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

Alexeis Garcia-Perez and Amit Mitra
Department of Information Systems, Cranfield University, UK
a.garcia-perez@cranfield.ac.uk
a.mitra@cranfield.ac.uk

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.

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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.

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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.

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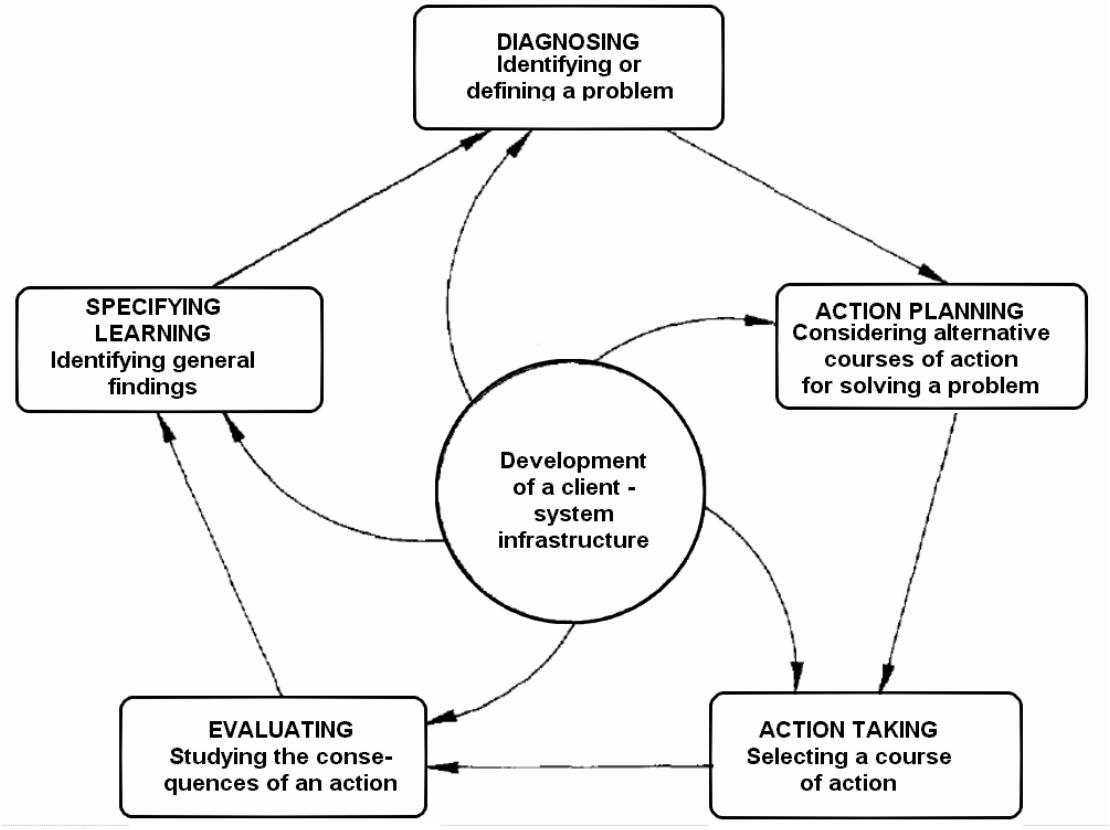

Figure 1: The cyclical process of action research according to Susman and Evered (1978)

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*.

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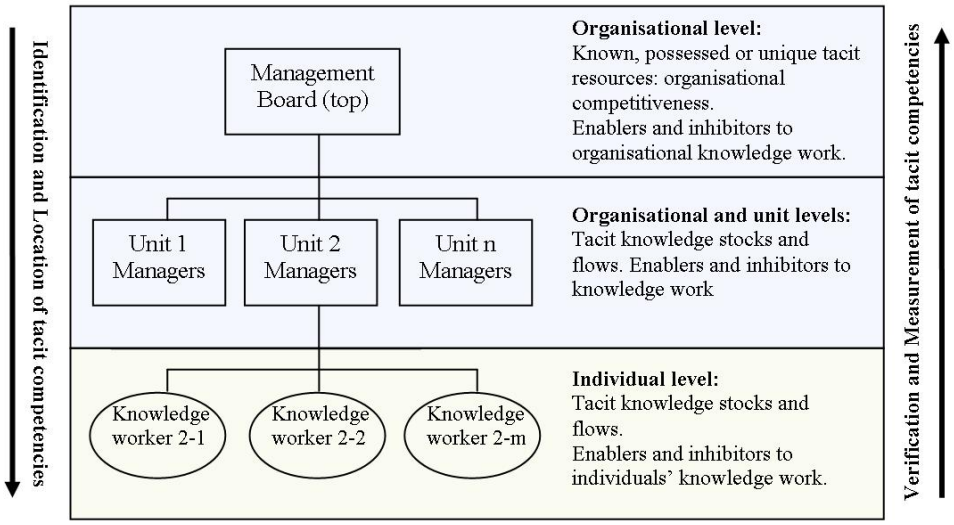

Figure 2: Knowledge discovery and measurement at different levels in the organisational structure

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

Level	Component		
	Human	Knowledge	Systems
Organisation	Management board	Organisational knowledge-based competencies: known, possessed and unique tacit resources	1. KM strategies and systems in place. 2. ICT-based systems: - Systems for data and information storage, processing, protection and retrevial. - Live and asynchronous information and transmission systems 3. Organisational structure and culture (routines, etc.)
Organisational units: departments/ groups / teams	Middle management	Unit competencies: tacit knowledge stocks and flows	
Individual	Knowledge workers	Individuals' tacit knowledge stocks and flows	

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.

<u>Interview with the top management board.</u>
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.

<u>Interview with the middle-level management board.</u>
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.

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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.

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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.) and

   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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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.

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