Knowledge Creation and Sharing in a Project Team: An Organizational Analysis Based on the Concept of Organizational Relation

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Abstract: In today's competitive arena, knowledge and intellectual assets management seems to be the best answer when looking to gain a competitive edge. Furthermore, traditional approaches to knowledge management based on a "single company perspective" are becoming limited; more frequently the problem is to manage "inter-organizational "collaborations, projects and temporary structures.

It is thus necessary to rethink some organizational topics (organizational structures design, personnel involvement and motivation mechanisms etc.) and to review them by introducing suitable and effective modifications with respect to specific knowledge processes.

This paper takes the "Organizational Relational Approach" into consideration and applies a method for describing and interpreting the interactions among organizational actors- also belonging to different organizations- defined as Organizational Relations (OR): the method analyses these relations according to several distinct dimensions:

- the *goals* of the OR and the level of sharing for the organizational actors;
- the *organizational rules* regulating the behaviour of actors within the OR;
- the technological and organizational *tools* supporting the OR;
- the *cultural background* associated to the OR.

Only when all four dimensions are highly developed is it possible to qualify the existing organizational relations as "rich "or, in this context, as "knowledge intensive" relations.

The paper applies the Organizational Relations method of analysis to a successful case study of knowledge transfer from the aerospace field to the health care field. We examined the joint research project carried out by the ASI,-Italian Space Agency- Ferrari DTM and two Italian Orthopaedics Departments. This project has led to the industrial production of an innovative external bone-setting device.

This analysis explains the key factors for success and the effectiveness of the managerial decisions that were adopted.

Empirical findings derived from the case study analysis on one hand and results obtained from the application of the Organizational Relational Method on the other have been found to be convergent and this constitutes a good validation of the method used.

Keywords: Organizational Relation, Knowledge creation and sharing, Inter-organizational project team management, case study

1. Introduction

In the present competitive arena, knowledge and intellectual asset management seem to be the key to success.

Many authors think that this competitive advantage depends on the ability to create new knowledge, to disseminate it throughout the organization and to embody it in products, services and systems (Alvesson 1995, Drucker 1988, Nonaka and Takeuchi 1995, Prusak 1997). Many executives also believe that organizational knowledge creation should be an essential part of any business strategy.

Therefore, there is wide consensus on the strategic importance of organizational knowledge creation.

Moreover, many stress the fact that new organizational models call for innovative techniques to manage knowledge, while the traditional approaches based on a "single company perspective" are

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becoming less relevant. More frequently the problem is to manage inter-organizational collaborations, projects and temporary structures.

Thus, increasing interest is emerging on the topic of knowledge creation in multidisciplinary and inter-organizational project teams (Fong 2003, Love et al. 2005).

Several researchers have described the new product development processes (Fong 2005, Holland 2000). New product development often involves cross-functional linkages, where the participants in a team have differing viewpoints. Such teams are often characterized by their synergy as well as by the risk involved with their interaction with other team members (Migliarese and Ferioli 1996).

Other authors study team-working management in depth (Salas 2000, Sapsed et al. 2002) and suggest that the interaction in a team brings out the need to organize, integrate, filter, condense and annotate the collaborative data and other relevant information that these team members contribute.

Sapsed et al (2002) in a recent review noted that the Organizational Behaviour textbook theory of team-working tends to overemphasize the interpersonal dynamics or the 'strong 'groupness' factor in team-working. Recent literature and empirical work, on the contrary, suggests that commitment to task appears to be a more powerful predictor of performance, rather than cohesiveness.

So, the team-working and knowledge management fields are increasingly converging, but a certain disillusionment is emerging with knowledge management approaches that are seen as excessively 'hard', 'objectified' or 'information technology dominated' (Blackler 1995, Cook and Brown 1999, McDermott 1999, Tsoukas 1998).

On the other hand, also in the team-working literatures and praxis, often more attention is paid to some technical aspect (ICT instruments supporting cooperative work, project management activities, etc…).

In this paper we argue that success in knowledge intensive activities strictly depends on the organizational aspects (more than on the technical ones).

The open question, nevertheless, is to verify if the traditional organizational solutions, developed for the material production of goods, are still adequate in managing the processes of knowledge creation, sharing, transfer and reuse.

