of reciprocity. This makes knowledge sharing different from information sharing. Whereas knowledge sharing contains elements of reciprocity, information sharing is about the management making information available to all members of the organisation and it could be unidirectional and unrequested.

Knowledge sharing is a key component of knowledge management systems (Alvi and Leidner, 2001; Earl, 2001). Based on the taxonomy of knowledge management systems proposed by Earl (2001), Bartol and Srivastava (2002) identified four major mechanisms for individuals to share their knowledge in organisation: (1) contribution of knowledge to organisational databases; (2) sharing knowledge in formal interactions within or across teams or work units; (3) sharing knowledge in informal interactions within individuals; and (4) sharing knowledge within communities of practice, which are voluntary forums of employees around a topic of interest.

Knowledge sharing can also be compared to organisational citizenship behaviour or prosocial organisational behaviour. Brief and Motowildo (1986) defined prosocial organisational behaviour as positive social acts carried out to produce and maintain the well being and integrity of others. Examples of prosocial behaviours include acts like helping, sharing, donating, cooperating, and volunteering. Like knowledge sharing, these behaviours can be directed towards an individual or towards the organisation as a whole. However, knowledge sharing is not synonymous to these constructs. For an action to be considered organisational citizenship behaviour it must be performed both spontaneously and voluntarily. Although knowledge sharing may be voluntary (Kelloway and Barling, 2000), it is not necessarily spontaneous. In fact, knowledge sharing is almost always the subject of managerial exhortations and organisational reward structures, while organisational citizenship behaviour is largely unrewarded extra behaviour.

2.2 Learning orientation

Learning orientation affects the information that an organisation attends to, interprets, evaluates, and ultimately accepts or rejects (Argyris and Schon, 1978; Dixon, 1992; Hedberg, 1981). Sinkula, Baker and Noordewier (1997) described three organisational values routinely associated with the predisposition of the firm to learn. These values are: commitment to learning, open-mindedness, and shared vision.
Companies that are committed to learning value the need to understand the cause and effects of their actions (Shaw and Perkins, 1991). If an organisation places little value on learning and sharing knowledge, little learning or sharing is likely to occur (Sackmann, 1991). Galer and van der Heijden (1992) described a shared vision as ‘goal convergence.’ If the employees and management in an organisation have an understanding and an agreement on knowledge sharing as an important end/journey then it is more likely that it will take place. Divergent or conflicting assumptions undermine the ability of the members of the organisation to agree on the interpretation of knowledge of local market, as well as knowledge of government and culture and, thus, their ability to respond quickly to emerging trends or problems. Finally, open-mindedness is linked to the notion of unlearning (Nystrom and Starbuck, 1984). When organisations proactively question long-held routines, assumptions, and beliefs, they are engaging in the practice of unlearning. The paper, therefore, makes the following proposition:

P1:- the higher the degree of learning orientation of an organisation the higher the level of knowledge sharing within the organisation

2.3 Market orientation

Martin and Grbac (2003) defined market orientation as the implementation of marketing activities designed to satisfy customer needs better than competitors are able to satisfy customer needs. Celuch, Kasouf and Peruvemba (2002) argued that market orientation typically focuses on three components; customer focus, competitor focus and interfunctional coordination. Baker and Sinkula (1999) contended that market orientation has an operational focus on information gathering, information dissemination and the ability to behaviourally respond to what is received.

Kohli and Jaworski (1990) define market orientation in terms of three dimensions: the generation of market information about needs of customers and external environmental factors, the dissemination of such information among organisational functions and the development and implementation of strategies in response to the information. These elements include continuous and systematic information gathering regarding customers and competitors, cross-functional sharing of information and coordination of activities, and responsiveness to changing market needs (Martin and Grbac, 2003). The paper, therefore, makes the following proposition:

P2- the higher the degree of market orientation of an organisation the higher the level of knowledge sharing within the organisation

2.4 Absorptive capacity

Cohen and Levinthal (1990: 128) defined absorptive capacity as the ‘ability to recognise the value of new external information, assimilate it, and apply it to commercial ends’. Cohen and Levinthal (1990:150) assumed that a firm’s absorptive capacity tends to develop cumulatively, is path dependent and builds on existing knowledge: ‘absorptive capacity is more likely to be developed and maintained as a by-product of routine activity when the knowledge domain that the firm wishes to exploit is closely related to its current knowledge base’. Zahra and George (2002) summarised representative empirical studies on absorptive capacity. According to Zahra and George (2002), absorptive capacity has four dimensions – acquisition, assimilation, transformation, and exploitation – where the first two dimensions form potential absorptive capacity, the latter two – realised absorptive capacity. The paper, therefore, makes the following proposition:

P3: The higher the level of firm absorptive capacity the higher the level of knowledge sharing within the organisation

2.5 Positive social interaction culture

Most knowledge is shared socially, e.g., face-to-face or telephone conversations (Bechina and Bommen, 2006). In an organisation with a positive social interaction culture, both management and employees socialise and interact frequently with each other, with little regard to organisational status. Organisational efforts should be focused on creating opportunities for employees to interact, whether formally or informally, to foster knowledge sharing. Creating these opportunities should aid in building trust among employees, to overcome the knowledge sharing obstacle whereby employees are not comfortable sharing their knowledge with people they do not know (Goman, 2002). Kelloway and Barling (2000) suggest some benefits of social interaction with respect to knowledge sharing may include: employees who are more knowledgeable about
their colleagues’ potential for being knowledge sources, as well as employees who trust more colleagues and trust more completely, and who are willing to share knowledge with them as a result. Informal opportunities would include unscheduled meetings, informal seminars, or coffee break conversations. Formal opportunities would include training sessions, plant tours, and scheduled debriefings. While knowledge sharing may be facilitated through formal opportunities, this may stifle creativity (Alavi and Leidner, 2001). The paper, therefore, makes the following proposition:

P4: the existence of strong relational ties and networks in an organisation results in a higher level of knowledge sharing

2.6 Trust
According to Nahapiet and Ghoshal (1998), trust and cooperation have a two-way interaction: ‘trust lubricates cooperation, and cooperation itself breeds trust.’ This means that both are tightly connected and interdependent, and trust may help solve problems of cooperation. As trust lubricates these social relationships it provides opportunities for knowledge exchange. Additionally, given the higher levels of trust people are more willing to take risks in knowledge exchange (Nahapiet and Ghoshal, 1998). The paper makes the following propositions:

P5: the higher the level of trust among organisational members the higher the level of knowledge sharing within the organisation

2.7 Technology
The information technology infrastructure encompasses the technology tools supporting the knowledge sharing effort (Bechina and Bommen, 2006). Smith (2003) draws a very clear relationship between technology and knowledge sharing. One must remember that information technology makes possible the connections that enable knowledge sharing, but it does not motivate employees to share their knowledge. Technology should be viewed as an enabler of knowledge sharing. While organisations can put the tools in place, there is no guarantee that employees are going to use them, or use them effectively, so there is still a human aspect to the knowledge sharing tools.

For example, organisations develop knowledge maps whereby fields of expertise and mode of communication are added to a human resource system. This enables employees to access employees with the necessary expertise to solve their problems (Desouza and Awazu, 2003). This tool can also help employees in overcoming geographic boundaries (Desouza and Awazu, 2003). Technology tools for knowledge sharing include electronic bulletin boards, discussion forums, knowledge directories, groupware, databases, intranets, intelligent search engines, personal web pages, electronic mail, virtual conference rooms, libraries, corporate yellow pages, among many others (Alavi and Leidner, 2001; Bender and Fish, 2000; Chase, 1997; Geraint, 1998). E-learning is a training tool which can be used to train employees to use the knowledge sharing systems, and to recognise knowledge sharing behaviours (Wild et al., 2002).

P6: the existence of an effective information technology infrastructure in an organisation results in higher levels of knowledge sharing

2.8 Rewards
Numerous studies argued that the presence of a reward system is critical for the success of knowledge sharing in an organisation. For example, Bartol and Srivastava (2002) examined the role of monetary rewards in encouraging knowledge sharing in organisations. Bartol and Srivastava (2002) examined four mechanisms of knowledge sharing and found a positive relationship between monetary rewards and knowledge sharing. Further, Bartol and Srivastava (2002) argued that the system of contributing knowledge to databases is the most amenable to rewards contingent on knowledge sharing behaviours because of opportunities for the reward allocator to measure the knowledge sharing behaviours.

Kugel and Schostek (2004) examined the effect of monetary rewards on knowledge sharing in Simens, the German giant and concluded monetary rewards seemed to have an immediate effect on motivation to share knowledge. Nevertheless, the authors argued that the quality of the knowledge shared can be inferior, and the attitude that knowledge is a private and non collective good is enforced. The authors noted that once the rewards are withdrawn knowledge sharing will decrease.
Gammelgaard (2007), using a questionnaire survey producing data from 1,535 respondents from 9 different organisations localised in 4 different countries, demonstrated that employees are mostly intrinsically motivated and preferred ‘soft’ incentives like acknowledgements and personal development over increases in salary. In addition, Gammelgaard (2007) found that the type of knowledge management system used – a system based on face-to-face transfers or one based on information technology (IT) systems - affects preferences for the intrinsically-motivated incentives. The paper makes the following proposition:

P7:- the use of ‘soft’ incentives over monetary incentives results in higher levels of knowledge sharing

2.9 Demographics

There has been little work done on the impact of demographic variables on knowledge sharing. However, some demographic variables may have an effect on how employees choose to share their knowledge. For example, Organ and Rayan (1995) argued that employees with shorter tuners are more likely to share knowledge. Organ and Rayan (1995) also argued that gender may have an impact on the communication styles and hence, there is a possibility that it will have an effect on knowledge sharing. The paper, therefore, makes the following proposition:

P8: demographic variables have an influence on levels of knowledge sharing

3. Conclusion

This paper looks at how organisations can become more sophisticated at supporting knowledge sharing, by identifying antecedents of knowledge sharing. The basic premise of this paper is that effective knowledge sharing has three interrelated links. The first link relates to knowledge values held by organisational members, i.e. learning orientation. Here, learning orientation describes three organisational values routinely associated with the predisposition of the firm to learn: commitment to learning, open-mindedness, and shared vision. The second link relates to market orientation which typically focuses on three components: customer focus, competitor focus and inter-functional coordination. The final link has to do with the organisations’ absorptive capacity which is defined as ‘the ability to recognise the value of new external information, assimilate it, and apply it to commercial ends’. The paper also argues that the successful sharing of knowledge requires enablers in the form of information technology infrastructure, a reward system that reinforces and encourages knowledge sharing activities and a positive social interaction that creates trust among organisational members.

These links are reflected in different views of knowledge. For example, while competitive-based and product-based strategy formulation generally makes markets and customers the starting point for the study and therefore the market orientation link, the resource-based approach tends to place more emphasis on the organisation’s capabilities or core competences, hence the absorptive capacity link. And finally, knowledge based view of the firm which believes that people can use their competence to create value in two directions: by transferring and converting knowledge externally and internally to the organisation they belong to; hence learning orientation.

The implication for managers is that effective knowledge sharing is multifaceted. At the core of organisation where people are seen as the greatest resource of all there is a need for: a commitment to learning, willingness to think outside the box, and the willingness to unlearn old knowledge. At the organisational level, the organisation should have the right routines that support finding, assimilation and accumulation of knowledge and consequently the successful development of this knowledge into commercial ends. This is not possible, however, without a focus on the market in terms of: the needs of customers, competitions and inter-functional coordination. Managers also need to understand what motivates each employee and provide soft and/or hard incentives to encourage and reinforce knowledge sharing activities. And finally, there is a need to foster an environment of trust and cooperation to overcome risk and the unwillingness to share knowledge. This paper should be seen as work in progress and represents the first stage of a major research project. In the second phase of the research a refined version of the model will be tested in technology parks in Australia and Malaysia.

References


A Consistent Assessment of Intellectual Capital in SMEs
InCaS: Intellectual Capital Statement – Made in Europe

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Abstract: Globalisation and the accompanying increasing international competition put considerable pressure on European small and medium-sized enterprises (SME). The key to competitiveness increasingly appears to be the way people combine, master and commercialise their know-how. Hence it is crucial for European SMEs to utilise and manage knowledge efficiently in order to obtain a competitive advantage. While different national approaches on the management of Intellectual Capital (IC) have been developed and tested, there is no European wide standard regarding the measurement of IC. The collective research project “Intellectual Capital Statement – Made in Europe” aims at harmonising these scattered approaches on a scientific as well as a practical level. Based on scientific consensus a first framework has been developed providing a common ground for the measurement of IC by introducing the Intellectual Capital Statement (ICS). The ICS is an instrument to assess, develop and report an organisation’s IC, to monitor critical success factors systematically, and to support strategic management decisions. As InCaS puts emphasis on a practical approach suitable for SMEs, the framework is to be understood as a starting point for phase I of the project, providing the basis for further development of the method towards practicability and harmonisation. It will be expanded to the final “European ICS guideline” and supported by the “ICS toolbox” in subsequent project phases. Main focus of this paper is the InCaS project and the accompanying European approach on measuring IC. As a first result a brief overview on the existing approaches on measuring IC is provided. Furthermore, the InCaS project as well as the ICS method is described and preliminary results are discussed.

Keywords: Intellectual capital, intellectual capital statement, knowledge management, innovation, SME, european commission/research

1. Introduction

1.1 Challenges

Today’s economy is characterised by continuous globalisation of markets, furthermore the classical driving forces of economic growth changed towards the generation, application and exploitation of knowledge. At first only large organisations, so-called global players were affected, but over the years it spread to all industries, high-tech and low-tech, manufacturing and services, retailing and agriculture. The key to competitiveness increasingly turns on the way people combine, master and commercialise their know-how. Taking this development into account, the Lisbon Agenda from 2000 declares the aim for the European Union to become the most dynamic and competitive knowledge-based market in the world until 2010. Small and medium-sized companies (SMEs) are especially affected by this plan as they are the driving force of Europe’s economy. To obtain their competitive advantage, it is crucial for SMEs to utilise knowledge efficiently and to enhance their innovation potential. Thus, managing their specific Intellectual Capital (IC) becomes more and more important for future-oriented organisations. Furthermore, reporting those intangible assets to customers, partners and investors systematically has become a critical factor of success in the context of the globalisation process (Mertins, Alwert, Will 2006).

Some authors argue that the value of traditional annual reports is declining (Lev and Zarowin 1999). “There is widespread and growing frustration with traditional financial reporting...They all argue that the financial reporting system is incapable of explaining ‘new’ resources such as relationships, internally generated assets and knowledge” (Mouritsen, Bukh, Marr 2004). The disclosure of such information could decrease uncertainty about future prospects of a company and allow for a more precise valuation of the company (Botosan, Plumlee 2000).

In recent years different national approaches on the management of IC have been developed and tested but there is no European wide standard regarding the measurement and management of IC. To develop a European accepted approach on managing IC it is crucial to give an overview on existing approaches related to IC in the following subchapter. The emerging need for a consistent method is the starting-point for the European project “Intellectual Capital Statement – Made in Europe (InCaS)”, which is described in reasonable detail in the next chapter.
1.2 Existing IC management approaches

Initial efforts to measure IC and evaluate its potential started in the nineteen-sixties, driven by Becker (Becker 1964) and Schultz (Schultz 1961), and later Flamholtz (Flamholtz 1974) and Fitz-enz (Fitz-enz 1984) in the context of “Human Resource Accounting”.

A crucial role in the field of IC played the practitioners Edvinsson and Sveiby in the mid of the nineties. They developed two different models (“Skandia Navigator”, (Edvinsson, Malone 1997) and the “Intangible Asset Monitor” (Sveiby 2002)) to measure the components of IC by using qualitative and quantitative indicators and communicate the results in an intellectual capital statement. Edvinsson subdivided intellectual capital into human capital, structural capital, and relational capital. This structure is currently the most frequently used to describe intangible assets (Alwert 2006).

Besides this structural model of IC the Anglo-American researcher predominately developed overall monetary evaluations of IC, for instance “Tobin’s Q” (Tobin 1969) or the “market to book ratio” as well as “Calculated Intangible Value” (Steward 1997) or the “Intangibles Scoreboard” (Gu, Lev 2001). All the approaches aim to quantify organisations’ total intangible assets in financial terms by using the cost, market or income approach. The monetary approach is appropriate in case of merger & acquisitions or to calculate the value of the company as a whole, but it makes it difficult to identify the strengths and weaknesses of the intellectual resources as well as pathways to future value. This is crucial to improve and manage the IC of a company effectively.

Norton and Kaplan focused on this strategic aspect and developed the “Balanced Scorecard” (Kaplan, Norton 1996) as a management tool that aims to enable managers implementing the strategy of a company by using financial and non-financial indicators. More recent approaches for the evaluation and management of IC, mainly developed by Austrian researchers and practitioners, try to include these aspects, as well as an operative link to the business processes. For instance the model of the Austrian Research Centres Seibersdorf (Austrian Research Centres Seibersdorf 2004) relates the IC to the operative business processes and combines it with the EFQM model (EFQM 2003). Furthermore approaches were developed to combine the advantages of both concepts, on the one hand the evaluation of IC in financial terms and on the other hand the analysis of the strength and weaknesses by using non-monetary indicators.

National and international research projects initiated at the end of the nineties were primarily concerned with the theoretical/academic concept of IC, its measurement and evaluation. Different accounting boards like IASB (IASB 1998) or FASB (FASB 2001) paid their attention to the intangible assets as well and try to find solutions to measure and recognise them in the balance sheet.

The research results, for instance the “Danish Guideline for Intellectual Capital Statements”, supported by the Danish Ministry of Science, Technology and Innovation (Danish Ministry of Science, Technology and Innovation 2003) and the most recent German guideline “Intellectual Capital Statements – Made in Germany” by the German Federal Ministry of Economics and Labour (Alwert, Bornemann, Kivikas 2004) are focusing more on the practical application of ICS in companies. These guidelines include practical tips and proposals for drafting an Intellectual Capital Statement as a supplement to the annual report. They both go far beyond the reporting standards for intangible assets, developed by the accounting boards.

2. Intellectual capital statement – Made in Europe

2.1 The InCaS project

So far, all of these methods and ideas for the evaluation and assessment of IC are standing side by side and until today there has been no attempt to harmonise these scattered approaches on a scientific level. This is where the InCaS project starts from: integrating and consolidating academic insights as well as practical experiences shall result in a harmonised and consistent assessment of IC applying Intellectual Capital Statements (ICS).

An Intellectual Capital Statement is an instrument to assess, develop and report organisations’ IC qualities, to monitor critical success factors systematically and to support strategic management decisions by revealing the SMEs’ innovation potential systematically. It aims at detecting strengths and weaknesses of organisations’ IC, serving two purposes: as an internal management instrument supporting strategic decision-making on the one hand and as an external reporting tool to communicate to creditors, investors, customers or partners on the other.
InCaS was designed to tackle these various challenges at one time: based on existing national and international approaches, a consolidated ICS method is being developed taking the special needs and requirements of SMEs from 5 European core countries and core branches into account.

In July 2006 InCaS started as part of the program “Collective Research” funded by the European Commission, DG Research. The project counts 40 participants from 8 countries and brings together scientists, entrepreneurs as well as IAGs (Industrial Associations/Groupings).

The development and improvement of InCaS ICS method is mainly driven by the main scientific partners “Fraunhofer IPK Berlin”, “London School of Economics (LSE)” and “Universidad Politècnica de Catalunya (UPC)”. An Expert Group bringing together IC experts from all over Europe is supporting the research partners in the development of the method as well as assisting and evaluating the pilot-implementations.

InCaS follows a step-by-step approach to combine and alternate between scientific development and empirical testing. In three phases within a project duration of 2.5 years, 25 pilot-SMEs will go through two phases of ICS implementations, intermitted by evaluation and harmonisation activities.

In phase I the 25 SMEs will be guided through the entire ICS process by specially qualified ICS trainers in order to enable the companies on an experience-based learning approach. In phase II the same pilot-users will go through a second reporting cycle with minimal support from the trainers in order to test and prove the practicability of the method at minimum costs.

2.2 The ICS method

As InCaS wants to consolidate all experiences on Intellectual Capital Statements, the method builds upon previous experiences from Sweden, Denmark, Austria and other European countries, taking the German ICS guideline as a basis for InCaS ICS methodology. In 50 pilot implementations the German method proved to be a practicable method to introduce and implement ICS in SMEs (Will, Wuscher, Bodderas 2006). Nevertheless, the InCaS approach aims at going beyond the German methodology in terms of practicability and comparability.

Both serving as a methodological basis for the ICS implementation, InCaS has developed two models which prepare and accompany the implementation process:

The Structural Model aims at defining the “language”, i.e. the vocabulary (terms/ elements) and “grammar” (interrelation of terms/elements) to be used when talking about IC and ICS.

The Procedural Model leads through the ICS process and defines the steps to implement an ICS, i.e. the methodology to be used in the process of assessment and measurement of IC factors.

2.2.1 InCaS structural model

As an ICS requires careful planning, it is crucial that the basic concepts and principles on which the organisation is based are understood. In order to make this step easier, a Structural Model taking a systemic view on the organisation has been developed (see figure 1). The model aims to display all of the relevant organisational structures linking Intellectual Capital to Business Processes and Business Success and embedding the organisation in its business environment. The starting point is the vision and strategy of the organisation with a view to the possibilities and risks encountered in the business environment. Following the most frequently used structure to describe intangible assets, the InCaS methodological framework divides Intellectual Capital into the three dimensions: human, structural and relational capital.

Human Capital includes the staff’s competencies, skills, attitudes and the employee’s motivation. Human Capital is owned by the employee and can be taken home or onto the next employer.

Structural Capital comprises all structures and processes needed by the employee in order to be productive and innovative. According to a sloppy but useful definition, it “consists of those intangible structures which remain with the organisation when the employee leaves” (Edvinsson, Malone 1997).

Relational Capital sums up the organisation’s relations to customers, suppliers, partners and the public in general.
According to this model the interaction of business and knowledge based processes, together with the other tangible and financial resources, leads to business success. While the structural model displays the different aspects of this interaction contributing to business success, the procedural model shows the way how to assess these aspects in order to find out about the efficiency of alignment between processes and IC.

2.2.2 InCaS procedural model

The Procedural Model defines the steps to implement an ICS, i.e. the methodology to be used in the process of assessment and measurement of IC factors. As the project puts strong emphasis on a practical method for SMEs, the InCaS approach aims at going beyond the German methodology also in terms of practicability and quick wins for SMEs. A scalable approach has been chosen in order to ensure this objective: SMEs can choose the level of detail at the beginning of each implementation, depending on size, age, life-cycle-stage, maturity level (concerning management techniques in use) and cultural environment of the company. The scalable approach shall support a step-by-step learning process during the ICS implementation. In phase I the SMEs are supposed to develop awareness for IC related topics in their specific value creation process, to gain insights about their individual strengths and weaknesses of IC as well as to find out about the potential for managing IC systematically. Based on this learning experience, phase II shall create deeper insights into the single interdependencies of IC factors, business processes and strategic objectives as well as a solid basis for decisions on further strategic changes.

Based on the experiences with the German ICS methodology (Alwert, Bornemann, Kivikas 2004), the procedure for ICS implementation in phase I has been adjusted with respect to simplicity and clearness (see figure 2).
The approach of conducting an ICS is divided into five steps with each step building on the prior one. Step 1, Step 2 and Step 4 are accomplished in direct support by ICS Trainers. Step 3 and Step 5 are prepared internally without a direct participation of an ICS Trainer on-site. The implementation process is furthermore sustained by various support material as guidelines, checklists or Excel working sheets.

**Step 1** is planned as a management meeting and comprises the description and definition of the business model, i.e. defining the value creating model, the external business environment, the main strategic objectives and the business processes and business success. Due to the fact that an ICS can be developed for the whole company, a department, a business process or any other part of the organisation it is also important to clearly define which part of the organisation is analysed.

**Step 2** is the crucial one as the SME’s IC is analysed in a workshop. An ICS team consisting of members from different hierarchical and functional levels across the firm is assigned to the task. As the self-assessment by the team members will later be reflected in the ICS, representativeness is crucial in order to avoid a too subjective or biased self-perception.

Starting point is the identification of IC factors, which are important on the value-adding business processes and strategic business success. The main factors in the areas of human (e.g. professional competence, motivation), structural (e.g. cooperation and knowledge transfer, product and process innovation) and relational capital (e.g. customer relationships, partner network) are defined.

The assessment of IC factors identifies their status quo in respect to their strengths and weaknesses. The evaluation of the IC factors is conducted as a self-assessment, i.e. each factor is evaluated regarding its current existing *quantity, quality, and systematic management* (“QQS assessment”) by the project team.

The impact analysis, as the next part of step 2, enables the prioritisation of fields of intervention. In order to analyse the relative importance of each single factor, the ICS team sets up a cross impact matrix that captures the mutual influence of all factors. Building on this fundament, the team can conduct a sensitivity analysis and the management may focus those drivers that promise to return the highest benefits or marginal utility. In the simplified version of the impact analysis a ranking of the IC factors is generated by the project team, also allowing for prioritisation by a significant reduced effort (scalable approach).
For the measurement of IC, *Step 3* determines indicators and relates them to the defined IC factors. The team discusses and develops indicators that provide adequate facts and data to monitor the performance of the different factors that have previously been assessed. Indicators show, whether implemented measures were successful.

In *step 4* all relevant information from the previous steps is gathered for further interpretation and for the deduction of adequate measures specific to the organisational and strategic needs. An Excel tool makes it possible to visualise the results in various diagrams.

Hence, it is possible to quickly assess strengths and weaknesses as well as interrelations between IC, business processes and the firm’s performance. Despite the inherent complexity, graphical representations support the efficient evaluation and interpretation of the data, for example by using the IC Management Portfolio, to deduce and prioritize fields of intervention (cf. figure 3).

**Figure 3: Example of an IC management portfolio**

The IC Management Portfolio displays the future potential of the different IC factors in a four quadrant matrix. The IC factors’ potential of intervention depends on the assessment of their status quo (QQS-assessment) and on their relative importance regarding the strategic objectives (impact analysis).

In general, IC factors in the upper left typically represent future fields for intervention. If a factor appears in this section, the status quo is rather poor according to the QQS-Assessment while their relative importance is rather high. Therefore, it is crucial to develop these IC factors, as they have the highest potential of intervention. By systematically searching for the factors with the highest potential for intervention, the essential question for the top management can be answered: “Where should we start to invest? Where can we get the maximum impact at minimum costs?”

IC Factors appearing in the upper right quadrant represent the strengths of the organisation. A large number of factors in this sector is generally regarded as a good sign since they do meet the strategic requirements and stabilise the firm. Hence, they should be stabilised on the current level in the future.

The IC factors appearing in the lower left quadrant would generally benefit from management intervention but they have little influence on the organisations strategic objectives. IC factors in the lower right quadrant do not have to be developed actively. They are already in a very good condition and an improvement has little influence. Thus, there is little or no need for action in that segment. Based on the interpretation of the results, adequate measures can be derived to leverage improvement.

The ICS implementation process is finalised in *Step 5*: the compilation and presentation of ICS process’ results within a final ICS document. The document has two major functions and its actual structure and content depends on the intended function. It can be used for internal purposes as a management tool and for
external purposes as a communication instrument. The external version might not show all data whereas in the internal version all data should be disclosed in order to provide a sound basis for management decisions.

The outcome of an ICS is a defined set of measures aiming at the systematic development of particular IC factors as well as a set of indicators that help measuring changes in those factors. This set of measures can be viewed as a first rough IC strategy which can be elaborated over time. Based on those findings, management might expand their business strategy taking into account IC related objectives and the opportunities deriving from systematic IC development.

Hence, the ICS marks the beginning and end of a strategic management cycle by providing sound planning and managing opportunities and continuously controlling the progress of improvement activities.

3. Preliminary results

At the time being, InCaS has successfully concluded the phase I implementation by the end of June 2007. By that time, the SMEs have gone through all the ICS steps and hold their first Intellectual Capital Statement in their hands.

During phase I, InCaS has put much research effort in meeting the challenges of a consolidated methodology of ICS for Europe, taking into account existing European and international approaches in the field of IC measurement. Therefore, the existing international approaches and methods have been analysed and scientifically evaluated in order to identify basic scientific coherences and consensuses on ICS. Thus, the consolidation of the different ICS approaches in the paper “State of the Art in Measuring and Reporting Intellectual Capital” has been the first milestone.

This first project paper has paved the way for the development of a consolidated and well-structured ICS method based on scientific consensus, referred to as the “ICS Framework”. The ICS framework aims at practical consensus and is supposed to provide a common ground for the ICS approach used in InCaS. It is to be understood as a starting point for the further development of the method in subsequent project phases. While the ICS Framework takes a first step towards the standardisation/harmonisation of the ICS method, supporting material like guidelines, templates and checklists landmark the beginning of content harmonisation. E.g. working with basic indicators or standard IC factors has consequently lead to a set of 25 ICSs which are already comparable concerning their structure and implementation process.

With respect to a practical approach, sets of standard IC factors and indicators simplify the process and reduce complexity within the vast field of IC. Referring to a first feedback, pilot SMEs have appreciated the level of practicability as well as the structured process.

As the most important supporting tool promoting harmonisation and practicability at the same time, an Excel-tool has been developed. It guides the user through the implementation process and offers structured templates for each ICS step of the procedural model. Workshop results, such as data from the QQS assessment or the impact analysis are inserted in the Excel sheets and main results can be shown in diagrams. This facilitates the interpretation of results and the deduction of adequate measures in step 4.

4. Outlook

Following the scalable approach of InCaS, the second phase of ICS implementations will start at the beginning of 2008 using the more comprehensive version of the ICS method. As the SMEs will profit from phase I experiences and the practice-based learning approach, they are challenged to go through the ICS process a second time on their own with minimal external support.

Following this approach not only increases sustainability of ICS implementation in the respective pilot-company, but also allows generating 50 sets of data that may be used for evaluation and further validation. Before triggering this second ICS reporting cycle, a major challenge for scientific work in phase II will be the harmonisation of the ICS method. InCaS follows a three step harmonisation process (figure 4).
The harmonisation objectives of InCaS phase I have been achieved by providing the ICS Framework as a consistent and practical method for ICS implementation, based on the scientific consolidation of existing IC management approaches, as described above.

Starting from this harmonised methodological framework, the main harmonisation objective of phase II will be to evaluate the experiences of the first 25 pilot-implementations in order to come up with harmonised ICS content, such as typical IC factors and indicators, e.g. on the level of core branches.

This step is crucial in order to introduce the ICS successfully to the financial market. Field reports and surveys have shown that complementing financial data with information on intangible resources can sharpen the view on SMEs’ creditworthiness (Thomas 2003; Will, Alwert, Bornemann, Wuscher 2007). If some requirements about structure, content and length of an IC report are fulfilled (Wuscher, Will, Alwert, Bornemann 2006), it contributes to a more homogeneous rating of SMEs, than analysts’ assessment based solely on information from annual financial reporting. Therefore it reduces risks for both banks and SMEs (Alwert, Bornemann, Will 2007). InCaS needs to work out these aspects in order to develop the ICS as a reporting instrument to close the existing gap and information asymmetry.

Using the ICS as a reporting instrument in general, not only creditors might be addressed but also customers or business partners. In this case, the question of general credibility arises and leads to the field of quality assurance. Experiences from ISO 9001 or the EFQM assessment clearly show the necessity of validation from a third party to better answer the question, whether the ICS is believable or not. To validate the matching between the ICS method and the factual implementation process, a concept for an ICS quality audit will be developed and contribute to long-term quality of the ICS method (Mertins, Wang, Will 2007).

All of these research fields will be taken into account when adjusting the ICS Framework: the first draft of the ICS Framework from phase I shall be expanded to the final “European ICS guideline” until the termination of the InCaS project in December 2008, ensuring minimum quality standards for future ICS implementations. The aim of this document is to describe a common ground for a practicable European method to introduce and implement ICS in SMEs, setting standards for the internal implementation process as well as the external reporting. The development of the ICS method is accompanied by the improvement of existing support material like checklists, tools and templates, the most important of which is the ICS toolbox.

Not only shall the final ICS Toolbox support the implementation process, save all the IC related data from workshops and thus help the SMEs to manage their IC. The enhanced version of the ICS Toolbox is also supposed to serve as an ICS Training Tool and thus ensure the method transfer even after the completion of the project.

Having achieved this desired level of harmonisation and quality standards, the future challenge for InCaS is to trigger the development of an IC benchmarking concept in order to make ICSs comparable between organisations which will generate an additional benefit for both, SMEs and the financial market. To learn from best-practices or exchange experiences with companies operating within the same branch would support innovation processes and strengthen the SMEs competitiveness. This IC benchmarking concept
based on minimal reporting requirements would ensure quality and comparability of ICSs as a management and reporting instrument all over Europe.

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How to Ensure the Quality and Reliability of Intellectual Capital Statements?

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Abstract: To gain competitive advantage in Europe, it is vital for small and medium sized enterprises (SMEs) to utilise knowledge efficiently and to tap into full innovation potential. Reporting those intangible assets systematically to customers, partners, investors or creditors has become a critical success factor. Thus, managing “intellectual capital” (IC) becomes increasingly important for future-oriented organisations. Conventional balance sheets and controlling instruments are not sufficient any more, because intangible assets are not considered. The collective research project “Intellectual Capital Statement – Made in Europe” considers national experiences and the current state-of-the-art on measuring IC and will establish a European ICS guideline for implementing Intellectual Capital Statements (ICS). The ICS is an instrument to assess, develop and report an organisation’s IC, to monitor critical success factors systematically, and to support strategic management decisions (cf. Mertins, Will 2007). For customers, investors and especially creditors, after receiving an ICS, one of the first things that usually comes into their mind is: Is this information “reliable”? To ensure a high quality level of ICS and to be accepted by, for instance, the financial market, it is important to have a neutral third party who certifies the reliability of the document. Learning from the experiences of ISO 9001 certification, assessment for the European Excellence Award and of financial audits, an ICS audit methodology has been developed. The ICS audit verifies the conformity with the European guideline respective ICS implementation process and the completeness of the ICS content. Furthermore, it will check whether the content is plausible, verifiable and representative for the company. To ensure sustainability, the auditor will get a picture of whether the ICS content is communicated and the stated actions for improvements are in progress or already realised. The main focus of this paper is to demonstrate how to ensure the quality and reliability of IC reporting and how to promote the sustainable realisation of actions by ICS audits.

Keywords: Intellectual capital, intellectual capital statement, quality management, audit methodology, knowledge management, SME European commission/research

1. Introduction

There is a need for managing intellectual capital, since the effective utilisation of knowledge and innovation potential often results in competitive advantage. Furthermore, reporting those intangible assets systematically to customers, partners and investors, as well as creditors has become a critical success factor (cf. Mertins, Alwert, Will 2006). Conventional balance sheets and controlling instruments are not sufficient any more, because intangible assets are not considered so far.

Currently, the reports about intellectual capital are varied in structure and content (cf. Alwert 2006). Resulting from increased interest in managing and reporting of IC, stakeholders such as creditors or investors will receive more and more IC reports of totally different qualities - from very trustworthy to not at all believable.

The project “Intellectual Capital Statement – Made in Europe” aims to establish a European ICS guideline for implementing Intellectual Capital Statements (cf. Alwert, Bornemann, Kivikas 2004) including basic contents of ICS for external reporting. However, how could, for instance, a creditor know whether the ICS on his table was conducted according to this guideline?