An example in this trend, of taking into account the organizational variables and considering organization as a multidimensional variable, linked to economic, structural, interpersonal, cultural dimensions, has been identified in the 'Organizational Model Approach' (Migliarese and Ferioli 1997; Migliarese and Verteramo 2003) and in the associated method of analysis based on 'Organizational Relations'.

The Organizational Relations method of analysis has been applied in this paper to a successful case study of knowledge transfer from the aerospace field to the health care field. The examined case study regards the joint research project carried out by some different organizations, which has led to the industrial production of an innovative external bone-setting device.

2. The Organizational Relations method of analysis

2.1 The concept of Organizational Relations: Definition and dimensions

According to the "Organizational Relational Approach" (Migliarese and Ferioli 1996, Laise et al. 2005) an Organization can be defined as an ordered set of people, that is:

$$ORG = < A, R > \qquad (1)$$

where:
A = a finite set of organizational actors;
R = a set of Organizational Relations (OR) among elements of A;
R is the texture linking agents of an organization.

Note that, from a logical point of view, the definition (1) is equivalent to that of graph and network. In fact, graph and network consist of a set of nodes (agents) and a

set of arcs (relations) whose elements are ordered pairs of distinct nodes (Rapoport and Horwath, 1969; Ahuja et al., 1993; Wasserman and Faust, 1997).

Different levels of aggregation could be considered in defining the set A of organizational actors: people, organizational units, organizations. At a lower level of aggregation, actors could be considered a single human agent. At a higher level of aggregation, actors could be considered organizational units or offices or even external institutions or enterprises. In any case, the set A element should be an active element, i.e. an active agent with a certain level of autonomy, initiative and awareness; thus any actor is capable of establishing several organizational relations with other actors.

On the other hand, organizational relations among organizational actors are complex interactions deriving from several and different points of view (economic, organizational, social or interpersonal): an analysis based on only one dimension is not sufficient to capture the complexity and the richness of the relations linking the organizational actors.

The concept itself of transaction proposed by O. Williamson (1975), for example, is mainly a mono- dimensional concept, specifically an economicly based concept, related to the exchange involved. On the other hand, the word "relation" refers often only to psycho-sociological or inter-personal relations, and therefore is still a mono-dimensional concept.

The 'Organizational Relational Approach', instead, proposes to analyse the Organizational Relations among the nodes, as a whole: the Organizational relations here play the role of an overall conceptual entity, able to globally characterize the existing relation.

A method for the analysis of the Organizational Relations has been proposed by Migliarese and Ferioli, (1997). This method is derived from the AGIL model (Adaptation, Goal, Integration, Latency), proposed at a societal level, by T. Parsons (1977).

The OR method of analysis has been defined by looking at four dimensions (See fig. 1).

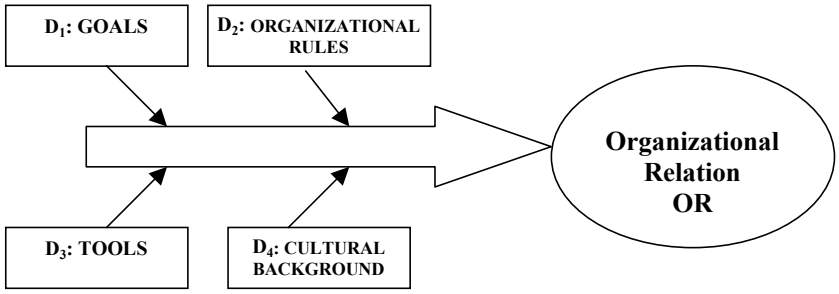

Figure 1: The dimensions of an Organizational Relation

D_1) The first dimension refers to goals. An OR exists when there is a set of agents that share specific goals and purposes.

D_2) The second dimension refers to organizational rules. The nature of the OR depends of the set of rules (formal and informal), principles, standards and regulations that describe how people are required to act.

D_3) The third attribute refers to the tools used to improve coordination, communication and information among agents. In general, the tools indicate the instruments that enable a relation to operate. An OR can be supported by different kinds of tools: technological, economic and organizational.