In response to this problem, the InCaS project also deals with the question of sustainable quality assurance of ICS. Learning from quality management audits and financial audits, a statement is trustworthy when:

- A review has been conducted, with a methodology which ensures the reliability of the statement and
- The review has been conducted by a neutral authority, whose opinion a, for instance, creditor trusts

To meet these challenges, a methodology called “ICS auditing” has been developed and is based on the knowledge gained in quality and financial auditing and assessment according to the model of the European Foundation of Quality Management (cf. EFQM 2007a).

This paper shows the preliminary result of this research work within the InCaS project.
Objectives of ICS auditing are:

- to ensure the reliability of ICS so that the partners (e.g. creditors, investors) will consider this information as an important input for their rating decisions,
- to establish the reputation of ICS as a trustworthy document,
- to consolidate the ICS as a valuable management tool, since greater acceptance by stakeholder will trigger further use of the method,
- to ensure the proper application of the European ICS guidelines,
- to encourage sustainable usage of ICS as an internal management tool by checking the progress of realisation measures,
- to facilitate ICS comparability by promoting completeness of ICS and
- to assure the quality of ICS in Europe.

2. Existing auditing approaches

For developing a methodology for the verification of ICS, three common auditing approaches are partially applicable and have been considered in detail. The main basis for the consideration are:

- for quality management systems the “ISO 19011:2002 - Guidelines for quality and/or environmental management systems auditing” (cf. ISO 2002),
- for EFQM application for European Excellence Award the “Guidelines for the Excellence Award Applicants” (cf. EFQM 2007),
- for financial auditing the German guideline “IDW PS 201 Rechnungslegungs- und Prüfungsgrundsätze für die Abschlussprüfung” (cf. IDW 2006).

Table 1 shows similarities and differences between the three common auditing approaches and the ICS auditing approach.

**Table 1: Comparison of ICS auditing and other auditing approaches**

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<tbody>
<tr>
<td>Purpose: verification of document</td>
<td>different</td>
<td>similar</td>
<td>different</td>
</tr>
<tr>
<td>Review of self assessment</td>
<td>different</td>
<td>different</td>
<td>similar</td>
</tr>
<tr>
<td>Procedure: Audit application with the possibility of rejection</td>
<td>similar (reject applying organisation, if the documentation shows serious nonconformities)</td>
<td>different</td>
<td>different (strict admission rule: organisations have to score at least 500 points)</td>
</tr>
<tr>
<td>Procedure: Document Review</td>
<td>similar (much more detailed)</td>
<td>different</td>
<td>similar</td>
</tr>
<tr>
<td>Use of scoring matrix for assessment results</td>
<td>different</td>
<td>similar</td>
<td>similar</td>
</tr>
<tr>
<td>Audit follow-up with the opportunity for second document check or follow-up audit</td>
<td>similar</td>
<td>different</td>
<td>different</td>
</tr>
<tr>
<td>Audit certificate to be attached to the document</td>
<td>similar / different (certificate can be attached to the quality manual)</td>
<td>similar</td>
<td>different (EFQM submission document is usually not used for external communication)</td>
</tr>
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</table>
3. Preliminary results - ICS auditing concept

Ensuring the authenticity of ICS is important for establishing the reputation of ICS as a trustworthy document. Thus, an effective tool to provide adequate information needs to be implemented. Conducting audits is an appropriate approach to achieve the goal, because it ensures that the auditors receive sufficient information and draw proper conclusions. In order to do so, one needs to adhere to audit principles. The ISO 19011 specifies the principles in reference to both the auditor as well the audit itself. The three main areas related to auditors are:

- ethical behaviour – the auditor must be professional and treat the information collected in confidence,
- accurate demonstration – the auditor must give clear and factual statements,
- professional due diligence – the auditor must be well prepared for his tasks.

The principles of audit itself regarding:

- independence and objectivity of the audit conclusions as well as
- systematic proceeding which ensures reproducible conclusions. Audits are based on a convention of random sampling. Thus, the audit findings are verifiable.

The ICS audit will target several types of groups with different views or objectives:

- organisation, which wants to use their ICS for external reporting (e.g. communication to creditor),
- organisation, which established and implemented their ICS without external consultation and
- organisation, which wants to verify their ICS from an external view (cf. ISO 2002).

The recommended time for carrying out an ICS audit is approximately one month after the ICS completion. The duration of the audit depends on the size, complexity and number of locations of the organisation to be audited (auditee). In general on-site audit should last approximately one day but the duration increases with the number of locations.

3.1 ICS auditor

According to ISO 19011 confidence in and reliance on the audit process depends on the competence of those conducting the audit. This competence is based on the demonstration of the personal attributes and ability to apply the knowledge and skills for ICS auditing gained through education, training and work experience.

ICS auditors should possess such personal attributes to enable them to act in accordance with the principles of auditing (cf. previous chapter).

ICS auditors should have knowledge and skills in the following areas:

- Audit principles, procedures and techniques: to enable the auditor to apply those appropriate to different audits and ensure that audits are conducted in a consistent and systematic manner.
- European ICS guideline: to enable the auditor to comprehend the scope of the audit and apply audit criteria.

ICS auditors should have the following education, work experience, training and audit experience:

- They should have completed an education sufficient to acquire the knowledge and skills described above.
- They should have work experience that contributes to the development of the knowledge and skills.
- Part of the work experience should be in a position where the activities undertaken contribute to the development of knowledge and skills in general management and/or financial management.
- They should have completed auditor training that contributes to the development of the knowledge and skills described above.
- They should have conducted several ICS implementations as ICS trainers.
Auditors should maintain and demonstrate their auditing ability through regular participation in ICS audits (cf. ISO 2002). The Fraunhofer Technology Academy offers ICS audits and training courses for ICS trainers and ICS auditors in cooperation with Fraunhofer IPK.

3.2 ICS auditing process

A number of basic activities are common among most audits such as auditing quality management systems. Several activities are undertaken before the on-site audit, some during the on-site audit, and others after the fieldwork has been completed.

An overview of the audit process illustrates figure 1. It specifies the respective audit procedures which can be divided into five phases.

The ICS auditing process begins with one initial point and end with two possible outcomes, depending on the audit result. The individual phases will be introduced separately in the following.

3.2.1 Phase 1 – audit application

The ICS auditing process starts with an audit application. The organisation completes an application form and submits it to the auditor. Subsequently, the ICS and other documents are required by the auditor for the document check.

3.2.2 Phase 2 – document check

Prior to the on-site audit, the ICS and other documents of the auditee are checked to determine the conformity of the ICS with the audit criteria. The document check may include documents such as:

- accompanying documentation during the ICS implementation (e.g. documentation in the ICS Toolbox),
- previous ICS,
- previous audit reports and
- financial reports.
Furthermore, the auditor has to verify that the ICS is suitably appropriate. The proper usage of terms and concepts as well as the coherence within the ICS are important aspects in the document check.

An audit application can also be rejected if the document check identifies too many discrepancies in the ICS or is found to be inadequate. Reasons for rejection can be: definitions of IC factors were not clearly understood by the organisation or basic issues in the implementation procedure could not be adjusted by a corrective action. In this situation, the application cannot be approved and a report of the document check will be distributed.

3.2.3 Phase 3 – preparation for on-site audit

A sound planning and preparation is fundamental for an audit which gives the auditee the highest benefit. Once the auditor has gained a thorough understanding of the auditee and its documents, the on-site audit need to be prepared.

Preparing the audit plan

Soon after the audit date has been fixed, the auditor determines a representative cross-section of employees to be interviewed and document this information together with the audit content and the organisational matters (duration, location etc.) in an audit plan. The audit plan will inform the auditee about the audit execution and will help to ensure that the appropriate people are available on the audit day.
Preparing work documents
Based on the result of the document check, the auditor identifies the priority topics for the audit. Thus, the auditor prepares work documents as necessary for reference and for recording audit proceedings. Work documents may include:

- checklists,
- scoring matrixes, and
- forms for recording information such as supporting evidence, audit findings and records of meetings.

3.2.4 Phase 4 – on-site audit
The on-site audit itself consists of an opening meeting, the interviews, assessment time for the auditor and a closing meeting. At the end of the audit, the auditee will receive the audit conclusion including positive findings, recommendations and agreed corrective actions if necessary.

Conducting the opening meeting
An opening meeting is held with the auditee's executives with the main function

- to confirm the audit plan,
- to give a brief introduction of how the audit will be undertaken and
- to provide an opportunity for the auditee to ask questions (cf. ISO 2002).

Collecting and verifying information
The auditor collects information relevant for ensuring ICS’ credibility by appropriate sampling and records it. Both the content of the ICS and the ICS implementation process are subject of the audit. Audit evidences are only information that is provable, such as records, statements of fact confirmed by many people. Audit conclusions shall only the reached based on the audit evidences. Since the audit evidences are based on samples, there is always a factor of uncertainty in auditing. The means by which the auditor collects data fall into three broad categories:

- interviewing,
- observation of activities and
- review of documents (cf. ISO 2002).

The Quality-Quantity-Systematic Management (QQS) assessment is an evaluation of IC factors carried out during the ICS implementation by questioning a project team. The evaluation is conducted regarding the dimensions quantity, quality, and systematic. The QQS results show the status quo of each IC factor in respect to strengths and weaknesses and are visualized in the ICS (cf. figure 2).

![QQS-Bar-Chart of one IC Factor within the IC Categorie 'Human Capital']

**Figure 2:** QQS result of the example IC factor “professional competence”
The purpose of the QQS cross-check during the audit is to find out whether the QQS results in the ICS are representative for the company. The auditor has to ensure that the sample of people who will be interviewed for the QQS cross-check is representative for the company. The interview procedure is similar to the one at the QQS assessment workshop within the ICS implementation (cf. Figure 3). By getting the reasons for the
interviewees’ rating results, the auditor can assess whether the employees agree with the QQS result in the ICS.

Figure 3: Screenshot of the QQS cross-check interface
The auditor evaluates the audit evidence against the audit criteria and decides on either conformity or nonconformity with audit criteria. After the collection of information, the auditor devotes a few hours at the end of the audit to evaluate and finalize these audit findings. The auditor confirms that there is sufficient data to support all findings, identifies trends in findings that may be more significant than the individual deficiencies, and summarizes each finding in a way that most clearly conveys its significance.

Conducting the closing meeting
At the closing meeting the auditor presents and communicates the audit findings and conclusions in a comprehensive and accessible manner for the auditee. Corrective actions, if appropriate, have to be agreed upon by the organisation and follow-up actions have to be arranged. Furthermore, auditor’s recommendations and positive statements are pointed out at the closing meeting.

3.2.5 Phase 5 – audit wrap-up
Preparing and distributing the audit report
At the conclusion of the ICS audit, the findings are to be documented in an audit report. Its purpose is to identify areas or sections which do not conform to the European ICS guideline. In addition, the auditor has to confirm the veracity of the statement and the plausibility of the content.

The audit report should include the following:
- Initial point and audit environment
- Assessment of the ICS
  - Business Model
  - Status quo of Intellectual Capital
  - Development of Intellectual Capital
- Results of the appraisal
Further proceedings / arrangements
- Corrective action
- Potentials for improvements / recommendations
- Positive statements

Conclusion

After the ICS audit report has been prepared and approved, it will be distributed to appropriate parties of the organisation, such as the top management, for follow-up action if necessary.

Conducting audit follow-up
Subsequent to the audit itself, a follow-up audit with corrective actions must occur if the audit report indicates the need. Priority is given to those findings that the auditor felt was fundamental and these items are the first to be addressed and resolved by the auditee within an agreed timeframe. The auditee should keep the auditor informed of the status of these corrective actions. A final step in the overall audit process is the verification of completion and effectiveness of corrective action.

Awarding / denying audit certificate
Depending on the results of the audit report and, if required, the verification of corrective actions, an audit certificate will be awarded. If the auditor raises no objections, he/she will grant a certificate, which the organisation may use as a testament that its ICS is authentic and reliable. On the other hand, if the auditor finds, for example, open issues or items in his/her assessment, that could not be eliminated by corrective actions or could not be approved, he/she may deny the certificate, subject to a detailed explanatory report.

3.3 ICS audit criteria
The audit criteria provide the means, on which the auditor generates the audit findings. The fundamental of the ICS audit is the ICS guideline regarding the basic structure and elements of an ICS as well as the ICS implementation process. Audit criteria for ICS auditing are: completeness, plausibility, verifiability, representativeness and sustainability. Table 2 presents the three assessment phases and the audit criteria to be examined in each phase.

<table>
<thead>
<tr>
<th>Phase Title</th>
<th>Basis of the Audit</th>
<th>Audit Object</th>
<th>Audit Criteria</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Document Check</td>
<td>ICS guideline, Requirements regarding: ICS implementation process structure, basis IC factors and basic indicators for external reporting</td>
<td>Main material ICS: structure, IC factors, IC indicators Application document: ICS implementation process</td>
<td>correct ICS implementation process, so the result would be of high quality completeness of the ICS content plausibility of the ICS content</td>
<td>decision about denying or continuing the audit issues to be addressed at the on-site audit In case of nonconformity: corrective actions</td>
</tr>
<tr>
<td>QoS Cross-Check</td>
<td>ICS: QQS assessment results</td>
<td>ICS Answers of the interviewee Evidence shown at the audit</td>
<td>representativeness of the QQS result for the company</td>
<td>issues to be addressed at the on-site audit In case of nonconformity: corrective actions</td>
</tr>
<tr>
<td>On-Site Audit</td>
<td>ICS guideline, Requirements regarding: ICS implementation process ICS for external reporting</td>
<td>ICS Answers of the interviewee Evidence shown at the audit</td>
<td>completeness of the ICS content plausibility of the ICS content verifiability of the ICS content sustainability of the ICS</td>
<td>decision about providing audit certificate or record of denial In case of nonconformity: corrective actions</td>
</tr>
</tbody>
</table>
The audit scheme serves as a general guide and helps the auditor to track and assess the audit objects regarding the audit criteria. The generated results are used again as a basis for the assessment in the next phase. To track and assess the findings in the document check and on-site audit, the auditor uses a scoring matrix, as illustrated below. Based on the criterion complete, plausible and evidential the auditor reviews the ICS and implementation procedure. He verifies the conformity against the ICS requirements and marks them afterwards. In addition, necessary corrective actions can be targeted and formulated in the matrix.

Table 3: Scoring matrix

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Finding*</th>
<th>Score</th>
<th>Corrective action</th>
</tr>
</thead>
<tbody>
<tr>
<td>complete</td>
<td>yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>plausible</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Evidential</td>
<td></td>
<td></td>
</tr>
<tr>
<td>comprehensive evidence</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>some evidence</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>no evidence</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>or anecdotal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>no</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Legend

<table>
<thead>
<tr>
<th>Score</th>
<th>Explanation</th>
<th>Score</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>😳</td>
<td>Conformity with the requirement</td>
<td>😢</td>
<td>Partial conformity with the requirement</td>
</tr>
<tr>
<td>😥</td>
<td>Nonconformity with the requirement</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Finding * Please ✓ the appropriate finding

After the QQS cross-check is conducted by the organisation, the auditor analyses the results with the QQS cross-check scoring matrix. Table 4 is used in the third phase to check whether the ICS is representative for the organisation and whether the ICS content is communicated.

Table 4: QQS cross-check scoring matrix

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Finding*</th>
<th>Score</th>
<th>Corrective action</th>
</tr>
</thead>
<tbody>
<tr>
<td>representative</td>
<td>yes</td>
<td>😳</td>
<td></td>
</tr>
<tr>
<td></td>
<td>no</td>
<td>😥</td>
<td></td>
</tr>
</tbody>
</table>

Legend

<table>
<thead>
<tr>
<th>Score</th>
<th>Explanation</th>
<th>Score</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>😳</td>
<td>Conformity with the requirement</td>
<td>😢</td>
<td>Partial conformity with the requirement</td>
</tr>
<tr>
<td>😥</td>
<td>Nonconformity with the requirement</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Finding * Please ✓ the appropriate finding

Like the scoring matrix for the document check and on-site audit, the auditor indicates his opinion of the cross-check results and suggests potential corrective actions. The sustainability matrix is an additional tool to be used at on-site audit. It verifies the sustainability of the communicated ICS content and stated actions for improvement. However, compared to the ICS content the measures of current or previous ICS actions give no statement about the quality of the ICS. The measures exhibit only the current or previous status of actions and provide information for the organisation. An example for a sustainability matrix illustrates the table 5.
<table>
<thead>
<tr>
<th>Table 5: Sustainability matrix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criterion</td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>Content of the ICS</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>sustainable</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

The auditor has to use different tools, like the above-mentioned matrix, to generate and afterwards assess these findings in an appropriate and provable manner.

4. Discussion

The main purpose of the method “ICS auditing” is to ensure the quality of ICS. Besides this objective, the method may cause several potentially negative and positive impacts. These will be discussed in this chapter, starting with the some potential negative impacts.

Employees could be offended by an audit as an additional examination of their work

It is important to address this concern by ensuring a good qualification of ICS auditors. An audit should be a constructive discussion about intellectual capital, strength and areas of improvement of the organisation. The employees must not have the feeling of being examined. The ICS audit will give the company the information, whether their ICS is representative and of high quality. In case non-conformities have been detected, the company has the opportunity to update the ICS according to the agreed corrective actions.

QQS assessment workshop and QQS cross-check, do companies have to the same thing twice?

The answer is a clear “no”. The purpose of QQS assessment workshop is to assess IC factors and discuss the strengths and weaknesses in the project team. Based on this information, among others, measures can be developed. Fewer people – just the ICS project team – are involved. The purpose of QQS cross-check is to get a representative assessment result for re-checking whether the QQS result in the ICS is correct. For the QQS cross-check, a lot more employees are involved. Because ICS communicates information about strategic objectives and IC factors beforehand, the duration needed for the QQS cross-check is minimized.

Apart from these impacts, possible positive impacts which can arise are:

- Result of an employee attitude survey, identification of an internal opinion
- Every employee can issue his own assessment and advance a statement
- Enhancement of motivation, because employee’s opinion has an impact on the organisation
- Comprehensive interview increase higher identity with the ICS content
- Greater motivation in the implementation of the measures, because all employees contributed to the development of measures
- Communication of the ICS results is guaranteed
- Possible better credit rating by financial institutions
- Useful advice of strengths and opportunities by external experts
- External audit increase significance of the ICS
- Assurance, that relevant evidence are kept accessible
- Assurance, that important decisions are based on reliable sources
- Potentially detailed analysis possible through QQS check (e.g. sectoral evaluation and reporting)
- Consequent link between objectives, strategy and measures
ICS audit assures a high quality of proven and certified IC statements, so that the methodology of the intellectual capital is taken seriously by the financial market.

Financial institutions receive additional information of the organisation through the audit certificate.

5. Conclusion

The ICS audit methodology offers an approach based on basic principles of ISO 9001 certification (cf. ISO 2000), financial audit and European Excellence Award approach, which are accepted and already commonly used. Stakeholder such as a creditor can be sure a certified ICS has been audited by a neutral third party regarding:

- completeness,
- plausibility,
- verifiability,
- representativeness and
- sustainability.

The next steps for the methodology are the discussion, refinement and realisation at some pilot SME sites within the InCaS project. The result of the ICS audits will additionally contribute valuable information for the improvement of ICS.

In Germany, experiences with the described method for ICS auditing have already been gained in cooperation with Fraunhofer Technology Academy. The Fraunhofer-Gesellschaft as a non-profit organisation provides ICS audits and will include the results of this research work into the further development.

References

EFQM (2007b) Guidelines for the Excellence Award Applicants
Knowledge and Life Cycle of an Organization

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Abstract: Knowledge is an essential imperative of the company growth and development. This imperative determines the economy of aims realized by the company. The majority of small and medium enterprises (SME) are not aware of that as they do not economize on knowledge efficiently. The authors of the report found out about that while conducting research work within the framework of the Community Initiative Programme EQUAL in Poland in 2004-2006. The research was carried out in the SMEs involved in the Programme “Supporting restructured companies and their employees”, the aim of which was choosing and preparing a company for restructuring. The authors recommend their own model of supporting restructured enterprises and their employees.

Keywords: knowledge, life cycle of the organization

1. Introduction

Knowledge in a general sense is a system of categories, conceptual dimensions, operations, principles and procedures representing various conditions and world processes in a human brain: environmental, technical, social and cultural (Kuc 2006). However, in a narrower approach “knowledge constitutes system of cognitive units, conceptual categories and mental procedures which simultaneously play two major functions: orientational and pragmatic” (Nosal 2002). Knowledge is a tool which allows a human being to use gathered information efficiently (Grudzewski 2004). Together with skills, experiences, character, attitude and behavior, it is a constituent part of competence. A competent entrepreneur is the one who can use his knowledge and skills in practice. The following components of competence are also conducive to that: personal predispositions characteristic of particular actions, general (life) and specific (vocational) experience, attitude towards work and colleagues resulting from individual motivation and organizational aims, and also other behavior determined by cultural values and norms (Kuc 2006).

Entrepreneur’s activities take various forms depending on external and internal conditions affecting the company. Moreover, organization may be in different stages of development. Thus, the entrepreneur’s knowledge should be consistent with the life stage of a given organization.

2. Organization’s life cycle

There are four stages of an organization’s life cycle: introduction, growth, maturity and decline which are described in the following way. Introduction stage – high rate of expenditures connected with entering the market and product development; expenditures usually exceed inflows; growth stage – dynamic sales growth which requires searching for external sources of financing in spite of the company’s profitability; maturity stage – sales growth is being stabilized (growth rate slows down), withdrawal from external financing sources as a consequence of generating bigger and bigger profits, problem with using cash surplus effectively in the company internal development, reorientation towards external development by investing in stocks and bonds of other companies, possibility of taking control over other companies; decline stage - sales and profitability decrease. The company now has a problem of how to reinvest cash surplus in its internal development. Similarly to the maturity stage, stocks and bonds of other companies are purchased. Apart from that, the company invests in new products. It often withdraws from the market, at the same time entering new future activities. It disposes of assets which decrease productivity.

From the research carried out by the authors, it can be concluded that the owners of micro and small enterprises hold knowledge of organizing management at the first stage of the organization’s life. At this stage the enthusiasm is accompanied by high level of optimism connected with sales dynamics, and current barriers of business activity do not seem so strong to control emotions accompanying the enterprise development at all costs. Those entrepreneurs whose undertakings are in the development stage declare also increase in employment more willingly than they do in any subsequent stages.

The companies subject to the research were founded in the transformation period of the Polish economy, that is, at the beginning of the nineties. Nevertheless, they stuck in the first stage of the cycle. Their owners are the biggest threat for their existence. They think the enterprises exist and will still exist as their own
experience treated as capital – risk insurance – will help them. A great number of them understand the necessity for education and developing their managerial skills, but they do not believe that knowledge confronted with economic practice will allow success of their enterprises.

In fact, the market of micro and small enterprises in which they could be easily sold and bought does not exist in Poland. Thus, if the company is in a difficult situation, it can only liquidate its business. Costs of this solution often exceed the costs of starting the undertaking. Hence, owners of such enterprises decide to keep the company at any cost, even at the price of its functioning beyond the limits of law. In the authors’ opinion, solution to this problem can be education of entrepreneurs, the aim of which is mainly to make them aware that the knowledge they gained can be used not to run the business on their own but to entrust a competent manager with this task.

This is the best suggestion on how to run micro and small enterprises that can be offered at the present stage of the research. However, the following thesis can be formulated: if the entrepreneur’s activity is not coherent with the requirements of the development stage in which the company is at the moment, then eliminating it from the market is just a matter of time.

A success-oriented entrepreneur should adapt his activities to the stage of the company life cycle. Proper enterprising actions, understanding the rules of entrepreneurship and knowledge connected with it, will enable to adjust individual actions to the life cycle of an organization and to maximize the effects of these actions, thus allowing the entrepreneur to achieve success understood as efficient realization of the company’s aims. The present work shows experience of experts/counselors participating in the Project Supporting restructured companies and their employees realized within the Community Initiative EQUAL. Managers of companies were supported by the author’s model, the basis of which was equipping the entrepreneurs of micro, small, and medium companies with knowledge necessary for efficient action.

What struck attention during the first meeting of experts/counselors with the entrepreneurs taking part in the project, was their absolute commitment in company’s activity and often depression caused by the fact that their success did not bring expected results. Most of them have considerable experience in the sphere they act. They also possess a certain scope of theoretical knowledge which is not really useful because they cannot use it in practice. Moreover, they often claim that theory of organization and management is not coherent with managerial practice. They perceive the results of bad management as a cause, and they tend to blame the environment for the present state of action.

3. Model to support restructured enterprises and their staff

The experts’ aim is to equip the entrepreneurs with the competence that is substantial to identify and solve problems as well as to help them become professionals. That can be achieved, among other things, by drawing attention to determinants of professionalism localized in:

- entrepreneur’s personality represented by curiosity, willingness to develop skills and to improve quality and work efficiency;
- outer reality referring to the training system of managers and candidates for entrepreneurs, access to finance, etc.

As far as professionalism of entrepreneurs is concerned, opportunities and methods of improving their managerial skills are the most significant things. Entrepreneurs commonly believe that training focus mostly on theoretical knowledge. After completing such courses, they still have difficulty in solving problems. Apart from that, they do not gain knowledge and skills to diagnose and then to determine what actions must be taken to improve the situation. During the courses realized in the programme they do exercises within autodiagnosis of their own economic undertakings through EMPI method (Economic Matrix of Information Connections).

In the light of the above deficiencies, the following procedure has been developed to support the entrepreneurs and their workforce (Fig. 1).

Within the framework of the first stage, self-presentation is made during which the company owner(s) and experts/advisers sound out their willingness to cooperate. If this willingness appears, the entrepreneur is asked to describe current situation in the company.

During the talks the experts/advisers listen attentively to the contents of given information and try to spot the differences between the condition in which the company is at that moment and the condition that is desired
or expected by the entrepreneur. The final result of Stage One is a report identifying the problems. What is more, a list of subjects and range of appropriate training courses are suggested, both for the employees and the company owners. The trainings aim at improving current skills and also at acquiring new ones. The owner (or the person in charge) is encouraged to acquire skills that allow them to prepare the autodiagnosis of the company’s condition.

Trainings and workshops on setting budgets by the means of EMPI method are conducted at Stage Two. Due to participation in these activities, company owners learn to prepare autodiagnosis of managing the company’s assets and identifying the normative strategy to achieve the goals. The final result of this stage is the entrepreneur’s autodiagnosis.

At Stage Three (Reaction) the experts/advisers hold another meeting with the entrepreneur and the staff. Basing on the autodiagnosis, the company’s economic situation is analyzed and then possible solutions are presented. Also, problem-solving strategies are worked out. However, the way of restructuring and implementing particular solutions are to be chosen by the entrepreneur. At this stage, a training/workshop is conducted to diagnose their managerial predispositions and skills.

Stage Four is the time when the experts/advisers evaluate actions taken by the entrepreneur and submit a final report to the Project administrator.

**Figure 1:** Model to support restructured enterprises and their staff Source: own elaboration.

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4. Conclusion

On the basis of experience resulting from the contacts with numerous entrepreneurs participating in realizaton of the Project, it can be concluded that most of them cannot find themselves in dynamically changing environment in which new challenges and problems to be solved appear constantly. They make routine decisions. According to the authors, the reason for the situation is a competence gap which can be defined as difference between individual (managerial) and institutional (organizational) entrepreneurship. When both of those types of entrepreneurship are not coherent, then the conflict of the entrepreneur’s and the company’s interests appears. Entrepreneurs often do not possess knowledge which is required by the company because they do not make the diagnosis of their company systematically and, as a result, they do not know at which stage of life cycle the company is. This lack of knowledge often leads to the company’s failure.

References

Building a Taxonomy for Understanding Knowledge Management

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²International Institute for Applied Systems Analysis, Austria

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Abstract: As an interdisciplinary research field emerging recently, Knowledge Management (KM) has been given many different definitions. This paper introduces two studies we carried out to provide a holistic and better understanding of KM. By applying the methodology of domain analysis to investigate leading peer-reviewed journals regarding KM, the first study explores six fundamental issues regarding KM, which are: why is KM necessary; what enables the birth of KM and triggers actions on KM; what does KM deal with; how to implement KM; how to support KM by information technology; and where has KM been applied. By building an ontology structure of research topics within the community of the Graduate School of Knowledge Science at Japan Advanced Institute of Science and Technology (JAIST), the second study examines KM within a more general disciplinary called Knowledge Science, which gives a description of how KM is related to other research topics.

Keywords: knowledge management, domain analysis, ontology

1. Introduction

It is widely agreed that we are entering a knowledge economy and knowledge society, and the ability to manage knowledge has been proved to be the most critical thing for an organization to survive and maintain its competitive advantage (Shariq, 1997; Li & Zhao, 2006; Qi, et al., 2006). Subsequently, triggered or influenced by this, “knowledge management” (KM) was born as a new scientific discipline, followed by the invention of some new words or expressions, such as, chief knowledge officer (CKO), knowledge coordinator, knowledge creator, knowledge facilitator, etc. (Guns, 1997; Ellinger, et al., 1999).

Yet, “knowledge” and “knowledge management” include almost everything, and are difficult to understand, which is also shown in the results of a survey in the next section of this paper. KM seems to be a maze although a large number of publications and new established journals have been booming up in this field. For meta-level research on KM, first, Serenko and Bontis (2005) conducted a meta-review of KM by investigating three leading peer-reviewed journals in this area, namely, “Journal of intellectual capital”, “Journal of knowledge management” and “knowledge and process management”, in which research productivity and citation analysis were applied to rank researchers, institutions, countries and publications of KM at the world-wide level, for example, leading authors such as “Nonaka, I” and “Davenport, T.H.”, and foundational publications such as “The Knowledge Creating Company” and “Working Knowledge” were referenced regularly. Secondly, Sugiyama, Nagata, et al. (2002) in their book introduced and elaborated 64 most important keywords in the discipline of Knowledge Science, such as “knowledge creating company”, “SECI model”, “Ba”, “tacit knowledge”, etc. This book is a production by the faculty of a graduate university, and hereby can be considered as a local university-based understanding of KM. Thirdly, Satio (2007) summarized KM field in terms of four basic epistemological perspectives with each leading to different ways to understand knowledge and its management: information, human, computing and strategy.

The above previous studies pursued research productivity and citation analysis on KM literatures, a local understanding of KM, and what KM deals with respectively. Yet a more brief and holistic understanding of KM content at the world-wide level is missing, and the question about how KM relates to other research disciplines is not well answered. Concerning these two points, we carried out two studies on KM. The first study applies the methodology of domain analysis to investigate leading peer-reviewed journals regarding KM which include Journal of Knowledge Management, Journal of Knowledge-based System, and 12 special issues on KM from other Journals. In this study, we explore six fundamental issues regarding KM, which are: why is KM necessary; what enables the birth of KM and triggers actions on KM; what does KM deal with; how to implement KM; how to support KM by information technology; and where has KM been applied. The second study examines KM within a more general disciplinary called Knowledge Science, by building ontology structure of research topics within the community of JAIST Knowledge Science School. The result of this study gives a description of how KM is related to other research disciplines.
The remainder of this paper is organized as follows: Section 2 brings in a survey which indicates how people understand knowledge science and knowledge management differently; Section 3 introduces the methodology of domain analysis and then implements it to describe KM -- the first study; Section 4 introduces the methodology, process, and results of building ontology structure of research topics within the community of JAIST Knowledge Science School -- the second study; Section 5 summarizes this paper and gives concluding remarks.

2. Myths about understanding knowledge science and knowledge management

The catalyst to start this research can be traced back to a corresponding survey we conducted in 2006 at Graduate School of Knowledge Science, Japan Advanced Institute of Science and Technology. In 1998, Graduate School of Knowledge Science was established as the world’s first research and education institute on the theme of knowledge. However, after 8-year research and practices within this research discipline, students and faculties in the school found them still being asked frequently “what is Knowledge Science”, “what is knowledge management”, and most of them found it was difficult to answer them. Then, a survey was conducted to obtain a working definition of Knowledge Science (KS)-a KM-related concept. The researchers with positions higher than Post-doctors were invited to take part in the survey, and the distribution of the final 20 respondents is shown in Fig.1. Among these 20, some of the answers are listed below:

- KS is a study of creativity …
- KS is a systematic study of knowledge…
- KS is a study of human science…
- KS is a study of efficient method of knowledge transfer, knowledge utilization and knowledge creation…
- Others

![Distribution of 20 respondents](image)

**Figure 1:** Distribution of respondents

Given these 20 responses, the similarity and dissimilarity among them were measured subjectively and intuitively, which led to a classification of 10 groups shown in Fig. 2, and a key which interprets what each group in Fig. 2 stands for is specified in Table 1. The result told us that, among 20 respondents, 6 of them (A group) argued that KS is about creativity, knowledge creation and knowledge use; 5 of them (B group) argued that KS is about human science and social science; and for the rest, for instance, 1 of them (AC group) argued that KS is combination of A group and C group, that is, KS is about creativity, knowledge creation and knowledge technologies, etc., see below.
Kun Nie, Tieju Ma, and Yoshiteru Nakamori

Clustering of Arguments on Understanding Knowledge Science

![Clustered Arguments](image)

**Figure 2:** Clustering of arguments on understanding *knowledge science*

**Table 1:** The key to fig. 2

<table>
<thead>
<tr>
<th>Group ID</th>
<th>Contents</th>
<th>Number of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Creativity, knowledge creation, knowledge use</td>
<td>6</td>
</tr>
<tr>
<td>B</td>
<td>Human science, Social science</td>
<td>5</td>
</tr>
<tr>
<td>C</td>
<td>Knowledge technologies, knowledge systems</td>
<td>0</td>
</tr>
<tr>
<td>D</td>
<td>Knowledge process</td>
<td>2</td>
</tr>
<tr>
<td>E</td>
<td>Management of Information</td>
<td>1</td>
</tr>
<tr>
<td>F</td>
<td>Knowledge itself</td>
<td>2</td>
</tr>
<tr>
<td>G</td>
<td>Solve problems produced by knowledge society</td>
<td>1</td>
</tr>
<tr>
<td>AC</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>CD</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>ABCD</td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

In total: 20

From this survey it can be concluded that opinions about *knowledge science* are various and not identical, even within a small research group (in our case, Graduate School of Knowledge Science). *Knowledge management* and *knowledge science* are much closely connected, and we believe in that KM is suffering the same situation that different people are confused of KM and have many different understandings of KM and this also includes experts, particularly because KM is a new emerging research discipline. Therefore, it is required to research KM and reach a brief holistic understanding of KM to help those who are confused of KM. The approach put forward in the next section is for this purpose.

3. Applying domain analysis to describe KM

3.1 What is domain analysis?

Domain analysis is “the process of identifying, collecting, organizing, and representing the relevant information in a domain, based upon the study of existing systems and their development histories, knowledge captured from domain experts, underlying theory, and emerging technology within a domain” (Kang *et al.*, 1990). The idea of domain analysis was originally from software engineering, first
introduced by Neighbors in 1981, then Prieto-Diaz (1987) and Arango et al. (1989) proposed a more cohesive procedural SADT (Structured Analysis and Design Technique) model for performing domain analysis, later on, Bjorner (2006) developed a completely theory of domain engineering in his third of three textbooks on the engineering principles and techniques of software engineering.

It should be pointed out that domain analysis is different from systems analysis; systems analysis is concerned with the objects and operations in a specific system while domain analysis is concerned with objects and actions in a class of similar systems in a particular problem domain (Neighbors, 1981). In the triptych dogma of software engineering interpreted below (Bjorner, 2006), systems analysis can be associated to understanding requirements, while domain analysis can be associated to understanding domain.

- Before software can be designed, programmed, coded, its requirements must first be reasonably well understood.
- Before requirements can be expressed properly, the domain of the application must first be reasonably well understood.

In the tradition of the methodology of domain analysis, the basic thing is to understand entities, functions, events, behaviors, plus support technologies of a domain. A brief introduction and simple example about them are shown in Table 2.

**Table 2:** A brief introduction to entities, functions, events, behaviors, and support technologies

<table>
<thead>
<tr>
<th>Categories</th>
<th>Definition in Software Engineering</th>
<th>A Brief Incomplete Example of “Banking”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entities</td>
<td>Something fixed, immobile or static, if implemented inside computers, could typically be represented as data.</td>
<td>[demand/deposit, savings, mortgage]bank account; money; clients; bankbook, etc</td>
</tr>
<tr>
<td>Events</td>
<td>The occurrence of something that may either trigger an action, or is triggered by an action, or alter the course of a behavior, or a combination of these.</td>
<td>Losing a bankbook, etc</td>
</tr>
<tr>
<td>Functions</td>
<td>A mathematical quantity when apply to entities, either test for some property, or observe some subentity or actually change the entity value</td>
<td>[opening, closing, deposit, withdrawal, transfer, statements] operations on accounts, etc</td>
</tr>
<tr>
<td>Behaviors</td>
<td>A sequence of actions and events</td>
<td>A specific series of deposit and withdrawal events and actions, etc</td>
</tr>
<tr>
<td>Support technologies</td>
<td>Ways and means of implementing certain observed phenomena or concept</td>
<td>ATM machine; bankcard, etc</td>
</tr>
</tbody>
</table>

*Reorganized from material (Bjorner, 2006)

### 3.2 Design an approach based on domain analysis for describing KM

Treating KM as a conceptual domain, we implement domain analysis on it for getting a better understanding and overview on it. As the original SADT model [Prieto-Diaz, 1987] which is known as a procedural model of describing the process how to implement domain analysis, this paper takes it but additionally considers its some drawbacks to construct a new modified SADT model (see Figure3) in order to adjust to the new application of this study.

Following this new modified model to describe KM, as shown in Fig. 3, the main domain knowledge as input for implementing domain analysis is from scientific literatures, if practicable with financial constraints, question surveys and expert advices are additional inputs; then this study mainly concentrates on answering those five fundamental issues about KM through the iterative process of conducting domain analysis by domain experts and analysts, domain analysts here can be understood as a kind of knowledge coordinators (Nakamori, 2003; Ma, 2006) who is expected to be a person of all trades, he or she must understand systems analysis, the domain of application, the software technology at hand, and be able to communicate with the player among different disciplines; some drawbacks are taken into account and need to be fixed when questions like “Are these five categories sufficient to understand KM?” are probably being asked; a taxonomy of understanding KM is supposed to be produced as the final output of domain analysis.
Figure 3: A modified SADT diagram

With this diagram, our approach of implementing domain analysis on KM is composed of the following six phases.

- Phase 1. Selecting leading journals regarding KM
- Phase 2. Extracting keywords from publications in the leading journals
- Phase 3. Analyzing extracted keywords: statistics and visualization
- Phase 4. Assigning keywords to the five categories regarding KM
- Phase 5. Considering the drawbacks and fix them out
- Phase 6. Achieving the taxonomy to understanding KM

3.3 Work on describing KM

3.3.1 Input for domain analysis

Before performing domain analysis, domain knowledge is prerequisite. The problem is that how to access and obtain KM domain knowledge, the most direct way might be survey those researchers and practitioners of KM field, but it is a huge project and therefore almost impossible. Then this paper turns to the second strategy that we collect KM domain knowledge from top-ranked scientific literatures by KM experts, these scientific literature covers: (a) Journal of knowledge management; (b) Journal of knowledge-based system; (c) 12 special issues on KM from various top-ranked Journals. These sources are chosen based on two main reasons: First, there are other good KM journals, for instance, Knowledge and process management is one of noted KM journals, but the keywords information is not specified in those journals; secondly, it is believed that the contents among these sources and other journals largely overlap.

Information from the above scientific literature is rich but disordered, and usually the keywords in a paper specified by the authors can roughly express what this paper contains, so this study simplifies to use these keywords from the raw articles as source of domain knowledge. No doubt, sometimes the information provided by only keywords themselves is not sufficient, and it is highly intuitive to understand what it means by these keywords directly. So it is necessary to refer back often to the articles where these keywords appeared to get what is really meant by them.

Since not all keywords from data sources are essential to KM, the most important keywords ranked by their frequency are selected. As a result, 100 keywords from Journal of Knowledge Management, 50 keywords from Journal of Knowledge-Based system, and 50 keywords from special issues on KM (Table 3), that is, around 200 keywords are taken as domain knowledge, which is then used as input to the following domain analysis. Table 3 provides more details of those scientific literatures and number of extracted keywords from them.
Table 3: Input for domain analysis

<table>
<thead>
<tr>
<th>Data Resources</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Journal of Knowledge Management (Soft perspectives on KM)</td>
<td>From 1997 to 2006, 411 articles, 574 keywords in total. 100 most frequent keywords of all are selected as input to domain analysis</td>
</tr>
<tr>
<td>Journal of Knowledge-based System (Hard perspectives on KM)</td>
<td>From 1987 to 2006, 720 articles, 2033 keywords in total. 50 most frequent keywords of all are selected as input to domain analysis</td>
</tr>
<tr>
<td>Special issues on Knowledge management (Mixed perspectives on KM)</td>
<td>95 articles, 338 keywords in total from 12 special issues of a variety of Journals, such as Decisions Sciences, Decision Support Systems, Information Visualization, etc. 50 most frequent keywords of all are selected as input to domain analysis.</td>
</tr>
</tbody>
</table>

3.3.2 Basic data analysis

Taking Journal of Knowledge Management as an example, basic data analysis investigates frequency of keywords, relations between keywords, and visualization of keyword relations, etc. Table 4 tells us the most frequent keywords are knowledge management, innovation, intellectual capital, learning organizations, etc. Table 5 relates one keyword with another keyword in terms of their co-occurrence (that is, they appeared together in the keyword list of one or more articles specified by authors). Figure 4 visualizes the relations denoted in Table 6, which provides a more direct and easier way to understand data, and identifies hidden complex pattern behind the data and relationship. From Figure 4 it is easy to see that two isolated groups are formed, and the smaller one includes only two keywords: management and information; while in the bigger group, knowledge management lies in the center and acts as broker/bridge between many other pairs of keywords.

Table 4: The most frequent keywords from Journal of Knowledge Management

<table>
<thead>
<tr>
<th>Keywords</th>
<th>Frequency</th>
<th>Keywords</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>knowledge management</td>
<td>291</td>
<td>organizational learning</td>
<td>15</td>
</tr>
<tr>
<td>innovation</td>
<td>38</td>
<td>knowledge processes</td>
<td>14</td>
</tr>
<tr>
<td>intellectual capital</td>
<td>28</td>
<td>organizations</td>
<td>14</td>
</tr>
<tr>
<td>learning organizations</td>
<td>21</td>
<td>competitive advantage</td>
<td>14</td>
</tr>
<tr>
<td>information</td>
<td>18</td>
<td>knowledge creation</td>
<td>12</td>
</tr>
<tr>
<td>knowledge workers</td>
<td>18</td>
<td>information systems</td>
<td>11</td>
</tr>
<tr>
<td>learning</td>
<td>17</td>
<td>knowledge</td>
<td>11</td>
</tr>
<tr>
<td>tacit knowledge</td>
<td>17</td>
<td>networks</td>
<td>11</td>
</tr>
<tr>
<td>management</td>
<td>16</td>
<td>knowledge transfer</td>
<td>10</td>
</tr>
<tr>
<td>information technology</td>
<td>15</td>
<td>knowledge management systems</td>
<td>9</td>
</tr>
</tbody>
</table>

Table 5: Relations between keywords

<table>
<thead>
<tr>
<th>Keyword 1</th>
<th>Keyword 2</th>
<th>Number of Co-occurrences</th>
</tr>
</thead>
<tbody>
<tr>
<td>innovation</td>
<td>knowledge management</td>
<td>28</td>
</tr>
<tr>
<td>intellectual capital</td>
<td>knowledge management</td>
<td>17</td>
</tr>
<tr>
<td>knowledge management</td>
<td>knowledge processes</td>
<td>13</td>
</tr>
<tr>
<td>knowledge management</td>
<td>Organizations</td>
<td>13</td>
</tr>
<tr>
<td>information</td>
<td>Management</td>
<td>12</td>
</tr>
<tr>
<td>competitive advantage</td>
<td>knowledge management</td>
<td>11</td>
</tr>
<tr>
<td>knowledge management</td>
<td>learning organizations</td>
<td>11</td>
</tr>
<tr>
<td>information technology</td>
<td>knowledge management</td>
<td>11</td>
</tr>
<tr>
<td>knowledge management</td>
<td>organizational learning</td>
<td>10</td>
</tr>
<tr>
<td>knowledge management</td>
<td>tacit knowledge</td>
<td>10</td>
</tr>
<tr>
<td>information systems</td>
<td>knowledge management</td>
<td>9</td>
</tr>
<tr>
<td>explicit knowledge</td>
<td>tacit knowledge</td>
<td>8</td>
</tr>
</tbody>
</table>
3.3.3 Match Keywords and five categories

This part mainly dedicates to investigate entities, events, functions, behaviors, and support technology of KM domain. To fit these five categories to the context of KM, Table 6 explains them again in contrast to their original meanings in Table 2, where they are slightly different.

**Table 6: What Do These Five Categories Mean in KM**

<table>
<thead>
<tr>
<th>Categories</th>
<th>Corresponding issues in context of KM</th>
<th>Short Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entities</td>
<td>What does KM deal with?</td>
<td>Know-what</td>
</tr>
<tr>
<td>Events</td>
<td>What enables the birth of KM and triggers actions on entities of KM?</td>
<td>Know-where</td>
</tr>
<tr>
<td>Functions</td>
<td>Which actions/operations are performed on entities of KM?</td>
<td>Know-how</td>
</tr>
<tr>
<td>Behaviors</td>
<td>Which sequence of actions and events are performed on entities of KM?</td>
<td>Know-how</td>
</tr>
<tr>
<td>Support technologies</td>
<td>Which ways and means are used to support KM?</td>
<td>Know-how</td>
</tr>
</tbody>
</table>

So far, 200 most important keywords of KM field were prepared as input for domain analysis. We assume that these input as domain knowledge covers all the above five categories in KM, to proceed domain analysis, we need to match those 200 keywords with five categories carefully and correctly. In order to classify 200 keywords to the five categories, several discussions were held among the authors and other experts and researchers in KM discipline. Based on those conversations, the category of entities and functions is further divided into five detailed sub-categories, namely, general, strategy-oriented, information-oriented, human-oriented, and process-oriented; the category of events is further divided into two detailed subcategories, namely, external and internal, and the category of support technologies is further divided into...
two subcategories, namely, soft and hard. The result of classification of 200 keywords into five categories is reported below:

3.3.4 Fix drawbacks and two more categories

During the process of distributing keywords to the above five categories, there were some keywords that were difficult to assign. What is the reason for those unassigned keywords? A deep analysis showed that the unassigned keywords are not saying something related to those above five categories, but something else. This is considered as drawbacks of traditional domain analysis when it is applied to the new area of describing KM. Therefore, two more categories are added, one is objectives/targets, and the other is applications. Objectives/targets answers why to use KM, and applications answers where KM has been applied. See Table 8 and 9 below:

<table>
<thead>
<tr>
<th>Two more categories</th>
<th>Corresponding issues in context of KM</th>
<th>Short Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objectives/Targets</td>
<td>Why is KM necessary?</td>
<td>Know-why</td>
</tr>
<tr>
<td>Applications</td>
<td>Where has KM been applied?</td>
<td></td>
</tr>
</tbody>
</table>

Table 9: The keywords for the two more categories

<table>
<thead>
<tr>
<th>Categories</th>
<th>Sub-categories</th>
<th>The assigned keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objectives / Targets</td>
<td>(no sub-aspect)</td>
<td>Competitive advantage, performance, organizational performance, competences, organizational development</td>
</tr>
</tbody>
</table>
3.3.5 Taxonomy and understand KM

Based on the above analysis, the taxonomy to understanding KM can be easily obtained, see Figure 5, which help us to roughly conclude KM as following: Resulting from restructuring changes both outside and inside an organization, on the outside, such as, economic growth, globalization, knowledge society, on the inside, such as learning organization, culture change, and community of practice, KM has been established as to improve organizational competitive advantage, organizational competences, etc, it is dedicate to deal with strategy-oriented knowledge (organizational culture, corporate strategy, etc), information-oriented knowledge (information, explicit knowledge, etc), human-oriented knowledge (intellectual capital, intangible assets, etc) and process-oriented knowledge (knowledge process, etc), soft method such as knowledge workers, chief knowledge officers, etc, and hard technology such as information technology, information systems, KM systems, etc, has been developing to support KM, so far, KM has been applied to project management, product development and many other areas.

Figure 5: The taxonomy to understanding KM

4. Understanding KM in a more general discipline

The above study focused on KM itself. For a more holistic understanding of KM, it is necessary to examine KM in a wider or more general interdisciplinary to understand its relations with other disciplines or topics. With this purpose, we carried out a study to building ontology structure of research topics within the community of Graduate Knowledge Science School at Japan Advanced Institute of Science and Technology (JAIST KS School).

JAIST KS School specializes in this unique position in the world to have a variety of interdisciplinary or multidisciplinary research. With KM as one of the vast research topics in JAIST KS School, it provides a good chance to see how KM is related to other research topics. This study attempts to map the relationships among past research topics in JAIST KS School, and further construct an ontology structure of research topics for JAIST KS School. This study includes the following process:

- Collecting research topics information from papers/articles in KS school
- Measuring the similarity and mapping the relationships among these research topics
- Clustering the research topics into a certain number of groups
- Building an ontology structure for KS school

Two groups of data are collected; one is master thesis and doctoral dissertation by students in JAIST KS School with the purpose to know what has been done in the community of students, the other is papers/articles by faculty of JAIST KS School with the purpose to know what has been done in the community of KS school faculty. This case study only concentrates on the first group of data.
In the following, we will first introduce I-System methodology and its application in the context of our work in subsection 4.1; then in subsection 4.2 we will introduce an algorithm for building ontology structure, designed with the help of I-System methodology; subsection 4.3 provides the result of the study.

4.1 I-System methodology

Nakamori (2003) proposed I-System methodology which includes five sub-systems: Intervention, Intelligence, Involvement, Imagination and Integration. I-System methodology stresses that most uncertain complex problem couldn’t be solved only from scientific front; social front and cognitive front need to be considered as well. That is, we have to integrate scientific, social and cognitive dimensions in order to arrive at a good solution for an uncertain problem. Figure 6 puts I-System in the context of our work and explains it in more depth.

**Figure 6: I-System methodology**

In our work, I-System is used to assist thinking and working on how to build ontology structure of research topics.

- Subsystem of Intervention: “Intervention” is the first subsystem in which the faced problem has to be shaped or clarified clearly. To us, the problem needed to be solved is “what has been done in the community of JAIST students”. Once has a problem, this subsystem request the following three subsystems to concentrate on it from scientific front, cognitive front and social front respectively.
- Subsystem of Intelligence: “Intelligence” is bottom-up approach to analyze research topics. In our work, two important techniques, namely, network analysis and clustering analysis are applied.
- Subsystem of Imagination: “Imagination” is experience-based or top-down approach to analyze research topics.
- Subsystem of Involvement: “Involvement” is from social front, we believe that both scientific method and cognitive method do have their advantages and disadvantages, and a conflict between them often happens. And this subsystem attempts to build a bridge between scientific and cognitive front.
- Subsystem of Integration: “Integration” is final subsystem. The tasks of this subsystem is to integrate results from the above four subsystems, and submit the final report.
4.2 Algorithm for ontology construction

Here we explain how to build the ontology structure based on the I-system methodology that we mentioned above. Our procedure that combines stages of expert-supervised and automatic construction is articulated below:

**Step 1:** Start by selecting an ontological category that needs to be divided. This category can be determined either by expert or automatic construction.

**Step 2:** In the expert-supervised stage, the experts specifies several examples objects for the ontological category given in step 1.

**Step 3:** In the automatic construction stage, all objects that are similar to those example objects are clustered to the same ontological category automatically.

**Step 4:** The resulting division in step 3 may again be submitted for the approval of the experts, if the experts disapprove, go back to step 2.

**Step 5:** Steps 1-4 forms one iteration. The entire procedure is repeated for as long as there are no more categories that need to be divided, or until another stopping condition.

**Step 6:** The final version of ontology is achieved and submitted to experts for evaluation of looking for incompleteness, inconsistence, and redundancy. Future maintenance and refinement are allowed.

In automatic construction stage, two important techniques, network analysis and clustering method, are specifically used. Network analysis allows measuring the degree centrality of a research topic which is defined as the number of other research topics directly connected to it (Hanneman, 2005; Wasserman, 1999). Because degree centrality can speak the power of a research topic in the network, that is, the higher degree centrality is, the more powerful a research topic has. By this reason, we also found that research topics with higher degree centrality are always top-level concepts, like knowledge management, knowledge creation, system, and vice versa, see Table 10. So network analysis assists assigning research topics into different layers of ontological category.

**Table 10:** Top keywords ranked by degree centrality

<table>
<thead>
<tr>
<th>Keyword</th>
<th>Degree Centrality</th>
</tr>
</thead>
<tbody>
<tr>
<td>knowledge creation</td>
<td>17</td>
</tr>
<tr>
<td>knowledge management</td>
<td>16</td>
</tr>
<tr>
<td>system</td>
<td>16</td>
</tr>
<tr>
<td>leadership</td>
<td>15</td>
</tr>
<tr>
<td>simulation</td>
<td>13</td>
</tr>
<tr>
<td>innovation</td>
<td>11</td>
</tr>
<tr>
<td>data mining</td>
<td>10</td>
</tr>
<tr>
<td>community</td>
<td>10</td>
</tr>
<tr>
<td>groupware</td>
<td>9</td>
</tr>
</tbody>
</table>

Our clustering method is based on network similarity which can be understood as the same pattern of connectivity in the network (Hanneman, et al. 2005; Wasserman et al. 1999). That is, two research topics are similar if they are connected to the same other research topics. As an example, two research topics, brainstorming and brain writing, both of them are connected to research topics divergent thinking and groupware, they are considered having high similarity and thus they are clustered together into the same ontological category even they don’t have a direct connection between them. Therefore, to measure similarity of two research topics, first, co-occurrence matrix is calculated and obtained from data, each value in the matrix represents the frequency of a pair of research topics, that is, the total number of the two research topics appearing together in all papers; secondly, classical similarity measuring algorithm, in our work, Euclidean distances-based algorithm is performed on co-occurrence matrix which is then converted to similarity matrix. See Formula 1 and Formula 2, in Formula 1, R(ki, kj) is computed from co-occurrence matrix by considering a fact that the values in co-occurrence matrix are dependent on the frequencies of their two connected research topics and thus are not comparable with each other; in Formula 2, S(ki, kj) is computed again from R(ki, kj); finally, classical cluster analytical method is performed on similarity matrix to group those research topics that are most similar first, then similarity matrix is then re-calculated, and the next most similar pair are then joined, this process continues until all research topics are joined together and hierarchical dendrogram including all research topics is produced, Our work uses single-link, or nearest
neighbor method (Manning et al., 1999), in which in each step the two clusters whose two closest members have the smallest distance, or the two clusters with the smallest minimum pairwise distance are merged.

\[ \text{# relation between keyword } i \text{ and keyword } j, R(k_i, k_j) \]
\[ = \frac{\text{# joint frequency of keyword } i \text{ and keyword } j}{(\text{# frequency of keyword } i) \times (\text{# frequency of keyword } j)} \]
\[ = \frac{\text{frequency}(k_i, k_j)}{\text{frequency}(k_i) \times \text{frequency}(k_j)} \]  

\[ \text{# similarity between keyword } i \text{ and keyword } j, S(k_i, k_j) \]
\[ = \frac{1}{\text{Euclidean distance between keyword } i \text{ and keyword } j} \]
\[ = \frac{1}{\sum_{s=1}^{n} [R(k_i, k_s) - R(k_j, k_s)]^2} \]  

4.3 Results and discussions

Research topics are considered as building blocks and are collected from master theses and doctoral dissertations of JAIST KS School. In total, 415 papers are collected and the top 200 research topics are selected depending on their frequency in the total number of papers. Then these 200 research topics are used as resources to build domain ontology of knowledge science.

With these 200 research topics and the procedure discussed in the above section, it is able to construct the ontology structure of research topics for JAIST KS School. A part result is given below:

![Ontology structure for research topics at JAIST KS school](image)

**Figure 7: Ontology structure for research topics at JAIST KS school**

The result of this study (Fig. 7) showed that within the boundary of knowledge science discipline, “knowledge management” is closely connected to essential concepts like “system science”, “computer science”, “knowledge creation”, “knowledge itself”, and “information support systems”. The constituent elements of each category and each sub-category can also be seen, for example, the research topics under category of
“knowledge management” include “SECI model”, “management of information”, “human resource management”, etc.

5. Concluding remarks

As a new emerging research field, “Knowledge management” has received a lot of focus, and its importance has been emphasized in both industry and academia. Nevertheless, literature analysis and our survey indicated the presence of much confusion of understanding it, different people means different things when they use this term.

A better and holistic understanding of “knowledge management” promises to help people share and transfer knowledge within this domain, and thus speed up development of this research area. For this reason, two significant things need to be figured out, one is an intensive clarification rather than giving a simple definition of “knowledge management”, the other is to see how this new research area is related to other current existing research topics. In our work, two studies have been carried out to achieve to these purposes. The first study investigates leading peer-reviewed journals regarding KM by applying domain analysis methodology to provide a taxonomy for understanding six essential issues about KM, that is, why to use KM, what enables and triggers KM, what to deal with in KM, how to implement KM, how to support KM by technologies, and where has KM been applied. The second study examined KM in a more general research discipline by constructing an ontology structure of research topics for JAIST KS School.

We have organized some seminars to introduce and explain our methods and results to researchers and practitioners of KM fields, they agreed that our research really help in providing a big picture of what KM is, and reduce the people’s confusion about this new area. However, we still believe in that further future evaluation and refinement of this research is of necessity. Particularly we are now constructing an ontology-based semantic search engine that incorporate the results from this research, the users can use semantic search engine in parallel with our constructed ontology to access KM relevant documents. This system allows users to send comments about both search engine and ontology as well, which then can be used as very important information for future improvement of this research.

Acknowledgements

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Knowledge Management: Turning Intangible Assets into Feasibility in the Automotive Sector

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Abstract: Knowledge Management has become the most strategic resource in the new business environment. This research is based on the analysis of the strategic knowledge held within a multinational group; a leader in the design and production of a great variety of components for the automotive industry. It focuses on achieving feasibility and real applications by identifying knowledge gaps that must be overcome to perform certain activities, so as to take the right decision on its acquisition in terms of what to acquire, how to acquire it, and the associated time and costs. We use a recently developed artificial neural architecture called Cooperative Maximum-Likelihood Hebbian Learning, a tool to develop part of an Integral Global Model of Business Management, which has the potential to bring about a global improvement in the firm by adding value, flexibility and competitiveness. From this perspective, the model used in the study generalizes the hypothesis of organizational survival and competitiveness, so that the organization is able to identify, strengthen, and use key knowledge to reach pole position. Our conclusions suggest that it is possible to specify the knowledge that is held but is underused in the departments, taking into account their current levels of knowledge, their relevance and the urgency to acquire new knowledge. Moreover, an analysis of the required evolution rate of the present knowledge may be included which, among other aspects helps detect new knowledge, eliminate obsolete knowledge and validate new needs.

Keywords: Knowledge Management, Intangible Assets, Metaheuristic Algorithms.

1. Introduction

Knowledge has become the most strategic resource in the new business environment (Viedma, 1992; Grant, 1996; Davenport and Prusak, 1998; Zack, 1999; Ordóñez, 2002; David and Foray, 2002; Sáiz and Manzanoed, 2002; Sáiz, Peña and Lara, 2003; Ordóñez and Peteraf, 2004; Viedma, 2005; Bueno, 2005; Carrillo, 2006; Arboníes, 2006). We specifically centre our attention on the study of knowledge management from a pragmatic approach that believes knowledge can be better understood through its classification and organisation (Polanyi, 1958; Myers, 1996; Corchado, Fyfe, Sáiz and Lara, 2004). This approach is based on an understanding of different states of knowledge and their transformation from an initial low starting point - data and information- to other higher points, such as the knowledge itself, its management, and individual, and even organisational responsibilities (Viedma, 2000; Muñoz-Seca and Riverola, 2003; Collison and Parcell, 2003; Lara, Sáiz and Peña, 2003).

In this paper, we use a recently developed artificial neural architecture in order to categorize the needs for the Acquisition, Transfer and Upgrading of Knowledge held by the different departments of an automotive company. It is an extension of a Negative Feedback Network characterised by the use of lateral connections on the output layer and the use of a family of learning rules in the form of lateral connections that are derived from the Rectified Gaussian distribution. The results in this study are drawn from the analysis of a multinational group, leader in the design and production of a great variety of components for the automotive industry. The multinational is undergoing organizational change and faces high levels of growth and expansion, which requires rapid adaptation to the demands of the sector, greater resources, imminent transfers and accurate forecasting of knowledge, coupled with pressing demands to capitalize, share and use them within the group.

The design of the preliminary theoretical model of Knowledge Management is based on three components: the Organization -Strategy and People-, Processes -Acquisition, Transfer and Upgrading of Knowledge- and Technology (Lara, Sáiz and Peña, 2002). The population sample used came from 277 registry entries (individuals) that correspond to the "needs for knowledge" presented by the senior managers of the company departments participating in the study. The knowledge that was gathered involves different stages (knowledge levels) that depicted the actual situation of each department with respect to their assigned tasks or activities that had to be successfully accomplished. It was also possible to obtain valuable data on the degree of importance for the company of the gathered knowledge.
It is possible then to identify the knowledge gap that needs to be overcome to perform the activity, so as to make the right decision on its acquisition in terms of how it shall be acquired, the time needed and to acquire it. In the same way, it is possible to specify the knowledge that is held but is underused, either because the person who holds it does not use it to the full or because it also has a value and potential use for other departments. Moreover, an analysis of the required evolution of actual knowledge levels may be included to detect new knowledge, eliminate obsolete knowledge and validate new needs.

2. Theoretical model

In this study, knowledge management is understood as a system that integrates its specific functions and processes to create/acquire, transfer/distribute and put into practice/update the ideas and knowledge of a firm’s personnel. By doing so, knowledge management, allows people to achieve greater levels of creativity, ensures permanent training and recycling in their specialist areas, and helps them to share and pass on the benefits of their knowledge to other workers who also integrate their colleagues’ knowledge into their own work. With this grounding, our new knowledge management model used in this study, shown in figure 1, divides the firm up into three areas, according to the different situations that can arise in the field of strategic knowledge: a knowledge deficit, a partial knowledge deficit and no knowledge deficit. The processes under consideration are creation/acquisition of knowledge, transference/distribution and putting into practice/upgrading knowledge.

Figure 1: The preliminary theoretical Knowledge Management model proposed in this study (Manzanedo, Sáiz, Peña and Lara, 2002)

This approach was chosen to develop the functions and processes sequentially according to the overall circumstances of the firm or its individual parts. Thus, the complete circuit begins with the creation/acquisition of knowledge, which leads to its distribution and transference and is concluded with its upgrading or putting into practice. In order to apply the model satisfactorily, the knowledge states need to be considered (Polanyi, 1958) along with their possible conversion processes (Nonaka and Takeuchi, 1995) -
explicit and tacit- and the agents responsible for creating them: individuals, groups, firm, and environment (Nonaka, 1994; Nonaka and Takeuchi, 1995; Ruggles, 1997).

This new model represents three possible knowledge situations: deficit, partial deficit, and no deficit, which might require one or more of the processes: Creation/Acquisition, Transference/Distribution, and Putting into practice/Upgrading -that will give rise to different proposals. In areas with a knowledge deficit, the objective is to acquire or create the necessary knowledge, prior to which the shortcomings need to be detected and identified, as well as the level or specificity of knowledge that is required. Here, it is equally a question of analyzing the way of acquiring the knowledge and estimating the degree of urgency so that it comes on line when necessary.

A partial knowledge deficit in an area indicates that knowledge is only available to experts, and has neither been made explicit nor widely communicated within the organization. The firm holds critical knowledge, but it is not accessible to everybody who needs it. Under this situation and on a case-by-case basis, the knowledge needs to be communicated and shared; a process by which experts and potential usages are identified, involving a search for the means to express it and to make it available. Finally, the areas with no knowledge deficits represent areas where the people and the firm have mastered the required know-how and it is available to those who need it. Through the process of Putting into practice/Upgrading the knowledge, the knowledge is used to the full and is kept updated through the elimination of obsolete knowledge and the detection of other types as new realities are brought to bear. The system provides its own feedback, as this latter process is, necessarily, linked to that of Creation/Acquisition, to obtain this new knowledge, which, in turn, will subsequently lead to Transference/Distribution, before the process is activated once again in due course. Contributions made by authors such as Wiig (1993), Hedlund (1994), Marquardt (1996), Beckman (1997), Ruggles (1997), and Holsapple and Joshi (1998), were given preferential attention in the formulation of the proposed model, to which the upgrading process that was not considered by the latter authors has been added. This process is one of the principal novelties of the model presented in this work which, as well as being very necessary, helps to complement the study and design of Knowledge management models that are of great utility and interest to firms.

3. The artificial neural architecture

We use the standard Maximum-Likelihood Network (Corchado, MacDonald and Fyfe, 2004) with an additional lateral connection (which acts after the feed forward but before the feedback) derived from the Rectified Gaussian Distribution (Seung, Socci and Lee, 1998; Corchado and Fyfe, 2003) and using the cooperative distribution.

This architecture considers an N-dimensional input vector, \( \mathbf{x} \), and a M-dimensional output vector, \( \mathbf{y} \), with \( W_{ij} \) being the weight linking input \( j \) to output \( i \) and let \( \eta \) be the learning rate. The initial situation is that there is no activation at all in the network. The input data is fed forward via weights from the input neurons (the \( x \)-values) to the output neurons (the \( y \)-values) where a linear summation is performed to give the activation of the output neuron. The Rectified Gaussian Distribution is a modification of the standard Gaussian distribution in which the variables are constrained to be non-negative, enabling the use of non-convex energy functions:

Feedforward:
\[
y_i = \sum_{j=1}^{N} W_{ij} x_j, \forall i
\]  

Lateral Activation Passing:
\[
y_i(t + 1) = \left[ y_i(t) + \eta(\mathbf{b} - A\mathbf{y}) \right]^+
\]  

Feedback:
\[
e_j = x_j - \sum_{i=1}^{M} W_{ij} y_i,
\]  

Weight change:
\[
\Delta W_{ij} = \eta y_i \cdot \text{sign}(e_j) |e_j|^{p-1}
\]

Where the parameter \( \tau \) represents the strength of the lateral connections.

The cooperative distribution in the case of \( N \) variables is defined by:
\[
A_{ij} = \delta_{ij} + \frac{1}{N} - \frac{4}{N} \cos \left( \frac{2\pi}{N} (i - j) \right)
\]
\[
b_j = 1
\]

Where \( \delta_{ij} \) is the Kronecker delta \( i \) and \( j \) represents the identifiers of output neuron.
3.1 Application of the neural network to the proposed model

For each of the Directions considered (A, B and C) different knowledge have been identified (277 in total), independent of their presence or not inside them. They have been evaluated in terms of urgency of acquisition, importance for the company and current status among the employees. For the knowledge presents inside the different areas, it has been reported also their current status inside and in relation with others.

The variables have been coded as follow:

- **Urgency of acquisition, Level in other areas and Importance to acquire** it have been set as 1 for Low, 3 for Medium and 9 for High.
- Current level of the knowledge in the direction studied is 1 when is Null, 3 for Low, 5 for Medium and 7 for Maximum.
- **Situation of the knowledge** in other areas is 3 when Low, 6 if Medium and 9 if High.

As variables have a strict ordinary character, this quantification is not distorted by the read meaning of the values (as the separate relative situation between themselves) and allows more comfortable set up with the neural network. The outputs of the net are real continuous values.

4. Real data set and results

4.1 Results of descriptive analysis

The data sample comprises 277 registry entries (individuals) that describe the state of "critical knowledge" revealed by the senior management of the company under study.

The critical knowledge, for each entry, is based on information that refers to the actual level of knowledge; the degree of importance attributed to it in order for the activity to be successfully carried out; the most favourable moment for its acquisition, if it is lacking; as well as the level at which such knowledge is needed as well as the level at which it is held in other areas of the company.

Thus, it is possible to identify the knowledge needed to develop the activity that is either unavailable or is not held, and to arrive at the right decision as regards its acquisition. Equally, it is possible to build up a picture of the knowledge that is held, but is not fully exploited, either because it is not fully used by the individual who holds it, or because it is not shared at the required level, or because its potential value and use in other areas of the company is unknown. Furthermore, the study incorporates an analysis of actual knowledge levels and their evolution and upgrading, to detect the need for new knowledge and to eliminate those that serve no purpose.

In the study, knowledge was categorized into eleven classes corresponding to three Corporate Directions. "Direction A" comprises New Business, Purchases and Commercial Relations. "Direction B" covers Project management, Better Industrial Practices, Protection of Design and Technology and Finances. "Direction C" refers to Human Resources, Quality, Organization and Information Systems. All of the areas are grouped together with reference to the flowchart of the company exclusively in terms of critical knowledge. Subsequently, the eleven classes mentioned are sorted out by lines of knowledge, each being assigned the specific knowledge that is inherent to that area.

Table 1 summarizes, in terms of percentages and frequencies, the descriptive profile of the needs for knowledge of each Corporate Direction in relation to the group of the company, as well as their position with respect to the processes of acquisition, sharing and upgrading of the knowledge.

Table 1: Indicative results of the Knowledge Management processes

<table>
<thead>
<tr>
<th>CORPORATE DIRECTIONS</th>
<th>KNOWLEDGE SHARING</th>
<th>KNOWLEDGE MANAGEMENT PROCESSES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ACQUISITION</td>
<td>SHARING</td>
</tr>
<tr>
<td>Direction A</td>
<td>18%</td>
<td>18%</td>
</tr>
<tr>
<td>Direction B</td>
<td>51%</td>
<td>8%</td>
</tr>
<tr>
<td>Direction C</td>
<td>31%</td>
<td>7%</td>
</tr>
</tbody>
</table>

The results obtained allow us to conclude that "Direction A" has 82% of the necessary knowledge, which is shared out among 43% of the expert workers, but is not shared with other individuals or areas of the
company that require it, and 39% exists at a group or an organizational level, which is therefore potentially upgradable. Such results suggest an excessive centralization of decision making, as the success of this managerial area is dependent on critical knowledge that is concentrated in the hands of a few people. Some of the causes may be explained by the pressing need for this Direction to adapt to numerous different and hitherto unknown markets, which, due in part to their emergent nature, implies that business administration and decisions have to be developed in complex, highly uncertain, and unstable situations. Absent knowledge represents 18%, which is much higher than in other areas of the company.

As regards Direction B, the data shows that only a mere 8% of all necessary knowledge is unknown, and that this Direction participates in the company while holding over half of the key knowledge. It therefore possesses 92% of all critical knowledge, 48% of which is at the exclusive disposal of experts, which requires a sharing process, and 44% is available to the organization. It is worth mentioning that the classes that comprise Direction B refer on the whole to essential competitive abilities that generate most of the company’s competitive advantages, which in addition allow it to maintain a position of leadership in the sector. Although the company has shown itself able to master them, an important drawback is also revealed, relating to the great amount of knowledge that is not shared.