D_4) The fourth attribute refers to the cultural background of the actors. An OR requires some sort of agreement among actors about values and beliefs, that is about culture. Common assumptions reduce the need for negotiation and information exchange.

For each OR between two organizational nodes, it is possible to analyse the four proposed dimensions.

In accordance with the proposed method of analysis, it is possible to evaluate:

- the degree of shared goals (D_1)
- the degree of definition and effectiveness of organizational rules (D_2)
- the effectiveness of technological, economic, institutional etc. tools, that support the relation (D_3)
- the level of implicit assumptions and common culture background among the nodes (D_4)

The more the analysed OR is characterised by a high level in all four dimensions, the more the analysed OR could be considered a "Rich" Organizational Relations (OR*). Rich Organizational Relations means they are more effective, less ephemeral, more motivating. Moreover, in the context of knowledge transfer characterizing our case study, Rich organizational Relations means also that there are more knowledge intensive organizational relations. In an OR*, the two organizational actors involved are able to select an action that is coherent with the organizational goals and effective from an organizational point of view. Thus, in our case, they are able to create, transfer, and reuse knowledge. As a result, we can say that there is a Knowledge Intensive Organizational Relation (OR*).

In fact, a high degree of agreement and homogeneity among agents regarding strategic goals provides the information needed to design and to manage their own work structures and processes. An incompatibility of goals is probably the greatest cause of conflict and failure in knowledge oriented organizations. In fact it does not encourage collaboration, knowledge sharing and knowledge creation (Dimension of Goals).

Without organizational rules, an OR cannot exist. Besides, a high degree of regulation and self regulation is a further necessary condition for the existence of an OR* (Dimension of Rules).

The existence of an OR* requires sophisticated and specific tools at the technological, institutional and economic level. An example of a technological tool may be an Information Technology System (ITS) (Dimension of Tools).

A high degree of common cultural background makes communication faster; but common cultural background does not mean there is the same type or level of education or the same technical language. Instead, common culture is the groundwork (values and beliefs) on which organizational knowledge is based (Dimension of Cultural Background).

Therefore, in an OR* the actors are strongly linked and oriented to the achievement of the organizational goals. Ambiguous or ill defined situations can be effectively faced: the significance and the richness of the relation, in fact, enables actors to have a proactive orientation and behaviour even without precise and clear directions. However the good will of the actors is not enough without the support of the Organization: availability of tools and the definition of rules are an example of this support. Common cultural background allows to reduce the information exchange and to act under the guidance of common values.

3. A successful case of technological transfer from the aerospace field to health care field

The analysis of the role of the Organizational Relations has been already successful applied. These applications have permitted to foresee some critical points during the implementation of two distinct Knowledge Management Projects within two Research and Education Centres by the University of Calabria, Italy (ICAR-CNR and CIES) (Verteramo et al. 2002; Migliarese and Verteramo 2003, Laise et al. 2005) and in a Health Agency (Migliarese and Ferioli, 1997).

It in this paper an application to a successful case of knowledge creation and transfer from the aerospace to health field is described. The process that led to the design and commercialisation of an external bone-setting device is illustrated. This device is radiolucent, in carbon fibre, with patented techno-polymer spherical joints, and includes telemetry for data transmission on the Internet.
The project represents a successful case of technological transfer carried out by the ASI (Italian Space Agency), Ferrari DTM (Design Technological Material), and the Careggi Hospital (Florence) and Umberto I General Hospital (Rome) Orthopaedics Departments.

In fact, the phase of medical experimentation, developed in the two Orthopaedics Departments, has given positive results. The interest of the orthopaedic doctors, due to the innovative use of material and telemetry, has convinced ASI and DTM to start with the industrial production of this bone-setting device.

This case points out that the processes of knowledge creation and transfer, in a network of different organizations, particularly in an inter-organizational project team, could be analysed through the concept of Organizational Relation and the four proposed dimensions.