Direction C accumulates 31% of the need for knowledge, which in terms of its relevance situates it behind Direction B. It holds 93% of the necessary knowledge, of which 38% requires sharing and 55% is available to the organization. In order not to lose this substantially favorable situation, constant monitoring is necessary to identify new needs for knowledge.

4.2 Results and conclusions of the unsupervised model (empirical analysis)

Figure 2 shows the results obtained from the application of the neural architecture to this date set, while table 2 explains those same results in detail.

![Figure 2: CMLHL on the real data](image)

<table>
<thead>
<tr>
<th>Cloud 1A: CRITICAL</th>
<th>Cloud 2A: CRITICAL</th>
<th>Cloud 3A: CHAOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>URGENCY</td>
<td>9</td>
<td>URGENCY</td>
</tr>
<tr>
<td>LEVEL IN OTHER AREAS</td>
<td>1</td>
<td>LEVEL IN OTHER AREAS</td>
</tr>
<tr>
<td>IMPORTANCE</td>
<td>6,9</td>
<td>IMPORTANCE</td>
</tr>
<tr>
<td>CURRENT LEVEL</td>
<td>1,3,5</td>
<td>CURRENT LEVEL</td>
</tr>
<tr>
<td>SITUATION IN OTHER AREAS</td>
<td>3,6,9</td>
<td>SITUATION IN OTHER AREAS</td>
</tr>
</tbody>
</table>

Table 2: Results
<table>
<thead>
<tr>
<th>Cloud 1B: ALMOST OPTIMAL</th>
<th>Cloud 2B: ALARM</th>
<th>Cloud 3B: CHAOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>URGENCY</td>
<td>6</td>
<td>URGENCY</td>
</tr>
<tr>
<td>LEVEL IN OTHER AREAS</td>
<td>1</td>
<td>LEVEL IN OTHER AREAS</td>
</tr>
<tr>
<td>IMPORTANCE</td>
<td>6</td>
<td>IMPORTANCE</td>
</tr>
<tr>
<td>CURRENT LEVEL</td>
<td>1,3,5</td>
<td>CURRENT LEVEL</td>
</tr>
<tr>
<td>SITUATION IN OTHER AREAS</td>
<td>3,6,9</td>
<td>SITUATION IN OTHER AREAS</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cloud 1C: GOOD</th>
<th>Cloud 2C: IMPROVEMENT STRATEGY</th>
<th>Cloud 3C: ALARM</th>
</tr>
</thead>
<tbody>
<tr>
<td>URGENCY</td>
<td>1</td>
<td>URGENCY</td>
</tr>
<tr>
<td>LEVEL IN OTHER AREAS</td>
<td>1</td>
<td>LEVEL IN OTHER AREAS</td>
</tr>
<tr>
<td>IMPORTANCE</td>
<td>6</td>
<td>IMPORTANCE</td>
</tr>
<tr>
<td>CURRENT LEVEL</td>
<td>5</td>
<td>CURRENT LEVEL</td>
</tr>
<tr>
<td>SITUATION IN OTHER AREAS</td>
<td>9</td>
<td>SITUATION IN OTHER AREAS</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cloud 3D: ALARM</th>
<th>Cloud 3E: GROWTH STRATEGY</th>
</tr>
</thead>
<tbody>
<tr>
<td>URGENCY</td>
<td>6</td>
</tr>
<tr>
<td>LEVEL IN OTHER AREAS</td>
<td>9</td>
</tr>
<tr>
<td>IMPORTANCE</td>
<td>6</td>
</tr>
<tr>
<td>CURRENT LEVEL</td>
<td>1,3,5</td>
</tr>
<tr>
<td>SITUATION IN OTHER AREAS</td>
<td>6</td>
</tr>
</tbody>
</table>

The fringe of the matrix occupied by clouds 1A, 1B and 1C coincides with the variable "the level needed in other areas", which represents BASIC knowledge, and to the "importance of the knowledge" that is of an essential nature for the company, whereas the variable "current level of knowledge held" does not extend to the expert category.

The area occupied by clouds 2A, 2B and 2C refers to a MEDIUM value in the variable "the level needed in other areas", whereas the "importance of the knowledge" continues to be very important and indispensable for the development of the activity and the "current level of knowledge held" extends across all the categories, including that of the maximum level.

The area occupied by clouds 3A, 3B, 3C, 3D and 3E reflect the maximum parameters of the need for knowledge expressed by other areas, as well as the importance that is attributed to it, which continues to be key, however the greater part is not categorized as expert knowledge.

The fringe of the matrix occupied by clouds 1A, 2A, 3A and 3B reveals areas of immediate "urgency" in the command of knowledge, which even though it is not held by the company, is of enormous importance to it. It is noted, on the other hand, that the majority of knowledge that is present in the area does not reach the most expert grades.

The data contained in clouds 1B, 2B, 3C and 3D add a degree of "urgency" to the acquisition of medium level knowledge, despite being very important and, indeed even indispensable for the successful development of the activity; it therefore sounds a warning bell as to future needs for new knowledge. As expected the knowledge contained in this fringe of the matrix did not reach the expert category.

Clouds 1C, 2C and 3E represent the calmest situation for the variable "urgency", because they suggest that the knowledge can be acquired later on, without that damaging managerial activity. Both the importance as well as the degree of the knowledge is at medium level. In view of the data presented above, the conclusions drawn from this case study allow us to state that the area occupied by cloud 1C is an OPTIMAL situation, because, amongst other reasons, it means that even though absent knowledge is identified in the area to which it belongs, its acquisition is not urgent and the need for that knowledge expressed by other departments or activities is at a basic level. The knowledge held is considered sufficient, very important and
is shared.

The contrary arises in relation to the points around clouds 3A and 3B, where the immediate acquisition and application of knowledge that is not held is considered urgent, at the same time as the level of the need for knowledge in the other areas of the company reaches its maximum value. We are, therefore, faced with a situation that we refer to as CHAOS that clearly warns of knowledge-related decisions that the company should face up to. Knowledge that is held and applied extends to the expert level and is very important and essential for the development of company strategy.

Similarly, the positions of clouds 1A and 2A warn us that maximum acquisition of knowledge is required in the areas to which the knowledge corresponds, although the needs in other areas are located at a basic and medium level. In these cases, it might be said there is a portfolio of knowledge that can be described as "CRITICAL" for the company, because the concession of new projects might perhaps depend on the correct application of such knowledge, the improvement of certain processes, the incorporation of new clients and, in short, the creation and maintenance of competitive advantages for the company. The knowledge held is at a high level and of extreme importance to the company.

The area occupied by cloud 2C reflects an urgent need for acquisition at a later stage, while the needs expressed by the other areas exist at a medium level. This situation might signify an "IMPROVEMENT STRATEGY", which calls for progressive and gradual improvement and consolidation of knowledge that is already held. The situation of current knowledge in the area itself, it is present at the levels of basic, sufficient and expert and is of reasonable and relative importance.

The points that define cloud 3E attract attention, because they refer to knowledge needed by others at a wider level, nevertheless its acquisition is not urgent. This might be a case of knowledge needed for the future in order to expand and to grow, either in new processes, markets or products, which is given the name of "GROWTH STRATEGY. The purpose of the company will determine the most appropriate moment to take on these decisions. The knowledge held is important and above average.

Cloud 1B represents a medium level urgency of acquisition, at a basic level; it can therefore be described as an ALMOST OPTIMAL situation; knowledge is held at an acceptable level and its importance reaches an intermediate value. Clouds 2B, 3C and 3D identify a situation of ALARM, because, although the urgency is not at maximum but at medium level, the need for this knowledge in other areas is indispensable. This leads us to conclude that the key knowledge is held and applied only in the area to which it corresponds, but it is not fully exploited, as it is neither transferred nor shared with other areas and activities that need it.

5. Discussion

The results obtained allow us to propose three approaches to the matter. The unfavourable situation that appears in the areas where there is a lack of knowledge may be due to the critical knowledge that depends, in great measure, on non-controllable factors for the company. At the same time, these are crucial to its success and progress. It therefore becomes necessary to take immediate steps towards the acquisition and control of such knowledge. It has been demonstrated that areas of the firm exist where the knowledge is mastered but is not shared among workers. Some of the reasons are due to the unrestricted growth experienced over recent years that has up until the present prevented consolidation; the responsibility and difficulty involved in new forms of working, moving from simple pieces to complete processes; recent expansion at an international level of the company that imply various economic-financial, and fiscal regulations in other business environments; and the traditional confidentiality and security required by patents. As a consequence, in order not to lose this essential knowledge and to continue maintaining its leadership, it is necessary to act on the transfer and sharing of knowledge that is, at present, only held by a limited number of professionals.

In the process of updating and refining knowledge, actions are proposed which tend to anticipate new knowledge and renew existing knowledge. This leads us to suggest actions that are intended to advance and to update/upgrade present levels of knowledge, through the elimination of obsolete knowledge and the acquisition, generation or creation, before its business competitors, of knowledge that will direct future managerial activity. However, to do the set up of the model and evaluate the knowledge presents and absents in each Direction, is required to establish as first step an strategic analysis of the situation of the company: to know where the company is and where would like to be in the future. If, as result of this
exercise, it comes to be that the activities of the firm would go inside different sectors, the help of experts in these sectors should be required (as consultants or as new employees).

This set up of the model has some limitations. First one in the transfer of the knowledge requirements to the economic factor, as the results of this audit tool would have to be presented the administration organism inside the company. Therefore an intense work of costing and analysis has to be taken, always considering some hypothesis that will determine the success of the decisions. So depending of the person taking that responsibility the outcome can be one or other. The second limitation is related to the way of transferring the knowledge between persons and departments. This process has to be quietly arranged, because knowledge uses to be quite spread all around and to perform a general process to transfer it at the same timeframe can result in a total revolution that can drive the company to the chaos and stop all normal activities.

Despite all difficulties, the model breaks the barriers between the departments of the company and forces them to work together and set common action plans to identify, share and acquire everything that they need to improve their development, in benefit of the whole company and employees. It forces also the company to arrange training plans for the employees and acts as a firewall against the brainscape.

References


Knowledge Management for Virtual Reality Applications in a Home Rehabilitation Virtual Network

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Abstract: This paper describes the reference architecture to support a multi-user virtual healthcare network that enables rehabilitation and social reintegration of people with disabilities. The network, based on a virtual collaborative environment supported by the www, includes collaboration and interpersonal communication devices and data collection mechanisms that provide knowledge management for the system and effectiveness evaluation.

The Virtual Network (VN) allows the rehabilitation patients spread in geographically dispersed areas, a very frequent reality in the considered context, to access a distributed virtual platform able to offer communication and shared knowledge with doctors, nurses, therapists, social workers and other people involved in the process of rehabilitation. VN solutions allow building a virtual shared space, a context of understanding and knowledge where the “real world” knowledge affects virtual interaction and virtual interaction modifies “real world” therapies.

The main aim of the VN is to achieve a higher quality of life for the people with disabilities and, in the long term, from the economic point of view, to produce important savings/profits and bring about feasible ways to improving/re-organizing health care services. The present paper illustrates our team’s first steps in building such a network in Romania.

The first section establishes the link between the virtual reality and the medical rehabilitation as an important branch of the healthcare system. Several applications in the field are presented here.

The second section focuses on two main aspects: on the one hand, the current Romanian reality of medical rehabilitation and, on the other hand, the existing possibilities to build a VN for rehabilitation as a solution to the main problems Romania has in this field.

The third section is a technical preamble to the knowledge sharing process particularized for a healthcare VN in section number four.

The last part of the paper includes both pro and cons arguments for the designing of a VN as a solution to the discrepancy between the demand and the real current hospitals’ supply of medical rehabilitation in Romania.

Keywords: home rehabilitation, virtual reality, virtual healthcare network, virtual organization, knowledge sharing models, information broker agent, personal healthcare agent

1. Virtual reality in home rehabilitation

Generally speaking, Virtual environments (VEs) present a unified workspace allowing more or less complete functionality without requiring that all the functions to be located in the same physical space. According to Pratt, Zyda, and Kelleher (1995) „a virtual world is an application that lets users navigate and interact with a three-dimensional, computer-generated (and computer-maintained) environment in real time. This type of system has three major elements: interaction, 3-D graphics, and immersion”.

Virtual reality (VR) is an emerging technology that alters the way on which individuals interact with computers. „Virtual reality is a fully three-dimensional computer-generated „world” in which a person can move about and interact as if he actually were in an imaginary place. This is accomplished by totally immersing the person’s senses...using a head-mounted display (HMD)” or some other immersive display device, and an interaction device such as a DataGlove™ or a joystick (Satava 1993).

VEs and VR are also used today to develop skills, and to train the people with disabilities. Among the Health-Care Applications of VEs Satava (1995) includes „Skill enhancement and rehabilitation”. These particular applications include those that provide training in the use of equipment, those that allow the exploration of virtual space, those that augment physical abilities, and those that teach skills (see Table 1 (Moline 1998)).
### Table 1: Applications for skills enhancement and rehabilitation

<table>
<thead>
<tr>
<th>Application</th>
<th>Examples</th>
<th>Who/Where</th>
</tr>
</thead>
<tbody>
<tr>
<td>Training in use of equipment</td>
<td>Training disabled children to control motorized wheelchairs</td>
<td>Dean Imman, University of Oregon</td>
</tr>
<tr>
<td>Exploration of „physical space”</td>
<td>Providing virtual environments for exploration in a wheelchair</td>
<td>Greenleaf Medical Systems, Palo Alto, CA</td>
</tr>
<tr>
<td>Empowerment of the disabled using an eyetracker device</td>
<td>Providing a quadriplegic child the opportunity to develop interactions with the outside world before its disability causes him/her to become too introverted to communicate</td>
<td>David Warner, Human Performance Institute of Loma Linda University Medical Center, CA</td>
</tr>
<tr>
<td>Use of virtual reality to enhance vision of the visually impaired</td>
<td>Providing a virtual computer monitor that moves the user’s line of sight across an enlarged virtual monitor</td>
<td>University Applied Physics Laboratory at The John Hopkins University, Baltimore, MD</td>
</tr>
<tr>
<td></td>
<td>Providing vision enhancement</td>
<td>Suzanne Weghorst, University of Washington</td>
</tr>
<tr>
<td></td>
<td>Using glasses that display a television image to help Parkinson’s disease patients overcome their halting, hesitant gait</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Substituting virtual reality bus rides for the real thing to train individuals to use the public transportation system independently</td>
<td>University of Dayton Research Institute, OH, and Miami Valley Regional Transit Authority, FL</td>
</tr>
</tbody>
</table>

All of these applications bring the real world closer for the people who need and want to be an active part of it, those with different disabilities. The Train to Travel project, for example, „substitutes [VR] bus rides for the real thing. Students learn independently in the classroom, eliminating the need for a teacher to accompany or follow them on real trips” (Buckert-Donelson 1995a). They …. use interactive multimedia to recognize landmarks and learn what to do in case of an emergency. When they master basic skills, they progress to the VR environment, where they use an HMD system with head tracking to look around a computer-generated landscape” (Buckert-Donelson 1995b).

In this context, a virtual healthcare network (VHN) can be described as an environment where data and knowledge of medical interest can be stored, processed and made available to the appropriate actors within a distributed system. Among the projects of VN that have been developed lately: a virtual hospital in Finland (ATULINE), the Stroke Center Enchede (Nederland), the SYSCO Health Care System (USA) etc.

2. **Home rehabilitation – a realistic solution for the Romanian healthcare system?**

Rehabilitation is a concept that should involve the entire healthcare system, and at the same time it is a special medical therapeutic section connected to the diagnosis and recovery programs.

Basically, *Rehabilitation* is a process of helping people to reach the fullest physical, psychological, social, vocational and educational potential level. All of these goals of the rehabilitation process depend of the patient’s physiological or anatomic impairment, on their willing to be rehabilitated and environmental limitation. Rehabilitation consists in “the use of all means aimed at reducing the impact of disabling and handicapping conditions and at enabling people with disabilities to achieve optimal social integration” (World Health Organization).

In this section we focus on the particularities and the problems of the rehabilitation system in Romania, trying to find an appropriate answer to its.

2.1 **The current Romanian rehabilitation system in figures**

Medical rehabilitation occurs as a distinct branch of the Romanian healthcare system in earlier ‘70s. In the decade 1970-1980, the ambulatory network was designed, and the first rehabilitation clinics within the existent hospitals occur. In 1984 the design of the neurological rehabilitation program was started, including the University Clinics in Bucharest, Timisoara, Iasi, Cluj and Targu-Mures, and having as a main result the
only one medical facility entirely dedicated to the rehabilitation services, the National Institute of
Rehabilitation, Physical Medicine and Balneo-climatology from Bucharest (INRMFB).

The total supply on the medical rehabilitation field in Romania today is presented in Table 2.

<table>
<thead>
<tr>
<th>Crt. No.</th>
<th>Institution</th>
<th>Type/Characteristics</th>
<th>Total number of hospital beds</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>INRMFB National Institute containing 3 Medical Rehabilitation Clinics with an Average of 75 beds</td>
<td>225</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Bucharest, Timisoara, Iasi, Cluj, Targu-Mures University Clinics with an Average of 60 beds</td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>County Hospitals Rehabilitation Clinics within each of the 41 county hospitals with an Average of 25 beds</td>
<td>1025</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Private Hospitals None</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
<td>1,550 beds</td>
</tr>
</tbody>
</table>

In 2006 this capacity succeeds to cover between 25% and 30% of the real demand for medical rehabilitation services. According with the Statistics Department of the INRMFB, this percentage will decrease continuously due to the following factors:

- the increasing number of strokes among the adults and young people;
- the decreasing of the average age with maximum risk of strokes from 50 years old in the ‘90s, at 40 years old in 2000;
- the permanent increase of the traffic and work accidents;
- the demographic phenomenon of increasing the aged people, i.e. that segment of the population with the highest risk for neurological problems;
- the hospitalization of those patients who didn’t need an in-patient system (for example the ones who requires just post-traumatic treatment), but who are integrated in this classic system because of the huge distance between the hospital and their home.

In order to increase the ratio offer/demand for rehabilitation services, in some cases the hospitals’ managers succeed to find some pseudo-solution for the people that need specialized medical assistance, but who can be hospitalized only if they are willing to wait between 2.5 – 3 months. Such pseudo-solutions for the INRMFB consist in programs as:

- Outpatient – the patient come into the hospital just to receive the treatment; and
- Hospital by day patient – the patient is hospitalized only during the day and is supervised to accomplish his rehabilitation program, without receiving any medication or food from the hospital.

The biggest clinic of INRMFB - Clinic III Filantropia with 85 beds - succeeds in this way in 2006, to have a record number of 2,489 hospitalized patients, even if it can offers only 85 x 2 = 160 hospitalizations per month, so a total of 1,920 patients per year! This surplus of 23% non-in-patients plus a 10% from the in-patients for whom the hospitalization isn’t compulsory, constitute the group of patients to whom the existence of a home rehabilitation system is the best solution for recovering, both as effectiveness and from economic considerations (hospital and patients costs/savings).

But still, is the home rehabilitation system a feasible solution for Romania today? We will try to give an answer in the next two paragraphs.

2.2 The required infrastructure for sustaining a rehabilitation VN

In order to design a functional VN for home rehabilitation, a set of conditions has to be fulfilled:

1. First of all, every patient enrolled into the VN must to have access to a PC connected via Internet with the entire network. From this perspective, according with the European Foundation for the Improvement of Living and Working Conditions (www.eurofound.europa.eu), in 2005 Romania has the lowest density of computers at 1,000 inhabitants, namely a quarter from the average number in the EU countries. This could be a serious constraint of building a VN for home rehabilitation. Fortunately, in the last 2 years the Romanian IT&C sector had the highest growing rhythm (45% per year) among the Central and Eastern
EU countries (according with the Economist Intelligence Unit (EIU), [www.eiu.com](http://www.eiu.com)), the number of Internet connections increasing with 100% every year.

2. Secondly, each computer has to be equipped with the dedicated software for the particular rehabilitation program a certain patient follows. Even if this kind of software is very expensive (especially if we compare its prices with the Average Net Earnings in Romania – 302 Euros per month in May 2007), there are good chances for it to be designing by the Romanian IT specialists. In this area, Romania has not only the highest number of IT&C certified specialists at 1,000 inhabitants from Europe (higher than USA or Russia), but also they are worldwide recognized for their competence and skills.

3. Third, even for a pilot rehabilitation VN, the necessary investment funds are considerable. Until now, we had identified more possible financing sources for the initial investment in equipments: national and EU funds for R&D programs, Health Ministry’s budget, and cooperation with the (IT&C) business environment.

### 2.3 Extend the real hospitals’ offer vs Design a VN for home rehabilitation

Because the most important investment sources can be the public funds attracted through the Health Ministry’s budget, a fair question has to receive an answer here: **why the Romanian government would want to invest public money in developing a VHN?** This question is more legitimate today when:

- among other medical fields, the rehabilitation systems is not a priority for the Romanian Government, so there are small chances to receive more money even to extend the in-patient system;
- lately, to reduce the number of hospitals beds for all the clinics, and to invest more in prevention activities is the Romanian Minister of Health’s medium run strategy. But this strategy requires a solid educational program which, for the moment, doesn’t exist in Romania.

In these hypotheses, an answer in cost/benefit terms is the most appropriate one and, as is results from Table 3, is the final argument in financing the design of the rehabilitation VN.

**Table 3: In-patient vs Home rehabilitation system – cost analysis**

<table>
<thead>
<tr>
<th>System</th>
<th>Real/Estimated costs (Euro / day / patient)</th>
<th>Computing method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classical in-patient</td>
<td>From 26 (Targu-Mures Clinic) to 48 (INRMFB)</td>
<td>Real costs in May 2007 (source – Monthly Financial Reports)</td>
</tr>
</tbody>
</table>
| Home rehabilitation within a VN     | From 8 to 12                                 | Salaries:
- 3 specialists (IT, MD and Physiotherapist) each day (16 hours) x (17.35$/hour[^1]) = 277.60$;
- 1 Professional Nurse every night (8 hours) x (13.48$/hour[^1]) = 107.84$;
Total costs with salaries = 385.44$/day;
Number of patients assisted through the VN: 64 (daily) + 8 (night) = 72 people;
Average cost with work force = 5.35$/patient;
Average total cost (including the equipments) = 5.35 x 2 = 10.7$ = 7.67 Euro/patient[^2];
Maximum average cost including special intervention at patient’s residence:
7.67 Euro + 4 Euro = 11.67 Euro/patient |

[^1]: [www.worldsalaries.org](http://www.worldsalaries.org)

Based on the above analysis we conclude that a VN for home rehabilitation is indeed a feasible solution for Romania’s healthcare system.

### 3. Knowledge sharing in the healthcare VN for home rehabilitation

The healthcare network for home rehabilitation of people with disabilities is considered as being a *virtual organization (VO) with loosely coupled independent components, cooperating for a specific goal*. The fundamental aspect of virtual organizations, *the flexibility to offer healthcare services where and when they are most needed*, requires individuals and components to exchange knowledge for various reasons such as to establish common goals and diagnostics, synchronization of treatments, agreements between physicians...
and other healthcare professionals (nurses, physiotherapists, social workers, members of patient family) in care procedures’ planning etc.

It is a fact that a serious number of medical mistakes occurs from the incorrect or incomplete information about the patients’ records and the lack of communication between the rehabilitation process’ actors.

Due to the diversity of remnant symptoms of people with neurological disorders, a large number of health care professionals are involved in the care process of such patients. Those patients are transferred from one participating component to another during a chain of care. This chain may consist of a hospital, rehabilitation services, geriatric center, indoor and outdoor healthcare professionals, occupational therapists etc. These components actors work together a long period of time and use a large diversity of knowledge about the patient and his disorders.

Currently, the major part of knowledge and information exchange take place through personal contacts, phone calls and patient medical files.

Healthcare professionals frequently indicate that the information about the patient is incomplete and not timely available. In particular, the rehabilitation treatment can hardly ever been applied with the maximum efficiency. This process is a knowledge intensive operation that involves many medical professionals and data. The data and knowledge from the patients’ records must be retrieved and used throughout the whole rehabilitation chain.

Understanding rehabilitation processes as chains needs all healthcare professionals just in time, involves standardization and the use of a new conception about the role of knowledge in these processes as the main ingredients of creating an effective virtual network centered on the patient.

A key requirement in the design of a VHN is to integrate the rehabilitation treatment with the new information and communication technology at home.

Many patients are elderly and chronically ill persons, which do not always have the physical and mental surplus in order to support a long period of treatment. The virtual organization of network challenges the course of treatment for rehabilitation by moving the healthcare practitioners from the hospital or care centers to the patient own home using the virtual reality and ITC.

Through a patient-centered rehabilitation process the network is designing, developing, deploying and implementing a flexible solution for the patient and permit the homecare practitioners to be in direct contact with the hospital while staying in the patient’s home. The perspective for the patient is to get a better and more qualified course of treatment, avoiding many visits in the out-patients clinics and unnecessary hospitalization as a consequence of difficult transportation between home and hospital.

But the home care of patients requires collection, interpretation and sharing of large amounts of time dependent data and knowledge.

For knowledge to be shared effectively and efficiently between, within and across healthcare practitioners, those who possess knowledge (Provider Agents, see Figure 1) should make it available in an accessible place and manner. The actors who seek knowledge (Requester Agents) should first be aware of the knowledge locus and, second, be capable of interpreting the knowledge within their own context, prior to applying it. But this needs the existence of a Knowledge Sharing Network (KSN) as a type of network among patients, healthcare practitioners and hospital which have as main common characteristic the sharing of both tacit and explicit knowledge (von Krogh 1998, Zack 1999a, Dyer and Nobeoka 2000). A KSN is a locus for facilitating knowledge sharing and effective knowledge use, since it makes knowledge permanent, accessible and portable to those who need it, inside and outside.

Knowledge is inherently hard to control as it is ever expanding and unpredictable. In the VHN these characteristics are more obvious because of the distributed character of their structure and the lack of a staff control. But in this kind of organizations there could appear other barriers in generating and sharing knowledge between the members of the VHN.

We are summarizing here some reasons that make the process of sharing knowledge a complicated task in the VHN:
Distance – both physical and time – makes sharing of knowledge, and especially its tacit dimension, difficult. It may offer a partial solution, despite the fact that a lot of knowledge is generated and transferred through personal contacts and relationships like physical skill demonstration, body language, conversations etc;

- The individual who possesses knowledge – especially the tacit one – may be discouraged or may refuse to share it with other individuals from the VHN;
- Inequality in status among practitioners is also a strong inhibitor in sharing knowledge, especially when is worsened by differences in accessing information;
- The culture of the organization often blocks sharing, especially in highly competitive environment (such as private hospitals, for example);
- Missing a centralized knowledge basis makes it very difficult to access the complete knowledge of the VHN;
- Differences in the workflow - possible difficulties in coordination of the knowledge transfer;
- Differences in terms - possible misunderstandings can lead to a different interpretation in the knowledge exchange process;
- Difficulties in structuring and classifying the knowledge etc.

Especially in the VHN, knowledge, and therefore also knowledge sharing, plays a significant role, because the care services are based on complex non-standardized solutions, that are patient specific. To ensure an efficient and effective rehabilitation process certain suppositions need to be created, which enable an efficient knowledge sharing (and generally information exchange) between the healthcare practitioners.

In order to solve the problems of the missing centralized knowledge basis as well as the sharing knowledge coordination, some knowledge models are developed which describes the organizational knowledge basis of the VHN.

In addition to the requirement of process orientation, the Sharing Knowledge Model (SKM) needs to be readable by computers (because the model is an intrinsic part of an IT-system), and is has to consider the particular knowledge backgrounds of the care practitioners and hospital as an essential requirement for the precise identification of the knowledge needed.

4. Knowledge sharing models in the home rehabilitation VN

We focus in this section on investigating a framework for an agent-based knowledge sharing model (AB-KSM). This model includes a number of informative agents who share their results with a just-in-time information presentation agent. The presentation agent does not only suggest its own documents of relevance, but information found by the other agents as well. Agents deposit information for later use by themselves or by other agents. In this way, knowledge sharing between agents is possible, but it is controlled in such a manner that allows modular inclusion of agents within the framework.

The AB-KSM has a tree-layer structure (Figure 1) that makes it possible to abstract over the various techniques that are hidden under its surface. Each layer is focused on one specific part of the activity, and is supported by corresponding types of agents:

- Requester agent (medical staff, patients);
- Provider agent (IT specialists, database administration system); and
- Middle agents (database administrators, MDs).

Figure 1: Architecture of an agent-based model

The essential role in this architecture is played by the middle agents (profile agent and infomediaries). They deal with preference or capability information and actively inform the users (Requester agents) when they...
find items (information or knowledge) that match their requirement. Very often, such agents may not understand the knowledge domain directly, but are instead facilitators that can find other people who understand the domain better.

The behavior of middle agents has certain implications for efficiency, privacy, robustness and adaptive power which are related to characteristics of the external environment and of the agents themselves. In the VHN the middle agents have to:
- compare the agents’ information in a peer-to-peer, decentralized fashion;
- refer users to others who have similar interests; and
- share the knowledge between the most interested users.

The user agents’ behavior is based on the concept of stereotype. This means that for a patient and the known information about him, it is possible to generate stereotypes for user groups (different healthcare practitioners that offer care services in the rehabilitation process). Individual users can then be modeled by customizing an instance of their profile from the general class. Each user specifies group preferences when registering within the system.

This process of knowledge sharing has a conflict potential between agents. For example, a situation may arise when a user agent reviews sets of knowledge patterns acquired through an interaction and determines that an identifiable agent is unable to provide quality information, and hence should not be consulted in the future (for example when a “second opinion” system is available within the VHN, both for the patients and the medical staff). In order to solve this issue, the system uses a two-stage-filtering process to improve the performance of the middle agent. The first stage of filtering takes place when the middle agent accepts an information request. It examines the user profile encoded in the information request, and uses this information to filter out undesirable agents, or identify favorable agents from whom to acquire quality information. A second filter will help the user agent reviews the knowledge that was acquired from the agent community, and decides whether to adopt this knowledge into its dictionary. After that, the filter allows the user agent to review the accepted and rejected knowledge, and then determines if some agents are providing low-quality knowledge. This analysis may prompt the user agent to initiate a change to their profile, in order to avoid undesirable agents, or to favor helpful user agents in future requests.

Different types of middle agents have been proposed in the knowledge sharing, such as matchmakers, information brokers and blackboards [Decker et al., 1996]. The broker agent-based model contains an information agent (broker agent) who has the capability to accept registration from user agents, which define the user’s knowledge capabilities to provide knowledge as well as to accept advertisements from provider agents, which contain the user desired information that can be retrieved by requester agents. All the received information concerning user preferences and advertisements will be stored as meta-data in the broker’s external database.

A user agent discovering the lack of sufficient knowledge about a particular patient (domain) can choose to ask the information agent to build an information request containing detailed information about the patient (domain of knowledge) and some of the user’s knowledge acquisition preferences. As long as the information agent accepts such requirements, it will be primarily responsible for using previously advertised user agent capabilities to recognize which user agent in the VN can provide the desired information by sharing the knowledge. Figure 2 represents the basic architecture of broker agent-based model of sharing knowledge adapted for the home rehabilitation network.

In general terms, each VN must have a policy for specifying its sharing knowledge strategy, which particular agent within the organization has roles in this activity, and what these roles are. But every AB-KSM can be more or less effective and efficient in the process of operating a VN.

For our VN we use the information broker architecture because it is more efficient and flexible, linking the knowledge about the health problems to the symptoms, the clinical signs and the observations in order to chooses the health care procedures that are most appropriate to be administered to the patient. Of course, the diagnostic hypothesis is a priori reserved to the physicians, but the treatment can sometimes imply therapeutic decisions of the non-medical actors like physiotherapists, occupational and social workers, family members etc.
The knowledge shared between these actors is structured in the internal database on four layers:
1. The current symptoms and clinical parameters of the patient (EI);
2. Observations and diagnostics of the physicians (EI);
3. The previous known diseases or health problems of the patient (ID); and
4. Procedures and protocols set up in order to solve the rehabilitation problems of the patient (PK).

Initially, for every patient, the first and the second layer are activated. During the process of rehabilitation, the other two layers are activated.

On every layer there are structured different pieces of knowledge. For example, on the first layer, there are data and information about the history of the patient’s diseases, the current symptoms of the patient and the dynamics of the clinical parameters.

On the second layer there are observations and diagnostics established by different physicians and reactions at different procedures applied to the patient during the evolution of the rehabilitation process.

On the third layer there is registered knowledge about the health problems and diseases of the patient using the terms and relations defined by the medical ontology from the external database.

Finally, the fourth layer is dedicated to the procedures and protocols associated with the different diseases of the patient. These protocols establish the main stages of the treatment applied to every patient.

Figure 2: The architecture of the information agent-based model for a rehabilitation VN

Because of the particular nature of the healthcare activity, and especially of the rehabilitation process, designing of a VN for home rehabilitation has to take account of several specific issues:
- The information and knowledge that are shared among the “actors” in the VN must be accessible for the final user – the patient;
All the medical staff involved in the home rehabilitation process has to ensure a high level of patient cooperation. This means that they must succeed in convincing the patient that the home care system (based on virtual collaboration) not only preserves all the advantages of an in-patient system, but it also reduces some of the latter’s inherent disadvantages: psychical discomfort, other patients’ negative influences, long term living into a non-familiar environment, and so on. In this matter, gaining the cooperation of the patient’s family members is a key factor;

The contact with the patient mustn’t be interrupted, otherwise it may cause a panic attack to those patients who will feel lost, and, as a result, can lead to losing their confidence in the system.

Due to the present development stage of healthcare system, all these particularities are more amplified in the Romania’s case. And also they are more necessary than ever. The main cause that makes the VHN so necessary is related to the huge existent gap between the demand for medical rehabilitation services and the hospitals’ supply of such services in the present type of organization.

5. Pros and cons VN in home rehabilitation. Future works

Within rehabilitation VN, individuals with loco-motor disabilities can communicate, participate and learn by means of VR as to obtain social reintegration. The network also comprises the possibility for a virtual therapist to intervene in order to drive the complex process of rehabilitation and to launch new activities favoring processes of physical and mental reintegration. Moreover, it also includes a management and evaluation layer, enabling system feedback and corrections, therapeutic knowledge and management functions (configuration, updating, storage, sharing etc.).

Having a flexible architecture, the VN uses intensive methods of KM to implement virtual reality applications capable to emulate real participation scenarios concerning representation of “real world” metaphors, spatial and multi-dimensional representation of contextual situations, manipulation and navigation possibilities, dynamism and realism.

Also, from the economic point of view, on the long term, the existence of such a virtual network system will bring important savings/profits and possibilities for reconsidering the way of organizing healthcare services. In this field, we hope that our team’s future work will result in more quantitative arguments (cost/benefits arguments) that can sustain the opportunity of a VN designing in home rehabilitation process.

We already have a real interest and precise short term objectives for analyzing and decomposing this process using the Supply Chain approach.

In the Romanian medical rehabilitation context, as we had showed in section 2, using the advantages of a VN is more than a necessity, it is a must. Benefit from different specialists’ experiences in similar clinical conjuncture (elements of the Data Base of an AB-KSM), without the necessity of an in-patient system could make the difference between life and death for many individuals with disabilities leaving miles away from the rehabilitation centers.

Still, designing a VN with all its above mentioned advantages, at the beginning could seem to be an “expensive” method to support the necessary medical procedures in rehabilitation: to many IT and modeling specialists involved, different gaps between the way of viewing things from the medical and non-medical point of view, a (partially justified) reticent attitude of medical teams in learning to use even a very friendly IT product, the insufficient number of computers in the Romanian healthcare system, the necessity to adopt robotics structures and dedicated soft for rehabilitation, and so on.

In fact, the most important element that makes the difference between YES or NO for VN in Romania’s healthcare system consists in the ability to identify and to turn in the strengths and weaknesses for each organizational manner: in-patient rehabilitation and/or home rehabilitation within a VN. We believe that this is the corner stone in changing both the mentalities of the involved people, and of course the way things are done now in Romania in this important medical field.

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MaKE First Steps – How a Definition of Knowledge Can Help your Organisation

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Abstract: Suitable definitions of knowledge for particular organisational contexts are valuable for knowledge management (KM). This paper explains why it is valuable, how it can be done and discusses valuable results that have been created by doing it.

The why is explained in a brief discussion of relevant literature. The how is described through the use of MaKE First Steps (2006a). This paper summarises the process and this constitutes the methodology of the paper. The paper then describes three diverse organisational contexts in which it has been applied: a UK Fast Moving Consumer Goods (FMCG) company; a group of international postgraduate business students; and a large Chinese bank.

The outputs of this work (definitions of knowledge for these organisational contexts) are presented and discussed in detail. There are significant patterns that can be discerned which give some clear suggestions about what knowledge is valuable for organisations and should be the focus of managers investment and time.

This research gives us an insight into what organisations should focus on in terms of investment of energy, time and resources. Broadly, without being too prescriptive, they should focus on the skills and learning of the personnel that make the organisation they work for, special.

Keywords: knowledge definition, collaborative process, organizational context, skills

1. Introduction
The ability to define knowledge in a suitable way for organisations is incredibly valuable. This paper explains why it so valuable, how it can be done (the process), and discusses outputs that have been generated from applying the process.

Why defining knowledge for particular organisational contexts is so valuable is partly explained in Section 2 in a brief literature survey. Section 3 provides theoretical foundations that underpin the process (MaKE First Steps) designed by the author to address the challenge of how it can be done. Section 4 briefly describes the process of MaKE First Steps. Therefore, sections 3 and 4 constitute the methodology of the paper. Section 5 explains three organizational contexts in which it has been applied. Section 6 gives a description and analysis of the results from the application of MaKE First Steps. Section 7 is the conclusion.

2. Why a process for defining knowledge is important
There are a number of reasons why it is important for organisations to be able to define knowledge as part of their management strategy. This section discusses literature which reveals these reasons.

It is recognised that, on the whole, the valuable assets in organisations are knowledge related ones. This is apparent in a wide range of organisations in different economic sectors including car manufacture and steel and the software industry (Wiig 1993, Nonaka and Takeuchi 1999, Leonard Barton 1995, Sveiby 1997, Teece 1998, and Stewart 1998;2002) and there is a long-term trend in economies towards greater value accruing from intangible resources (Machlup 1980).

Consequently the fields of intellectual capital and knowledge management have burgeoned in significance among academics and practitioners (Sharp 2003). It has been recognised that the concentration on cost cutting without regard to knowledge strategy has been an unwise approach for the long term existence of a number of organisations (Larsen and Myers, 1999 and Standfield 2000).

However, some authors have argued that KM as a field of study and practise is confused and potentially useless (Galliers et al. 2001 and Galliers and Newell 2001). Arguably this view is only sustainable on a narrow definition of knowledge that is used by these authors (Galliers and Newell 2001) which does conform with many definitions used by other authors (Sharp 2003). However, the fact that there are so many different
definitions of knowledge for organisations (Sharp 2003 identifies over 20 unique ones) means that such arguments as those of Galliers and Newell (2001) will inevitably exist unless there are ways of bringing consensus and/or providing a common starting point for proper KM discussion.

Consistent with these arguments of academics are trends in practise. Organisations question the value of KM projects. This is partly because different stakeholders (who may be important players in sponsoring KM projects) have different notions of what ‘knowledge’ means and question whether it can be managed (Sharp 2003). Consequently, the author invented MaKE First Steps – a pragmatic foundation for KM in practise (Sharp 2006a).

Partly because of this, it was hailed as a seminal work, and upon which other KM workers should build, in the International Conference of Intellectual Capital and Knowledge Management in 2005 (ICICKM 2005) (Remenyi 2005 [ed]). This paper takes the work further. It briefly explains the fundamental assumptions and parts of the process and then focuses on outputs of the application of MaKE First Steps in three different organisational contexts.

The process is a new one that has not been extensively applied before. Therefore outputs from the research are novel and break new ground (see Section 6).

3. Theoretical foundations and assumptions

MaKE First Steps (Sharp 2006a) is a process for defining knowledge collaboratively in organisations. The approach taken in this process rests on various epistemological assumptions. This section outlines these assumptions and the theoretical background before its design and application is explained.

First, the author takes the view that ‘knowledge’ is defined, discerned and created by humans. Also, because humans do not always have the same view, definitions of knowledge differ. The definition of knowledge is also something that is multifaceted, changes over time, varies according to the context in which it is being considered, and once articulated, it can be something that is shared and reflected upon. In all these respects the author of MaKE First Steps agrees with Sveiby (1997) and Hirschheim et al. (1995).

These assumptions are also very practical in nature. It is clear from research into definitions of knowledge that there is very little consensus on the subject. A practical approach is one that accepts this as a reality and asks - "how can this be used to an organisation's advantage?" Because there is little consensus it is sensible to incorporate in the process a high degree of human input that is channelled into achieving a consensus within the organisational context where the participants work. Participants can also help to validate and refine the outcome. In light of this, this research was applied in workshops.

The scope to which MaKE First Steps can be applied in organisations is determined by the human-determined context that is deemed appropriate (e.g. the whole of a company, a department, a project, or in an information system development project). This is because the only vital ingredients for MaKE First Steps are willing participants in the organisation with an appropriate understanding of the context to which it is to be applied. The emphasis in this research was upon defining knowledge in the context of organisations where people work and the literature survey of definitions and related concepts reflected this. However the process itself sits above the content of definitions of knowledge. Section 3 outlines how MaKE First Steps works.

4. MaKE First Steps

The design of MaKE First Steps was based on certain premises, most of which, map from the theoretical foundations and assumptions:
1. The process is to facilitate the production of a definition by the participants;
2. The participants should refine and shape it and ultimately be happy with it;
3. Information of experts on the concept of knowledge would be joined with 'where the participants are coming from' after the participants have expressed their own view;
4. The process is allied with establishing a context for KM in the organisation;
5. An acceptance that the definition may only be relevant for a certain period of time;
6. An acceptance that there maybe disagreements that may need to be addressed in the process;
7. Adopt a practical view accepting that users time is limited and;
8. That the process seeks to help users navigate and ‘tap into’ a body of work about the concept of knowledge in a relatively simple way

There are three key aspects to the process which became clear from the first application of the process, reflection and feedback on the process (Sharp 2006a). These are:
1. Domain for Definition;
2. Definition Selection and;
3. Hone Definition to Taste.

Before these key aspects of the process are conducted the participants decide who will be an arbitrator (Knowledge Arbitrator) who can resolve disagreements if required in the group. Also, the time period available for the process is determined, participants define knowledge on blank sheets of paper and identify any current statements or definitions of knowledge they may have created already.

For a full explanation of all the possible steps to the process see Sharp (2006a). The remainder of this section will summarise the key aspects of the process noted above.

4.1 Domain for definition
This stage is the one where the context for which the definition is determined. The boundary of the context is people-dependent. Once the context has been determined, suitable employees can be chosen to participate in MaKE First Steps. A suitable participant is a person who has an overview of the context that has been chosen. Two, three or four participants are required. Input from more than one person normally helps in drafting. A group that is no bigger than four in size is practicably easy to manage.

4.2 Definition selection
This stage is where participants select definitions of knowledge that have been devised by experts. Suitable definitions are selected from a comprehensive list of definitions (Sharp 2006a) and are used as a starting point for creating a definition for the participants’ context.

The facilitator and participants may use visual tools which categorise definitions of knowledge to do this (Sharp 2006a).

The selected definitions are copied, pasted and listed on a computer in a word processing package. The participants can then highlight parts of the definitions that they wish to include in their final version. Once this is done the participants complete MaKE First Steps by honing their definition.

4.3 Hone definition to taste
The final stage is to hone the definition of knowledge and create a final version. This stage is iterative and is illustrated in Figure 1.

This is a key aspect of the process because it is important for participants to tailor the definition to their satisfaction. In doing so, the participants become more obviously ‘owners’ of the definition and make it relevant to their context. It also brings closure to the MaKE First Steps process.
The key features to note about the honing process are below.
1. Collate Highlighted Statements (box 4 in Figure 1)
2. This refers to the process where participants look at definitions of knowledge that they have selected from a list and then they highlight statements they want to include in their definition. Then they collate their highlighted words into one coherent definition.
3. At first, this is done by inclusion of ‘AND’ between the various parts of the definition. During the honing process unnecessary words are removed.
4. The process of honing takes place using a computer and word processing package.
5. Changes are made only if there is consensus among the participants.
6. The honing process relies to some degree on the part-intuitive process of drafting.
7. If there is a disagreement during the honing process the Knowledge Arbitrator will resolve the disagreement and move the process towards its conclusion.

This process has been applied in different contexts. These contexts are described in the next section.

5. Three contexts
This paper discusses three contexts in which the MaKE First Steps process has been applied.

5.1 FMCG
The company in which the first implementation of MaKE First Steps took place is a major UK FMCG manufacturer and distributor. It makes and distributes FMCG branded goods. It has several brands within the 20 top-selling grocery brands in the UK and holds major UK franchises.

A workshop was the context in which MaKE First Steps was applied. There were seven people present at the workshop: four employees, the author and his two PhD supervisors. The four employees held different positions within the company. One was a newly appointed IT Project Manager, who was introduced to the
project. Another was an IT Development Programme Manager, who had been involved in the negotiations about the project over the previous eleven months. There was also an Insight Resource Manager and a Head of Category Insight, who had an overview of the domain to which the project would be applied.

The exact domain to which MaKE would be applied had not been articulated before MaKE First Steps was implemented. However, the IT-based KM project was being undertaken across the marketing and sales functions of the company, and two of the employees in the workshop were overseeing that project. It was decided that this project would relate to the area of the company over which they had an overview, and that they would be the participants involved in MaKE First Steps. Those who were not directly relevant to the domain, for which the definition was being created, only helped with the honing of the definition.

An agenda was agreed for the workshop. It was agreed to allocate three and quarter hours in total for conducting MaKE First Steps. MaKE First Steps was only applied once.

5.2 International business school

MaKE First Steps was next applied within an international business school called Regent’s Business School London in a postgraduate class.

Regent’s Business School London is a new business school which is in its tenth anniversary. It is situated in private grounds in Regent’s Park. The postgraduate department comprises students from across the world from approximately 29 different countries. The school applies a learning philosophy that conforms to an action research approach that underpinned the development of MaKE (Sharp 2006b).

The domain in which MaKE First Steps was applied was within a module called ‘Organisational Effectiveness’ run in 2005. The process was applied in a workshop where the concept of ‘knowledge’ was considered and applied to a case study of General Electric. The KM workshop comprised of 3 groups of 4 students from 6 different nationalities, the majority from the Indian sub-continent. Most of the students were between the ages of 22 and 26 years old and worked part time in family businesses.

MaKE First Steps was applied once in each group in a session of 3 hours duration.

5.3 Chinese bank

MaKE First Steps was also applied among a group of 25 delegates from a major Chinese bank in a day long workshop run by the author in London.

The Chinese bank specialises in products that assist clients in the agricultural sector. It employs over 50,000 employees and the delegates came from across China. The delegates were all middle managers seeking KM advice within the context of their organisation. All the delegates, except for one, were between the ages of 25 and 35.

This work took place in the summer of 2006. MaKE First Steps was applied once in each of the 5 groups of delegates.

The total number of people involved in producing the definitions described in sub-sections 5.1 to 5.3 was 43.

6. Description of the results of application of MaKE First Steps to the three cases

The rest of this paper will focus on the outputs from the application of the MaKE First Steps process (i.e. the definitions of knowledge).

Table 1 (overleaf) reveals the definitions of knowledge the groups produced. The author has created an identity number for each definition (first column in Table 1). The second column refers to the three contexts (see above) in which the definitions were produced.

The next section provides an analysis and discussion of these results.
Table 1: Results of application of First Steps

<table>
<thead>
<tr>
<th>Definition Identity Number</th>
<th>Context</th>
<th>Definition of Knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>See 5.1</td>
<td>&quot;the integration and reuse of ideas, experience, skills, intuition and lessons learned that influences our problem solving, decision making and the way we work to continually create tangible outcomes of brand value and business worth.&quot;</td>
</tr>
<tr>
<td>2</td>
<td>See 5.2</td>
<td>&quot;Knowledge is an intangible asset and a spiral process of sharing information with each other&quot; Group 1</td>
</tr>
<tr>
<td>3</td>
<td>See 5.2</td>
<td>&quot;Includes the ideas and experience known by a group or an individual in an organisation. This includes awareness of the structure, processes, technology and the people&quot; Group 2</td>
</tr>
<tr>
<td>4</td>
<td>See 5.2</td>
<td>&quot;A continuous process of learning from experiences, collecting information, recording insights to measure and enhance performance for the effectiveness and efficiency of the organisation.&quot; Group 3</td>
</tr>
<tr>
<td>5</td>
<td>See 5.3</td>
<td>&quot;Knowledge is an understanding or information that has been obtained by study or experience and that is either in a person’s mind or possessed by people generally which can be applied to a business as a sort of intangible asset to run the business more scientifically and effectively&quot; Group 1</td>
</tr>
<tr>
<td>6</td>
<td>See 5.3</td>
<td>&quot;Knowledge is an important intangible asset which can bring a large amount of value to the organisation. It includes science, technology, information, experience, management talent, concepts and adjudgement, etc., which are essential elements for efficiency promotion, organisation, innovation and stronger competition, power advancement and are used to conduct the organisation's behaviour. The main character of knowledge is easy to be learnt, spread and transformed in the organization.&quot; Group 2</td>
</tr>
<tr>
<td>7</td>
<td>See 5.3</td>
<td>&quot;It is a kind of special intangible asset. It consists of experience, know how, technology, insights etc Through effective use, it can bring productivity, creativity, competitive advantages, effectiveness and profits etc&quot; Group 3</td>
</tr>
<tr>
<td>8</td>
<td>See 5.3</td>
<td>&quot;Knowledge is [an] intangible resource that can be integrated and organised. It represents the fruits of the human resource which includes insights, skills, experiences, procedures and diversified cultures. It is an essential resource to improve the efficiency of organisations and to make its development sustainable and strong.&quot; Group 4</td>
</tr>
<tr>
<td>9</td>
<td>See 5.3</td>
<td>&quot;Knowledge is a kind of asset. It consists of experiences, thoughts, creative ability, intelligence and a set of insights which are known by a person or group of people in a company. It is very important for a company’s efficiency, competition and future development.&quot; Group 5</td>
</tr>
</tbody>
</table>

7. Analysis and discussion of results
This section analyses and discusses the results using different approaches.

The first approach is a word count. This is an approach that can be applied to the analysis of qualitative data that is a relatively simple way of categorising it (Saunders et al. 2007). All the definitions in Table 1 were analysed to see what, if any, words were repeated, and if so, how many times. To determine this, each word (other than ‘knowledge’ and prepositions) were counted. Some words can be truncated. For example ‘created’ has the ‘trunk’ of ‘creat’. This trunk can be used to form a number of different words by the addition of different endings. For these words, the truncated stem of the word was used in the word count find. The results of this simple approach technique are given in Table 2.
Table 2: Words used more than once in definitions of knowledge

<table>
<thead>
<tr>
<th>Repeated Words (alternative spellings are in brackets and truncated words are identified by asterisks)</th>
<th>Number of times word repeated in definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experience(s)</td>
<td>8</td>
</tr>
<tr>
<td>Organis(z)ation</td>
<td>8</td>
</tr>
<tr>
<td>Intangible</td>
<td>5</td>
</tr>
<tr>
<td>Asset(s)</td>
<td>5</td>
</tr>
<tr>
<td>Information</td>
<td>4</td>
</tr>
<tr>
<td>Efficiency</td>
<td>4</td>
</tr>
<tr>
<td>Insight(s)</td>
<td>4</td>
</tr>
<tr>
<td>People / person</td>
<td>3</td>
</tr>
<tr>
<td>Learn*</td>
<td>3</td>
</tr>
<tr>
<td>Technology</td>
<td>3</td>
</tr>
<tr>
<td>Business</td>
<td>3</td>
</tr>
<tr>
<td>Etc</td>
<td>3</td>
</tr>
<tr>
<td>Resource</td>
<td>3</td>
</tr>
<tr>
<td>Process*</td>
<td>3</td>
</tr>
<tr>
<td>Creat*</td>
<td>3</td>
</tr>
<tr>
<td>Ideas</td>
<td>2</td>
</tr>
<tr>
<td>Science / scientifically</td>
<td>2</td>
</tr>
<tr>
<td>Effectiveness</td>
<td>2</td>
</tr>
<tr>
<td>Value</td>
<td>2</td>
</tr>
<tr>
<td>Group</td>
<td>2</td>
</tr>
<tr>
<td>Essential</td>
<td>2</td>
</tr>
<tr>
<td>Competition</td>
<td>2</td>
</tr>
<tr>
<td>Integrat*</td>
<td>2</td>
</tr>
<tr>
<td>Development</td>
<td>2</td>
</tr>
<tr>
<td>Strong*</td>
<td>2</td>
</tr>
</tbody>
</table>

In the definitions of knowledge in Table 1, the words experience(s) and organis(z)ation are used more than any other words. This suggests most of the participants considered experience as an important aspect of knowledge, and that experience and knowledge are linked. It also suggests that they focused on knowledge relevant to their organisation. This is probably explained by the environment in which the research was conducted.

The next most popular words were ‘intangible’ and ‘asset(s)’ which have a count of five each. In the majority of definitions knowledge is considered an intangible asset, and a number of participants attempted to suggest where it resides in an organisation. Where this occurs, most suggest that it resides or derives from people. Virtually all the other words that are repeated relate to intangible aspects of knowledge that are people-centric (not computer-centric or paper-based).

The other repeated terms (i.e. etc, strong, business, competition, process, and technology) indicate that the participants believe that knowledge is something that has many different qualities / characteristics that can be added to, and that it provides competitive advantage. Some suggest that it is also related to technology and processes.

Another way to analyse the results is to categorise the content of the definitions. One way to do this, is to see what forms of knowledge participants refer to. Sharp (2003 adapting Snowden 2002) suggested that knowledge can exist in a number of different forms in an organisation. It can be tacit. By this, the author refers to what is within someone’s head / body and may not be possible to articulate. It can also take the form of being manifested in speech and action. Finally, it can also take the form of physical objects or be expressed in writing in diagrams or text. Table 3 summarises the content of the definitions using these categories.

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Table 3: Forms of knowledge referred to in the results

<table>
<thead>
<tr>
<th>Form of knowledge</th>
<th>Which definitions refer to these different types of knowledge (identity numbers from Table 1 used below)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tacit (within someone’s head / body and not necessarily possible to articulate)</td>
<td>1, 2, 3, 4, 5, 6, 7, 8, and 9</td>
</tr>
<tr>
<td>Manifested in speech and action</td>
<td>1, 2, 3, 4, 5, 6, 8 and 9</td>
</tr>
<tr>
<td>Formed into physical objects or be expressed in writing in diagrams or text</td>
<td>2, 4, 6, [in each case referring to information generation / use / sharing]</td>
</tr>
</tbody>
</table>

All the definitions refer to the tacit nature of knowledge and in all except one case, the definitions refer in some way to communicating it by speech or action. In three cases it is inferred that it is something that should be expressed in writing or on paper in some way.

The results can also be analysed by scanning the definitions and repeatedly reading them to discern whether there are any common themes. There seem to be five common themes that are referred to in all, or virtually all, the definitions. These are that knowledge:

- is human-based and particularly refers to the use of skills learnt through experience; [‘Skills’ refers here to what employees can actually do in a company. Broadly this includes virtually any activity described by a verb.]
- is bound up with its organisational context and valuable when tailored to it;
- improves the effectiveness, value and/or competitive edge of organisations;
- is particularly valued when it is applied in its organisational context and;
- is also valued when it is possible to share it.

Also, a couple of definitions suggest the integration of knowledge in an organisation using technology also helps.

These observations corroborate the trends noted using different approaches to analysing the primary data.

Finally, the author observed how the different participants reacted to their own definitions once they had created them. In all cases the participants found the definition itself a focus for conversation about the relevant organizational context. In the case of the FMCG, it publicized in the organization and used in the implementation of MaKE (Sharp 2003). Among the international students it was also used to devise strategies for their case study. In the Chinese bank it was used by delegates to generate ideas to change the organization which are being implemented. The way the participants used their definitions suggests they think that relevant definitions of knowledge can really help make plans to manage knowledge in organizations. These findings corroborates with the others referred to in this section.

8. Conclusion

The results of this research reveal that definitions of knowledge for organisational contexts are valued by participants. MaKE First Steps was implemented with very different participants in terms of culture and organisational context. However, there are some common strands to their definitions of knowledge that accompany differences. The common strands are that knowledge is:

- is human-based and particularly refers to the use of skills learnt through experience;
- is bound up with its organisational context and valuable when tailored to it;
- improves the effectiveness, value and/or competitive edge of organisations;
- is particularly valued when it is applied in its organisational context and;
- is also valued when it is possible to share it.

The particular skills that are referred to are problem-solving, insights, learning, ideas, structures, and judgement. The processing of these things, integration and communication of them along with the technology completes the picture of what is valued.

So what should we learn from this about the nature of knowledge and how to manage it in organisations? This research gives us an insight into what organisations should focus on in terms of investment of energy, time and resources. Broadly, they should focus on the skills and learning of the personnel that make the
organisation they work for special. These areas should be nurtured, tailored and applied to the organisation's context to make it more effective for its purpose(s). The processing of information and sharing ideas using technology should support the above.

This research in conjunction with MaKE (2006b) also shows that defining knowledge for specific organisational contexts is useful in identifying what to focus on and how to do it.

Note about MaKE and MaKE First Steps

MaKE stands for 'Manage Knowledge Effectively' (Sharp, 2003). The author wishes to acknowledge that this is not to be confused with an acronym symilar, but different to this one, which is described in Winfield, M. J., Basden, A., and Cresswell, I. (1996), Knowledge Elicitation Using a Multi-Modal Approach, World Futures, Vol. 47, pp.93-101. MaKE is a trademark owned by its author, Peter Sharp who also designed and created MaKE First Steps. Michael Simm helped 'test' it prior to taking it into a commercial environment. Alan Eardley and Hanifa Shah were Peter's supervisors.

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References


Knowledge Maps and Mathematical Modelling

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Abstract: The aim of our paper is to explain a mathematical model as a special case of symbolic knowledge map. Each knowledge mapping is a visualization of knowledge for the purpose of eliciting, sharing and expanding. Tools of such visualization can be of various types. But in reality many types of so-called knowledge maps are only data flow or information flow diagrams. Our paper will define the most important features which every knowledge map must satisfy, for instance it must include chronological, hierarchical, associative, causal and evaluative relationships, it must improve the quality of knowledge etc. In our paper we will prove that a mathematical model satisfies all requirements to be called a knowledge map. Neither definition nor categorization and taxonomy of knowledge mapping are unified in the literature so the authors try to start with working on this field. Knowledge map is a visual interception of knowledge with the aim of its storage, sharing and development. Weak descriptive knowledge maps may be used for explaining the ideas and concepts connected with OR models, as well as for explaining the new knowledge gained with the models, in a well-structured form.

Strong descriptive knowledge maps can serve to describe real relations between the objects of the models or real elements in relation to their positioning. In this case the object placing does not describe only its physical position but also, for instance, its economical indexes. Like the normative OR models, the normative knowledge maps show the normative solution, or help to find the best, desirable or advisable solution. After suggestions of how to categorize knowledge maps (above) mathematical models of various types with all features and properties are presented as a knowledge map.

Keywords: knowledge map, knowledge map categorization, mathematical model, model construction, algorithm, model solution

1. Introduction

Mapping knowledge in its authentic substance has a template in geographical mapping, particularly military mapping, the roots of which stretch deep into the antique world. The first cartographers, who were already conscious of their limited knowledge, decorated their maps with various dragons and lions in the places, where exact data were absent. The maps documenting the ratio of knowledge in the face of ignorance arose this way, because knowledge in itself rises only on the basis of a successfully solved problem. Geographical maps were static in the principal points, but military maps included some dynamic features because of drawings or other graphic descriptions of the battle or the progress of its stages (pre-battle tactics, battle strategy, possible post-battle situations – many times in various scenarios). Much sooner, 30 000 years ago, the first cave paintings showing how to hunt a wild beast appeared. An unknown hunter codified his knowledge in the dynamic form for the purpose of sharing it with future generations. Knowledge mapping is the visualization of knowledge using a map, it means using non textual graphical form including a progress of problem solving for the purpose of its further reading, using, sharing and evolving.

2. Proposed knowledge maps typology

As mentioned above, the knowledge map is a visual representation of a successfully solved problem, including solving process (Stanford 2000). The solving process should contain at least four steps of the Simon’s problem decomposition, i.e. intelligence activity, design activity, choice activity, and review activity (Simon 1960). Gordon (2002) also shows that knowledge maps may be referred to as maps of the way of acquiring knowledge. The knowledge maps are important as building knowledge tools as well as thinking tools (Rogers 2000). There are various definitions of the terms 'knowledge map' and 'knowledge mapping'. Stanford (2001) defines it as follows: "Knowledge mapping quite simply is any visualization of knowledge beyond textual for the purpose of eliciting, codifying, sharing, using and expanding knowledge." Graphic symbols play a key role in each knowledge map; their positions and spatial relationships are mostly expressed with the use of arcs or edges. The knowledge map must show a progression of ideas with relationships beyond their being just spatial. Knowledge maps include conceptual relationships, such as chronological, hierarchical, associative, causal, logical and evaluative (Stanford 2001). Each knowledge map, as a special type of reality model, for instance, a reality image, simplifies the visualisation of reality.

Similarly to the typology of models based on the model form, knowledge maps could be divided into two main groups:

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Analogical maps and iconic maps, where the analogy between real objects and symbols, plus their spatial relationships and behaviour are crucial for the map understanding.

Symbolic maps emphasizing the meaning of symbols, usually mathematical or verbal. This kind of maps generally doesn’t insist on the symbol position. Elements of these maps are rather abstract (terms, expressions) and relations between them are expressed using mathematical formulas or verbal sentences or phrases.

Another typology of knowledge maps is based on the character of judgment or solution of the (successfully) solved problem (Baron, 2004):

- Descriptive maps (weak and strong), describing and simulating the real situation as precisely as possible.
- Normative maps, relating to a typical standard or norm, to optimal solution, or to the best decision,

2.1 Weak descriptive knowledge maps

Weak descriptive maps describe the real situations using different kinds of symbols and arcs connecting them. Graph theory models are typical tools for building this kind of maps. Passing through this map helps the user to reach the problem understanding, increasing his/her level of knowledge of “how to” solve a problem. The mutual positions of objects (elements) are unimportant, only the symbols themselves and the quality of their relationships are relevant for map reading and problem solving. Conceptual maps (Figure 1) as typical weak descriptive maps are simple and practical knowledge representation tools that allow you to convey complex conceptual messages in a clear, understandable way. It helps to organize terms, concepts and other items mostly in a hierarchical way, where the most general concepts lie in the root of the tree, and as we move down the structure we replace them with the more specific ones. A conceptual map is a diagram showing the relationships between concepts. Concepts are connected with labelled arrows, in a downward-branching hierarchical structure. The relationship between concepts is articulated in linking phrases, e.g., “gives rise to”, “results in”, “is required by,” or “contributes to” (http://en.wikipedia.org). Passing through this map means following the flows not only from general to specific but also from abstract to concrete.

Decision trees, flow charts representing algorithm progresses, and network diagrams for strategy implementation are only just a few representatives of this kind of maps in the field of Operations Research and Management Science.

![Concept Map](http://en.wikipedia.org)
2.2 Strong descriptive knowledge maps

Not only objects, symbols or texts are important for this kind of knowledge map. It includes more than text, such as symbols, legends and other visual objects. Thus to be a knowledge map the item must use spatial relationships to elicit, share and codify knowledge (Stanford 2001). Such knowledge map must show a progression of ideas with relationships beyond their being just spatial. Knowledge maps include conceptual relationships, such as chronological, hierarchical, associative, causal, logical and evaluative. Geographical maps are typical representatives of strong descriptive maps. Objects with properties and their spatial relations are mapped using isomorphic projection and a good quality quantitative (or sometimes qualitative) metric is needed for object distances measurement. As a quantitative expression of distance the closest distance between two nearest points of objects is considered. Not only the distance units can be used for such measurements - in special types of strong descriptive maps also costs, weights or points could be used.

Considering the distance ad its measurement, three types of spatial relationships are defined: proximity, adjacency, and containment (Figure 2).

Figure 2: Spatial relationships types in strong descriptive maps

The rules for relationship types establishing:

- **Proximity**: Distance between objects $U_i$ and $U_j$ is non-zero, positive but small, i.e. $V(U_i, U_j) \in (0; M)$, where $M$ is the upper limit of distance, where the objects still interact.

- **Adjacency**: Distance between objects $U_i$ and $U_j$ is equal to zero, both objects have a common interface, i.e. $V(U_i, U_j) = 0$.

- **Containment**: Distance between objects $U_i$ and $U_j$ is negative. i.e. $(V(U_i, U_j) < 0)$. Objects can but need not have a common interface. According to the existence or non-existence of a common interface we define either partial or full containment.

2.3 Normative knowledge maps

In this case, the aim of the knowledge map is to introduce the approach of how to reach the target (solution), or of how to reach the comparative norm. Strategy maps cover the major part of this knowledge map type. Strategy maps are a way of providing a *macro* view of an organization’s strategy, and provide it with a language in which they can describe their strategy, prior to constructing metrics to evaluate the performance against their strategy [en.wikipedia.org]. Strategy knowledge map is a technique of creation and use of graphical interpretation of situation in an organization or any other system. A Strategy Map is a diagram that describes how an organization creates a value by connecting strategic objectives. It describes organizations trends, main streams of effort (Mission and Vision statements) and targeting (way of reaching the norm). A good example of normativity of strategic maps can be shown by the example of the so-called Vee map (Figure 3). As its name suggests, the Vee map is of the letter "V" shape. It is a way of exploring the tension between the theory and the method and using this to gain and retain knowledge. The Vee map follows two axes extending down from the top to form a point at which they join at the bottom. The theory or concepts follow one axis and the methods or how-to follow the other. The problem statements or questions for examination are fed or funnelled down the centre between the two axes and eventually the assessment against each will bring the examiners to their conclusions or solutions (Stanford 2001).

Figure 3: Basic vee map as a representative of normative knowledge maps (Stanford 2001)
3. Knowledge maps and mathematical models

3.1 When and why use mathematical models

Answer to this question can be found using a conceptual map describing the relation between solved problems, existing models and the process of application. This map can be characterized as a weak descriptive map showing the main steps of process solving. Brinkmann (2005) shows this type of knowledge maps as a tool to build structures in mathematics. Let's use the Leontief Input – Output model as a typical example of knowledge maps. The first map (Figure 4) represents the selection of the proper model type. This map is a normative map, because it shows which model has to be used for solving of different problems. The second one (Figure 5) shows the data that are necessary for the application of this type of model and relations between the model features, so it is a weak descriptive knowledge map.

![Figure 4: Normative knowledge map for the best model selection](image)

3.2 Simulation models

What kind of knowledge map is a standard simulation model? Usually this kind of models is described (drawn) as a flow chart (Figure 6) – which shows a weak descriptive map. Only object symbols and quality of relations between them are important for the model simulation. The object placement is important only for objects consequence description and it is impossible to set some metric for this placement.
3.3 Decision tree

Decision tree is a graphical form of a decision model and it can be explained as a weak descriptive knowledge map describing decision situations, possible decision alternatives, and states of nature and sequence of these elements (Figure 7).

Figure 7: Decision tree – description of successive decisions

When we add rules for the best alternative selection we obtain a normative knowledge map leading to the normative decision (Figure 8).
3.4 Strategic knowledge mapping in project management

Conventional project management model is, from the mathematical point of view, a graph theory model or network model. Usually, the project tasks are drawn with the use of the nodes in this chart and the relationships between the nodes are expressed using arcs ("Activity on Node graphs). As mentioned before, the network model (sometimes called a PERT Chart) is a weak descriptive knowledge map. More sophisticated methods can be used for expressing the knowledge flow and transformation during the project tasks progress. One of them is a WBS chart (Figure 9), which describes the project tasks hierarchy without time information. This chart is also a weak descriptive map.

Figure 8: Decision tree with the best decision selection

| **Figure 9:** WBS chart (weak descriptive map) |

The Gantt chart (Figure 10) places every task on a specific date and displays the tasks dependencies exactly on the time scale, and is therefore a strong descriptive map. Usage of timescale moves this kind of knowledge map one level higher – into the group of strong descriptive maps. Tools for the tracking project progress and comparison of the task finish dates transform this mapping into a normative knowledge map.

| **Figure 10:** Gantt chart (strong descriptive map) |
4. Conclusion

This paper suggests a new type of knowledge map classification based on OR models features. This approach arises from the idea that knowledge and application of the Operational Research models can be read as a graphical representation using different types of knowledge maps. Weak descriptive knowledge maps may be used for explaining the ideas and concepts connected with OR models, as well as for explaining the new knowledge gained with the models, in a well-structured form. Strong descriptive knowledge maps can serve to describe real relations between the objects of the models or real elements in relation to their positioning. In this case the object placing does not describe only its physical position but also, for instance, its economical indexes. Like the normative OR models, the normative knowledge maps show the normative solution, or help to find the best, desirable or advisable solution.

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Exploration of Knowledge Sharing Challenges in Value Networks: a Case Study in the Finnish Grocery Industry

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Abstract: Business activities are increasingly organized through networks. This article considers the value network of the Finnish grocery industry, a network where the web of relationships between two or more companies creates tangible and intangible value through the complex and dynamic exchanges. In value networks the relationships between the participants of the network tend to be more complex than the traditional make-buy-relationships, as companies create value together through different types of relationships such as deep buyer-supplier-relationships or strategic partnerships. This variance in the nature and level of collaborative relationships poses new challenges to knowledge sharing. Complementing previous research on the challenges to knowledge sharing in other network settings, this article explores the knowledge sharing challenges specific to value networks based on a qualitative case study about the value network of the Finnish grocery industry. The data consists of 32 thematic interviews of top and upper management representatives from 16 companies in the value network.

The results show that the current collaborative relationships in the Finnish grocery industry are functional and working, but mostly just traditional “arms-length” buyer-supplier-relationships. However, the challenges to knowledge sharing seem to be somewhat different to those present in other network settings. The challenges to knowledge sharing in value networks do not seem to concern so much the opportunities for knowledge sharing, but the motivational and cultural factors affecting what knowledge is shared and how much knowledge is shared. Based on these results, the knowledge sharing challenges of the value network can be crystallized under three points. First, the focus of knowledge sharing has been on information, and the organizational arrangements do not encourage the sharing of valuable know-how. Second, the organizational cultures and top management directives do not encourage external knowledge sharing, and therefore knowledge is not shared. And third, the experiences of past abuses of trust and the retail groups renewed focus on price bargaining undermine the trust between the companies, thus inhibiting knowledge sharing.