3.1 The involved organizations: ASI (Italian Space Agency), Ferrari DTM and two Orthopaedics Departments.

The ASI (Italian Space Agency) has the responsibility to encourage, to manage and to carry out Italian space activities. The ASI has, in fact, the task to set up and accomplish the National Space Plan related to Italian strategic choices in the space context. A new organizational unit has been recently created in order to transfer the technologies and know-how achieved during the performance of space projects in "land" technologies, also with the collaboration of private firms ("Technology Transfer Program").

The Ferrari DTM (Design Technological Material) is a specialised high performance engineering group, born from the Space Division of Ferrari, the well known sports car manufacturer. DTM was launched as an independent company (DTM) in 2002: it originates from the pre-existent Space Division, that for a long time had already done experiments in the aerospace field.

The Orthopaedics Departments of the Careggi Hospital in Florence and of Umberto I General Hospital of Rome represent two advanced structures in the medical-orthopaedics field in Italy.

3.2 The characteristics of the "external bone setting device" in carbon fibre

For institutional reasons, the Italian Space Agency and the Ferrari Space Division have kept up various collaborative relations for several years. But, when in the ASI a specific new organizational unit was in charge of the 'Technology Transfer Program', Ferrari's managers were contacted. The problem was to study if some of Ferrari's technologies could be transferred to other application domains. The medical domain was selected first.

The first idea was to study the application of innovative materials (carbon fibres with distinctive physical and chemical properties) for the production of an adequate "bone-setting device", as physical support for the setting of broken bones. Currently the material used for the production of these supports is aluminium. This solution, however, is not optimal, both because of the weight of the splint and because of a problem of "radio-transparency", that is of fracture visibility using frontal radiograph (X-ray). The project team decided to produce a device in carbon fibres in order to solve these problems.

At the beginning of 2001 the project was financed, with the Ferrari sharing investment at 50%. The project team was composed by three people from the Italian Space Agency (including the 'Technology Transfer Program' manager), some engineers from the Ferrari Space Division, and some doctors from the Orthopaedics Departments (including the two head physicians).

A specific and dedicated agreement among the three organizations was drawn up to regulate roles, economic commitments and property rights.

In 2003 the prototyping phase was concluded and an international patent was released (see Fig. 2).

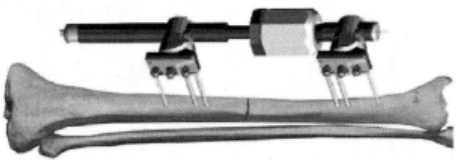

Figure 2: The external bone setting device in carbon fibre

The main goal of the project team was achieved. In fact the characteristics of the designed device are:

- The use of high-performance composite materials and relevant manufacturing technologies, to achieve a lighter, stronger and more reliable product.
- The use of exclusive technologies, tuned by TDM, to create a perfectly radiolucent product.

During the project, other innovative and unforeseen features were developed:

- The use of Telemetry (borrowed from the Ferrari Formula 1 car) to transfer data via radiofrequency. This application allows for the acquisition of data related to the stress level acting on the patient's bone, in real time, directly on the surgeon's PC.
- The data bank can also be sent to a specific Internet site, to allow surgeons and doctors worldwide to take advantage of the experience gained in all hospitals.

The use of telemetry is very efficient for the surgeons (they can continually control convalescence progress) and for the patients (lack of wires and cables allows for maximum freedom). Eventually, the number of X-ray examinations can be reduced.

3.3 The application of the Organizational Relations method of analysis

The described case represents an interesting case of knowledge transfer and creation in an inter-organizational team project. In fact, the project team has reached the scheduled project goals (design of an external bone setting, radiolucent, in carbon fibre). Furthermore, the team was able to develop new ideas during the project, in addition to the specific project goals (the patented techno-polymer spherical joint, the innovative use of the telemetry).

The starting phase of commercialisation, due to the interest of surgeons and doctors, demonstrates the project's success.

The Organizational Relations analysis has been conducted through three sessions of in-depth interviews to the ASI team leader, to one DTM engineer and one Orthopaedic surgeon (see Table 1).

Table 1: Plan of the conducted interviews

Number of interviews	Phase	Timing
1x3	Start of the project	2001
1x3	Release of the patent	2003
1x3	Start of commercialisation	2005

The interviews, concerning the same key-points, were aimed at analysing the organizational relations among the nodes along the four proposed dimensions. The findings of this analysis have been read and confirmed by the informants themselves.