Keywords: knowledge sharing, knowledge sharing challenges, value networks, collaboration, case studies

1. Introduction

In today’s competitive environment, business activities are more and more organized through networks as globalization, increased technological complexity, and development of ICT make them increasingly attractive to companies. The concept of network has gained in popularity also in the management literature, and many different collaborative relations such as supply networks (e.g. Harland et al. 1999), industrial networks (e.g. Axelsson and Easton 1992), R&D networks (e.g. Lam 2003), strategic networks (e.g. Gulati et al. 2000), and the network organization (e.g. Baker 1992) have recently been studied. However, even if it has been widely acknowledged that the business of companies or even the company itself should be viewed in the context of networks very few articles consider the actual business, i.e. value creation, in network terms.

To address this lack in existing literature, this article will discuss value networks. A value network is the network of relationships that creates tangible and intangible value through the complex and dynamic exchanges between two or more organizations (Allee 2002). Any network where the participants are engaged in these kinds of exchange relations can be seen as a value network, whether in private industry or in public sector, or whether the value network has been acknowledged by its participants.

In the traditional value chain model (Porter 1985) value was created through the exchange of tangibles such as goods and services. According to the value network approach (Allee 2000, 2002) value is created not only through the exchange of tangibles, but also through the exchange of intangibles such as knowledge, customer loyalty, sense of community, or increased security. The value network approach considers that intangibles are negotiable and deliverable, not just plain assets. People engaged in knowledge exchange, for example, are usually held accountable for the execution of that exchange, and companies have developed various performance metrics for the quality, speed, quantity, etc. of the knowledge they deliver or receive. Further on, companies use the intangibles of others as part of their own offering, and e.g. car manufactures often co-produce value with various insurance and financing companies in order to provide their customers with a complete, competitive package. Thus, in value networks the exchange is not just about realizing value, but about providing value for the other participants, enabling them to do something better.
Due to their above described nature, the relationships between companies in value networks tend to be more complex than the traditional make-buy-relationships. Traditional buyer-supplier-relationships consider only the exchange of tangible value, and do not see intangibles as objects of exchange between business partners. On the contrary, in value networks this intangible value exchange is considered to be the real foundation for value creation (Allee 2002). In these value networks companies usually operate through different types of relationships than traditional make-buy-relationships, e.g. deep buyer-supplier-relationships (Dyer 1996; Liker and Choi 2004) or strategic partnerships (Jarillo 1988). Thus, in order to stay competitive companies need to look beyond the traditional “arms-length” buyer-supplier-relationships, and build deeper and more intricate value networks with their suppliers, distributors, customers, competitors, and other stakeholders.

This variance in the nature and the level of collaboration between the different actors of a value network poses new challenges to interorganizational knowledge sharing. A growing body of empirical evidence indicates that organizations that are able to share knowledge effectively from one unit to another are more productive and more likely to survive than organizations that are less adept at knowledge sharing (e.g. Baum and Ingram 1998; Darr et al. 1995). However, even if knowledge sharing is essential for the functioning of any business network, it is especially important in value networks as it directly influences the co-creation of value between the different actors participating in the network. Without the capacity for sharing knowledge, companies can not access and utilize the specialized resources and capabilities of other companies in order to create new knowledge (Nonaka and Takeuchi 1995).

Knowledge sharing is a complex process (Lessard and Zaheer 1996) as it refers not only to information but also beliefs, experiences, and contextualized practices that are difficult to convey (Davenport and Prusak 1998). Most accounts of interorganizational knowledge sharing have disregarded this point, considering sharing more as a process of knowledge transfer, where one unit (e.g. individual, group, department, division) is affected by the experience of another (Argote et al. 2000). In this article, we will especially concentrate on the challenges of sharing knowledge: why do different units like individuals intentionally make knowledge available to other units? Accordingly, our research question is the following: What knowledge sharing challenges exist in value networks?

In the following we will first present existing literature on the topic of knowledge sharing. We will then discuss the methodology and results of our case study on the value network of the Finnish grocery industry. We will evaluate the factors affecting knowledge sharing in this specific value network, after which we will answer the research question of the knowledge sharing challenges in value networks.

2. Knowledge sharing

Researchers use many different expressions in defining knowledge. Knowledge is often cited to be a “justified true belief” (see e.g. Nonaka 1994). This traditional definition focuses on the truthfulness as an essential attribute of knowledge, emphasizing the absolute, static, and nonhuman nature of knowledge. It can not be denied however, that real-world knowledge is based at least partly on sensory data, and can be inaccurate, not truthful, and value-laid. In deed, knowledge can also present itself as ‘ground truths’ and ‘rules of thumb’ people use to understand and act in different situations, the experience that people develop through time, the intuition and insights that arises from the unconscious use of one’s skills and knowledge, and the values and beliefs that determine in large part what people notice, absorb or conclude form their observations (Davenport and Prusak 1998). So, in practice, there is often little practical utility to make a distinction between information, knowledge, and expertise (Alavi and Leidner 2001). Based on this view, we consider knowledge to include information, ideas, and expertise relevant for tasks performed by individuals, groups, or organizations.

So, knowledge sharing between individuals is the process by which knowledge held by an individual is converted into a form that can be understood, absorbed, and used by other individuals (Ipe 2003). Even if the context in this paper is on the interorganizational setting (the value network), we believe that the collaborative nature of these exchange relations demands interpersonal collaboration and sharing of knowledge. Knowledge sharing is also important because it provides a link between the individual and the organization by moving knowledge that resides with individuals to the organizational level, where it is converted into economic and competitive value for the organization (Hendriks 1999).
Various benefits of knowledge sharing in network settings have been recognized in the literature. Without the capacity for sharing knowledge, companies can’t access and utilize the specialized resources and capabilities of the various companies involved in the network. This capacity to share knowledge is also a necessary condition for the creation of new knowledge (Nonaka and Takeuchi 1995), and it has been argued that networks with superior knowledge transfer mechanisms will be able to ‘out-innovate’ networks with less effective knowledge-sharing routines (von Hippel 1988). As knowledge sharing refers to sharing of not just codified knowledge but also beliefs, experiences, and contextualized practices (Davenport and Prusak 1998), it is only through knowledge sharing that a base of jointly held knowledge, necessary for mutual understanding, can be created (Nonaka and Takeuchi 1995). This jointly held knowledge base is also vital for the development of trust between companies, necessary for deeper collaborative relations (Dyer and Nobeoka 2000; Ring and van de Ven 1994). There is also a growing acceptance of the claim that knowledge sharing is critical to performance achievement (Barthol and Srivastava 2002).

There are, however, numerous dilemmas associated with knowledge sharing in network settings. Previously as individuals in companies have always shared knowledge, knowledge sharing was considered to be a natural function of workplaces, an activity that took place automatically. Now it has been acknowledged that even under the best circumstances, knowledge sharing is a complex process (Hendriks 1999; Lessard and Zaheer 1996). Previous research suggests that there are a number of challenges associated with knowledge sharing in network settings. On one hand, Dyer and Nobeoka (2000) suggest that these problems are related to three principal reasons: lack of motivation of participants to participate and openly share valuable knowledge in the network, the problem of free riders, and the costs associated in finding the opportunities to share knowledge. On the other hand, knowledge sharing between different organizations can also be inhibited due to fear of losing competitive edge by sharing valuable knowledge, fear that can be further increased by top management directives that do not support inter-company knowledge sharing (Sun and Scott 2005). Existing differences between organizational cultures and practices can also create situations that hamper knowledge sharing: there can be clashes due to personal differences of conflicting values, people might not be open to new ideas or ways of doing things, or organizational processes might be inflexible and hard to change (Sun and Scott 2005). Finally, also the existing relationship between two or more companies and how it is managed affects knowledge sharing, for example if there is no common objective set for the collaboration or if experiences of past behavior create mistrust and discourage knowledge sharing (Larsson et al. 1998).

As all these examples suggest, many different challenges relate to the settings of knowledge sharing. However, several challenges exist also related to knowledge and the knowledge sharing process itself. For example the tacit and sticky nature of knowledge can create problems related to how the knowledge can be shared, and at the other end, the limitations related to absorptive capacity can create problems in receiving and understanding the shared knowledge (Polanyi 1966; von Hippel 1994). So, even if explicit and codified knowledge is easily shared, the tacit, sticky and complex know-how is hard to codify and imitate, and thus difficult to share (Kogut and Zander 1992; Szulanski 1996). Also the limitations related to absorptive capacity can create problems in understanding the knowledge that is being shared (Cohen and Levinthal 1990). Finally, the embedded nature of knowledge makes it context dependent, narrowly applicable, and personalized (Weiss 1999). Therefore, even information that is very context-dependent, i.e. embedded, is not likely to be shared among individuals.

In this article we will study the knowledge sharing challenges in value networks using the conceptual framework created by Ipe (2003). Ipe considers the different factors that are related to the nature of knowledge, but also to the motivations and opportunities to share knowledge. The influence of organizational culture is also considered. This framework is presented in Figure 1, and it will be used to analyze the knowledge sharing challenges in our case study.
3. Methodology

This qualitative case study (Yin 1994) presents the value network of the Finnish grocery industry. In this article, ‘retail’ refers to the daily consumer goods trade, ‘suppliers’ or ‘food industry’ to the food processing industry, and ‘grocery industry’ is used to cover both retail and food industry.

This case study is based on a research project in which the collaboration between the Finnish retail and its major suppliers was explored. The aim of the research project was to describe the current state of the collaboration from a strategic point of view, and to explore anticipated future directions. The research project was funded by a global IT service company and was carried out between September 2006 and April 2007.

The data for the case study was collected through 32 thematic interviews. The interview themes used in the study were 1) collaborative practices of the company, 2) experiences and impressions concerning the industry-wide forums promoting collaboration, and 3) the current state of the value network. The interviews lasted 1-1.5 hours and were transcribed for the analysis. As the aim of the research project was to take a strategic view to the collaboration, the interviewees represent the top and upper management of their companies: CEOs, sales and marketing executives, retail chain managers, logistics managers, and development managers. The interviewees are from 16 different organizations, including all three principal Finnish retail groups, and the major companies from bakery, meat processing, dairy, brewing, and food processing industries. Figure 2 illustrates the value network of the Finnish grocery industry and all the organizations included in the interviews.
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Figure 2: The value network of the Finnish grocery industry. The organizations included in the interviews are marked in squared, darker grey, and only the relationships between these companies are marked in the figure. Deep buyer-supplier-relationships are marked with broader lines.

The interviews were analyzed inductively. First, an analysis framework of twelve sub-themes was constructed based on a first reading of the interviews. Second, quotations concerning different sub-themes were extracted from the transcriptions and analyzed in detail using Atlas.ti software. The results were then validated in a 3-hour workshop together with the interviewees.

In the following we will first discuss the value network of the Finnish grocery industry as the context of knowledge sharing, before concentrating on the results of the study.

4. The value network of the Finnish grocery industry

We consider that the value network of the Finnish grocery industry consists of all the companies participating to the production and delivery of groceries in Finland. The number of companies in this value network is quite small. The retail is dominated by three groups that cover about 85% of total sales. Also in all the food and beverage industry branches the market is dealt between two or three big players. Besides being concentrated, the Finnish grocery market is also quite small, and all major suppliers deliver their products to the three retail groups. It is thus impossible for a retail group to build a dedicated value network, resulting in one big industry-wide value network, which all the companies are embedded in.

In the past few decades, the industry has invested in the development of supply chain processes, logistics, ICT systems for collecting customer data, category management, and continuous replenishment programs. The Efficient Consumer Response (ECR) initiative, a joint retail and food industry movement promoting a more responsive to consumer demand and the removal of unnecessary costs from the supply chain, has
been a major force in this development. There have also been initiatives to develop the collaborative relationships, until the international low-price competition hit the market some five years ago. The stiffened competition has now increased the rivalry between the three retail groups and the focus has sifted from collaboration to a hardening price competition and bargaining with the suppliers. At the same time the concentration of the market has increased the bargaining power of the retail groups over the suppliers, which has even led to some repressing behavior toward the suppliers.

The interviewees consider that these development projects have not resulted in better long-term collaborative practices in general. In fact, the companies in the industry do not currently evaluate or manage their value network. The current collaborative relations in the grocery industry are characterized by the interviewees as functional and working, but traditional: most of the relations are so-called ‘arms-length’ buyer-supplier-relationships, not deep buyer-supplier-relationships or strategic partnerships. The interviewees say that new collaborative processes are in fact needed, and the value network should be managed. However, as the industry consists of only a few major companies, the key persons still know each other rather well and meet each other regularly through the industry organizations’ collaborative forums. Generally, the interviewees consider that the greatest challenges to collaboration are related to the organizational practices and different ways of thinking, not the people themselves.

5. Results

In this chapter we will present the results of the case study considering the knowledge sharing challenges. These challenges will be considered through the following four factors (see Figure 1): nature of shared knowledge, motivation to share knowledge, opportunities to share knowledge, and organizational culture.

5.1 Nature of shared knowledge

Before considering the nature of shared knowledge, we have to discuss what knowledge is actually shared in the value network. The Finnish retail groups collect huge amounts of information about consumers, such as point-of-sale data (what is bought and what groceries are brought together) and demographic information through various customer programs. Through this information the retail groups have developed valuable know-how about consumer preferences. This knowledge is valuable to the food industry in many ways. For example, point-of-sale data can be used to make more accurate demand forecasts which are important for production planning, and know-how about consumer preferences is valuable when developing new products. The retail groups have valuable knowledge also about category management in general, in-store logistics that affect product packaging, retail chain concepts, marketing plans and so on.

The food industry conducts extensive research about various aliments, and on consumer preferences considering individual food or beverage branches. This knowledge can be valuable to the retail groups e.g. when discussing individual grocery categories and their management, or profitable bargain prices of marketing campaigns. The food industry has valuable knowledge also about the logistical challenges of their products, the pricing structure and value added of their products, the effective practices and solutions of competing retail groups and so on.

Based on the interviews, it seems that the Finnish grocery industry values especially knowledge about consumers, prices or value added, category management, other companies, and category management. Only knowledge about production volumes or demand, i.e. knowledge needed for the supply chain processes, is shared voluntarily. Also valuable knowledge is shared, but companies are suspicious and do not engage in sharing of valuable knowledge unless they receive something in return. This is the case even with companies that are engaged in deeper collaboration: companies can share knowledge related to category management, but at the same time they do not share their know-how about customer preferences and new product ideas.

According to the interviewees, the industry values both information and know-how. As we saw, earlier development has recently focused on various ICT systems and processes based on them, so it is natural that the companies attribute special value not just to know-how but also to information. It is true that in the industry the amount of available information is enormous (e.g. point-of-sales data), and its use has high potential e.g. in demand forecasting. However, the potential of this kind of information is dependent on network externalities. For example, in production planning the potential of demand forecasting will realize only if all the retail groups use the same kind of forecasting methods or at least provide the same information to the food industry.
Even if know-how is considered to be valuable, the focus is still on information. In fact, the knowledge that is been shared in the industry is mostly information, not know-how. The interviewees told that some know-how was shared, for example when exact information about demand forecasts were not available, people shared estimates based on know-how. These situations were still mainly informal. One reason why know-how is not shared seems to be that it has more emotional ownership (Jones and Jordan 1998) than information, a matter that affects the motivation to share that knowledge.

5.2 Motivation to share knowledge

The motivation to share knowledge is influenced by both internal and external factors. Internal factors include the perceived power attached to the knowledge, and the reciprocity that results from sharing knowledge (Ipe 2003). Based on the interviews, the perceived power does not seem to affect knowledge sharing in the Finnish grocery industry. Knowledge is not shared because of fear of losing competitive edge by sharing valuable knowledge, not because of motivation to gain power through it. Nonetheless, reciprocity was an important factor in knowledge sharing, as the sharing is easier in situations where both parties considered that they were benefiting from collaboration (win-win-situations). However, the fear of exploitation seems to be present even in these situations, and the trust that was created is easily destroyed if one of the participants leaks the received knowledge to other parties.

External factors that influence the motivation to share knowledge include the nature of the relationship between the companies, and the rewards that are received for sharing knowledge (Ipe 2003). The lack of trust is a critical barrier to knowledge sharing. According to the interviewees, mistrust is often related to experiences of past behaviors. In deed, the interviewees had many stories about situations where the sharing of valuable knowledge with a collaborative partner had resulted in the partner either using the knowledge to his own purposes (e.g. retail groups using new product ideas for their own private labels) or leaking it to competitors.

On an individual level, the relationships are quite good as the people know each other. However, the effects of good personal relations are bounded by two things. First, often the contact between companies is arranged through one specific person, typically a client account manager or a category captain, so only a limited number of opportunities to share knowledge exist. Second, the fact that no formal incentives or rewards for sharing knowledge are introduced hinders the knowledge sharing considerably, especially as people are not likely to share knowledge without strong personal motivation (Stenmark 2001). In the Finnish grocery industry no rewards for knowledge sharing exist, and in general top management has not initiated directives that tell what kind of knowledge can or even should be shared.

5.3 Opportunities to share knowledge

The opportunities to share knowledge can be both formal and informal in nature. Formal opportunities include e.g. training programs, structured work teams, and ICT systems that facilitate the knowledge sharing (Ipe 2003). Through the Efficient Consumer Response (ECR) initiative the industry has recently invested on training programs e.g. on the development of a “common vocabulary and mindset” for collaboration. Also various collaborative forums exist, organized by an industry organization common to both the retail and food industries. However, other formal opportunities, especially in company-specific relationships, are lacking. Very few structured work teams are formed, and the ICT systems for sharing information are still under development. As was already stated, formal knowledge sharing between companies is usually organized through one specific person, which creates many problems related to sharing of complex and embedded knowledge (e.g. logistics information), that is not understood by this person. In these cases interviewees normally relied on informal opportunities to knowledge sharing.

Informal opportunities to share knowledge include e.g. personal relationships and social networks that facilitate the sharing of knowledge (Ipe 2003). In the absence of trust, people have an increased need for informal opportunities to share knowledge (Andrews and Delahaye 2000). In the Finnish grocery industry, the close relationships between people and the various collaborative forums imply that plenty of informal opportunities for knowledge sharing exist. However, the focus on information and ICT systems somewhat hinders the use of these opportunities.

5.4 Organizational culture

Organizational culture shapes the assumptions about which knowledge is valuable and when to share knowledge, thus creating the context for knowledge sharing (de Long and Fahey 2000). Based on the
interviews, it seems that most of the companies in the Finnish grocery industry do not have organizational cultures that encourage knowledge sharing. Many companies encourage internal knowledge sharing and openness, but according to one interviewee, they consider external knowledge sharing as a “necessary evil”. It seems that past experiences of deceit have made even companies previously supporting knowledge sharing cynical about the possibilities of honest collaboration.

Even more barriers to knowledge sharing are created by the strong power-position of the retail groups. These groups are now in a powerful bargaining position, and this has made them very self-assured and arrogant toward their suppliers. Some interviewees told stories about retail groups intentionally making decisions against the recommendations of their suppliers at first, just to prove that they can, and later on implementing these recommendations when nobody is watching anymore. This repressing attitude has somewhat deteriorated the collaborative relationships between the companies, and is clearly affecting the attitudes toward knowledge sharing.

6. Discussion

As the results show, the challenges to knowledge sharing in value networks do not seem to concern so much the opportunities to knowledge sharing, but the motivational and cultural factors affecting what knowledge is shared and how much knowledge is shared. The mistrusting atmosphere in the value network is also a major factor in hindering the motivation to share knowledge. Based on these results, the knowledge sharing challenges in the value network of the Finnish grocery industry can be crystallized under following three points.

First, the focus of knowledge sharing has been on information, and the organizational arrangements do not encourage the sharing of valuable know-how. More attention should be paid to developing formal opportunities to share know-how, and in developing deeper relationships that facilitate the development of mutual understanding that promotes the sharing of know-how.

Second, organizational cultures and top management directives do not encourage external knowledge sharing, so knowledge is not shared. If the companies truly want to share knowledge, they should pay more attention to the objectives of inter-company collaboration, and create top management directives that clearly specify what knowledge can be shared. For example, formal rewards for knowledge sharing could be taken into use.

And third, the experiences of past abuses of trust and the retail groups’ renewed focus on price bargaining undermine the trust between the companies, thus inhibiting knowledge sharing. The power position of the retail groups and their acting on that position through increased focus on low prices and “arms-length” supplier relationships has highly restricted the amount of knowledge that is being shared in the value network. The companies should pay more attention to the nature of relationships, and develop deeper relationships that promote trust between companies.

In general, these challenges to knowledge sharing reflect the challenges found in previous research. Challenges such as lack of trust and mutual understanding, experiences of past behavior that hamper the knowledge sharing, fear of losing competitive edge by sharing valuable knowledge, and lack of common objectives between companies, are relevant also in value networks.

In value networks no top management directives are available, which stifles the knowledge sharing (Sun and Scott 2005): the question is more about the lack of directives. It seems that in value networks the role of valuable knowledge is also more important than in other network settings, and the power positions between companies are more significant. It should also be noted that value networks are not voluntary in the same sense than e.g. strategic networks, at least in concentrated markets where companies have to collaborate with all the major companies. The companies in value networks collaborate with each other, but at the same time they are competitors. For example, in the grocery industry the private labels directly compete with other food products. In these kinds of situations it is especially difficult to determine what knowledge can be shared, and the role of top management directives gain importance.

7. Conclusion

In conclusion, the knowledge sharing challenges of value networks concern mainly the lack of motivation and tendency to avoid knowledge sharing when it is not specifically encouraged by the top management. As clear opportunities to share knowledge do exist, companies should concentrate on building trust between
their partners and clarifying the objectives of collaboration. More focus should also be paid on the sharing of
know-how, supported by deeper relationships and strategic partnerships, especially if companies wish to
enhance the co-creation of value through knowledge creation, e.g. in developing new innovative products
together.

As this article has studied the knowledge sharing challenges in value networks only through one particular
study, the results are hardly very generalizable. We feel, however, that the presented results provide
valuable insights into knowledge sharing challenges in value networks that warrant further attention. It seems
that the nature of the collaborative relationships and the value network itself affect the processes of
knowledge sharing in ways that are not yet covered in the current literature. More research is needed
especially on the operational level of collaboration, so that the challenges can be studied in more detail.
Future studies should also take into consideration the nature of the value network itself, as different value
systems impose different knowledge sharing requirements for the value network (Möller and Svahn 2002)
and thus affect also the challenges to knowledge sharing.

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Does Intellectual Capital Management ‘Make a Difference’? A Critical Case Study Application of Structuration Theory

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Abstract: The central problem addressed in this paper is how intellectual capital (IC) management can progress beyond measurement and disclosure to provide a more dynamic interpretive scheme, in order to meet strategic management’s demand that IC should ‘make a difference’.

Via a longitudinal case study, we observe an evolving use of narrative in disclosing IC and the manner and impacts of that change, set in the real example of a sophisticated organisation’s struggle to realise the potential value of managing IC amidst rapid business change and intense competition. In order to frame the discussion, elements of Giddens’ ‘structuration theory’ are critically applied to understand the recursiveness of the change that occurred from within the organisation.

We report three main findings. First, we identify how IC narrative evolved in response to significant changes to the organisation’s operating environment, as reflected in changes to the framework adopted for managing IC despite continuing frustration in realising the envisaged benefits. Second, we establish the use of structuration theory as a tool to analyse the manner and impact of IC practices in future research. Third, we show how the stated aims of IC practice have not yet been fully realised by the studied organisation, thus providing a realistic example of the possible failings of IC practice due to inadequacies of the modalities employed by management to bring about recursive change and the need for a fuller assessment of projective agency.

Keywords: intellectual capital, structuration, narrative, organisational change, strategic impact

1. Introduction

The study of intellectual capital (IC) has been marred by the inability to create similar meaning for all organisations and, as Mouritsen (2006: 822) posits, attempting to do so may be almost an impossible task. Furthermore, IC discourse has essentially been about ‘knowledge intensive’ companies, those wherein a very high proportion of market value is ascribed to intangibles (Guthrie, 2001), leaving the question of the relevance of IC for ‘other’ types of firms subject to speculation or silence. Additionally, the theoretical frameworks by which IC has been investigated have not developed much in the past few years, suggesting there is possible value in looking at the practice of IC from different theoretical perspectives.

This paper addresses these issues through a case study of IC practice in a European manufacturing firm, in order to evaluate the impact of the management of IC on the organisation and to account for their continuing struggle to achieve desired outcomes. Giddens’ (1976; 1984) structuration theory is used as the analytical framework. To do so, this paper is presented in four further sections. First, section 2 establishes the use of structuration theory and justifies its applicability to the analysis of IC narrative. Section 3 then profiles our research site and method, while section 4 discusses the results of our research through a critical application of the structuration theory framework. Lastly, section 5 discusses our findings and limitations, and offers brief concluding remarks on further application of the framework.

2. Narrative, structuration theory and IC discourse

Why do organisations invest in IC and what difference does it supposedly make? To answer this Marr et al. (2003) identified five main reasons why organisations manage IC, namely: to support strategy formulation; strategic development, diversification and expansion decisions; assessing strategy execution; employee compensation; and communication of measures to external stakeholders. In addition Peña (2002) argues that active management and development of IC may be associated with higher levels of organisational performance, while Dumay and Tull (2007) found that even partial disclosure of how an organisation manages its IC may also lead to other benefits such as a sustained increase in share price and mitigates the negative consequences of otherwise failing to fully disclose such information. Thus, the management of IC seems to offer potential benefits ranging from assisting the improvement of management processes to potential operational and financial benefits for multiple stakeholders.
In response to a need for IC disclosure tools, numerous frameworks have been proffered for the management, measurement and reporting of IC (see Sveiby (2007) for a review of 34 different frameworks). Most frequently, the dissemination of IC information to stakeholders has occurred either via the annual report (Guthrie et al., 2004) or the IC report (ICR) as some form of discrete disclosure (Mouritsen et al., 2003; Mouritsen et al., 2001). While the literature on IC often espouses the benefits of disclosure (Andriessen, 2004; Marr et al., 2003; Mouritsen et al., 2003), there can be disadvantages as well (van der Meer-Kooistra and Zijlstra, 2001) and IC can be seen as both an asset and as a liability (Caddy, 2000). Therefore, the decision to disclose IC information must be balanced between the needs and wants of the stakeholders and the interests of the organisation.

ICR’s can be presented in many different forms, from simple one page matrices (Boedker, 2005; Sveiby, 1989), and as supplements to annual reports (see NSW Department of Lands, 2006), to comprehensive independent documents (see Systematic, 2002, 2004). But as can be seen from Sveiby’s (2007) collation of different ICR frameworks, a fascination with numbers dominates the IC literature (for example Andriessen, 2004; Chen, 2003; Mouritsen et al., 2001). One of the claimed differentiating features of supplemental and comprehensive documents is the use of narrative to complement the reporting of the measures of IC. The main benefit of using narrative in IC disclosure is espoused by Mouritsen et al. (2002: 14) as follows:

“The narrative presents something close to the identity of the firm, and therefore presents some kind of raison d’être of its activities. Therefore, when understanding knowledge as a narrative it is part of a wider justification of its role in helping the firm to develop and produce something ‘good’, and it also suggests where it is different from things, which in the situation is considered ‘bad’.”

Narrative offers the promise of giving meaningful explanations of why and how an organisation is concerned with managing its IC in addition to disclosing its IC measures. This can serve as a basis for explicating the application and impact of IC from the perspective of the organisational actors who construct that narrative. However, few empirical studies of the role of narrative in IC practice have been conducted to date. Thus, there is a gap in the IC literature as to the role of narrative in offering an explanation of an organisation’s foray into IC and the resulting strategic impact. This leads to our research question: “Can narratives of IC be analysed to determine whether the management of IC makes a strategic difference?”

In order to address this research question a framework is required that is capable of analysing the impact of IC, evidenced as change at an organisational level, by utilising the role of narrative. This has recently been addressed by Dumay (2007) who combined Giddens’ (1976; 1984) structuration theory with insights from narrative theory (see Czarniawska, 1998; Weick and Browning, 1986), to analyse the impact of IC-driven change on an organisation by examining its IC discourse. He identified that structuration theory is a useful framework for analysing IC and change, offering deep insights into IC-in-action (see also Gurd, 2007). Structuration theory, while not specifically explicating organisational change, does provide a framework that allows us to think about the maintenance, reproduction and changes of social structures (Gurd, 2007: 5). Other popular theories used in the analysis of accounting change, such as Laughlin’s (1991) alternative models of organisational change, have been critiqued as being too simplistic (Gurd, 2007: 4) and as presenting a static perspective (Dumay and Guthrie, 2007). Thus, as our aim here is to identify and evaluate the impact of IC over time and not as a static phenomenon, we argue that Giddens’ theory of structuration is better able to explain the complexities and dynamics of change.

The term ‘structure’ is a neologism constructed by Giddens’ (1984: 377), defined as being “the rules and resources, recursively implicated in the reproduction of social systems.” Structure is simultaneously both a product of and the basis for social interactions. Giddens (1984: 29) explains that in structuration theory, interactions (classified as being of three types: communication, power and sanction) are constantly transformed into related categories of structure (signification, domination and legitimation) by way of socially constructed instruments or modalities (interpretive schemes, facilities and norms); and vice versa (see Figure 1). This essential recursiveness forms the concept of the ‘duality of structure’, in that structure is continuously recreated through interactions and thereby in turn provides the basis of such future interactions.
Another important aspect of structuration theory is the concept of ‘agency’ (see Figure 2); being the “actions taken by individuals in social settings” (Macintosh and Scapens, 1990: 458). Agents intervene in, rather than react to, social situations, allowing them to influence and alter social structures. But it is not possible for agents to “…pause, reflect and make conscious choices about their behaviour” in every intervention (Macintosh and Scapens, 1990: 458); as many interactions are in fact “routinized”, although always subject to reflexive review. The actions of agents are seen to occur at different levels of consciousness however (Giddens, 1984). At the unconscious level, agents possess ‘ontological security’ in acting, having “…confidence or trust that the natural and social worlds are as they appear to be, including…self and social identity.” (Giddens 1984: 375) At the conscious level, actors' behaviour is reflexive and occurs at two levels: practical and discursive (Giddens 1984: 7). At the practical level, agents rely on their tacit knowledge about how to act and interpret the world (Rose, 1998). Whereas at the discursive level, agents imply reasoning to explain their actions, and the resulting discourse affects structure in addition to affecting the modalities of interpretive schemes, norms and facilities (Weick and Browning, 1986). Changes result from both the intended and unintended consequences of action and interaction and are a direct result of agents’ recognition, at the level of discursive consciousness, of the need to change structure (Giddens, 1984: 8-12).

Weick and Browning (1986: 243-5) identify two forms of communication which can affect the structure of ‘signification’, namely argument and narration. They contend that the application of structuration theory to the process of communication highlights the relevance of narration as the preferred form of communication, as narration gives greater meaning to actors. Every human agent has narrative capacity, allowing them to participate in the collective sensemaking of narratives, whereas argument privileges some parties as ‘experts’ required to judge the argument (Weick and Browning, 1986: 248-9). Thus, communicative interaction concerning IC, arising through agents’ reflexivity at the practical level of consciousness, is a reproduction of the structure of signification (meaning) of IC within an organisation. It is these shared communicative interactions, by means of the modality of IC statements and related documents, which is of interest in this paper. This is because the narratives in these statements provide evidence of why the organisation invested resources to implement and maintain IC practices and of how IC has impacted the organisation.

3. The PARTSCO research

The data in this study relates to the implementation of IC practice at ‘PARTSCO’ (disguised), a European manufacturer of automotive components. We chose a manufacturing company as this sector appears to be the ‘Cinderella’ in the study of IC, in that services and information technology-based organisations clearly dominate the IC research literature (Nilsson and Ford, 2004). For example, of the 53 organisations involved in the Danish IC guidelines, only three firms are considered to have a manufacturing base (see Mouritsen et al., 2003).

PARTSCO, a medium-sized firm embedded in a complex supply chain of high value-added production within an increasingly competitive industry sector, has been managing its IC explicitly since 2000 when it began reporting specifically on IC by way of an annual Statement of Intellectual Capital (SIC). The authors visited PARTSCO in 2004 and 2006 to investigate PARTSCO’s IC-in-action, where they received extensive access to primary and secondary sources of data as summarised in Table 1.
Table 1: Data collection 2004-2006

<table>
<thead>
<tr>
<th>Sources</th>
<th>Represented by</th>
</tr>
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<tbody>
<tr>
<td>Management presentations, informal interviews during site visits (2004 and 2006)</td>
<td>Internal IC Documents, observations, management interviews, unstructured dialogue with management and supervisors, field notes</td>
</tr>
<tr>
<td>Statement of Intangible Capital (six years: focus on 2002 and 2005 SICs)</td>
<td>IC measurements, accompanying narrative, workplace artefact observation, external presentations made by management, corporate website</td>
</tr>
</tbody>
</table>

The SICs provide a narrative-based longitudinal observation of changes at PARTSCO, from a managerial perspective. They provide evidence of which elements were discussed or ignored, the conclusions drawn and the decisions made. Additionally, PARTSCO management provided feedback on our observations, reducing bias and specificity in the case study (Creswell, 1998; Yin, 2003). This feedback was essential, as by 2005 the authors had become aware that PARTSCO personnel were dissatisfied with the results from their IC management practice.

4. PARTSCO IC through a structuration lens

For the purpose of this paper we concentrate on the narrative and metrics contained in the 2002 and 2005 SIC’s (PARTSCO, 2002, 2005), representing a significant passage of time to allow observation of change. In addition this is supported from the field notes of observations and informal discussions by the authors during their visits to PARTSCO in 2004 and 2006. In terms of structuration analysis, the SIC is an interpretive scheme modality which reproduces the structure of IC at any particular point in time within the company. It is representative of an ongoing communicative interaction, sponsored by management and brought about by reflexive monitoring of the action and interactions by actors in the development of IC by PARTSCO.

4.1 The need for change – why IC?

Having sponsored the launch of the SIC and related processes in 2000, by 2004 the Managing Director expressed a growing frustration at the rate of progress, stating that they needed to “get something more” out of the IC practice. This was still the case in 2006, however, reiterated by the Managing director in an interview as the “need for IC management to make more of a difference” in a context of ever-shortening product lifecycles and the new threat of emerging market competitors from China and India.

In trying to understand how IC practice has evolved at PARTSCO, we must first understand the reasons why management believes that managing IC would benefit the organisation. In 2002 the company appeared upbeat about its two year venture into IC, experiencing increased sales and market share. At this juncture, the rationale for investing in IC management was internal (PARTSCO, 2002), stated in the SIC as the:

“…comprehension of the dynamics that enable a company to create intellectual capital would appear…to be a lever for the development of the value of the company”

By 2005 the purpose for the development of IC had changed to include a substantial external focus, in particular the need for improved communication with external stakeholders to complement the financial reports and to increase customer confidence. By this time PARTSCO’s business was less upbeat, as a result of increasing competition and economic downturn in its home country, as indicated with a shrug by the Managing Director in a 2006 interview:

“…it is becoming increasingly difficult to understand why anyone would invest in this industry”.

4.2 Signification structure

These changing pressures are reflected in the evolving SIC, as seen in changes in the representation of the signification structure, beginning with the choice of what to highlight and measure. In developing the SIC, PARTSCO has adopted the IC classification scheme of ‘structural’, ‘relational’ and ‘human’ capital, with multiple content categories identified for each attribute of IC. Our examination of the documents revealed how comprehensive PARTSCO’s reporting of IC is, with between 50 and almost 80 measurements reported at various times, and how it has evolved over time, as summarised in Table 2.
PARTSCO's sustained investment in IC reporting only partly achieves management's stated objectives; but what is absent is a model of how everything inter-relates (Rimmel et al., 2004). In Table 2 we see that PARTSCO has consistently emphasised the reporting and management of human capital and corporate culture, as these affect both external stakeholders and employees, evidencing their priority in the company's development of IC. Narrative descriptions with occasional explanation are provided in addition to figures and graphics. Achievement against purportedly critical metrics relating to quality and production efficiency varies from year to year, with very limited discussion of causes and effects in the SIC. We also observe notable shifts in attention to certain attributes, such as Customer Loyalty and Distribution Channels; and potentially significant omissions, such as Brands, Licensing/Marketing and aspects of Intellectual Property, throughout the duration. This may reflect enduring strengths of PARTSCO, reflecting the bonding with a small number of major customers and suppliers. Conversely, this may reflect an inward-directedness, undermining the company's prospects for IC to support business expansion.

If we assume that PARTSCO's adjudged 'more meaningful' elements of IC are reflected in these reports, Table 2 summarises important changes in the structure of IC. We interpret this as due to heightened awareness of the changing circumstances of the firm in an increasingly competitive market, signalled by the identification of IC elements that require greater understanding and management. This is further evidenced by the manner in which the format of the SIC has changed. The 2002 statement contained 77 measurements of intangible assets whereas by 2005 the company claimed to use 68 measurements but provided just 47 in the SIC. This reflects a shift towards a narrative-based presentation, commensurate with the changed reasons for managing IC, from wanting to understand IC per-se as a discipline, to improving its management and the subsequent realisation of value from IC and to demonstrate to its stakeholders, via communicative interactions, with that it was in control of IC.

4.3 Legitimation structure

The legitimisation process for IC at PARTSCO is analysed by asking “What modality is used to sanction IC as a management practice requiring corporate investment, and how has this changed?” The answer to this question is viewed from two perspectives: value creation and the framework utilised to represent IC.

Value creation figures as the primary legitimising rationale in the 2002 SIC, wherein PARTSCO argues that the IC indicators chosen are those identified by management to ‘create value’. They do not specify exactly what ‘value’ is, but do assert linkages to sales and strategic considerations. By the 2005 SIC, the value focus changes to concentrating on customers, internal factors of value creation and with a need for providing
greater transparency to stakeholders. The related IC indicators are legitimised as being necessary for the management of PARTSCO’s value creation through IC in these focal areas. Changing competitive and economic environments are at work here, forcing PARTSCO to have a harder look at ‘value’ from within. This is then communicated to internal and external stakeholders, in order to legitimise the ongoing management of IC as a worthwhile and necessary endeavour. The Managing Director expressed in 2006 that PARTSCO’s internal agenda needed to change, from:

“…(an) historical focus on customer satisfaction, with cost considerations coming only afterwards, to a heightened level of cost consciousness across the company as the first priority.”

One of the unresolved debates in IC concerns which IC framework to use and whether we can establish that the chosen framework is the correct one. Unlike statutory financial reports or budgets which gain their legitimisation by communicating “a common set of values and ideals about what is approved and what is disapproved” (Macintosh and Scapens, 1990: 462), there is no regulation sanctioning what form an IC statement should take, nor an agreed standard framework that can be used to represent IC (Brennan and Connell, 2000). Thus the framework that is used to legitimise the IC statement is of particular interest.

Complementing the ‘value’ argument for legitimising chosen IC measures, PARTSCO management recognise the importance of also providing a normative framework to legitimise the use of IC. In its initial SIC, PARTSCO projected a distinctly numerical perspective, with management depicting the report as an extension of the financial accounts which, at that time, reported good ‘economic’ performance. This was sanctioned through narrative text espousing the SIC’s “compliance” with accounting-related guidelines (see Loro et al., 2002). By the time of the 2005 SIC however, management announced the use of the Intellectual Capital Value® framework as depicted (in a modified form) in Figure 3, a proprietary framework developed by Summit Consulting originally for Brembo Group (D’Egido and Caredda, 2002). Summit was employed by PARTSCO to help it to identify and manage IC, including the development of their SIC.

PARTSCO (2005) describes the motivation for the use of this changed model as being the need for achieving greater value from IC:

“The traditional models for evaluation, starting with the conventional Financial Statements, are no longer sufficient to determine the real worth of a corporation. New instruments are necessary to measure those aspects of the business that are less tangible.”

In the absence of rules, standards or legislation, management now asserted a methodological legitimisation for their selected approach based on the Intellectual Capital Value® structure. Our analysis is that, as business competition intensified, the normalisation of IC was now handed over to the consultants, representing ‘business’ expertise via their proprietary framework. This symbolised the failure of the accountants to provide PARTSCO with the correct formulae for developing IC that was more than simply ‘complying’ with a measurement framework, to one that gained legitimacy through the discernibly greater potential to ‘make a difference’.
4.4 Domination structure

The domination structure is dependent on the organisation and its use of two types of resources, being allocative and authoritative (Giddens, 1984: 33). In this light, the 2002 SIC indicated that, resulting from an inability to fully achieve the desired objectives in PARTSCO’s development of IC, it was mobilising resources under an ‘Intellectual Capital Action Plan’. Consequently, management set up four strategic focus working groups of employee and supervisor volunteers to concentrate on internal customers, external customers, R&D and suppliers. The significance of this working group formation is evidenced by two changes in the organisation of resources: first, by the prioritisation of the formation and operation of these groups, consuming organisational resources; and second, by the necessary transfer of some authority and responsibility from management to these groups in order to address specific IC applications.

However, the progress of these company-wide task forces is not evaluated in any subsequent SIC. In 2005, the ‘Intellectual Capital Action Plan’ and the working groups were reported to still be in existence. The SIC was transformed from analysing IC measures and implementing actions, to the Intellectual Capital Value® framework complemented by stronger efforts at communication about IC practice to internal and external stakeholders. Nevertheless, causal linkages continued to be omitted in the discourse, leaving implications un-stated and contradictions unevaluated. For example, costs increased significantly for externally sourced R&D in 2005, due to “inferior internal planning”, whereas the 2002 SIC had espoused the strategic importance of an opposite approach, that of developing greater R&D self-reliance. Apart from what was noted above, no commentary was provided as to the rationale behind such a change in direction.

Thus, the continued existence of the Intellectual Capital Action Plan and the working groups in 2005 signifies their consolidation within the domination structure. However these SIC discursive narratives are essentially descriptive. The managers preparing the SIC reflect in their narrative only that there are ‘shortcomings’ in the management of IC, thus its value is ‘questioned’; and that within each area, ‘improvements’ are required. We would question whether their failure to present coherent stories about industry conditions, business strategies and the outcomes of actions, can provide sufficient guidance to the strategic focus working groups to enable achievement of their objectives.

By contrast, the Managing Director reflected strategically in a 2006 interview that IC management needed a change of modality and focus, to enable the organisation to begin “seeing the group more as a whole, not
In commencing in this new direction, he had just initiated an organisational separation of Development from Manufacturing in order to gain better visibility and control of design cost and development efficiency, as reflected through the realignment of metrics in that latest SIC.

4.5 Extension of Giddens’ Structuration

We adopted a focus on narrative in the PARTSCO analysis, as narrative can provide greater understanding of IC (see Mouritsen et al., 2002). Narrative, however, also requires a ‘plot’ to be effective (Czarniawska, 1998). The Managing Director continues to espouse a need for strategic change which led him to sponsor modifications to IC practices, including by way of increased narrative disclosure of PARTSCO’s IC. However, even when the modalities of the SIC and IC Action Plans remain constant, the lack of sufficient underlying ‘plot’ in crucial areas either fails completely to link strategic responses to those IC modalities, or provides narrative accounts but not in a form that can guide employees and value chain partners to execute consistently. For example, in a thorough search of the 2002 SIC narratives we were unable to find the use of the word ‘problem’ or any closely associated synonym such as ‘difficulty, trouble, crisis, dilemma, predicament, quandary, or setback’ to symbolise the evidence of any coherent plot. This was still the case in the 2005 SIC, thus indicating that PARTSCO, while realising what was needed to better manage its IC and recursively creating and enacting routines around specific points of emphasis, as usefully analysed by Giddens’ structuration theory, is nevertheless not yet fully able to tell the story of why and how.

This lends support for one critique of Giddens’ interpretation of structuration, the argument that he overemphasises the recursive routinization of structures, offering little explanation of how new structures may emerge (Emirbayer and Mische, 1998), even during in periods of disruption (Giddens 1984: 60-62). Instead, agency involves purpose and judgement in addition to routine – a temporal element highlighting agents’ abilities to shift their focus to projections of the future. A more agent-oriented account creates the possibility of projective change in those structures, arising in response to the effect of interests, their “hopes, fears and desires for the future” (Emirbayer and Mische, 1998: 971).

This may help us interpret the gap between PARTSCO top management’s attention to IC and the inconsistent execution of strategy as witnessed in the case. PARTSCO’s IC narratives focus on the tasks and goals as set by management, but do not develop them in persuasive narratives depicting causal themes and collective implications, nor do they relate them to the interests of employees required to enact those decisions. Interviews corroborated a universal awareness of and access to IC information by employees; however as a shop floor supervisor observed in a 2006 interview “…not everyone in the unit participates, it isn’t closely managed”.

This reinforces our sense that even after six years of vigorous sponsorship, the concept of IC had not yet fully been accepted within PARTSCO’s workplace culture. Our findings suggest that, to the extent that change must be enacted by agents in order to make a difference, Giddens’ structuration framework should be extended beyond recursively routinized embodiment to include fuller consideration of modes for engaging that projective agency.

5. Discussion and conclusion

In this section we focus on three findings in order to develop new insights into how IC impacts an organisation. First, we find that the evolving use of narrative becomes increasingly important in times of disruptive change; we saw this reflected in the IC practices of PARTSCO management as economic downturn, customer relationship dynamics and emergence of stronger, non-traditional competition increased business risk. This enables PARTSCO to at least partially explain the why and how of developing IC resources, to communicate more effectively with stakeholders and to give meaning to the selected measures of IC. As the HR Director espoused in 2006, the aim being:

“…to present the innovation capability, knowledge, motivation and strength of external relationships, so that employees understand their organisation and we can prevent future contingencies through anticipation and action.”

We witness a longstanding frustration by senior management concerning the strategic implications of the slower than expected rate of progress in IC contributions to the desired outcomes. IC practice is still only partially effective, as seen in the quantitative disclosures of sudden reversals in multiple measures of quality, wastage and new business development, along with continuing omissions noted earlier. It is noteworthy that only rarely does the SIC include commentary on the strategic risks or implications of the results recorded.
In our second finding, we evaluate, through a case study application, the use of structuration theory as a tool to analyse the manner and impact of IC practices. This can be viewed from two perspectives. First, we show that the use of structuration theory provides an ability to understand the recursive changes in an organisation's structure as a result of the operation of IC practices. In PARTSCO's case we note the continued drive to develop their IC resources through the SIC, and management's continued concern to legitimise the activity. This development of IC through the SIC is identified as the principal interpretive modality by which the evolving structure of PARTSCO's IC has emerged. Further, structuration analysis allows us to observe the response of IC practices to external forces of competition and business environment, and to assess their impact on the structure of IC. These structural responses range from management's decision to continue to manage specific measures that it perceives as representing strategic IC categories, regardless of environmental pressures, to a marked adaptation of other IC practices in order to communicate more effectively about its IC with all stakeholders.

However, we observe a gap between declared strategic imperatives and management's satisfaction with the degree to which IC practice seems capable of resulting in desired impacts. This suggests a process lag, one that may for the first time be explicated by means of structuration theory's account of the recursive nature of the interactions that underlie both the use and adaptation of the interpretive modalities by which the evolving structure of IC emerges.

Our third finding is to identify that structuration theory provides a useful framework for analysing how management intended their promotion and 'routinization' (see Giddens, 1984) of IC narrative to help make cognitive links between IC indicators and their meaning, in support of a program of improvements in process and product innovation. We find that the stated aims of IC practice have not yet been fully realised by PARTSCO, thus providing a realistic example of the possible failings of IC practice due at least in part to inadequacies of the modalities that are required to bring about recursive change. The expressions of frustration about IC outcomes constitute a reflexive monitoring by the Managing Director of the organisation's capacity for strategic change, at the level of discursive consciousness. However the recursiveness of that change process, mediated by agents and how they enact current and sought-for interactions, is a significant factor in steering and implementing change.

As a result, the original concept of IC and management's growing attention to narrative disclosure affect the 'structure' of the organisation, but the task of re-crafting the signification, legitimation and domination structures of IC within PARTSCO remains a 'work in progress'. We suggest that this work needs to continue, but with greater inclusion of the agency and interests of employees, in a mode beyond Giddens' focus on routinization, in order to make the desired difference through IC.

5.1 Implications for future research

This study highlights the need to better understand the evolution of IC in even relatively less knowledge intensive organisations through analysis of observed management responses to changes in the external environment. By means of structuration theory, future research could extend the investigation of such changes through analysis at both the discursive and reflexive levels. This provides a model for recursive change that accommodates the dynamic effect of external factors mediated by purposive, reflexive agents, as well as encompassing the internal factors more frequently focused upon in IC discourse.

Future research could use this approach to analyse the impact of IC in terms of the effects of IC practice modalities on the actions of agents. It could also investigate whether a more dynamic view of the structure of IC can close the observed gap between strategic management requirements and perceptions to date of the capability of IC management to 'make a difference'.

5.2 Limitations

This case study is limited to the presentation of findings of a phenomenon within a particular organisation within a manufacturing sector context. In addition, the reasons for change that influenced the researched company to adopt and persevere with IC practice may have different impacts in other organisations.

5.3 Conclusion

This case study builds upon the theme of IC practice by offering insights into the applicability of narrative in helping IC practice create value; provides a realistic look at why the promise of IC remains only partly
realised in the subject organisation despite sustained executive sponsorship; and holds out structuration theory as an applicable framework for a more inclusive interpretation of the evolution and impact of IC.

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References

Abstract: Knowledge management initiatives enable an organisation to learn from its successes and mistakes. The nature of knowledge and learning processes means that in seeking to improve the way the organisation learns, knowledge management also has to pay attention to the learning of individuals. In most organisations, other functional specialists also have responsibility for individual learning. This exploratory qualitative research has examined the ways that planned learning initiatives generated by knowledge management and human resources management functions can be integrated more effectively.

A survey of the planned individual and organisational learning activities and processes in ten large organisations was undertaken. Eleven examples of initiatives that integrate individual and organisational learning were also identified from within these organisations. These were evaluated and the issues associated with implementation explored through an expert panel and interview process with knowledge managers and human resource managers.

Factors that positively influence integration were found to include widespread recognition of the business value of both individual and organisational learning, high level sponsorship that acts as a bridge across functional boundaries and line managers adopting an integrating approach to learning in managing their people and the tasks they undertake. Factors that negatively impact the adoption of an integrated approach were found to include the lack of mechanisms to coordinate across functions and a culture in which functional managers feel unable to change practices.

This research has generated a model that appears to be useful in organising the analysis of the planned learning initiatives that are being undertaken by different functions. Together with the examples of integration and its enablers and barriers, knowledge managers and human resource managers can use this to proactively move forward with a more “joined up” approach to learning.

Keywords: knowledge management, human resources management, individual learning, organisational learning

1. Introduction

Although the scope of knowledge management is very broad and the design of a knowledge strategy needs to be highly contextual if it is to generate organisational value (McKenzie and van Winkelen 2004) learning is a necessary element of any knowledge strategy. For example, the business and industry context determine the dynamic balance an organisation needs to establish between exploiting existing knowledge to improve organisational efficiency, and exploring new knowledge domains to improve effectiveness (Gupta et al. 2006). However, both knowledge exploitation and the development of new knowledge rely on the capability of an organisation to learn from its own actions and from the environment in which it is operating.

The connection between individual learning and organisational learning is demonstrated in the knowledge creation spiral proposed by Nonaka (1991). In this, organisational knowledge is created through the conversion of the experience and intuitive knowledge of individuals into articulated and recordable knowledge, with group and organisational processes progressively refining, testing, integrating and institutionalising it (Crossan et al. 1999). Whether the individual or the organisation has the most important role in generating valuable new knowledge and therefore should receive the most attention is still the subject of discussion (Felin and Hesterly 2007). However, knowledge management initiatives seeking to improve organisational learning will inevitably need to encompass aspects of individual learning too.

The effective integration of individual and organisation learning is an important characteristic of what has come to be known as the learning organisation. As Charles Handy noted:

“The learning organisation can mean two things. It can mean an organisation which learns and/or an organisation which encourages learning in its people. It should mean both.” (Handy 1995, p179)

In most large organisations Human Resource Management, Human Resources Development, Personnel, Training and Development, or Corporate Universities functions are “responsible” for individual learning in that...
they shape policies and direct resource allocation. For conciseness, we will refer to all of these as the "human resources management" function.

In an organisation that also has a specific knowledge management function, the fact that different functions have different roles and responsibilities with respect to aspects of learning raises the issue of agendas and the question as to whether they are necessarily pursuing objectives that are consistent with each other. The research described in this paper was initiated when knowledge managers from twelve major organisations perceived that there was a need to understand more about how to integrate the various learning initiatives within each of their organisations, specifically in relation to those being pursued by knowledge managers and their human resource management colleagues.

Exploratory research was undertaken to address the question: in what ways can planned learning initiatives in organisations be integrated more effectively?

Three assumptions were made in undertaking the research:

- In many organisations planned learning related processes and activities may be happening in relative isolation to each other.
- Different kinds of learning related processes and activities might need to be "joined up" in different ways.
- Dialogue between people involved in learning in different functional areas is the basis for understanding how to achieve this "joined up" approach.

In this paper, two perspectives on the nature of knowledge and learning are described, together with the consequences for the design of both individual and organisational learning initiatives. This was used to develop a research framework to study the planned learning initiatives in ten large organisations. The issues associated with adopting a more integrated approach to learning were explored through an expert panel and interviews with knowledge managers and human resource managers.

2. Perspectives on the nature of knowledge and learning

The mechanisms by which knowledge is constructed as the result of a learning process have been the subject of much debate. Here we treat two of the perspectives as complementary, though we acknowledge that it has been argued that their different ontological positions mean that they are actually contradictory (Easterby-Smith and Araujo 1999). (For a more detailed discussion of the ideas presented in this section see Ventzin et al. 1998, von Krogh et al.1994).

In the information processing perspective, learning by individuals is viewed as an attempt to make increasingly accurate representations of the world. The environment is accepted as available to everyone to understand in the same way and learning efforts are focused on collecting and assimilating information about that environment in order to understand it better. New information is compared with previously acquired mental models and frames of reference and efforts are made to adjust internal models of the world closer to an actual reality. Achieving a more accurate representation of reality is achieved by collecting more data (Schramm 2002, Burgoyne 2002).

At the level of organisations, this view of knowledge construction corresponds to the technical view of organisational learning (Easterby-Smith and Araujo 1999, Huber 1991). Identifying, collecting and redistributing information are the mechanisms by which new knowledge is developed. Knowledge transfer between individuals and groups across organisations (viewed as learning processes) is improved by information management systems. Again, there is an assumption of an objective reality, but now different experts collect information about parts of the representation and the local nature of the network determines how this is jointly combined into knowledge of “reality out there.”

In the second perspective on the construction of knowledge, the mental act of perceiving knowledge is viewed as a creative act rather than a descriptive one. Learning is viewed as a process of extracting meaning from experiences, activities, ideas and feelings. This is the psychological perspective of learning (Easterby-Smith 1997). The way a person interprets these inputs is highly context dependent and the knowledge developed is subjective. Knowledge is no longer an abstract entity to be searched for, but is interpretation cultivated through the process of living and uniquely construed at each level of the social system, be that in the head of the individual, or in the small and large groups to which he/she belongs.
Individuals primarily create meaning through the use of language and “languaging” is the general term to describe the emergence of meaning as a result of linguistic distinctions (von Krogh et al. 1994). It is recognised that the language of expertise can act as a barrier that excludes others who do not share that language (Szulanski 1996). Within an area of shared work practice, a system of meaning is communicated through a common language that allows knowledge to develop and be embedded in the practice (Wenger 1998) and in the case of a professional specialism, the knowledge domain boundary may sit across the external boundary of the organisation. Knowledge can leak from organizations when practices are shared with outsiders and it can stick in certain places within organizations where practice is not shared sufficiently to allow effective communication (Brown and Duguid 2001). Explicit knowledge is knowledge that can be communicated through language, though different systems of meaning making inevitably result in different constructions, interpretations and application by different people. Tacit knowledge cannot easily be put into words and therefore is inherently more difficult to transfer between individuals. It takes time and effort to develop, and is potentially the source of more value to the organisation because of this, and is highly dependent on the systems of meaning making involved.

The concept of absorptive capacity provides further insights into the connection between individual and organisational knowledge “levels” (Cohen and Levinthal 1990). Prior related knowledge impacts the firm’s ability to “recognise the value of new external information, assimilate it, and apply it to commercial ends”. This is essential if the organisation is to learn and adapt to a changing world. Factors that affect absorptive capacity are known to include breadth of knowledge of individuals within the organisation (diversity) and “gatekeeper” or “boundary spanner” individuals who provide linkages across the boundaries of the firm. There are two key facets of absorptive capacity (Zahra and George 2002). Firstly, potential absorptive capacity, which is the acquisition and assimilation of potentially useful knowledge, produces breadth of perspective and requires a strong learning culture. Secondly, realised absorptive capacity, which relates to the transformation of potential knowledge into operational capability, is the basis for value generation and it requires the reduction of structural, cultural and behavioural barriers that might hinder knowledge integration between functions, groups and businesses.

2.1 Implications for the design of learning interventions

The information processing perspective of learning views the individual as a relatively passive recipient of learning, while the psychological perspective view requires the individual to be actively engaged in the construction of meaning. The training and development interventions that are commonly undertaken in many organisations encompass both of these schools of thought, with the content and context usually being used to determine the most appropriate approach. A spectrum to describe learning activities and initiatives in terms of the level of involvement of the individual learner has been proposed by Leonard and Swap (2004), see Figure 1.

![Figure 1: Spectrum of learning activities according to the level of engagement of the learner (Leonard and Swap 2004)](image)

The passive learning interventions would only be expected to be able to convey information (organised facts) and rely on the information processing perspective of learning. Progression through the spectrum towards active learning implies the intention that explicit knowledge and finally even tacit knowledge could be conveyed (Baumard 1999). This is based on the psychological perspective of learning in which understanding and meaning making are the basis for learning and require the active engagement of the individual in this process.
Knowledge management initiatives aimed at improving organisational learning can also be viewed as falling on a similar spectrum, with initiatives focusing on sharing information and explicit knowledge (for example through database systems) at one end where shared language supports knowledge exchange and relatively passive individual involvement is required, and those attempting to support tacit knowledge exchange (for example through communities for knowledge creation) at the other where language cannot easily transfer knowledge and shared experience and active participation are also needed. Increasingly, there is a view that groups defined by a knowledge domain associated with a work practice play an essential role in stewarding and developing both explicit and tacit knowledge (see for example Brown and Duguid 1991, Brown and Duguid 2001, Wenger 1998, Wenger et al. 2002).

3. Methodology

The interactive research method (van Winkelen and Truch 2002) was used for this research, which was undertaken collaboratively within the Henley KM Forum. This is research with and by working groups of active practitioners, and keeps attention close to the reality of organizational issues and priorities. Findings are tested against experience, as well as interpreted within the appropriate body of academic literature, typical of Mode 2 applied research (Bryman and Bell 2003, p5). Experienced knowledge managers from twelve large organisations (multi-national private sector and UK public sector) were involved in this research and participated in the collection and interpretation of data and validated the conclusions by providing additional evidence from their experience. This exploratory research was undertaken in two stages:

1. For the first stage, data was collected through a structured qualitative survey based on the research model shown in Figure 2. This was used to collect comprehensive information about individual and organisational learning initiatives, categorised against Leonard and Swap’s (2004) nine-point spectrum from active to passive. Data sets were received from ten of the participating organisations, representing a comprehensive review of planned learning interventions in a cross-section of private and public sector organisations. Additionally, the survey asked for examples of current integrated approaches to learning that bridged individual and organisational learning, as well as requiring cross-functional involvement, where they existed.

2. For the second stage, an expert panel of twelve knowledge managers and six human resources managers evaluated the integrated approaches that had been identified, proposed new ones based on the individual and organisational learning initiatives collated through the survey and explored the issues associated with implementing them. The panel also received input from two additional two human resource managers who explored the ideas with their knowledge management colleagues in face-to-face interviews rather than in the workshop sessions due to availability considerations.

**Figure 2:** Conceptual model

The limited data set and qualitative methodology means that the data cannot be used to prove the best way to produce a more integrated approach to learning. However, the diverse nature of the organisations involved provided an opportunity to carry out a comparative study that focused attention on similarities and differences between different types of organisational context and as a consequence, the findings can be viewed as having some generalisability. Further research would be needed to confirm the findings.
4. Findings

4.1 The pattern of individual and organisational learning initiatives.

The consolidated view of planned learning initiatives that focused on learning by individuals and learning by the organisation is presented in Figure 3. As might be expected, many (though not all) of the interventions relating to individual learning were initiated by Human Resources or training functions. Many (though not all) of the interventions relating to organisational learning were initiated by knowledge management functions.

The organisational learning activities involving tacit knowledge exchange rely on the active engagement of individuals. However, their categorisation as organisational rather than individual learning activities is justified, as their purpose is to enhance organisational knowledge, rather than to develop an individual.

4.2 Integrated learning initiatives

Eleven examples of integrated learning activities and processes were identified through this research and these are summarised in Table 1. They range from technology systems integration (intranet, people finder, human resources learning management systems), to process integration (for example, human resources processes at various stages of the employee cycle being combined with knowledge management processes to capture and share knowledge), to people-based interventions (for example that identify mentors through communities of practice).

Communities of practice were viewed as playing a particularly important role in the “mixed” and “active” categories. This would be expected as they are known to form a “bridge” between individual and organisational learning (reaching across the “individual” and “group” categories). The lifecycle of an employee within an organisation proved to be one useful way to map some of the opportunities to link individual and organisational learning initiatives, and demonstrates the collaboration opportunities that this would present for KM and HR specialists. Figure 4 illustrates what this might involve.

![Figure 4: Joining up processes and activities across the employee lifecycle](image)

In addition to looking at how communities of practice operate in the organisation, a joint cross-functional community of practice for all training, knowledge and learning specialist was recommended as the vehicle to review and maintain progress in implementing an integrated approach to learning.

4.3 Factors affecting integration

Three factors tended to facilitate the integration of learning initiatives across traditional functional boundaries in the organisations studied:

- Widespread recognition of the importance of individual and organisational learning for the future performance of the organisation: effectively the business case for learning had been made and accepted.
- High-level sponsorship and understanding that bridged functional boundaries within the organisation.
Line managers empowered and expected to adopt an integrating approach to learning in managing both their people and the tasks for which their teams are responsible. The focus group and interviews with knowledge managers and human resource managers showed that functional agendas with regard to learning are often significantly different and currently act as barriers to collaboration. This was often reinforced by different objectives being placed on the leaders of the functions.

**Figure 3**: Consolidated summary of the planned learning interventions in ten organisations
Table 1: Eleven integrating learning processes and activities

<table>
<thead>
<tr>
<th>Predominant type of learning</th>
<th>Integrating activity or process</th>
<th>Individual learning dimension</th>
<th>Organisational learning dimension</th>
</tr>
</thead>
</table>
| Active learning             | 1. Employee leaver and transfer processes linked to knowledge capture and transfer initiatives.  
2. Communities of practice used as a vehicle to support mentoring programmes.  
3. Personal and organisational development initiatives to generate better quality productive conversations between people. | 1. Expertise developed in post.  
2. Judgement and in-post expertise refined.  
3. Decision-making skills and innovative thinking developed. | 1. Retained organisational memory.  
2. Distributed knowledge channelled to where it is needed.  
3. More viewpoints taken into account in organisational decision-making; improves creativity and reduces risk. |
5. Communities of practice provide experience and expertise to shape the design and delivery of formal training & e-learning courses.  
6. Induction process enables and encourages new hires to join Communities of Practice and includes training in knowledge sharing behaviours, using collaborative tools etc  
7. Knowledge sharing / management principles included in management and leadership programmes. | 4. Training in specific skills and competencies.  
5. Training more relevant and applicable to job.  
6. Individuals more quickly learn “who knows what” and how to access their knowledge.  
7. Managers learn how to help their teams be more productive. | 4. Higher return on training investments expected.  
5. More rapid updating of training materials to reflect business conditions.  
6. New ideas and challenging discussions keep communities vibrant and interesting.  
7. Cultural development to embed learning in all activities enhanced by management understanding and commitment. |
| Passive learning            | 8. Learning from after action project and event reviews fed into induction and training design (courses and e-learning).  
10. Participants in conferences / standards meetings etc provide briefings and seminars as part of continuous professional development initiatives.  
11. Intranet Portal used in a coherent way to distribute information, good practices, policies etc as well as links to experts. HR learning management/e-learning systems combined with the intranet/knowledge portal of the company. | 8. Training more relevant and applicable to job.  
9. Individuals become more visible and involved in interesting projects more quickly.  
10. Personal visibility enhanced. Learning reinforced by having to explain to others.  
11. Performance improved through time saved with single system access and better view of how to access disparate resources for to solve problems. | 8. Reduced errors in the future (saving money and time).  
9. Expertise of new hires more quickly accessible across the organisation.  
10. Increased value from expenditure on attendance. External perspective brought into wider range of decisions.  
11. Cost saving from maintaining a single system. Clearer communication possible about priorities. |

Further barriers to learning integration were identified as:

- The current trend to e-learning as the preferred method of training delivery pushes learning towards the “passive” mode and can reduce the productive conversations that may allow tacit knowledge to be exchanged. This impacts the individual learning potential, as well as the organisational learning potential by limiting feedback loops.
Lack of mechanisms for different functions to know what respective priorities are and opportunities (and time) to communicate regularly with each other to identify areas of common interest.

A culture in which functional managers do not feel that they have the remit to change the way learning is managed. Anything working in opposition to the prevailing culture is unlikely to be effective in the short term and a more productive approach was seen to be changing processes and systems within the existing culture.

5. Discussion

5.1 Differentiating types of learning initiatives

The research model differentiated between active and passive learning mechanisms and it was an assumption of this research that this was important. Although the research design was not appropriate for testing whether or not it was a valid assumption, the pattern of integrating learning processes and activities suggests that it is indeed a useful approach as it reflects the reality that both knowledge management and human resources functions focus attention and resources differently on different kinds of initiatives.

A strategic approach to knowledge management requires decisions to be made about the relative emphasis on tacit and explicit knowledge (for example, in a consulting organisation context, this has been described as a personalisation versus codification strategy (Hansen et al. 1999)). Similarly, a strategic approach to human resources management requires a view of the relative worth of the human capital of the organisation and the investments needed in different categories of employees (Lepak and Snell 1999, Lepak and Snell 2002, Kang et al. 2007). Active learning initiatives tend to be more resource intensive and are therefore more likely to be used with core workers.

Aligning and integrating initiatives requires a way for these priorities to be clearly communicated and the research model based on the active-passive spectrum was a useful way to do this as it provides a “bridge” which resonates with the strategic considerations of both functions.

5.2 Working across functional boundaries in organisations

This research aimed to better understand the issues associated with integrating initiatives generated by different functions (specifically knowledge management and human resource management). The advantage of grouping jobs by function is that “when like specialists are grouped together, they learn from each other and become more adept at their specialized work” (Mintzberg 1979, p122), and therefore individuals may tend to have more similarity with each other in terms of their system of meaning making with regard to that specialism, than they do with others outside the group.

Child and Heavens (2003) discussed the social context and internal boundaries within organisations and what this means for learning. These boundaries distinguish different groups and departments. They comment that:

“Each of these specialities will have its own set of competencies and knowledge. However, specialised groups attach their own values to their expertise and express them through their own codes and terminology” (Child and Heavens 2003, p317).

They add that where these groups are also broadly aligned with professions then the codes and language of their discipline can be seen as reflections of their social identity and market value, and this can be particularly strong when “this identity is bolstered by an external institutional base” (in other words, a professional institution – which is certainly the case with human resources management, and increasingly the case with knowledge management). This impacts the learning capability of the organisation as:

“It therefore can be difficult to bridge internal boundaries and integrate the contributions of different groups to organizational learning because of contrasts in the technologies they offer, and the goals they attach, to the process” (Child and Heavens 2003, p317).

Organisations seeking to benefit from the multiple specialised knowledge bases represented by different functions must resolve the organisational dilemma of differentiation and integration (Lawrence and Lorsch 1967). A consequence of this tension is that there will be differences of opinion and interest, and potentially conflict. Child and Heavens quote Mary Parker Follett who expressed the view that conflict is the legitimate
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expression of differences of opinion and interest and that this should be “acknowledged and made to work for people, rather than hidden or ignored”. This requires conflict to be resolved in a constructive way and she “advocated integration as the most fruitful approach. Integration involves searching for an innovative solution in which all expressed desires and views find a place. Her argument implies that the most fruitful way of dealing with conflict that arises across internal organizational boundaries is to turn it toward collective learning and knowledge creation. If achievable, an innovative solution embodying collective learning stands not only to be enriched by the range of internal organizational specialties: it should also help bridge internal boundaries by offering a mutually attractive solution to the various parties involved.” (Child and Heavens 2003, p318)

In organisations where different functions (for example, knowledge management, human resources management and training) have responsibility for different aspects of learning, we propose that differences of opinion and interest are probably inevitable. Different approaches to the design of interventions are likely to arise from the different professional knowledge bases and frames of reference involved and the tensions that result are best resolved by integration. The eleven integrating mechanisms identified in this research are examples of approaches that could be adopted. Alternatively, knowledge management and human resources management colleagues could map their respective initiatives using the research model as a framework and collaboratively seek their own innovative opportunities for integration.

Much of the implementation of knowledge management has change management at its heart. The issue of integrating learning activities and processes is no different. There has been work elsewhere that offers generic advice on how to go about this. Seo (2003) studied the impact of emotional barriers, political obstacles and management control processes on individual and organisational learning. His main recommendations are summarised in Table 2.

Table 2: Overcoming barriers to learning (Seo 2003)

<table>
<thead>
<tr>
<th>Barrier</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emotional barrier</td>
<td>Encourage a positive attitude by: Trust / friendship building Starting with incremental win-win approaches Actively engaging emotionally with those involved</td>
</tr>
<tr>
<td>Political obstacle</td>
<td>Leveraging opposing forces by: Utilising an organisational crisis moment Actively joining with potential change agents</td>
</tr>
<tr>
<td>Managerial control imperative (the goals and objectives that are shaping current behaviour).</td>
<td>Bringing external legitimacy by: Reframing with an alternative logic Actively connecting to outside institutions</td>
</tr>
</tbody>
</table>

It is interesting to see the emphasis placed on “external legitimacy” as a mechanism for challenging current internal goals and objectives that have been long accepted within the culture. Effectively this research and its recommendations could be viewed as providing just such external legitimacy for knowledge managers looking to shift priorities.

6. Conclusion

Political and power realities are different in every organisation. Bridging functional divides to collaborate with colleagues interested in learning was clearly a political challenge in several of the organisations studied in this research. The different frames of reference and mindsets of different functions make any kind of cross-boundary learning problematic. There is no reason to expect anything different from the different functions involved in learning related activities in an organisation. The step forward we are proposing is in Parker Follet’s words (Child and Heavens 2003, p318) that this should be “acknowledged and made to work for people, rather than hidden or ignored”.