The results can be summarized as follows.

The actors are the three distinct organizations:

- A.S.I. Italian Space Agency
- Ferrari DTM
- Orthopaedic Departments of Florence and of Rome

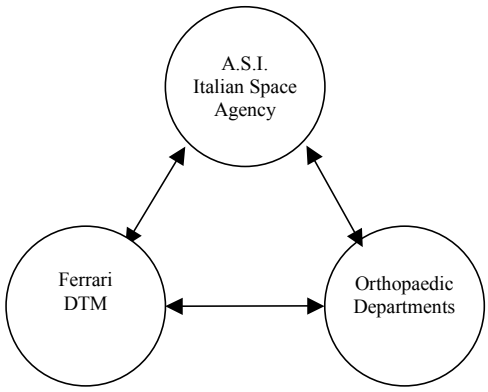

Figure 3: The organizational actors and the OR analysed

Note that, from the analysis point of view, the two Orthopaedic Departments can be considered as a single node because their characteristics and role in the project has been similar.

Applying the proposed methodology to the case study, we obtain the following evaluation of the existing Organizational Relations:

3.3.1 D1) Goals

We can analyse the goals of the involved nodes both at an institutional and at a personal level.

At an institutional level, the recent creation in the ASI of a specific organizational unit for the "Technology Transfer Program" shows a new interest on "land" applications of space technologies. This project has been co-financed (50%) by the ASI (public funds) and DTM (private capital). The co-financing practice in this context is meaningful. Up to now, in the ASI it was common practice to resort completely to public financing: the contribution of private risk capital is an indication of DTM's interest as well.

With regards to the Orthopaedic Departments, the commitment of the top clinicians is evidence of their strong interest: lower use of resources and a higher level of the offered services are, in fact, possible.

Personal motivations have also been crucial.

The project was the first task for the new organizational unit in charge of the "ASI Technology Transfer Program" and its responsible executive: his commitment has been decisive in contrasting the inertia in his organization, which is typical of innovation processes. The good results of this project have promoted the launch of other similar initiatives.

From a psychological point of view, the strong commitment of the DTM Ferrari team can be explained as an homage to the charismatic figure of Enzo Ferrari. Having lost a son because of bone disease, Enzo Ferrari has always encouraged his collaborators to not neglect activities expressing social solidarity.

The chief physicians were the first to study the medical aspects related to this experiment and to its feasible developments (see Cassese et al. 2003)
Thus, there is a high degree of agreement and homogeneity among agents for the goals of the Organizational Relations.

3.3.2 D2) Rules

At the start of the project one of the main problems was the coordination of people who were daily operating in very different organizations.

For this reason, the team leader chose to allow for, initially, a lot of time for informal discussions and brainstorming during project meetings. Time and informality favoured mutual knowledge and a more clear definition of goals. The self-regulation mechanisms and the cooperative style that emerged during the project supported the creative commitment of the involved people (*informal rules*).

At the same time, the agreement among these organizations defined the main features, milestones and activities of the research project (*formal rules*).

The team leader was thus able to propose a creative mix of formal and informal organizational rules in order to support the work of the team project.

Therefore, a high degree of overall coordination characterized the Organizational Relations going on among the nodes.

3.3.3 D3) Tools

The ASI has developed a well-established experience in the joint management of research projects. The choice made to propose to the partners to work within a specifically designed *semiautonomous project team*, can be considered as a specific *organizational tool*. At the same time, the agreement can be seen as an economic and juridical tool. In fact, it provided the team with resources, financial funds, and technical structures for the experiment and gave to the organizational actors a certain degree of autonomy in defining the way of working.

Moreover, several Project Management tools have been employed to schedule the deadlines and to control the work progress of the project.

Obviously also ICT instruments (mail, video-conferences, other web-based technologies) have been widely used because of the distances among the agents.

Thus, these organizational, contractual and technological tools have adequately supported the Organizational Relations, improving coordination, communication and knowledge sharing.