Nahapiet, Gratton and O Rocha (2005) argue that the knowledge economy places ever more emphasis on cooperative relationships within organisations (and with partners). Yet, the design of organisations has historically assumed that people and their relationships are motivated by self-interest. Their proposition is that encouraging and institutionalising cooperative relationships requires a fundamental shift in assumptions about motivation. The central proposition is that people strive for excellence and the challenge is to create an environment that encourages and allows people to achieve their potential. Fostering mutual respect and knowledge exchange, encouraging the habits of cooperation and fostering a sense of community shifts the patterns of behaviour in the organisation and encourages the emergence of cooperation as the norm. This
requires a long-term perspective that may be more possible in some organisations than others. In making cooperation the norm, the consequences of the functional boundaries that we have been exploring in this paper may become much less relevant and the shift from an industrial era to a knowledge era organisation may be supported.

This research has generated a model that appears to be useful in organising the analysis of the individual and organisational planned learning initiatives that are being undertaken by different functions. Together with the eleven examples of integrated learning processes and activities and the enablers of and barriers to integration, knowledge managers and human resource managers can use this to proactively move the debate forward in their organisations. Further confirmatory research to evaluate the outcome of this process is recommended.

Acknowledgements
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Abstract: The paper is devoted to the question of how important Intangible Assets (IA) are in today's knowledge-based economy. The latest surveys show that the value of companies is now mostly generated by Intangible Assets, and not by "traditional" assets having a tangible form. The main research objective is to define the impact of fundamental value of both tangible and intangible assets on the market value of assets of Russian companies. As a general approach used herein for IA evaluation, the method of calculated intangible value offered by T. Stewart was chosen. Developed econometric models are tested on the data of Russian stock market from 2001 to 2005 year. In the focus of the research there is both the analysis of the sampled companies (43 companies) as a whole as well as divided into five aggregated fields: mechanical engineering, extractive industry, engineering, communication services, and metallurgy. Some suggestions for managing IA in Russian companies are presented in the paper. In conclusion, the main directions for further research in this field are outlined.

Keywords: knowledge-based economy, intangible assets, intellectual capital, valuation, calculated intangible value

1. Introduction: Knowledge Management and intangible assets

In today's economy – knowledge-based economy – the value of goods, services and companies is created not only by tangible assets but mostly by assets based on all kinds of knowledge – Intangible Assets. Results obtained from traditional factors such as labour, land and capital are more and more dependant on effective usage of knowledge and therefore knowledge management.

The main characteristics of knowledge-based economy or intangible economy according to Andriessen (2004) are the following:

- Knowledge replaces labour and capital as fundamental resources in production and intangible assets create a substantial part of the value added of companies;
- The knowledge content of the products and services is growing rapidly;
- The concept of ownership of resources has changed: knowledge resides in the head of employees;
- The organizations have changed and the management of intangible resources is different from tangible or financial resources.

Only about ten years passed since K.Wiig, a guru in the sphere of Intellectual Capital, published his books on the point of Knowledge Management. Now there is a huge amount of works in this field – articles, books, reports which provide not only new scientific information, but also practical recommendations for companies on how to improve their management and results using Intangible Assets. Among them are such famous works as [Prusak, 1997; Davenport, Prusak, 2000], [Nonaka, Takeuchi, 1995], [Stapleton, 2003], [Stewart, 1997] and others.

While the questions on Knowledge Management and Intangible Assets have interested a huge number of scientists from all over the world, only a few Russian scientists pay much attention to this point. Some narrow questions are discussed in works of [Katkalo, 2002, 2003a; Efremov, Hanykov, 2002; 2003] and some surveys on the strategy of a company concerning IA are represented in works of [Tambovtsev, 2000; Klejner, 2002; Kotelkin, Musin, 2003; Milner, 2003; Gurkov, 2004].

In 1959 Penrose E. wrote that a company is both an administrative organization and a set of resources: productive and human. According to Penrose just the resources themselves do not take place in production processes, all resources should be transformed into services. Services are the function of experience and knowledge obtained by a company. This thought was widely developed only in 1980s. And now almost everyone stays to the position of Nonaka and Takeuchi who wrote in their book “The knowledge – creating company” that only those companies that can create knowledge can be successful in today's world.
The knowledge in today’s economy becomes a locomotive that defines the development of the contemporary companies. The successful companies are, undoubtedly, those constantly introducing the innovations based on new technologies as well as on knowledge, experience and attainments of their employees. It is arguable that the value of companies is now mostly generated by Intangible Assets, and not by “traditional” assets having the tangible form.

The surveys reveal that 2/3 American companies have recently turned to pro-active thinking and place a higher emphasis on collection and analysis of non-financial data. The same surveys confirm the fact, that one third of all the effected investment solutions is based on the existing Intangible Assets, and that the decisions made on the basis of Intangible Assets allow to make a more accurate prediction of income and profitability of a company in the future, and, hence, the company’s value for the shareholders. The inclusion of the effects connected with the Intangible Assets of a company into the measuring system of the activity results admits making them more efficient, and, therefore, opens the possibility of making executive compensation system more efficient as well.

Even though there does not exist the only one right method for knowledge valuation, nowadays a wide variety of methods are developed. According to the latest surveys only from 6 to 30% of company’s value are obtained from tangible assets. Everything else comes from Intangible Assets. That is why about 50% of all investments of companies are made in the sphere of Intangible Assets: R&D, personnel development, infrastructure, etc. [see Fuller, 2002]. That is why it is more and more important for managers to pay attention to Intangible Assets and be able to evaluate them in order to use them more effectively and obtain core competences for their companies.

1.1 The approaches to intangible assets and intellectual capital definition

There exist various approaches to defining the Intangibles, Intangible Assets and Intellectual Capital. Some authors consider these terms to be synonyms, while the others still separate them from each other. Apart from that, a number of authors do not offer any definition, but only separate the basic components, being a part of the concepts referred above. Without claiming the completeness, lets us examine the basic approaches to defining Intangible Assets and Intellectual Capital. At that, we shall firstly give the approaches to the definitions of the concepts, and afterwards consider the composition and structure of Intangible Assets (Intellectual Capital).

According to the opinion of B. Lev, to which the authors of this paper subscribe, the terms Intangible Assets, Knowledge Assets and Intellectual Capital are interchangeable owing to the fact that all three terms are “widely used: Intangible Assets in accounting literature, Knowledge Assets – by economists, Intellectual Capital – in management and law literature; and on the whole they come to the same: to the future benefits that are not embodied materially” (Lev, 2003).

Hence, Intangible Assets, or Intellectual Capital, are defined by B. Lev as “non-physical sources of value (claims to future benefits) generated by innovation (discovery), unique organizational designs, or human resource practices”. Intangible Assets, as defined in (Lönnqvist, Mettänen, 2002), are non-material sources of creating a company’s value, based on the employees capabilities, organizations’ resources, the way of operating and relations with the shareholders. In (Lönnqvist, Mettänen, 2002), as in (Lev, 2003), the terms Intellectual Capital and Intangible Assets are suggested for interchangeable usage.

The generic definitions presented above may be somewhat concretized. Thus, (Rechtman, 2001) mentions the following definition given by the Financial Accounting Standards Board (FASB), according to which one can refer to Intangible Assets the assets having no material form that appear as a result of (1) past events that has a (2) measurable effect and that presents a (3) future benefit. The similar definition, but referring to Intangibles is given in (Bouteiller, 2002), where they are defined as assets arising as a result of past events and possess three main attributes: they are non physical in nature, they are capable of producing future economic net benefits, and they are protected legally or through a de facto right.

As shown earlier, along with Intangible Assets concept the term “Intellectual Capital” is used. Various definitions of Intellectual Capital are mentioned in (Klein, Prusack, 1994; Edvinsson, Mallone, 1997; Stewart, 1997; Sullivan, 2000). In (Bouteiller, 2002), the definitions of Intellectual Capital existing in literature are generalized, and the following variant is suggested: “Intellectual Capital – is a developmental knowledge that is human, structural, and customer-based, and needs to be aligned with the corporate strategy and formalized / packaged in some way.” We would like to separately stress, that in (Bouteiller, 2002), as well as in (Lev, 2003), the concepts of Intangible Assets and Intellectual Capital are synonyms. A. Brookings adheres
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to the same position and considers Intellectual Capital as the term given to the combined Intangible Assets which enable the company to function. (Brooking, 1996, p.12).

At the same time, there are quite a number of papers that make a difference between the concepts of Intellectual Capital and Intangible Assets. Thus, in particular, in (Ståhle, Grönroos, 2000, p.192-199), Intellectual Capital concept is divided into potential and realized one, i.e. leading to the increase of Economic Value Added. At the same time, it is accentuated, that Intangible Assets are only a constituent part of the potential Intellectual Capital. In (Starovic, Marr, 2003), a widespread approach is described, under which Intellectual Capital (or Intangibles) is a broader concept than Intangible Assets. In this sense, Intangible Assets are only a part of Intellectual Capital acknowledged as the assets in a company’s bookkeeping and accounting records.

The authors assume that narrowing of the Intangible Assets concept only to the assets acknowledged in accounting is unjustified. Such opinion is a result of confusing two different problems. Firstly, what an asset is in general, and secondly, which assets can be acknowledged in accounting and which can not. In view of the fact that under the asset is basically understood any possible future economic benefit, obtained and controlled by a company, as a result of past transactions and events (Volkov, 2006), then all the elements (tangible or intangible) coming within the above definition appear to be a company’s assets.

It is quite another matter, if these elements match the criteria of recognition in bookkeeping and accounting or not. Thus, according to (IFAC 38), “intangible asset is an identifiable non-financial asset, having no physical form and serving for production usage or for providing the goods or services, for leasing to others or for administrative purposes.” The Russian accounting standards (PBU 14/2000) supplement the enumerated criteria with a range of conditions for “recognition assets by accounting and bookkeeping as intangible”. Consequently, if summarizing the criteria of recognition of Intangible Assets, it appears that any non-financial, non-physical assets that can be divided from other property of the company and having the utility period of (as a rule) more that 12 months may be referred to Intangible Assets.

Thus, the authors’ position may be summarized as follows. Any asset, belonging to a company or controlled by it, having no physical or financial (in case of financial investment) form, but capable of producing future economic benefits is an Intangible Asset. The aggregate of Intangible Assets of a company may also be named Intellectual Capital, or Intangibles. At the same time, two subgroups should be distinguished within Intangible Assets: recognized Intangible Assets and non-recognized Intangible Assets in bookkeeping and accounting (see Figure 1).

Figure 1: The intangible assets concept

2. Evaluation of intangible assets:

2.1 The method of calculated intangible value

The Intangible Assets evaluation problem is immensely complicated and disputable. Apart from the specific character of the evaluated subject (its intangibility), the difficulty of the problem is connected with the fact that in this case the evaluation models do not only give the numerical evaluation, but also in a certain way determine the essence of the evaluated subject. But it is clear that the problem is really important in the
A great number of papers are devoted to the problem of Intangible Assets evaluation. The reviews of various approaches to this kind of assets evaluation are presented in the works by [Luthy, 1998; Sveiby, 2002; Bontis, 2001; Petty, Guthrie, 2000; Andriessen, Tissen, 2004]. Besides, some Russian researchers also develop the above problem in their works [Kozyrev, Makarov, 2003; Bukhvalov 2004a; 2004b; 2004c]. The task of this paper does not include the detailed analysis of all existing approaches; therefore we have chosen only one approach for this purpose.

As a general approach used herein for IA evaluation, we have chosen the method of Calculated Intangible Value (CIV) offered by T. Stewart [Stewart, 1995]. According to CIV, intangible value of a company is determined as a difference between the company’s value (which, in its turn, is determined by the book value of the company’s assets and discounted flow of residual operating income) and the possessed value of its tangible assets (determined by the book value of these assets and discounted flow of residual earnings using the average industrial rate of return). This difference characterizes the company’s capability to use the Intangible Assets in order to “outrun” the competitors in the industry.

The calculation of Intangible Assets value in accordance with the chosen valuation method (CIV) is based on the residual operating income (REOI) model as a variant of fundamental value of equity model. Residual operating income is a net operating income of a company after cost deduction on all company’s capital. In this case investments mean book value of net assets (NA) of a company. Consequently, we take here the value of net operating income for the income, i.e. the value of income before interest but after taxes (or earnings before interest – EBI) and we take the rate of weighed average cost of all capital (WACC) — \( k_w \) for the required return.

The residual income model, the theoretical evidence in this research area, the practical application of the model, the fundamental works and present-day publications on the point are presented in [Volkov, 2006, 2005a, 2005b, 2004a; 2004b; Bukhvalov, Volkov, 2005a, 2005b; Volkov, Berezinets, 2006a, 2006b].

As mentioned above, the basis for valuation in this paper is the REOI model:

\[
V_E^{REOI} = E_0^{BV} + \sum_{j=1}^{\infty} \frac{REOI_j}{(1+k_w)^j} = \left[ NA_0^{BV} + \sum_{j=1}^{\infty} \frac{REOI_j}{(1+k_w)^j} \right] - D_0, \tag{1}
\]

where \( V_E^{REOI} \) — the fundamental value of equity according to the REOI model;

\( E_0^{BV}, NA_0^{BV}, D_0 \) — book value of equity, net assets and debt at the moment (respectively);

\( REOI_j \) — residual operating income in year \( j \). REOI variant is EVA (economic added value);

\( k_w \) — weighted average cost of capital (WACC)

The value in square brackets in the formula (1) is a fundamental value of assets according to the REOI model (\( V_A^{REOI} \)):

\[
V_A^{REOI} = NA_0^{BV} + \sum_{j=1}^{\infty} \frac{REOI_j}{(1+k_w)^j}. \tag{2}
\]

Here, the residual operating income equals the residual earnings after deducting the cost of invested capital:

\[
REOI_j = NOPAT_j - k_w \times NA_{j-1}^{BV}, \tag{3}
\]

where \( NOPAT \) — net operating profit after taxes (also \( EBI \) — earnings before interest), calculated according to the formula:

\[
NOPAT = NI + i \times (1-T), \tag{4}
\]

where \( NI \) — net income

\( i \) — interest

\( T \) — income tax rate according to the income statement
If in expression (2) we presume that \( REOI \) value is constant within infinite research period, \( (REOI = const) \), then model (2) may be presented as:

\[
V_A^{REOI} = \frac{REOI}{k_w} \cdot NA_0^BV + \frac{REOI}{k_w} \cdot NA^BV \cdot k_{w} \cdot k_{w}.
\] (5)

Let us divide the book value of net assets into two constituents: tangible assets \( (NA_T) \) and intangible assets \( (NA_I) \). The upper index \( BV \) means that the assets are taken according to their book value:

\[
NA^BV = NA_T^BV + NA_I^BV.
\] (6)

Let us presume that intangible assets are not reflected in the balance sheet at all, or their part in the book value is small enough to be neglected. Then, expression (6) transforms as follows:

\[
NA^BV = NA_T^BV.
\] (7)

If accepting the presumption (7), model (5) turns into:

\[
V_A^{REOI} = \frac{REOI}{k_w} \cdot NA_T^BV + \frac{REOI}{k_w} \cdot NA_T^BV \cdot k_{w} \cdot k_{w}.
\] (8)

Hence, the \( REOI \) defines the effect obtained by a company from both tangible and intangible assets. The main problem lies in dividing the general effect into constituent factors. In order to solve the problem, we shall set up the following interconnected hypotheses.

**Hypothesis 1.** The companies referring to the same industry are characterized by approximately similar structure of assets. Therefore we may presume, that one monetary unit invested into tangible assets gives the same return throughout all the companies of the industry.

**Hypothesis 2.** The intra-branch differences in return of companies are explained only by exclusive intangible assets of each company.

If to accept the mentioned hypotheses, then:

- the return on tangible assets is the same for all companies and equals the average industry return rate;
- the return on intangible assets is the difference between the actual return of a company and average return in industry. In this sense, the effect of intangible assets on general return rate may be either positive (if a company’s return rate prevails the average industry return rate), or negative (if opposite);
- From the above, we draw two principal conclusions:
  - the fundamental value of a company’s equity may be either positive or zero (if the average industry return is larger than or equals null);
  - the fundamental value of intangible assets may be either positive or negative, if the average industry return is non-negative.

Accepting the above presumptions, we shall distinguish in the REOI model the effects induced by tangible and intangible assets. For that, we shall re-arrange the expression (3) taking into account the presumption (7) as follows:

\[
REOI = NOPAT - k_w \times NA_T^BV \pm RONA_{AVG} \times NA_T^BV \times k_w \times NA_T^BV,
\] (9)

where \( RONA_{AVG} \) — industry average return on net assets.

In the result of the re-arrangement we get:

\[
REOI = NOPAT - RONA_{AVG} \times NA_T^BV \pm [RONA_{AVG} \times NA_T^BV - k_w \times NA_T^BV].
\] (10)

Granting (5), expression (11) may be rewritten as follows:

---

1 This assumption complies with the allowance of linear information dynamics (\( LID \)). \( LID \) is defined as the linear stochastic process, expressing time changes and correlation of accounting and non-accounting variables. \( LID \) gives forecast for future expected residual earnings value, resting on the actual value of accounting variables and other information at present time. Detailed variants of valuation models under various \( LID \) modifications are examined in [Volkov, 2006; Volkov, Berezinets, 2006].
REOI = \left[ N_{AT}^{BV} \times (RONA - RONA_{AVG}) \right] + \left[ N_{AT}^{BV} \times (RONA_{AVG} - k_w) \right]. \quad (11)

The expression in the first square brackets of formula (11) may be interpreted as residual operational income generated by intangible assets \( (REOI_I) \); the expression in the second square brackets – as residual operational income generated by tangible assets \( (REOI_T) \):

\begin{align*}
REOI_I &= N_{AT}^{BV} \times (RONA - RONA_{AVG}), \quad (12) \\
REOI_T &= N_{AT}^{BV} \times (RONA_{AVG} - k_w). \quad (13)
\end{align*}

The fundamental value of assets formula (5) subject to (12) and (13) may be presented as:

\begin{align*}
V_A^{REOI} &= N_{AT}^{BV} + \frac{REOI}{k_w} = \left[ N_{AT}^{BV} + \frac{REOI_I}{k_w} \right] + \left[ \frac{REOI_T}{k_w} \right] = V_T + V_I, \quad (14)
\end{align*}

where fundamental value of a company’s assets can be divided into the fundamental value of tangible assets \( (V_T) \) and intangible assets \( (V_I) \) as follows:

\begin{align*}
V_T^{REOI} &= N_{AT}^{BV} + \frac{REOI_I}{k_w} = N_{AT}^{BV} \times \left( 1 + \frac{RONA_{AVG} - k_w}{k_w} \right) = N_{AT}^{BV} \times \frac{RONA_{AVG}}{k_w}, \quad (15) \\
V_I^{REOI} &= \frac{REOI_T}{k_w} = N_{AT}^{BV} \times \frac{RONA - RONA_{AVG}}{k_w}. \quad (16)
\end{align*}

3. The drafting of the research models

Three models of the regression analysis which characterize the correlation between the market-value of assets and the fundamental value of tangible and intangible assets are analyzed in this research.

The market-value of a company’s assets can be characterized by such subordination:

\[ P_A^M = P_E^M + P_D^M, \quad (17) \]

where

\[ P_A^M, P_E^M, P_D^M \] – the market-value of assets, equity and debt thereafter.

Considering that the market-value of equity is market capitalization (\( Cap \)), and the market-value of dept (\( D \)) is usually assumed as its book value, equation (17) can be rewritten as:

\[ P_A^M = Cap + D. \quad (18) \]

The market-value of assets for the model calculation are appointed as average weighted market capitalization to the content of bids over a period of 2\textsuperscript{nd} quarter, which follows after the accounting year\(^2\), plus book value of dept to the end of the accounting period.

Thereby the single-factor model, where the influence of fundamental value of intangible assets \( (V_I) \), which is appointed by the term (16), upon the market-value of assets of a company is shown, looks like the following:

\[ P_A^M = \beta_0 + \beta_1 \times V_I + \epsilon_1, \quad (19) \]

where

\[ \beta_0, \beta_1 \] - coefficients of the regression equation

\[ \epsilon_1 \] - random error.

The model which allows to evaluate the influence of fundamental value of tangible assets \( (V_I) \), appointed by the term (15), upon the market-value of a company’s assets, looks like the following:

\(^2\) The ground of such method of calculation of market capitalization is represented particularly in [Volkov, 2006b; Volkov, Berezinets, 2006a, 2006b]

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\[ P_A^M = \lambda_0 + \lambda_1 \times V_I + \varepsilon_2, \]  
where \( \lambda_0, \lambda_1 \) - coefficients of the regression equation  
\( \varepsilon_2 \) - random error

The third model is a two-factor one which includes the influence of fundamental value of both tangible and intangible assets upon the market-value of assets of a company:

\[ P_A^M = \mu_0 + \mu_1 \times V_I + \mu_2 \times V_I + \varepsilon_3, \]

where \( \mu_0, \mu_1, \mu_2 \) - coefficients of the regression equation  
\( \varepsilon_3 \) - random error

4. Statistical information

The test of hypothesis was held on the sample of Russian companies-emitters, which sell their stocks within the Russian Trade System (RTS). Financial intermediaries (banks and financial institutes) were not included into the sample in order to adhere to the data uniformity. The final sample includes 43 companies. Firstly, three econometric models were checked on the whole sample of the companies, and then separately on each industry. The companies are divided into 6 aggregated industries: mechanical engineering (includes aircraft industry and automobile manufacturing), extractive industry (includes oil holdings and oil-and-gas companies), engineering, communication services, chemical industry and metallurgy (non-ferrous and ferrous metallurgy).

Information of the publicly available nonconsolidated financial accountancy of the companies from 2001 till 2005, accommodated on their sites, was used for analysis. The general content of the sample was 215 firm-years (43 firms during 5 years). At first, this number of firms was analyzed with the help of the approach introduced by Stewart. But after the correction of the approach, which will be described below, 172 firm-years contented the sample.

Primary information about the market capitalization of the researched companies was got from the site of stock exchange RTS (www.rts.ru). An average weighted market capitalization was used in analysis. Market capitalization represented by RTS was recounted into rubles on the average course, because ruble was elected as a currency for all the accounts. One of the most important problems of this analysis that was mentioned above is a problem of weighted average cost of capital \( k_{W} \). An average RONA for each industry is taken as a value of \( k_{W} \) in this analysis.

General statistical characteristics of the researched sample are represented in Table 1.

<table>
<thead>
<tr>
<th>№</th>
<th>Name of the variables/characteristic</th>
<th>Mean</th>
<th>Mediana</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Market-value of the assets (mlrd.rub.)</td>
<td>81 558</td>
<td>17 862</td>
<td>167 988</td>
</tr>
<tr>
<td>2</td>
<td>Fundamental value of tangible assets (mlrd.rub.)</td>
<td>62 091</td>
<td>19 841</td>
<td>123 426</td>
</tr>
<tr>
<td>3</td>
<td>Fundamental value of intangible assets (mlrd. Rub.)</td>
<td>5 619</td>
<td>– 605</td>
<td>80 202</td>
</tr>
</tbody>
</table>

As it was shown before the method of calculated intangible value (CIV) which was offered by T. Stuart, is used in this research for Intangible Assets valuation. Possibility of the application of this method on the example of Merck company was shown in [Stewart, 1995]. Stewart used an average RONA for 3 years.

Firstly the authors of this paper tried to apply the same method for the research on the Russian market. The models were tested for finding relationship between the average market value of assets of companies and 5-year average fundamental values of tangible and intangible assets. And an average RONA for 5 years was used in order to calculate the fundamental values. But an application of this method showed to be not correct as the size of the sample in the each industry was not big enough.

The authors supposed that in Russian conditions upon the market value of assets in the analyzed year the most influence have fundamental values and respectively RONA of the previous year. By this fact the
relationship between market value of assets of the current year and fundamental values of tangible and intangible assets, based on the parameters of the previous year was analyzed in three introduced models.

5. The results of the research

The 1st stage of the research is an estimation of the regression equation on the whole sample of the analyzed companies-emitters.

The test of the model (19) brings the following results.

The coefficient of determination equals 0.341 and the whole equation and coefficients are significant. Thus with required rate of return being equal 13.44%, the considered equation is:

\[ \hat{P}_{MA} = 45731.8 + 0.5201 \times V_i. \]  (22)

T-test is used for the analysis of significance of explanatory variables (Student criterion), and F-test (Fisher criterion) is used for testing the models for adequacy. Null and alternative hypotheses are stated in the following way:

\[ H_0 : \beta_i = 0, \quad H_1 : \beta_i \neq 0. \]

If null hypothesis is rejected and the alternative hypotheses is accepted, that means that market value of assets depends on the fundamental value of intangible assets. In our case the calculated value of \( t \)-statistics equals 3.84 and with 5% confidence level \( t \)-critical equals 1.974. If \( -t_{crit} < t < t_{crit} \) is not carried out, null hypothesis should be rejected and the alternative hypothesis should be accepted. That means that the market value of assets of Russian companies depends on the fundamental value of intangible assets.

The regression equation (20), the parameters of which are estimated with the help of Least Square Method, is the following:

\[ \hat{P}_{MA} = 4823.391 + 1.1299 \times V_T. \]  (23)

There the coefficient of determination equals 0.8044, that means that the obtained regression equation explains for 80.44% the modification of the market value of assets of a company with the help of the fundamental value of its tangible assets. In our case the calculated value of \( t \)-equals 20.82 and the critical one equals 1.974, that means that null hypothesis should be rejected. Thus we can accept the assumption that in Russian conditions the market value of assets of a company depends on the fundamental value of its tangible assets.

So it can be concluded that in Russian conditions the market value of assets of a company depends on fundamental values of both tangible and intangible assets.

The analysis of two-factor model allows us to make the conclusion, in what degree each of the independent parameters influence the dependent one. As the result of the test following regression equation is obtained:

\[ \hat{P}_{MA} = 8.0923 + 1.0966 \times V_T + 0.2689 \times V_f. \]  (24)

In this case the value of the coefficient of determination and adjusted coefficient of determination have high values (0.8199 and 0.8088 respectively), what says about the tight correlation between the analyzed variables. That means that in Russian conditions the market value of assets of companies for 81.99% depends on the fundamental value of its tangible and intangible assets.

The following hypotheses are formulated in order to test the significance of the explanatory variables, which the model contains:

\[ H_0^1 : \mu_1 = 0, \quad H_1^1 : \mu_1 \neq 0 \]
\[ H_0^2 : \mu_2 = 0, \quad H_1^2 : \mu_2 \neq 0 \]

As the test shows, null hypotheses can be rejected on both explanatory variables and that means that the market value of assets of Russian companies depends on fundamental value of both tangible and intangible assets. The results of the analysis concerning model (21) are represented in Table 2.
The 2nd stage of the research concerns the analysis of models on the sample that is divided into 5 selected industries: mechanical engineering (1), extractive industry (2), engineering (3), communication services (4) and metallurgy (5). Chemical industry was excluded because of the shortage of sample. The results of the analysis of single-factor models (19), (20) and two-factor model (21) are represented in Tables 3–5.

### Table 2: The results of testing two-factor model (21) for the whole sample

<table>
<thead>
<tr>
<th>№</th>
<th>The name of characteristic</th>
<th>Coefficients</th>
<th>m₁</th>
<th>m₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Standard error</td>
<td>0.0529</td>
<td>0.0721</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>t-statistics</td>
<td>20.7</td>
<td>3.73</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>t-critical (5%-confidence level)</td>
<td>1.9741</td>
<td>1.9741</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>The conclusion about null hypothesis according to the results of t-test</td>
<td>To reject</td>
<td>To reject</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Confidence interval (5%- significance level)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>lower bound</td>
<td>0.9919</td>
<td>0.1265</td>
<td></td>
</tr>
<tr>
<td></td>
<td>upper bound</td>
<td>1.2013</td>
<td>0.4113</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>F-statistics</td>
<td>73.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>F-critical (5%- significance level)</td>
<td>3.0491</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>The conclusion about null hypothesis according to the results of F-test</td>
<td>To reject</td>
<td>To reject</td>
<td></td>
</tr>
</tbody>
</table>

### Table 3: The results of testing single-factor model (19)

<table>
<thead>
<tr>
<th>№</th>
<th>The name of characteristic</th>
<th>Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>1</td>
<td>Coefficient of determination R²</td>
<td>0.1156</td>
</tr>
<tr>
<td>2</td>
<td>Standard error</td>
<td>0.2333</td>
</tr>
<tr>
<td>3</td>
<td>t-statistics</td>
<td>0.42</td>
</tr>
<tr>
<td>4</td>
<td>t-critical (5%-significance level)</td>
<td>2,101</td>
</tr>
<tr>
<td>5</td>
<td>The conclusion about null hypothesis according to the results of t-test</td>
<td>To accept</td>
</tr>
</tbody>
</table>

### Table 4: The results of testing single-factor model (20)

<table>
<thead>
<tr>
<th>№</th>
<th>The name of characteristic</th>
<th>Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>1</td>
<td>Coefficient of determination R²</td>
<td>0.2787</td>
</tr>
<tr>
<td>2</td>
<td>Standard error</td>
<td>0.2865</td>
</tr>
<tr>
<td>3</td>
<td>t-statistics</td>
<td>1.9</td>
</tr>
<tr>
<td>4</td>
<td>t-critical (5%-significance level)</td>
<td>2,101</td>
</tr>
<tr>
<td>5</td>
<td>The conclusion about null hypothesis according to the results of t-test</td>
<td>To accept</td>
</tr>
</tbody>
</table>

Dmitry Volkov and Tatiana Garanina
Table 5: The results of testing two-factor model (21)

<table>
<thead>
<tr>
<th>№</th>
<th>The name of characteristic</th>
<th>Industry (1)</th>
<th>Industry (2)</th>
<th>Industry (3)</th>
<th>Industry (4)</th>
<th>Industry (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Coefficients of determination</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>— $R^2$</td>
<td>0.3242</td>
<td>0.7566</td>
<td>0.8425</td>
<td>0.7648</td>
<td>0.8811</td>
</tr>
<tr>
<td></td>
<td>— adjusted $R^2$</td>
<td>0.0829</td>
<td>0.7166</td>
<td>0.8238</td>
<td>0.7256</td>
<td>0.8386</td>
</tr>
<tr>
<td>2</td>
<td>Standard errors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>— coefficient m1</td>
<td>0.3725</td>
<td>0.1176</td>
<td>0.1762</td>
<td>0.1578</td>
<td>0.1602</td>
</tr>
<tr>
<td></td>
<td>— coefficient m2</td>
<td>0.2739</td>
<td>0.2454</td>
<td>0.1146</td>
<td>0.0797</td>
<td>0.2211</td>
</tr>
<tr>
<td>3</td>
<td>t-test (5%-significance level)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>— t-critical</td>
<td>2.109</td>
<td>2.035</td>
<td>2.014</td>
<td>2.034</td>
<td>2.109</td>
</tr>
<tr>
<td></td>
<td>— t- statistics (m1)</td>
<td>2.08</td>
<td>8.97</td>
<td>9.03</td>
<td>6.37</td>
<td>7.66</td>
</tr>
<tr>
<td></td>
<td>— t- statistics (m2)</td>
<td>– 0.97</td>
<td>2.05</td>
<td>2.44</td>
<td>2.08</td>
<td>1.82</td>
</tr>
<tr>
<td>4</td>
<td>The conclusion about null hypothesis according to the results of t-test</td>
<td>To accept</td>
<td>To reject</td>
<td>To reject</td>
<td>To reject</td>
<td>To reject</td>
</tr>
<tr>
<td>5</td>
<td>Confidence interval (5%-significance level)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>— coefficient m1 lower bound</td>
<td>– 0.0245</td>
<td>0.8149</td>
<td>1.2363</td>
<td>0.6837</td>
<td>1.0045</td>
</tr>
<tr>
<td></td>
<td>upper bound</td>
<td>1.5735</td>
<td>1.2954</td>
<td>1.9478</td>
<td>1.3286</td>
<td>1.8312</td>
</tr>
<tr>
<td></td>
<td>— coefficient m2 lower bound</td>
<td>– 0.8538</td>
<td>0.0475</td>
<td>0.2821</td>
<td>0.0032</td>
<td>– 0.1964</td>
</tr>
<tr>
<td></td>
<td>upper bound</td>
<td>0.3215</td>
<td>0.9549</td>
<td>0.1803</td>
<td>0.3289</td>
<td>0.8939</td>
</tr>
<tr>
<td>6</td>
<td>F- test (5%-significance level)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>— F- statistics</td>
<td>1.34</td>
<td>18.65</td>
<td>44.95</td>
<td>19.51</td>
<td>19.07</td>
</tr>
<tr>
<td>7</td>
<td>The conclusion about null hypothesis according to the results of F-test</td>
<td>To accept</td>
<td>To reject</td>
<td>To reject</td>
<td>To reject</td>
<td>To reject</td>
</tr>
</tbody>
</table>

While testing the model (19) the following facts were found out: the relationship between the market value of assets of companies and the fundamental value of intangible assets was better explained in such industries as engineering and communication services where coefficients of determination equal 0.5368 and 0.4464 respectively. A little bit lower the level of correlation between the analyzed variables is in metallurgy, where the coefficient of determination equals 0.3821. Only in these industries null hypothesis is rejected. In all the other industries null hypothesis can not be rejected as the result of the analysis.

The test of model (20) revealed the following fact: the relationship between the market value of assets of companies and the fundamental value of tangible assets was better explained in such industries as metallurgy and engineering. Coefficients of determination for both industries are more than 0.84. Despite of the fact that the value of $R^2$ in the other industries is a little bit lower, in all the industries, except mechanical engineering, null hypothesis is rejected and the alternative hypothesis is accepted.

And after testing the two-factor model (21) in all the industries, except mechanical engineering, a very close relationship between the analyzed variables was found. Coefficient of determination in all the cases is more than 0.756. Null hypothesis is rejected in all the industries, that means that the market value of assets depends on the fundamental value of tangible and intangible assets in all the researched branches.

We can make a conclusion that on the Russian market the influence of fundamental value of tangible assets on the market value of assets of a company surpasses the influence of fundamental value of intangible assets upon the same parameter.

6. Conclusion

Intangible Assets are a company’s “weightless wealth” that helps it to obtain real profit. Every company should understand that nowadays paying much attention to Knowledge Management in general and to
Intangible Assets especially may help to create and develop its core competences and thus yield competitive advantage on the market.

Using the balance-sheet methodology, firm value can be viewed as the sum of values of tangible and intangible assets. More precisely, valuation of a company’s tangible assets to access the fair market value needs to be adjusted by the value of intangible assets. These idiosyncratic assets are now of greater importance than those already in place in terms of a company’s value creation. Due to the strategic relevance of intangible assets management for a company’s competitiveness, understanding the way these assets are converted into value is vital. In particular this understanding should help managers to be able to make better informed decisions with regard to intangible assets allocation and their management.

The tested econometric models show that unfortunately Russian companies still do not consider Intangible Assets as the key factor for success. In all industries it is still more profitable to invest in tangible assets than in intangible ones. One of the main conclusions that can be made is that in Russian economy tangible assets still play a more important role. The econometric results obtained with the significant coefficients confirm the fact that the developed models can be used for defining relationship between market value of assets and fundamental value of both tangible and intangible assets in practice.

It was really interesting to make the first step in Intangible Assets valuation on the Russian market with the help of Calculated Intangible Value method presented by Stewart. The further research in this field will develop not only the direction of testing the researched models for sustainability as statistical information accumulated, but also the direction of developing and testing other models of Intangible Assets valuation in Russian companies. Moreover, the problem of extracting separate elements of Intangible Assets from their aggregate value needs to be solved.

7. References


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