3.3.4 D4) Cultural background

Another difficulty at the beginning of the project were the "linguistic barriers" among engineers and physicians: often, for example, even the units of measurement for the same phenomenon are different. The project leader's choice to allow time for brainstorming and mutual knowledge allowed them to discover common approaches and to emphasize the richness arising from heterogeneity. So, for example, during the activities an unexpected common groundwork emerged. The possibility to build a device helpful for people who are suffering, by applying knowledge developed within space activities to the medical field, became something meaningful for DTM and ASI engineers.

Also, the scientific approach to problem solving, typical of ASI and DTM engineers, became an interesting common point with the doctors, who were interested in improving their services and, for some of them, in developing scientific research in the medical field.

These shared ethical values and scientific interests became the common ground between engineers and doctors, and fostered the creation of shared codes of communication.

Thus, the team leader was able to give the people the possibility to discover their common values rather than their differing ones and, so, to become aware of the high level of their common cultural background.

The analysis through the four proposed axis initially highlighted some weak points along the dimensions of 'organizational rules' and of 'cultural background', but we can say that the managerial decisions (semi-autonomous team project, self-organization, much time for informal discussions) were aimed at improving precisely those two dimensions.

When a high level was reached along all four dimensions, the team members became able to create new ideas and to develop some innovative and unforeseen solutions.

Nevertheless, such good will alone would not have been able to produce the same results: synergy in all four dimensions was useful (shared goals, well-established rules, effective tools, common culture).

Thus, we can say that the Organizational Relations developed in this inter-organizational team project are rich and knowledge intensive. In fact, as the results of our case study analysis and the application of the OR method point out, we can say that:

- from an empirical point of view the project of knowledge transfer obtained very good results (knowledge transfer from the aerospace sector to the orthopaedic one) and that
- the relations among the nodes, evaluated through the OR method, has been "rich and knowledge intensive".

Empirical findings derived from the case study analysis, on one hand and the results obtained from the application of the Organizational Relational Method on the other, are convergent and this constitutes a good validation of the method used.

4. Conclusion and managerial implications

The literature points out that the juxtaposition of several "components" does not necessarily lead to knowledge transfer and/or to knowledge creation.

In the described case study different actors, coming from deeply different cultures and organizations, created a profitable and collaborative project team. This team obtained excellent results, overreaching even the initial research project goals themselves.

This case study has been analysed with a method based on the concept of organizational relation, defined by four different elements: the (shared) goals, the (designed) organizational rules, the (employed) tools, and the existing cultural background.

If the project team members belong to different organizations, then goals, rules, tools and implicit assumptions have to be well defined and monitored. This is a critical point regarding the success of the venture. Instead team project leaders, often, take care of only the technical aspects (for example ICT instruments supporting cooperative work, project management activities, etc).

The presented case study highlights instead that the actions taken by the team leader were aimed at improving the level of all four proposed dimensions. These actions were effective: we can say in this case that the OR were transformed into knowledge intensive ones as a result of these managerial actions.

Moreover, this case study points out that a certain level of autonomy of the actors proved positive: the actors were able to set new goals, to establish by themselves some behavioural or organizational rules and to choose more effective tools. However, only psychological motivations and the good will of the involved people would not have been sufficient without adequate support of the organizational systems and structures with regards to the actors. Organizational rules were established during the project, top-down or bottom-up. These shared rules allowed to focus on the final goal and to avoid confusion and wasting of time and resources. Several tools were used to manage the coordination of meetings and the specific tasks (contracts, project management tools, ICT technology). A common cultural background made the interdependent tasks of the actors easier.

This paper shows that these aspects have to be integrated within an overall examination of existing and future OR. The more the actors are "distant" (different organizations, different functions), the more attention has to be paid to the comprehension and sharing of the goals, to the implicit assumptions, to the expected behaviours, to the new facilitating tools.

A lack of attention to these dimensions can lead to the partial failure of the Knowledge Management project (Migliarese and Verteramo 2003, Laise et al. 2005).

Thus, the Organizational Relations analysis is able to highlight quite a lot key success factors for knowledge intensive activities and for organizational design and intervention. The coherence between the results obtained in this case study through the organizational analysis and the observed empirical situation constitutes a validation of the proposed method of analysis. This method can help project team leaders, and, more generally, management, to design effective organizational actions.

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